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PRELIMINARY ASSESSMENT
OF THE
CHU CHUA COAL PROSPECT
BRITISH COLUMBIA

PREPARED FOR

TEXACO CANADA RESOURCES LTD.

SUBMITTED BY

ASSOCIATED MINING CONSULTANTS LTD.

MAY 1983

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May 16, 1983

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0201-2002

Mr. H. Dan Frank
Texaco Canada Resources Ltd.
605 - 5 Avenue SW
Box 333, Station M
CALGARY, Alberta
T2P 2P8

Attention: Dr. D.B. Livesey
Research Associate

Dear Sirs:

Re: Chu Chua Coal Prospect

Further to your instructions of March 11, 1983 we enclose for your information and attention our preliminary assessment of the status of the Chu Chua coal prospect north of Kamloops, BC.

The Chu Chua coal prospect falls within the broad guidelines for thermal coal project development established previously by Texaco. Established infrastructure is in place and the coal is of high thermal value. Due to the lack of hard geologic data available, certain assumptions have been made to assess the potential of this prospect. Depending upon the combination of assumptions potential coal resources range between 1 Mt and 14 Mt. However, because of a lack of documented geologic data concerning the Chu Chua prospect, the controlling parameters on which the potential coal resource is predicated can only be determined by field exploration.

We recommend that Texaco prepare and document a corporate strategic plan as outlined in Appendix B, and consider further evaluation of the Chu Chua prospect within the confines of that plan.

Respectfully submitted,

ASSOCIATED MINING CONSULTANTS LTD.

Brandon T. Wild, P.Eng.
Manager
HUB:ms

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CHU CHUA COAL PROSPECT
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PRELIMINARY ASSESSMENT OF THE
CHU CHUA COAL PROSPECT, BRITISH COLUMBIA

I. INTRODUCTION

Terms of Reference

In a previous assignment entitled **'Coal Lease Assessment and Potential for the Crowsnest Pass Region'** (AMCL Report AR-59, December 1982), AMCL carried out initial evaluations of regional geology and existing coal leases in the Crowsnest Pass region in Southwest Alberta and Southeast BC, within broad guidelines established by Texaco Canada Resources Ltd. concerning the potential for thermal coal development as part of Texaco's corporate strategy. These guidelines essentially require that the coal prospect satisfy the following conditions:

- located near established infrastructure and within 30 km road haul distance from railway
- contain coal with a high calorific value suitable for thermal markets
- be capable of supporting a 200 000 to 500 000 t/a clean coal production for 10 years
- mineable by open pit or easily accessible underground.

AMCL Report AR-59 made specific recommendations concerning 'grass roots' exploration of coal prospects in the Crowsnest Pass Region both in Alberta and BC. Following submission of Report AR-59, as an extension of the Crowsnest Pass assignment AMCL was instructed to carry out a preliminary assessment of the Chu Chua coal prospect,

located 88 km north of Kamloops, and to comment on the prospect potential within the guidelines established by Texaco.

Background

The Chu Chua coal deposit has been reported on most comprehensively by W.L. Uglow as part of a 1922 Geological Survey of Canada Report entitled 'Geology of the North Thompson Valley Map-Area, B.C.'

Uglow identifies three main seams, which, in descending order, are the Thomas (A and B Seams), the Smith (A and B Seams) and the Gray Seam. Several other thin seams also exist. The seams thicken and thin, roll, split and unite over short distances laterally.

The Chu Chua coal deposit was mined under various owners from the early 1890's until 1924 with total coal production of some 10 000 t. Development took place in all three main seams, but with commercial production only from the Thomas and Gray Seams. It does not appear to have been documented why mining on the property ceased, but it is likely that the local domestic market was inadequate to support the operation.

Following testing by the Mines Branch in Ottawa, Uglow identified the coal as high ash, low moisture, high rank sub-bituminous to low rank bituminous coal. The coal has a high inherent heat altered thermal content with the potential for significant enhancement with cleaning, to above present market specifications.

In his report Uglow suggested that the Thomas A and B Seams may unite at a level below that at which development occurred to form a single 1.5 m seam. Uglow also suggested the potential for other coal seams of commercial interest in the 460 m interval between the lowest known main seam, the Gray Seam, and the basal conglomerate.

In the spring of 1982 Magenta Mines Ltd. filed for a coal exploration licence on the prospect but this was withdrawn in early 1983 as a result of objections raised by certain landowners during the licence application process. There was some indication that Manalta Coal Ltd. had expressed an interest in the property in 1982 as a result of Magenta Mines' activities. Texaco filed a coal exploration licence application for 1847.3 ha on March 18, 1983.

2. GEOLOGY

The coal seams occur within the Tertiary Chu Chua Formation of Eocene Age. This formation is the sedimentary record of a restricted interior basin receiving sediments from the surrounding igneous, volcanic and metamorphic complexes. Coal seam continuity within these restricted basins tends to be poor because of local variations in the sedimentation rate along the basin. Coal seams deposited in these restricted basins tend to have a high variability in ash content and generally tend to split towards the basin margins with the effect of increasing ash content. Seam splits towards the basin edge have been documented at Chu Chua in the Smith Seam by Uglow.

The Chu Chua Formation in the licence area rests unconformably on the Mississippian Fennel Formation; a basal conglomerate up to 50 m thick has been reported.

The Chu Chua Formation is overlain by the Skull Hill Formation (Eocene to Oligocene Age), comprising acidic and basic lava flows. These lava flows are probably responsible for the relatively high rank of the young Chu Chua coals.

The stratigraphy of the Chu Chua Formation is detailed by Uglow and a simplified version is shown below:

	Thickness (m)
Sediments, thin coal seams	80
Thomas A Seam	0.7
Shale	3
Thomas B Seam	0.8
Sediments, thin coal seams	80
Gray Seam	1.2
Sediments	460
Basal conglomerate	50

The structure over the licence area is thought to be fairly simple. The coal bearing strata dip 23° in an easterly direction. A major fault parallels the North Thompson River valley west of the licence area.

3. POTENTIAL COAL RESOURCES

The geologic data for the Chu Chua coal deposit is very limited but speculative 'potential coal resources' have been estimated on the basis of the assumptions shown below in order to assist in assessment of the prospect.

Assumptions

- Coal seam attitude - a wide variation was available from the literature, two were chosen N 02° E, 23° E and N 30° E, 23° SE; in both cases continuity over the licence area was assumed.
- Contact with the underlying Fennel Formation - dip 60° W. This assumption implies a near vertical contact during Chu Chua Formation deposition. Reducing the dip angle would have the effect of decreasing the coal resource potential.
- Seam thicknesses as reported by Uglow persist over the licence area. This is unlikely in this depositional environment, but could increase or decrease.
- Pleistocene cover depth to bedrock - two cases were evaluated, a thin, less than 10 m cover; and a thick, less than 150 m cover.

The results are shown in Table 1 and Figure 1. The northerly strike assumption provides a potential coal resource of 13.8 Mt for thin cover and 6.9 Mt for thick cover. The northeasterly strike assumption provides a potential coal resource of 6.0 Mt for thin cover and 1.0 Mt for thick cover.

4. MINEABILITY

The Chu Chua coal seams dip eastward into a west sloping hillside. This geometric relationship results in total overburden of up to 500 m. Coal extraction on the prospect would be predominantly by underground methods and the viability of this would be sensitive to seam thickness.

5. RECOMMENDATIONS

The coal resource potential at Chu Chua is very sensitive to coal seam attitude, seam thickness and bedrock cover. Because of a lack of documented hard geologic data, these factors can only be determined by field exploration.

In considering future courses of action and before making specific recommendations concerning Chu Chua we recommend that Texaco consider its longer-term goals with respect to investment in coal, while continuing to examine specific opportunities which may present attractive investment potential as these arise.

Texaco have recently examined various specific opportunities which have been brought to their attention. To date, none of these opportunities have proven attractive for a variety of technical and economic reasons. While the industry remains in its depressed state, good and bad investment opportunities will exist for prospective purchasers. The problem is to identify the best opportunities, bearing in mind Texaco's

long-term corporate plans. In this environment it would seem appropriate to develop a systematic approach to the search for coal investment opportunities. Such an approach is outlined in Appendix B and summarized below:

- Phase 1: Establish Objectives, Criteria and Preferences
- Phase 2: Industry Sector Analysis (Market Intelligence)
- Phase 3: Short List Most Attractive Prospects and prepare Acquisition Plan.

The phased approach we recommend has the benefit of gradually refining Texaco's preferred course of action with each new step justified by findings arrived at in an earlier phase.

With regard to our recommendation that Texaco prepare a corporate strategic plan within which all potential coal developments would be evaluated, our recommendation concerning Chu Chua is to delay any further consideration of this prospect and not to carry out any field exploration until a corporate strategic plan has been developed and the potential for alternative prospects identified.

6. REFERENCES

BC Ministry of Mines Reports
1900 to 1925:

Campbell, R.B., and Tipper, H.W.
1971: Geology of Bonaparte Lake Map Area, British Columbia; Geol. Surv. Can., Mem. 363.

Uglow, W.L.
1922: Geology of the North Thompson Valley Map Area, B.C.; Geol. Surv. Can. Sum. Report 1921, Pt. A, pp. 72 - 106.

TABLE I

TEXACO CANADA RESOURCES LIMITED

CHU CHUA PROPERTY

POTENTIAL COAL RESOURCE

Seam	Strata Attitude N 02° E, 23° E						Strata Attitude N 30° E, 23° SE					
	Pleistocene Cover < 10 m			Pleistocene Cover < 150 m			Pleistocene Cover < 10 m			Pleistocene Cover < 150 m		
	Area km^2	Thick m	Mt**	Area km^2	Thick m	Mt	Area km^2	Thick m	Mt	Area km^2	Thick m	Mt
J		0.2										
Thomas A*	3.4	0.7	3.3	1.5	0.7	1.5	1.2	0.7	1.2	0.1	0.7	0.1
Thomas B	3.4	0.8	3.8	1.5	0.8	1.7	1.2	0.8	1.3	0.1	0.8	0.1
F		0.3										
D		0.2										
C		0.4										
Lower Smith*		0.5										
Gray*	4.0	1.2	6.7	2.2	1.2	3.7	2.1	1.2	3.5	0.5	1.2	0.8
TOTAL			13.8			6.9			6.0			1.0
			Fig. I-A			Fig. I-B			Fig. I-C			Fig. I-D

* mined previously

** relative density 1.4

TABLE I

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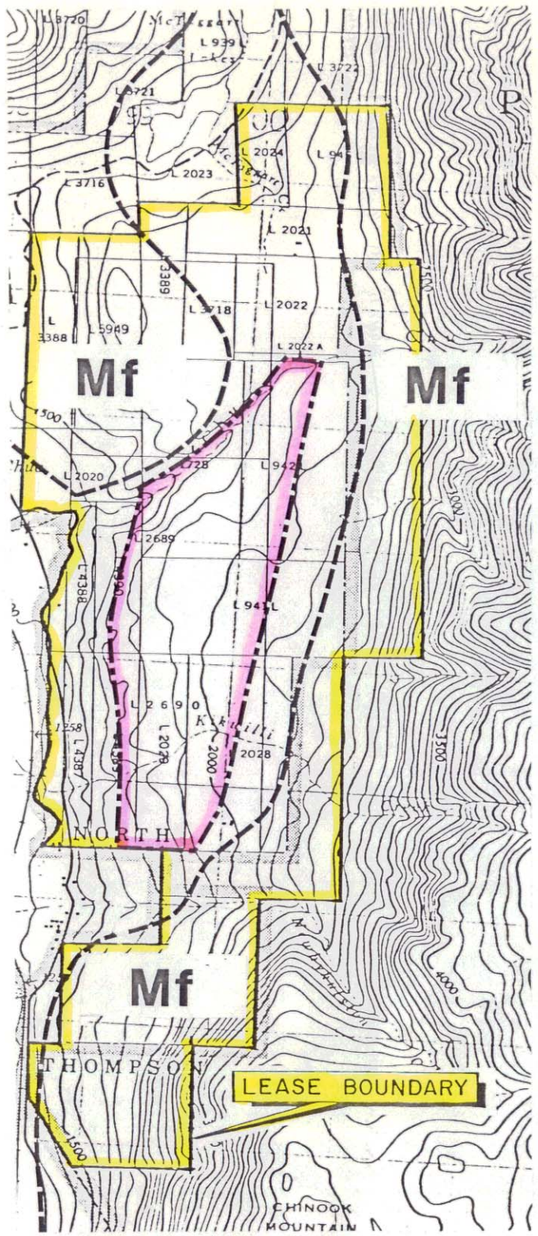
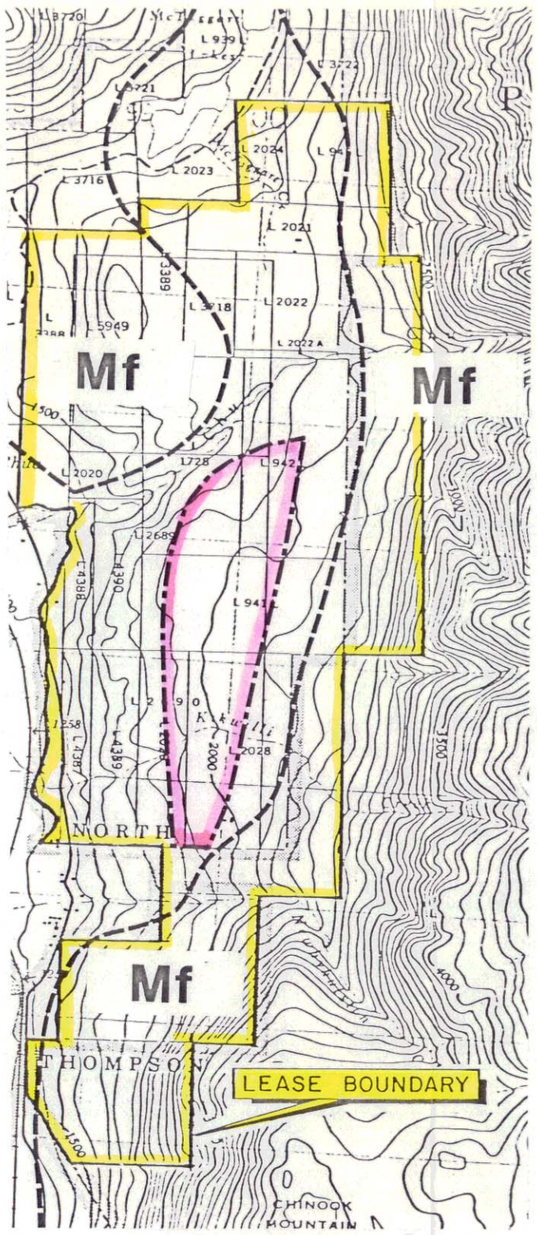
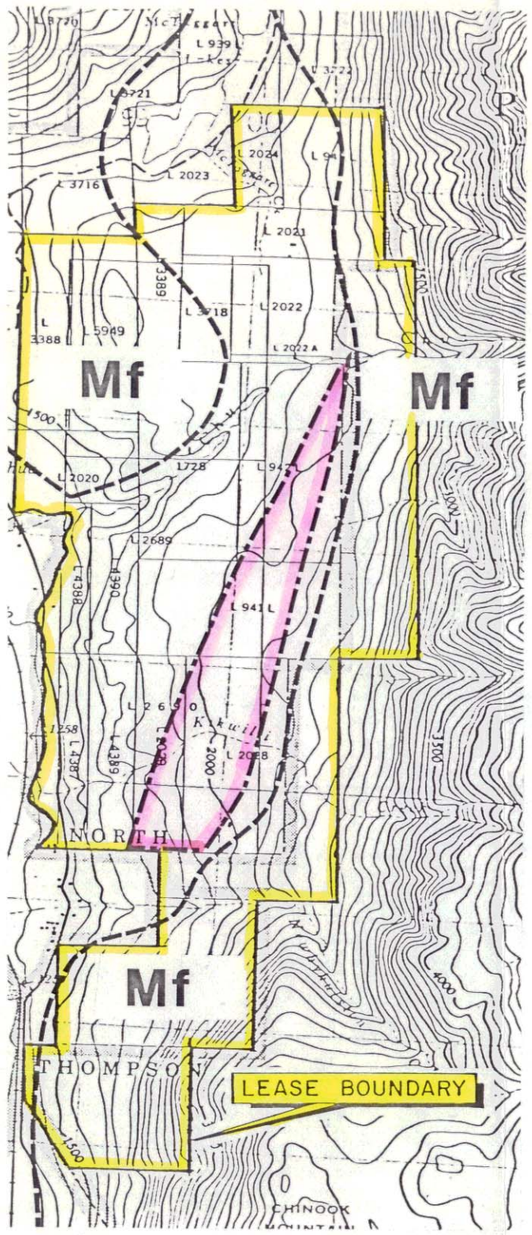


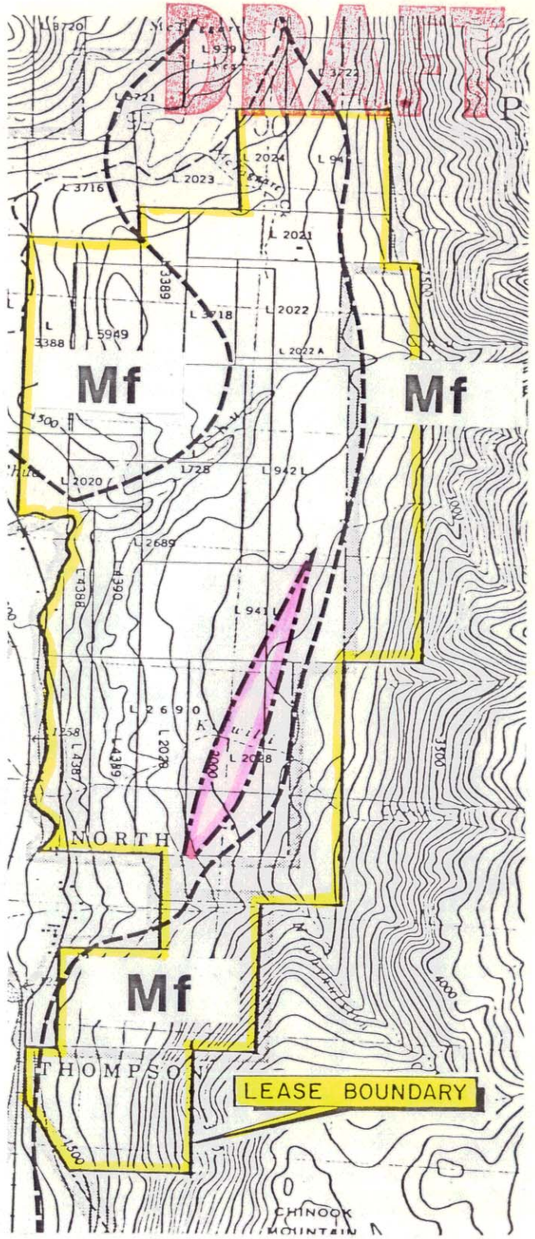
A Bedding N 02° E, 23° E
Pleistocene Cover <10m



B Bedding N 02° E, 23° E
Pleistocene Cover <150 m



C Bedding N 30° E, 23° SE
Pleistocene Cover <10 m



D Bedding N 30° E, 23° SE
Pleistocene Cover <150 m

1:50000

1 0 1 2 3 miles

1 0 1 2 3 4 kilometres

AMCL 92 P/8
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FIGURE 1
TEXACO CANADA RESOURCES LIMITED
CHU CHUA PROPERTY

POTENTIAL COAL RESOURCE

APPENDIX A

Geology of the North Thompson Valley Map-Area, BC
W.L. Uglow, Geol. Surv. of Can., Summary Report Part A, 1921
(reproduced in part) pp 72 - 106

GEOLOGY OF THE NORTH THOMPSON VALLEY MAP-AREA, B. C.

By W. L. Uglow

CONTENTS

Illustrations

INTRODUCTION

The North Thompson Valley area extends from Fishtrap rapids, 27 miles north of Kamloops, to the vicinity of Boulder (Figure 19). The east and west boundaries of the area are from 3 to 10 miles on each side of the river, sufficiently far apart in most cases to include the slopes of the Thompson trench and a part of the adjoining plateau. The Canadian National railway fringes the east bank of the North Thompson throughout the length of the sheet.

The geology was plotted on an excellent topographical base map made by D. A. Nichols, Geological Survey, during the seasons of 1918 and 1919. The rugged character of most of this country, and the thick timber, made mapping difficult, and it is a pleasure to acknowledge the extent to which the base map facilitated the work of the geologist.

The geological mapping was done on a scale of 4,000 feet to 1 inch. Traverses were run by the Brunton compass and aneroid method. Three and one-half months during the summer of 1921 were occupied by this work. Special attention was paid to the coal and mineral deposits. Short trips were taken outside the boundaries of the sheet, particularly to correlate the geology of the Adams and Barrière Lakes districts, as described by Dawson and Daly, with that of the North Thompson valley to the west.

The progress of the work was greatly facilitated by the courtesy and assistance of the settlers of the district. Special acknowledgments are due to the officers of the staff of the Chu Chua Coal Company; to W. J. Smith of Louis Creek; to J. J. Smith of Chinook Cove; and to George Fennell of Chu Chua. Very valuable assistance was given at times by D. A. Nichols, whose suggestions were the means of saving considerable time in geological mapping.

C. O. Swanson rendered efficient assistance in every branch of the work; and on occasions he was allotted semi-independent investigations. C. J. Cock also acted as field assistant.

PREVIOUS WORK

Previous geological investigations of this and adjacent areas had been made by the following members of the Geological Survey:

A. R. C. Selwyn[1] in 1871 made a traverse up North Thompson River valley from Kamloops and continued his reconnaissance beyond Tête Jaune to the Rocky mountains. He gives some preliminary notes on the occurrence of the Lower Cache Creek series, and the Tertiary lavas of the North Thompson; and on the granite gneiss and mica schist series near Raft river.

G. M. Dawson[2] in 1877 made a reconnaissance geological map covering 250,000 square miles of southern British Columbia. He reported briefly on the geology of North Thompson River valley, as far north as the Indian reservation near Chu Chua. He describes the first detailed section of the Tertiary coal measures, which are exposed in the valley of Newhykulston creek. His map, on a scale of 8 miles to 1 inch, is exceedingly general, and its northern boundary passes just south of the present village of Chu Chua.

G. M. Dawson[3], during the seasons of 1888, 1889, and 1890, geologically mapped the area of the Kamloops sheet (Figure 19). This work was done on a scale of 4 miles to 1 inch and embraced an area of 6,400 square miles. The areal and structural geology was, of necessity, done in a broad and general fashion, but with certain detailed examinations and sections in some of the crucial areas. His correlation of geological series was carried out in a tentative manner from the eastern slopes of the Coast range across the Interior plateau to the Selkirk and Rocky mountains. In many respects, it was based on the occurrence in widely separated districts of similar lithological successions of formations. Dawson describes the geology of the North Thompson valley from Kamloops to Chu Chua, and the distribution of the formations is shown in the extreme northeastern corner of his map. The structure, petrography, and economic geology of this part of the valley are dealt with in some detail. No new information is presented with regard to the Tertiary coal measures on Newhykulston creek.

G. M. Dawson, in the years following the completion of his Kamloops report, geologically mapped the area of the Shuswap sheet, which immediately adjoins on

[1] Geol. Surv., Can., Rept. of Prog., 1871-72.
[2] Geol. Surv., Can., Rept. of Prog., 1877-78.
[3] Geol. Surv., Can., Ann. Rept., vol. VII, N.S., 1894.

the east (Figure 19) and slightly overlaps the Kamloops sheet. The Shuswap map includes an area of 6,400 square miles on a scale of 4 miles to 1 inch. Unfortunately Dawson was unable to complete his Shuswap report, so that the only published record of his results is embodied in his Shuswap geological map[1] and its marginal notes.

R. A. Daly,[2] in 1911 and 1912, carried on a geological survey of a belt of country paralleling the Canadian Pacific railway from Clan William on the east to a point 11 miles east of Kamloops. He extended his mapping to include the shores of Adams and Shuswap lakes, and outlined a general revision of Dawson's correlation. The work of the present writer in 1921 was extended easterly to the shores of Adams lake, and an areal connexion was thus established with the work of Daly.

TOPOGRAPHY AND CLIMATE

The North Thompson valley lies near the eastern margin of the Interior plateau. The strip of country included in the North Thompson Valley map-area is chiefly confined to the flat valley bottom and the rather steep valley slopes. In places, the map extends easterly from the lip of the valley to take in parts of the relatively flat uplands.

North Thompson river has entrenched itself from 2,500 to 3,000 feet below the level of the plateau. The gently undulating plateau country above altitudes of 3,500 to 4,000 feet is in very marked topographical contrast with the steep and in some places, rugged and rocky sides of the valley (Plate III A). The lower slopes are finely terraced, whereas the valley bottom is unusually flat and has an average width of one mile. Here and there isolated knolls and ridges stand in the middle of the valley, erosion remnants whose tops still rise very nearly to the general level of the plateau (Plate III B).

A large part of the district is drift-covered and well timbered. The chief areas of exposed rock are confined to the more rugged portions of the sides of the valley, the stream and river canyons, and the few monadnocks which rise above the plateau.

The area of the sheet lies just beyond the northeastern margin of the "Dry belt". The sage-brush country, so characteristic of Kamloops and the valley of Thompson river, does not extend northerly as far as Fishtrap rapids, a few miles south of which is a rather abrupt transition from treeless to timbered country.

The climate is warm and comparatively dry in summer with occasional rains. The precipitation is not sufficient, however, to render the flat terrace-lands arable, without irrigation; but barren-looking valley flats may be converted by irrigation into rich fruit-growing ground.

GENERAL GEOLOGY

GENERAL STATEMENT

The lower formations of the district, namely the Badger Creek, Fennell, and Barrière, consist of a series of quartzite, quartz slate, micaceous quartzite, sericite schist, chlorite schist, limestone, dolomite, argillite, argillaceous schist, greenstone pillow lava, with intrusive gabbro and diorite masses. They were included in the Cambrian system by G. M. Dawson, but later work shows this correlation to be doubtful. They are here classified as Precambrian or late Palæozoic.

These rocks are intruded by dykes, sills, stocks, and a batholith, consisting of granodiorite, granite, quartz diorite, micropegmatite-pyroxenite, alkaline syenite, aplite, and pegmatite. The age of these intrusives is not definitely known, but they belong, probably, to the period of Coast Range intrusion.

The above-mentioned formations are overlain unconformably by a series of late Eocene sediments consisting of basal conglomerate, arkose, arenaceous shale, and coal,

[1] Geol. Surv., Can., Map 604, 1898.
[2] Geol. Surv., Can., Mem. 68, 1915.

which are confined to certain protected re-entrant positions near the bottom of the North Thompson trench. They are erosion remnants of a much more widespread series of mechanical and organic sediments. These sediments are unconformably overlain by a thick cover of Miocene augite-hornblende andesite flows, which have baked and somewhat metamorphosed the Eocene sediments. These two Tertiary formations have been considerably faulted and eroded, and, later, covered by glacial drift. Post-Pleistocene lava was found in Mann creek, overlying Recent stream gravels.

The North Thompson river occupies an antecedent course inherited from Cretaceous times. Its Cretaceous valley is still preserved as a slight depression in the uplifted Cretaceous peneplain.

The North Thompson valley was developed at least to its present depth in Middle Eocene time, for the Chu Chua (Eocene) sediments are now found along its lowest slopes. The valley was later flooded by Miocene lavas, and was re-excavated during the late Tertiary. Evidences of extensive glaciation are found in the valley, and on the highest peaks up to an altitude of 7,500 feet.

Several prospects are located in or near the map-area. The most important metalliferous deposits known are the Gold Hill, carrying free gold with galena; the Wind Pass and the Sweet Home, carrying free gold, magnetite, and native bismuth; the Queen Bess, a silver-zinc-lead deposit; and the Homestake, a silver-lead-barite deposit near Adams lake. The chief economic interest of the area, from a mining standpoint, is the occurrence of coal in the Eocene measures at Chu Chua. During the summer and autumn of 1921 active development and mining was being carried on by the Chu Chua Coal Company.

Table of Formations

Formations			Rock types
Quaternary	Recent		Lava River gravels, sands, silts, "White Silts" of Dawson
	Pleistocene		Glacial drift
Unconformity			
Tertiary	Miocene	Skull Hill	Hornblende andesite Augite andesite Andesitic breccias Amygdaloidal andesite and basalt
	Unconformity		
	Eocene (Middle or Upper)	Chu Chua	Sandy shale Coal seams Arkosic sandstone Intraformational conglomerate Basal conglomerate
Unconformity			
Mesozoic (?)	Jurassic (?)	Peterson Creek stock Baldie batholith Sills Sills Darlington stocks	Porphyritic alkali syenite Granite, porphyritic granodiorite Biotite granodiorite, quartz diorite Micropegmatite-pyroxenite Hornblende granodiorite, hornblende granite, orthogneiss

Table of Formations—Continued

Intrusive Contact

Palæozoic or Precambrian		Barrière	Quartzite, sericitic quartzite, sericite schist, quartz pebble conglomerate, argillite, crystalline limestone, chlorite schist, schistose amygdaloidal lava.
		Fennell	Ellipsoidal (pillow) greenstone, gabbro and diorite sills, chert, volcanic breccia.
		Badger Creek	Slaty quartzite, quartz slate, biotite schist, dolomite, hornblende schist.

ECONOMIC GEOLOGY

COAL

Coal has been known for a great many years to occur on the lands of the Indian reservation near Chu Chua. The exact locality of the occurrence is in the gorge of Newhykulston (Coal) creek three-quarters of a mile above its mouth. The exposures are at altitudes of 1,400 to 1,500 feet. A road running down the valley for 1,200 yards to a siding on the Canadian National railway makes the coal readily accessible.

Stratigraphy and Structure

The coal measures are of Middle or Upper Eocene age as determined from the flora found at the top of the main seams. A detailed section of the coal measures is given below. The beds strike north 20 degrees east and dip 23 degrees to 25 degrees southeast (Figure 20 A and B).

Coal Seams

There are three main seams which are referred to as the Gray, the Smith (A and B), and the Thomas (A and B) seams. Several other thin seams are shown on Figure 20 A and B as the A, B, C, D, E, F, G, H, J seams. For the thickness and physical characters of the minor seams, attention is directed to the stratigraphical section.

The coal is usually frozen to the bands of sandstone that occur within the main boundaries of the seam, but it breaks free from the capping and floor.

The capping is rigid, and requires very little timbering.

There is an absence of fire-clay at the base of the coal seams.

The seams thin and thicken, roll, split, and unite in short distances laterally. Such an occurrence makes an estimate of reserves exceedingly difficult to make.

Thomas Seam. Until the end of the summer of 1921, practically all the development had been confined to this horizon. It is a double seam, the upper part being the A, and the lower the B. In the outcrop along the side hill, these two parts of the seam are separated by 9 to 10 feet of arkosic sandstone and arenaceous shale. At the time of the writer's examination, they were seen to be not more than 3 feet apart in the bottom of the slope. At a lower level they may unite and form a seam 4 to 5 feet thick.

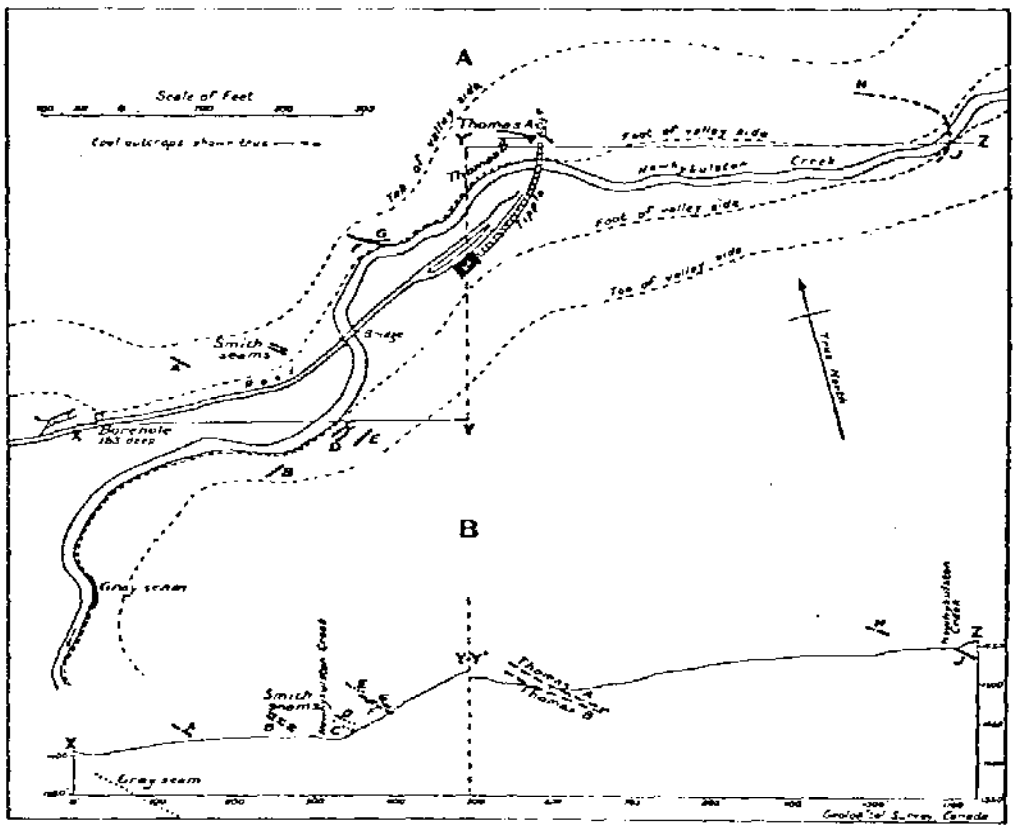

Figure 20. A. Plan showing outcrops of coal on the property of the Chu Chua Coal Company.
B. Representation of outcrops of coal seams in a vertical plane along lines XY-Y'Z. Coal seam outcropping on the line of section is shown in solid line; coal seams on north side of line are shown by broken line; and coal seams on south side of line are shown by dotted line.

The two parts of this seam vary in physical character and thickness within very short distances along the beds. The following sections reveal in detail the nature of the seams:

(1)

Sandstone roof
1½ inches hard, black, lustrous coal (streak brown)
1½ inches sandy shale
1 inch hard, lustrous coal
3 inches grey sandstone
10 inches hard, black, lustrous coal (streak brown)
3½ inches sandstone
7 inches coal
2 feet sandstone floor
Total coal: 30 inches.

(2)

Sandstone roof
8 inches hard, massive, lustrous coal
2 inches shale
1½ inches coal
1 inch shale
7½ inches coal
2 inches sandy shale
6 inches coal
Sandstone (smooth floor)
Total coal: 22 inches.

(3)

Sandstone roof
30 inches coal—Thomas A seam
36 inches sandstone
36 inches clean coal—Thomas B seam

(1) Vertical section of Thomas B seam on south wall at the bottom of main slope.
(2) Vertical section of Thomas A seam on north face, lower level.
(3) Vertical section of Thomas A and B seams, 20 feet north of No. 1 chute, lower level.

Smith Seam. This is also a double seam and is exposed in a short slope. A section down the slope is given in Figure 21.

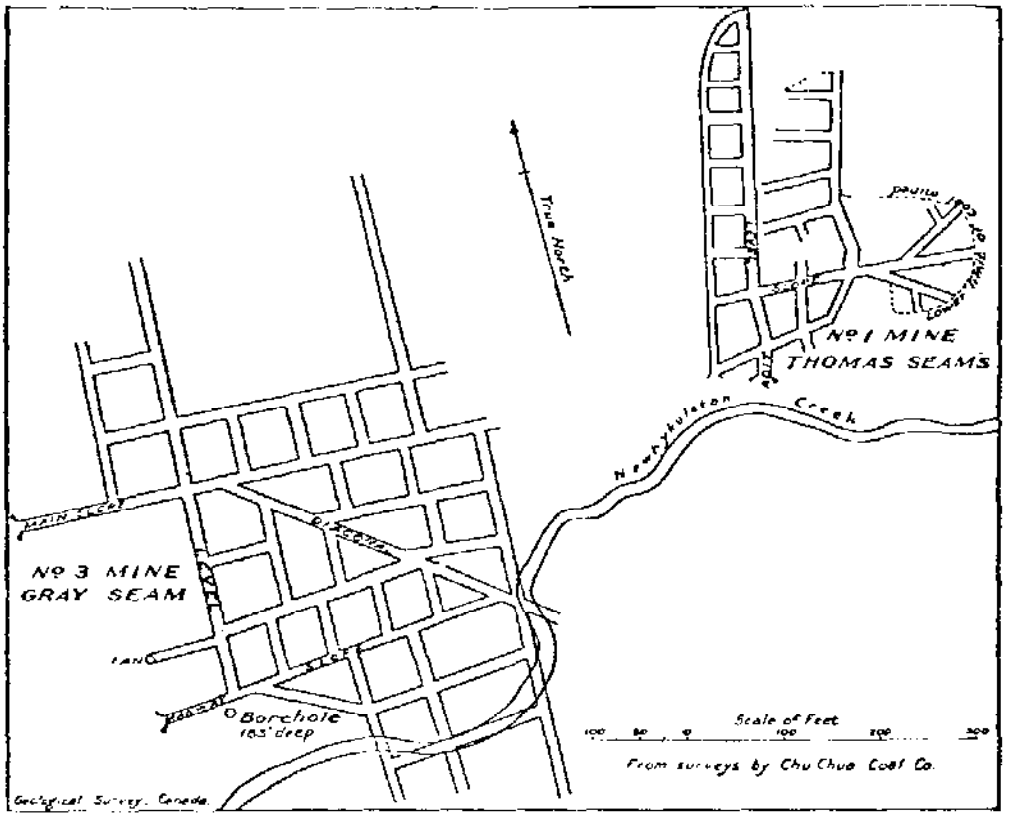

Figure 21. Plan of underground workings of Chu Chua Coal Company.

The detailed stratigraphic section at the portal of this slope is as follows:

Massive pebbly sandstone capping.
18 inches to 20 inches hard, thinly laminated, fairly clean coal.
20 inches to 48 inches hard, massive grey sandstone.
6 inches shale with coaly partings.
10 inches coal with shale partings.
Fissile grey (arenaceous) shale floor.

Gray Seam. This is the lowest coal so far discovered in the measures. It was uncovered at the time of the stream freshet in June, 1921, by the sapping of a thick mantle of glacial drift. At the suggestion of the writer a small excavation was made at this point and revealed the structure and relations shown in Figure 22. This outcrop was much weathered and it was difficult to determine how much clean coal was in the seam.

Physical Characteristics and Grade of Coal. The coal is a hard, black, lustrous, thinly laminated variety with a dark brown streak. It is very friable but it does not readily blacken the fingers. The seams lack the perpendicular prismatic jointing so characteristic of bituminous coal, but possess instead the thinly laminated structure found in lignites. The coal weathers rapidly and becomes coated with a yellowish-white alteration product. It burns readily with a long yellow flame, and it is said to be an excellent steam-producing fuel.

Small lenses, blebs, and irregular-shaped masses of a semi-transparent, amber-yellow material occur within the seams. This is the fossilized form of some of the resins of the coal-forming trees. As a result of the biochemical and dynamochemical changes which took place during the formation of the coal, the woody parts of the seam were much carbonized and fractured, whereas the resins resisted the biochemical changes to the last.[1] Being plastic, the fossilized resins accommodated themselves by

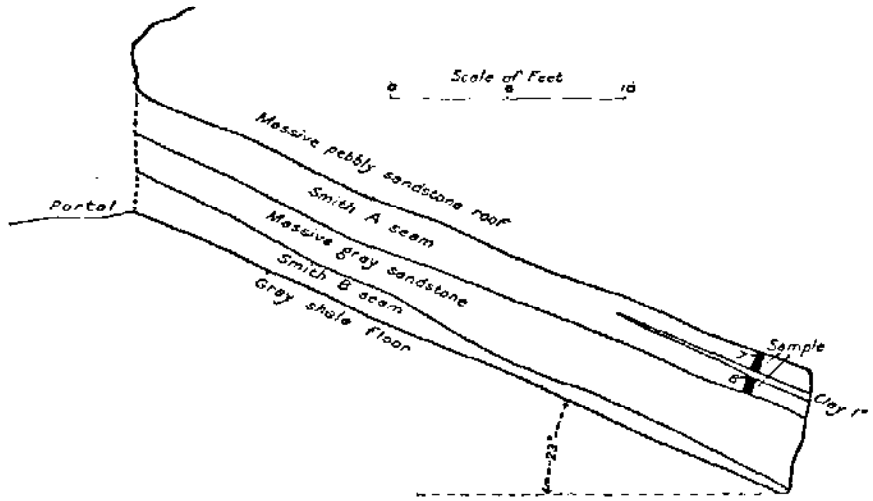

Figure 22. Vertical section through slope on Smith seam, Chu Chua Coal Company.

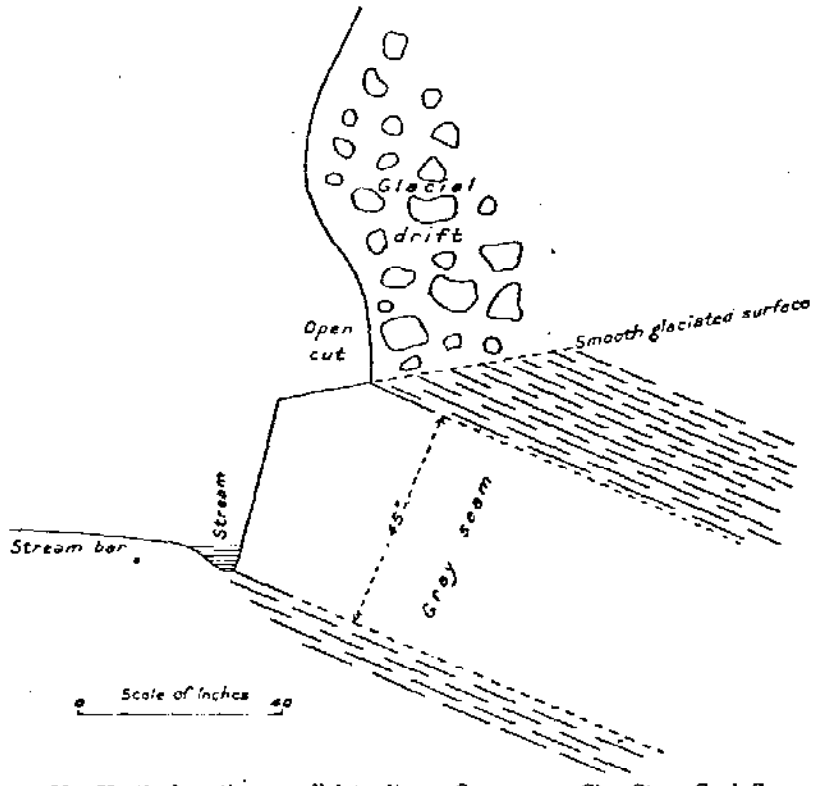

Figure 23. Vertical section parallel to dip on Gray seam, Chu Chua Coal Company.

[1]U.S. Geol. Surv., Prof. Paper 85, 1914.

flow to the shapes of the fractures in the coal, and now they occur in cracks and cavities of all shapes; and in places they present the appearance of having replaced the coal.

Four samples of coal from the seams were submitted to the Mines Branch, Ottawa, for analysis. The samples were analysed as received (R) and as dried at 105 degrees C. (D). The results are given herewith:

	(1)		(2)	
	R	*D*	*R*	*D*
	Per cent	Per cent	Per cent	Per cent
Moisture	4·0		3·7	
Ash	24·0	25·0	37·3	38·8
Volatile matter	36·1	37·6	29·4	30·5
Fixed carbon	35·9	37·4	29·6	30·7
Fuel ratio	0·99	0·99	1·01	1·01
	Sample made poor coke in very small lumps		Sample agglomerates	
British thermal units	10,290	10,700	8,230	8,550

	(3)		(4)	
	R	*D*	*R*	*D*
	Per cent	Per cent	Per cent	Per cent
Moisture	3·6		4·0	
Ash	13·8	14·3	22·1	23·0
Volatile matter	37·9	39·3	37·9	39·5
Fixed carbon	44·7	46·4	36·0	37·5
Fuel ratio	1·15	1·15	0·95	0·95
	Small lump fair coke		Small lump poor coke	
British thermal units	12,040	12,490	10,780	11,230

(1) Sample represents a channel of 15 inches in length across the Smith A seam, at a point 20 feet down the slope from the portal (Figure 21).

(2) Sample represents a channel 41 inches in length across the Gray seam. It includes 4 inches of coal shale, 8 to 10 inches of hard lustrous coal, 1 inch of clay, followed by weathered soft, shaly coal to the bottom.

(3) Selected sample of the best grade of coal from the upper 8-inch part of the Thomas A seam.

(4) Selected sample of the best grade of coal from the Thomas B seam.

These results show that the coal should be classified as low grade, low rank bituminous, or low grade, high rank sub-bituminous.[1] The fuel ratio is that of a low rank bituminous coal; the moisture content suggests a high rank bituminous; the large amount of ash makes it a low grade coal; and the lack of prismatic structure and the tendency to split into sheets parallel to the bedding indicate a sub-bituminous coal.

It seems probable that the original lignitic coal seams of this district were raised to sub-bituminous rank by thermochemical means; the heat having been supplied by Miocene lavas which, it is believed, formerly covered the coal measures. These lavas have since been completely removed by erosion.

Development. During the summer of 1921 development was confined to the Thomas seams, on which there was an adit 125 feet long, with workings which continued down the slope for about 200 feet. About twenty-five men were being employed by the Chu Chua Coal Company, the only operators. During the winter of 1921-22 underground development was carried out on the Gray seam. A short slope on the Smith seams, driven several years ago, was abandoned (Figure 20 B).

[1] U.S. Geol. Surv., Prof. Paper, 160-A, 1917, p. 3.

Production. During September, 1921, this property produced from one to two cars of coal a week. Towards the end of the year the Chu Chua Coal Company reported a production of about 40 tons a day.

Extent of Basin. As stated above in the discussion of the Chu Chua formation, owing to lack of exposures very little information is available regarding the longitudinal extent of the coal measures. They may extend 5 to 6 miles in a north-south direction underneath the low ridge that parallels the base of Chinook mountains.

Down the dip, the seams will, of course, be cut off where they overlap the surface of the Fennell greenstones, which represent the old shore-line of the lake.

In the detailed stratigraphic section of the coal measures in Newhykulston creek there is shown an interval of about 1,500 feet between the Gray seam and the basal conglomerate. In this interval, other seams of commercial value may occur.

The most important point to be determined by the present operations is, however, the longitudinal extent of the basin and this can be done only by intelligent drilling.

Coal may also be found in other parts of the North Thompson or tributary valleys where erosive agencies have not entirely removed the rocks of the Chu Chua formation.

Section of Chu Chua Formation on Newhykulston Creek

	Ft.	In.	
South Side of Creek—			
Black carbonaceous shale		3	
Coarse grey sandstone with black shale parting	5	0	
Coal shale		6	
Crossbedded shaly sandstone	1	6	
Coarse grey sandstone	4	0	
Grey shale	1	6	
Coarse grey sandstone, massive	3	0	
Grey shale and sandstone, interbedded	3	0	
Hard, massive, fine-grained grey sandstone	2	0	
Grey and black sandstone and shale interbedded	9	0	
Black carbonaceous shale		9	
Grey sandstone with shale partings	1	9	
Grey shale		6	
Black carbonaceous shale		6	
Coal, fissile, clean—J seam		7	
Shaly sandstone		6	
Black carbonaceous shale		6	
Massive grey sandstone	1	6	
Cap	200±		
North Side of Creek—			
Grey sandy shale, weathers blotched white	8	0	
Fine-grained grey sandstone	2	0	
Grey, sandy shale	4	0	
Grey shale, with sandstone at top, and 6 inches carbonaceous shale at bottom	2	0	
Grey shale, carbonaceous at base, sandy at top	1	3	
Loose sandstone with 6 inches of fine conglomerate in centre	2	0	
Grey, flaggy shale, weathers blotched		8	
Massive, fine-grained grey sandstone	1	9	
Fissile, carbonaceous shale		12	
Massive, fine-grained grey sandstone		12	
Fissile grey shale		8	
Coal and shale, interbedded		4	
Brownish-grey, thinly laminated, fissile shale, fossiliferous		6	
Coal, clean		8	Thomas A seam
Coal shale with 1-inch to 2-inch seams of coal		12	Thomas A seam
Coal, clean		11	Thomas A seam
Brown carbonaceous shale		4	
Coal shale with 2 inches of *coal*		7	
Grey, friable, thin-bedded shale	10	0	
Coal shale		6	Thomas B seam
Coal	1	4	Thomas B seam
Gap—Buried	20	0	
Coarse sandstone and fine pebble conglomerate	10	0	
Grey sandy shale		12	
Fine conglomerate	1	6	
Coarse grey sandstone	7	0	
Gap—buried	30	0	
Massive, coarse grey sandstone	10	0	

Section of Chu Chua Formation on Newhylulston Creek—Continued

	Ft.	In.	
North Side of Creek—Con.			
Grey fissile shale	5	0	
Massive grey sandstone bed	2	5	
Fissile grey shale		4	
Shaly *coal*, weathered—G seam		12	
Massive grey sandstone	3	0	
Fissile grey shale		9	
Coal, thinly laminated, weathered—F seam		11	
Hard, fine-grained, greenish grey clayey sandstone	1	2	
Fissile carbonaceous shale	2	0	
Grey sandy shale	1	10	
Hard, massive grey sandstone		12	
Fine-grained crossbedded pebble conglomerate	10	0	
Coarse, grey, crossbedded sandstone	12	0	
Grey flaggy shale	5	0	
South Side of Creek—			
Black carbonaceous shale	1	6	
Grey sandstone	2	0	
Grey sandy shale		12	
Coal shale } D		3	
Coal, thinly laminated } seam		9	
Grey, massive sandstone with 6 inches shaly sandstone at top	6	0	
Gap—Buried	3	6	
Coal } C		6	
Coal shale } seam		12	
Gap—Buried	20		
Shaly *coal*—Upper Smith seam	1	10	
Sandy shale		12	
Hard, grey, massive sandstone	3		
Shaly *coal*		4	} Lower
Coal, brittle, thinly laminated rusty weathering		12	} Smith
Shaly *coal*		4	} seam
Grey fissile shale		6	
Hard, buff, massive sandstone	2	6	
Grey fissile shale		12	
Buff sandstone with sandy shale	4	0	
Massive grey sandstone	2	7	
Black carbonaceous shale		5	
Shaly sandstone		12	
Coal shale		4	
Grey sandy shale	1	3	
Carbonaceous shale	3	8	
Coarse, pebbly grey sandstone, massive	16	0	
Grey sandstone	2	0	
Conglomerate		12	
Black carbonaceous shale		7	
Gap—Buried	4	6	
Shaly sandstone	2	0	
Shale		12	
North Side of Creek—			
Coarse, pebbly grey sandstone with three interbeds of conglomerate	4	6	
Gap—Buried	6	6	
Coarse, pebbly sandstone with few black and grey shale partings	6	6	
Grey sandy shale		12	
Coal }		1	
Carbonaceous shale } A seam		3	
Coal }		4	
Buff sandy shale		6	
Gap—Buried	10		
Massive grey sandstone, coarse to fine	12	6	
Grey sandstone with thin beds of conglomerate	2	6	
Gap—Buried	45		
South Side of Creek—			
Coal—Grey seam	3	9	
Gap—Buried	1,500±		
Basal conglomerate	150+		
Base unexposed.			

APPENDIX B
RECOMMENDED FUTURE COURSES OF ACTION

I. Current Position

In considering future courses of action we recommend that Texaco consider its longer-term corporate goals with respect to investment in coal, while continuing to examine specific opportunities which may present attractive investment potential as these arise.

As a large integrated energy company, Texaco would be prudent to continuously review investment opportunities in all types of energy resources. In the case of coal, the industry in Western Canada is currently in a depressed state with reduced demand for exports, contract prices being negotiated downwards and an excess of supply over demand prevailing. Nonetheless, long-term prospects remain good and for this reason other large oil and gas companies retain ownership positions in operating mines and undeveloped coal properties in Western Canada, as do Japanese coal purchasers. It is also true that the best long-term investment opportunities are often available at bargain prices during a time of temporary recession. In this situation, a reasonable strategy for Texaco would be to consider purchasing an interest in a property while purchase prices are depressed, with a view to developing the property in the future when demand and sales prices improve.

Texaco have recently examined various specific coal opportunities but apparently to date, none of these have proven attractive for a variety of technical and economic reasons. These could include the purchase price asked, the estimated costs of exploration and development, and the current depressed sales price of coal which may have combined to reduce the forecast internal rate of return to an unacceptable level.

While the coal industry remains in its depressed state, both good and bad investment opportunities will exist for prospective purchasers. The problem is to identify the best opportunities, bearing in mind Texaco's

available acquisition budget, long-term corporate plans and appreciating that the better prospects are not necessarily offered for sale on the open market, and that having first identified the prospect it may be up to Texaco to make the first approach.

Thus, it would seem appropriate to develop a systematic approach to the search for coal investment opportunities. Such an approach is outlined below:

2. Texaco Strategic Plan for Coal Investment

The purpose of any corporate strategic plan is to anticipate possible changes in a company's business environment and develop responses to them. The process begins with an examination of objectives and criteria, continues with an analysis of the future prospects of the sector being considered and an assessment of the type and timing of opportunity which could be attractive to the company. Having determined the overall direction and appropriate timing of the move, the next step is to identify suitable acquisition prospects and, in due course, to negotiate with the most promising prospects. The main thing is to plan a course of action in advance and to look in the right places, rather than be forced to react hurriedly to randomly presented opportunities.

2.1 Phase I: Establish Objectives, Criteria and Preferences

Before embarking on the selection process, it would be beneficial to examine Texaco's initial investment/acquisition criteria, even though opportunities may be subsequently revealed which vary from initial preferences. It is not expected that all of the criteria will be settled at this stage. The important thing is to discuss the company's preferences at the outset and review them on a regular basis as the planning process proceeds.

As far as investment in coal is concerned, the following items should be discussed:

- benefits/disadvantages of diversification into coal
- compatibility with Texaco moves into this sector in other countries
- thermal or metallurgical coal
- open pit or underground mining
- coal for export or sale in Canada
- maximum and minimum purchase price to be paid for the property
- preferred timing of purchase relative to other company activities
- operating mine or undeveloped reserves
- unexplored, partially explored, or proven reserves
- location of mine/reserves/infrastructure
- size of mine/reserves (maximum and minimum)
- preferred properties of coal and reserve geology
- ownership position of preferred (100% or joint venture with operator, utility or customer)
- operating position preferred (run by Texaco staff, run by joint venture partner, etc.)
- limits on future capital or operating expenditures
- minimum rate of internal return required (or the minimum sales price which would produce this return)
- public and government relations benefits to the company (eg: purchase from foreign based owner)

2.2 Phase 2: Industry Sector Analysis

The next step would be to prepare a market intelligence type report assessing the future prospects of the industry. The report would contain:

- demand forecasts (domestic and foreign) for thermal/metallurgical coal
- supply forecasts (Western Canadian and foreign competitors)
- analysis of possible markets by country and customer
- sales price forecasts
- regulatory hurdles anticipated
- list of producing mines, sales contracts, positions, reserves remaining, etc

- list and map of non-producing mines, known data on reserves, coal quality, strip ratios, mining plans, mining methods, transportation proposed, ownership, location map, environmental problems, approximate valuation, etc.
- list and map of undeveloped properties, known reserves, ownership, other relevant data re coal quality, geology, environmental problems, approximate valuation etc.

This report should be updated at regular intervals to record any changes in the business environment, whether or not Texaco decide to proceed with Phase 3.

2.3 Phase 3: Short List Most Attractive Prospects and Prepare Acquisition Plan

Assuming future prospects for the coal industry appear reasonable, the following procedure is suggested:

- re-examine investment/acquisition priorities
- short list most attractive prospects
- gather further information on prospects and their willingness to sell
- valuation of prospects
- decide timing of formal approach (perhaps dependent on export sales prices approaching a certain level and the time required to develop the mine)
- decide negotiation strategy
- begin negotiations and carry out investment analysis on data provided.

3. Conclusion

We believe the phased approach suggested here has the benefit of gradually refining Texaco's preferred course of action. An added advantage is that each new step can be justified by findings arrived at in an earlier phase. This logical approach will prove particularly useful when making recommendations to Texaco senior management. The suggested updating of Phase 2 on a regular basis insures that no new

opportunities will be missed. Any new approaches to Texaco by prospective sellers can also be judged within an up-to-date overall information framework and set of criteria.

4. Recommendation

We recommend that Texaco initiate, as soon as possible, preparation of a corporate strategic plan as detailed here.