K-FERNIE-MORRESSEY R 60(1)A

PROGRESS REPORT

on the

EXAMINATION OF THE HOLDINGS OF

THE CROW'S NEST PASS COAL COMPANY, LTD.

of

Fernie, British Columbia
Canada

Written for

Columbia Iron Mining Company
United States Steel Corporation Subsidiary

By

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April 15, 1961

PREFACE

Because of the fact that the writer was not advised until some weeks after the close of the field season that the responsibility of preparing the current progress report would be his, some data are lacking that otherwise would have been included. Foremost amongst such needed information is more complete current data pertaining to the mining operation at Michel, and more extensive photographic coverage to help the reader visualize the terrain and specific pieces of work that were accomplished.

The very fine earlier reports written by, or for, the Corporation have been drawn upon freely. These reports, by Old, et. al. and the three by Sweeney, have provided much information to the current report and have added greatly to it.

For the combined purposes of convenience and brevity, several abbreviations are used in this text. These are set forth below:

Corporation	=	the United States Steel Corporation
Columbia	=	Columbia Iron Mining Company
Coal Company	=	The Crow's Nest Pass Coal Company, Ltd.
Cropco	=	a word coined from the Coal Company name (by the Raw Materials Division - Pittsburgh) to identify the over-all project of this examination and appraisal. It is used herein not only to this end but also, with a postscript, to break the over-all examination into yearly periods, i.e. Cropco '60, Cropco '61, etc.

A. R. S.

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SUMMARY

Introduction:

In line with a long-term program for the expansion of western United States steel production the Corporation, in 1949, conducted a survey of western Canadian coking coal deposits. This investigation revealed that the Crow's Nest Coal Fields, of eastern British Columbia, contained the largest such reserve in western Canada.

On May 1, 1960 the Corporation entered into an "Investigation and Option Agreement", with the Crow's Nest Pass Coal Co., Ltd. of Fernie, B. C., the fee owners of the largest part of the Crow's Nest Coal Fields. This agreement gives the Corporation the right to enter and examine the extensive Coal Company holdings, over a four year period, and the right to purchase those holdings, or parts thereof, prior to the end of that period.

Physical work on the actual field examination of the Coal Company ground was started on June 1, 1960, and continued, in the drilling phase, up to November 24th, 1960.

The report contained herein is a progress report on the first year of the above cited examination and appraisal.

Location, Accessibility and Climate:

The Crow's Nest Coal Fields are located in southeastern British Columbia adjacent to the B. C.-Alberta line and some 30 to 60 miles north of the international boundary. They are in the heart of the Canadian Rockies, with elevations on the Coal Company property ranging from 3,000 feet to approximately 7,000 feet above sea level. The topography of the area is rugged and the main physiographic feature is the doubly plunging synclinal area that constitutes the Crow's Nest Coal Basin.

The major drainage in the area is the Elk River, which trends along the western side of the Coal Basin. The area is serviced by B. C. Provincial Highway No. 3 and by the Crow's Nest Branch of the Canadian Pacific Railway, both of which follow the Elk River drainage along the western side of the coal basin and then turn to the east to cross the Rockies at Crow's Nest Pass.

Fernie, the largest town in the area, is situated on the Elk River at an elevation of 3,300 feet above sea level and has a population of about 2,300 inhabitants. Precipitation at Fernie, taken over a 39 year period, has averaged 40" per year of which some 13" (10.9') has been in the form of snow. Extreme temperatures recorded during the same 39 year period have been -40° and $+97^{\circ}$, with the probable average daytime temperature during the summer being close to 70° and that in the winter being close to 20°.

The area derives essentially all of its economy from the operations of the Coal Company. At the present time only one mine is in

production, at Michel some 20 miles north of Fernie, the Coal Creek (Fernie area) mines having been closed in 1958. The region is in a state of moderate economic depression.

Property Description and Ownership:

By far the largest part of the Crow's Nest Coal Fields are owned in fee by the Coal Company, this land being acquired between 1889 and 1897 and amounting to some 249,034.15 acres (389 square miles).

Other sizeable tracts within the coal field are held by the Dominion government and the B. C. Provincial government. Utah of the Americas, a subsidiary of Utah Mining and Construction Company, holds a large tract in the upper Elk Valley under option.

Land status is shown on Map No. 6C-403, following page 9 in the main text.

Geologic Setting:

The Crow's Nest Coal Fields are one of three basin areas that form a belt of coal measures some 100 miles long northward from the international boundary. The Crow's Nest area is the central, and the largest, of the three basins and is the only one that has had any appreciable production.

The stratigraphic horizon of prime interest to this study is the Kootenay formation, of Upper Jurassic or Lower Cretaceous age, that contains all of the workable coal seams known within the area. The Kootenay formation consists largely of shales, sandstone and coal. These coal measures vary in thickness from 1,850 to 3,600 feet and contain up to as many as 24 workable (+3 ft.) coal seams. They are underlain by marine shales of the Fernie formation and overlain by conglomerates, sandstones and shales of the Elk and Blairmore formations. Although no workable coal seams are known to occur in the formations overlying the Kootenay coal measures, they are known to contain thin discontinuous seams, and carbonaceous areas, and the possibility of some mineable zones within these younger sediments, over limited areas, should not be entirely discounted.

The Kootenay, along with the underlying Fernie and overlying Elk and Blairmore formations, has been downwarped into a doubly plunging closed synclinal basin that measures some 35 miles in length and 15 miles in width. The coal measures outcrop all the way around the outside rim of this basin and occur, at depth, within the basin. The eastern side of the coal basin has been modified, to a large extent, by thrust faulting. Such structures are known to occur, to a much lesser degree, on the western side of the basin as well. Locally, the lower portion of the coal measures has been deformed by relatively sharp drag folding, such structures dying out rapidly going upward in the sequence. This drag folding in the lower Kootenay has given rise to local areas of thickening within the basal coal seams, resulting in restricted areas where open pitting is feasible.

History, Development and Production:

The date of original discovery of coal within the area is unknown but its existence was known for many years prior to the initial development of the district. The first freehold grants on coal-bearing property were made in 1889 and the present Coal Company holdings were consolidated by 1897.

Coal mining operations have existed on the Coal Company lands at only three places - Morrissey Creek, Coal Creek and Michel. The Morrissey operations were in production from 1902 through 1909 and produced some 486,000 tons; those at Coal Creek were in operation from 1898 through 1958 and produced a total of just over 20 million tons and the Michel area mines, which are still in operation, started in 1899 and have produced a total to date of more than 28 million tons.

Two other operations have existed in the coal fields that did not belong to the Coal Company. These are the Canadian Pacific Railway's "Hosmer Colliery" (1908-1914 @ 860,956 tons), and the Corbin Colliery (1908-1948 @ 4 million tons). In addition, an open pit operation on Coal Company ground that is being mined under lease to Coleman Collieries, has contributed some 586,000 tons to the district production since 1950.

The total production from the district, up to December 31, 1960, has been 54,666,308 tons of which approximately 11.9 million tons have been used for the making of coke. Of this total, 89.7% has been produced by the Coal Company.

While no accurate total figure of open pit production is available, it appears likely that underground operations would account for close to 95% of the district's total production to date. The mines have been developed, almost exclusively, within the major drainages which dissect the edges of of the coal basin. Haulage ways were driven in along the strike of the coal seams, slopes and inclines were then driven along the dip from the haulage and roadways were driven parallel to the haulage. The seams of the district have been mined by pillar-and-stall, modified longwall and caving methods.

Physical Work - Cropco '60:

The entire effort during the 1960 field season was concentrated on that sector of the western side of the coal basin that lies between Coal Creek and Morrissey Creek. This 8 mile long "Morrissey Ridge Sector" was mapped, trenched and partially bulk sampled. On the basis of the geologic mapping and the stratigraphic and coal seam descriptions, a preliminary correlation of coal seams was made, resulting in the naming of 24 separate seams. Twelve adits were driven and 9 four ton bulk samples were taken from Morrissey Ridge seams. One four ton bulk sample was taken from a new mine under development at Michel.

Diamond drilling was started, late in the season, at one site on the backslope of Morrissey Ridge. This hole was taken to a depth of 1,934 feet, which is approximately to the top of the coal measures, and will be bottomed during Cropco '61.

A total of some $27\frac{1}{2}$ miles of roads were constructed, for both general access and for diamond drill access, during the season.

Field personnel averaged 33 men including the supervisory staff.

A total of $192,128.89 was expended on the examination during the 1960 year.

Coal Beds:

The Kootenay formation, which contains all of the commercial coal beds in the area, is variable in thickness and contains a variable number of coal seams. Coals from the uppermost seams, which have constituted the bulk of the past production from the district, are classified as being of medium-volatile rank. They are low in sulphur, and have from moderate to strong coking characteristics. While the ash content from these seams is somewhat variable, they are easily cleaned, by conventional methods, to yield a washed coal with an ash content of less than 8%. The coke produced from these coals is entirely suitable for blast furnace use.

The chemical and physical properties of the coals change going stratigraphically downward in the coal measures. In general, seam widths and ash content increase, and volatile content and coking characteristics decrease, going progressively downward in the sequence. The coals in roughly the lower one-half of the coal measures should probably be in the rank of low-volatile bituminous. However, some of these stratigraphically lower coals appear to be easily cleaned to an acceptable ash content and they may be useable when blended with the upper strongly coking coals. The lower seams are of decided significance, from a potential tonnage point of view, because of their great thicknesses (i.e. plus 40 ft.).

The coals within the district are from hard to soft, from bright to dull and from blocky to fissile. The seams contain visible partings - of shale, bog iron and sandstone--and it is indicated that the quantity of such visible impurities is a characteristic of each given seam over long intervals. This characteristic may be useable in the selection of representative sites for bulk sampling.

Because of the fact that the seams do pinch and swell, and the interval of other materials between the seams may change drastically, all past attempts at district wide correlation of coal seams have been largely unsuccessful. A preliminary correlation of seams along the Morrissey Ridge Sector (Map No. 6L-145), based upon all of the data accumulated during the past field season, does appear to be largely correct but this correlation, over a 6.6 mile (R-1 through R-21) interval, utilized vastly more data than had been available over any similar area in the past. It is the writer's opinion that detailed geologic mapping and trenching, on relatively close spaced intervals, is the only manner by which such correlations within the district will be feasible.

The results of washability test work conducted on the 10 Cropco '60 bulk samples have revealed that, at 1.55 sp. gr. and using the $+\frac{1}{4}$ x 0 fraction, 5 seams result in washed coals of +80% recovery and less than 9% ash (range 4.1 to 8.97%), 2 seams result in washed coals of +80%

recovery and ash between 9 and 10% and three seams give less than 80% recovery at this specific gravity. The washed coals from the best 6 seam samples would combine, in equal proportion of washed coal, to give 82.65% recovery at 7.43% ash, 0.51% S and 21.35% volatile.

Calculations based on the results of washability testwork on the ten Cropco '60 bulk samples is given in Table VII.

Coal Quality Testing Program:

Due to the fact that the results of coking tests are not, as yet, available the entire subject encompassed by this heading will be covered in a supplemental report, by Dr. Vard Johnson, at a later date.

Estimated Reserves:

District Wide:

The previous estimates run for total reserves of the coal fields have varied in the minimum seam thicknesses used as well as in the allowable cover. All such estimates, however, have had the one common conclusion that the potential district reserves are immense.

The most widely accepted district estimate is that of McKay (1946), which used only seams 3 ft. or greater in thickness and a maximum cover of 2,500 feet. McKay's work indicated a reserve, including both coking and non-coking coals, of 8.2 billion tons.

In 1956 Mr. J. F. Sweeney ran estimates of coking coal reserves for the Coal Company lands, using a minimum seam thickness of 3 feet and a maximum cover of 2,500 feet. He estimated that the reserve of mineable coal on the entire holdings was 2.35 billion tons of which 77 million tons were accessible through the present mines or of reasonable access. Reserves of recoverable coal would be 50% of the above figures.

Morrissey Ridge Sector:

Even though little diamond drilling was completed during the 1960 field season, there still exists a sufficient amount of data on the coal seams of the Morrissey Ridge Sector to warrant the running of a "Potential Reserve" estimate. While such an estimate is not microscopically accurate, and will stand some revision after the conclusion of the diamond drilling of the area, it should still, none the less, indicate the order of magnitude of tonnage that can reasonably be expected to exist.

Based upon the Cropco '60 work, and the subsequent correlation of coal seams, we have estimated that the Morrissey Ridge Sector contains a total Potential Reserve of mineable coal as shown below:

Total Tons	Average Total Width	Average Coal Width	Average Waste Width	% Coal	% Waste
511,638,316	20.85 ft.	19.00 ft.	1.85 ft.	91.1	9.1

Of this total tonnage, the 9 Cropco '60 bulk samples were taken from seams representing some 66%, or 335.9 million tons.

The above tonnage figure is based upon seams 3 ft. or greater in thicknesses, cover of less than 2,000 feet and the block that is situated between the Cropco Ridge Numbers 1 through 21. Of the total tonnage, that portion represented by seams of the thickness interval of 3.0 to 5.0 feet is only 2.54%.

Due to the very great strike length of many of these seams, as compared with the down dip projections used, probably something in the order of 80% of the above tonnage could be termed "Indicated" rather than "Potential."

Development and Mining Cost Estimates:

Estimates as to the cost of developing new areas within the basin are deemed as being inappropriate, at this time, due to the early stage of the examination.

On the basis of production, labor costs and efficiency data provided by the Coal Company we have estimated that their present total cost for underground production from the Michel area is $6.49 per ton of cleaned coal, f.o.b. cars at the washery siding. Open pit production in the Michel area is reported by the Coal Company to cost a total of $2.06 per ton f.o.b. trucks.

Quite obviously, a new mine with greater mechanization could reduce the $6.49 per ton cost to some extent.

Mining Geology:

Areas exploited in the past within the coal basin have utilized the major cross drainages where, for the most part, haulage ways could be driven in directly along the strike of the seams.

Access to the elevated areas of coal, such as in the central portion of the Morrissey Ridge block, would have to be made by either rock tunnels driven in from low on the mountain front or by the building of good access roads up the front of the mountain and then sinking incline shafts into the dipping coal measures.

Water has not proven to be a major district problem in the past, largely due to the fact that most of the mines have been developed by haulage adits and the bulk of the mining has been conducted above these adits. In the event of future mining through shafts, the pumping of any water influx would have to be anticipated. The mines in the area may be somewhat more gassy than those in other coal mining areas but the past production from the district would appear to demonstrate that this is not a difficulty which cannot be overcome.

The mines within the area have been subjected to bumps and outbursts within limited areas of specific seams, and occasional sizeable disasters have occurred in the past. This is a definite district hazard.

For the most part, the roof and floor rocks of the seams of the district are shale, although in some instances they are either sandstone or conglomerate. The conglomerate and sandstone roofs are very firm and, on a past experience basis, the shales themselves are normally sufficiently firm and hard to allow for safe mining with only a reasonable amount of dilution.

Past mining experience in the district has demonstrated that the usual economic mining limit is 2,000 feet of vertical cover. Beyond this, the incident of bumps and outbursts is greatly enhanced and the general increase in support necessary makes mining impractical.

Due to the structural shape of the coal basin, most of the seams are dipping from 0 to as much as 30 degrees over much of the Coal Company area. The basal portion of the coal measures is locally very sharply contorted by drag folding but such structures have given rise to thickening of the basal seams and areas of open pit potential. Some faults are encountered underground, and have upon occasion resulted in the abandonment of mines, but this does not appear to be a serious district problem.

Proposed Program - Cropco '61:

The Cropco '61 program has been planned to include: (1) the reconnaissance of the entire Coal Company lands, (2) the evaluation of the Michel (Option B) area, (3) the completion of the diamond drilling program on the Morrissey Ridge Sector and (4) the continuation of the detailed study of the west side of the basin (northward from Coal Creek). It is contemplated that the field personnel will total 49 men, of which 14 will be fully technical, excluding the supervisory staff. The approved budget for the 1961 year of the examination is $376,700.

Due to the fact that no reconnaissance work was done during Cropco '60, our knowledge as to the over-all potential of the Coal Company lands is the same as it was at the beginning of the examination. This condition must be rapidly rectified if the examination and appraisal is to be intelligently, and most advantageously, carried out during the remainder of the option period. Two field parties will work on reconnaissance geology during the entire summer - utilizing four wheel drive vehicles, pack horses and, if necessary, helicopters. This work will include geologic mapping of all Kootenay outcrops, relatively wide-spaced trenching and detailed stratigraphic descriptions, the evaluation of potential of the deep drainage areas within the basin (where cover may be less than 2,000 feet) and the initial appraisal of open pit prospects. Following this work, it should be possible to establish a "potential priority rating" for the various Coal Company tracts, and such a tabulation will serve as guidance during the remainder of the examination.

Because of the manner in which the "Investigation and Option Agreement" is drawn, the Michel area must be the subject of a special examination. It is the writer's opinion that such an examination should be conducted prior to the end of the second year of the option period. It is contemplated that this examination and appraisal will be made by a

three-man team consisting of a Senior Mining Engineer, a Senior Geologist and one assistant. The Senior Mining Engineer will head up the team. He is to be a man well experienced in coal mining practice and is to be provided to the project by the Corporation.

The diamond drilling to be conducted during 1961 will be that which is necessary to complete the evaluation of the Morrissey Ridge block, plus probably some short hole drilling to round out the Michel area appraisal if the budget will permit. The drilling of the Morrissey Ridge block will consist of 3 frontslope and 3 backslope holes, as shown on Map No. 6L-144. The backslope holes will test the upper coal seams while the frontslope holes will collar near the top of the Kootenay and test the middle and lower seams. One of these holes (DDH BC-1) was partially drilled during Cropco '60. The remaining drilling necessary within the block amounts to approximately 13,900 feet.

INTRODUCTION

Purpose and Scope of Investigation

In line with a long-term program for the expansion of western United States steel production, the Corporation has been investigating for several years the availability of steel raw materials within the western part of the North American Continent. A survey of coking coal deposits in Western Canada made by the Corporation in 1949 (Old, Noble, Jones & Martin) indicated that the Crow's Nest Coal Basin, in eastern British Columbia, contained one of the largest potentials for coking coals within that geologic province. These coals have strong coking characteristics, can be washed to give a sufficiently clean final product, and have physical properties making them suitable for blast furnace use. They are classified by rank as medium-volatile bituminous.

The largest part of the Crow's Nest Coal Basin is held by The Crow's Nest Pass Coal Company, Ltd., who own and control some 245,000 acres. This company has produced coal from the basin since 1897, and some coking coal from this area has been used at the Geneva Works, in Provo, Utah, for several years.

Under a date of May 1, 1960, an "Investigation and Option Agreement" was entered into between Columbia Iron Mining Company and the Crow's Nest Pass Coal Company, Ltd.* In essence, this agreement stipulates that Columbia has the right to enter and examine the holdings of the Coal Company over a four-year period, and the option to purchase holdings of that company, under two separate alternatives, prior to the end of that period.

The two alternatives are based on the areas, as shown on the plate following this page, and the physical assets to be purchased. Under Option B, essentially all physical assets of the Coal Company, and the two joining sub-

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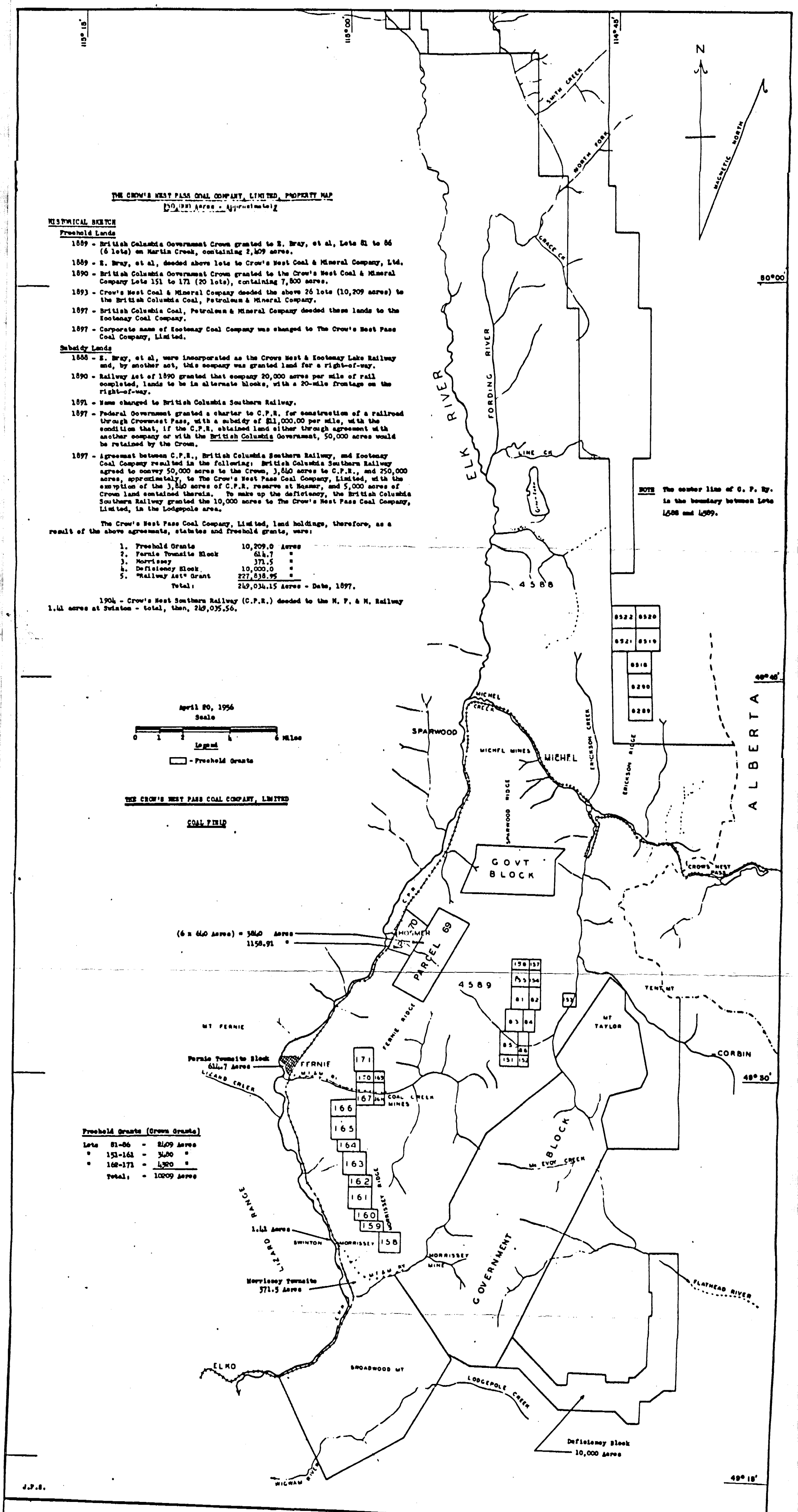
*The Coal Company was joined in this agreement by two wholly-owned subsidiaries: The Crow's Nest Pass Light and Power Co., Ltd., and The Morrissey, Fernie and Michel Railway Company.



THE CROW'S NEST PASS COAL COMPANY, LIMITED, PROPERTY MAP

[10,209] Acres - Approximately

HISTORICAL SKETCH

Freehold Lands

1889 - British Columbia Government Crown granted to E. Bray, et al, Lots 81 to 86 (6 lots) on Martin Creek, containing 2,409 acres.

1889 - E. Bray, et al, deeded above lots to Crow's Nest Coal & Mineral Company, Ltd.

1890 - British Columbia Government Crown granted to the Crow's Nest Coal & Mineral Company Lots 151 to 171 (20 lots), containing 7,800 acres.

1893 - Crow's Nest Coal & Mineral Company deeded the above 26 lots (10,209 acres) to the British Columbia Coal, Petroleum & Mineral Company.

1897 - British Columbia Coal, Petroleum & Mineral Company deeded these lands to the Kootenay Coal Company.

1897 - Corporate name of Kootenay Coal Company was changed to The Crow's Nest Pass Coal Company, Limited.

Subsidy Lands

1888 - E. Bray, et al, were incorporated as the Crows Nest & Kootenay Lake Railway and, by another act, this company was granted land for a right-of-way.

1890 - Railway act of 1890 granted that company 20,000 acres per mile of rail completed, lands to be in alternate blocks, with a 20-mile frontage on the right-of-way.

1891 - Name changed to British Columbia Southern Railway.

1897 - Federal Government granted a charter to C.P.R. for construction of a railroad through Crowsnest Pass, with a subsidy of $11,000.00 per mile, with the condition that, if the C.P.R. obtained land either through agreement with another company or with the British Columbia Government, 50,000 acres would be retained by the Crown.

1897 - Agreement between C.P.R., British Columbia Southern Railway, and Kootenay Coal Company resulted in the following: British Columbia Southern Railway agreed to convey 50,000 acres to the Crown, 3,840 acres to C.P.R., and 250,000 acres, approximately, to The Crow's Nest Pass Coal Company, Limited, with the exception of the 3,840 acres of C.P.R. reserve at Hosmer, and 5,000 acres of Crown land contained therein. To make up the deficiency, the British Columbia Southern Railway granted the 10,000 acres to The Crow's Nest Pass Coal Company, Limited, in the Lodgepole area.

The Crow's Nest Pass Coal Company, Limited, land holdings, therefore, as a result of the above agreements, statutes and freehold grants, were:

1.	Freehold Grants	10,209.0 Acres
2.	Fernie Townsite Block	614.7 "
3.	Morrissey	371.5 "
4.	Deficiency Block	10,000.0 "
5.	"Railway Act" Grant	227,838.95 "
	Total:	249,034.15 Acres - Date, 1897.

1904 - Crow's Nest Southern Railway (C.P.R.) deeded to the N. P. & M. Railway 1.11 acres at Swinton - total, then, 249,035.56.

NOTE: The center line of C. P. Ry. is the boundary between Lots 4588 and 4589.

SCALE IN MILES

2 0 2 4 6 8 10 12 14 16 18

PROPERTY

- CROW'S NEST PASS COAL CO., Ltd.
- DOMINION GOVERNMENT
- PROVINCIAL GOVERNMENT
- CANADIAN PACIFIC RAILROAD

NOTE: Taken from a map furnished by J.F. SWEENEY

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COLUMBIA IRON MINING COMPANY
ASSOCIATE SUBSIDIARY
UNITED STATES STEEL CORPORATION

PROPERTY MAP
CROW'S NEST PASS and South Portion of ELK RIVER COAL FIELDS
BRITISH COLUMBIA-CANADA

FIELD EXPLORATION IRONTON-UTAH

DRAWN	JFS	SCALE	6C-403
TRACED			
CHECKED	WRG		
APPROVED	CAM		
FILED WITH			

sidiaries, would be acquired. Under Option A, variable mining rights on various tracts around Michel, the operating mine at Michel, and some other more minor concessions are excluded, while all coal mining rights both to the north and south of the Michel area would be purchased. Oil and gas rights, as well as timber rights, are reserved to the Coal Company under both options.

In return for these options, Columbia has agreed to expend not less than $500,000 on the examination and metallurgical testing of the coals, and to make this data available to the Coal Company upon written request.

The two options call for purchase prices of $12,000,000 (Option A) and $19,000,000 (Option B), with saving clauses of $2,000,000 applicable to each if Columbia meets all of the obligations as stated in the previous paragraph.

The Crow's Nest Coal Basin is known to contain a vast quantity of coal, but only relatively small tonnages can be termed "blocked out" reserves and little is known of the quality of this coal save for the few uppermost seams which have contributed essentially all of the past production from the district.

The intended purposes of this investigation, to be conducted over that portion of the four-year option that may be necessary, are as tabulated below:

(1) to more thoroughly test the quality of the coals throughout the entire thickness of the coal measures,

(2) to delimit a sufficient minimum tonnage of known quality--by geologic mapping, trenching, bulk sampling and diamond drilling--to justify the purchase prices under each of the separate options, and

(3) to evaluate the economic aspects of obtaining the necessary coal from this area.

Previous Work:

The most recent, and probably most comprehensive, published geologic report on the Crow's Nest Coal Basin is that of Newmarch (1953). In this

report, Newmarch discusses the district as a whole in general terms, and the Fernie area in greater detail. Numerous earlier reports on the district can be found in bibliographies, but most of these are out of print and have proven from difficult to impossible to obtain. For completeness of text, all of the earlier reports on the area are included in the attached list of references, but only the publications of Newmarch (1953), MacKay (1946) and Dowling (1915), were actually available to me at this time. Newmarch draws on these older reports and briefly describes their findings. For the most part, they seem to include only highly-generalized statements relative to the district geology and their absence, as reference material, at least at this stage in the examination, does not appear to be a very serious loss.

Previous investigations made by the Corporation, all of which reports were available to me, are as follows:

Old, K. B., Noble, J. A., Jones, R. H. B., and Martin, J. S. (1949): West Coast Raw Materials Survey, Vol. 6, Coking Coal Resources of Western Canada.

Sweeney, J. F. (1956): Coal Properties, The Crow's Nest Pass Coal Company, Ltd., Fernie, B. C., Canada.

Sweeney, J. F. (1957): Crow's Nest Pass Coal Co., Coal Operations, Briquetting, Coke Production and R.R. Operations.

Sweeney, J. F. (1958): Crow's Nest Pass Coal Company, Ltd., Coal Reserves Contiguous to Existing Mines.

It has been the objective of the writer to attempt to condense most of the highly pertinent data contained in these earlier reports by the Corporation and by others into the present Progress Report, so that it can tend to serve as a single source of reference during the period of the examination.

Present Investigation:

Work on the present investigation actively started in the field on June 1, and terminated, with respect to most of the crew, on October 1, 1960. Some mining was conducted to October 10, road construction continued up to November 5, and diamond drilling was in progress up to November 24. One

geologist, Mr. Brian Murphy, stayed on to supervise the taking of a 4-ton bulk sample from new workings at Michel until December 23.

The direct management of the project was under Dr. James A. Noble from its instigation until a date in early October, with the writer being the assistant project manager under Dr. Noble. Mr. M. D. Okerlund of the Columbia Iron Mining Company--Field Exploration, Provo--was assigned to the project as a staff assistant and advisor to the project chief.

On October 25, 1960, the direct management of the Cropco Project was given over to the writer. It is presently contemplated that this arrangement will continue up until approximately July 1, 1961, at which time the management of the project will be delivered to a staff member of Columbia's Exploration Division.

This report was compiled and written by Arthur R. Still, with the exception of the section on the Coal Quality Testing Program. That section is to be written by Dr. Vard Johnson. The bulk of the finishing work on the maps and plates contained herein was done by the drafting department of the Provo Exploration Office.

Acknowledgments:

As a general rule, acknowledgments are not commonly found in private technical reports written for industry. However, because of the scope of this examination, both past and future, as well as some unusual circumstances present in this case, it is the writer's belief that some formal acknowledgment should be given by him at this stage in the appraisal.

Initially, I would like to express my most sincere appreciation collectively to all of the staff members of the Coal Company for their complete cooperation with me in all phases of the appraisal to this date. Particularly I would like to recognize and express my appreciation to Mr. J. J. Crabb, Coal Company geologist, whose never-failing willingness to help and thorough knowledge

of the geology of the region not only made my job easier, but also many times more pleasant.

A particular note of gratitude is due to Columbia's Field Exploration office in Provo, Utah, and particularly to Mr. J. K. Hayes, Supervisor of that office. I am appreciative here not only for the drafting which was done by that office, but, more importantly, for the complete cooperation that they have extended to me.

Mr. M. D. Okerlund, who has most ably assisted me in many ways, has done an admirable job while working under the adverse conditions of having several bosses all at the same time. I am indebted to him for his thorough cooperation and help.

To the Corporation I am indebted for giving me this opportunity to be of service.

LOCATION, ACCESSIBILITY AND CLIMATE

The Coal Company holdings are located in the Crow's Nest Coal Basin in eastern British Columbia, Canada. The center of the basin is situated at about 49°-30' N. latitude, 114°-50' W. longitude. The area is within the Fort Steele Mining District. An area index map is shown as an inset on Map No. 6L-144.

The topography in the area is very rugged, with elevations ranging from about 3,000 ft. to as high as nearly 10,000 ft. above sea level. The area is located within the Canadian Rockies some 30 to 60 miles north of the international boundary. The dominant land forms are the doubly-plunging, closed, synclinal area known as the Crow's Nest Coal Basin and the extremely rugged ranges of Paleozoic limestones that lie to the east and west of the basin.

Within the area of the basin, the downwarped Late Cretaceous (?) Kootenay formation, containing the coal measures, is capped by the Elk Conglomerate and overlying Blairmore formation of sandstones, conglomerates and shales. The topography of the region is largely controlled by the resistance to erosion offered by these various rock types, with the out-facing western edge of the basin forming very prominent steep-faced ridges due to the conglomerate and sandstone cap rocks. Within the heart of the basin, the topography is somewhat more subdued, consisting of comparatively gently-rolling highlands, but the entire area is dissected by steep-sided valleys and local relief of 3,000 feet or more is not uncommon.

The dominant drainage in the area is the Elk River, which flows southward along the western edge of the basin. It is within this valley and its tributaries that essentially all of the culture in the region is centered. The towns of Elko, Fernie, and Hosmer are all located on the Elk River, with Michel and Natal being located on Michel Creek, a tributary to the major Elk River drainage. The Elk River and Michel Creek drainages form the access to

Crowsnest Pass, the only pass over the Rockies in southeastern British Columbia. Newhouse (1953) states that the physiography of the region has reached a stage of early maturity.

The region derives essentially all of its economy from the operations of the Coal Company, with lumbering bringing in the second-largest revenue. Some minor contributions to the district economy are made by small-scale farming and dairying in the Elk River Valley, and by guide service and packing during the hunting seasons.

Vegetation in the area consists of a variety of conifers, lodgepole pine, Douglas fir, tamarack, spruce and balsam. Poplars are locally abundant, as are, unfortunately, alder thickets. A wide variety of scrub undergrowth flourishes, as does a multitude of wildflowers.

The Fernie and Michel areas are accessible both by modern paved highway and by rail. Provincial Highway No. 3 passes through both towns, giving a connection to Vancouver on the west and the Lethbridge-Calgary areas to the east. Connection to U. S. highways can be made at Kingsgate and Roosville, B. C., or at Carway, Alberta. The area is serviced by the Crow's Nest Pass branch of the Canadian Pacific Railway, with connections to the United States at Kingsgate, B. C., and Eastport, Idaho. Rail distance from Fernie to Vancouver is 712 miles. Railroad coal loading facilities exist now only at Michel.

The nearest airline service to the area is at Cranbrook, some 64 miles to the west of Fernie, where the Canadian Pacific Airline has one flight east and one flight west daily, connecting with flights at Vancouver, B. C., or Calgary, Alberta.

Fernie, the largest town in the area, is situated at an elevation of 3,300 feet, and has a population of about 2,300. Due to the closing of the Elk River Colliery (at Coal Creek), in 1958, an adequate supply of non-technical


OPTION ALTERNATIVES
COAL LANDS OUTLINED RED
OPTION "A" EXCEPTIONS OUTLINED BLUE
ALL COAL EXCEPTED FROM OPTION "A" COLORED PURPLE
A & B COAL SEAMS ONLY EXCEPTED FROM OPTION "A" COLORED ORANGE
STRIP MINE COAL ONLY EXCEPTED FROM OPTION "A" COLORED GREEN
ELK RIVER GAME RESERVE
4588
ELK FOREST
PARCEL 73
5000 AC.
DOM. GOVT. BLOCK
PORTION OF PARCEL 82 APPROX. 12,800 AC.
C.P.R. Block
C. N. P. C. Co.
FERNIE
Sparwood
Natal
Michel
Hosmer
Crowsnest
Morrissey
LOT 4589
DOMINION COAL LANDS DESIRED BY COLUMBIA IRON MINING COMPANY

295 (2)

labor is available in the area. Shopping facilities in Fernie have proven to be entirely adequate for the needs of the investigation to date.

On the basis of climatic data maintained by the Coal Company, total annual precipitation in the Fernie area averages about 40 inches per year, with some 13 inches of this total being in the form of snow (i.e. 131 inches, or 10.9 feet, average snowfall per year over 39 year period of 1914-1953). Extreme temperatures recorded since 1913 are -40° and +97°, with the average daily temperature during the summer being probably close to 70° and during the winter close to 20°. The Michel area is without a weather station, but is reported to have much less precipitation and snowfall even though only some 20 miles distant from Fernie.

PROPERTY DESCRIPTION AND OWNERSHIP

The Crow's Nest Pass Coal Co., Ltd.:

The largest part of the Crow's Nest Pass Coal Field is owned in fee by the Coal Company, the distribution and status of the 249,034.15 acres so owned being as shown on Map No. 6C-403, bound following this page. As shown under the "Historic Sketch" on that map, the ground was acquired during the period of 1889 through 1897 in the form of "Free Hold" and "Railway Act" grants.

A more detailed description of this land and the history of its acquisition is addended as Appendix A.

Other:

The next most sizable tracts of ground within the coal field are held by the Dominion Government, there being two such areas, comprising a total of approximately 55,000 acres. The Corporation is presently negotiating with the Dominion Government for prospecting rights on some 17,800 acres of this ground, as shown in stippling on Plate 1. The areas indicated as being desired by the Corporation are of interest for two reasons: (1) to give continuity to our appraisal and correlation of coal seams on the Coal Company ground which surrounds these Dominion tracts, and (2) for whatever coal they may be proven to contain. To this date, no definite privileges have been granted to the Corporation as a result of their initial inquiries.

A tract of some 3,840 acres (Parcel 69) near Hosmer is owned by the Provincial Government of British Columbia. This is an area that was previously held by the Canadian Pacific Railway, and was the site of their Hosmer coal operation from 1906 to 1914. Upon the termination of active mining, the railway let the parcel revert back to the Province. The Corporation plans to seek prospecting rights from the Provincial Government on this block for purposes of continuity of data.

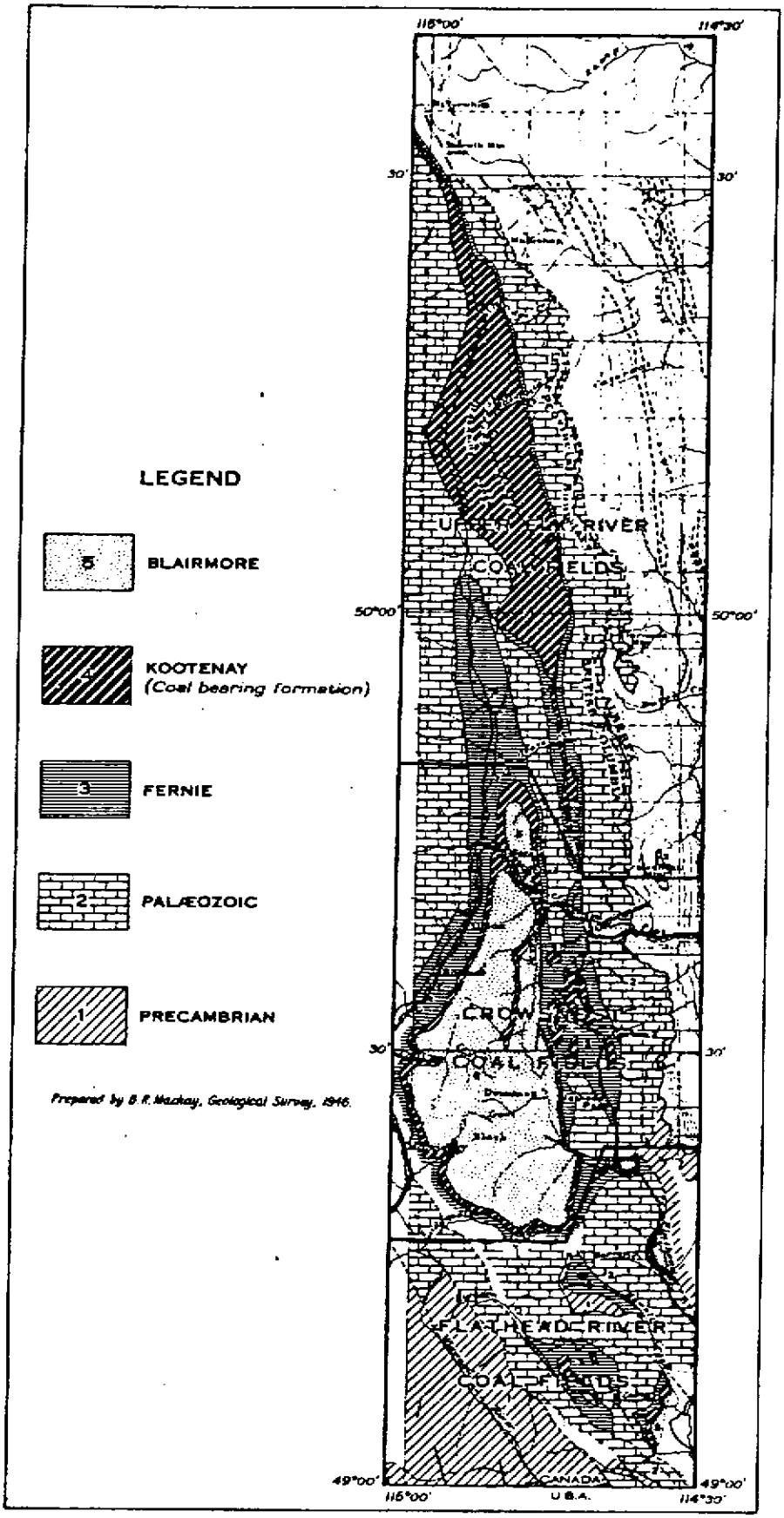
Mineral rights of the "CPR Block" of 1158.19 acres (Parcel 70)

adjoining the Provincial block on the west at Hosmer are held by the Canadian Pacific Railway, but the surface rights are owned by an individual. This tract actually lies outside of the Coal Basin, and covers an area that is underlain entirely by the marine Fernie shale. It is of no interest whatsoever from a coal reserve point of view, but it is of consequence with regard to access to the Hosmer basin and Provincial Block areas. During the past summer, verbal permission was obtained from the surface rights owner to cross this ground in order to do initial reconnaissance in the Hosmer area, and there appears to be no reason to assume that such ingress will be denied in the future.

To the north and east of Michel, a very sizable tract of Freehold Grant land (Lots No. 6756 through 6781 and 6783) is held, to my knowledge, by Utah of the Americas, the Canadian subsidiary of Utah Construction and Mining Company.

Lots Nos. 6999 and 6997, on the east side of the basin, near Corbin, are held by Mr. W. D. Roberts and Mr. A. M. Allen, of Spokane, Washington. Consolidated Mining and Smelting Company of Canada operated an open pit on Lot 6997 up until 1948.

Plate 2



COAL FIELDS OF SOUTHEASTERN BRITISH COLUMBIA

SCALE OF MILES

10 0 10 20 30

GEOLOGIC SETTING

Summary Statement:

Enclosed, as Map No. 6M-321 (following this page), is a copy of the most detailed district-wide geologic map that is available at this time. Indicated on the geologic plan, and enclosed as Maps Nos. 6H-311 and 6H-312, are those geologic sections that have been prepared through the district, or parts of the district, to this date. This basic geologic map was initially compiled by J. J. Crabb, Coal Company geologist. It is based upon the earlier mapping that was available supplemented largely by reconnaissance mapping and aerial photo interpretation by Mr. Crabb in preparation for construction of the excellent district topographic and geologic model that is exhibited in the Coal Company office in Fernie. The geologic plan and sections should be referred to by the reader while going through the following text.

The Crow's Nest Pass Coal Field is one of three basins that form a belt of coal measures some 100 miles long northward from the international boundary (see facing page). The Crow's Nest field, which is the central and largest of the three basins, is the only oneof the three that has had any appreciable production. The holdings of the Coal Company cover the largest part of the Crow's Nest Coal Field, as well as a small part of the Upper Elk River Coal Fields. The coal measures of these three basins occur in a long structural trough that has protected them from removal by erosion. They correlate with, and were once connected to, the Inner Foothills Belt of coal measures in Alberta, the two being separated by faulting during the formation of the Rocky Mountains.

The Crow's Nest Coal Field consists principally of the Crow's Nest Coal Basin, but also includes outliers from the basin at Corbin and Tent Mountain. This basin is essentially a doubly-plunging synclinorium, modified locally by faulting, that has been likened in shape to a canoe or to a pear with the stem

pointed to the north. The coal measures dip inward toward the center of the basin, at varying angles, all the way around the outside rim. Regional scale faulting has greatly disturbed and modified the eastern side of the basin, but such structures are not of significant importance on the other three sides.

The stratigraphic units within the area that are of interest to this study are, from the top down, the Blairmore, Elk, Kootenay and Fernie formations. Of these, the Kootenay formation, which contains the coal measures of the district and all presently known workable coal seams, is obviously of prime importance. The Blairmore and Elk formations are of concern, since they constitute the cover over the coal measures. The Fernie, which is largely marine shale, is of interest only in that it directly underlies the coal measures. These formations vary in age from Jurassic, in the case of the Fernie, through Lower Cretaceous in the case of the Blairmore. They are largely conformable except for the contact between the Elk and Blairmore formations. Recent tills and gravels occur in the stream valleys, and, due to the past existence of a Tertiary lake in the Elk River Valley, lake bed sediments are to be found part way up the side of the ridges on the western edge of the basin.

Brief descriptions of the pertinent Jurassic through Lower Cretaceous sedimentary units are given below. Much more detailed descriptions are to be found in Newmarch (1953).

Stratigraphy

Fernie Formation:

The Fernie formation consists principally of grey to black shales with some interbedded fine-grained sandstones. It was initially dated in 1903 as being of Jurassic age, on the basis of fossils, and this dating has been confirmed by more recent work. It is appreciably thicker on the west side of the basin (3,000 feet) than on the east side (900 feet). It disconformably overlies the Triassic Spray River formation, and is conformably overlain by the Upper

Jurassic or Lower Cretaceous (?) Kootenay formation. The Fernie, which is probably of marine origin, is entirely devoid of coal.

Kootenay Formation:

The Kootenay formation consists principally of grey to black shales, fine to medium-grained sandstones, a few bands of pebble conglomerate, and a varying number of coal seams. All of the mineable coal seams known to this date within the district occur within this formation.

During the course of the Cropco 1960 field work, some 15 stratigraphic columns were measured through the Kootenay formation, this data being bound and enclosed in the folio with this report. As a result of this work, it appears that the Kootenay is in the order of 30% sandstone, siltstone, or conglomerate, and the balance is either coal or shale. Within the limits of the Crow's Nest Coal Field, the formation varies in thickness from a minimum of 1850 feet at Corbin to a maximum of 3,600 feet at Michel. Thicknesses at Coal Creek and Morrissey are 2,050 feet and 2,250 feet, respectively. While Newmarch (1953) states that throughout the entire area the beds within the formation are characteristically lenticular, within the Morrissey Ridge sector (see Map No. 6L-145) several of the sandstone and coal beds were continuous throughout the 8-mile length.

The distribution, number and nature of the coal seams within the formation are discussed under the heading "Coal Beds."

The dating of the Kootenay formation, as based upon plant remains and one very large ammonite, is somewhat inconclusive. Newmarch (1953) includes both the Kootenay and the overlying Elk formation under the heading of "Upper Jurassic or Lower Cretaceous."

Due to the existence of a massive basal sandstone, the general lower limit of the Kootenay is quite distinct. However, since this basal Kootenay sandstone is itself gradational into an underlying sandstone to siltstone

within the Fernie formation, the actual contact between the two formations may or may not be readily discerned locally. Since no coal is known to exist below the basal Kootenay sandstone, the top of this bed was used, in effect, as being the lower limit of that portion of the Kootenay of economic interest, and all stratigraphic sections measured were started at that point.

The contact between the Kootenay and the overlying Elk formation is by no means sharp. As one progresses upward in the Kootenay sequence, the beds become more sandstone and conglomerate at the expense of the shales, until finally the sandstones and conglomerates make up in the order of 80% of the sequence. Newmarch (1953) states that a recognizable contact between the two formations exists at local points within the district, one such point being near Natal, but for convenience within the district the base of the Elk formation is generally considered to be the first massive conglomerate above the highest workable coal seam. This arbitrary designation of the contact is in large measure the basis for the statement that all economic coal seams occur within the Kootenay formation.

Elk formation:

The Elk formation consists of a sequence of cherty conglomerates, gritty sandstones and grey to black shales that lie stratigraphically above the coal measures. The thickness of this formation appears usually to be in inverse proportion to that of the underlying Kootenay. At Coal Creek, the Elk formation is 1,704 feet, at Morrissey 1,310 feet, and at Michel it is only about 100 feet. The predominance of conglomerate and coarse sandstone within the sequence led McEvoy (1902) to apply the name "Elk conglomerate" to the formation.

Due to the nature of the composition of the sequence, the Elk formation usually forms very prominent cliffs. The shale beds within the formation commonly are carbonaceous and locally contain thin discontinuous coal seams, the Coal Creek "C" seam probably falling into this classification. While

no mineable coal is known at this time within the Elk formation, the possibility of such seams should not be entirely disregarded during the drilling and evaluation of the district.

As mentioned above, Newmarch (1953) applies a dating of "Upper Jurassic to Lower Cretaceous" to the Elk formation.

Blairmore Formation:

The Blairmore formation, which derives its name for its type, local of Blairmore, Alberta, consists of conglomerates, light colored sandstones and vari-colored shales (green, maroon, yellow and grey). The most distinctive feature of the Blairmore, as compared with the underlying formations, is the presence of the vari-colored shales. Newmarch (1953) states that the Blairmore has a basal conglomerate, some 40 feet thick, that can usually be distinguished from Elk formation conglomerates of similar character.

The Blairmore achieves a maximum thickness of some 6,500 feet east of Michel. However, it has been partially stripped by erosion over the greater part of the coal basin. Its thickness in the Fernie area is reported by Newmarch to be approximately 1500 feet, although toward the central part of the basin it may well exceed 4,000 feet.

Structure:

The most dominant structural element within the area, for the purposes of this study, is the major closed synclinal coal basin itself. Second in importance to this would be the major thrust faults that occur principally along the eastern edge of the synclinal basin. Of these thrusts, the Lewis Overthrust, which is a major structural feature of the Canadian Rockies, has by far the largest displacement. It is worthy of note that all of the prime structural elements of the region have a nearly north-south trend.

The synclinal basin is in essence a doubly-plunging syncline, the axis of which plunges toward the center at about 7 degrees from the south and

some 11 degrees from the north. On the edges of the basin, to the east and west of the synclinal axis, the coal measures dip inward at angles which normally vary between 20 to 45 degrees. The basin is not, in the strictest sense, a simple doubly-plunging syncline, but rather a series of undulating gentle folds which form a synclinal area in overall aspect. For this reason, it could probably be termed a synclinorium, although it has only rarely been so designated in the published reports on the area. In the sense of folding, the area is by no means as simple as the generalized geology of Map No. 6M-321 would lead one to believe. In addition to the major structures shown on that plate, a great deal of smaller scale drag folding has occurred, particularly within the lower portion of the Kootenay formation. This is illustrated by the work done by Newmarch around Coal Creek, and the mapping conducted by Cropco 1960 in the Morrissey Ridge sector (Map No. 6M-323). From an economic geology point of view, however, this local drag folding of the lower Kootenay is probably a fortunate circumstance, since it is only in areas where thickening of coal seams has occurred, due to such folding, that open pitting operations can be conducted.

The thrust faults on the eastern edge of the basin are, for the most part, high angle and westerly dipping. They have locally greatly deformed and tilted the coal measures up to relatively steep angles. To determine the effect of this faulting on the coal measures locally, with respect to mineability, is one of the objectives of the reconnaissance geologic mapping that is to be conducted during Cropco '61.

Thrust faults, of a smaller scale, are known to occur also along the western edge of the basin. Newmarch (1953) describes two such structures, one in Coal Creek and one underlying the cap on Castle Mountain, and the geologic mapping along the Morrissey Ridge front conducted during the past summer has revealed several others, principally within the first two miles north of Morrissey

Creek. These structures, for the most part, cross the bedding at moderate angles and presumably pass into bedding plane faults within a relatively short distance.

Normal faults, of small displacement, are known in the mine workings at both Michel and Coal Creek, and are occasionally mappable features on the surface.

HISTORY, DEVELOPMENT AND PRODUCTION

General Statements:

There appears to be no written record of who first discovered the coal in the Crow's Nest Coal Basin, but as stated in Newmarch (1953) "The existence of coal deposits in East Kootenay has been known since the first Europeans saw the region."

The initial lots of ground now controlled by the Coal Company were granted in 1889, and the initial production from the district was made by the Coal Company in 1897. Underground mining operations existed in Coal Creek (Coal Creek Colliery and Elk River Colliery) from 1897 until 1958. The Michel Colliery was opened in 1899 and is the only Coal Company operation still working in the district. The mines in Morrissey Creek (8 in all) ran from 1902 through 1909 under the name of the Carbonado Colliery, although owned entirely by the Coal Company. Outlines of the areas of Coal Creek and Morrissey mine workings are shown on Maps Nos. 6C-405 and 6L-144.

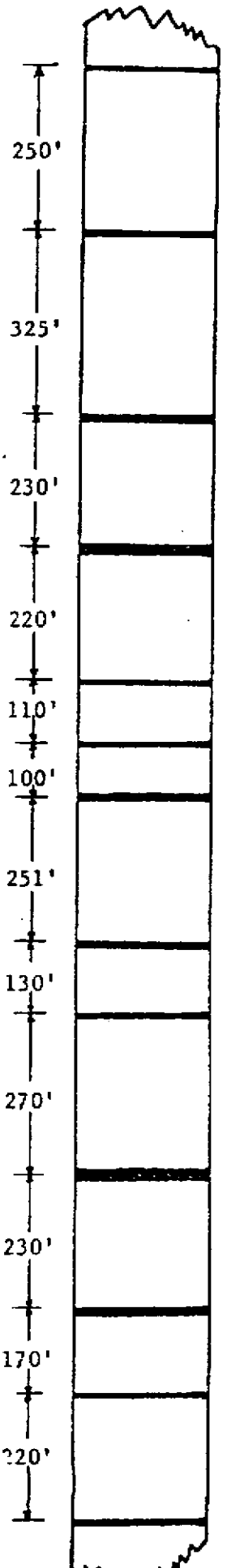
Two operations have existed in the Crow's Nest Coal Basin on lands that did not belong to the Coal Company. These are the CPR mine at Hosmer that produced from 1908 through 1914, and the Corbin property that operated intermittently between 1908 and 1948.

An additional operation at Tent Mountain, on the B. C-Alberta boundary, has contributed some production to the district. This area is not, strictly speaking, within the coal basin, although it is within the Crow's Nest Coal Field. The bulk of this deposit lies on the Alberta side of the boundary, and it is being exploited as an open pit by Coleman Collieries, Ltd. That portion of the deposit that is situated within British Columbia was leased by the Coal Company to Coleman Collieries, under a date of March 12, 1953, on a sliding scale royalty that averages 35¢ per ton.

Up to December 31, 1960, the district has produced 54,666,308 tons

Plate 3

Coal Creek Mining Area
Generalized Stratigraphic Column of the Coal Seams in the Kootenay Formation



	B Seam	8'	Coal and Shale
250'			
	No. 10 Seam Upper	10'	Coal
325'			
	No. 9 Seam	6'	Coal
230'			
	No. 8 Seam	17'	Coal
220'			
	No. 5 Seam	5'	Coal
110'			
	No. 4 Seam Upper	2'	Coal
100'			
	No. 4 Seam Lower	19'	Coal
251'			
	No. 3 Seam Upper	7.8'	Coal
130'			
	No. 3 Seam Lower	2.5'	Coal
270'			
	No. 2 Seam	33'	Coal
230'			
	No. 1 Seam Upper	10'	Coal
170'			
	No. 1 Seam Lower	10.5'	Coal
220'			
	No. 0 Seam	7.5'	Coal

Seams included in reserve estimate of known coking coal (By Sweeney)

of coal, of which approximately 11,890,000 tons were used for making coke. Of this total, some 89.7%, or 49,061,362 tons, has been produced by the Coal Company. Following this page is a tabulation of the district production.

By far most of this total tonnage (probably 95+%) has come from underground operations. The only open pits in the area are the two small Coal Company strip mines at Michel, the "Big Showing" pit at Corbin and the Coleman Collieries operation at Tent Mountain.

From a past production point of view, the two most important areas in the basin are those at Coal Creek and Michel, which are discussed in more detail below.

Coal Creek:

The geology in the Coal Creek area is relatively simple, as shown on Maps Nos. 6M-321 and 6C-405. In essence, the coal seams are dipping to the east at moderate angles, steep near the outcrop ($35^{\circ}\pm$) and more gently in the area of the Collieries ($10\text{-}15^{\circ}\pm$) and toward the center of the basin.

The mines were developed by driving haulage roads in along the strike of the seams, this direction being roughly at right angles to the Coal Creek drainage. Slopes and inclines were driven along the dip from the haulage and roadways were driven parallel to the haulage. The seams were then mined by pillar-and-stall or modified longwall methods. The old mines to the north of the drainage lines were serviced largely by roadways built to the various portals. The new mines developed as a result of the construction of the Elk River Colliery in 1943 were serviced by a 30° incline hoistway and retarding button conveyor.

A generalized stratigraphic column of the coal seams in the Coal Creek area is bound facing this page, and other data on the Coal Creek seams is bound following this page (from Sweeney 1956, after Newmarch 1953).

The Coal Creek area was initially developed both north and south of

COAL PRODUCED AT COLLIERIES OF THE CROWSNEST COAL BASIN

(Net Tons)

Year	CORBIN COLLIERY		MICHEL COLLIERY			HOSMER COLLIERY			COAL CREEK AND ELK RIVER COLLIERIES (2)			MORRISSEY-CARBONADO COLLIERY			Total Gross Output Tons (1)
	Total Sales Tons	Gross Output Tons	Total Sales Tons	Used forCoke Tons	Gross Output Tons	Total Sales Tons	Used forCoke Tons	Gross Output Tons	Total Sales Tons	Used forCoke Tons	Gross Output Tons	Total Sales Tons	Used forCoke Tons	Gross Output Tons	
1898	-	-	-	-	-	-	-	-	10,454	526	11,148	-	-	-	11,148
1899	-	-	438	-	438	-	-	-	69,819	42,865	114,922	-	-	-	115,498
1900	-	-	3,455	7,483	11,162	-	-	-	109,546	107,912	220,457	-	-	-	231,619
1901	-	-	15,639	36,005	52,763	-	-	-	202,209	166,456	372,114	-	-	-	424,877
1902	-	-	68,314	55,898	127,515	-	-	-	129,864	131,318	267,429	40,961	-	46,292	441,236
1903	-	-	130,997	125,757	263,589	-	-	-	83,931	147,618	241,686	143,427	8,122	155,400	660,675
1904	-	-	85,155	171,350	263,487	-	-	-	160,178	213,455	387,409	76,296	8,223	91,311	742,207
1905	-	-	116,824	217,799	346,646	-	-	-	241,839	211,698	476,552	83,670	15,070	108,566	931,764
1906	-	-	121,546	172,807	306,317	-	-	-	285,433	167,723	478,008	20,476	-	22,378	806,903
1907	-	-	168,804	208,599	398,175	-	-	-	398,669	153,016	585,517	241	-	246	981,938
1908	4,604	4,604	207,899	231,082	461,647	706	813	2,942	285,367	171,786	493,924	25,291	-	26,072	989,189
1909	67,415	68,125	232,753	176,114	437,318	15,040	39,508	67,562	200,129	193,697	452,565	35,243	-	36,181	1,051,729
1910	139,854	142,075	315,633	164,790	512,491	60,590	77,228	177,098	529,628	132,644	697,272	-	-	-	1,528,934
1911	88,964	91,524	72,827	45,139	128,110	12,320	22,025	44,127	167,526	50,051	231,345	-	-	-	495,106
1912	133,507	136,935	146,546	115,316	284,325	103,956	81,291	210,632	492,746	247,927	780,466	-	-	-	1,412,558
1913	78,744	81,523	108,440	113,299	242,171	107,762	110,658	243,531	619,888	261,313	924,207	-	-	-	1,491,532
1914	80,588	83,229	111,377	95,882	225,236	36,195	66,444	114,764	364,654	237,790	646,575	-	-	-	1,069,804
1915	85,968	70,049	146,340	145,939	311,499	-	-	-	294,619	238,771	573,332	-	-	-	954,880
1916	72,018	77,302	76,141	176,216	275,413	-	-	-	569,585	218,014	637,427	-	-	-	988,142
1917	105,494	113,193	35,096	89,718	142,380	-	-	-	195,011	128,068	362,388	-	-	-	817,961
1918	110,049	138,868	85,788	126,539	231,181	-	-	-	276,406	138,125	450,759	-	-	-	820,808
1919	98,577	89,317	101,489	76,080	193,612	-	-	-	291,922	19,943	342,934	-	-	-	625,863
1920	160,073	169,136	161,822	113,847	296,343	-	-	-	444,653	-	485,597	-	-	-	949,076
1921	67,005	76,083	190,200	95,921	311,697	-	-	-	416,338	-	465,146	-	-	-	850,926
1922	59,905	51,545	164,027	68,877	242,668	-	-	-	304,916	-	326,672	-	-	-	620,885
1923	48,890	54,058	187,204	100,536	289,440	-	-	-	443,290	-	485,897	-	-	-	829,395
1924	25,059	31,011	104,591	52,026	165,541	-	-	-	93,819	1,742	109,768	-	-	-	306,340
1925	69,055	77,069	264,462	78,083	360,119	-	-	-	428,792	51,579	519,829	-	-	-	957,017
1926	77,749	132,831	289,975	99,799	407,450	-	-	-	322,148	60,180	409,981	-	-	-	950,262
1927	130,405	145,731	289,771	91,429	399,500	-	-	-	385,394	54,096	471,191	-	-	-	1,016,422
1928	168,356	200,752	317,612	66,780	402,693	-	-	-	443,912	36,940	518,261	-	-	-	1,[illegible]
1929	133,905	188,450	295,060	70,190	383,200	-	-	-	362,681	45,292	421,460	-	-	-	993,110
1930	201,729	239,021	219,274	60,883	297,429	-	-	-	176,725	49,072	255,493	-	-	-	771,943
1931	262,703	288,067	206,948	59,885	277,217	-	-	-	117,312	50,335	175,515	-	-	-	740,797
1932	270,630	314,373	200,626	31,078	240,022	-	-	-	81,790	16,565	104,024	-	-	-	658,421
1933	205,529	243,277	215,889	9,447	231,382	-	-	-	56,748	-	60,339	-	-	-	534,998
1934	229,953	275,287	262,917	53,841	327,070	-	-	-	99,175	-	102,598	-	-	-	702,955
1935	10,840	11,170	300,110	41,639	347,489	-	-	-	93,696	-	97,304	-	-	-	455,963
1936	-	-	349,272	12,916	424,436	-	-	-	99,595	-	102,642	-	-	-	527,078
1937	-	-	288,846	71,838	389,616	-	-	-	116,971	3,912	124,617	-	-	-	514,233
1938	-	-	266,673	86,615	367,732	-	-	-	114,983	-	118,424	-	-	-	486,156
1939	-	-	385,023	87,615	515,613	-	-	-	112,606	-	115,780	-	-	-	629,393
1940	-	-	562,819	99,028	730,862	-	-	-	135,055	-	138,839	-	-	-	869,701
1941	-	-	721,246	140,887	953,389	-	-	-	192,278	-	195,791	-	-	-	1,149,180
1942	-	-	750,245	143,854	972,250	-	-	-	197,177	-	201,189	-	-	-	1,173,439
1943	34,131	39,762	591,251	130,465	772,264	-	-	-	219,854 (2)	-	226,754 (2)	-	-	-	1,038,780
1944	155,468	185,528	544,719	126,623	728,665	-	-	-	311,406	-	340,952	-	-	-	1,255,145
1945	-	-	497,166	100,800	860,494	-	-	-	285,949	-	313,510	-	-	-	974,004
1946	1,294	1,294	462,880	108,122	649,256	-	-	-	280,767	-	315,640	-	-	-	966,190
1947	98,856	98,856	551,162	175,665	848,712	-	-	-	323,341	-	354,349	-	-	-	1,301,917
1948	150,538	150,638	573,077	154,342	844,690	-	-	-	286,812	-	293,857	-	-	-	1,289,185
1949	-	-	533,461	226,792	899,677	-	-	-	309,518	-	338,899	-	-	-	1,238,576
1950	-	-	525,894	213,218	808,696	-	-	-	277,841	-	304,943	-	-	-	1,138,389
1951	-	-	532,552	236,871	851,458	-	-	-	282,355	-	312,860	-	-	-	1,249,501
1952	-	-	543,907	245,528	888,856	-	-	-	272,706	-	305,255	-	-	-	1,197,549
1953	-	-	493,153	230,814	817,076	-	-	-	272,253	-	306,462	-	-	-	1,236,997
1954	-	-	449,366	214,702	757,373	-	-	-	253,905	4,221	281,315	-	-	-	1,169,788
1955	-	-	499,513	229,014	826,623	-	-	-	275,670	1,450	308,720	-	-	-	1,164,438
1956	-	-	535,520	243,047	888,952	-	-	-	257,412	5,548	299,182	-	-	-	1,302,584
1957	-	-	366,894	199,756	647,330	-	-	-	211,850	-	237,162	-	-	-	904,635
1958	-	-	358,338	224,408	644,265	-	-	-	14,922	-	16,235	-	-	-	691,642
1959	-	-	332,948	172,927	569,221	-	-	-	-	-	-	-	-	-	597,540
1960 (3)	-	-	460,515	187,460	672,705	-	-	-	-	-	-	-	-	-	672,705 (4)
	3,603,973	4,068,661	15,122,427	7,700,475	28,316,944	334,569	397,767	860,956	15,133,823	3,761,623	20,257,882	425,605	30,415	486,626	54,656,308

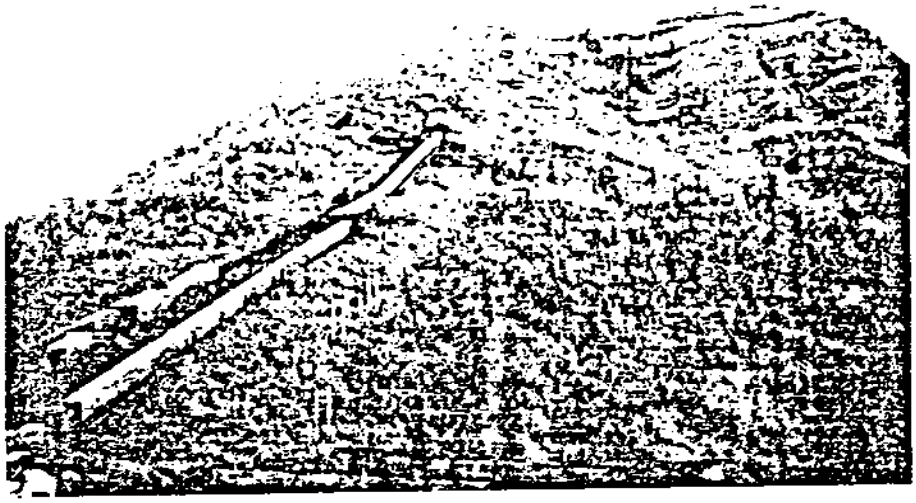
NOTE: Gross output includes material discarded as washery waste, coal used in making coke, and coal burned at colliery.

(1) Total gross output includes: From Erickson Colliery, 138 tons in 1899; from the Coleman Collieries, 24,750 tons in 1950; 85,183 tons in 1951; 5,458 tons in 1952; 113,459 tons in 1953; 131,100 tons in 1954; 31,095 in 1955; 114,450 in 1956; 110,143 in 1957; 31,144 in 1958; 29,319 in 1959; (4) in 1960.

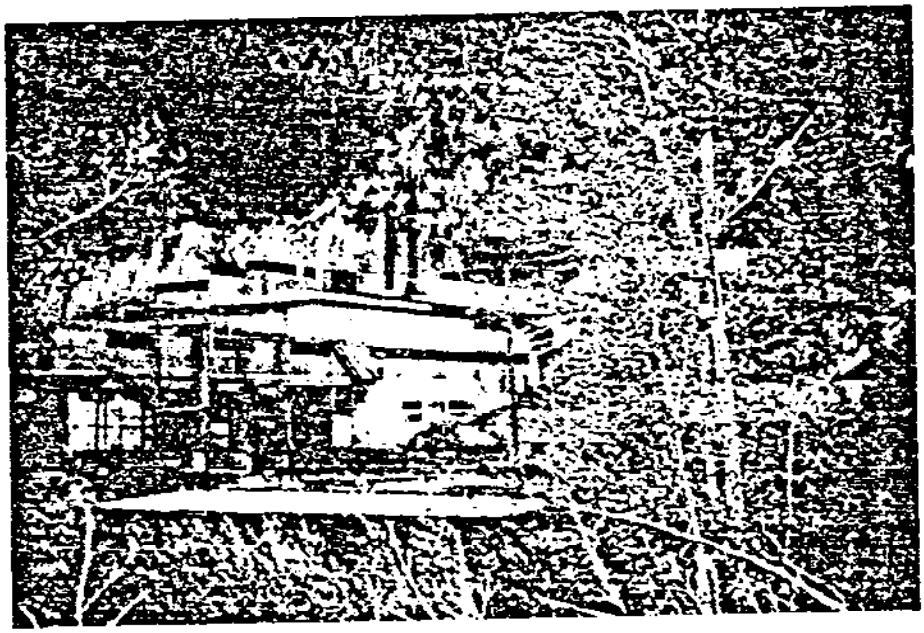
(2) 1943 and subsequent years, production credited is from the Elk River Colliery.

(3) Data direct from Crow's Nest Pass Coal Co., Ltd.

(4) Coleman Collieries, Ltd. 1960 production from B. C. portion of Tent Mtn. strip mine not available at this time.



A. Elk River Colliery, Button Conveyor and Inclined Hoistway. (Closed in 1958)



B. Elk River Colliery - Washery, main building. (Closed in 1958)

the drainage line under the name of the Coal Creek Colliery. During the period of 1897-1942, some 14,276,874 tons of coal were produced from this colliery from the B, No. 10, No. 9, No. 5, and No. 4 seams. In 1943, the Elk River Colliery washing plant and incline were constructed at a cost of $1,500,000. This colliery ran until January 31, 1958, producing some 4,152,501 tons of coal from the No. 3, No. 4, No. 9 and No. 10 seams, the latter two seams accounting for essentially 70% of this production.

Total production from the Coal Creek area, by both mines and seams, is as shown in the table following this page. In addition, Map No. 6C-405, following the table, shows the outline and extent of the workings on various seams for both the Coal Creek and Elk River Collieries.

The closing of the Coal Creek area workings in 1958 is attributable to a declining market for coal, largely brought on by the conversion of CPR locomotives from coal to diesel, rather than to any lack of reserves or difficult mining conditions.

Michel Area:

General Statements:

The Michel Colliery is the only Coal Company facility currently under production in the coal basin. Production from the colliery has been in excess of 28 million tons from 1899 to date.

Because of the fact that no work was done in this area during Cropco '60, save for the taking of one 4-ton bulk sample, the discussion as given herein will be rather brief and based largely on information as given by others (Sweeney, Newmarch). However, the progress report for Cropco '61 should contain a great deal of current data on Michel as that area is to be the subject of a special study during the coming field season.

Geologically, the Michel area is located essentially on the axis of one of the major synclines forming the basin. The Sparwood Ridge sector, which

TABLE A

Net Production from Coal Creek Mines

Mine #	Seam #	Period of Operation	Short Tons Totals	% of Total Prod. by Mines
Coal Creek Colliery (1897-1942)				
North Side (1897-1923)				
B North	B	1913-1923	521,587	2.8
Old No. 1	10	1897-1911	410,124	2.2
No. 1 N	10	1908-1923	965,169	5.2
Old No. 9	9	1904-1913	665,248	3.6
No. 5	5	1904-1915	1,560,844	8.5
Old No. 4	4	1904-1906	7,722	0.1
			4,130,694	
South Side				
No. 1 S	10	1909-1930	1,681,998	9.1
No. 1 E	10	1910-1942+	4,653,519	25.3 (1)
No. 2	9	1904-1932	2,392,508	13.0
Old No. 3	9	1904-1933	1,418,155	7.7
			10,146,180	
Elk River Colliery (1943-1958)				
North Side		None		
South Side				
No. 1 E	10	1942-1958	1,501,057	8.1 (1)
No. 10	10)	1942-1958	1,425,817	7.7
No. 9	9)			
New No. 4	4)	1942-1957	1,225,627	6.7
New No. 3	3)		4,152,501	100.0
			18,429,375	

TABLE B

Net Production from Coal Creek Seams

Seam #	Short Tons	%
B	521,587	2.8
10) 9)	15,113,595 (2)	82.0
5	1,560,844	8.5
4) 3)	1,233,349	6.7
	18,429,375	100.0

(1) No. 1 E - 33.4% total

(2) Of this figure, 60.95% is No. 10 seam, 29.62% is No. 9 seam, and 9.43% could not be separated

TABLE III

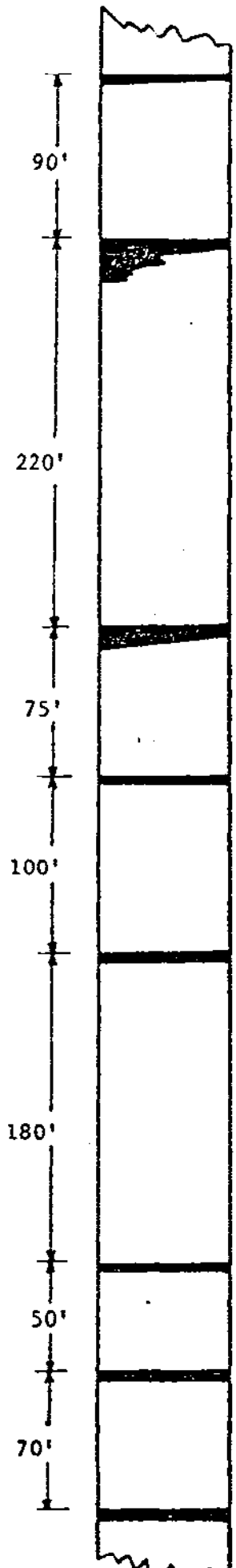
DATA ON COAL SEAMS, COAL CREEK AREA

Mine	Seam No.	Thickness of seam in feet: From	To	Average thickness	Nature of coal (fairly hard)	Nature of roof (fairly good)	Year Opened 1912	Year Closed and Reason for closing 1943, operating difficulties	Outbursts of gases None, low occlusion	Method of mining Pillar-and-stall
Old No. 1	10	6	10	7	Soft	Hard sandy shale	1897-98	1911, worked to a fault	Moderate bumps occasionally, no serious accidents	Pillar-and-stall
No. 1 N	10	10	15	12	Soft, friable	Coaly shale	1908	1923, worked to a fault, and operating difficulties	None	Pillar-and-stall, small areas by longwall
No. 1 S	10	12	20	16	Soft, friable	Fairly strong shale overlain by conglomerate	1908	1930, roads were hard to maintain, marketing difficulties	Very few, several fires	Pillar-and-stall
No. 1 E	10	6	50	20	Friable, top 2 feet was hard	Sandy shale outside, conglomerate inside	1910		Numerous, both	Pillar-and-stall and modified longwall
No. 10	10	6	15	9	Friable, high ash	Soft shale	1945		None	Pillar-and-stall and modified longwall
No. 2	9	5	16	8	Fairly hard	Sandy shale overlain by conglomerate	1897-98	1932, marketing difficulties	Bumps in outer workings	Pillar-and-stall, minor longwall
Old No. 3	9	3	7	5	Fairly hard, high quality	Sandy shale	1900	1905-08, flooded after tipple fire, 1933 marketing difficulties	Numerous bumps along main entry	Pillar-and-stall and longwall
Old No. 9	9	4	9	5	Hard, good quality	Strong shale, a 2-inch clod in roof caused caves	1904	1913, operating difficulties, faults	Very few, no outbursts	Longwall and pillar-and-stall
New No. 9	9	2	14	8	Hard, low ash	Hard sandy shale, conglomerate locally	1942		None	Pillar-and-stall and modified longwall
No. 8	8	5	6	5-1/2	Hard, good quality	Strong shale	1931	1932, marketing difficulties, faults	None	Development
No. 6	6			7	Fairly good	Shale	1906	1907, band of rock in middle of seam	None	Development
No. 5	5	5	16	12	Rather soft	Moderately strong shale, overlain by conglomerate	1904	1915, faults and operating difficulties	None	Pillar-and-stall
Old No. 4	4	12	16	14	Soft, fairly high ash, poor coking	Moderately strong shale	1904	1906, coal did not coke well	None	Development
New No. 4	4	6	13	8	Friable and high ash	Hard shale subject to caves	1942		None	Pillar-and-stall and modified longwall
New No. 3	3		15	11	Friable, clean	Hard shale	1946		Occasional outbursts	Pillar-and-stall
No. 12	1		25		Fairly hard, high ash	Sandy shale	1906	1908, encountered a fault	None	Development
No. 11	0	7	12	10	Hard, low ash	Soft shale overlain by hard, sandy shale	1906	1908, worked to a fault	None	Development

Source - Bulletin No. 33 British Columbia Department of Mines, C. B. Newcomb

Plate 4

Michel Mining Area
Generalized Stratigraphic Column of the
Coal Seams in the Kootenay Formation



B Seam 2 #10 Coal w. 4 to 6' Coal

A Seam 10 to 30' Coal

No. 1 Seam 9 to 12' Coal

No. 2 Seam 7' Coal
Omitted from estimate because of lack of data

No. 3 Seam Upper 10' Coal

No. 3 Seam Lower 7' Coal

No. 4 Seam 10' Coal

No. 5 Seam 9' Coal

Seams included in reserve estimate of known coking coal
(By Sweeney)

comprises the major mining area, is shaped like a canoe, due to this folding, with the coal seams dipping down toward a common line in the center and the trough of the syncline plunging gently to the south.

Facing this page is a generalized stratigraphic section which shows the uppermost coal seams in the Michel area. It should be pointed out here that these seam designations do not correspond with the naming of seams at Coal Creek. At Michel, the sequence of numbering is from top to bottom, while at Coal Creek it is from bottom to top. In addition, the A and B seams at Michel do not correlate with the A and B designations at Coal Creek. It is the opinion of Mr. Jack Crabb that the Michel B seam probably roughly correlates, at least in time, with the No. 10 seam at Coal Creek.

Current Production Rate:

During 1960, the Michel Colliery had a gross production of 672,705 tons of coal, of which 187,460 tons were used for making coke. Of this gross production, 9.7% was derived from the open pit operation. Daily production for the year averaged approximately 3,000 tons per operating day as broken down below by mines:

Mine	Seam	Average tons/day
A East	A	650
A South	A	400
A West	A	1,100
B South	B	350
A North	A	200
No. 10	No. 10	- *
Open Pit	No. 10	300
		3,000

*No. 10 mine under development

Sales for the year amounted to 460,515 tons of coal and 139,041 tons of coke.

Mines:

The colliery consists of 6 underground mines, one new underground prospect and an open pit. The mines are exploiting the "A" and "B" Seams, which

are stratigraphically high in the coal measures, while the open pit and the new underground prospect are both in No. 10 seam, which is the basal seam in this area.

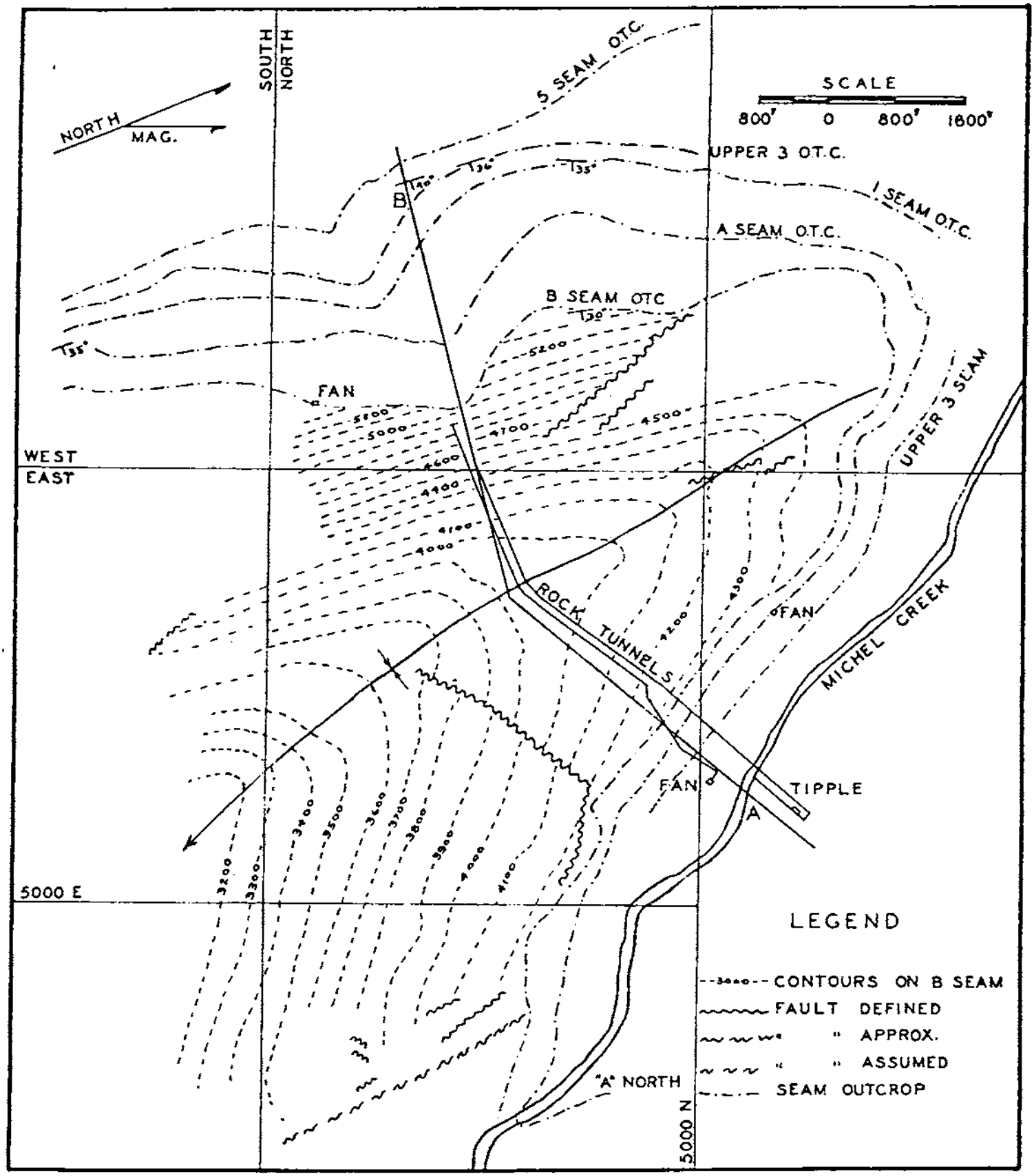
The underground mines are situated both in the north and the south of Michel Creek, although the bulk of the current production is coming from the 4 mines on the south side of the drainage (i.e. A East, A South, A West and B South).

The mines south of the creek are developed by two rock tunnels that are driven into the synclinal structure. As all of the sediments in the area have been folded, the seams vary in dip from 0° to 40°. Mining is conducted, mainly above the level of the rock tunnels, by room and pillar, modified longwall, or caving methods. Figures showing structure contours and outcrop patterns, the outlines of the major workings (as they existed in 1953) and a cross section through the area are bound following this page.

The only underground production currently coming from the north side of Michel Creek is from A North Mine (A seam), although rather extensive mining has been done in the past in this same general area in the stratigraphically lower No. 3 seam (No. 8 Mine). The A North Mine is the newest, and the most modern, mine in the colliery. The portion of A seam being exploited averages about 12 feet in thickness, and dips at an angle of from 15 to 30 degrees. Mining is done by the room and pillar method.

Two miles northwest of Michel, on the south side of the drainage and directly opposite the western edge of Natal, the Coal Company is currently testing the basal coal seam in the area (No. 10) with an underground prospect that is called the No. 10 Mine. This mine was started during the summer of 1960 and was sampled by the Cropco No. 10 Bulk Sample (see Map No. 6B-578 and Table VII). Under a date of February 3, 1961, the Coal Company advised as follows relative to this mine:

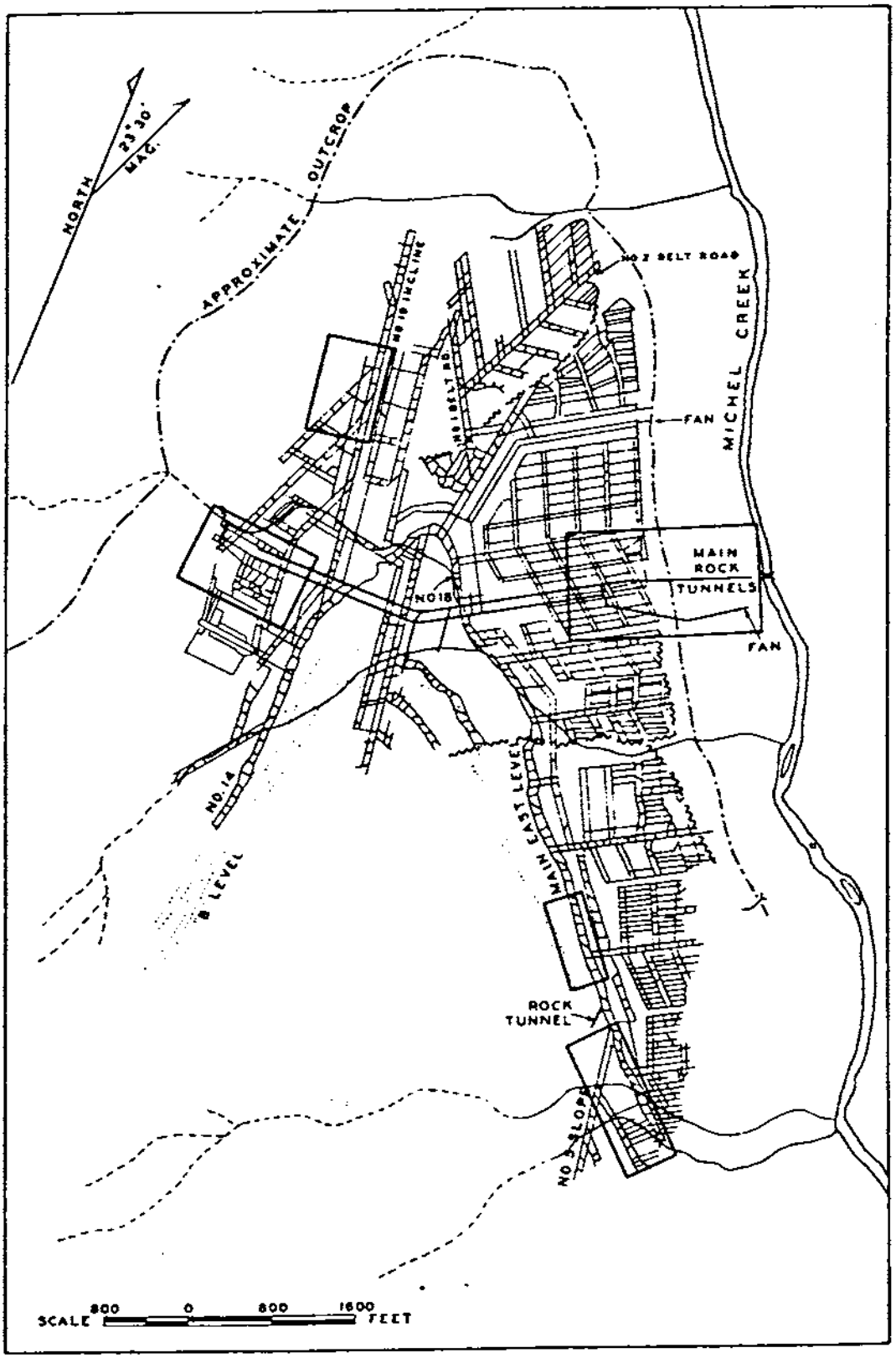
> "At the point where the prospect intersects #10 seam, the seam has a pitch of approximately 28 degrees and a thickness



MICHEL MINING AREA

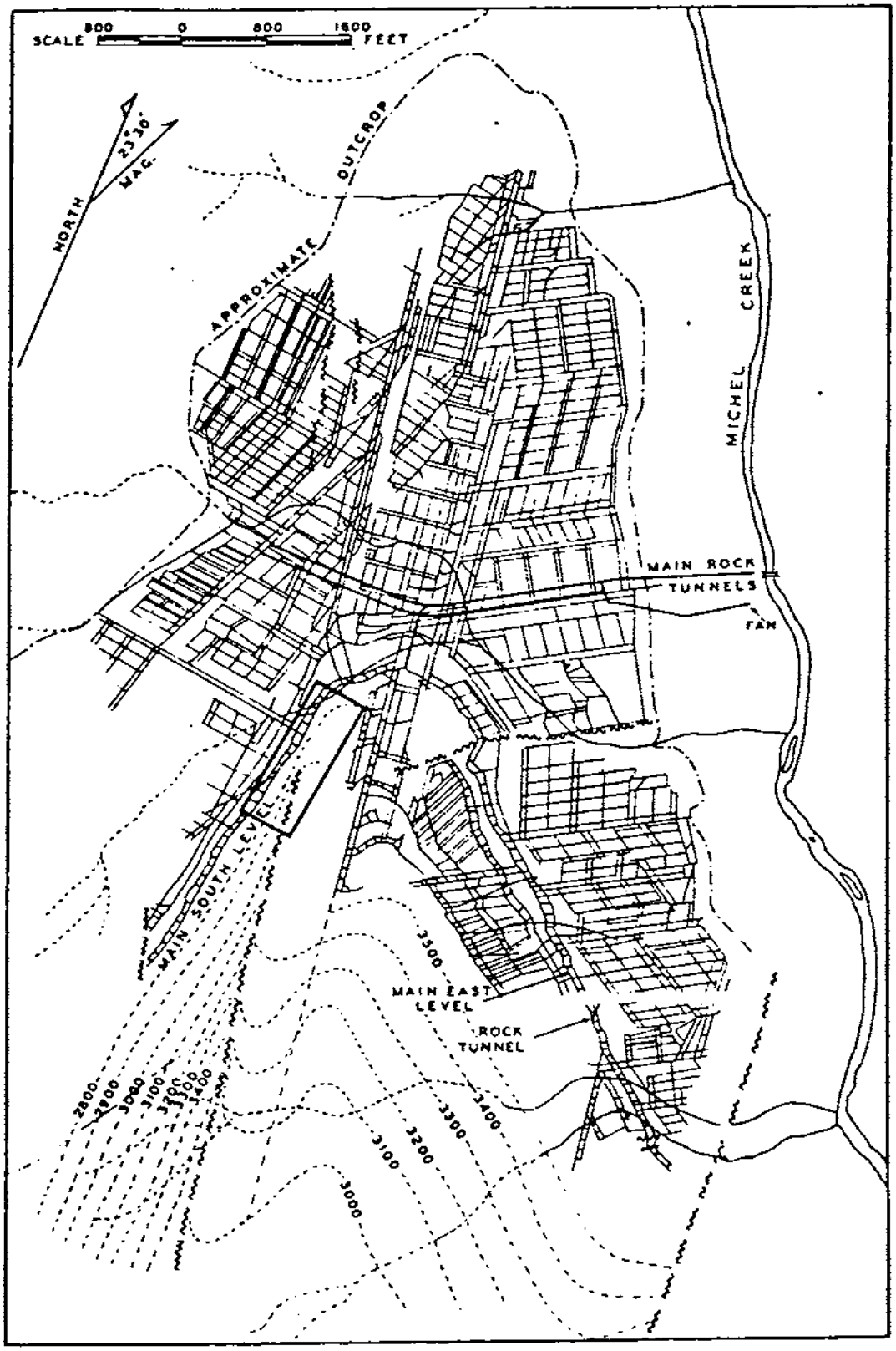
STRUCTURE CONTOUR AND SEAM OUTCROP MAP

Plate 6

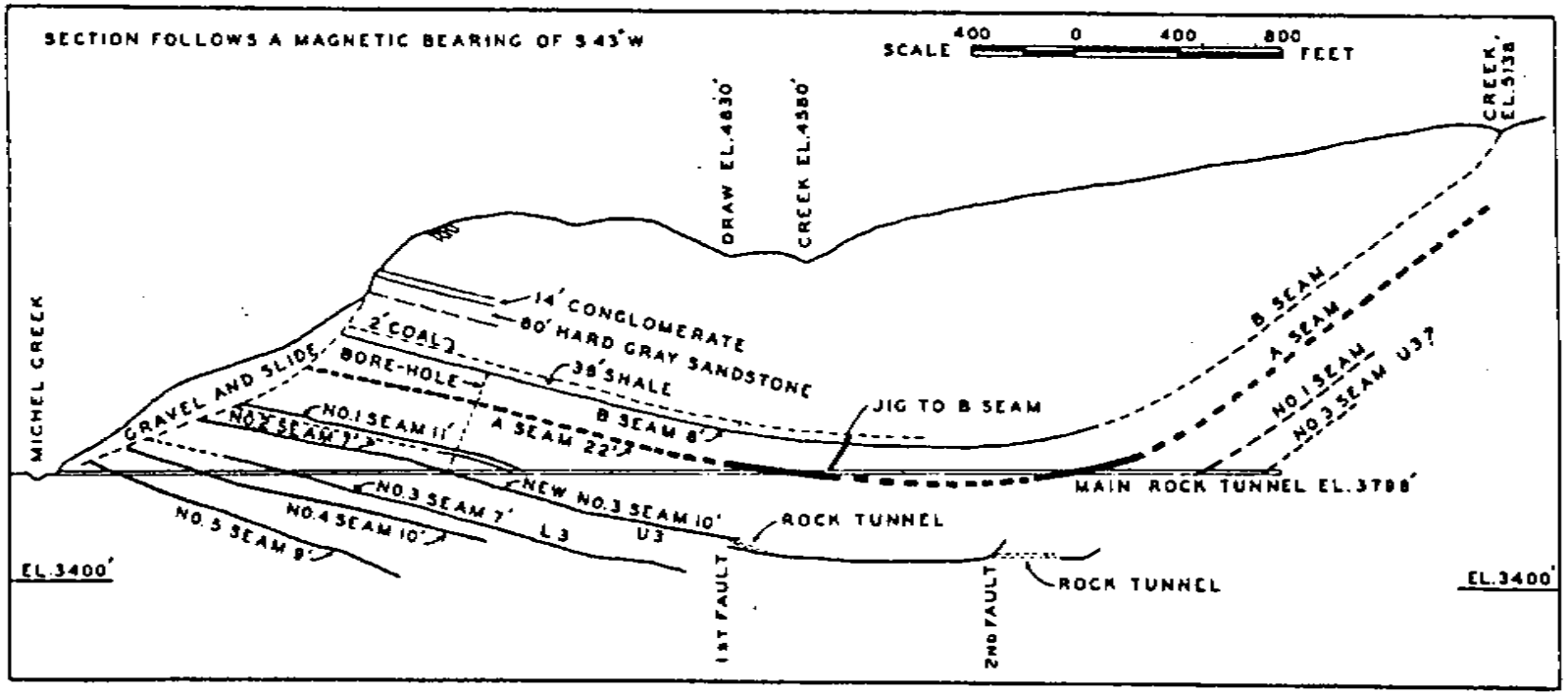


Michel - "A" Seam Workings

Plate 7



Michel - "B" Seam Workings



Michel - Cross Sections Through Rock Tunnels

> of 54 feet. It is believed that the thickness at this point is abnormal, and that the average thickness would be approximately 40 feet. Little test work has been done on the coal other than an analytical section which averages approximately 13% ash, and a coking test which indicates good coking properties.
>
> "It is our intention to continue opening up this seam to the extent that a pillar containing approximately 700,000 tons of coal would be available for extraction. During this period further testing will take place, and the possibility of a major operation will then be appraised."

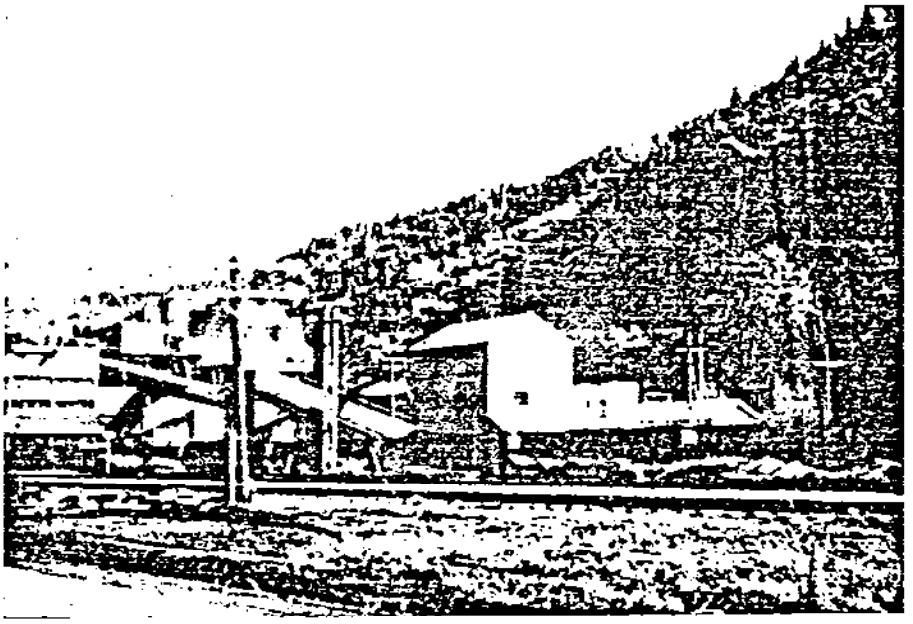
The present open pit production from the colliery is derived from the Baldy Mountain Strip Mine that is located some 5 miles northwest of Michel. This pit is exploiting an area on the basal No. 10 seam that has been thickened due to local folding. This coal is variable in quality, but is reported to be generally low ash, low volatile, and from non-coking to fair coking (Newmarch, 1953). Thicknesses are reported to very from 45 feet up to 110 feet, with the strippable area being over a mile in length (Newmarch, 1953).

Treatment Plant:

The washery at Michel, built in 1938, has a capacity of 380 tons per hour. The following description is taken from Sweeney (1956):

> "The coal is sized by vibrating screens prior to being transported to the 'Vissac jigs.' Coal is put over the 7" 'Heinrich' step-slot screen, the plus 7" fraction goes to a hand picking table where the rock is picked with the plus 7" coal being segregated as domestic fuel. The 7" x 1-5/8" fraction goes to the #1 Vissac jig while the 1-5/8" x 0" is screened by six two deck 'Plato' screens into 1-5/8" x 3/8" fraction (#2 Vissac Jig); 3/8" x 1/4" fraction (#3 Vissac Jig) and the -1/4" fraction is taken to an American type air table. The clean coal from the jigs is taken to the five Vissac driers where a stream of air at approximately 700 degrees F removes most of the surface moisture. The clean coal is then fed to a common loading distributor where it is size mixed to specification."

Prior to 1939, coke was produced in beehive ovens, but since that date it has been produced in horizontal Curran-Knowles by-product ovens, of which there are now 4 batteries totalling 52 ovens. These coke ovens have a capacity of 245,000 net tons of coal per year to produce 180,000 net tons of



Michel Colliery - Partial View of Washery

coke. The only saleable by-product produced at this time is coal tar, which is sold to the Canadian Pacific Railway for making creosote.

A briquetting plant, built in 1954 at a cost of $562,000, is now shut down.

Mining Costs:

On the basis of production, indicated cost and efficiency data supplied by the Coal Company, we have estimated the current cost per ton of cleaned coal from underground mining, f.o.b. the washery siding, to be $6.49/ton. The information and calculations leading to this figure are tabulated on the following page.

Strip mining at Michel is presently done under contract with the Emil Anderson Construction Company, Ltd. The unit price for rock is $1.55 per yard, and for other materials $0.50 per yard. The total cost f.o.b. trucks for coal depends upon the overburden that has to be moved and the writeoff. Presently the Coal Company is charging out the overburden at $1.16 per ton, the loading at $0.60 per ton, and other miscellaneous charges at $0.30 per ton. This comes to a total of $2.06 per ton f.o.b. trucks, or 46% of the direct mining cost per raw ton of underground coal ($4.52).

TABLE IV

ESTIMATE OF COST PER TON OF CLEANED COAL

FOR WASHERY SIDING, MICHEL, B. C.

Data from Crow's Nest Pass Coal Company, Limited:

1960:	Sales		460,515 tons
	Used for coke		187,460 "
	" at plant		24,498 "
	Total		672,473 "
	90.3% was underground production or		607,452 "

1960: Total Employees 12/31/60

UG	527
Surface	143
Office & shops	26
Total	696
Not chargeable to mining	95
	601

1960:	Average cost per manshift UG	$15.98
	" tons produced per MS UG	5.44
	Percentage of mining cost represented by labor	65%

From above data, following estimated cost derived:

$\frac{\$15.98 \text{ cost/MS}}{5.44 \text{ tons/MS}}$ = $2.9375 labor cost/ton raw coal, mining

$\frac{\$\ 2.9375}{.65}$ = $4.52 direct cost/ton raw coal, mining

Washery loss @ 9.85%(1)	0.44
Est. Washery cost	0.45
	$5.41 direct cost/ton cleaned coal
Plus 20% for taxes, administration, overhead & operating contingencies	$1.08

ESTIMATED TOTAL ..... $6.49 cost/ton cleaned coal

Note (1) 5 year average % of washery refuse.... 9.85%

PHYSICAL WORK - CROPCO '60

Summary Statement:

Essentially all work conducted during the 1960 field season was concentrated on that portion along the western edge of the coal basin that lies between Coal Creek and Morrissey Creek. For purposes of brevity, this area is referred to as the Morrissey Ridge Sector. The Kootenay formation outcrop along this ridge front was mapped (1" = 750'), 15 ridges making out from the major range front were completely pot holed and the discovered coal seams trenched and described, and diamond drill access roads were constructed and drill sites prepared on both the face and the backslope of the range. In addition, 12 adits were driven into weathered coal seams and 9 four-ton bulk samples were taken for metallurgical test work.

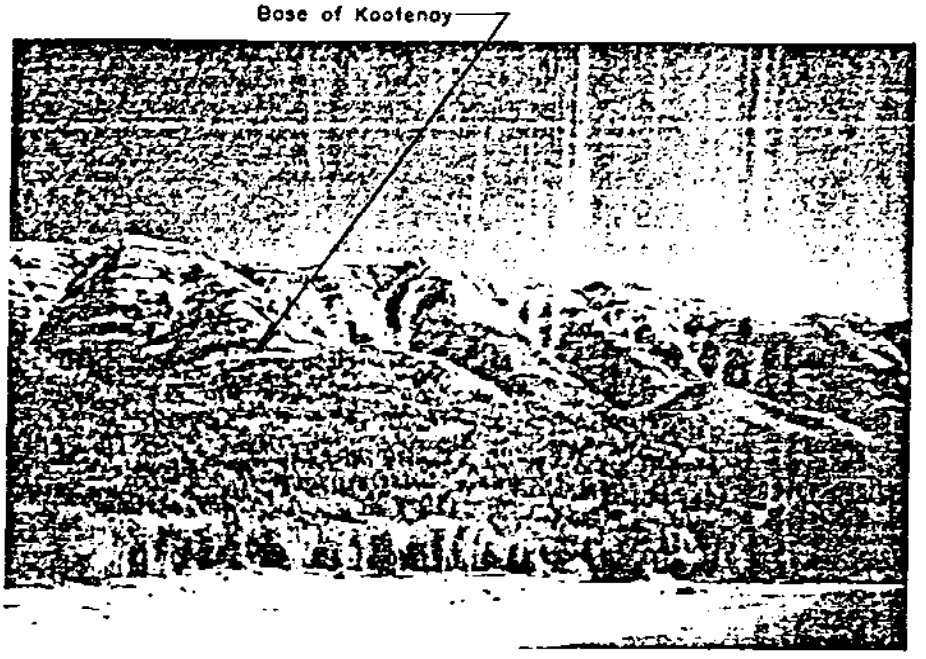
During the peak of the field season the project personnel averaged 33 men, including Noble, Still, and Okerlund, breaking down as follows: 4 party chiefs, 4 assistant geologists, 11 trenchers, 1 overman, 2 firebosses, 4 miners, 2 supply men (chargeable to mining) and two bulldozer swampers. Of this group, two men (both geologists) were American and the rest were Canadian, with 25 being residents of either Fernie or Natal.

In the early part of the summer, essentially all of the field personnel were camped out because of the inaccessibility of the Kootenay along the face of the ridge. By mid-summer a sufficient number of access roads had been constructed up to the base of the Kootenay to allow for the closure of most of the camps.

Diamond drilling was not started until late in the season, and as a result no holes were bottomed.

Additional work late in the season consisted of the partial trenching of two ridges in the Hosmer area, the construction of a 10-mile access road up the backslope of Fernie Ridge*, and the taking of one four-ton bulk sample

*That portion of the western edge of the basin between Coal Creek and



A. Portion of Morrissey Ridge front, from about Ridge 5 (on left) to Ridge 12 (on right). Note Microwave tower on skyline and Elk River in near foreground.

B. Portion of Morrissey Ridge front, from about Ridge 8 (on left) to Ridge 14 (on right).

from the seam being explored by the new No. 10 Mine at Michel. This work is shown for the most part on Map No. 6L-144.

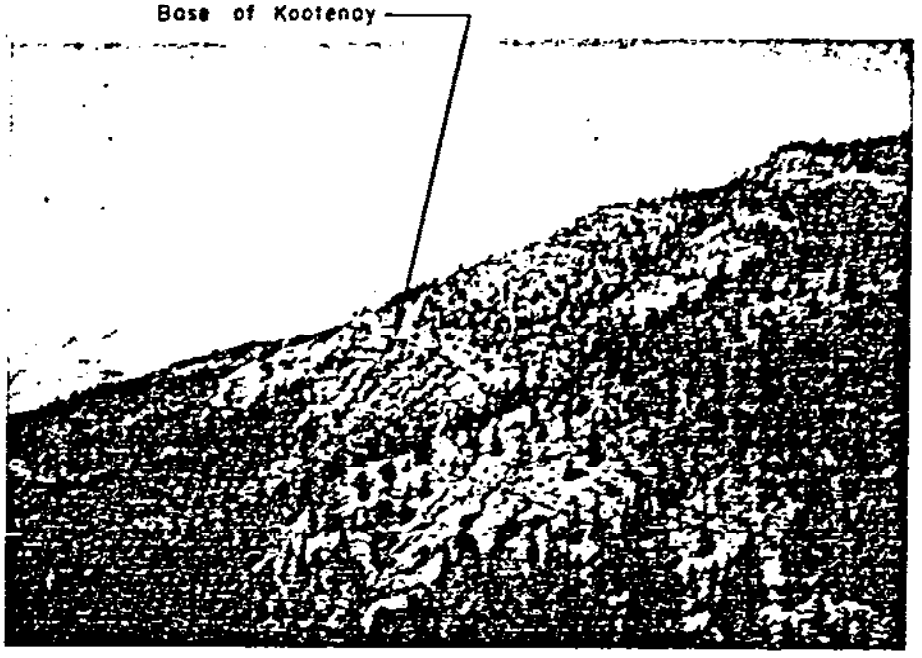
During the year, a total of $192,128.89 was expended on the Cropco Project.

Trenching:

Due to the fact that the coals within the region weather more rapidly than the enclosing rocks, by far most of the coal seams do not outcrop, but rather are covered by a mantle of either soil, coal bloom or slump debris. Because of this factor, it is necessary to dig through the cover, at closely spaced intervals, in order to prospect for coal seams in new areas. Since this cover is usually at a minimum on the crest of the ridges, pot holing is done directly on the ridge lines, and whenever coal is indicated actual trenching is conducted until both the floor and roof of the seam, or coaly zone, are exposed. In most instances, the removal of only some 1 to 3 feet of cover is necessary to expose the coal, but then it is normally necessary to go into the coal for an additional 2 to 3 feet in order to get into material that is sufficiently unweathered to describe. In a few instances (such as ridges 13 and 21), trenches were dug to depths of up to 8 feet without getting through either the cover or the zone of coal "bloom."

Due to the very steep nature of the hillsides, it was not possible to use mechanized equipment for this work except within the immediate Morrissey Creek area, where some trenching was done with a bulldozer.

During the past season, some 12 men were usually chargeable to trenching, and the work was directed by the various party chiefs (i.e. geologists). Following the exposure of the coal seams, the coal was measured and described, these detailed descriptions being enclosed with this report. During the summer, in the order of 4,500 linear feet of trenches were dug. A typical trench is shown in the photograph of Figure 4B.



A.

B.

A. Lower portion of Kootenay formation - looking north from top of basal Kootenay sandstone on Ridge 10.

B. Typical trench in a basal Kootenay coal seam. (R-10)

Geologic Mapping:

The outcrop of the Kootenay formation was mapped along the Morrissey Ridge Sector all the way from Coal Creek to the Morrissey Creek. This work is shown on Map No. 6M-323. The base used for mapping were enlargements of the B. C. Provincial aerial photography of the region. As these photographs were originally taken on 5" x 5" film, and the enlargements were 30" x 30" (approximately 1" = 750'), a great deal of distortion resulted. However, this distortion was removed by radial line plotting from adjacent photo centers. The topography shown on Map Numbers 6M-323 and 6L-144 was taken from preliminary topographic sheets that were prepared by the Dominion Department of Mines and Technical Surveys. For Map No. 6M-323, topography was enlarged to 1" = 750' from the original maps which are on scales of 1:40,000 and 2" = 1 mile.

The Morrissey Ridge Sector was divided into three segments, a north, central, and southern area. The northern segment was mapped by Garnett Pessel, a graduate student from the California Institute of Technology. The central segment was mapped by Brian Murphy and Raymond Hughes, Murphy being a geologist recently graduated from the University of B. C. and Hughes being a school teacher that had some three years of undergraduate geology training before switching to education. The southern segment was mapped by Harry Lawrence, also a graduate student from the California Institute of Technology.

While the quality of this mapping may not be the very best, it will suffice for the project's needs at the moment. It is likely that the Cropco '61 program will include the re-mapping of this section.

Mining and Bulk Sampling:

Due to the large amount of rainfall and snow fall in the area, the coals weather for quite a distance back from the outcrop. Due to this, it is necessary to drive adits into the seams for some distance before fresh coal, for metallurgical testing purposes, can be obtained. In order to determine

SCALE IN FEET

EXPLANATION

- CONGLOMERATE
- SHALE
- SANDSTONE
- COVER
- Rock Talus along Basal Kootenay Sandstone
- FAULT (showing relative displacement)
- ANTICLINE (direction and plunge)
- SYNCLINE (direction and plunge)
- DIP and STRIKE of BEDDING
- CONTACTS
  - Exposed
  - Inferred
- TRENCHES
  - Columbia Iron Mining Co.
  - J. Crabb
- DH BC-3 DRILL HOLE
- ADIT

NOTE:
Topography taken from Canadian Topog. Sheets (contour interval 100 ft.)

(3)

COLUMBIA IRON MINING COMPANY
ASSOCIATE SUBSIDIARY
UNITED STATES (USS) STEEL CORPORATION

TOPOGRAPHY AND GEOLOGY
MORRISSEY RIDGE SECTOR
CROPCO PROJECT
BRITISH COLUMBIA-CANADA

FIELD EXPLORATION — IRONTON-UTAH
SCALE 1 in = 1000 ft

DRAWN	ARS	5-61
TRACED	JH	[illegible]
CHECKED	[illegible]	[illegible]
APPROVED	[illegible]	[illegible]
FIELD WORK	[illegible]	[illegible]

6M-323

when fresh coal was reached (other than by megascopic observation) it was decided early in the program that the seams would be sampled, and partial analyses run, at ten-foot intervals as the adits progressed. The assumption was that when two or more analyses were essentially the same, relative to volatile on an ash free basis and coking characteristics, that fresh coal had been reached. This procedure was followed, the results of the partial analyses being appended hereto as Appendix B. In general, it was necessary to drive about 50 feet in from the outcrop before consistent analyses were obtained.

Upon reaching fresh coal, the seam was then sampled by either raising and winzing or by crosscutting from the floor to the roof of the seam. Drawings of these workings, which show the description of the seams, the method of sampling, and the relationship of the sample to the surface, are bound herein as Maps Nos. 6B-570 through 6B-578.

The samples taken were to be four tons each, and, for the most part, this figure was adhered to quite closely. The sampled material was placed in canvas and/or burlap bags at the adit sites and weighed on bathroom-type scales. The sacks were then packed on horseback to the nearest road and transported by Land Rover to a central weighing and loading area at Coal Creek. At this point, the coal was weighed more accurately, as it was placed in 50-gallon steel drums, the drums were labelled and the samples shipped either to Robena or the Commercial Testing Laboratory.

In all, nine 4-ton bulk samples were taken from the Morrissey Ridge Sector, from the adits on Ridges 9 and 10, and one four-ton sample was taken from the new No. 10 mine at Michel.

Unfortunately, aditing was started only six days after the start of the field season, and before any knowledge was had of the geology locally. For this reason, two adits (No. 1 and No. 4) had to be later abandoned, since they were in locations where, due to geologic structure, they either could not

result in a fresh sample (Adit No. 1) or where they represented a repetition of effort (Adit No. 4 being driven in the same seam as Adit No. 2).

The crew chargeable to mining consisted of one overman, two firebosses, four miners, and 2 laborers. Three headings were being driven at all times. Due to the inaccessibility of the adit sites to roads, all adits with the exception of No. 12 had to be driven entirely with hand tools (i.e., coal augers, cyclones, etc.).

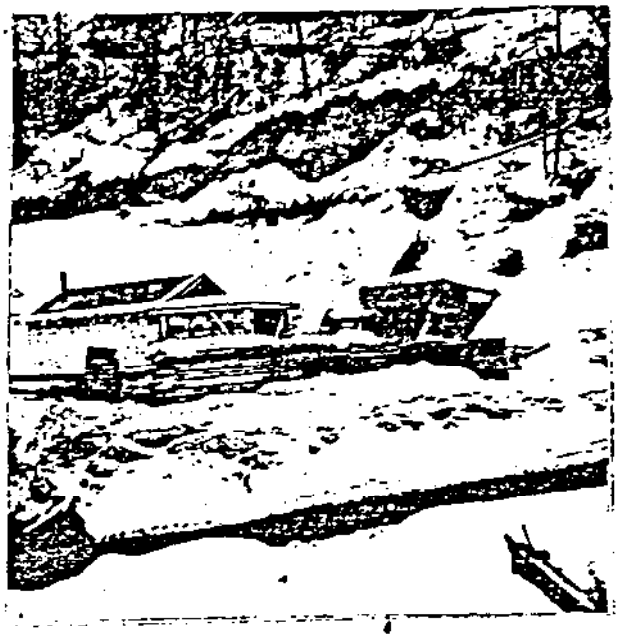
The underground mining work completed during the summer is tabulated below, and the location of the various adits is shown on Map Nos. 6M-323 and 6L-144.

	Footage		
Adit No.	Drifting	Raising & Winzing	Crosscutting
1 (abort)	63		
2 (1)	70		34
3	46	9.3	
4 (abort)	32		
5	55	27.5	
6	50	9.0	
7	50	38.5	
8	49	6.5	
9	59	11.0	
10 (2)	44		
11	39		
12 (3)	70		
	627	101.8	34

(1) The top half of the seam being exposed by Adit 2 is to be sampled during Cropco '61.
(2) The seam being exposed by Adit 10 is to be sampled during Cropco '61.
(3) Adit 12, driven in the basal seam, appears to be in an area that is not representative, and will probably be aborted without sampling.

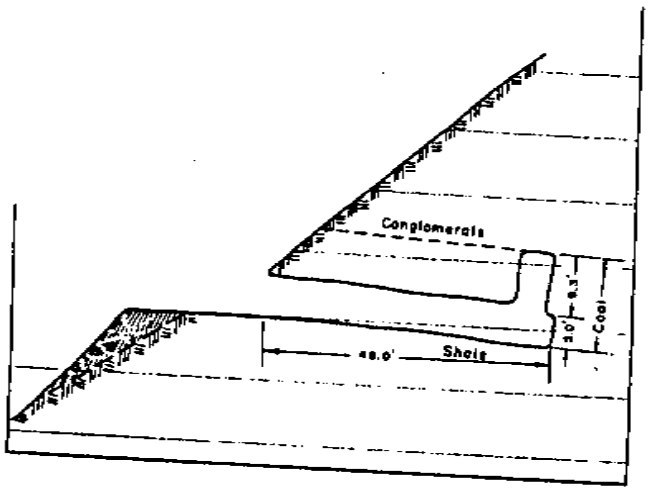
An analysis of the mining work completed to date has shown that an advance of 0.8 feet per manshift was achieved at a cost of $22.44 per foot (drifting, raising and crosscutting all combined). This figure includes all items chargeable to the mining account: labor , supplies, bulk sampling, camp charges, and transportation of mining crews.

A. Portal, Adit No. 2, Ridge 10

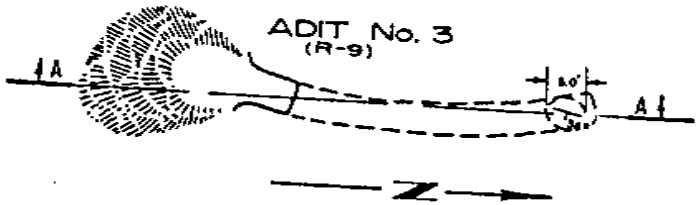


B. Portal, New No. 10 Mine - Michel

C. Pack team hauling coal for bulk samples, at end of road on Ridge 10.



SECTION A-A
SCALE 1"=20'



PLAN
SCALE 1"=20'

BULK SAMPLE No. 1

DESCRIPTION: Seam sampled at right angles to walls. Thickness = 14.3' Floor shale, then 3.0' Clean Coal, then 1.0' Bone, then 10.3' Clean Coal, then Conglomerate Roof

MINED: Aug. 10, 1960

DATE in BARRELS: Sept. 2 to 30, 1960

NET WEIGHT SHIPPED: 8215.5 lbs.

COLUMBIA IRON MINING COMPANY
ASSOCIATE SUBSIDIARY
UNITED STATES STEEL CORPORATION

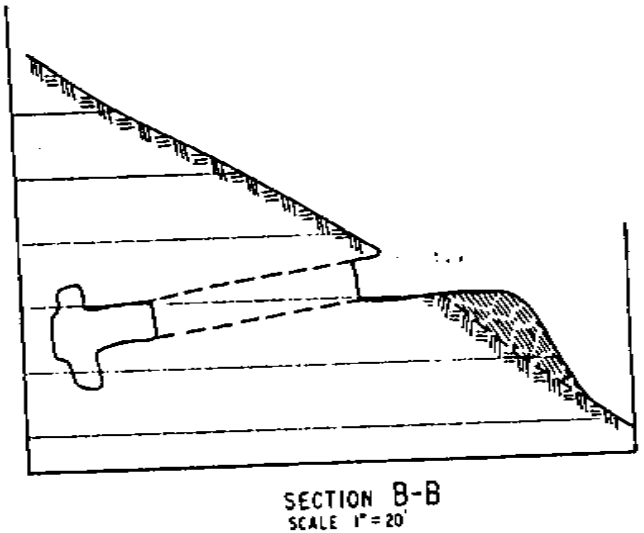
PLAN AND SECTION
ADIT NO. 3 (R-9)

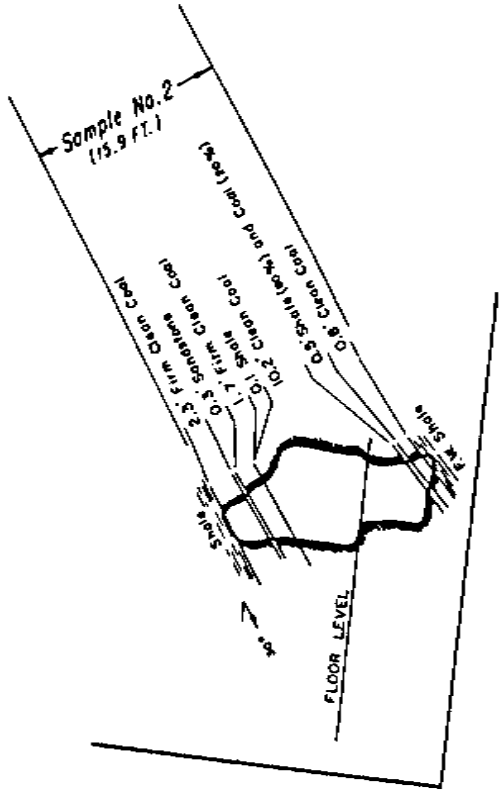
CROPCO PROJECT
BRITISH COLUMBIA-CANADA

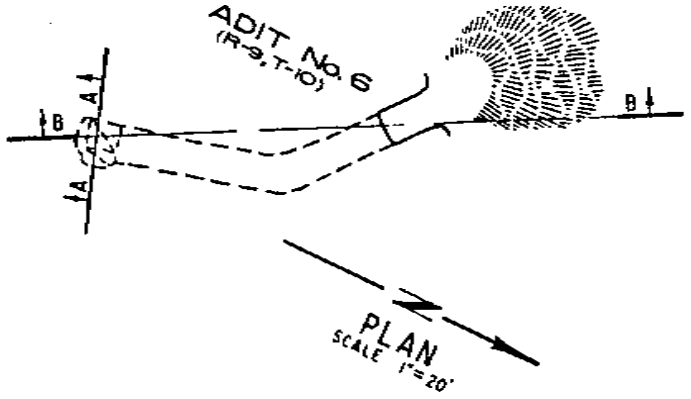
FIELD EXPLORATION

SCALE: As Shown

55-57C







BULK SAMPLE No. 2

MINED: Aug 24 to 26, 1960

DATE in BARRELS: Sept. 2 to Oct. 3, 1960

NET WEIGHT SHIPPED 8356.5 lbs.

COLUMBIA IRON MINING COMPANY
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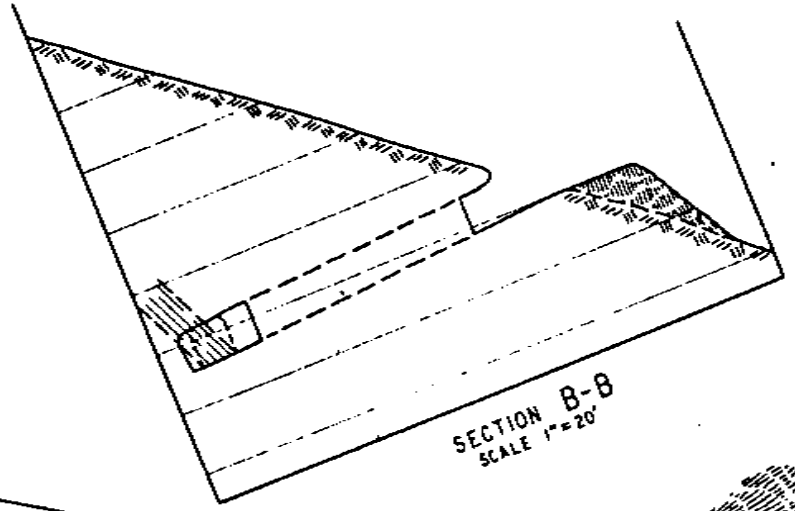
UNITED STATES STEEL CORPORATION

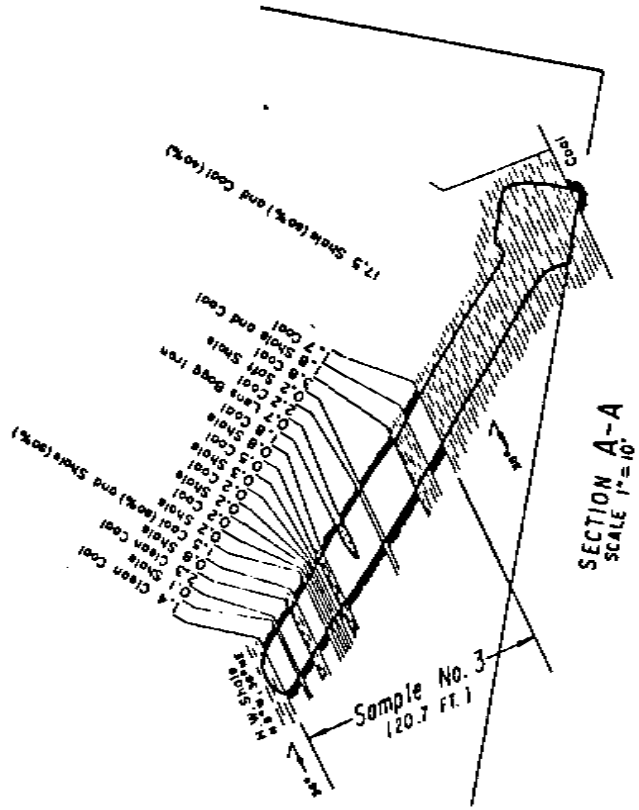
PLAN and SECTIONS
ADIT NO. 6 (R-9, T-10)
CROPCO PROJECT
BRITISH COLUMBIA-CANADA

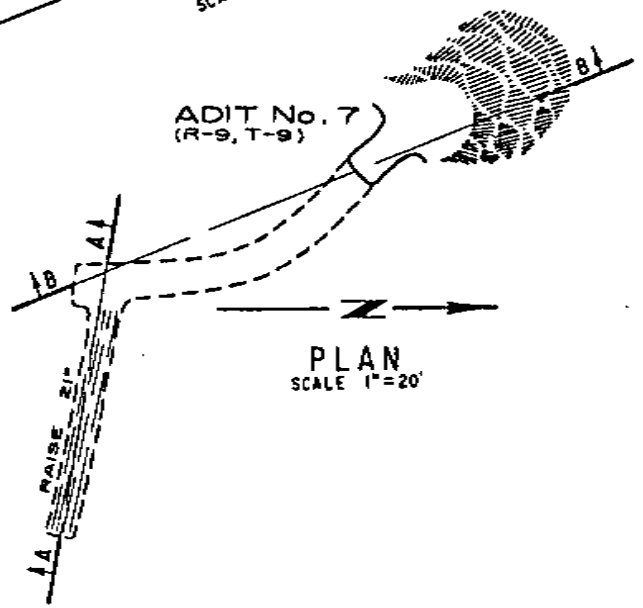
FIELD EXPLORATION — IRONTON-UTAH

SCALE: As Shown

68-671







BULK SAMPLE No. 3

MINED: Aug. 26 to Sept. 1, 1960

DATE in BARRELS: Sept. 6, 7, 1960

NET WEIGHT SHIPPED: 8688.5 lbs.

COLUMBIA IRON MINING COMPANY
ASSOCIATE SUBSIDIARY
UNITED STATES STEEL CORPORATION

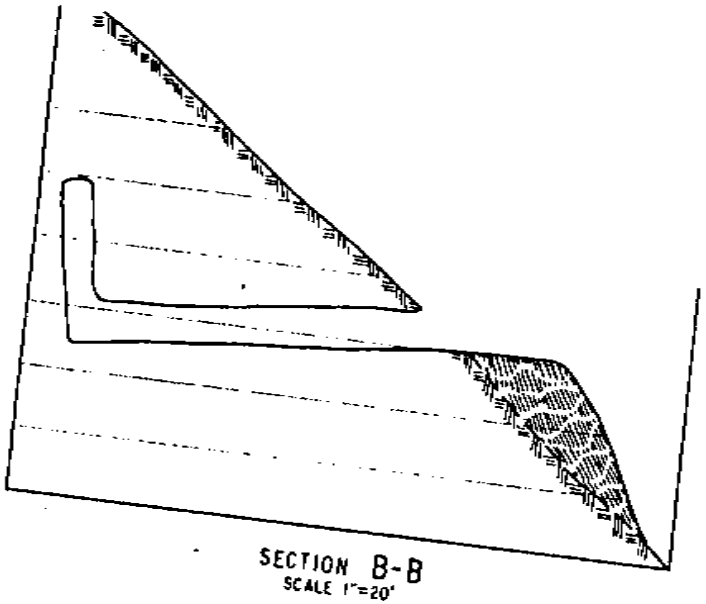
PLAN AND SECTIONS
ADIT NO. 7 (R-9, T-9)

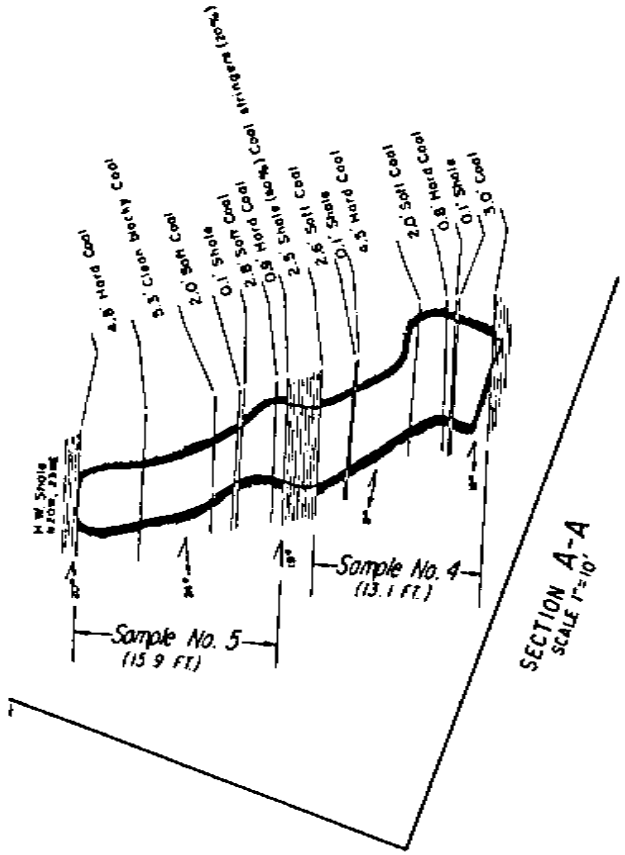
CROPCO PROJECT
BRITISH COLUMBIA-CANADA

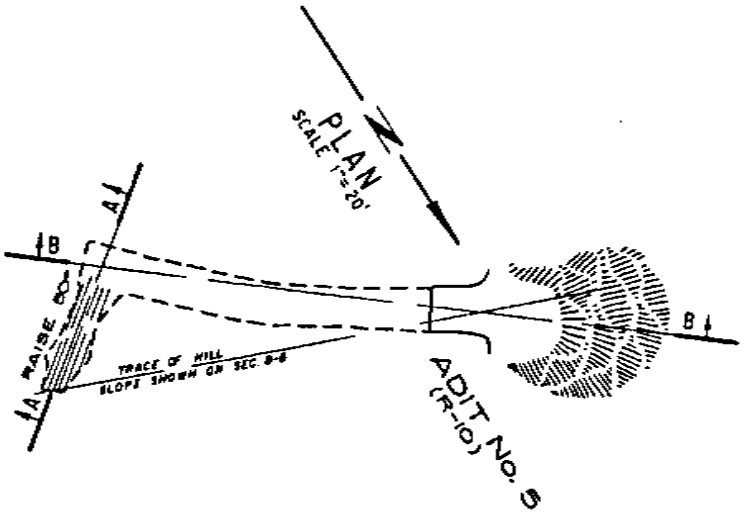
FIELD EXPLORATION — EDMONTON

SCALE: As Shown

68-57







BULK SAMPLE No. 4 (lower seam)

MINED: Aug. 26 to Sept. 1, 1960

DATE in BARRELS: Sept. 7 & 8, 1960

NET WEIGHT SHIPPED: 9213.0 lbs.

BULK SAMPLE No. 5 (upper seam)

MINED: Sept. 2 to 6, 1960

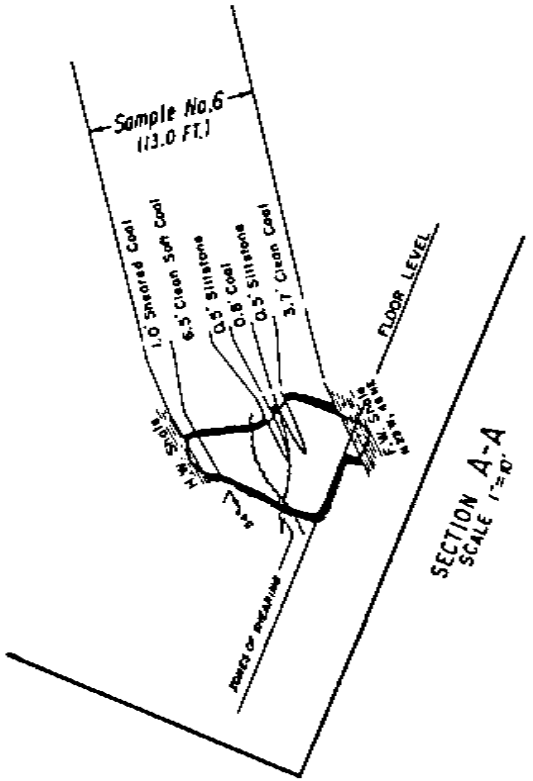
DATE in BARRELS: Oct. 5 to 11, 1960

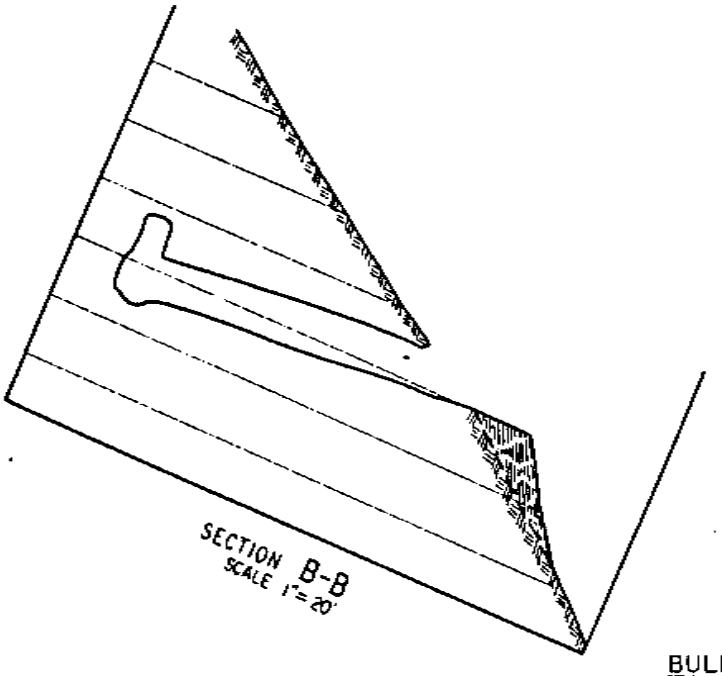
NET WEIGHT SHIPPED 8021.0 lbs.

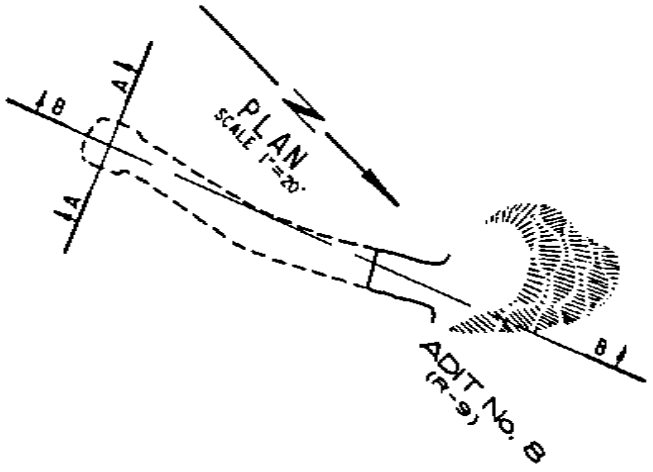
COLUMBIA IRON MINING COMPANY
ASSOCIATE SUBSIDIARY
UNITED STATES STEEL CORPORATION

PLAN and SECTIONS
ADIT NO. 5 (R-10)
CROPCO PROJECT
BRITISH COLUMBIA-CANADA

FIELD EXPLORATION — EDMONTON-ALTA.
SCALE: As Shown
68-673







BULK SAMPLE No. 6

MINED: Sept. 13 to 19, 1960

DATE in BARRELS: Sept. 28 to Oct. 3, 1960

NET WEIGHT SHIPPED: 7759.0 lbs.

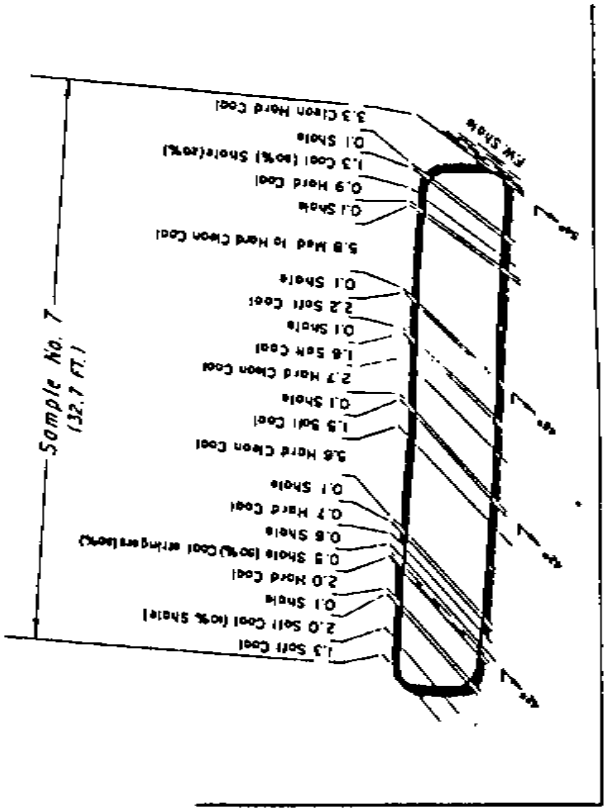
COLUMBIA IRON MINING COMPANY
ASSOCIATE SUBSIDIARY
UNITED STATES STEEL CORPORATION

PLAN AND SECTIONS
ADIT NO. 8 (R-9)
CROPCO PROJECT
BRITISH COLUMBIA-CANADA

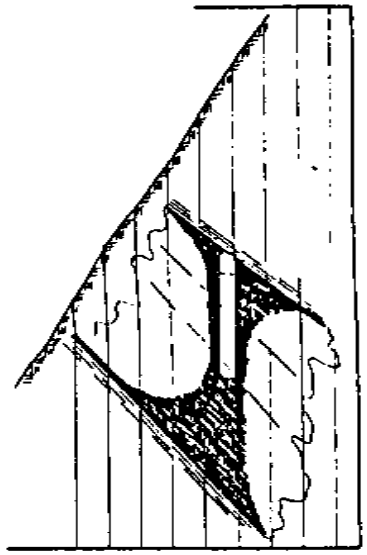
FIELD EXPLORATION — IRONTON-UTA

SCALE: As Shown

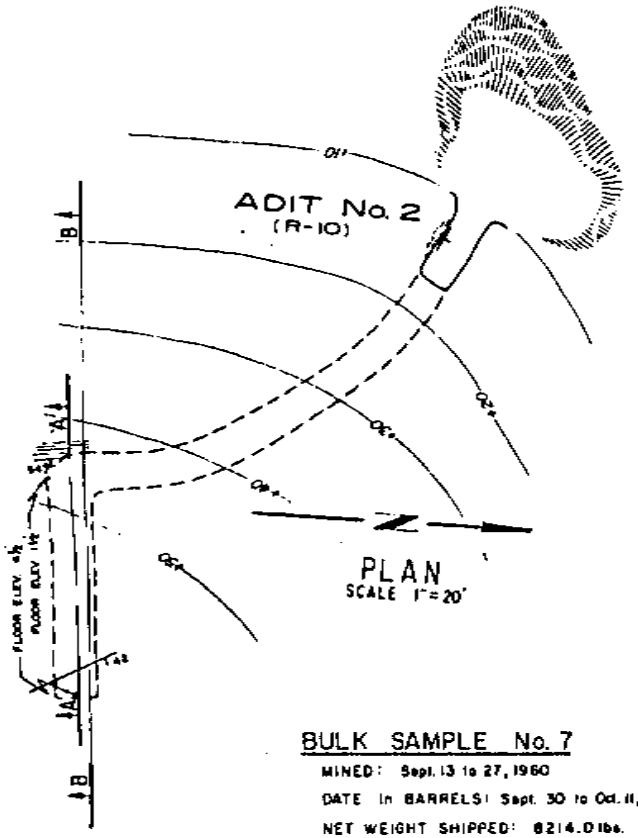
68-574



SECTION A-A
SCALE 1"=10'



SECTION B-B
SCALE 1"=40'



BULK SAMPLE No. 7

MINED: Sept. 13 to 27, 1960

DATE In BARRELS: Sept. 30 to Oct. 11, 1960

NET WEIGHT SHIPPED: 8214.0 lbs.

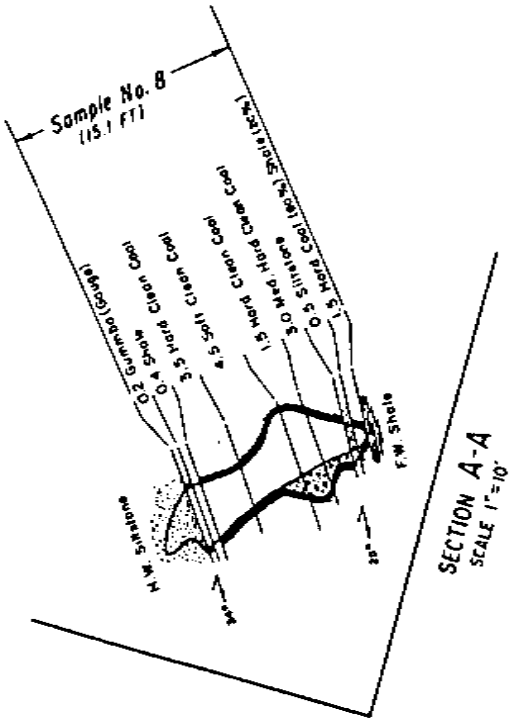
COLUMBIA IRON MINING COMPANY
ASSOCIATE SUBSIDIARY
UNITED STATES STEEL CORPORATION

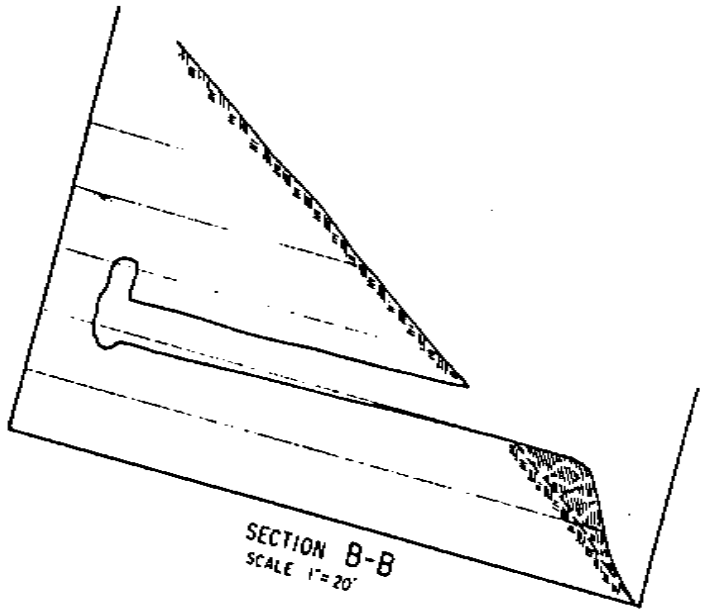
PLAN and SECTIONS
ADIT NO. 2 (R-10)
CROPCO PROJECT
BRITISH COLUMBIA-CANADA

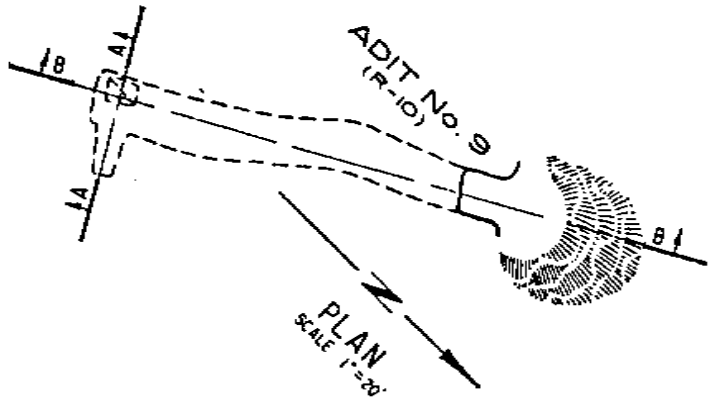
FIELD EXPLORATION — IRONTON-UTAH

SCALE: As Shown

68-575







BULK SAMPLE No. 8

MINED: Sept. 20 & 21, 1960

DATE in BARRELS: Oct. 3 to 5, 1960

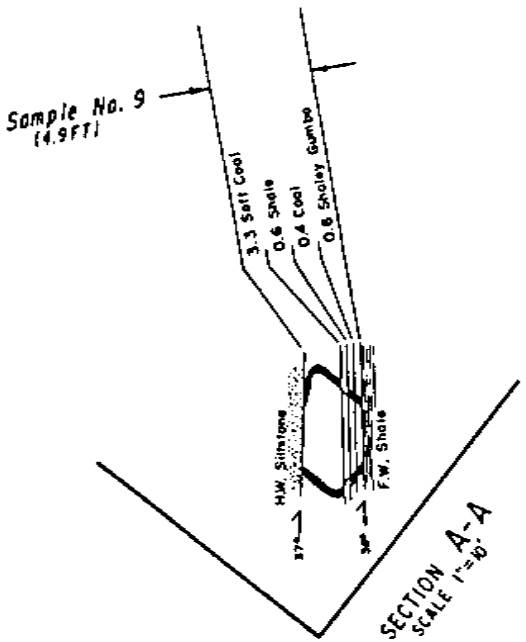
NET WEIGHT SHIPPED: 7485.0 lbs.

COLUMBIA IRON MINING COMPANY
ASSOCIATE SUBSIDIARY
UNITED STATES (USS) STEEL CORPORATION

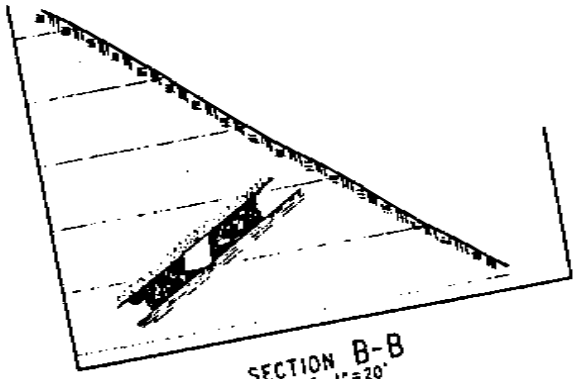
PLAN and SECTIONS
ADIT NO. 9 (R-9)
CROPCO PROJECT
BRITISH COLUMBIA-CANADA

FIELD EXPLORATION — IRONTON-Utah

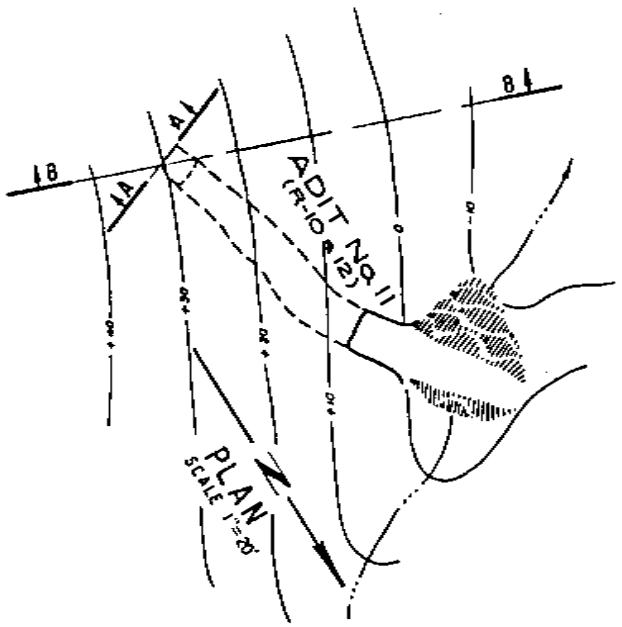
68-576



SECTION A-A
SCALE 1"=10'



SECTION B-B
SCALE 1"=20'



BULK SAMPLE No. 9

MINED: Sept. 26 to 28, 1960

DATE in BARRELS: Oct. 8, 1960

NET WEIGHT SHIPPED: 8818.0 lbs.

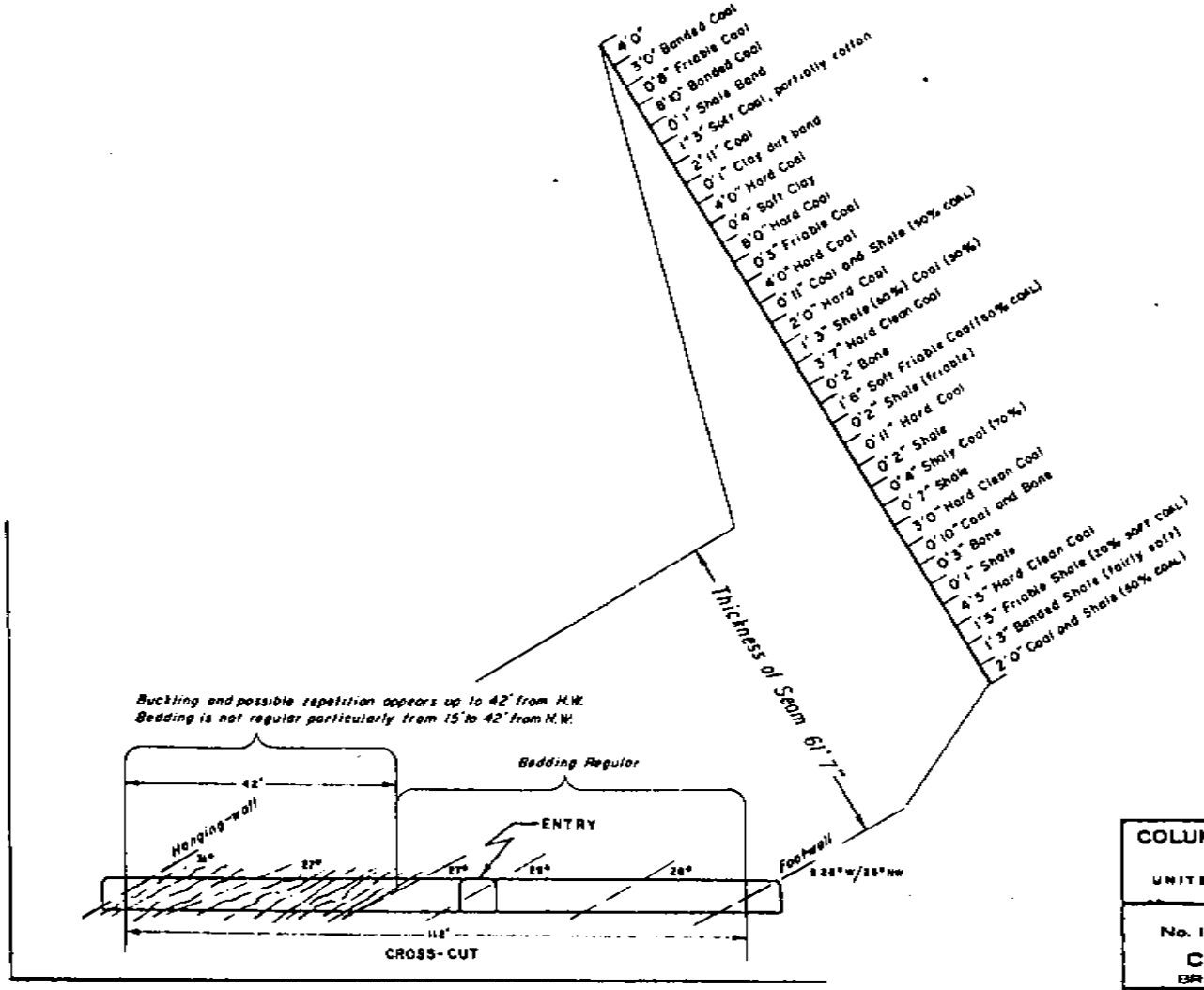
COLUMBIA IRON MINING COMPANY
ASSOCIATE SUBSIDIARY
UNITED STATES STEEL CORPORATION

PLAN and SECTIONS
ADIT NO. 11 (R-10,12)
CROPCO PROJECT
BRITISH COLUMBIA-CANADA

FIELD EXPLORATION — IRONTON-UTAH

SCALE: As Shown

68-577



VERTICAL SECTION ALONG No. 10 SEAM CROSS-CUT
SCALE 1" = 20'

COLUMBIA IRON MINING COMPANY
ASSOCIATE SUBSIDIARY
UNITED STATES STEEL CORPORATION

SECTION
No. 10 SEAM - MICHEL COLLIERY
CROPCO PROJECT
BRITISH COLUMBIA - CANADA

FIELD EXPLORATION — IRONTON-UTAH
SCALE: As Shown
68-578

Road Construction:

During the field season, two bulldozers were employed most of the time, and as many as 5 for short periods, building access roads up the front of the range to the base of the Kootenay formation and building diamond drill roads both up the front of the range as well as on the backslope. In addition, a 7-mile road was built up the back of Fernie Ridge to serve as access for both geological work in Cropco '61 and for drilling in Cropco '62. From past experience, it has been determined that road construction within the Fernie shale costs about $480 per mile. The road constructed through the Kootenay formation to serve diamond drill sites 4, 5 and 6 cost an average of $1,722.63 per mile, but probably could have been constructed for about $200 per mile less, since a 600 cfm rental compressor was on hand all the time but was only used on the road construction for the four days necessary to shoot through the basal Kootenay sandstone.

For future reference, probable costs for road construction of different types is tabulated below:

Area or Material	Est. Cost per Mile	Remarks
Frontslope:		
Kootenay Portion	$1,500±	Most of drilling and blasting required is to cross basal ss.
Fernie shale	$ 480	Digs well, only rare ss ribs
Backslope		
DDH Access	$ 950	Occasional rock, part of cost due to mud conditions

In all, a total of 27½ miles of road were constructed during the field season. These roads are shown on Map No. 6L-144.

Diamond Drilling:

Due to the depth of the holes anticipated (3 each at 4,000'±), and the stringent drilling specifications upon which bidding was to be based, difficulty was encountered in obtaining bids for the Cropco '60 drilling. Three contract

drilling firms were originally contacted in early April, informed of the coming job, and asked if they would be interested in bidding it. These firms were Boyles Bros. Drilling, Ltd., Joy Manufacturing Co. (Canada) Ltd., and T. Connors Diamond Drilling Co., Ltd. All three indicated interest in the project and specifications were mailed out to them on May 18. By May 25, both Connors and Joy had backed away from the job "because of other commitments."

On June 11, the Boyles representatives arrived in Fernie, and the site for DDH BC-1 was examined by them on the 12th. While in Fernie during this visit, Mr. Jack McTeague, Alberta Manager for Boyles, stated that they could not bid based upon the specifications submitted by the Corporation, but that they would make a counter proposal. Following this, Mr. J. D. Campbell, Western Manager for Boyles, visited the Columbia offices in San Francisco, and their counter proposal was written and submitted under a date of June 22, 1960. The original specifications were revised to conform to their proposal, and a contract for one hole was awarded on June 30.

Boyles' foreman, Mr. John Duval, arrived in Fernie on July 25, and a railroad car of camp and rigging equipment arrived on the 26th. The drill rig, a Boyles BBS-4 capable of 6,000 feet of depth, and an 80-foot steel derrick arrived in a second carload lot on August 11. The hole was collared on the morning of August 24, the intervening period being used to make a permanent winter camp and to set up the rig and derrick.

Boyles had a great deal of difficulty with the hole from the very start, partly due to the extreme hardness of the Elk formation conglomerates, but more largely due to their own equipment breakdowns, poor drilling practices, and very poor expedition of needed supplies and repair parts. They were either broken down, stuck in the hole, or awaiting parts or supplies for 36% of the potential drilling time. Based upon Mr. Okerlund's drilling cost estimates, it would appear that Boyles lost $11,600 (or $6.01 per foot) on the 1,934

feet of hole DDH BC-1 completed to date. The total cost of the hole, to the Corporation, amounted to $34,206.42, or $17.70 per foot. Enclosed, following this section, is other pertinent data regarding the hole.

From a geological point of view, very little was learned by the drilling, since it was stopped, on November 24, only a few feet after having passed through what is believed to be the zone of No. 10 seam, this seam being very near the top of the Kootenay coal measures. A geologic cross section through Ridge 9 and the drill hole is bound as Map No. 6H-311. Several thin coal seams, or coaly zones, were crossed above the No. 10 seam area, but core recovery in all of the coal areas, as tabulated below, was very poor.

Coal Seams of DDH BC-1, 0-1934 Ft.

	Coal Zone Footage From	To	Thickness	Coal Ft.	Coal Core Rec. Ft.	%	Remarks
(1)	1002.0	1009.0	7.0	7	0	0	Coal
(2)	1173.0	1175.0	2.0	2.0	0	0	Coal
(3)	1359.0	1360.0	1.0	1.0	0.5	50	Coal
(4)	1438.0	1439.5	1.5	1.5	0	0	Coal
(5)	1534.0	1535.8	1.8	1.8	0	0	Coal
(6)	1688.5	1704.8	16.3	8.7	3.6	41	Interbedded coal and shale
(7)	1756.0	1772.3	16.3	13.1	4.5	34	From top: 1.5 sh., 8.3 coal (@ 25% rec.), 0.4 sh., 1.8 coal, 0.7 sh., 3.0 coal, 0.6 sh.
				35.1	8.6	24.5	

The two potentially mineable width seams are underlined in the above tabulation. In addition to these, one interval of 3.0 feet of coal (@ 50% core recovery) was encountered in zone (6) above.

This hole did establish that mineable width seams may occur within the Elk formation, the best indication to date being the 7-foot seam encountered at 1002 feet of hole depth. Due to the lack of core recovery in this initial intersection, the zone should be wedged and redrilled during the Crcpco '61 program. The significance of coal this high in the stratigraphic

section is major, due to the considerations of (1) the increasing purity and coking properties of the coals within the Kootenay going upward in the stratigraphy and (2) the ramifications relative to tonnage of seams that are sufficiently high in the section to be covered by less than 2,000 feet of cover over broad areas within the basin.

During future drilling within the basin, consideration should be given either to coring the Elk formation or wedging and drilling all mineable width coal seams encountered within the Elk while coming out of holes after completion to their final bottom depth.

Aerial Photography:

Due to the fact that the existing aerial photography of the region was deemed as being not entirely suitable for our purposes, and because of the complete lack of suitable scale topographic coverage, the project had the main Crow's Nest Coal Field re-flown during the latter part of the summer.

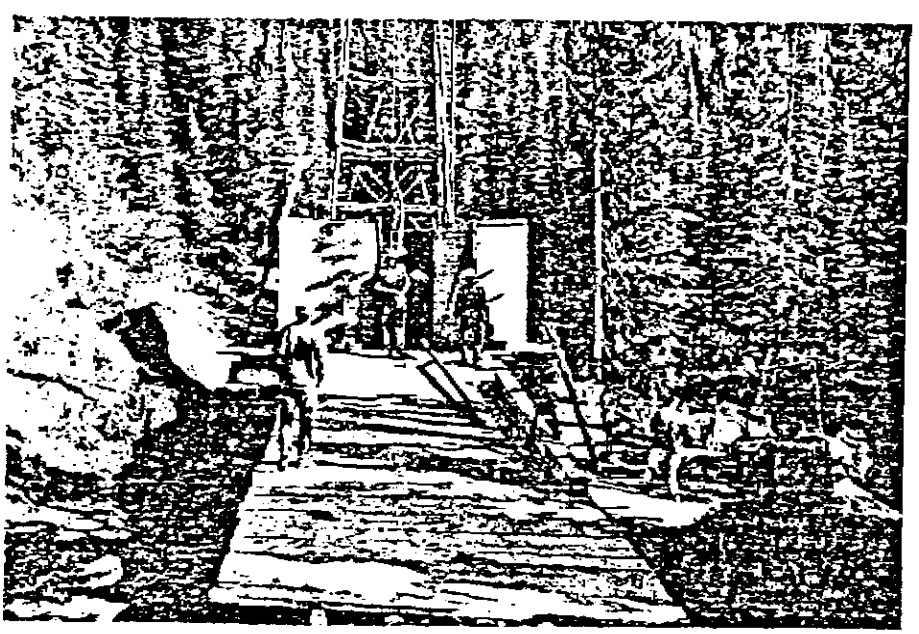
This work was done under contract by Spartan Air Services, Ltd., of Calgary, Alberta. The flying was done at two levels, resulting in photographs on scales of 1" = 5,000 feet and 1" = 2,000 feet. Complete topographic coverage of the basin, on a scale of 1" = 2,000 feet with 25-foot contours, was included in the contract with Spartan. These topographic maps are to be delivered on or before May 15, 1961.

Helicopter Use:

Helicopters were used twice during the summer: once in the early period of the program, to move camp and mining supplies up to the Ridge 9 and 10 areas, and once late in the summer to reconnaissance the proposed Alberta Natural Gas Company right-of-way routing.

Actually, two helicopters were used during the early summer, as the one initially sent in to do the job crashed on the first day (see photograph, following page). Fortunately, the pilot was not killed, although he sustained

A. Site of drill hole BC-1, from Microwave road.



B. Close up of drilling rig - drill hole BC-1.

Helicopter after crash - note Elk River
in the background.

injuries to one leg that will partially cripple him for an unknown period of time. The accident occurred at the lower heliport on Ridge 10 while flying in mine timbers. Immediately after landing, with a 450-pound load of lagging strapped on to side baskets, a gust of wind "ballooned" the aircraft off the platform. Lacking flying speed, and due to the load, the pilot could not maintain stability, and the aircraft tilted over backwards and rolled for some distance down the side of the ridge, ending up in the condition as shown in the photograph.

Cost Data:

During the year 1960, a total of $192,128.89 was expended by the Corporation on the Cropco Project, as broken down below:

Account No.	Description	Amount
51	General Administration	$ 30,715.65
52	Property Acquisition	-
53	Equipment	18,035.30
54	Inventory	2,117.56
55	Surveying and Geology (trenching, mapping, bulk sample expense)	35,859.47
56	Construction and roads (does not include drilling access roads)	7,256.95
57	Drilling (all items chargeable to drilling including access roads)	61,531.69
58	Underground Work	19,962.94
59	Special Services (aerial photography, geophysics, etc.)	9,849.74
60	Miscellaneous (Exchange, etc.)	6,799.59
		$192,128.89

In addition to the above, project carry-over expenses--that will have to be paid out of 1961 funds--amount to approximately $17,500.

COAL BEDS

General Discussion:

The Kootenay formation contains all of the commercial coal seams in the area partly due to the manner of defining its upper contact, as explained earlier. It has a variable thickness and contains a variable number of seams.

Presently known data on the number of coal seams in the Kootenay, and of the stratigraphic thickness of the Kootenay, at different locations in the basin, are as given below:

Location	Coal #Seams	Coal Total Coal	Incl. Seams Down To	Kootenay Thickness (Ft.)	Remarks
Morrissey (1)	23	216	1 ft.	3,676	Includes Elk formation (?)
Fernie (1)	23	172	1	2,250	
Sparwood (1)	23	173	1	2,050	Lower portion
Sparwood (1)	24	43	1	2,015	Upper portion (probably largely Elk formation)
Morrissey (2)	14	199	3 ft.		
Fernie (2)	15	159	3 ft.	2,063 (3)	
Fernie (2)	4	46	3	" "	Worked seams only
Hosmer (2)	10	100	3	?	As based on CPR rock tunnel
Hosmer	15	129	1	2,071 (*)	Cropco '60 trenching
Hosmer	10	120.5	3	2,071 (*)	" "
Michel (2)	18	203.5	3	3,600 (4)	Newmarch reports 22 "Mineable coal seams."
Michel (2)	5	47.5	3	-	Worked seams only

(1) After Dowling, 1915; (2) After Old et. al., 1949; (3) After Newmarch, 1953;
(4) From Newmarch but after MacKay, 1933.
(*) Based on the assumption that the 45 ft. conglomerate found 125 ft. above the highest coal seam found is the base of the Elk formation.

For comparison with the above tabulation, the Cropco '60 trenching in the Morrissey Ridge sector has indicated that within that area the Kootenay averages 2,338 ft. thick, from the top of the basal sandstone to the top of "B" seam, and contains an average of 14.8 seams (in excess of 3 ft. thick) with an average total coal of 197.0 ft. More detailed information on the coals of the Morrissey Ridge Sector are as shown on Maps No. 6L-145 and 6L-146 and in the table on the following page.

This data indicates that the Kootenay formation is thickest in the Michel area (3,600 ft.), has thinned appreciably in the Fernie area (2,063 ft.) and then thickens somewhat again toward Morrissey (2,147 ft.). Newmarch reports that the Kootenay thins quite rapidly, with a more than proportional loss in coal seams, to the southeast from Michel, resulting in only 1,850 ft. of Kootenay with 2 commercial coal seams near Corbin and 1,600 ft. of Kootenay with little to no commercial coal further to the southeast at the old Flathead townsite. This would indicate that the eastern side of the basin probably has considerably less potential than the Elk River side.

Correlation:

District Wide:

Due to the locally rapid changes of seam thicknesses, and intervals between seams, none of the past attempts at district wide correlation of coal zones in the Crow's Nest area have been very successful. During his study of the district Newmarch (1953) made a very thorough evaluation of all known methods of broad scale coal seam correlation and tried to apply each such method to this particular district. Included in his evaluation of known methods were the following:

TABLE VI

KOOTENAY FORMATION & COAL SEAM THICKNESSES

BY RIDGES - MORRISSEY RIDGE SECTOR

Ridge No.	Meas. To	Kootenay Thickness Section		(+3') No. Seams		Total Coal	
3	B Upper	2538		14		219.2	
4	B Upper	2331		15		192.3	
			2338 av.		14.8 av.		197.0 av.
18	B Upper	2147		16		218.3	
1	B Upper	2337		14		158.3	
7	#10 Upper	2133		15		301.5	
14	#10 Upper	2142		16		283.3	
10	#10 Lower	1780		11		277.2	
12	#10 Lower	1895		11		205.2	
15	#10 Lower	1618		9		213.2	
9	#9	1906		14		243.0	
17	#9	1796		10		201.8	
19	#9	1664		9		156.9	
21	#8	1426 (1680 - #9)		8		235.1	
20	#7	1220 (1515 - #8)		8		208.5	

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(1) Lithology and Stratigraphy
    (a) Cyclothems
    (b) Marine Bands
    (c) Continuous tracing
(2) Plant Remains
    (a) Distribution of Flora
    (b) Spore identifications
    (c) Cellular plant debris
(3) Non-marine fossils
(4) Inherent characters of the seam
(5) Fuel Ratio
(6) Coking characteristics
(7) Radioactivity of the coal seams
(8) Spectrographic analyses of coal ashes

For the details of Newmarch's findings I refer the reader to his paper. In essence, his findings indicated that none of the above techniques were applicable to the coals of the Crow's Nest area save for the continuous tracing (i.e. walking along the outcrop) of seams and possibly the spectrographic analyses of coal ashes. Unfortunately, due to the weathering characteristics of the coals and the large amounts of cover in the area the continuous tracing of seams is possible only over small areas. The findings of Newmarch relative to the study of trace elements in coal ashes showed promise but were restricted to the immediate Michel area and may or may not be applicable over larger areas in the basin. This technique is, at best, extremely time consuming, expensive and laborious since a sufficiently large number of spectrographic analyses of ash from each seam being considered must be available to allow for a statistical analysis of the results.

Dowling (1915, pgs. 17 & 26) suggests a correlation between the Morrissey area (our Ridge No. 17?) and Coal Creek and between Morrissey and a partial section measured on the South Fork of Michel Creek. In the attempt at correlation between the Morrissey area and Coal Creek Dowling assumed that the coal seams were persistent for the seven mile interval and, based largely on the similarity of seam thicknesses, he correlated three of his seams with the three Coal Creek seams that "up to the present have been chiefly worked at the mines." That is to say, he correlated three Morrissey area seams to seams 10

Upper, 10 Lower and No. 9 at Coal Creek. On the basis of the Cropco '60 trenching, and the Morrissey Ridge Sector correlation as shown on Map No. 6L-145, it appears quite probable that he actually was trying to correlate seams No. 7, No. 6 Upper and No. 4 of Ridge 17, with the higher seams being worked at Coal Creek. No basis is available, at this time, on which to base an evaluation of his early attempt at seam correlations between Morrissey and the South Fork of Michel Creek.

Morrissey Ridge Sector:

Map No. 6L-145 shows the preliminary correlation along the Morrissey Ridge Sector. This correlation is based upon the detailed stratigraphic sections measured through 14 ridges, the geologic mapping done along the ridge front during Cropco '60 and the nature and character of the seams themselves. One of the prime controls used in the correlation, and the seam numbering, is the correlation of sandstone beds. Tentative ties have been made between Ridge 1 and Coal Creek and between Ridge 21 and Morrissey Creek.

It appears that there has been no real standardization of seam numbering even within local areas of the coal basin. As shown on the left hand side of the correlation chart, Newmarch's and the Coal Company's (Crabb's) seam numbering, while similar, do not even agree entirely. The seams along the Morrissey Ridge Sector have been assigned numbers that correspond as closely as possible to those used by the Coal Company at Coal Creek, although a number of "upper" and "lower" designations had to be thrown in to take care of some of the less continuous seams encountered.

In all, some 24 seams have been assigned numbers as a result of this correlation. These seam designations, from the top down, are as follows:

(Top)
"B" Upper
"B" Lower
#10 Upper
#10 Lower
#9
#8 Upper
#8 Lower
#7
#6 Upper
#6 Lower
#5
#4 Upper
#4 Lower
#3 Upper
#3 Lower
#2 Upper
#2 Middle
#2 Lower
#1 Upper
#1 Middle
#1 Lower
#0 Upper
#0
-1 (minus one)
(Base)

As can been seen on the correlation chart, many of these seams are continuous over long distances, although only the basal and #6 Upper seams are traceable without interruption over the entire length between Coal Creek and Morrissey Creek.

Unfortunately, the Cropco '60 trenching did not go up far enough in the sequence to test the entire thickness of the Kootenay in the case of 8 out of the 14 ridges (i.e. Ridges 7, 10, 12, 15, 17, 19, 20 and 21 are short of "B" seam) and in 6 of these cases they did not even go sufficiently high to adequately test the zone of #10 seam. Also, on one ridge (R-1) the zone where No. 10 seam should occur was logged only as a "covered area." This information will have to be filled in during the Cropco '61 field season to complete our knowledge of the potential of the Morrissey Ridge Sector.

The tie from Ridge 1 to Coal Creek is entirely tentative due to the distance involved (16,000 ft.) between the two measured sections. The correlation for this interval as shown, however, does appear to fit reasonably well.

The tie to Morrissey, on the south, is the best that can be made based on the data presently available. No information is at hand as to the exact location of MacEvoy's measured section or of his methods in resolving the structural complications that are so evident in that area as a result of the Cropco'60 geologic mapping. Based on this correlation, it would appear that the stratigraphically highest mines at Morrissey (the #0 and #6 Mines) were

probably exploiting what would correlate with #10 Upper and #10 seams at Coal Creek. Speculation as to correlation of seam and mine numbers between Morrissey and Coal Creek, beyond this, is not warranted at this time.

Nature of the Coal Seams:

The coal seams of the district are highly variable in thickness, in purity and in coking characteristics. Generalized statements that can be made relative to these properties, as based on the Morrissey Ridge Sector work, are as tabulated below:

(1) Favorable coking characteristics and volatile content normally increase going upward in the sequence

(2) Seam thicknesses and ash content normally increase going down in the sequence

(3) The ash content in the washed coals has a decided tendency to increase going down in the sequence

(4) Ash content can change drastically within relatively short lateral distances, although such changes in purity do not appear to be the general rule.

The following table, based on the washability testwork, illustrates the above statements that are relative to volatile and ash.

DATA ON CROPCO'60 BULK SAMPLES

Seam #	(Ft.) Thickness	Cropco '60 Sample #	Washability Data - 1.55 sp. gr. % Recovery (*)	% Ash	% S	% Vol.	Calc. %Vol. (AFB)
#10L	4.9	9	47.6	11.08	0.88	26.34	29.62
# 9	14.3	1	93.0	4.11	0.48	25.81	26.91
# 8	15.9	2	83.7	7.10	0.50	23.74	25.55
# 7	20.7	3	55.8	5.94	0.52	24.31	25.83
# 6	13.0	6	85.4	8.30	0.56	21.63	23.59
# 5	15.1	8	86.3	8.12	0.56	20.09	21.86
# 1 U	15.9	5	86.1	7.79	0.47	18.16	19.70
	13.1	4	67.0	8.97	0.53	18.30	20.11
# 0	32.7 ($\frac{1}{2}$)	7	82.0	9.95	0.29	17.99	19.97
#10 Michel	61.6	10	85.1	9.50	0.35	17.99	19.97

(*) Includes 200 x 0 fraction

The coals of the district all appear to be low in sulphur content. The available past reports have classified all of the district coals as being medium-volatile bituminous. However, based strictly on volatile (AFB) content, since complete analyses are not as yet available, it would appear that the coals below No. 5 seam would more correctly be in the rank of low-volatile bituminous (ASTM Classification by Rank).

While seam thicknesses are quite variable relatively few seams occur that are less than a minimum (3 ft.) mining width. As shown by the figures in Table VIII (under Potential Ore Reserve Estimates), the coal within the 21 seams included in the potential reserve calculations vary in average thickness from 3.2 ft. up to 41.8 ft. but the over-all weighted average thickness for the coal within the 21 seams is 19.0 ft. Appended in the rear are all of the measured stratigraphic sections and detailed coal seam descriptions covering the Morrissey Ridge Sector work to date (Maps No. 6M-304 through 320).

The coals are from hard to soft, from bright to dull and from blocky to fissile, frequently all types occurring in one seam. The number and thickness of the waste partings is highly variable. Partings for the most part are shale in composition but thin layers of clay, bog iron and sandstone also occur.

Ash content in the unwashed coals is also variable. At the points of bulk sampling in the adits, beyond surface weathering effects, face samples from 5 seams (#9, #8, #6, #5 and #0) were between 6.0 and 10.0% ash while the other three seams (#10L, #7 and #1 U) sampled were 26.0%, 64.3% and (*) 15.0 respectively. Additional data relative to ash from face samples is appended (Appendix B).

(*) NO. 7 adit was driven in bone in the floor of the coal seam. See Map #6B-572

Two types of waste material occur within the coals: (1) that which is interbedded as visible seams and bands of clay, shale, bog iron, sandstone or bone, and (2) that which is so intimately admixed with the coal that it is not visible by the unaided eye. On the basis of the coal seam detail descriptions, the percentage of visible coal in each seam has been calculated and posted on the Potential Coal Reserve Estimate Section (Map No. 6L-146), coarse impurities making up the difference between the figure shown and 100%. This compilation shows that the seams, for the most part, are quite consistent in the percentage of contained coarse waste material, the quantity of such waste usually increasing toward the ends of the seams where they are lensing out. No consistent relationship in the quantity of coarse waste in the vertical plane, from seam to seam, is evident nor is there any geologic reason to assume that such a relationship would exist.

Due to the apparent consistency of the percentage of coarse waste laterally within a given seam, the weighted average percentage of such waste should be taken into consideration in the future in selecting sites for bulk sampling so that the resulting samples will be as representative as possible. Conversely, this same reasoning can be utilized to evaluate the representativeness of the bulk samples already taken, as tabulated below:

Visible Logging Data

Seam #	Adit #	Sample #	At Point of Sampling		Wt'd Av. Entire Seam	
			% Coal	% Crs.Waste	% Coal	% Crs.Waste
#10L	11	9	76	24	96	4
# 9	3	1	93	7	93	7
# 8	6	2	95	5	91	9
# 7	7	3	77	23	96	4
#6	8	6	92	8	89	11
# 5	9	8	91	9	94	6
# 1U	5	5	99	1)	90	10
	5	4	98	2)		
# 0	2	7	94	6	95	5

On the basis of the above tabulation, it is readily apparent that the samples taken from seams #9 and #0 are truly representative while those taken from seams #10L and #7 are not representative of the over-all seams at all but reflect local areas that are appreciably dirtier than the average. The other samples are from areas that are either slightly dirtier or slightly cleaner than the average but are all, at least, in the same general order of magnitude as the over-all seam averages. These observations are of more than passing interest when one considers that the samples from seams #10L and #7 (the two that are decidedly not representative) gave the least favorable recoveries in the washability testing. Another factor testifying to the unreliability of our present single sample of #10 seam as being representative over any appreciable length is the fact that #10 seam has been one of the major producers of the area, both at Coal Creek and apparently at Morrissey as well.

Coal Quality:

Uppermost Seams:

Most of the information at hand relative to the quality of the coals of the Crow's Nest district is based upon only those seams that occur in the upper portion of the coal measures. Of these stratigraphically high coals it can be said that they are low sulphur, from moderately to strongly coking, medium-volatile bituminous. The ash content, in the natural state, varies from low (6%±) to high (15%±) but they are easily cleaned, by conventional methods, to an acceptable ash content of less than 8%. The coke produced from these coals is, on the basis of past consumption and test work, entirely acceptable for blast furnace use.

The best testimony as to the quality of these uppermost seams is the past production, of both coal and coke, from the district. At the present time the Michel Colliery is producing at the rate of approximately 600,000 tons per year with the raw coal averaging between 8% and 9% ash and the washed coal, for the Japanese market, being held to less than 7.5% ash. During 1960 the

Corporation used some 17,593 tons of this coal at the Columbia-Geneva plant in Utah.

During the Corporation's 1949 investigation 4 samples were taken from Coal Creek and 5 from Michel, all representing seams that were, at that time, being mined (Old, 1949). In addition to this information, several of the Cropco '60 four ton bulk samples from the Morrissey Ridge Sector also were from seams in the upper portion of the coal measures. These data will be discussed, under the title of "Coal Quality Testing Program," at a later date.

Lower Seams:

The seams within roughly the lower one-half of the coal measures appear to be markedly different, both physically and chemically, from those in the upper half. These lower coals appear to be low-volatile bituminous, they are higher in ash and they are probably, for the most part, only weakly coking at best.

However, these lower seams are frequently of great thickness; they are low in sulphur and, in some cases, they may still give washed coal that is acceptable from the standpoint of ash. These seams are of decided consequence in the evaluation of the district potential, from the Corporation aspect, since their greater thicknesses would contribute rapidly to expanding proven tonnages and they may prove to be, to a presently unknown extent, entirely suitable for purposes of blending with the strongly coking coals of the upper seams.

At the present time the only factual data relative to the quality of these lower coals is that which was obtained by the test work conducted on the Cropco '60 bulk samples taken from these seams. On the following page is a brief tabulation of the washability test results of all ten of the Cropco '60 samples. The reader will note that the samples from the lower (No. 5 and below) seams, with one exception, result in washed coals with ash contents

SUMMARY OF CALCULATIONS BASED ON WASHABILITY TESTING

Seam No.	Cropco Sample No.	Adit No.	Seam Thickness	Fraction Used	@ 1.45 sp. gr. % Recovery	% Ash	% S	% V.M.	@ 1.55 sp. gr. % Recovery	% Ash	% S	% V.M.
10 L	9	11	4.9 ft.	+¼ x 200	35.87	6.34	0.85	27.49	42.75	8.56	0.84	27.11
				+¼ x 0	40.67	9.56	0.90	26.55	47.55	11.08	0.88	26.34
9	1	3	14.3	+¼ x 200	86.08	3.38	0.43	25.86	88.44	3.85	0.45	25.79
				+¼ x 0	90.58	3.67	0.47	25.88	92.94	4.11	0.48	25.81
				(entire - raw)	(100.00)	(7.35)	(0.59)	(25.19)				
8	2	6	15.9	+¼ x 200	69.09	5.22	0.48	24.25	78.80	6.76	0.49	23.71
				+¼ x 0	73.99	5.70	0.49	24.25	83.70	7.10	0.50	23.74
7	3	7 (*)	20.7	+¼ x 200	46.89	4.18	0.51	24.77	49.48	4.90	0.51	24.57
				+¼ x 0	52.49	5.35	0.52	24.48	55.08	5.94	0.52	24.31
6	6	8	13.0	+¼ x 200	71.15	6.64	0.57	22.26	80.65	7.97	0.56	21.76
				+¼ x 0	75.95	7.10	0.57	22.08	85.45	8.30	0.56	21.63
5	8	9	15.1	+¼ x 200	73.32	6.83	0.56	20.39	82.92	8.02	0.55	20.14
				+¼ x 0	76.72	6.99	0.57	20.33	86.32	8.12	0.56	20.09
1 U	5	5	15.9	+¼ x 200	73.87	6.44	0.46	18.32	80.86	7.69	0.46	18.19
				+¼ x 0	79.07	6.62	0.47	18.28	86.06	7.78	0.47	18.16
1 U	4	5	13.1	+¼ x 200	55.10	6.85	0.50	18.58	63.04	8.61	0.50	18.31
				+¼ x 0	59.10	7.38	0.54	18.56	67.04	8.97	0.53	18.30
0	7	2	32.7(½)	+¼ x 200	63.62	7.43	0.30	18.47	78.60	9.88	0.29	17.94
				+¼ x 0	67.02	7.64	0.30	18.51	82.00	9.95	0.29	17.99
#10	10	Michel	61.6	+¼ x 200	74.89	8.01	0.33	18.22	82.41	9.39	0.34	17.95
				+¼ x 0	77.59	8.18	0.34	18.25	85.11	9.50	0.35	17.99

(*) 40.7% of this entire sample runs 79.6% ash and sinks at 1.75 sp. gr.

Note: Only the lower one-half of seam #0 was sampled during Cropco '60

TABLE VII

between 7.7% and 9% and recoveries in excess of 80%.

The interpretation of this test work will be discussed more fully at a later date.

COAL QUALITY TESTING PROGRAM

Due to the fact that the results of coking tests on the Cropco '60 bulk samples are not, as yet, available the entire subject encompassed by this heading will be covered in a supplemental report, by Dr. Vard Johnson, at a later date.

ESTIMATED RESERVES

Reserve Estimates by Others:

Numerous district wide, and local area, estimates of possible reserves within the Crow's Nest Coal Field have been run in the past. These estimates have varied as to the minimum seam thicknesses included and depth of cover used but all have one thing in common, namely that the potential coal tonnage is very large. Tabulated below is the essential data excerpted from some of these early estimates:

Source	Year	Min. Seam Thickness Incl.	Total Coal Used	Area	(Ft.) Max. Cover	Total Tons of Coal(*)
Dowling	1915	?	100 ft.	230 sq.mi.	?	22.6 billion
McKay	1946	3 ft.	Variable by areas	55 sq.mi.	2,500	8.2 billion (1)
Olds, et.al.	1949	3	Coking seams only: Michel 47.5' 12 sq.mi.) Coal Cr. 40' 2 sq.mi.) North end 47.5 10 sq.mi.)		2,500'	1.27 billion
Coal Co.	1946	Actual	Assured & Prob. Reserves Adjacent to Coal Cr. & Michel Mines: Coal Cr..... 2,090 acres) Michel..... 7,168 acres)		4,000	102.8 million

(*) All mineable coal, reduce by 50% to obtain recoverable coal.
(1) This estimate is held as being the most realistic estimate for the entire district (includes both coking and non-coking coals).

The most exhaustive estimate of coal reserves conducted to date by the Corporation have been those made by Mr. J. F. Sweeney (1956). Sweeney specifically limited his study to those coals that were known to be of good coking quality; four of the uppermost seams in the Michel area and two of the uppermost seams in the Coal Creek area. Due to the scope of Sweeney's work it is not only briefly summarized in table form below but the entire section on reserves of his report of 1956 and the summary of his special report of 1958 are appended.

SWEENEY - COKING COAL RESERVES - 1956

	Tons - In Millions	
	Mineable Reserve	Recoverable Reserve
(1) Total probably mineable coking coal reserve - Entire Coal Co. lands +3' thickness & less than 2,500 ft. cover	2,350	1,175
(2) Accessible through present mines or of reasonable access:		
Michel area	51	25.5
Coal Creek area	11	5.5
Morrissey Ridge Block	15	7.5
	77	38.5
(3) Lands not owned by Coal Co.		
Hosmer Block (now B.C. prov.)	23	11.5
Large Dominion Gov'n. Block	30	15

(Location of specific areas and estimated cover, as shown on plate appended with other Sweeney tonnage estimate data)

The only modifications that are appropriate to Mr. Sweeney's estimates, at this time, would be to correct for the production from the Coal Creek and Michel areas since the date of his original report (July, 1956). This would amount to a reduction of only 0.3 million tons in the Coal Creek area and 2.98 million tons in the Michel area to update the figures to January 1, 1961.

Potential Coal Reserve - Morrissey Ridge Sector:

A sufficient amount of data is at hand on which to run a preliminary estimate of the potential coal reserve of the Morrissey Ridge Sector block, even though little diamond drilling was completed during the 1960 field season. The block is defined, for the purpose of this estimate, as being that portion of the western edge of the coal basin that lies between our Ridge Numbers 1 and 21 of the Morrissey Ridge front.

The following estimate of Potential Coal Reserve is not intended to be microscopically accurate but merely to indicate the order of magnitude of tonnage that can reasonably be expected to occur within the block. It is

based on the Cropco '60 geologic mapping, trenching, coal seam description and subsequent correlation of seams. This estimate includes only those seams that are 3 feet or greater in thickness and that contain not less than 80% visible coal. No seams that occur on less than two adjoining ridges were included. In zones where more than one mineable seam thickness occurred, and where the intervening material was not sufficiently thick to reasonably allow for the extraction of more than one of the seams, only that seam which in our opinion was the most optimum was included in the estimate.

The seams were projected down dip, for the most part, to either one half of their outcrop length or to a maximum depth of 2,000 ft. of vertical cover, whichever was the lesser distance. A few exceptions to the "one-half of the outcrop length" rule do occur where special conditions exist. Estimated dip lengths were arrived at by the construction of 6 geologic cross sections (Maps No. 6H-311 & 6H-312) through the crest lines of Ridges 3, 9, 15, 17, 20 and 21. The 2,000 ft. of vertical cover line was then determined on these sections and the dip lengths were averaged for the blocks between adjacent cross sections. Average strike lengths within the blocks between sections were obtained for each seam. The seams, and portions of seams, included in the estimate are shown on Map No. 6L-146.

On the basis of the above conditions, the total potential mineable coal reserve of the 21 separate seams included in the estimate is as given below:

Tons	Average Total Width	Avg Coal Width	Avg Width Waste	% Coal	% Waste
511,638,316	20.85'	19.00'	1.85'	91.1	9.1

The detail from which the above total was taken is shown on Table A following page 63...

Of this total, the bulk samples taken were from seams representing some 335,929,375 tons, or about 66%, of the indicated 511,638,316 tons total. By difference, the quantity represented by unsampled seams is 175,714,570 tons. Based on the results of washability tests and analyses of washed coal (1.55 sp. gr.) from the 9 bulk samples taken, this 335,929,375 tons can be roughly broken down as to quality as follows:

	Tons	% Rec.	% Ash	% Sulphur	% Volatile
BEST Sample #1 Seam #9	35,278,060	92.9	4.1	0.48	25.81
NEXT BEST Samples #2, 4, 5, 6, 8 Seams #8, 10, 6, 5	176,147,440	80.6	8.1	0.52	20.46
WORST Samples #3, 7, 9 Seams #7, 0, 10L	124,503,875	73.3	9.5	0.41	19.51
	335,929,375				

The detail on this 335,929,375 tons, covering the mining widths, coal widths, percentage of waste, etc. is shown on Table B following this page.

Several factors pertinent to this estimate that should be put on record are as follows:

(1) No estimate was run on potential tonnage between Ridge 1 and Coal Creek, on the north, or between Ridge 21 and Morrissey Creek, to the south. Additional data as to the more accurate topography of both drainage areas is needed to establish more precisely the 2,000 ft. of cover by seams, and this data will be forthcoming with the new Spartan topographic maps that are due for delivery by May 15, 1961.

(2) Reserves in addition to those shown for Seam #10 undoubtedly exist in the Morrissey Ridge sector. The tentative correlation of seams (Map No. 6L-145) shows that our data with regard to that seam is in part fragmental and, as such, no tonnage was figured for No. 10 seam over sizeable portions of the area.

TABLE VIII

TABLE A

(Tons in 1000's)

Seam No.	Exposed on Ridges	Outcrop Length	Thickness of Coal	Est. Dip Length	Tons Coal	Thickness Waste	Tons Waste
-1	1-15	19,545'	23.4'	2,283'	41,748	3.6'	6,430
	19	2,215'	35.8'	2,375'	7,533	7.3'	1,534
0	1-17	25,700'	37.7'	2,312'	89,616	3.5'	8,327
1L	1-3	3,225'	13.7'	1,612'	2,851	2.3'	477
1M	7-9	5,212'	10.6'	2,100'	4,639	1.6'	698
1U	9-15	14,045'	41.8'	2,250'	52,837	3.0'	3,792
	18-21	9,065'	29.7'	2,500'	26,923	5.4'	4,895
2L	1-4	5,625'	20.1'	2,250'	10,176	1.3'	658
2M	3-9	9,637'	7.8'	2,100'	6,312	0.0'	———
2U	7-19	24,545'	34.0'	2,300'	79,905	3.0'	6,774
4L	7-9	5,312'	3.2'	1,900'	1,238	0.0'	———
4U	14-17	9,790'	20.1'	2,250'	17,710	2.6'	2,291
5	7-9	5,312'	13.8'	1,875'	5,498	0.9'	356
6L)							
6U)	1-21	34,765'	17.4'	2,290'	55,415	2.2'	6,988
7	17-20	10,470'	16.0'	2,500'	16,752	0.6'	628
8L	1-3	3,225'	14.1'	2,100'	3,818	2.0'	542
8U	1-3	3,225'	3.6'	2,100'	974	0.4'	110
8	7-21	24,045'	14.6'	2,185'	30,681	1.3'	2,741
9	1-14	19,550'	11.7'	2,785'	25,473	0.8'	1,740
	17-19	7,498'	6.2'	5,280'	9,804	0.2'	315
10	3-4	4,425'	4.9'	4,200'	3,642	0.5'	372
	10-15	11,832'	5.8'	5,280'	14,494	0.0'	———
BL	1-3	3,225'	6.4'	1,612'	1,332	0.7'	145
BU	3-4	4,425'	5.1'	2,212'	1,996	0.0'	———
Totals & Averages			19.0'		511,638	1.85'	49,814

TABLE B

Sample #	Seam #	Tons Coal	Outcrop Length	Mining Thickness	Coal Thickness	Waste Thickness
1	9	35,278,060	27,040'	10.8'	10.1'	0.7'
2	8	35,473,770	30,475'	14.7'	13.4'	1.3'
3	7	16,752,000	10,470'	16.6'	16.0'	0.6'
4 & 5	1U	79,760,340	23,110'	41.0'	37.0'	4.0'
6	6	55,415,410	34,765'	19.6'	17.4'	2.2'
7	0	89,615,900	25,700'	41.2'	37.7'	3.5'
8	5	5,497,920	5,312'	14.7'	13.8'	0.9'
9	10L	18,135,975	16,257'	5.7'	5.5'	0.2'
Totals & Averages		335,929,375		19.5'	17.8'	1.7'

(3) A separate calculation run for coals of the thickness interval of 3.0 to 5.0 ft. within the Morrissey Ridge Sector revealed that this thickness range accounts for only 2.54% (or 13,025,480 tons) of the total of 511.6 million tons.

(4) Due to the relatively great strike length of many of these seams, as compared with the short down dip projections used in most cases, something in the order of 80% of this coal could probably be termed "Indicated" rather than "Potential".

Quite obviously, the completion of drillholes DDH BC-1 through 6, and the new topographic mapping, will enable a more accurate calculation of tonnage to be run for this area following the Cropco 1961 field season.

DEVELOPMENT AND MINING COST ESTIMATES-

Estimates for the cost of developing new areas within the basin are not considered to be appropriate at this time due to the early stage of the examination. At a later date, probably as a part of the 1962 Progress Report, a sufficient amount of data will be on hand to allow a selection of the most promising area, excluding those currently in production, for starting new mines. At that time, a thorough and complete appraisal of the cost of development of a new mine, or mines, would be meaningful.

With regard to current district mining costs, we have estimated that production from the Michel underground operation is presently costing a total of $6.49 per ton of cleaned coal, f.o.b. cars at the washery siding. Present open pit production is reported by the Coal Company to cost $2.06 per ton f.o.b. trucks. The details of these estimates are included under the Michel area section of "History, Development and Production."

This underground cost figure is very much in line with similar estimates in the past, when escalation for increasing labor and supply costs is taken into consideration. Sweeney estimated the cost of underground cleaned coal production from the district in 1956 to be $5.85 per ton and the actual Coal Company cost for 1948 (Old, 1949) was reported to be $5.50 per ton. In order to compare these figures more accurately, it is important to note that the rate of gross annual production has been on the decline since 1956, being approximately one million tons per year in 1948, and 1.1 million tons in 1956 but only 0.6 million tons in 1960.

Quite obviously, a new mine with greater mechanization and cleaning facilities could reduce the $6.49 per ton cost to some extent.

A new two year Wage Agreement was recently signed between the Coal Operators Association of Western Canada, of which the Coal Company is a member, and the United Mine Workers of America, the union representing the workers of

the district. This agreement, which went into effect July 3, 1960, provides for a wage increase of 40¢ per day, effective July 3, 1960, and an additional increase of 40¢ per day effective July 3, 1961. This wage increase on July 3, 1961 will, obviously, affect the mining costs as given herein.

MINING GEOLOGY

Mine Access:

The areas that have been principally exploited in the district to date - Michel, Coal Creek, Morrissey - have been concentrated in the major cross drainages of the basin where access to the gently dipping coal beds could be made by driving haulage ways in along the strike of the seams. This manner of access is, for obvious reasons, the most economic and advantageous.

Areas such as the Morrissey Ridge block, or at least those portions that are too far from the Coal Creek or Morrissey Creek drainages to be advantageously exploited by the past district procedure, pose a different problem. Such areas of relatively elevated coals could be exploited in either of two ways: (1) the driving of rock tunnels through the Fernie shale and Kootenay formation, in under the coal, from part way up the ridge front and then mining up along the dip of the seams, or (2) by putting in good access roads up the face of the ridge to the various favorable seam outcrops and sinking inclined shafts that parallel the dip of the coal seams. While the building of access roads up the front of a mountain mass such as Morrissey Ridge could only have been done at a prohibitively high cost during the early period of the district's development, modern earth moving equipment makes this procedure of exploitation economically sound.

Water, Gas and Drainage:

To my knowledge the existing, and previous, operations in the district have not encountered any great amount of difficulty from water problems. In the Michel area some water finds its way into the mine, through old working that "hole out" to the surface, during the period of spring snow melting but this water finds its way down to, and discharges out of, the rock tunnel haulage level.

During the 1960 diamond drilling, a heavy flow of water, under artesian head, was encountered in DDH BC-1 at a depth of from 230 to 240 feet. This flow

was not immediately gauged but some 24 hours later it was determined to be 43 Imperial gallons per minute. The inflow of water did cause some difficulty in the drilling operation but it was finally cased off. From the nature of this artesian flow it is believed that its source was a reservoir of trapped water immediately above, or between, conglomerate layers of the Elk formation.

Drainage of water that finds its way into the mines has not been a district problem to date for two reasons: (1) all past workings have been served by haulage levels driven with the grade in favor of the load, and (2) little work has been attempted below the level of the creeks. In the event of the exploitation of elevated coals, such as the Morrissey Ridge sector, drainage should not be a problem if the areas are developed by deep level adits. In the event of the mining of these coals by inclined shafts driven downward from their outcrops, pumping of any water influx would have to be anticipated.

While gas is a problem at any coal mine, the extensive past operations in this district should serve to illustrate that the problem locally is not greatly more serious than elsewhere. Some of the past reports that refer to the old Morrissey operations credit the extremely gassy nature of the coals in that area as causing the termination of the operations. Due to the fact that these mines have been closed for many years, and any factual data on them is extremely scanty, this factor cannot be entirely evaluated. However, it is probable that many factors, other than gas, also contributed to the troubles of the Morrissey area.

Bumps and Outbursts:

Local outbursts and bumps, and occasional sizeable disasters, have occurred in the district. The following review of these hazards is taken directly from Sweeney (1956, p. 9):

"While not directly related to the geologic structure, one of the major underground mining hazards in this area is the sudden release of ground stresses which have appeared in two characteristic forms, namely 'bumps' and 'outbursts,' the latter being commonly referred to in this locale as blowouts. Bumps can be divided into three classes, namely 1) Coal bumps or bounces in which the coal seam alone moves, 2) Face bumps where material is projected out from the face and ribs, and 3) District bumps which usually occurs 300 to 500 feet back from advancing faces when the weakest strata, usually the floor, is forced out from under the pillars that are crushed and/or shattered. 'Outbursts' are the result of stresses within the coal bed resulting in the coal being blown from the working face into mine openings occasionally in enormous quantities. 'Bumps' have been experienced mainly at the Elk River Colliery, and the most serious manifestation occurred in large sections of the No. 9 and 10 seam. 'Outbursts' at the Elk River Colliery occurred in a comparatively restricted area (a shallow canoe-shaped fold in the No. 10 seam), some of which were of almost incredible violence. Similar phenomena have occurred at Michel and also at two mines of the Carbonado Colliery. On November 18, 1904, at the Carbonado Colliery, occurred one of the largest outbursts in the district which was one of the major contributory factors to the closing of this operation. At this time, there were over 4,000 tons of coal blown from the face with a result in loss of 14 lives."

Roof and Floor Rocks:

The roof and floor rocks of the mineable seams of the district are usually shale although in some instances they are either conglomerate or sandstone. However, in most instances the shale is from firm to hard and is sufficiently competent to allow for safe mining with only a reasonable amount of dilution. Local areas of incompetent shales in the roof do occur, as in the New No. 4 mine at Coal Creek which required heavy timbering, but this is not the district rule.

Overburden:

It has been found through past district experience that the usual economic mining limit for depth is 2,000 ft. of vertical cover. Beyond this, and locally even at more shallow depths, the incident of bumps and outbursts is such, in conjunction with the general increase in support necessary, to make mining impractical, at least by present methods.

Structure:

The structure of the district, as related to mining geology, can be

divided into two categories, viz. faulting and folding.

The faulting off, and displacement of coal seams, has given rise to mining problems locally. The termination of mining on the north side of Coal Creek is largely attributable to this type of structural complication. However, the large areas exploited both south of Coal Creek and at Michel, even though local faults were encountered, would suggest that this problem is not one which cannot be overcome.

Sharp folding, particularly within the lower seams of the Kootenay formation, could give rise to serious mining problems. Geologic mapping conducted in the district, including that done during Cropco'60, has demonstrated that roughly the lower one-third of the Kootenay sequence is locally subjected to very sharp folding but that this structure dies out rapidly going upward in the sequence such that the upper portion of the measures are undeformed. While this type of structural complication could certainly create serious mining problems, it is a local condition that must be evaluated, in conjunction with the many other factors, within each restricted area where it occurs. It should be noted, however, that this local folding of the basal Kootenay seams is what has given rise to all of the areas of sufficient thickening of seams to support open pit, or strip mining, operations.

PROPOSED PROGRAM - CROPCO '61

Purpose and Scope:

The Cropco '61 program has been planned to accomplish the following:

(1) the reconnaissance of the entire Coal Company holdings to obtain specific information as to its over-all potential,

(2) the evaluation and appraisal of the Option B (Michel) area,

(3) the completion of the drilling program on the Morrissey Ridge Sector, and

(4) the continuation of detailed geologic and bulk sampling work on the west side of the basin, northward from Coal Creek.

The approved budget for this project, for the 1961 year, is $376,700 as detailed in a later section under the heading of Estimated Cost.

Personnel:

The minimum technical personnel necessary to accomplish the above listed aims, excluding the project supervisory staff, has been estimated by the writer to be 7 Senior Geologists, 6 Assistant Geologists and one Senior Mining Engineer. The total field personnel necessary, both technical and non-technical, are as tabulated below:

General Summary of Personnel

Type of Work	No. Crews	Total No. Men
Geologic Mapping Parties, 2 man	4	8
Michel Area Evaluation Team, 3 man . .		3
Trenching: Trench boss plus four 4 man trenching crews	4	17
Supervisor of Mining and Road Work . .		1
Mining: Overman plus six 2 man mining teams plus 4 laborers . . .	6	17
Drilling: Geologist and assistant . .		2
Office personnel		1
		49

The size, scale and importance of this appraisal is such that it should be conducted by the very best field personnel available. While it is not possible to obtain, for a four-month period, a sizeable staff of competent senior personnel that have had past experience specifically in coal, it is possible to obtain such personnel that are well experienced in mapping and interpreting structure in soft rock environments. It has been the aim of the writer, over the period of the past four months, to engage such personnel within Canada.

Prior to the start of actual field mapping, a one-week period, of May 24 through 31, is to be spent in familiarizing the geologic staff with the local geology, nature of the coal seams and aims of the project. Standardized forms for the recording of both coal seam descriptions and stratigraphic columns have been prepared and standardized mapping procedures have been worked out.

The Senior Mining Engineer, experienced in coal, to head up the Michel Area examination team is to be provided by the Corporation.

An abundant supply of non-technical personnel is available in the Fernie-Natal area to meet the needs of the project.

Reconnaissance Work:

Due to the fact that the entire effort put forth by the project during Cropco '60 was restricted to a single very small portion of the basin, our knowledge of the over-all potential of the Coal Company ground, save for this small area, is the same now as it was a year ago. This condition must be rapidly rectified. The reconnaissance of the entire basin, to gain reliable information as to the potential, or lack of it, within specific areas is one of the principal aims of the 1961 program.

The reconnaissance work will consist of the geologic study of all areas of Kootenay formation outcrop. The work will entail geologic mapping (directly onto 1" = 2,000' scale aerial photographs), relatively wide-spaced trenching and stratigraphic column measurements and the delimiting of areas with presumed open pit potential. In conjunction with this work, key index horizons in the Elk and/or Blairmore formations will be selected and mapped back into those major drainage areas within the basin which have a reasonable likelihood of containing Kootenay coal seams at depths of less than 2,000 feet of cover so that the potential of such areas can also be evaluated.

It should be possible a year from now to establish a "potential priority rating" for the various tracts controlled by the Coal Company, both from an underground mining and an open pit point of view, as a result of this work.

Without such primary knowledge of the vast Coal Company holdings, it is impossible to determine where exploration (or coal tonnage development) money should be spent to gain the most advantageous results. This reconnaissance work, quite obviously, should have been done during the first field season of the option. However, that was not the case, making it even more pressing that it be completed during this second field season.

Two geologic mapping teams will devote their entire summer to this phase of the project. They will utilize pack horse teams and, if necessary and desirable, helicopters. In the early part of the summer each reconnaissance party will consist of a Senior Geologist, an Assistant Geologist and a packer. Within approximately one month after the beginning of the field season, each party will be augmented by the addition of some trenchers.

Michel Area Examination and Appraisal:

Because of the optioning arrangement, the Michel area, to this date, constitutes a seven million dollar question mark. It is my opinion that the potential, and worth to the Corporation, of this Option B property should be precisely determined before the close of the second year of the option period. It is anticipated that such an appraisal, as a somewhat distinct and separate study from the balance of the project, will be accomplished during the Cropco '61 season. Due to the nature of this appraisal, and the special problems involved, it should be conducted by a Senior Mining Engineer and a Senior Geologist jointly, the Mining Engineer to be well experienced in coal mining practice and to head up the examining team.

This examination is to determine not only the dollar worth of the presently existing mining, washing and coking facilities but also the reserves, or potential reserves, within the three separate and distinct category blocks that are excepted from Option A (see Plate 1).

Diamond Drilling:

As a result of the little diamond drilling that was accomplished during the past field season, the over-all appraisal is one year behind in that phase of work. As a result, the drilling to be conducted during Cropco '61 will largely be that which is necessary to provide proof of down dip continuity, and additional samples, from the Morrissey Ridge Sector. In addition, late in the season some short hole drilling will probably be desirable to fill out the Michel area appraisal, assuming that budgetary limitations will allow for such additional drilling.

It is anticipated that the drilling of the Morrissey Ridge Sector will follow the general recommendations as laid out in a special

report by Still and Okerlund under a date of August 18, 1960. This report compared the cost of drilling 3 deep (4,000+ feet) holes from the backslope of the range to the drilling of 6 holes of moderate depth (2,500± feet), three of which would be on the backslope and the other three on the frontslope. It was clearly shown at that time that the combination of the 6 moderate depth holes was the most economically advantageous, even when the cost of constructing a road up to the frontslope sites was included. As a result of this study the frontslope road was constructed and all drill sites were prepared during Cropco '60, the road and drilling sites being located as shown on Map No. 6L-144.

These six drill holes will test the coal measures in the Morrissey Ridge Block at three sections that are approximately equally spaced between the exploited areas at Coal Creek and Morrissey Creek. The bottoming of hole DDH BC-1 plus the drilling of the other 5 holes is estimated to run to approximately 13,900 feet of drilling.

Fernie Ridge Detail Area:

At this stage in our knowledge of the district, it appears entirely likely that the western edge of the basin (the Elk River side) has, for various reasons, the greatest coal potential of all of the Option A ground. For this reason, detailed geologic work and bulk sampling, paralleling that done on the Morrissey Ridge Sector, will be conducted northward from Coal Creek, along the Fernie Ridge Sector, during the coming field season.

This work will consist of the geologic mapping of the Kootenay outcrop along the range front (at a scale of 1" = 1,000 feet), the trenching of some 16 ridge lines and the taking of bulk samples both at Coal Creek and at some point yet to be determined north of Coal Creek. In addition, bulk sampling will be completed within the Morrissey Ridge

Sector and at Morrissey Creek.

The bulk of the Cropco '61 field personnel will be assigned to this work: 2 geologic mapping parties, 17 men on trenching and 17 men on mining for bulk samples.

Toward the end of the season, when sufficient data is at hand to allow for the intelligent laying out of diamond drill sites for the testing of the Fernie Ridge block, roads and drill sites will be constructed for use during the 1962 program.

Estimated Cost:

The budget which has been approved for the 1961 year of the Cropco project totals $376,700, as broken down below:

Acc't No.	Item	$
51	Gen'l Administration	$ 35,000
52	Acquiring Property	-0-
53	Equipment (vehicles)	$ 24,500
54	Inventory	$ 6,000
55	Surveying and Geology	$ 66,700
56	Construction and roads	$ 4,200
57	Drilling (incl. drill roads for 1962)	$150,000
58	Underground Work	$ 35,300
59	Special Services	-0-
60	Misc.: Gov't fees, exchange, etc.	$ 15,000
		$336,700
	Laboratory charges	$ 40,000
	Total	$376,700

This budget is that which was originally submitted by Dr. James A. Noble on September 10, 1960. While the presently contemplated program does not exactly coincide with that planned by Noble it should be

possible to stay within this total budget figure although the final distribution of funds, by account numbers, will vary somewhat from the above.

The item which is most apt to upset the contemplated program, or the budget, is the cost of diamond drilling. The budgeted figure (of which $135,000 is for drilling and $15,000 for roads) is based upon an estimated drilling cost that is realistic but which may or may not be in agreement with actual contractors' bids yet to be received. In the event that the most reasonable drilling contractor's bid is grossly in excess of the estimated drilling cost, either the contemplated drilling footage will have to be curtailed or the budget increased. Because of the fact that the project is already one year behind in diamond drilling, it would be quite damaging to the over-all appraisal to curtail drilling footage in 1961.

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THE CROW'S NEST PASS COAL COMPANY, LIMITED

HISTORY - THE COMPANIES' LANDS

(After Sweeney, 1957)

THE CROW'S NEST PASS COAL COMPANY, LIMITED

HISTORY - THE COMPANIES' LANDS

FREEHOLD LANDS - In 1889 the Government of British Columbia Crown granted to E. Bray and others, Lots 81 to 86 on Martin Creek, Group 1 Kootenay District, containing 2,409 acres: on March 26, 1889 to The Crow's Nest Coal & Mineral Company.

Freehold

In 1890 the Government of British Columbia Crown granted to The Crow's Nest Coal & Mineral Company, Lots 151 to 161 on Michel Creek and Lots 162 to 171 on Coal Creek, all in Group 1 Kootenay District, and containing respectively 3,480 and 4,320 acres.

Lands

On the 17th of April, 1893, The Crow's Nest Coal & Mineral Company deeded these lands, 10,209 acres in all, to the British Columbia Coal Petroleum and Mineral Company.

Area

On the 22nd of May, 1897, the British Columbia Coal Petroleum and Mineral Company deeded the lands to The Kootenay Coal Company, and Certificate of Title dated 3rd June, 1897, was issued vesting the lands in the latter Company.

10,209

Acres

The Kootenay Coal Company later, by change of name, became the Crow's Nest Pass Coal Company, Limited.

These lands totaling 10,209 acres are usually referred to as the "Freehold Grants."

SUBSIDY LANDS - The Crow's Nest & Kootenay Lake Railway Company was incorporated in 1888, its Charter giving it authority to construct a Railway in the Crow's Nest Pass. The controlling interest in the Charter was the same as in the Kootenay Coal Company. An act passed during the same year gave it a land grant 99 feet wide for right-of-way and such crown lands as were necessary for station, siding, terminal purposes, etc. In 1890 the "Railway Aid Act of 1890" gave it an additional land grant of 20,000 acres per mile of railway completed, the lands to be taken in alternate blocks, with a 20-mile frontage on the right-of-way.

C.N.&K. Lake Charter

Subsidy Lands

The deficiency lands to be taken where selection in the prescribed manner was impossible, were specified.

Later, by change of name the railway became "The British Columbia Southern Railway Company."

Change of name

(After J. F. Sweeney, 1957)

HISTORY - THE COMPANIES' LANDS (Continued)

C.P.R. Charter

In 1897, The Canadian Pacific Railway Company obtained from the Dominion a charter for the construction of a Railway also through the Crow's Nest Pass, and coupled therewith a subsidy of $11,000.00 per mile, subject to the condition that should the C.P.R. by arrangement with any other Company or with the B. C. Government, receive a land grant in connection with the construction of the road through the Crow's Nest Pass, 50,000 acres of coal-bearing lands be conveyed to the Crown.

Crown reservation of 50,000 acres

Tripartite Agreement 30 July , 1897

In the same year, (1897, July 30th) a tripartite agreement was entered into between the Canadian Pacific Railway Company, The British Columbia Southern Railway Company and the Kootenay Coal Company.

In it, The Canadian Pacific Railway Company Covenanted:

Covenants by C.P.R.

1. To construct the Crow's Nest Pass Main Line.
2. To construct branches.
3. Not to mine coal for ten years from the date of the completion of the main line.
4. To furnish facilities for the transportation of coal and coke.
5. To furnish transportation to miners in parties of five or over at three cents per mile, and to
6. Make a rate on the Coal Company's construction material of six tenths the ordinary tariff rate.

The British Columbia Southern Railway Company covenanted:

Covenants by B.C.S.

1. To sell lands other than coal-bearing to the public at prices subject to the supervision of the Lieutenant Governor in Council.
2. To convey to the Dominion of Canada 50,000 acres of coal-bearing lands.
3. To convey to the C.P.R. six sections of 640 acres each, 3840 acres in all, out of the lands described in Section 16 of the Railway Aid Act of 1890 as those from which selection should be made where such section was impossible in the manner prescribed; in other words, the deficiency lands.
4. To convey to the Coal Company the lands earned by the construction of the Eastern Section of the Railway, estimated at approximately 250,000 acres, excepting thereout the 3840 acres to be conveyed to the C.P.R. (No. 3 above) and so much of the

50,000 acres to be conveyed to the Crown as fell within this area.

5. To further convey to the Coal Company 10,000 acres of coal and petroleum-bearing lands.

The Kootenay Coal Company covenanted:

1. To develop and equip coal mines.
2. To furnish coal at reasonable prices.
3. That if the withholding from sale of its coal lands by the C.P.R. should result in the imposition of Provincial, School and Municipal taxes thereon, the Coal Company will pay the said taxes, or failing which the C.P.R. shall be at liberty to dispose of the lands so taxed.

Covenants by the Kootenay Coal Co.

The Coal Company's land holdings, therefore, as a result of the above freehold grant, statutes and agreements were:

	Acres
1. Freehold Grants (see page 1).	10,209.00
2. The Fernie Townsite Block. This was prior to conveyance by the B.C.S. Railway to the Coal Company on the 5th of November, 1900, to facilitate the latter's business, and is part of the Railway Aid Act of 1890.	614.66
3. The Morrissey Townsite Block. This was a prior conveyance similar to the above, dated 7th April, 1903.	371.50
4. The lands earned under Section 16 of the Railway Aid Act of 1890, regarding the construction of Eastern Section of the B.C.S. Railway, approximately	227,838.95

Note: The lands listed in the last item (#4) are referred to in the deed dated December 1, 1904, as being approximately 250,000.00 acres but there are the following exceptions:

a.	Six sections conveyed to the C.P.R. being	3,840.00 acres
b.	Conveyance to the Crown within this area	5,000.00 acres
c.	B.C.S. main line and Coal Creek Branch rights-of-way 885.12 and 40.77 acres	925.89 acres
d.	Fernie Block, already conveyed, being	614.66 acres

Acres Carried Forward 239,034.11

	Acres Brought Forward	239,034.11
e. Morrissey Block, already conveyed, being	371.50 acres	
f. Lands conveyed to the C.P.R. at Hosmer, (sold to C.P.Ry.Co. for $35.00) about	1,200.00 acres	
g. The Coal Company's freehold lands being	10,209.00 acres	
Excepting in all		22,161.05 acres
Leaving net as shown by item #4 page 3		227,838.95 acres
5. The Coal and Petroleum bearing lands in "Deficiency Block A" being		10,000.00
Total Land Holdings		249,034.11

About the same time, in fact the deed is dated 28th November, 1904, two days before the date of the deed to the Company from the B. C. Southern, the Coal Company transferred the following lands to the Crow's Nest Pass Electric Light & Power Company, Limited:

Item No. 4, previous page "A"	227,838.95 acres
Item No. 1, previous page "B"	10,209.00 acres
Item No. 2, previous page "C"	614.66 acres
	238,662.61 acres

The following exceptions were made from the transfer:

From "A"; M.F.&M. Right-of-way at Carbonado	58.30 acres	
to B.C.S. ballast pit	18.80 acres	
MF&M at Coal Creek	27.67 acres	
	104.77 acres	
From "B"; See below		
From "C"; Mutz & Scott Ltd.	2.69 acres	
Fernie Townsite	380.00 acres	
A. B. Trites	.92 acres	
Harry Herchmer	.92 acres	
Coke Oven Lands	14.53 acres	
	399.06 acres	

Some other lands upon which mining and other plants have been erected were also excepted from the deed of 28th November, 1904, but as the descriptions were vague the Government required further descriptions and accordingly deed dated 20th September, 1905 delimited the other lands excepted in the first deed, as follows:

From "A";	Carbonado lands	1,049.00 acres	
	Lands at Coal Creek above tipple	1,440.00 acres	
	Michel lands	2,480.00 acres	
From "B";	Lots 167, 168, 169 and 170 at Coal Creek	1,280.00 acres	
		6,249.00 acres	
	In all		6,752.83 acres
Making the net transfer to the Power Co.			231,909.78 acres
and leaving the total holdings of the Coal Co., including lands under the agreement for sale, above excepted.			17,124.33 acres

On the 30th of August, 1907, the Coal Company conveyed to the Power Co. 28.41 acres of land at Michel (part of 2,480 acres of Michel "Mining Plant Lands" which has been excepted from the conveyance of 1904). This made a total holding of lands by the

Power Company	231,938.19 acres
Coal Company	17,095.92 acres

In March, 1909, (March 12, 1909) the Power Company retransferred to the Coal Company all the lands firstly and secondly described in the Coal Company's conveyance to the Power Company of November 28th, 1904, and in deed of delimitation of 20th September, 1905, these being:

Firstly	227,734.18 acres
Secondly	3,960.00 acres
	231,694.18 acres

The following areas were excepted from the reconveyance by:

HISTORY - THE COMPANIES' LANDS (Continued)

Paragraph 1.	427 acres	North of the Fernie Townsite Block	These lands held for future townsites.
2.	650 acres	South of the Fernie Townsite Block	
3.	306 acres	East of the C.P.R. Railway at Cokato	
4.	74 acres	at Michel	
5.	920 acres	at Michel Prarie	
	2,377 acres		
" 6-16 inclusive	708.256 acres		This land sold by Power Co. to outside Parties
		Total 3,085.256 acres	

Making the net retransfer to the Coal Company 228,608.924 acres

The lands remaining in the two Companies as a result of the above are:

In the Coal Company			
Fernie Townsite Proper	380.00	acres	
Morrissey Townsite	371.50	acres	
Mining Plant for freehold lands	10,110.59	acres	
Deficiency Block	10,000.00	acres	
Outside Lands	224,718.924	acres	245,581.014 acres
In the Power Company			
Fernie Townsite Block (not in Fernie Townsite)	215.60	acres	
Michel Townsite	28.41	acres	
Land for future townsites			
North of Fernie,	427.00	acres	
South of Fernie,	650.00	acres	
East of Cokato	306.00	acres	
At Michel	74.00	acres	
At Michel Prairie	920.00	acres	2,621.01 acres
		Total	248,202.024 acres

Sales of lots have been made from time to time in all the Companies, Townsites and Outside lands, but only those are deducted in arriving at the above total which appear as reservations or exceptions in the documents dealt with. As sales are occurring constantly it would be impossible to give an accurate total. Practically all the Fernie Townsite Proper has passed out of the Companies' hands, also the greater part of the Fernie Annex, the Fernie Townsite Addition and the New Michel Townsite. The latest townsite is the Fernie Annex Extension. The Fernie Park has also been laid out and opened for sale.

NOTE: Regarding areas of land referred to in the foregoing statements: The basis of the figures given in these statements is in each case the deed covering same. In the deed of the B.C.S. Railway Company to the Coal Company, the area thereof is given as "Estimated to contain approximately 250,000 acres." They have never been surveyed but a basis was agreed upon by Mr. McEvoy, then Land Commissioner of this Company, and the assessor for this District, whereby the following areas were accepted as representing the Company's original ownership:

In Lot 4588	112,460 acres
In Lot 4589	130,000 acres
Total	242,460 acres

From these areas there were the same deductions which are shown from the areas as represented by the deed. This note is to make clear an apparent discrepancy between the above figures and those of the accessors' rolls. An actual survey would in all probability show both to be inaccurate.

All of the foregoing in regard to the Company's lands brings the situation up to December 31, 1916.

Important changes since the foregoing statement was written outside of the transaction of a minor nature within the townsite sub-divisions already referred to, are the laying out of a sub-division at Cokato, 2 miles southwest of Fernie, the purchase of the land originally sold to the Fernie Lumber Company, and the acquisition from the Canadian Pacific Railway Company through a long-term lease of the Coal Creek Branch running between Fernie and Coal Creek.

The Cokato Sub-division consisted of 85 parcels of approximately 10 acres each, put on the market in 1916 at prices ranging from $30.00 to $40.00 per acre, with payments spread over 5 years. The property was put on in response to an agitation for land for agricultural purposes, an agitation fostered among the employees by Union leaders as a grievance, and to which the Government, itself engaged in the consideration of settlement areas, lent a sympathetic ear. Of the 85 lots offered in 1916, 57 have been disposed of.

The Fernie Lumber Company purchased a millsite property which with a small subsequent addition totaled 103.58 acres. The property was acquired in 1905 for the sum of $7,268.10, including the addition. Some years ago, the Company ceased operations, and vacated the premises leaving a caretaker occupying the proprietor's house. The Coal Company's property surrounds it, and it was considered advisable to prevent its being acquired by undesirable neighbors to resume ownership of it. The price paid for the land and the buildings on it was $4,000.00

In 1914, the 10-year lease by the Morrissey, Fernie and Michel Railway Company of the Coal Creek Branch of the Canadian Pacific Railway Company expired. Negotiations were concluded with the Canadian Pacific Railway Company whereby the branch was taken over by the Coal Company on a nine hundred and ninety-nine year lease for the lump sum of $70,000.00 and an annual rental of $1.00 and taxes. The transaction was concluded in 1917, the lease being dated June 30, 1915, and on final execution it was transferred by the Coal Company to the Morrissey, Fernie and Michel Railway Company by agreement of July 3, 1919. In addition to the $70,000.00 above mentioned there was also expended in connection with the acquisition of this Branch $1,897.00 for legal expenses which were charged to the Capital Account.

The lands of the Coal Company are not on the market and subsequent to the transactions previously outlined there have been very few changes in the property and these are only minor items, with the exception of the disposal of the old cemetery block in Natal, B. C. This block was subdivided into 12 lots in 1941 (as plan No. 2050) of which the Provincial Government under the Land Act took one quarter or three lots. The remaining nine lots realized a gross amount of $4,050.00 or $450.00 per lot.

Most of the transactions now taking place are lot sales made from the townsites and similar holdings of the Power Company, but these are also few in number.

The following sheet is a print of the land holdings of the Companies, but does not show the miscellaneous sales which have been made.

ANALYSES OF

CROPCO '60 - ADIT CHANNEL SAMPLES

CROPCO 1960 - ADIT CHANNEL SAMPLES

Adit No.	Depth*	Volatile Matter	Volatile A.F.B.**	Ash	Coking Properties	Free Swelling Index
1	10	19.9	23.9	16.4	non-coking	
	20	19.0	23.9	20.5	" "	
	30	17.2	23.8	27.8	slightly caking	
	40	16.8	23.4	28.3	poor	1
	50	18.5	24.3	23.8	non-coking	
	60 (1)	20.3	23.6	13.7	poor	1
	60 (2)	18.5	21.3	13.3	weakly coking	
	60 (3)	17.1	21.6	20.7	weakly coking	
2	10	24.2	28.2	14.3	non-coking	
	20	19.9	24.0	17.0	non-coking	
	30	19.9	21.8	8.6	non-coking	
	35 top 33"	20.3	21.6	6.2	non-coking	
	lower 30"	20.1	22.6	11.0	non-coking	
	40 top 24'	20.2	21.7	6.8	non-coking	
	lower 36"	21.5	22.6	4.7	non-coking	
	50 top 36"	19.1	20.9	8.6	non-coking	
	lower 36"	19.5	20.4	4.6	non-coking	
	60	19.2	21.0	8.6	poor	1½
	70	15.4	21.7	29.2	non-coking	
3	10	26.8	35.7	25.0	non-coking	
	20	24.1	29.8	19.0	good	7½
	40 top 24"	28.1	29.3	4.2	good	8
	lower 36"	28.3	30.5	7.2	good	8
4	10	23.7	26.9	11.7	non-coking	
	20	21.0	24.6	14.7	non-coking	
	30	17.9	21.6	17.8	slight caking	
5	10	21.8	24.2	9.8	non-coking	
	20 top	15.3	16.8	9.0	non-coking	
	lower	18.4	20.4	10.1	fair	1
	30	18.5	20.3	8.7	fair	1½
	40	18.7	20.9	10.8	fiar	2½
	50	18.4	21.6	15.0	fiar	2
6	10	33.3	34.6	3.6	non-coking	
	20	20.6	23.5	12.4	weakly coking	1
	30	21.2	24.6	13.8	fair	2½
	40	24.1	25.9	7.0	good	7
	50	24.4	27.1	10.0	very good	7
7 ***	30	17.5	27.3	35.9	good	6
	40	12.6	36.9	65.8	good coking	1
	50	12.3	34.5	64.3	good coking	1

(for notes see page 2)

Adit No.	Depth	Volatile Matter	Volatile A.F.B.	Ash	Coking Properties	Free Swelling Index
8	10	28.1	31.2	10.0	non-coking	
	20	21.0	23.1	8.9	slightly caking	1
	30	20.6	24.1	14.3	good	3½
	40	21.1	23.4	9.9	good	6
9	10	30.5	36.7	16.9	non-coking	
	20	25.6	30.8	16.8	non-coking	
	30	20.8	23.2	10.5	good	4½
	40	20.2	22.6	10.4	good	7
	50	20.5	22.6	9.5	fair	1
10	10	29.8	32.0	6.9	non-coking	
	20	26.7	30.1	11.2	non-coking	
	30	22.5	26.9	16.1	non-coking	
	40	20.3	22.8	10.9	non-coking	
11	10	18.3	29.4	37.7	good	4½
	20	16.3	32.6	50.0 (+)	good	4
	30.	21.5	29.1	26.0	good	8
12	30	28.1	32.0	12.4	non-coking	
	40	17.1	19.6	12.7	weakly caking	
	50	16.6	19.3	14.0	poor coking	
	70	16.0	18.8	15.0	poor coking	

Notes: * Distance in feet from cap of portal set.
** Volatile as calculated on an ash free basis.
*** Adit 7 driven in a thick layer of bone in the immediate floor of the seam to be sampled.
Regarding adit 1 samples at 60 ft., (1) is a special sample by Noble, (2) is of the upper part of the seam taken at the point of a fold and (3) is the lower part of the seam.
(+) Sample noted as having an unusually great amount of hard coaly shale.

All of the above samples were analysed in the Michel laboratory of the Crow's Nest Pass Coal Co.

Adits No. 1 & 4 were abandoned, adit No. 1 being located in a poor position structurally to obtain a good sample and adit No. 4 being a repition of adit No. 2 since they were determined to be in the same seam.

Adits 10 and 12 are partially completed and will be sampled in '61, as will the upper half of the seam being tested by adit No. 2.

SUMMARY OF

TONNAGE ESTIMATES BY J.F. SWEENEY

RESERVES

The reserves in this report are covered in three phases, namely: (1) the total reserves of coking and non-coking coals for the entire basin; (2) the amount of coking coal reserves owned by the Crow's Nest Pass Coal Company, Ltd.; and (3) the coking coal reserves on lands contiguous to but not owned by the Crow's Nest Pass Coal Company, Ltd. A brief description of each is as follows:

(1) MacKay[11] in 1946 published a total minable reserve estimate of 8,187 million net tons of coking and non-coking coals for this entire basin. MacKay's estimate was made on the basis of including all seams over three feet in thickness and under less than 2,500 feet of overburden. His estimate on the basis of 50% expected recovery would yield a total reserve, both coking and non-coking coals, of 4,094 million net tons for the entire basin.

(2) Reserves on lands owned by the Crow's Nest Pass Coal Company, Ltd. include all seams over three feet thick and usually under less than 2,500 feet of overburden. The total probable minable coking coal reserve for this company's lands in the basin is approximately 2,350 million net tons which at 50% recovery would yield (1,750) million net tons. Although there has not been large scale controlled analyses made as to the coking properties of all the seams, it is generally believed that the top three seams of the coal measures exhibit stronger coking characteristics than the underlying seams in the same measures. 1,175

In the past these higher seams have been selectively mined for coking and therefore the following reserve estimate includes only those above mentioned higher seams. A resumé of the minable reserves of known coking coals on lands owned by the Crow's Nest Pass Coal Company, Ltd. is outlined below and included with the reserves of the government blocks on Plate No. 16.

Summary of Coking Coal Reserves Owned by the Crow's Nest Pass Coal Company, Ltd.

	Net Tons
Coal accessible through present mines	37,000,000
Coal accessible through present mines or of reasonable access	46,000,000
Coal of difficult access or remote from present operations	85,000,000
Total presently known coking coal reserves	168,000,000

The Total Minable Coking Coal Reserves Included in the Above Tonnages Which Are Contiguous to Present Operating Areas

	Net Tons
1. Michel Area	
(a) Accessible Reserves:	
(1) 'A' Seam, Sparwood Ridge	21,000,000
(2) 'A' North	15,000,000

(3) #1 Seam	10,000,000
(4) #3 Seam, Partly Extracted in #8 Mine	5,000,000
(5) 'B' Seam	?
Total	51,000,000

2. Coal Creek Area

(a) Accessible Reserves:	
(1) #9 and #10 Seams	10,000,000
(2) #9 and #1, East Mines	1,000,000
Total	11,000,000
(b) Possibly Accessible from Existing Mines:	
(1) Morrissey Ridge Blocks	15,000,000
Total accessible minable reserves of known coking coals	77,000,000

Reserves, as outlined above, are indicated on the accompanying Plate No. 16.

(3) The additional blocks outlined on Plate No. 16 include Dominion Government lands. Estimates on these blocks are tentative only, since data regarding thickness and lateral characteristics of the seams are almost entirely lacking. The following reserve estimates are made on the basis that one or more of the top seams in this area will be of minable thickness and also posses suitable coking characteristics..

(a) Canadian Pacific Railway Block located on the eastern rim of the coal basin near the town of Hosmer . . . . . 23,000,000 T.

(b) Government Block southeast of Morrissey, B. C. . . 30,000,000 T.

Total number of tons of minable coking coal on lands other than that owned by the Crow's Nest Pass Coal Company, Ltd. . . . . 53,000,000 T.

(After J. F. Sweeney, March 1,1958)

Coal Reserves Contiguous to Existing Mines
Crow's Nest Pass Coal Company
Fernie, B. C.

The coal reserves of the Crow's Nest Pass Coal Company property in the Kootenay land district of British Columbia are summarized on Plate No. 1. This illustration is a duplicate of that included in the report "Coal Properties of Crow's Nest Pass Coal Company Limited, Fernie, B. C." by J. F. Sweeney. The summary of mineable coking coal reserves adjacent to and accessible through existing mine facilities shown in the above report were compiled by the writer from detailed data examined and correlated during the months of June and July, 1956. The detailed data used in the compilation of the coal reserve stated in the above-mentioned report are presented herewith along with other pertinent data relating to various phases of the calculations.

The measured, mineable, recoverable coking coal reserve estimates as originally compiled were based on: (1) detailed geologic information, drill records and mine data compiled and made available to the writer by the Crow's Nest Pass Coal Company; (2) field examination of coal seams where exposed by outcrops, test pits or trenching; (3) developed stratigraphic columns at various locations based upon drill hole data and other geologic information; and (4) a study of variance in seam thickness, characteristics of the coal beds and percentage of recovery under present mining practice in all operating mines.

After accumulation of pertinent information on coal seam location, etc. for purposes of estimating reserves the areal extent of the coal seams were determined as follows:

(1) The entire area of the bed was used in the calculation in those instances where the continuity of the seam or seams was well known from examination of outcrops, mine workings and drill holes.

(2) Where outcrop examinations indicated that the seam or seams were of uniform thickness and quality around spurs or local basins, the seam was considered to underlie the area enclosed by the outcrops.

(3) Where the continuity of the outcrop extends for an appreciable distance and the persistence of seam thickness suggests the presence of coal at a greater distance from the outcrop and where no data were available other than measurements along the outcrop the reserve calculations included the presence of coal in a semi-circular area having a radius equal to one-half the length of the outcrop.

(4) The total area of coal reserves was considered to extend beyond such a semi-circular area of determination only if mine workings or drill holes so indicated, in which case the coal was considered to extend only one mile beyond the limits of the mine workings or drill hole.

(5) Any drill hole or outcrop located at a distance in excess of one mile from one of the previously defined areas was considered to determine an area of coal extending for a maximum radius of one-half mile around the hole or outcrop.

This aforementioned classification for determination of reserves is in accordance with the methods developed and adopted for estimation of coal reserves by the Geological Survey - United States Department of the Interior. The U.S.G.S. definitions recognize three classifications of reserves, namely, measured, indicated and inferred. Measured reserves as shown by the attached (Plate No. 1) are for those seams for which tonnage has been computed from observed dimensions revealed in outcrop trenches, mine workings and drill holes.

The points of these observations and measurements were in the writer's opinion so closely spaced and the thickness and extent of the coal so defined that the computed tonnage is judged to be accurate within 20% or less of the true total tonnage. Although spacing of observation points necessary to demonstrate continuity of coal varies in different regions depending on the character of the coal beds, the points of observation are, in general, in this area not over one-half mile in distance.

Tests indicate that most coals have a specific gravity of 1.29 resulting in a weight per cubic foot for solid coal of about 80 pounds. On this basis the coal reserves were calculated at 1750 net tons per acre-foot or 1,120,000 net tons per square mile foot.

Since all of the area measurements are based on level surfaces, no allowance was made in the reserve estimates for the inclination of the coal seams. The general dip of the coal seams in this area is between 20 to 40° with an average of approximately 25°, which, if taken into consideration in the computation of reserves, would have increased the total quantity of coal by approximately 10%.

After obtaining a total tonnage as described certain reductions in tonnage were necessary to convert the total reserve to (1) recoverable reserves and (2) recoverable reserves of coal of known coking characteristics. This was done by:

(1) Crow's Nest Pass Coal Company in the past has used recovery factors of 60% for most underground operations and 80% recovery when using the caving system. However, results of detailed investigations by Cady in Illinois, 1949, Flint in Ohio, 1951, B. W. Dyer in Utah, 1950 and Evanson in Pennsylvania, 1946, have shown that a more realistic

ratio of recoverable tonnage as compared with total tonnage of reserves is 50%. This factor allows for loss in mining, coal left in place for barrier pillars, haulage and various other factors which the Cropco percentage of recovery figures do not comprehend. Accordingly, the total reserves were reduced 50% in all reserve calculations in this report.

(2) Previous experience in the Crow's Nest Pass coal basin has shown that mining of coal from seams located under greater than 2000 feet of overburden resulted in hazardous and costly mining. Therefore, the reserves under greater than 2000 feet of cover have not been included.

(3) In view of the fact that the primary purpose of this estimate was to determine the recoverable coking coal reserve of this region only those seams which were known to be satisfactory for production of blast furnace coke were included in the reserves. Only a few of the many seams present in both the Michel and Coal Creek mining areas have been tested sufficiently to justify their inclusion in reserves suitable for metallurgical purposes. Therefore, all seams which, because of a paucity of geologic data, could not be classed as measured reserves or because of insufficient information could not be classed as known to have satisfactory coking characteristics have been deleted from the calculations.

At the time of this estimate the known seams of satisfactory coking characteristics were limited to the "B", "A", No. 1 and No. 3 seams at Michel and the No. 10 and No. 9 seams in the Coal Creek mining area.

Subsequent tests by the U. S. Steel Monroeville Research Laboratory have shown that other seams in this same area are of coking quality and probably possess beneficial blending properties suitable for mixing with the three seams of coking coals used in the estimate, or suitable for production of blast furnace coke alone.

The Total Mineable Coking Coal Reserves Included in the Above Tonnages Which Are Contiguous to Present Operating Areas

	Net Tons
1. Michel Area	
(a) Accessible Reserves:	
(1) "A" Seam, Sparwood Ridge	21,000,000
(2) "A" North	15,000,000
(3) #1 Seam	10,000,000
(4) #3 Seam, Partly Extracted in #8 Mine	5,000,000
(5) "B" Seam	?
Total	51,000,000
2. Coal Creek Area	
(a) Accessible Reserves:	
(1) #9 and #10 Seams	10,000,000
(2) #9 and #1, East Mines	1,000,000
Total	11,000,000
(b) Possible Accessible from Existing Mines:	
(1) Morrissey Ridge Blocks	15,000,000
Total mineable reserves of known coking coals	77,000,000

Thicknesses of each seam as indicated in the accompanying reserve calculation are based upon the observations and opinion of the undersigned as to the typical thickness to be expected of each of the seams within the areas of calculation. Sampling performed in 1956 from many of these seams gave thicknesses typical in some of the areas as shown on Plate No. 2.

This report and accompanying plates are divided into two sections covering (a) the Michel and (b) the Coal Creek or Fernie area.

It should be pointed out that the accompanying report includes only the mineable, recoverable coal reserve contiguous to or accessible through existing mines in the Coal Creek and the Michel mining areas. All reserves as included in this report are classified as "measured" and do not include "indicated" or "inferred" reserves by present U.S.G.S. standards. This reserve estimate is also limited to those coal seams which were known at the time of the examination to be satisfactory for the production of blast furnace coke. It necessarily follows that these reserves reflect only a small part of the total recoverable reserves in the Crow's Nest Pass Coal Company property.

J. F. Sweeney
February 26, 1958