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PRELIMINARY REPORT ON PORTAGE MOUNTAIN COAL PROPERTIES: CINNABAR PEAK MINES LTD.

PART ONE

JAMES MILLAR & ASSOCIATES LTD.

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PRELIMINARY REPORT ON PORTAGE MOUNTAIN COAL PROPERTIES: CINNABAR PEAK MINES LTD.

INTRODUCTION

The purpose of this report is to assemble the available data on the coal deposits held by Cinnabar Peak Mines Ltd. and to make a preliminary assessment of the present and possible future market requirements.

As an evaluation of coal deposits is necessarily closely guided by limitations of transportation and marketability as well as the morphology and tenor of the deposits, the process of an economic assessment must follow nearly parallel paths of investigation along the three lines. For the purposes of this report an overview of the industry in Western Canada will be presented as it pertains to the coal on the company properties near Hudson Hope. Similarly the present available data on the transportation will be discussed, again in a very general way. As certain morphological and grade data of the deposit are determined the studies of markets and transportation can likewise be advanced and the economics made more firm. The character of the industry makes it impractical to focus the investigation on a single variable; rather, the preliminary data must be used as a base from which subsequent work can be continued and firmer figures established .

The report is based on a personal examination of the company properties, discussion of the present situation regarding exploration, transportation and marketing of metallurgical grade coal from Western Canada with the operators, marketing groups and research organizations (hereafter credited where applicable) as well as an examination of the

following published and unpublished reports and surveys:

Antal, J. B. 1967	Unpublished report on the Hudson Hope Coal Properties.
Dowling, D. B.	
1909	The Coal Fields of Manitoba, Saskatchewan, Alberta and Eastern British Columbia. Geological Survey of Canada, Paper No. 1035.
1915	Coal Fields of British Columbia. Geological Survey of Canada Memoir 69 with Map 139A.
MacKay, B. R. 1947	Coal Reserves of Canada. Geological Survey of Canada.
McLearn, F. A. and Kindle, E. D. 1951	Geology of Northeastern British Columbia, Geological Survey of Canada, Memoir 259, with Map 1000 A, (Fig. 8, 9).
Spivak, J. 1944	Geology and Coal Deposits of Hasler Creek Area, British Columbia. Geological Survey of Canada.
Stott, D. F.	
1961	Type Sections of Some Formations of the Lower Cretaceous Fort St. John Group Near Pine River, British Columbia. Geological Survey of Canada, Paper 61-11.
1963	Stratigraphy of the Lower Cretaceous Fort St. John Group and Gething and Cadomin Formations, Foothills of Northern Alberta and British Columbia. Geological Survey of Canada, Paper 62-39.
Wickenden, R. T. and Shaw, G. 1943	Stratigraphy and Structure in Mount Hulcross- Commotion Creek Map-area, British Columbia. Geological Survey of Canada, Paper 43-13.

British Columbia Minister of Mines Annual Reports:

1905: 19, 60; 1912: 118, 122, 123; 1921: 118; 1923: 136, 344; 1926: 164; 1928: 185, 187; 1930: 159; 1940: A 101, A 126; 1941: A 96 and Bulletin 14: 10; 1942: A 94, 96, A 122; 1943: A 39, 121; 1944: 86, 88, 89, 93, 128; 1945: 172, 137; 1946: 216, 218, 248 and Bulletin 24:24; 1947: 266; 1948: 241, 216; 1949: 308, 309; 1950: 275; 1951: 289, 290; 1952: 309, 320, 321; 1953: 258.

Throughout this report the term "tons" will refer to "long tons".

CONCLUSIONS

Cinnabar Peak Mines Ltd. hold an option on the coal deposits on two blocks of leases on either side of the Peace River, a few miles east of the Portage Mountain damsite, and west and southwest of the town of Hudson Hope, B.C. The leases are underlain by well-known Upper Cretaceous coal formations containing important seams of coal, structurally suitable for mining by conventional methods and possibly of metallurgical grade. The deposits are amenable to relatively simple development with some sections that might be suitable for strip mining. The recent renewal of interest in the marketing of metallurgical grade coal from Western Canada and estimated future markets encourage the close examination of potentially productive coal deposits in the region and the evaluation of the production economics of those prospects. The two leases held by Cinnabar Peak Mines Ltd. contain such deposits and an investigation program should therefore be commenced.

RECOMMENDATIONS

The complete evaluation of a coal deposit such as those of Cinnabar Peak Mines Ltd. must be carried along three parallel, but independent lines of enquiry-

(i) the deposits must be investigated for grade, tonnage and mineability,

(ii) the market capacity, value and availability should be established, and,

(iii) transportation systems and economics must be assessed.

There is the necessity at an early stage of research to test the market acceptance of the potential product; this should follow closely the initial grade determination. Thereafter, a relatively continuous check should be maintained with the market as more detailed knowledge of grade is accumulated.

From the preliminary examination the possibility of proving tonnage reserves appears very good but the area requires detailed mapping to aid planning for optimum effectivity in the exploration program as well as to provide the necessary information on which to ultimately determine the mining and development program.

The mineability of the deposits appears generally practical although the most efficient method is indeterminate at this stage. Although of considerable importance in a final economic feasibility study, it is felt that the mineability past the general practicability level can be left for more definitive study at a more advanced phase in the program.

Anticipated market capacity indicated a continued demand for more reserves and sources on into the "seventies". Until the mineability/ reserves/tenor data is made more definite it would be premature to make

formal advances to markets or marketing agents. The company should, however, communicate with potential markets, notify them of the company's program and request an indication of their possible future interest.

The problem of transportation is one which will require direct negotiation with the Pacific Great Eastern Railway for its amenability to the use of "unit-train" haulage or some equivalent transportation system. Since this is a complex problem, yet with an integral effect on the production feasibility, it must be investigated along with the deposit and market investigation.

The evaluation program must be phased to allow the foregoing investigations to be proceeded with gradually more detailed and exacting objects. Each should be completed and assessed prior to continuing to subsequent phases. A series of four phases is contemplated with the final phase being a feasibility study aimed at recapitulation of production and marketing economics, based on firm and detailed data collected during the three preceeding phases.

Phase I

Predicated on the apparently favourable market investigations for metallurgical grade coal already carried out and the possibility of favourable transportation economics, the leases must be examined for the potentially productive coal seams and the structural geology. Further, these coal seams should be tested and sampled for the metallurgical characteristics of the contained coal. It is felt that these should be the main objects of Phase I.

Preliminary communication with markets and with the railways should also be made.

It is recommended that the following program be implemented as soon as is practical:

(i) The leases should be reconnaissance mapped geologically with picket line control along the main outcrop sections, accompanied by topographic mapping. A camp will be required and should consist of two trailers which could be located on the lease block being mapped. A bulldozer should be available for the geologist to expose any required sections and to provide access from the present road system. It is suggested that this work commence on the south leases. Surface samples of potentially productive seams should be taken and analysed.

(ii) Following the surface examination and testing, a program of underground sampling should be undertaken to test the possible grade of the potentially productive seams. The sampling must be carried out below the zone of surface weathering, normally considered about twenty feet normal to the exposed surface. For the known seams that appear to warrant testing a total of five hundred lineal foot adits will be required. When the opening exposes "unweathered" coal, samples should be channelled from the face, normal to the attitude and submitted to commercial laboratories for full analysis and free swelling index. Samples should be cut from a freshly exposed surface, placed in a closed container and filled with fresh water for shipment to a laboratory. It is suggested that at least three such samples be cut at one time. Two should be commercially analysed and one be sent to a government laboratory for analysis.

(iii) The results of the testing could be used for preliminary market

examination to assess the interest of the various outlets in the product, as indicated by the initial sampling.

(iv) The Pacific Great Eastern and the Canadian National Railway should be approached regarding realistic transportation organization for major tonnages.

Phase II

Based on the satisfactory conclusion of Phase I the second phase should be aimed at a continuation of the grade and tonnage investigations of other seams that would be considered supplementary to the main seams checked during Phase I as well as more detailed work designed to prove consistency of grade and the gross available tonnage of the seams of satisfactory grade.

The total coal formation on the south leases is nowhere exposed. To check the potential of the structure the formation should be sectioned with a diamond drill using 'wire-line' core recovery. The formation has a thickness of about 1400 feet which would require about 1600 feet of drilling, if 3 holes were drilled to provide a full section. Correlation with the surface mapping would provide preliminary tonnage evaluations. Alternative drilling methods have been proposed and may be acceptable if cost is substantially less and results comparable to the diamond coring method.

The market negotiations should be commenced during the late stage of this phase as the indications of tonnage are added to the indications of grade from Phase I.

The program for Phase II cannot be outlined in other than general terms and cannot be recommended until Phase I has

been completed. As the normal contract practise appears to extend over 15 years it would be necessary to prove tonnage for that period at a production rate predicated on some feasible economic minimum. This minimum productivity itself is governed by the physical limitations of extractability, amortization of capital expenditures, transportation limits and market limits. It would therefore be necessary to carry out a continuing preliminary feasibility study of these variables at this stage.

Phase III

This phase is generally aimed at collecting "finite" data on -

(i) Market acceptance of tonnage samples,

(ii) Mineability and mining methods,

(iii) Transportation routes, capital expense and costs,

(iv) Development costs,

(v) Production costs.

The program will require an experimental adit to provide data on which to base the cost estimates, mining plans and large scale samples for analysis, tests and beneficiation tests. The proposed rail spur from the P.G.E. at or near Chetwynd must be surveyed in detail and firm proposals for rail shipping system and rates established.

At this stage it is expected close cooperation would be maintained with the marketing agency or agencies, with firm market agreements dependent only on demonstration of economic feasibility.

Phase IV

Essentially a compilation of all data, Phase IV is the preparation of a detailed economic feasibility study of the project providing the basis for production financing and firm market agreements. All lines of investigation should have been concluded or be concluded during this phase.

BUDGET

Beyond the Phase I program it is impractical to propose a recommended budget for the project. However, it should be possible to be more explicit regarding possible financial requirements for Phases II to IV of the evaluation program after the assessment of Phase I. This budget includes only the field program and does not include office overhead and non-field management.

Phase I

A period of four months is allowed for the field work for this phase, with two months for analysis of samples, assessment and preparation of maps and reports.

Crew - Supervision and labor

Geologist, 4 months @ $750/mth	$ 3,000.00	
Superintendent (Company engineer) 6 mths @ $1000/mth	6,000.00	
Consulting Engineer, 30 days @$150/day	4,500.00	
	13,500.00	
2 geological assistants, 2 @ $600/mth/ for 3 months	3,600.00	
Cook, 4 mths @ $800/mth	3,200.00	
	6,800.00	
W.C.B., C.P., U.I.C. at 15% (all but consulting fees) 15% of $17,300	2,400.00	
		$ 22,700.00

Capital Expense

Lease rental	$ 100.00	
Camp equipment	500.00	
Engineering equipment	500.00	
		$ 1,100.00

Rentals

2 trailers, 3 mths @ $200/mth	600.00	
2, 4-W.D. Landrovers, 3 mths @ $270/mth	810.00	
Engineering equipment, transit, rods, etc.	500.00	
Headquarter office in Hudson Hope, 3 mths @ $150/mth	450.00	
Equipment for field analysis (Balance, etc.)	150.00	
		2,510.00

Contracts

Bulldozer, D-8 or equivalent 30 days @ $250/day	7,500.00	
Test adits, 500 lineal feet @ $30/ft. Contractor to provide all equipment, crew, compensation, board, accomodation, etc. Company provides engineering, surveying, sampling, etc.	15,000.00	
		22,500.00

Analysis

20 samples @ $15/analysis	300.00	
freight and equipment	100.00	
glassware, torch, etc. for field tests	200.00	
		600.00

Supplies

Camp, fuel	250.00	
Engineering	300.00	
Travel, fuel, oil, etc.	2,000.00	
Stationery, etc.	50.00	
		2,600.00

Expenses

Room and board, 20 man mths @ $150/mth	3,000.00	
Mobilization & demobilization of crew	2,000.00	
Travel for Co. engineer & consultant	1,500.00	
Field office services and costs	300.00	
Insurance, vehicles, office, etc.	400.00	
Telephone and telegraph	400.00	
Recapitulation Report preparation	1,000.00	
		8,600.00

Allowance for contingency, 10% of $61,420	$ 6,580.00
Total Recommended Field Budget - Phase I	$68,000.00

COAL DEPOSITS

PROPERTY

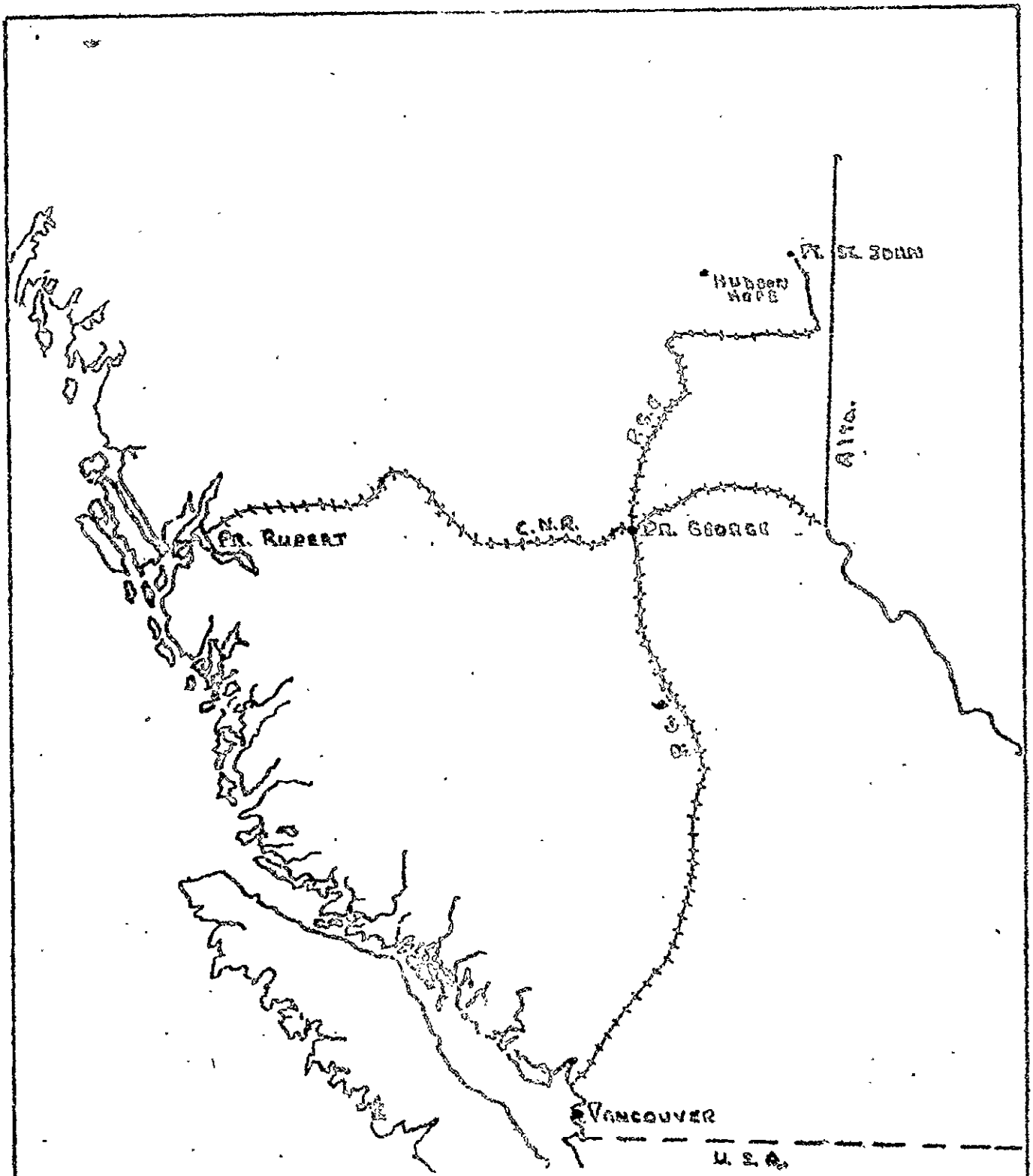
The leases being investigated by Cinnabar Peak Mines Ltd. are comprised of two blocks aggregating five parcels and 2-1/2 sections of land and cover all coal, petroleum and natural gas in and under that area (Map No. 2).

The lease-blocks are located a few miles apart on either side of the lower Peace River canyon area of northeastern British Columbia. The following table shows the available title data:

Block	Lease No.	Lot No.	Acreage	Assignee	Date
North	2063	276	160 ac.	Clayton Leslie Aylard (in trust)	Dec. 13/68
	2064	1039 (NW Quarter)	160 ac.	" " " "	" " "
			320 ac.		
South	2062	1050 S Half)	320 ac.	" " " "	Dec. 13/68
	2061	1055	640 ac.	" " " "	" " "
	2060	1054 (W Half)	320 ac.	" " " "	" " "
			1280 ac.		

The leases are subject only to an annual fee of $76.43 to hold them in perpetuity. Most of the area along this section of the Peace River is under Crown Reserve against possible future hydro dam development.

The Peace River coal area lies at the eastern end of the Peace River Pass through the Rocky Mountains in the mountain edge and foothills



LOCATION SKETCH MAP

PR-PM 6960A

To accompany report by I. Hillan July 14, 1969

section. The leases lie a few miles east, or downstream, from the W.A.C. Bennett Dam at Portage Mountain; the North Block lying about a mile north of the river canyon and the South Block about a mile to two miles south of the river. Hudson Hope, the main local business centre, lies about 10 miles east of the leases. The lumber mill town of Chetwynd is the closest rail point at present, lying about 40 miles southeast by highway. Fort St. John is 55 miles east and is the main distributing and service centre for the region.

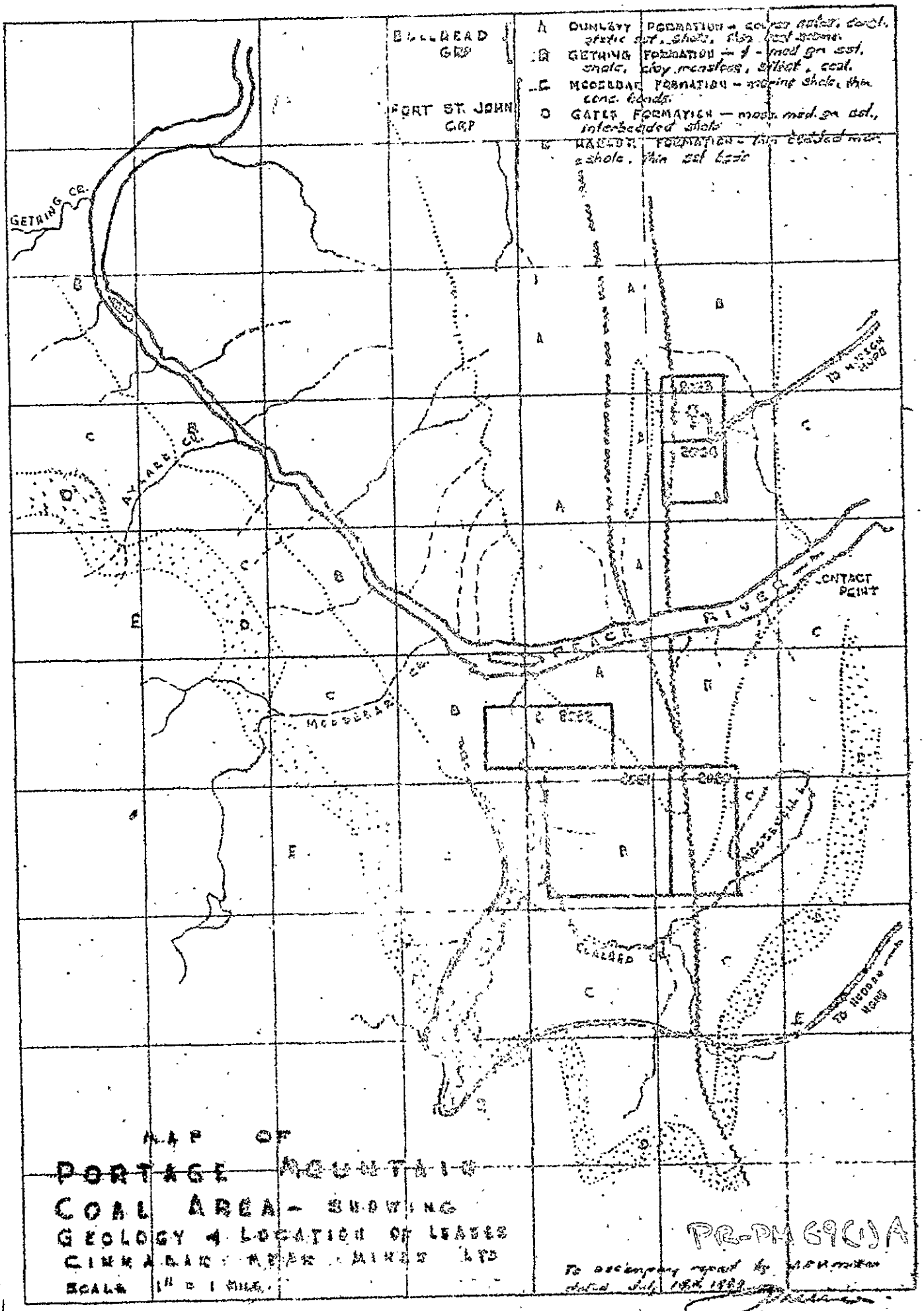
Block	Latitude	Longitude
North	55° 58' N	122° 8' W
South	55° 55' N	122° 19'W

The North Block contains the Gething Mine from which some 25,000 tons of coal were extracted and marketed during the period 1940 to 1958. No production is recorded for the South Block seams.

Although the coal deposits of the Peace River canyon area were known by Alexander MacKenzie in 1793 and were geologically examined as early as 1912 (B.C. Department of Mines, C.F.J. Galloway) only a small tonnage of production is recorded for the area, all directed to local consumption.

Geology of Deposits

In its dissection of the Rocky Mountains, the Peace River exposes a stratigraphic section of the eastern Cordillera from the Proterozoic schists and gneisses in the west to the late Mesozoic marine shales and sandstones of the Fort St. John Group, underlying the western plains of this group and assigned by McLearn (1950:73) to the Lower Cretaceous, is the Bullhead Group (Beach and Spivak, 1944) which outcrops along the river and adjoining eastern mountain ranges as well as the valley of



MAP OF

PORTAGE MOUNTAIN COAL AREA – SHOWING GEOLOGY & LOCATION OF LEASES

CINNABAR RIVER MINES LTD

SCALE 1" = 1 MILE.

PR-PM 69 (1) A

To accompany report by [illegible]
dated July 15th 1969

Carbon Creek to the southwest. Now divided into the Dunlevy and Gething formations, it consists of non-marine sediments varying from 4400 to nearly 5000 feet thick (Beach and Spivak: 1944; McLearn and Kindle 1950: 63-65).

The coal measures of the Peace River area occur mainly in the upper Bullhead or Gething Formation, which reaches thicknesses of at least 1400 feet. It has been studied by Galloway (1913), McLearn (1923), Williams and Bocock (1932), Beach and Spivak (1944) and McLearn and Irish (1944). Conformably overlying the Dunlevy Formation of the Lower Bullhead the sediments are most commonly fine sandstone and shale containing seams of coal varying from as thin as one inch up to measured thicknesses of eight feet three inches in the Peace River Canyon section and seventeen feet in the Carbon Creek Basin. One or more shale partings are reported in practically all of the economic-sized seams. Although a few thin seams of coal are reported in the Dunvegan Sandstone formation of the overlying Fort St. John Group, they are of limited economic importance.

The Gething Formation, where exposed on the east side of the Peace River Canyon, strikes northwesterly (True) with dips of 9 to 30 degrees southwesterly. From the data available the average dip would lie between 10 and 15 degrees in this section (McLearn and Kindle 1950: Fig. 10). In the canyon section the Gething Formation is exposed in two bands striking about northwesterly, with each band dipping in opposite directions, forming truncated limbs of a plunging anticline. The plunge locally is to the southeast with the Gething Formation exposed in a nearly continuous surface-arc connecting the two northwesterly bands. The South Block covers the crest and part of the westerly band in this section; the attitudes are therefore

variable, with strikes varying from northwest to northeast and dips from 15 to 22 degrees.

Exposure is excellent along the Peace River, Johnson Creek and several of the tributaries of Johnson Creek, but generally the areas away from the young creek cuts are obscured by glacial and colluvial deposits. However, a program of controlled bulldozer trenching on both the lease blocks would help clarify the geological stratigraphy and explore the coal seams reported or suspected, but not observed.

Coal Seams

The coal seams of the Gething Formation have been explored in six main areas: Peace River Canyon, Dunlevy Creek-Cust Creek-Butler Ridge, Carbon Creek, Fisher Creek-Pine River, Hasler Creek and Sikanni Chief-Halfway. Of these the Peace River Canyon area is the best known and studied, although several of the areas have produced modest tonnages of marketable coal over the past 30 years (McLearn and Kindle 1950:151).

The Royal Commission on Coal (MacKay 1947: 98, 99; Table 17) gave the following estimates of reserves for the combined areas:

Probable Mineable Coal 467,040,000 tons; Recoverable 233,520,000 tons

Possible Mineable Coal 573,440,000 tons; Recoverable 286,720,000 tons

For the Gething-Johnson Creek section of the Peace River Canyon MacKay gives:

Probable Mineable Coal 134,400,000 tons; Recoverable 67,200,000 tons

Possible Mineable Coal 44,800,000 tons; Recoverable 22,400,000 tons

For the Moosecall Lake Section of the Peace River Canyon area, MacKay calculates -

Probable Mineable Coal 33,600,000 tons; Recoverable 16,800,000 tons

Possible Mineable Coal 33,600,000 tons; Recoverable 16,800,000 tons.

These reserve calculations are based on mineability of seams over three

feet in thickness, to a maximum depth of 2500 feet. MacKay (1947: Table 17) classes all the coal of the area as Low Volatile Bituminous (ASTM; MacKay 1947: 7).

The Peace River Canyon area might be divided into three sub-sections: West Limb, Johnson Creek and East Limb, with the Johnson Creek section covered in part by the South Block and the East Limb covered in part by the North Block. Correlation has been attempted between the succession of seams of the three areas by McLearn and Kindle (1950) and the seams of each area are locally identified in terms of stratigraphic depth below the base of the bottom formation of the Fort St. John Group; the Moosebar Formation. Through the thickness of the Gething Formation in the areas exposed, a total of 50 seams were located and measured, while the estimated total number "would exceed sixty" (McLearn and Kindle 1950:155). They include-

19 seams 11 inches or less,
15 seams from 1 foot to 1 foot, 11 inches,
4 seams from 2 feet to 2 feet, 6 inches,
11 seams from 2 feet, 7 inches to 4 feet,
1 seam more than 4 feet.

Three of the 11 seams expand to more than 4 feet in some parts of the area. Of the ten best seams, two are found in the lower half of the formation and eight are in the upper half.

The following is a stratigraphic section of the coal measures of this section of the Gething as derived from McLearn (1923), McLearn and Kindle (1950) and Antal (1967).

TABLE I: STRATIGRAPHIC SECTION OF COAL MEASURES

Depth below base Moosebar Formation	Seam	Range of Thickness
23' - 26'	Superior	2'6" - 3'8"
93' in east 115 - 130' in west	Trojan	5'6"-8'4" with possible bifurcation in east to two second aggregate 6'2" separated by 4'6" shale and sandstone
200 - 255' in west 160' in east	Titan	4'1" - 5'2"
250' + (50' below Titan)	Falls	1'11" - 2'7"
460'	Little Mogul	2'8" - 3'3"
470' (10' below Little Mogul)	Mogul	3'2" - 4'8"
585'	Castle Point	2'1" - 2'3"
605' (28' below Castle Point)	Milligan	2'6" - 2'9"
1215'	Grant	5'5" - 5'9"
1250	Riverside	2'10"

Uncorrelated seams on Gething Creek include:

below Falls Seam	Gething	2'4"
below Gething Seam	Galloway	3'7" - 4'2"

Two uncorrelated seams on Johnson Creek are 2'10" - 3'0" and 4'1" in thickness and are fairly low on the stratigraphic column. Other seams are mapped in the upper canyon area but are uncorrelated.

The following Table II gives pertinent data on the thickness and grade of coal as reported by McLearn and Kindle (1950). Most seams have multiple analyses and are therefore given in ranges of variation. Further, only those seams of some potential economic size are covered in this table.

TABLE II : RANGES OF THICKNESS AND ANALYSES OF SURFACE SAMPLES TAKEN FROM THICKEST SEAMS

	Thickness					Analysis							
SEAM	Upper Canyon	Gething Cr.	Aylard Cr.	Moose-bar Cr.	Johnson Cr.	Contact Pt.	Moisture	Ash	Vol. Matter	F.C.	Coking Prop.	Color Ash	S	Btu
TROJAN		5'6" - 8'4"	3'8"	3'7"	6'8'	3'6"- 2'8"	0.7 - 1.6	6.1 - 21.5	18.8 - 28.6	58.4- 64.6	None to Good	White to Gray	0.5- 0.7	13350 to 13820
TITAN		5'0"		4'1"		5'2"								
GRANT				5'9"			0.6 - 0.8	2.1 - 6.5	18.7 - 24.8	70.8- 78.1	None to Good	Flesh to Brick	0.6- 0.7	14300 to 15130
JOHNSON CR.					4'1"		0.8	7.4	20.7	71.1	None	Dark Brown	0.07	13820

McLearn and Kindle (1950: 171-2) point out the variability in quality both laterally within a seam, between seams and even between benches within a seam. All the important seams known on the North Block contain bands of concretions. Most seams contain thin stringers of highly adamantine "jet" coal. On the basis of the surface sampling the coals rank as medium to low volatile bituminous and as non-agglomerating or with only a few samples showing good caking qualities. McLearn and Kindle (1950: 171) found some caking qualities in the lower parts of some seams; eg., Grant and Trojan seams. It should, however, be pointed out that surface samples are largely of little real value in assessing the rank or coking characteristics of a coal. Similarly, the suitability of an agglomerating coal to use for industrial coke is testable only by large scale tests.

South Block

The two sections of leases comprising the South Block cover the extreme south end of the West Limb and crest of the fold, in the area of Johnson Creek, Coalbed Creek and Moosecall Lake. Nearly the whole Gething Formation is exposed in the canyon of Johnson Creek with the Moosebar contact being exposed in the bed of Coalbed Creek about three-quarters of a mile from the mouth, and representing a section close to the crest of the anticline. Gething (Personal Communication) reports that the Grant Seam was located close to the mouth of Johnson Creek, indicating that all the potentially economic seams likely lie within the South Block.

The only seam having any serious exploration on the South Block is the Trojan Seam on which a 35 foot tunnel and 65 foot drift were driven. A total coal section of 7 feet, 2 inches contains two sandstone partings aggregating 6 inches in thickness. Analyses of coal (probably before

adit was driven) are as follows:

Bench	Moisture	Ash	Vol. Matter	Fixed Carbon	Coking Property	Color Ash	S	Btu
Upper 4-1/2'	1.1	21.5	18.8	58.6	non-agglom.	White	-	-
Middle 3'9"	1.2	10.6	24.1	64.1	poor	Flesh	-	-
Lower 1'3"	0.7	6.1	28.6	64.6	good	Flesh	-	-

During the examination of the property a sample was taken from the outcrop of a seam near the mouth of the Coalbed Creek, it returned the following analysis:

	As Received	Dry Basis
Moisture	1.9	
Ash	8.2	8.3
Volatile Matter	20.5	20.8
Free Carbon	69.5	70.8
B.T.U.'s	12,853	13,099
Sulphur	0.8	0.8

Free Swell - 1 Soft

From the topography of the north side of Coalbed Creek it seems probable that the stratigraphy parallels the hill slope for a considerable distance with the possibility of a favourable ratio for strip mining of that section of the Trojan seam.

North Block

Lying on the east side of the anticline, dips in this northern area are northeasterly, varying from 10 to 30 degrees. The two quarter-section leases cover two productive mine developments, both operated for a

number of years by the Gething Brothers. A number of seams are exposed and a number of intermediate seams are reported (K. Gething, Personal Communication, 1969). The two main known seams are the "King" and the "48", neither of which have been correlated with those measured on the west limb or crest subsections. The following is a simple stratigraphic table from data supplied by K. Gething. Those seams observed during the examination are so marked, while the balance are reported from old work and are now obscured.

Stratigraphic Location	Seam	Thickness
+ ?	King	5 feet
+ ?		2-1/2 ft. (reported)
+ 340 ft.	Kreuger	7-1/2 ft. (reported)
+ 220 ft. (?)	"	2 ft. (reported)
+ 160 ft.	Intermediate	3'3"
+ 100 ft.	Road	3'
Arbitrary 0	'48'	6-1/2 feet

The coal in the King Seam is generally of the medium volatile bituminous rank and the basal section displays good coking properties. Mc Learn and Kindle (1950: 174) record the following dry analysis of the 4 benches in the King Seam as exposed in the King Gething Mine.

Bench	(As Received) Moisture	Ash	Volatile Matter	Fixed Carbon	S	Btu	Coking Prop.	Soften. Temp Ash	Color
0.7'	3.8	10.9	23	66.1	1.8	13420	Aggl.	2050°F	Lt. Mauve
1.6'	5.9	17.1	28.5	54.4	0.9	11770	"	2300°F	Lt. Brown
2.0'	5.7	3.4	22.7	73.9	0.9	14680	"	2710°F	Very Lt. Pink
0.6'	4.5	1.4	27.4	71.2	0.9	15170	Good	2680°F	Lt. Salmon Pink

Samples taken on the "48" Seam during the examination trip included the following:

No. 3551 - Location, King Gething Mine -"48" Seam, -top 1 foot.

	As Received	Dry Basis
Moisture	1.1	
Ash	6.6	6.7
Volatile Matter	18.0	18.2
Free Carbon	74.4	75.1
B.T.U.'s	13,658	13,808
Sulphur	0.5	0.5

Free Swell - 1 Soft

No. 3552 - Location, King Gething Mine-' 48" Seam, 8" shale/coal band

Moisture	1.1	
Ash	25.7	26.0
Volatile Matter	13.1	13.2
Free Carbon	60.1	60.8
B.T.U.'s	10,608	10,725
Sulphur	0.3	0.3

Free Swell - 1 Soft

No. 3553 - Location, King Gething Mine-"48" Seam, 4'4' lower bench of "48" Seam

Moisture	0.8	
Ash	4.6	4.6
Volatile Matter	16.3	16.4
Free Carbon	78.3	79.0
B.T.U.'s	13,932	14,044
Sulphur	0.4	0.4

Free Swell - 1 Soft

The seams on this North Block appear to parallel the surface contour for some distance and may be suitable for strip mining of at least some tonnage. This would require more detailed study following the topographical and geological survey. The dip of the King and "48" seams are about 20 degrees. At the King Gething Mine (McLearn and Irish 1944) "shale partings and ironstone concretions cause difficulties in mining the King Seam. The shale partings must be removed and the large concretions are hard to remove without shattering the coal." In some parts of the area the dips approach 30 degrees which causes difficulties in handling and restrictions in mining method.

GENERAL NOTE ON COAL IN WESTERN CANADA

Where the use of Western Canadian coal reserves was reducing rapidly a few years ago, new markets and new technologies have given a new viability to the industry and stimulated exploration of undeveloped reserves. The Alberta Resources Railway was primarily promoted to permit the development of the vast reserves of the Smoky River area. The "unit-train" concept in rail transportation was proposed as a means of moving the large tonnages required at relatively reasonable rates. Technological research in the exploration, mining, beneficiation, transport and utilization of coal have further advanced the potential of the reserves. In the main, the present resurgence of interest and activity in Western Canada can be attributed to a large and growing Japanese market for metallurgical grade coal as well as an expansion in interest in the use of coal in the generation of power.

Classification and Analysis

Since the primary potential of the deposits under report lies in the

suitability of a substantial tonnage to use for the preparation of coke a few short notes are included to provide a frame of reference for the assessment of what limited grade data is available.

Although the final acceptance of a coal as a coking blend depends upon full scale tests and individual negotiations, some general criteria can be listed. The "as-shipped' ash content should be in the range of 8 percent, although cleaning could effectively reduce some coals having higher ash content "in situ". Lower ash coals are considered premium and therefore bonused. Volatile material should be in the 22 to 25 percent range. The sulfur content must be below 1 percent. Basically, the coal must be a medium volatile bituminous rank with well developed coking properties. It is reported that proper blending and washing processess affect the coking properties greatly and only large scale tests of unweathered coal can be considered reliable in the final evaluation. Antal (1967:6) reports a case in which the swelling index increased after crushing and washing to over three times that of the same raw coal. According to the "A.S.T.M. Classification of Coals by Rank" (Mineral Facts and Problems, 1960: Table No. 2, :115) the Medium Volatile Group of the Bituminous Class has the following limits:

Dry Fixed Carbon, 69 percent or more and less than 78 percent,

Dry Volatile-material, 31 percent or less and more than 22 percent.

Uses and Markets

The future utilization of coal in chemical, metallurgical and large scale energy generation is thought to represent a major potential expansion for markets.

The metallurgical industries represent a substantial present and expanding market for the coking coals of Alberta and British Columbia.

reputed to be the largest reserve of such grades west of the Mississippi River (Williams 1958: 470). Although the distant future may see a developing iron and steel industry in Western Canada, the present economic markets lie in the trans-Pacific area. The following table summarizes the present contracted tonnage in Western Canada (Berkowitz 1969, Personal Communication).

Company	Location	Long Tons Per Year	Duration	Total Contract
Kaiser Res. Ltd.	Michel, B.C.	5-6,000,000	15 years	51,000,000
Coleman Collieries	Coleman	1,000,000	15 years	15,000,000
Canmore Mines	Canmore	500,000	10 years	5,000,000
Cardinal Coals	Luscar	1,000,000	15 years	15,000,000
McIntyre Porcupine	Smoky Lake	2,000,000	15 years	30,000,000
Fording River	Michel, B.C.	3,000,000	15 years	45,000,000

Of the foregoing contractors Cardinal Coals Ltd. are reported to be negotiating toward doubling their contract to 2,000,000 tons annually and McIntyre-Porcupine Ltd. are talking of increasing the production to 4 or 5,000,000 tons, only part of which would be directed toward the Japanese market.

The following table lists the companies now reportedly negotiating contracts or carrying on exploration programs -

Company	Area	Status
Scurry Rainbow	Elk River, B.C.	Negotiating reported 2-3,000,000 tons annually
Crowsnest Industries Ltd.	" " "	Negotiating
Rio Tinto Mines Ltd.	Smoky River	Exploration
Dennison Mines Ltd.	" "	"

Company	Area	Status
Master Exploration Ltd.	Smoky River	Exploration
Jefferson Lake Petro-Chemicals Ltd.	"	"

From the above data a total of about 12,500,000 tons per year have been contracted for to date and an additional 5,000,000 tons are reportedly in the negotiation stage. A total projected requirement of 22,500,000 tons per year has been estimated for the Japanese markets alone by the mid-seventies, leaving a net difference of 5,000,000 tons per year to be developed.

The potential of the future chemical market has been suggested as greater than that of the metallurgical or energy use (Williams 1958: 470). Research in this field is advancing but must be accompanied by improvements in economics and development of commercial requirements for the variety of chemicals that might be produced. At the moment the liquid fuels and chemical products are more economically recoverable from petroleum and natural gas.

"The conversion of coal into electrical energy offers the most immediate and one of the largest markets for the coal reserves of Western Canada." (Williams 1958: 471). Generally, thermal-electric generation tends to be more practical when the fuel source is relatively close to the electrical market and from a relatively-homogeneous single-mine source. Back-up load plants integrated with hydro plants have a variable demand for coal creating production and economic problems for the miner.

Mining Methods

No basic changes have evolved in the overall methods of extracting the coal from the general surface or strip mine, the long-wall and the room-

and-pillar methods. Of the newly opened mines in Western Canada; the Kaiser, Cardinal River, Fording, and Calgary Power (new thermal power plant on the south side of Lake Wabumun) will be entirely strip mines, the Coleman and Canmore operations will be primarily underground with some production from strip mines, and McIntyre Porcupine will be an underground operation.

Surface operations have increased productivity with the use of 35 cubic yard draglines for stripping and 15 to 20 yard shovels for mining. Underground methods, while essentially unchanged, have found increased production per man through the continuous mining equipment on long-wall faces and room-and-pillar methods. Powered props and other support methods have been developed or are being tested. Hydraulic mining in Europe has reached a stage of commercial production, although it is only being evaluated on this continent.

Gardner (1958) proposed continuous mining of underground deposits might ultimately be competitive with the cost of strip mining in Western Canada and explored methods of continuous mining of pitching seams at comparable costs. It is understood that at least one operation is experimenting with the use of "unit-mining" of steeply dipping seams in the manner of hard rock mines.

Beneficiation

The improvement in coking qualities of a product with efficient and thorough cleaning has been noted. Research has developed a variety of advanced beneficiation techniques, the most highly developed of which is the "compound water cyclone". A series of commercial installations with capacities up to 200 tons per hour in the U.S.A. and Australia are reported. Pertinent to this project in which long distance shipping will

be necessary, research is active toward cleaning and dewatering coal fines.

Transportation

For the immediate future the major development in the transportation of coal is the proposed "unit-train concept". Movement from the Kaiser operation to the "super-port" at Roberts Bank, B.C. will be done by five, 105-car trains, automatically loaded and dumped and making a complete round trip in 72 hours. Similar proposals are being made for Coleman, Canmore, Fording, Cardinal River and McIntyre Porcupine operations. Rail transport rates of $3.50/ton are forecast for all those operations.

Future possibilities for cheap transport lie in slurry and capsule movement by pipeline. Research in both these directions is proceeding.

OVERVIEW OF ECONOMIC CONDITIONS

It would be premature to attempt close calculations into the eventual economics of any coal operation in the area due to the relative immaturity of the project. There are a number of controlling variables quite impossible to estimate at this time, except in very approximate terms. Included in this category are -

(i) Potential scope of the operation -

Existing contracts for coking coal delivery from Western Canada vary from 500,000 to 5,000,000 tons/year. The eventual rate from such an operation as the Portage Mountain project of Cinnabar Peak Mines Ltd. would likely have to lie between these capacities, but would be further predicated on provable reserves, extraction capacity,

transport capacity and the economic break-even capacity considering amortization of all facilities.

(ii) Grade of the coal for the market demand.

At the moment, the coking characteristics of the potentially economic seams are undefined. The only available analyses have been made on surface or weathered samples and the deleterious effect of this deterioration varies on different coals. The coal products of low ash and volatile content earn a bonus from consumers.

(iii) Recovery and Metallurgical Treatment.

The mining and beneficiation economics depend on a number of variables that are determinable only by test. Note has been made of the recovery problems experienced on the main seam of the Gething Mine; it is probable however, that large scale mining and an adequate beneficiation plant would obviate much of this problem.

(iv) Development Layout and Costs.

The design of the underground development and surface plant depends upon such important and as yet indeterminate data that capital development costs are similarly impractical to estimate at this stage. Based on a railway construction cost of $200,000 per mile (from a recently completed survey by the Canadian National Railway for northern regions, Edmonton Office), and a possible rail spur length of 20-30 miles, some $5-$6,000,000 would be required.

Antal (1967: 11) gave a general estimate of $20,000,000 to develop an operation in the Peace River capable of producing 2,000,000 tons annually.

(v) Mining Costs.

Without definitive studies of the most suitable mining method and equipment the mining cost of production in this area can only be approximated. Since it is possible that the operation could be a combination of underground and strip methods the economic formula is quite complex. For preliminary purposes only, a figure of $5.75 - $6.25 per ton f.o.b. loaded cars might be used to cover all mine costs, amortization, recovery loss, etc. This figure is "rule-of-thumb" for an underground operation. It should be used with caution until more information is available.

(vi) Transportation.

A major expense in the marketing of Western Canadian raw material is the cost of transport from mine to the consumer. There are no quoted commodity rates on coal from the Peace River to Vancouver or Prince Rupert on the P.G.E. or C.N.R. Enquiries from the P.G.E. returned a mileage commodity rate of $3.20 from Chetwynd to Prince George, a distance of 196 miles. Published commodity rates on coal from Hinton would be comparable (considering only the mileage factor) to what might be expected for similar class rates from Chetwynd; these were quoted at $6.30/ton to Prince Rupert and $5.80 /ton to Vancouver.

At some stage in the program it should be possible to conduct a study with the P.G.E. into the "unit-train" possibilities. Rail distance from Chetwynd to Vancouver is considerably less than Smoky River to Vancouver and it

would therefore be expected that a "unit-train" rate of $3.50 might be possible.

The location of the North Block on the north side of the Peace River constitutes a substantial hauling problem for production from this section. A railway bridge across the Peace is a remote possibility but trucking costs are likely to be 8 - 8-1/2 cents per long ton per mile. This would undoubtedly force consideration of two beneficiation plants with attendent higher costs.

Deep sea shipping of coal varies in cost from $5 - $7/long ton for 5000 ton loads to $3.60 - $4.00/long ton on full cargo sizes of 15 - 25,000 tons. The increased movements planned for the "seventies" have stimulated plans for 100,000 ton full cargo sizes that should materially reduce these rates. The Roberts Bank and the Neptune terminals will both be equipped to handle the "unit-trains" and the super-freighters. From enquiries it seems that port handling costs must be negotiated on an individual basis and are payable by the supplier. Costs are approximated at 60 - 70 cents/ton on annual contracts of at least a million tons and 80 - 90 cents/ton on annual contracts of at least a half a million tons - including unloading, surging capacity, ship loading and demurrage. Under the "unit-train" concept the port handling costs would likely be reduced.

(vii) By-product Use.

Some possibility exists for the utilization of the waste materials which might amount to 200,000 tons per year

on a production of 1,000,000 tons/year. The potential of power generation, particularly in this area, as a standby plant for surge capacity would seem to be worthy of consideration. The availability of the local very-low cost power from the dam would be an incentive to the consideration of a chemical industry.

(viii) The recent Fording Coal Ltd. contract was reported to cover 3,000,000 tons/year at $13.33/ton at Roberts Bank. The average f.o.b. price at the locality is probably $12.50 to $13/ton. However, bulk loading facilities in Prince Rupert would give a distinct freight advantage, both for the rail segment and for the ocean shipping segment.

Respectfully submitted,

James F. V. Millar, P. Eng.

July 16, 1969.

JFVM/gs.

APPENDIX I

PHONE 469-2391

CREST LABORATORIES LTD.

B.C. REGISTERED ASSAYERS
INDUSTRIAL and RESEARCH CHEMISTS

7911 ARGYLL ROAD
EDMONTON, ALBERTA

June 30, 1969.

Dr. J.W. Antal,
Cinnabar Peak Mines Ltd.

c.c. Dr. Millar and Mr Mike Sembaluk, 7203 - 81 Ave.

Lab No. 948 Sample Marked: No Tag.

Dear Sirs:

The results of the required analyses of the above sample are as follows:

	As Received	Dry Basis
Moisture	1.9	
Ash	8.2	8.3
Volatile Matter	20.5	20.8
Free Carbon	69.5	70.8
B.T.U.'s	12,853	13,099
Sulphur	0.8	0.8

Free Swell - 1 Soft

Yours very truly,

CREST LABORATORIES LTD.

R. Sawyer,
Chemist.

RS/sm

PHONE 469-2391

CREST LABORATORIES LTD.

B.C. REGISTERED ASSAYERS
INDUSTRIAL and RESEARCH CHEMISTS

7911 ARGYLL ROAD
EDMONTON, ALBERTA

June 30, 1969.

Dr.J.W. Antal,
Cinnabar Peak Mines Ltd.,

c.c. Dr. Millar and Mr Mike Semchuk

Lab No. 945 Sample Marked: 3551

Dear Sirs:

The results of the requested analyses of the above sample are as follows:

	As Received	Dry Basis
Moisture	1.1	
Ash	6.6	6.7
Volatile Matter	18.0	18.2
Fixed Carbon	74.4	75.1
B.T.U.'s	13,653	13,808
Sulphur	0.5	0.5

Free Swell - 1 Soft

Yours very truly,

CREST LABORATORIES LTD.

R. Sawyer,
Chemist.

RS/sm

CREST LABORATORIES LTD.

B.C. REGISTERED ASSAYERS
INDUSTRIAL and RESEARCH CHEMISTS

7911 ARGYLL ROAD
EDMONTON, ALBERTA

June 30, 1969.

Dr.J.W. Antal,
Cinnabar Peak Mines Ltd.,

c.c. Dr. Millar and Mr Mike Sambaluk.

Lab No. 946 Sample Marked: 3552

Dear Sirs:

The results of the requested analyses of the above sample are as follows:

	As Received	Dry Basis
Moisture	1.1	
Ash	25.7	26.0
Volatile Matter	13.1	13.2
Free Carbon	60.1	60.8
B.T.U.'s	10,608	10,725
Sulphur	0.3	0.3

Free Swell - 1 Soft

Yours very truly,

CREST LABORATORIES LTD.

R. Sawyer,
Chemist.

RS/sg

PHONE 469-2391

CREST LABORATORIES LTD.

B.C. REGISTERED ASSAYERS
INDUSTRIAL and RESEARCH CHEMISTS

7911 ARGYLL ROAD
EDMONTON, ALBERTA
June 30, 1969.

Dr.J.W. Antal,
Cinnabar Peak Mines Ltd.,

c.c. Dr. Millar and Mr Mike Sembaluk, 7203 - 81 Ave.

Lab No. 947 Sample Marked: 3553.

Dear Sirs:

The results of the requested analyses of the above sample are as follows:

	As Received	Dry Basis
Moisture	0.8	
Ash	4.6	4.6
Volatile Matter	16.3	16.4
Free Carbon	78.3	79.0
B.T.U.'s	13,932	14,044
Sulphur	0.4	0.4

Free Swell - 1 Soft.

Yours very truly,

CREST LABORATORIES LTD.

R. Sawyer,
Chemist.

RS/sm

APPENDIX II

TRIANGLE MINE SERVICES LTD.

PRESIDENT
W. 'BILL' PARLIAMENT

VICE-PRESIDENT
R. 'BOB' PHILLIPS

DEVELOPMENT, PRODUCTION AND ENGINEERING

TELEPHONE AREA CODE
403
429 5941
1902 CENTENNIAL BUILDING
10015 103RD AVENUE
EDMONTON ALBERTA

July 14, 1969.

Dr. J. F. B. Millar,
c/o Cinnabar Peak Mines Ltd.,
7203 - 81st Avenue,
EDMONTON 83, Alberta.

Gentlemen:

Our estimate of driving 6 short adits in coal from 25' to 100' in length at Hudson Hope, B.C. would be approximately $30.00 per foot.

The contractor supplies all necessary equipment and labour to carry out the job.

Yours very truly,

TRIANGLE MINE SERVICES LTD.,

R.C. PHILLIPS.

RCP/gb

CERTIFICATE OF QUALIFICATION

I, JAMES F. V. MILLAR, of the City of Calgary, in the Province of Alberta, Canada, HEREBY CERTIFY:

1. That I am a Mining Engineer and reside in the City of Calgary, Canada.

2. That I am a graduate of the University of British Columbia (1950), in Mining Engineering, and have been practising my profession for the past 19 years, and that I am a member of the Association of Professional Engineers in Alberta and British Columbia.

3. That I have no direct or indirect interest in the property of Cinnabar Peak Mines Ltd., in the Portage Mountain Coal properties near Hudson Hope in the Peace River District, which property is the subject of my report dated July 16, 1969, nor do I expect to receive any interest, either directly or indirectly in the property, or in the securities of the Company holding the property.

4. That the accompanying report dated July 16, 1969, is based on a personal knowledge of the property, having been on the ground June 9 - 11, 1969, with further information being obtained from published and unpublished reports, acknowledgement of which is given in the main body of this report.

JAMES F. V. MILLAR, P. ENG.

July 16, 1969.

TRIANGLE MINE SERVICES LTD.

PRESIDENT
W (BILL) PARLIAMENT

VICE-PRESIDENT
R (BOB) PHILLIPS

DEVELOPMENT, PRODUCTION AND ENGINEERING

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R. C. PHILLIPS.

RCP/gb

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1. That I am a Mining Engineer and reside in the City of Calgary, Canada.

2. That I am a graduate of the University of British Columbia (1950), in Mining Engineering, and have been practising my profession for the past 19 years, and that I am a member of the Association of Professional Engineers in Alberta and British Columbia.

3. That I have no direct or indirect interest in the property of Cinnabar Peak Mines Ltd., in the Portage Mountain Coal properties near Hudson Hope in the Peace River District, which property is the subject of my report dated July 16, 1969, nor do I expect to receive any interest, either directly or indirectly in the property, or in the securities of the Company holding the property.

4. That the accompanying report dated July 16, 1969, is based on a personal knowledge of the property, having been on the ground June 9 - 11, 1969, with further information being obtained from published and unpublished reports, acknowledgement of which is given in the main body of this report.

JAMES F. V. MILLAR, P. ENG.

July 16, 1969.

THIS IS TO CERTIFY THAT:

1. I have no beneficial interest in coal rights at the Portage Mountain Area.

2. I am a graduate Geologist, having completed the Bachelor of Science Degree at St. Francis Xavier University in 1948, and the Doctor of Science Degree at Lausanne University in 1960.

3. I am a registered Professional Geologist of the Province of Alberta.

4. I have worked in the Oil Industry in Canada for a period of five years.

5. I have worked with the Canadian Colombo Plan Survey in Pakistan for a period of two years.

6. I have worked in North Africa for a period of two years.

7. I was Shaft Geologist on the No. 2 Mine for the International Minerals and Chemical Corporation at Esterhazy.

8. I was Exploration Manager for Luscar Coals Ltd. for two years.

9. I am presently engaged as a Consulting Geologist in the Province of Alberta.

J. W. Antal

J. W. Antal, B.Sc., Sc.D., P. Geol.

PART TWO

PRELIMINARY REPORT

ON THE ECONOMIC ASPECTS OF

COAL PRODUCTION AT PORTAGE MOUNTAIN

by

J. W. Antal

Antal-Francl Consulting Ltd.
Geological & Engineering Consultants,
11445 - 124th Street,
Edmonton, Alberta.

PART TWO

I N D E X

FORWARD

This report is being written on behalf of Messrs King Gething and Lloyd Gething. The object of the report is to assess the potential of coal properties held by them in association with other interests, in the Portage Mountain area, in British Columbia.

This geological report is based primarily upon Memoir 259 of the Geological Survey of Canada, "Geology of Northeastern British Columbia" by F. H. McLearn and E. D. Kindle, 1950. It is from this report that the stratigraphy, coal thickness and coal quality are taken. The geological map accompanying the report by Messrs McLearn and Kindle, provides the structural data used in this report.

The undersigned is somewhat familiar with the property, having spent some time working in the general area for the Shell Oil Company, in 1961 and for Luscar Coals Limited in 1964.

The technical data is drawn from information provided by the Mines Branch of the Province of Alberta, the Annual Report of the Bituminous Coal Division of the Department of Mines and Mineral Industries of the Commonwealth of Pennsylavania, 1963, as well as personal knowledge, and personal communication obtained from other people in the coal mining industry.

Freight rates and costs involved in building spur lines have been obtained through the Canadian National Railway, personal communication.

Location and Accessibility

The property is located along the Peace River, near the Town of Hudson Hope, and on the west flank of Portage Mountain. There are holdings on both sides of the Peace River.

Specifically, the land includes lots 1024, 1025, 1/2 of lot 1026, lots 1027, 1028, 1029, 1034, 1035, 1043, 1047 and 1049, the Peace River District of British Columbia, Latitude 56°, Longtitude 122 . The land involves a total of 7,350 acres.

The area is accessible by a partially paved highway from Fort St. John, British Columbia, and a gravel highway from Chetwynd, British Columbia, which is on the Hart Highway.

At one point, the Pacific Great Eastern Railway passes to within about twenty miles of the area.

GEOLOGY

STRATIGRAPHY

The coal seams are within the Gething Formation of the Lower Cretaceous Bullhead Group. This formation includes fine to medium grained sandstone, shale, clay, ironstone, siltstone and coal.

The Gething Coal Measures are 1,400 feet thick and contain around 36 feet of coal in continuous beds, in known stratigraphic horizons. There is an additional 20 feet of coal, whose stratigraphic position is uncertain.

Stratigraphic Section of Coal Measures

Depth Below Moosebar Formation	Description	Thickness
26'	Sandstone, shale	26'
	Superior Seam	2' 6"
110'	Shale, coal, sandstone	80'
	Trojan Seam	5' 6"
225'	Shale, sandstone	115'
	Titan Seam	4' 9"
250'	Shale, clay ironstone	20'
	Falls Seam	3' 2 "
460'	Sandstone, shale clay ironstone	110'
	Unclassified coal	
	Little Mongul Seam	2' 8"
475'	Shale, sandstone	10'
	Mogul Seam	4' 0"
585'	Sandstone	110'
	Castle Point Seam	2' 9"
605'	Shale	28'
	Milligan Seam	2' 7"
1215'	Shale, sandstone	610'
	Unclassified coal	
	Grant Seam	5' 7"
1250'	Shale, clay ironstone	35'
	Riverside Seam	2' 10"

In addition to the above seams, there are a number of unclassified seams as follows:

	Thickness
Gething Seam	2' 5"
Murray Seam	7'
Galloway Seam	4'
Johnston Creek Seam	2' 10"
Johnston Creek No. 2 Seam	4' 1"

The optimum thickness of coal, for economic extraction is around 6 feet, and in order to work two adjoining seams, there should be a thickness of at least 100 feet between the two seams. For these reasons, we will limit our studies to those seams which are at least 4 feet thick and which have no other workable seam within 100 feet, stratigraphically below or above them.

The Trojan Seam

Sampling of this seam has been carried out mostly on outcrop, only one sample has been from a tunnel on the North branch of Gething Creek. There is nothing to indicate whether the coal in the tunnel was a fresh sample; it is taken for granted that those samples taken from the outcrop are more or less oxidized.

The Trojan Seam consists of 5 feet 6 inches of medium voletile bituminous coal. The coking properties range from non-agglomerating to good coking.

The Titan Seam

To the best of our knowledge, the samples of this coal have been taken from the outcrop and are probably oxidized.

The Titan Seam is a medium volitile bituminous coal; the coking properties are non-agglomerating to poorly coking.

The Mogul Seam

The samples of this coal have probably been taken from the outcrop, and are probably oxidized.

The Mogul Seam consists of 4 feet of low voletile bituminous coal; the coking properties are non-agglomerating.

The Grant Seam

The samples of this seam were probably taken from a tunnel at Grant Flat, and it can be assumed that the samples were fresh.

The Grant Seam consists of 5 feet 7 inches of low to medium voletile bituminous coal; the coking properties range from non-agglomerating to good coking. It should be further noted that this seam has low ash (maximum 6.5%) and a high fixed carbon ration (72.7 - 78.1). It is one of the better seams in the area.

The Galloway Seam

Apparently the samples of this seam had been taken from the outcrop, and can be considered to be oxidized.

The Galloway Seam consists of 4 feet of low voletile bituminous coal. Coking properties are non-agglomerating.

The Murray Seam

The sample of this seam has been taken from the outcrop, and can be considered to be oxidized.

The Murray Seam consists of 5 to 7 feet of medium voletile bituminous coal, with a 6 inch band of clay in the middle. It is non-agglomerating in tests.

Johnston Creek #2 Seam

Samples of this seam were probably taken from the outcrop. It consists of 4 feet 1 inch of low voletile bituminous coal. It is non-agglomerating.

There appears to be considerable variation in the coking qualities of the coals described above; this is most probably due to the varying degrees of oxidization of the coals. It should also be kept in mind that the ultimate test should be carried on a large scale and that blending and washing affect the results greatly. In a recent test run on another area for the undersigned, in Japan, a swelling index of 1.5 was found for the raw coal; crushing and washing increased the swelling index to 5.

STRUCTURE

The major structural feature in the area, is the anticline which forms Portage Mountain and Grant Knob. This prominence is composed of the coarse sandstone, conglomerates, quartzitic sandstones, shales and thin coal seams of the Dunlevy Formation of the Bullhead Group.

The overlying Gething Formation is eroded off of the structure, and laps up against the foot of the prominences. Immediately at the contact, the Gething Formation dips at angles of up to 40°, but the dip decreases rapidly, away from Portage Mountain, and rarely exceeds 15°. The majority of the dips are about 5°.

On the east flank of Portage Mountain, the Gething Formation is in fault contact with the underlying Dunlevy Formation, however, no great structural complications are evident here.

ECONOMIC ASSESSMENT

In the economic assessment of the coal mining operation, the following must be taken into account: Markets, Mining Methods, Underground Mining Costs, Surface Costs, Transportation Costs, Capital Outlay for Railway Spurs, Capital Outlay for Equipment.

MARKETS

A large market for low voletile and medium voletile coking coal exists in Japan. This is obvious by the number of Japanese companies that have representatives in Canada, searching for sources of coking coal.

The increase in productivity of the Japanese steel industry coincides with a tightening up of supplies of coking coal from the U.S.A.

The European Common Market is at present phasing out its uneconom coal mines; this coincides with an increased demand for steel, in Europe and elsewhere. It is evident that the future market for coal from Eastern U.S.A. will be the Eastern North America and Europe, rather than Japan or the West Coast of North America. The latter markets will have to be supplied from Western Canada.

The price of coal, at the docks in Japan, range from a low of $18.00 U.S.A. to a high of $26.00 U.S.A. per long ton. Paradoxically the differences in price are not tied to the quality of the coal, but rather to the transportation. The low voletile coking coal commands only 0.50¢ per long ton more than the medium voletile coking coal.

At present, it would not be difficult to find a contract to deliver 2,000,000 tons of coal per year to Japan, providing the supplier could prove his ability to deliver the coal. The minimum price which this coal would command is $19.26 Canadian per long ton, F.O.B. a port in Japan.

In a ten year period, this would amount to a gross income of 2,000,000 x 10 x $19.26 = $385,200,000.

UNDERGROUND MINING COSTS

The coal seams, which we have discussed, at Portage Mountain vary in thickness from 4 feet to 7 feet, that is, within the optimum range for mechanized mining. Maximum dips on the coal are at about 40° pitch, but most dips are between 5° to 15°. The optimum pitch on a coal seam for mechanized mining is about 7°. This pitch allows for proper drainage of the mine, and if the mine is properly planned, the force of gravity can be used to aid in the transportation of coal within the mine.

It is evident that the coal properties at Portage Mountain have almost ideal conditions for the extraction of coal by mechanized mining methods. In this particular case, long wall mining can be recommended.

By using the long wall mining method and mechanization, it is conservatively estimated that 60% of the available coal can be recovered, giving roughly about 164.7 million tons of coal.

In calculating mining costs, comparison can be made with the following mines: Canmore Mines at Canmore, Coleman Collieries at Coleman, Amalgamated Collieries at Drumheller, all in Alberta; and the Ka en Coal Mine of the United States Steel Corporation, Washington County, Pennsylvania, U.S.A.

At the Canmore Mines, the tonnage per man/shift underground is 8.2; this mine is not properly mechanized and the pitch on the seam is about 25°.

Coleman Collieries produces about 10 tons per man/shift underground; again the mechanization of the mine is incomplete and the pitch on the seam is about 25°.

Amalgamated Collieries of Drumheller, is completely mechanized and is one of the better run mines in the Province of Alberta. However, it still employs the room and pillar system. The pitch on the seam is negligible. It produces about 17 tons per man/shift underground.

The Karen Coal Mine of Pennsylvania is mined by drifting. It is highly mechanized, and produces about 16 tons per man/shift, underground and surface. It must be further noted that this latter mine is the only one that produces over one million tons of coal per year, that is a production comparable to what is foreseen for the coal properties at Portage Mountain.

It may be remarked that mining conditions at Portage Mountain would be better than those in existence at the Alberta mines; i.e. a pitch of 5^{o} - 10^{o} rather than the high pitch at Canmore and Coleman, or the horizontal beds at Drumheller.

From the aforegoing, it may be stated that coal mines at Portage Mountain could quite reasonably be expected to produce 17 tons per man/shift, underground. At an average of $26.00 per man per day, this comes to $1.55 per ton underground labor costs. It is estimated that power and other costs would come to $0.49 per ton. The total underground cost per ton would be about $2.04.

SURFACE COSTS

In an efficient operation, i.e. Amalgamated Collieries Ltd., the manpower required per ton, handling at the surface, would be 0.5 man/shifts or a cost of about $0.77 per ton on surface labour. A further cost of about $0.14 per ton can be anticipated for power and miscellaneous.

Treatment of the coal would be by the Compound Water Cyclone; the cost including equipment, power and operation, based on two million tons per year would be $0.17 per ton.- Verbal communication Dr. J. Visman, Department of Mines and Technical Surveys, Edmonton, Alberta.

It is estimated that losses in the washing would be about 15%. The cost of operation should therefore be increased accordingly: $0.47.

The total cost for surface operations would be in the vicinity of $0.77 + $0.14 + $0.17 + $0.47 = $1.55.

TRANSPORTATION COSTS

Railway transportation from Fort St. John to either Prince Rupert or Vancouver, would be $7.80 per ton. At any point south of Fort St. John, it should be less, therefore, the price quoted is in excess of what actual costs would be.

Handling at the port would be approximately $2.00/ton.

It should be noted that there is a great probability that there will be coal moving west from Hasler Creek, on the Pacific Great Eastern Railroad as well as from the Smokey River area of Alberta, using probably the same facilities in part as would be used by coal moving from Portage Mountain. It may therefore be assumed that both the abovementioned costs would be lower.

Shipping costs from Vancouver to Japan are quoted by the Japanese shippers at $3.50 per ton. The undersigned is aware of shipping firms that would ship at $2.70 per ton. As more coal moves out of Canadian ports, the bidding on the shipping will become even more competitive.

Total transportation costs should not therefore exceed $7.80 + $2.00 + $2.70 = $12.50 per ton.

CAPITAL INVESTMENT

In order to provide rail transportation from Portage Mountain to a point on the Pacific Eastern Railway, it would be necessary to build a twenty mile spur line. Under the most difficult condition, the cost of such a spur would be about $300,000 per mile or a total of Six Million Dollars.

A capital investment of six million dollars, at a 6% rate of interest and on a payout of ten years would cost about $360,000. The total cost of the spur would therefore be about $6,360,000.

No detailed study has been made by the undersigned on the capital necessary to establish a mechanized mining operation capable of producing two million tons of coal per year. However, a general estimate would be in the vicinity of twenty million dollars. On a ten year payout, this would come to a capital investment of about Twenty-five Million Dollars.

Flow Sheet

Gross Income on 20 Million Tons of Coal			$385,200,000
Capital Outlay:			
Equipment	$25,000,000		
R.R. Spur	6,360,000	$ 31,360,000	
Underground Costs:			
20,000,000 x 2.04		40,800,000	
Surface Costs:			
20,000,000 x 1.55		31,000,000	
Transportation:			
20,000,000 x 12.50		256,000,000	
Total Costs			$359,160,000
Profit excluding Taxes			$ 26,040,000

CONCLUSIONS

It is concluded that markets are available for a low to medium voletile coking coal. It is further felt that the coal at Portage Mountain would fall into this category.

With the availability of markets and of coking coal, there should be no trouble to find the initial capitalization required for opening up the coal seams at Portage Mountain.

Therefore, under the existing economic conditions, a well organized operation at Portage Mountain would, over a ten year period, show an average annual profit of 2,6 Million Dollars, before taxes. During this period, the cost of equipment would be paid off by the operation.

It is not felt that any great costs would be incurred on equipment maintenance during the first ten years, and no costs have been shown for new purchases.

Further equipment purchases could be envisioned during a second ten year period when the first capital outlay has been amortized.

It must be further pointed out that mining costs as well as transportation would tend downward, as methods improved, and as the amount of coal being shipped from Western Canada increased, and that infact actual profits over a ten year period should be greater than estimated.

RECOMMENDATIONS

It is recommended that the holders of the coal reserves at Portage Mountain proceed with a thorough testing of the coal seams involved.

The following procedure is recommended:

1) Driving adits into the seams, along strike, and having analysis run on each seam, until such time as the analysis indicate that the quality of the coal is constant. Under good roof conditions, this should be about twenty-five feet into the seam.
Such an approach would assure that the samples being analyzed are not oxidized.

2) Upon completion of the tunnelling, various blends of the coals should be tried, in order to get the best results.

3) The blend best suited should be sent to the prospective client, in order to have the coal tested at the steel mills.

The cost of this operation should be in the vicinity of 1.8 million dollars minus the value of equipment on hand.