HC Hat Creek 74(10)C

B.C. Hydro & Power Authority

THERMAL COAL RESOURCES OF BRITISH COLUMBIA

HAT CREEK

(No. 1 OPENPIT DEPOSIT)

SUMMARY REPORT

January 1, 1975

DOLMAGE CAMPBELL & ASSOCIATES LTD.
VANCOUVER, CANADA

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

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Dr. J. T. Fyles,
Deputy Minister,
Department of Mines and Petroleum Resources,
Parliament Buildings,
Victoria, B. C.

Dear Dr. Fyles:

Coal Task Force

With reference to our previous discussions relating to the reserves at Hat Creek it is recommended that the geological in-situ reserve (proven and probable) be used as outlined in the Preliminary Environmental Impact Study. The figure is given below in conjunction with a total for all categories. A total reserve estimate of the No. 2 deposit by Dolmage Campbell and Associates dated 25 July 1975 and based on drilling to 18 July 1975 is also listed.

Geological In-situ Reserves (short tons)

	Proven and Probable	Total (all categories)
No. 1 Deposit	480,000,000	567,000,000
No. 2 Deposit		1,500,000,000

In their report of 1 January 1975 Dolmage Campbell and Associates wrote that the potential resource of Hat Creek Valley could be as high as 15 billion tons. A preliminary excess mass calculation by A. Woodbury of B.C. Hydro supports this estimate. The excess mass calculation is based on the following assumptions:

1. average densities are correct,
2. the densities are homogeneous,
3. the background gravity fits a low order polynomial,
4. effects of using integration limits related to the map boundaries as opposed to infinity are minimal.

5. the mass is concentrated toward the mass centre,
6. the residual separation is correct.

It is hoped that we will have a report on the interpretation of the gravity completed soon.

Yours very truly,

C. B. Guelke
Assistant Manager
Generation Planning Department

cc: Dr. I. H. Warren

Table 4.6
4.7
4.8

how is the above incorporated exactly in these tables?

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CONSULTING GEOLOGICAL & MINING ENGINEERS
1000 GUINNESS TOWER
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DOLMAGE CAMPBELL & ASSOCIATES LTD.
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SUMMARY AND RECOMMENDATIONS

The No. 1 Openpit coal deposit, located at the north end of the 16-mile-long valley of Upper Hat Creek, 15 miles west of Cache Creek, B.C., has been defined by diamond drilling carried out in 1957-59 and in 1974 to contain a proven and probable reserve of openpit coal of approximately:

480 million short tons of subbituminous B

with a calorific value of 6000 Btu's/lb. and an ash content of 28%.

This reserve is sufficient to sustain a 2000 MW thermal plant for approximately 45 years.

The ultimate coal potential of the deposit must be determined by a program of final development drilling, at an approximate cost of $500,000.00, but at this time it appears to be in the order of 620 million tons, sufficient to sustain a 4000 MW plant for nearly 30 years.

The operating cost estimates for a preliminary openpit that is designed to mine most of the proven-probable coal reserve of the No. 1 Openpit deposit indicates that the coal to feed a 2000 MW plant for 33 years will cost:

$1.77 - $1.80 per short ton of coal at the plant

or

$0.148 - $0.150 per million Btu's

The capital cost of the mining plant for such an operation is estimated to be approximately $24.2 million.

The mining method favoured for the exploitation of the No. 1 Openpit deposit is the tried and proven method of drilling and blasting, loading with shovels and haulage by trucks of 80 to 150 ton capacity. Other methods and equipment do not compare favourably because of higher costs or uncertainties of dependability of operation in the Hat Creek conditions.

The ultimate coal resources of the remaining 80 percent of length of the valley of Upper Hat Creek are not known because of total cover by overburden. They are presently being explored by a reconnaissance drill program.

The available geological evidence suggests that the amount of economically pittable coal that could occur in the valley can be anything from nil to as much as 15 billion tons. The only presently practical means of determining where in that range the ultimate tonnage will fall is by drilling through the overburden cover on a grid system.

RECOMMENDATIONS

If the present reconnaissance drill program discovers a coal deposit in the valley that may be as large and as good quality as the No. 1 Openpit deposit, and possibly cheaper to mine, the new discovery should be drilled in detail in 1975 to determine if it may not be more favourable for the proposed thermal plant than No. 1 Openpit.

If the reconnaissance program fails to discover such a deposit, the No. 1 Openpit deposit should be drilled in detail in 1975 to provide complete data for mine and thermal plant design.

PART 2

INTRODUCTION

DOLMAGE CAMPBELL & ASSOCIATES LTD.
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INTRODUCTION

TERMS OF REFERENCE:

The explored portion of the Hat Creek Coal deposit was first comprehensively drilled and examined in 1957-59. No other fieldwork was done until 1974; however, the general feasibility of mining the deposit was reviewed in detail by the B.C. Energy Board in 1971. All studies and reports made on the Hat Creek deposit prior to mid-1974 are based on the data obtained from the diamond drilling of the deposit done in 1957-59 and presented in a series of progress reports entitled:

"Hat Creek Coal Investigations" 1958-59
Dolmage, Mason and Stewart Ltd., Vancouver

The 1971 review for the B.C. Energy Board was a recalculation of both the coal reserves in the deposit and the costs of mining the coal to feed a 2000 megawatt thermal plant. The results of that study are contained in the reports:

(1) "Hat Creek Coal Deposit, Reserves and Operating Costs", Sept. 28, 1971
Dolmage Campbell and Associates Ltd., Vancouver

(2) "Coal for Thermal Plant in British Columbia", (Sections 2 and 4) February, 1972
Montreal Engineering Co. Ltd., Montreal

The first of these two (1971, 1972) reports defines the reserves of the drilled portion of the deposit and estimates mining costs based on truck transport out of an openpit. The second report is concerned with more detailed operating cost estimates based on conveyor belt transport out of an openpit.

The purpose of the present report is to review the coal reserves and all aspects of mine capital and operating costs at Hat Creek, including comparisons of different methods of excavation. The geology and reserves of the coal deposit are reviewed and revised to accommodate the data from the 1974 drilling. A basic openpit excavation using conventional truck transport is then costed and then compared to other systems employing conveyor belts and bucketwheel excavators.

All of the data that form the basis for the present studies are appended to this report.

LOCATION: (50° 45'N, 121° 35'W), (Figures 1 and 2)

The Hat Creek coal deposit is located 120 miles northeast of Vancouver, B.C., midway between the towns of Lillooet and Ashcroft. Railheads can be reached at Pavilion, on the B.C. Railroad, 15 miles to the northwest, and at Ashcroft, on the CP and CN Railroads, 23 road miles to the east. Easiest access to the property is from the Trans Canada Highway at Cache Creek 13 miles to the east, via the well-graded gravel secondary highway between Cache Creek and Pavilion. The closest regularly serviced airport is at Kamloops, 60 miles to the east. The short access distance of the Hat Creek deposit to existing first-class highways and railroads, together with its location well-removed from any major towns of cities upon which its operation might infringe, would appear to be important advantages for the installation of a major thermal power plant on this coal resource.

PHYSIOGRAPHY:

The explored portion of the Hat Creek coal deposit underlies about one square mile of the north end of the broad, north-trending, grassland valley, about 16 miles in length, through which flows the upstream portion of Hat Creek. From the north end of this valley Hat Creek flows northeastward through a very narrow valley into the Bonaparte River, which flows south to join the Thompson River at Ashcroft.

The Upper Hat Creek valley lies within the Interior Dry Belt of British Columbia at a mean elevation of about 3500 feet. The coal deposit is located at an elevation of about 3000 feet. The valley is flanked by somewhat subdued mountains that rise to elevations of 6000-7000 feet four miles west of Hat Creek and to elevations of 5000-6000 feet six miles to the east. The uplands are covered with thin forests of fir and poplar and the valleys are open ranges of grass and sage with local, thin forests of pine.

Rock outcrops are sparse in the floor of the Upper Hat Creek valley. The overburden generally consists of loosely compacted sand and gravel that ranges in depth from 10 to 300 feet in the vicinity of the explored portion of the coal deposit. Some of the overburden is of volcanic (clastic) origin, not related to the sand and gravel in origin. Glacial till is also locally in evidence.

CLIMATE:

Mean daily temperatures in the Hat Creek area range from 85° F in the summer to 10° F in the winter, with about 5 months being frost-free, (May-September). Precipitation is low, 15 inches per year, and total annual snowfall is about 50 inches or less.

The prevailing (high level) wind at this latitude is westerly; however, in the Interior of British Columbia the flanking mountain ranges are so high and continuous that there is no definite circulation shown in the records except for some predominance of north-westerly wind in both winter and summer. Prevailing lower level (surface) winds in the Interior follow along the major valleys, so that at Kamloops they are east-west and at Ashcroft northeast and southwest. In any case, the Interior winds throughout the year are exceptionally light; the highest mean for a month at Ashcroft, the closest weather station to Hat Creek, is 9 mph. Calms are frequent and lengthy in the Ashcroft area.

The closest major sources of water to Hat Creek are the Fraser River, 12 miles to the west and 1500 feet lower in elevation, and the Thompson River, 14 miles to the east and 1500 feet lower.

HISTORY:

The Hat Creek coal deposits were first reported by Dr. G.M. Dawson of the Geological survey of Canada in 1877 and 1894. The only coal exposures were along the banks of Hat Creek where the overburden cover had been removed by creek erosion. By 1925 three shallow shafts and two short adits had been driven into the coal along the creek and seven holes had been bored into it. No further work was done on the deposit until 1933.

From 1933 until 1942 a few hundred tons of coal a year were produced from the property and sold to the nearby towns and villages. No work was done after 1942 until 1957 when the property was optioned by Western Development and Power Ltd., a subsidiary of B.C. Electric Co. Ltd., at which time one Crown Grant claim was extensively explored by surface diamond drilling.

Following expropriation of B.C. Electric by the Government of British Columbia the ownership of the one explored Crown Grant claim and two coal licences on the Hat Creek coal property passed to a government agency and no further exploration was done on the property until mid-1974 when the British Columbia Hydro and Power Authority began definitive drilling of the deposit.

REFERENCES:

1952 "Ashcroft Map-Area, B.C.", Geological Survey of Canada, Mem. 262

S. Duffell and K. C. McTaggart

1955 "The Climate of British Columbia and the Yukon Territory", W. G. Kendrew and D. Kerr, Meteorological Division, D.O.T.

1958-59 "Hat Creek Investigations", (B.C. Hydro file) Dolmage Mason & Stewart, Vancouver

1971 "Hat Creek Coal Deposit, Reserves and Operating Costs", Dolmage Campbell and Associates Ltd., Vancouver

1972 "Coal for Thermal Plant in British Columbia", (B.C. Hydro file) Montreal Engineering Co. Ltd., Montreal

Dr. D. D. Campbell, P.Eng., one of the authors of the present report, logged core and assisted in the compilation and preparation of the geology for the 1959 report of Dolmage, Mason and Stewart and co-authored the 1971 report. Mr. H. O. Howey, P.Eng., the other principal author of the present report assisted in the preparation of the 1959 report and co-authored the 1971 report. Mr. J. F. McIntyre, P.Eng., presently with Dolmage Campbell and Associates Ltd., supervised all of the fieldwork and drilling of the Hat Creek deposit in 1957-59 and has been a major contributor in the compilation of the present report.

PART 3

GEOLOGY

PART 4

COAL RESERVES

GEOLOGICAL SETTING

REGIONAL:

The valley of Upper Hat Creek is largely underlain by Tertiary strata that form a basin-like structure whose boundaries conform to the valley walls, at elevations of 1000 feet or more above the valley floor. The Upper Hat Creek basin is one of a large number of outcrop areas of Tertiary sedimentary and volcanic strata that are irregularly distributed in a belt through the south-central interior of British Columbia, from Princeton in the south to Prince George in the north, (Fig. 1). The strata along the edges of these areas of Tertiary rocks are generally truncated by erosion surfaces or by boundary block faults, thus it appears that the present areas likely do not represent original, separate basins of Tertiary deposition, but more likely are disconnected erosional remnants of larger basins.

Exploration of these areas of Tertiary strata has been hampered by their extensive overburden and/or volcanic cover; however, some have been intensely explored (for coal) and others have been locally mapped in considerable detail where river canyons have provided good stratigraphic exposures. These data reveal that many of the Tertiary "basins" share the following general stratigraphic succession:

Top: (5) Flat-lying volcanics.
(Erosion)
(Folding, possible faulting)

(4) Tuffaceous siltstone and conglomerates.

(3) Coal measure.

(2) Sandstone, siltstone, conglomerates
(Erosion?)

Bottom: (1) Basal volcanic flows and pyroclastics

This common stratigraphic history strongly suggests that the Interior Belt Tertiary areas are actually remnants of a major depositional trough that extended northwestward through the interior of British Columbia in Tertiary time. Following initial vulcanism this trough was occupied by a continental sea, or seas, along the shore of which extensive swamps existed for relatively long intervals. The conditions favourable for swamp formation were terminated rather abruptly, presumably by the uplift of the Coast Mountains to the west and the consequent inundation of the trough(s) by clastic sediments, including conglomerates. As the Coastal orogeny continued, the Tertiary strata in the trough(s) were broadly folded, block faulted, uplifted and variously eroded, and finally blanketed by late Tertiary volcanic sheet flows.

An important economic implication of the above-described hypothesis of the origin of the Tertiary formations is that the coal measure can occur in any or all of the Interior Tertiary areas, depending on the configuration and extent of the shoreline swamps, and that the coal measure will probably be continuous throughout any "basin" area in which it occurs. Some corroboration of this thesis exists in the fact that, where erosion has stripped the overlying Tertiary volcanic cover, coal has been discovered in the underlying strata in the Keremeos, Princeton, Tulameen, Merritt, Kamloops, Hat Creek and Quesnel basins.

The Hat Creek coal measure represents the thickest development of Tertiary coal discovered to date; however, available data indicate that the coal beds in the Princeton and Tulameen basins, 100 miles to the southeast, also tend to maintain relatively great thicknesses throughout their respective basins.

DISTRICT: (Figures 2 and 3)

The area of Tertiary rocks that underlies the valley of Upper Hat Creek lies in an en echelon position with a similarly shaped Tertiary area two miles to the north and east. Both areas are largely covered with overburden; however, it is evident from existing exposures that the northeast area is essentially entirely underlain by sedimentary rocks comprised principally of conglomerate and sandstone with lesser amounts of siltstone and shale, whereas the Hat Creek area (basin) is largely underlain by a cover of volcanic rocks in its southern half, south of Oregon Jack Creek, and by sedimentary rocks throughout most of the northern half. The sedimentary rocks in the Hat Creek basin include several thousands of feet of stratigraphic thicknesses of shale, siltstone and coal, as well as the conglomerates and sandstones that are characteristic of the other basin to the northeast.

STRATIGRAPHY: Reconnaissance mapping in 1974 of the northeast basin by Dr. T. Hoy of the British Columbia Department of Mines reveals that the Tertiary sedimentary strata, termed the Coldwater Group, in that area consist principally of coarsely clastic rocks with a minor shale component and no coal. These strata measure about 4,500 feet in total stratigraphic thickness and appear to represent the basal beds of the Coldwater Group to which the Upper Hat Creek strata would also belong. Coldwater strata in the northeast basin, as measured by Dr. Hoy, are comprised of four successive sedimentary cycles of which the uppermost one has been largely eroded. This stratigraphic succession is listed below because of its apparent relation to the strata in the Hat Creek "basin":

Top		ERODED		Approximate Thickness (ft.)
Unit 4	-	Conglomerate, sandstone and some volcanics		150
Unit 3	-	Siltstone, shale	(550')	850
	-	Sandstone	(150')	
	-	Conglomerate (base)	(150')	
Unit 2	-	Siltstone, shale	(850')	1650
	-	Sandstone	(400')	
	-	Conglomerate (base)	(400')	
Unit 1	-	Sandstone	(1300')	1900
	-	Conglomerate & sandstone	(600')	
		UNCONFORMABLY DEPOSITED ON CACHE CREEK FORMATIONS.		4550 ft.

From the work done to date in the Upper Hat Creek valley it appears that the bulk of the Coldwater strata within 2,000 feet of the surface in the Hat Creek "basin" is comprised of rocks that are evidently equivalent to the above-listed Unit 3 and higher. Also, there is some evidence that the basal sedimentary beds in Hat Creek are underlain by Tertiary volcanic rocks, which do not occur in Dr. Hoy's section unless in Unit 4. In the drilled portion of the Hat Creek "basin" it is evident that upwards of 3000-4000 feet of siltstone, shale and coal comprise the Coal Measure portion of the Coldwater beds. This thick section of coal-shale represents either a higher unit that is not exposed in the northeast "basin", because of erosion, or a lateral facies change of a rock sequence such as Unit 3. In any case, from the work done to date there is insufficient data available to permit a ready stratigraphic correlation between the Hat Creek Tertiary "basin" and that to the northeast.

STRUCTURE: It is evident from surface mapping, from diamond drilling, and from the study of aerial photos as well as earth satellite photos that the Tertiary strata that comprise the Hat Creek and the Northeast "basins" have been moderately deformed into north-northwest-trending broad folds and locally complexly dislocated by what appear to be steeply-dipping normal faults. The faults that have been mapped and inferred belong to two principal sets, one striking northward and the other east-northeastward. Both sets are represented on a regional scale as well as on a local scale within the Tertiary "basins".

The evidence to date concerning the fault pattern is far from complete; however, enough is available to suggest a reasonable working hypothesis that has been graphically depicted in Figures 2 and 3 of this report. There is good evidence that the Upper Hat Creek Tertiary "basin" is bounded on the west by a regional north-trending fault that is probably an eastern branch of the known Fraser Fault System that bounds the east flank of the Coast Mountains from as far south as Hope to as far north (possibly) as Hazelton. A major branch of the Fraser Fault has been mapped by the Geological Survey as splitting off at Lytton and rejoining halfway to Lillooet. Aerial photos strongly suggest that a component of this fault system continues north along the west side of Upper Hat Creek and then turns northeastward across the Bonaparte River, (Figures 2 and 3).

Dr. Hoy has mapped a fault contact along the east side of the northeast Tertiary "basin", (Figure 3).

There is strong photo and geological evidence that the east side of the southern half of the Hat Creek "basin" is also bounded by a major fault, (Figure 3).

Drilling and mapping in the north end of the Hat Creek "basin" indicate that the Tertiary strata and the underlying Cache Creek strata have been extensively dislocated by major block faults whose apparent vertical displacements range from a few hundred feet to several thousand feet. The apparent vertical displacement on the north-trending faults suggests that the areas of Tertiary rocks west of Ashcroft are remnants of what was originally a regional expanse of Tertiary strata. These remnants appear to have been preserved from erosion, at least in part, because of downdropping along regional blocks faults; in which case the term "graben" would be a better technical term for them than "basin".

<u>UPPER HAT CREEK:</u> (Figures 3 and 4)

The Hat Creek "graben" of Tertiary formations lies north-south along the valley of upper Hat Creek for a length of about 16 miles and an average width of about 3 miles. It is entirely within the confines of the mountains to the east and to the west. The Tertiary formations occur beneath the valley floor and along its lower sides.

Most of the bedrock in the Hat Creek valley is covered by deposits of overburden ranging up to 400 feet in depth. The higher elevations of the valley sides are underlain by terraces of volcanic rocks that apparently represent erosional remnants of volcanic deposits that once covered the valley.

The bedrock geology of the Hat Creek graben is known only from scattered surface outcrops and, in the north end only, from the diamond drill cores. Since the drilling of the coal deposit is very limited in scope, the interpretation of the stratigraphy and structure of the Tertiary formations is subject to considerable variation of interpretation; however, a few features are established by the existing data, these are:

Stratigraphy:

1) The drilled coal measure immediately west of Hat Creek strikes northward and dips generally steeply westward and the beds are right side up. The dips appear to flatten to the west. This portion of the coal measure is approximately 2,000 feet in surface width and is comprised mostly of one single coal sequence or bed, now termed No. 2 Seam.

2) About 2000-2500 feet west of Hat Creek, No. 2 Seam appears to be cut off by an inferred steeply-dipping block fault that trends almost along the strike of the coal measure. West of this presumed fault the sedimentary rocks dip gently eastward and include a coal sequence approximately 400 feet in thickness, now termed No. 1 Seam.

No. 1 Seam is underlain at depth and to the west by sandstones, siltstones and extensive conglomerates.

About 1½ miles west of Hat Creek the coal-bearing Coldwater beds are overlain by a remnant of flat-lying Tertiary volcanic rocks.

3) Along Hat Creek itself, east of No. 1 Seam, the coal measure is cut off by one and probably two steeply-dipping, north-trending block faults, one of which appears to repeat a portion of No. 2 Seam to the east. East of these block faults the lower elevations of the valley are underlain by gently folded beds of massive siltstone, sandstone and conglomerates, which contain coal pebbles or fragments. This sequence of beds is underlain by shale and some coal, which possibly represent the top of the coal measure drilled west of the block faults.

4) About 1½ miles east of Hat Creek the sedimentary rocks are overlain by volcanic rocks that apparently closed out the Tertiary Age in this region.

5) The total estimated stratigraphic thickness of the Coldwater sedimentary sequence, measured on the reconstructed assumed fault blocks, from the possible basal conglomerates to the west to the top of the massive siltstones to the east, is approximately 5,800 feet, of which 2,200 feet is coal that is contained in No.'s 1 and 2 Seams in the lower half of the sedimentary sequence.

Structure:

1) The Coldwater sedimentary strata, of which the coal measure is a major portion at the north end of the valley, directly underlies the overburden in a strip that apparently extends the full length of Upper Hat Creek valley. At the north end of the valley this "window" of sedimentary bedrock is approximately 3 miles in width; four miles south, at McCormak Creek, it is about $1\frac{1}{2}$ miles in width; at the south end of the valley, at Blue Earth Creek, it appears to be only about $\frac{1}{2}$ mile in width. (The presence of overlying volcanic rocks along the flanks of the valley has been determined from out crops and from a magnetometer survey.)

2) The Hat Creek Tertiary formations appear to be terminated along the entire western side of the valley by a north-trending, near-vertical block fault. Displacement on this fault is evidently down on the east. The location of this fault, termed the West Boundary Fault, has been inferred from outcrop evidence at the north end of the valley and from air photo evidence along the west side of the valley.

The occurrence of a similar fault along the east side of the southern half of the valley has been inferred from outcrop and air photo evidence as well.

3) The Tertiary formations at the north end of the valley are dislocated by one, and possibly three, eastnortheast-trending, near-vertical faults. One of these, the Medicine Creek Fault, is well located by outcrop evidence along Medicine Creek and by air photo evidence east beyond the town of Cache Creek, (Figure 3). The two other (parallel) faults, the Dry Lake and the Finney faults, north of the Medicine Creek Fault have been inferred from air photo evidence and some drill evidence but are not yet considered to be well established.

4) Diamond drilling and magnetometer surveys within the area of the coal measure north of the Finney Fault have established the presence of at least one, and probably three, northward-trending, steeply east-dipping faults that have an apparent displacement down to the east of more than 1,000 feet.

5) Because of the ubiquitous and thick cover of overburden that blankets the floor of Upper Hat Creek valley, the bedrock geology of the Tertiary formations south of Finney Creek is unknown.

COAL MEASURE: (Figures 5 and 6-11)

In 1959 Dolmage Mason and Stewart proposed a simple structure for the Hat Creek coal measure, namely an undistorted stratigraphic sequence of coal seams and sandstone-shale interbeds that strikes approximately north and dips steeply westward with a suggestion of flattening at a depth of 1,200 feet. This concept was reasonably based on the surface and mine exposures as well as the correlation of coal seams and sandstone and shale interbeds as revealed in the drill cores. Subsequent drilling, in 1974, has revealed that the main coal body consists of a single sequence of coal of about 1600-1800 feet in thickness. This unusually thick sequence of coal consists of three basic parts: the upper third is abundantly interbedded with siltstone, the middle third is interrupted by a few siltstone beds near its base, and the bottom third is essentially clean coal. This entire suequence of coal has now been designated as the No. 2 Seam, and all of the coal seam nomenclature used prior to 1974 has been discontinued because many of the 1957-59 "seams" are actually various parts of the main coal sequence.

The main coal sequence, No. 2 Seam, is underlain by at least 800 feet of interbedded shale, sandstone and siltstone.

1974 drilling west of No. 2 Seam did not intersect the down-dip continuation of that seam, but did intersect another coal sequence, dipping gently eastward, that is 400-600 feet in thickness and which has been now designated as No. 1 Seam. It is inferred that a major, steep, block fault separates No. 1 Seam on the west from No. 2 Seam on the east and that, since No. 1 Seam is underlain by extensive sandstone and conglomerates, No. 1 Seam is stratigraphically lower than No. 2 Seam.

The mass of coal intersected by drill holes immediately east of Hat Creek has been tentatively correlated by density logging of the drill holes to be a repeated portion of No. 2 Seam. In order to achieve this repetition of the coal, a steeply east-dipping north-trending fault has been inferred more or less along Hat Creek. This mass of coal has in turn been truncated to the east again by a northnorthwest-trending, steeply east-dipping fault that has been identified in drill cores and by the magnetometer survey. East of this fault, the Mag Fault, the Coldwater strata are comprised of gently dipping massive siltstones underlain by sandstone, conglomerate and shale to a depth of 1,400 feet. The deepest hole, (74-26), intersected clean coal at a depth of 1,400 below surface, but was not able to penetrate more than about 50 stratigraphic feet into it. It is conjectured from reconstructing the faulted stratigraphy that this deep coal possibly represents the top of the No. 2 Seam sequence.

Continuity:

The trace of the hangingwall contact (top) of No. 2 Seam has been well established from drill cores and by geophysical logging of the drill holes. This contact lies about 1,600 feet west of Hat Creek and strikes N 20° W for a distance of 4,800 feet. It is truncated at the south end (Sect. 6500 N) by the inferred Finney Fault and at the north end (Sect. 12000 N) by the inferred Dry Lake Fault or by the north-trending inferred block fault that separates No. 1 Seam from No. 2 Seam, (Figure 4).

Similarly, the footwall contact (bottom) of No. 2 Seam has been traced the same distance, with even more precision, by drill holes and geophysical logging.

The updip, westward, extension of No. 1 Seam has not yet been established.

South of the inferred Finney Fault, (Sect. 4000 N), the last hole drilled in 1974, DH 74-48, intersected a sequence of coal with a true thickness of about 700 feet at a depth of 500 feet. This coal does not correlate well geologically or geophysically with either Seam No. 1 or No. 2 but, since it is inferred to be in a different fault block, which may be displaced a major distance from the block to the north, this coal sequence could represent an up or down-dip expression of No. 1 or No. 2 Seam, vastly changed from its character where it is drilled in the north block.

GENERAL:

To date, the stratigraphy and structure of the Coldwater sedimentary strata that underlie the overburden that blankets the valley of Upper Hat Creek have been deduced entirely from the 1957-59 and 1974 diamond drill cores, with assistance from geophysical logging of the 1974 holes. Since most of the drilling has been confined to the vicinity of the coal deposit, with a minimum of fill-in check drilling, there are many gaps in the data where interpretation of structure is required. This is particularly the case in the vicinity of the known and the inferred faults within and around the drilled coal deposit, now designated the No. 1 Openpit deposit.

The dislocation of the coal measure in the vicinity of No. 1 Openpit is inferred, from drill core evidence, to be dominantly by block faulting on steep faults rather than by thrust faulting or by complex folding. This is generally corroborated by the lack of evidence in the drill core of extensive shearing or changes in bedding attitudes. Also, the coal measure rocks at Hat Creek are, with minor exceptions, markedly poorly indurated, (i.e., hardened from sediments into rocks by action of heat, pressure or cementing agents). The non-coal rocks in particular are soft and very incompetent, with negligible shear or compressive strengths; therefore, it would be impossible for them to sustain intense local folding or thrusting without dissembling into a chaotic rubble, such as found in many of the thick Rocky Mountain coal seams. There is no indication of such chaotic rock structures in the Hat Creek drill core other than isolated, very local occurrences.

Because the coal and the surrounding rocks at Hat Creek, with the exception of some sandstone and conglomerate beds, are so soft and incompetent, it is evident that most of the mining of the coal measure in the proposed openpit can be done with shovels or bucket-wheel excavators without drilling and blasting being required.

COAL SEAMS:

No. 2 Seam: It is evident from the results of the 1974 drilling that what were designated in 1959 as Numbers 2, 3 and 4 coal seams are all part of the main 1200-1800-foot coal layer, now designated as No. 2 Seam. This layer has tentatively been divided, on the basis of geology and the response to geophysical logging of drill holes, into three essentially equal layers that have been designated, from top to bottom, A, B and C. The general characteristics of these layers, and their relation to the previous seam designations, are summarized as follows:-

Layer A - Formerly included as the upper two thirds of Seam 3, all of Seam 4 and the intervening parting shale.

This layer is characterized by repetitive sequences of coal, coaly shale and shaly siltstone in beds up to 20 feet in thickness. As much as 50 percent of this layer will probably be discarded in the pit as waste in order to maintain an overall ash content of 28% or less.

The rock beds within this layer are extremely lensey and, except for the thicker ones, are not readily correlated from drill hole to drill hole.

Layer B - Formerly included as the lower third of Seam 3 and the top third of Seam 2.

This layer is characterized by relatively clean coal in its upper half, becoming progressively more intercalated with coaly shale in its lower half.

Layer C - Formerly included as the lower two thirds of Seam 2.

This layer is essentially 100 percent coal.

The formerly designated No. 1 and No. 0 Seams are now assumed to be a portion of the main coal layer (No. 2 Seam), down-faulted so that it lies mostly east of Hat Creek. It appears to be comprised mostly of Layer B.

What was previously termed No. 5 Seam is evidently part of Layer A in the new No. 2 coal layer.

The down-dip western extension of the No. 2 coal layer has, from available data, been displaced by a steep, north-trending fault. West of this presumed fault lies another coal layer, 400-500 feet in thickness, that is nearly flat-lying and possibly lies stratigraphically beneath the main coal layer. This lower coal layer appears to be intercalated with siltstone at the top but is otherwise relatively clean coal. It has been designated as No. 1 Coal Seam.

The coal layer intersected by one hole near Finney Creek, south of the inferred Finney Fault has not been assigned a numerical designation, pending further drilling to determine its continuity and possible relation to the northern coal.

The Hat Creek coals generally have an ASTM rank of subbituminous B and are entirely non-coking.

PART 4

COAL RESERVES

COAL RESERVE

All coal tonnage reserve estimates made prior to this report have been based on the 1957-59 drill hole data. Because that drilling was restricted by property boundaries and time limits, it was not comprehensive enough to fully define the limits of the deposit in any direction; therefore, prior reserve calculations have proven to be generally valid for that portion of the deposit drilled in 1957-59, but do not represent the total coal available for openpit mining from this deposit.

In 1974 a number of diamond drill holes were drilled well beyond the periphery of the 1957-59 coal area, thus defining the general limits of the deposit, now designated as No. 1 Openpit, but the previously estimated reserves were not significantly affected. In the same program eleven other diamond drill holes were subsequently drilled within and on the periphery of the 1957-59 coal area, (See Figure 5), and all of these holes either added to or put limits on parts of the previously estimated reserves. Although the 1974 drilling appreciably increased the previous coal reserve estimates it was still not comprehensive enough to precisely define either the detailed configuration of the coal within the deposit or the ultimate limits of the deposit to the west and to the southeast; therefore, the present reserve estimates are considered to be valid for the drill hole coverage that they are derived from, but they are not considered to be the ultimate reserves for the deposit. Such reserve calculations must await the next stage of drilling of the deposit, which will provide the concise data necessary for exact coal reserve estimates, for distribution of coal grades, for openpit design and (samples) for plant design.

Core recovery in coal at Hat Creek, both in 1957-59 and in 1974, has been better than 95 percent in all holes; therefore, assumptions regarding coal continuity or quality within holes have been unnecessary.

For the purpose of the present reserve estimates some basic assumptions and extrapolations of the internal geological structures of the deposit have had to be made; however, where such assumptions have been based mainly on geological inferences, rather than on available drill data, the coal reserves involved with them have been relegated to the "possible" category, to be confirmed by future drilling. The assumed geological structures within the deposit are illustrated in Figures 5 to 10 accompanying this report. These structures have been adopted because they best fit the available data from all holes drilled to date. It is appreciated that other geological structures can be imposed on the drill hole data; however, most such impositions would require drill core evidence that so far is not discernible, so the writers have concluded that such alternative solutions do not "best fit" the presently available data. In any case, sufficient drill hole control is available throughout the deposit to establish the fact that reasonable alternative assumptions regarding geological structures will not appreciably alter the estimated reserve figure; comparison of alternatives has indicated that where one alternative adds coal in one part of the deposit, it generally results in the loss of coal in another part.

BASIC DATA:

Prior to 1974 a total of 22 surface holes had been drilled into the coal measure within the No. 1 Openpit deposit; seven of thes, (No's. 1-7), were drilled prior to 1925 and no data is available from them, other than that three failed to find coal and the other four reported 1,531 feet of coal in 1, 992 feet drilled. These first seven holes were located close to or within the presently proposed openpit area and four of them, No's. 1, 2, 5, and 6, have been located and their data used to some extent in this report in establishing limits of coal seams.

Also, prior to 1925 limited adit underground workings were driven into No. 2 Seam but their exposures do not contribute to the reserve estimates. (Figure 5).

Eight diamond drill holes, No's. 8-15, were drilled in 1957 and seven final (deep) holes, No's. 16-22, were drilled in 1959 after the great size of the deposit was indicated by the 1957 drilling. All but one, (No. 21), of the 1957-1959 drill holes are located on three parallel east-west sections, 1,100 feet apart, which cross the deposit somewhat obliquely, (at about 70^{o}). These drill hole sections, previously numbered 1-3 from north to south, formed the primary basis for the coal reserve estimates prior to the 1974 drilling. For the present calculations and east-west grid has been established over the deposit and five east-west cross sections have been developed on it from the south end of the deposit, (7000 N), to the north end, (11500 N). All of the diamond drill holes within the deposit are located either on or relatively close to one of these sections. In addition to the holes drilled prior to 1974, eleven diamond drill holes were cored through the deposit in 1974, thus completing the data presently available for coal reserve estimates.

The locations of all of the drill holes used in the present reserve calculations are shown in plan on Figure 5 and on sections on Figures 6 to 10.

The coal reserve calculations have been made on the five cross-sections developed through the deposit. Zones of influence for each drill hole coal intersection have been marked as areas on each of the sections and modified by a conservative interpretation of the known and inferred geological structures. These coal reserve sections are included in this report as Figures 13 to 17, inclusive.

CALCULATIONS:

i) A factor of 21.6 cubic feet of coal per ton has been used for conversion from volume to weight; this figure has been derived from specific gravities determined for Hat Creek cored coal in 1957 and in 1974.

ii) The basic structural configuration and limits of the No. 1 Open-pit coal deposit have been developed on Section 9000 N, Figure 14, because that cross section is the most comprehensively drilled in the deposit. The two major assumptions adopted on this control section are the two inferred faults, one cutting off Seam 2 to the west and the other lying along Hat Creek west of the Mag Fault, forming the west side of an inferred down-faulted block of No. 2 Seam. These assumptions have been made to satisfy the following features:

1) The configuration of the coal intersections.

2) The bedding attitudes of the coal and waste rock in the cores.

3) The occurrences of gouge and/or distorted bedding in the cores.

4) The similarity in the geophysical log characteristics of No. 2 Seam with the wedge of coal to the east of Hat Creek.

The drill hole data indicates that the bottom of the No. 2 Seam coal layer is deepest at the south end of the deposit, at elev. 1000 on Sect. 7000 N, and rises gradually to the north so that it is at elev. 1800 on Sect. 10,000 N and possibly higher to the north. (The coal shown on Section 11,500 N is now believed to be possibly a fault fragment detached from and lying at the north end of the No. 2 Seam mass.

The coal configuration and fault structures developed on Section 9000 N have been projected north and south through all of the other sections and appear to satisfy the drill hole data on them without distortion or unreasonable accommodation.

iii) The area of coal on each cross section has been blocked out to conform primarily to the drill hole intersections. Limits of the coal areas on the sections have been defined by the drill holes in most cases, but also by the inferred faults in some cases. The lateral influence of each section has been taken halfway to the adjacent section; in most sections this has been 500 feet, (each way), but in the case of Sect. 10,000 N it is 700 feet north and 500 feet south, and in the case of Sect. 11,500 N, it is 700 feet south and 550 feet north, (See Figure 12).

The coal areas on each cross section have been measured by planimeter and have been converted to volumes by multiplying the areas by the length of influence of each particular section. These volumes have been converted to (short) tonnages by dividing by the 21.6 tonnage factor.

iv) The categories of coal reserves adopted for this report are defined, by their occurrence on the cross sections, as follows:

Proven	- Coal intersected by drill holes.
Probable	- Coal partially intersected by drill holes, and coal adjacent to "proven" coal, projected on the basis of drill holes or structures known from adjacent sections.
Possible	- Coal inferred to occur beyond "probable" coal, based on inferred structures. Most of this category occurs at the undrilled eastern and western extremities of the deposit, with some at depth.

v) The results of the tonnage calculations are given in Table 1.

COAL RESERVE TONNAGE:

COAL SEAMS: The total tonnages of the gross coal layers drilled and projected in the No. 1 Openpit deposit, as shown in Table 1, are:

	Proven	Probable	Possible
Short Tons	490,649,000	122,972,000	113,157,000

As described earlier, the assessment of the core logging, the geophysical logging and the coal analyses obtained from the 1959 and 1974 drill holes indicates that the No. 2 Seam, which comprises nearly 90 percent of the reserves, is tentatively divisible into three zones or layers, of approximately equal widths, which are characterized by markedly different waste contents. These three zones have been designated, from the top of No. 2 Seam to the bottom, as the A, B and C zones, (See Figure 14). Preliminary calculations indicate that the waste content of the three zones is:

		% Clean Waste	% Coaly Waste		
A Zone	-	14	23		
B Zone	-	3	18		
C Zone	-	Nil	Nil		
Composite ABC	-	6	16	=	22 %

TABLE 1

COAL RESERVE CALCULATIONS

HAT CREEK NO. 1 OPENPIT, JAN. 1, 1975

Cross Section	PROVEN		PROBABLE		POSSIBLE	
	Area (x 1000)	Tons (x 1000)	Area (x 1000)	Tons (x 1000)	Area (x 1000)	Tons (x 1000)
11,500 N	291	20,195	--	--	--	--
10,000 N	1724	79,821	746	34,540	386	17,872
9,000 N	3783	175,153	258	11,945	190	8,797
8,000 N	1456	67,413	881	40,790	891	41,253
7,000 N	3198	148,067	771	35,697	977	45,235
6500-6300 N*	--	--	(3198	29,611)*	--	--
TOTALS		490,649		122,972		113,157

SUMMARY

Proven	490,649,000	tons
Probable	122,972,000	tons
Sub-total	613,621,000	tons proven-probable
Possible	113,157,000	
Total	726,778,000	tons all categories

NB - Areas = Sq. ft.
Tons = Short tons (2000#/ton)

* Not included in present reserves, pending detailed drilling.

The above types of waste are defined as follows:

(i) Clean waste - Mineable widths of non-carbonaceous rock.

(ii) Coaly waste - Mineable widths of coaly material containing more than 44 percent ash on a moist basis.

All of the above waste can be selectively mined in the openpit without difficulty and be discarded. Its subtraction will leave a coal product for the plant with an average ash content of approximately 28 percent and an estimated Btu value of approximately 6000 Btu's/lb.

PLANT COAL: The reserves of coal that will be available to the plant after the elimination of the above-described pit-run waste are approximately 78 percent of the gross figures given in Table 1, that is:

Proven	382,706,200	short tons
Probable	95,918,200	
Sub-total	478,624,400	Proven-Probable short tons
Possible	88,262,500	
TOTAL	566,886,900	all categories

All of the above estimated reserve is minable from a single openpit.

The total reserve of 566,886,840 tons compares with the previous estimated reserve of 388,613,000 tons that was based on the 1957-59 drilling.

The reserve coal that can be accepted at the present time as well assured for the proposed thermal plant is:

Proven-probable - 478,624,400 short tons @ approx. 28% ash and 6000 Btu's/lb.

WASTE TONNAGE:

Until the No. 1 Openpit deposit is fully defined by final development drilling it is not possible to design the final openpit that will excavate all of the coal in the deposit. Consequently, it is only possible at this stage to make a very rough estimate of the waste that will have to be mined to extract the full coal reserve of the deposit. For the purpose of the present report an arbitrary openpit, with slopes at 45°, has been chosen to encompass most of the proven-probable coal reserves. It is appreciated that in the final design some of the slopes will probably be shallower than 45°; however, on the basis of the present data and occurrences of possible coal, the coal-waste ratio will probably not be much changed from that in the presently chosen preliminary pit. The plan outline of this pit is shown in Figure 5 and a typical cross section of it is depicted on Figure 8.

The waste that requires to be excavated to produce the coal from the preliminary pit has been calculated, in the case of overburden, and estimated, in the case of waste rock, to be:

Overburden. (Sand and gravel, etc.)	107,000,000 tons
Selected waste. (As described earlier)	135,000,000 tons
Waste rock. (Outside of the coal "seams")	272,083,000 tons
TOTAL	514,083,000 short tons

COAL POTENTIAL IN VALLEY:

The known Hat Creek coal deposit is unusually large, and when fully explored it may well prove to be the largest in the world, in terms of coal per square mile. The immense amount of coal already indicated within the one-half square mile area explored to date comprise the largest known coal reserve in the world that is available for a single openpit in such a restricted area.

As described in the preceding portion of this report, the drill-indicated coal reserve for the No. 1 Openpit deposit at Hat Creek is estimated to be 478,624,400 short tons. The coal that exists beyond this arbitrary pit area is designated as either potential reserve or potential resource. Potential reserve is the coal that geologically is reasonably projected outward from the drilled area; potential resource is the coal that may occur elsewhere in the valley as geological continuations or repetitions of the known coal measure.

POTENTIAL RESERVE:

The potential reserve within the drilled area has been designated as "possible" coal and estimated to total approximately 88 million tons. To this can be added other possible coal that may extend to the west of the calculated reserves, this could amount to 50 million tons or more, for a rough total in the area of No. 1 Openpit of approximately 140 million tons.

Another potential coal reserve exists south of No. 1 Openpit, near Finney Creek, where one drill hole has intersected a thick layer of relatively dirty coal, (See Figure 11). The possible coal indicated by this one hole is approximately 20 million tons.

Summary: On the basis of existing data, the potential reserve coal at Hat Creek is roughly estimated to be in the range of 160 million tons.

POTENTIAL RESOURCE:

The principal area for major potential surface coal occurrences is the remainder of the Upper Hat Creek valley to the south of No. 1 Openpit, approximately 12 miles. This is not a great distance to project a coal measure; however, the possible effects of erosion, folding and/or faulting are concealed by the deep overburden in the valley, therefore the extent and character of the coal measure in the valley is unknown. If the known coal measure in the north end of the valley continues without interruption or diminution throughout the entire length of the Upper Hat Creek valley, it could contain potential surface coal reserves upwards of 15 billion tons. This of course is a most hypothetical figure; nevertheless, it is within the realm of geological possibility. If only half of this potential is assumed to exist the potential surface minable coal to the south is still 7 billion tons. Only a drill exploration program will determine the possible existence of this potential.

At the time of submission of this report a major reconnaissance drill program is being mobilized to explore the floor of the valley of Upper Hat Creek south from Finney Creek. The purpose of this program is to determine if there are any indications to the south of the possible near-surface occurrence of major coal deposits similar to that drilled at No. 1 Openpit.

A second major coal resource probably occurs in the valley as deep coal. For example, if the geological inferrences described in this report are valid, as much as one billion tons of coal possibly exist immediately east of the No. 1 Openpit deposit, but at a depth of 2,500 feet or more. Such coal may conceivably be mined by openpit in the future, considering that the coal layer may be 2,000 feet thick itself, but it would appear more likely that it may be exploited by some means such as in situ gasification.

The ultimate coal potential of the valley of Upper Hat Creek can only be guessed at the present time; however, it is hoped that enough stratigraphic information and coal intersections will be obtained from the 1975 reconnaissance drilling of the valley to be able to assess the potential in at least a broad way.

The above-discussed potential coal resources are geologically speculative; however, their possible presence isolates a target for future exploration and suggests a possible ultimate coal potential for the Upper Hat Creek valley that could dwarf the requirements for the presently proposed thermal plant.

COAL QUALITY

A definitive assessment of the precise quality of the No. 1 Open-pit deposit coal deposit cannot be made until the deposit is completely drilled. The principal unknown quantities at this time are the mean ash content of the resource as a whole and, to a lesser degree of uncertainty, the in situ moisture content.

The principal reasons for the uncertainties are:

1. At the time of this writing, the proximate analyses results on significant numbers of the samples collected in 1974 are just being received. Also, a computer program set up to process the large numbers of samples has just become operational.

2. The reprensentativeness of the sampling of coal zones of different quality, (see, for example, the discussion on the A, B and C layers on Pages 15 and 16), is not known. Additional drilling is required not only to obtain more closely spaced samples but to confirm structures and establish the relative quantities of the different coal types present.

3. Moisture determinations on bulk samples have not been made.

Discussed below is the present state of knowledge of the coal quality.

COAL SAMPLING

1925: In 1925, proximate analyses were obtained on 24 mine samples and 23 drill samples. Only the averages for these two groups of samples are currently available. They were obtained from better quality portions of the No. 2 Seam and are not of particular significance to the present assessment.

1957-1959: Approximately 165 proximate analyses were obtained from drill cores in 1957 and 1959. Individual samples ranged in length from 10 to 100 feet and many were composed of field composites of coal layers separated by unanalysed waste.

The results show similar ash-calorific value relationships to those obtained in 1974 but the quality of the analytical data is not as good. The data is being integrated with that obtained in 1974.

1974: In 1974, 352 coal samples were collected from drill cores. Samples ranged in length from about 5 to 30 feet and averaged close to 20 feet. In general, waste layers less than three or four feet thick were included in the analytical samples because of the impracticality of rejecting such thin layers by selective mining.

Analytical results are available for only part of the 1974 samples. Proximate analyses samples are being composited into larger samples on which ultimate analyses, mineral analyses of ash, ash fusibilities, Hardgrove grindability indices, and other data are being obtained.

COAL ANALYSES:

MOISTURE: Lacking reliable in situ moisture determinations, which can be obtained best from fresh bulk samples, an estimated average in situ moisture content of 20 percent is being used as an average for the deposit. Available equilibrium moisture determinations suggest that the in situ moisture could range up to as high as 24 percent. On the other hand, the plant feed moisture could be below 20 percent because of the dry Hat Creek climate.

Unless otherwise specified, analytical values referred to in this report are calculated to a 20 percent moisture level.

ASH: The term "ash" as used in this section of the report includes inherent ash disseminated through the coal and, in particular, thin waste partings which are not removable by selective mining.

The minimum inherent ash, at 20 percent moisture, appears to be about 10 percent. No estimate is available on the maximum. Samples were analysed that range up to 50 or 55 percent total ash at 20 percent moisture. The bulk of such high ash material is probably composed of coal and thin shale or carbonaceous partings rather than of true inherent high ash coal. As such, it would be amenable to up-grading by washing.

As stated previously, the mean ash content of the entire coal resource is not known. It will probably be about 30 percent but may be slightly higher.

ASH AND CALORIFIC VALUE RELATIONSHIP: Although the mean ash content is not known, the relationship between the ash content and the calorific value, and also the rank of the coal, appear to be reasonably well established from the presently available data. This data indicates the following:

1. That the mineral-matter-free, moisture-free calorific value of the coal is about 12,600 Btu's/lb. (All calorific values given are gross values).

2. That the moist (20 percent), mineral-matter-free calorific value is about 10,080 Btu's/lb., which categorizes the coal as subbituminous B. (Some individual coal seams are high subbituminous C. Application of the standard Parr formula would indicate, because of the high ash levels, substantial quantities of the coal to be subbituminous C).

3. That an average of about 86 or 87 percent of the mineral matter ends up as the ash residue as reported in proximate analyses; the remainder is incombustible volatiles which report with combustible volatiles in the proximate analyses.

4. That a change of 1 percent in the ash (not mineral matter) level will change the calorific value by about <u>146 Btu's/lb.</u>

5. That a change of 1 percent in the moisture level willchange the calorific value by about 126 Btu's/lb.

<u>OTHER VALUES:</u> No new assessment has been made of the volatile matter and fixed carbon content of the coal. Computer processed data will be forthcoming in the near future.

The sulphur content of the coal ranges from about 0.10 percent to 2.00 percent and averages about 0.5 percent at 20 percent moisture. The sulphur is probably present primarily as organic sulphur.

Hardgrove grindability indices have been obtained for 12 samples. The results show that the index increases sharply with increasing ash content, (i.e., the shale is easier to pulverize than the coal). In fact, for higher ash samples the index is of roughly the same magnitude as the ash content in percent on the dry basis. It appears from the present data that for 25 percent ash coal, the grindability index will be in the mid 30's.

Ash fusion temperatures appear to be very high, in excess of 2600° F for initial softening.

<u>PLANT FEED QUALITY:</u> (Summary)

Lacking definitive data on the overall mean ash content, the average calorific value which would be obtained if the entire No. 1 Openpit coal resource were to be mined and burned cannot be specifically stated. However, using the information given above on the ash-calorific value relationship, limits can be set. The following table indicates such limits.

Moisture %	Ash %	Gross Calorific Value Btu's/lb.
20	22	6900
20	25	6450
20	28	6000

The ash-calorific value relationship, (i.e., the coal rank), is certainly subject to adjustment as more data become available, but the adjustment is not expected to exceed, say, 200 or 300 Btu's at the same ash level.

A 4 percent moisture increase, (to 24 percent - the probable maximum mine moisture content), or 4 percent moisture decrease, (to 16 percent - the probable minimum plant feed moisture content), would alter the above calorific values by about 500 Btu's.

Regardless of any other considerations, extensive blending will be required to produce plant feed which does not vary outside acceptable limits on a short term basis.

To achieve the 28 percent ash figure for the deposit as a whole, all that may be required is careful blending and careful removal by selective mining of waste partings, certainly of those in excess of 10 feet in thickness and possibly somewhat thinner. Such coal would average about 6000 Btu's/lb.

To achieve average lower ash figures and higher calorific values, it appears that either some high ash coal (i.e., coal with thin waste partings and averaging more than 40 or 45 percent ash at 20 percent moisture), will have to be stockpiled or wasted, or that the coal will have to be washed. Unless the washed coal is subsequently dried, the increased moisture content will partially offset the decreased ash content.

Alternatively, the openpit could be developed to exploit better quality coal in the earlier years, leaving the poorer quality for consumption under improved technological conditions.

PART 5

MINING COSTS

MINING METHOD

The unique, large, deep mass of coal that comprises the Hat Creek No. 1 Openpit deposit is amenable to surface excavation by means of openpit mining rather than by strip mining. Strip mining is a progressive system that results in a relatively shallow excavation being done over a relatively extensive area; the waste cover over the coal is first removed from a limited area, the coal is removed, and then the waste is replaced in the excavation and a new, adjacent cyclic excavation begins. In the case of a major openpit, of the size of No. 1 Openpit, tens of years are required to complete the excavation of the pit and no waste can be replaced in the pit before it is completed; therefore, waste disposal becomes a major and permanent part of the operation, and the backfilling of the completed pit is in most cases an impractical expedient. However, in contrast to strip mining, an openpit mine is confined to a relatively limited area, often a much larger area than the pit is required for waste disposal.

Because the No. 1 Openpit deposit at Hat Creek has not yet been completely delimited by drilling, the final openpit layout and design cannot be developed at this time; however, a preliminary openpit can be confidently designed that will excavate the bulk of the presently estimated proven-probable coal reserves and provide feed to a 2000 MW thermal plant for at least 33 years. The plan of this preliminary pit is shown on Figure 12 and a typical east-west section through it is shown on Figure 8. It is now indicated from recent drill results that the final pit will extend shallowly to the west to excavate the No. 1 Seam, and could be extended southward to excavate new coal in that direction. The north and east boundaries of the pit will probably not be changed, but it is possible that major tonnages of waste will be left in the bottom of the pit along the east side; for this report this waste has been included as excavated waste. It is considered that the anticipated ultimate changes that will be made in the configuration of the preliminary pit will probably have little influence on the presently calculated mining costs and, if anything, might improve them.

Openpit mining, in a wide variety of rock type and pit slope conditions, is widespread in the metal mines in Canada and has been particularly economically refined in British Columbia. The Hat Creek openpit will ultimately be considerably larger than any of the existing openpits in British Columbia and will be excavated in considerably softer rocks than any of the metal mines. The stability of these soft rocks will affect the configuration of the pit slopes; however, because the drilling to date indicates that these rocks are dry and relatively unfractured there is a good possibility that, with suitable treatment, they may sustain far steeper slopes that normally anticipated for such soft material. The stability of the pit wallrocks is under preliminary study by Dr. Ralph Peck, consultant.

EQUIPMENT:

There are many types of equipment available for the openpit excavation of coal. These include tractors with ripper and bulldozer attachments, power shovels, front end loaders, draglines, bucketwheel excavators and scrapers and push dozers. Transportation can be by truck haulage, conveyor belts, railroads, skipways or combinations of these.

Indications from the drilling to date suggest that possibly most of the coal and a good part of the waste rock are so soft and unconsolidated as to permit excavation without drilling and blasting; however, much of the coal is compact and relatively competent and some of the waste rock is hard and compact. Thus, until the deposit is more completely drilled and the cores all correlated, it is advisable to assume that the rock and coal will all have to be drilled and blasted, however lightly, to permit excavation. If it subsequently is demonstrated that drilling and blasting is not necessary, the mining costs calculated in this report will be reduced accordingly by about 10 percent. It is possible that the rock is sufficiently incompetent to permit direct excavation by means of tractors with rippers, or bucketwheel excavators, or draglines, or scrapers and pushdozers; however, each of these systems includes a considerable degree of uncertainty in this case where the physical characteristics of the rocks are still incompletely known. Because of this uncertainty a tried and proven mining method has been selected as the basis for the detailed calculation of mining costs for this study. This method employs drilling, blasting, and loading and hauling with equipment of well documented reliability. Loading into trucks is done with power shovels and compaction at dumps is done with tractors.

As suggested above, it is highly probable that the coal seams and a majority of the waste bands could be excavated by the shovels without the drilling and blasting operations. If this proves to be the case the present calculated cost per million Btu's could be decreased by approximately one cent. However; drilling and blasting capital and operating costs have been included to ensure that the costs presented are based on methods and equipment that have been used successfully, in many locations, over long periods of time and that no disastrous surprises would be encountered when the pit begins operation. All of the equipment that has been costed in the present study is well beyond the prototype stage.

Basic Equipment: The unit cost of truck haulage constituted the highest single cost item in the operation that has been costed for this study. To explore possible economies alternative cost calculations were made for using 85 ton, 120 ton, or 150 ton haulage units. The 150 ton units show an operating cost advantage over the smaller units and would be the most economical unit to use; however, these units, with a gross weight of over 250 tons, could encounter traction difficulties in the coal and shale in the pit, particularly under wet conditions. Unit costs developed for the three sizes of truck are shown in Appendix 1 "Cost Per Ton of Coal Delivered to Stockpile at the Plant".

Removal of the overburden that covers the proposed pit area is to be done by scrapers assisted by tractors equipped with rippers and push dozers. Exploration pits dug in the overburden during the 1959 investigation indicated that this method should be feasible.

Alternative mine methods, employing conveyor belts instead of trucks and bucketwheel excavators instead of shovels have also been studied. The results of these studies are given later in this report. An important problem encountered in the cases of bucketwheel excavators, draglines and other types of specialized equipment is inordinately long delivery times, one as high as 8 years. This condition has been one factor in the primary choice here of a conventional shovel-truck operation, that will deliver coal to a thermal plant within the minimum time after the beginning of construction.

Waste Disposal: For the purpose of this study, areas for proposed stockpile and waste disposal have been designated north and east of the proposed pit. These areas are relatively low-lying, readily accessible and they have no geological likelihood of being underlain by commercial coal.

The locations of these areas are shown on Figure 12 but it is stressed that they are tentative locations at this time insofar as they appear at this time to be the most economic ones available. Land use studies may indicate other areas that would better serve the purposes shown on Figure 12.

BASIS FOR COST ESTIMATES

The costs in this report cover all items of expense up to and including delivery to plant stockpile except for the cost of primary crushing previously related. Additional costs to be borne as part of thermal plant operation and not costed in this report would include dust abatement, pick-up from stockpile, conveying into the thermal plant and secondary crushing prior to pulverizing.

PIT RESTORATION:

For the purposes of this report, mining to a depth of 1,200 feet has been adopted; however, recent drill results suggest an ultimate depth for the No. 1 Openpit will be in the order of 1,600 feet, at its deepest level. Since this will require well in excess of 30 years to excavate, it is difficult to foresee at this time what pit restoration measures might ultimately be contemplated. In any event it is unlikely any extensive restoration would be undertaken during the first few decades of operation, hence no costs are included in the present estimates. It is possible, a long way into the future, that waste from additional pits might be disposed of in the initial pit. Otherwise the pit would likely remain indefinitely as an open hole with restoration limited to seeding vegetation on the slopes and waste dumps.

EMPLOYEE HOUSING:

The original terms of reference for the present study excluded establishment of a townsite at Hat Creek. It is planned that all employees involved in the ongoing operation after the construction stage will live in the adjacent established communities and commute to and from work. Accordingly no cost provision is made for employee housing in this report.

ROYALTIES & TAXES:

It is assumed that the Authority will pay the going coal royalties to the Crown as apply from time to time. At the present time the Provincial royalty for thermal coal is $0.50 per long ton (2,240 lbs.) of coal, or $0.446 per short ton. This royalty has been included in the present cost estimates. Future escalation of royalties may occur but there is no way of estimating such at this time. There is currently no Federal royalty and none is anticipated.

Provincial and Federal taxes that might apply to the Authority in relation to the Hat Creek mining operation are not considered in this report.

OPERATOR'S PROFIT:

The Authority has several options from which to choose for the Hat Creek mine operating, principally:

1. Purchase and amortize all equipment and operate the mine as a division of the Authority with all personnel employed directly by the Authority. This report is costed on this basis.

2. Purchase and amortize all equipment but engage a contractor to operate the mine for a fee on behalf of the Authority for a term of, say, 5 years or so at a time. If this option is chosen then an operator's profit will have to be negotiated and considered with the costs listed in this report. This option offers long-term flexibility and might hold significant advantages for the Authority but the choice is a matter of policy and hence beyond the scope of this report. It is anticipated that the cost difference between this option and the first will not be significant.

3. Engage a contractor to purchase and amortize all equipment and mine and deliver the coal on an agreed price basis. Such a choice might detract from the flexibility of management of the operations and would impose a heavy capital burden for even a very large contracting firm. Also it would require tying the Authority to a contractor for a very long term which could conceivably be very undesirable and an additional profit would have to be realized by the contractor to reflect ownership of equipment with all its attendent risks. This option would appear to hold serious disadvantages for the Authority.

DIVERSION OF HAT CREEK:

The contemplated pit at Hat Creek will include the existing stream bed; therefore, the entire flow of Hat Creek will have to be contained upstream of the pit and conducted around the limits of the pit and discharged back into the existing stream bed some distance downstream of the pit. This facility is of a most critical nature as under no circumstances could a break-out of water into the pit be tolerated. Such a break-out could cause a major disaster in the pit and intolerable disruption of mining operations and production of power.

The containment should be at least 2000'-3000' upstream of the southerly pit limit and the point of discharge some 1000'-2000' downstream of the northerly pit limit. A suitable site for diversion would appear to exist immediately below the mouth of Medicine Creek, approximately 3000' upstream of the presently contemplated southerly pit limit, (See Figure 12). The contemplated facility would involve a dam, a siphon with a lift of some 150-200', a trough at the lower end leading into the streambed and a diversion of Finney Creek into the reservoir.

Because the dam and reservoir have to be designed to accommodate the absolute maximum flow, the whole facility will be a sizeable project in itself. Ultimate design will be contingent upon completion of the No. 1 Openpit drilling; therefore, it is impossible to estimate a firm cost at this time. It is roughly estimated that this entire diversion facility would cost in the general order of $2,000,000.

MINE:

Unit cost calculations for the 45° pit were based on the removal of 107,000,000 tons of overburden in 6 years at 24 hours per day for 250 days per year.

Capital and operating cost estimates for mining the Hat Creek coal deposit were made using the following basic criteria:

	45° PIT
Btu value of coal with selected waste removed	6,000 Btu per lb.
Yearly coal requirements for 2000 MW plant	11,700,000 tons
Daily pit coal production 250 operating days per year	46,800 tons
Daily pit waste production at 250 operating days per year	49,024 tons
Total pit reserves - coal with selected waste removed	388,613,000 tons
Total waste - waste bands plus selected waste	407,083,000 tons
Total overburden to be removed	107,000,000 tons

Capital and operating cost estimates include all costs incurred in stripping the overburden, mining the coal and waste, transporting the coal and waste to the Thermal Plant and dump respectively, levelling the waste and levelling and packing the coal to retard spontaneous combustion.

The assumption has been made that a 13.8 KV power supply would be available near the top of the pit area, and that power would be supplied at $0.015 per Kilowatt hour.

Wages, equipment, construction and supply costs have been based on current rates and these were applied over the life of the pit reserves and no attempt was made to estimate inflationary effects on the costs.

Allowances have been made for pumping but these have been arbitrary pending further studies on possible groundwater inflow. Information to date suggests that the pit will not make significant water.

MINING DETAILS:

Cost estimates were made assuming the following pit specifications and employing the equipment listed:

Overall Pit slope	45°
Pit road grade	7%
Bench Height	40 ft.
Sub drilling	4 ft.
Drilling Pattern	25 ft. by 25 ft.
Hole Diameter	9 inches
Powder Factor	0.5 lb/ton
Coal densities	1.25 tons/cy bank 1.0 ton/cy loose
Waste densities	1.87 tons/cy bank 1.25 ton/cy loose

Drilling

3-Bucyrus Erie 45-R rotary blasthole drills. Estimated productivities 100 ft./hr. in coal, 80 ft./hr. in waste. Hourly ownership and operating cost $37.74

Blasting

Blastholes to be loaded with a slurry composed of 70% Anfo and 30% Nitrex by employees and trucks supplied by the explosives contractor. Blasts are initiated with Pentomex primers on primacord down lines and timed with detonating relays.

Loading

45° Pit Wall Slope Angle

2 Bucyrus Erie 190B electrically driven shovels with 14 cu. yd. buckets

2 Bucyrus Erie 190B electrically driven shovels with 10 cu. yd. buckets

Loading rates: 1180 tons/hr. for coal, 1150 tons/hr. for waste
Hourly ownership and operating cost $52.39

2 Caterpillar 992 loaders diesel powered with 12 cu. yd. buckets
Loading rate: 1000 tons/hr. Used for loading and pit cleanup.
Hourly ownership and operating costs $60.00

Haulage

45° Pit Wall Slope Angle

44 Wabco Haulpak 85 Ton Capacity		
Average hourly ownership and operating costs	waste	$38.52
Average hourly ownership and operating costs	coal	$40.39
33 Wabco Haulpak 120 Ton Capacity		
Average hourly ownership and operating costs	waste	$48.88
Average hourly ownership and operating costs	coal	$53.92
25 Wabco Haulpak 150 Ton Capacity		
Average hourly ownership and operating costs	waste	$59.47
Average hourly ownership and operating costs	coal	$65.23

Wabco 85C - Capital $220,125 ea. (on site costs)
Haulage requirements 44
Total capital costs $ 9,685,500.

Wabco 120B - Capital $344,609 ea. (on site costs)
Haulage requirements 33
Total capital costs $11,372,097.

Wabco 150B - Capital $455,617 ea. (on site costs)
Haulage requirements 25
Total capital costs $11,390,425.

Levelling and Packing

5 Tractors Caterpillar D-9-G
Hourly ownership and operating costs $43.00

Overburden Stripping

Densities 1.56 tons/cy. bank 1.36 tons/cy. loose
Terex TS-32 Scrapers-Rated 36 cu. yds. Pay load 49 Tons

14-Units used with a 45° Pit wall slope angle	
Hourly ownership and operating cost	$61.00
4 Tractors Caterpillar D9G	
Hourly ownership and operating cost	$43.00

OWNERSHIP AND OPERATING COSTS AND DEPRECIATION SCHEDULES

Ownership and operating costs as quoted for the equipment include depreciation, interest, taxes, insurance, tire replacement where applicable, general repairs, fuel cost, servicing and the operators wages.

These costs are incorporated into the unit costs per ton of coal and thus provision is made in the operating costs to replace equipment throughout the life of the project.

Depreciation schedules for the major items of equipment are listed below:

	Hours
Drills - Bucyrus Erie 45R	32,000
Shovels - Bucyrus Erie 190-B	108,000
Trucks: Wabco Haulpak-85C	20,000
Wabco Haulpak-120B	25,000
Wabco Haulpak-150B	25,000
Tractors - Caterpillar D-9G	10,000
Loaders - Caterpillar 992	10,000
Scrapers - Terex-TS-32	12,500

CAPITAL COSTS

The equipment and capital costs required for the previously described mining method and openpit are listed in detail in Table 2.

In summary, the total capital cost for the Hat Creek mining project, using 85 ton trucks (most assured reliability), are:

Pit wall slope of 45° = $ 24,242,500

(The above costs are exclusive of all thermal plant costs.)

The general breakdown of the total costs is:

	45° PIT
Open pit mining and haulage equipment (85 ton capacity)	$ 14,354,500
Overburden stripping equipment	3,924,000
Waste dump and coal stockpile	612,000
Support vehicles	373,000
Buildings & Services	2,979,000
Hat Creek Diversion	2,000,000
TOTAL	$ 24,242,500
With 120 ton capacity trucks TOTAL	$ 25,929,097
With 150 ton capacity trucks TOTAL	$ 25,947,425

The total capital outlay ranges from approximately $24,000,000 to $26,000,000, depending on the size of haulage truck used. This capital outlay will supply all of the necessary equipment, installations, roads, shops, offices and inventories required to remove the overburden, mine the coal and waste, deliver the coal to a stockpile adjacent to the thermal plant and transport the overburden and waste to the waste dump and level it.

The ranges of capital and operating costs presented earlier within the criteria of "Basis for Cost Estimates" should be achievable unless subsequent exploration in the pit area shows a radical increase in waste to ore ratios and this is considered unlikely. It is considered probable that exploration within the walls of the 45° pit will reveal more coal, which would reduce the ore to waste ratio and decrease the cost per ton of coal in that pit.

TABLE 2

CAPITAL EXPENDITURES

HAT CREEK NO. 1 OPENPIT
(Max. slopes = 45°)

OPEN PIT		
Drills		
3 - Bucyrus Erie 45-R	300,000	900,000
Shovels		
4 - Bucyrus Erie 190-B	777,000	3,108,000
2 - 14 c.y. coal 2-10 c.y. waste		
Trucks		
44 - Wabco Haulpak 85C	220,125	9,685,500
Tractors		
1 - Caterpillar D-9-G with Ripper	171,000	171,000
Loaders		
2 - Caterpillar 992 12 c.y.	245,000	490,000
WASTE DUMP		
Tractors		
2 - Caterpillars D-9-G	153,000	306,000
COAL STOCKPILE		
Tractors		
2 - Caterpillars D-9-G	153,000	306,000
OVERBURDEN STRIPPING		
Scrapers		
14 - Terex TS-32	234,000	3,276,000
Tractors		
2 @ cut @	171,000	342,000
2 @ dump @	153,000	306,000
HAT CREEK DIVERSION		2,000,000
SUPPORT		
10 - ½ Ton Pickup	4,000	40,000
2 - Caterpillar # 16 Grader	118,000	236,000
1 - Water Truck 2,000 Gal.	21,000	21,000
2 - Man Bus 40 man	16,000	32,000
1 - Lube Truck	13,000	13,000
1 - Ambulance & Equipment	7,000	7,000
3 - Weld Machine 400 amp mobile	8,000	24,000
SERVICES		
Pumping and Lighting	175,000	175,000
Roads	81,000	81,000
Shops, Warehouse, Office	2,068,000	2,068,000
Warehouse inventory	300,000	300,000
Communications mobile	50,000	50,000
Power Supply-Pit	225,000	225,000
Water Supply-Plant	30,000	30,000
Heating Plant	50,000	50,000
		$24,242,500

OPERATING COSTS

The operating costs per short ton of coal delivered to a stockpile adjacent to the thermal plant, or to crushing and stacking facilities provided at the thermal plant, for a 45° pit design and for usage of 85 ton, 120 ton or 150 ton capacity haulage units are tabulated below in relation to the years of operation for each 200 foot increase in pit depth, and finally as an average cost over the life of the pit coal reserves. Detailed tabulation of the unit operating costs for various pit elevations and years in included as Appendix 1 of this report. The total costs of overburden removal have been charged to the first six years production in the 45° pit.

45° PIT

Years of Operation Inclusive	Total cost per ton of coal	Cost per million Btu's	Total cost per ton of coal	Cost per million Btu's	Total cost per ton of coal	Cost per million Btu's
0 to 6th	$2.0753	$0.1729	$2.1002	$0.1750	$2.0970	$0.1748
7th to 13th	$1.5957	$0.1330	$1.5941	$0.1328	$1.5936	$0.1328
14th to 19th	$1.6569	$0.1381	$1.6521	$0.1377	$1.6328	$0.1361
20th to 24th	$1.7654	$0.1471	$1.7368	$0.1447	$1.7282	$0.1440
25th to 29th	$1.8323	$0.1527	$1.7982	$0.1499	$1.7860	$0.1488
30th to 33rd	$1.9279	$0.1606	$1.8768	$0.1564	$1.8467	$0.1539
Average 33 yrs	$1.7978	$0.1498	$1.7835	$0.1486	$1.7724	$0.1477

From the above tabulations it is seen that the average costs over the 33 year life of the 45° pit ranges from $1.7978 ($0.1498 per million Btu's), using 85 ton trucks, to $1.7724 (0.1477 per million Btu's), using 150 ton trucks. Thus within the limits of these pit wall slopes and the variable truck capacities, the cost of coal delivered to the thermal plant stockpile should be considered to be within the range of:

<u>$1.7724 to $1.7978 per ton of coal</u>

or

<u>$0.1477 to $0.1498 per million Btu's</u>

The average labour costs constitute around 30% of the total operating costs, thus an increase of 10% in labour costs would add around 5 cents to the cost per ton of coal or $0.004 per million Btu's.

The unit costs of royalties, taxes and Hat Creek diversion have been calculated for the operating costs as follows:

Royalties	Cost Per Short Ton of Coal
Royalties on thermal coal are currently $0.50 per long ton (2,240 lbs.) or $0.446 per short ton (2,000 lbs.)	$0.4464
Amortization of the Cost of Hat Creek Diversion	
Diversion costs estimated at $2,000,000 $2,000,000 @ 10% over 30 years = $212,158 annually	$0.0181
Land Taxes	
Capital Installations	
$4,629,000 @ 1% annually = $46,290	$0.0039

Total ancillary unit costs = $0.4684 per short ton of coal.

ALTERNATE EXCAVATION & TRANSPORTATION METHODS

For the purposes of this study the authors have selected "tried and proven" methods of excavation and transportation. These methods involve drilling and blasting of coal and waste with subsequent excavation by power shovels augmented by rubber-tired loaders, and transportation to plant (coal) or dump (waste) by heavy trucks. Overburden (gravel, sand, silt, clay and till) would be excavated by scrapers, assisted by push dozers, and transported to dump by the scrapers. The overburden dumps would be located as close as feasible to the pit and would probably be separate from the main pit waste dumps. The same dozers would be employed to level and trim the dumps. The equipment chosen is also all sufficiently portable to lend itself to maximum flexibility of utilization in all necessary areas of the pit dumps.

These methods were chosen because they are methods which can be relied upon to be practical without any reservations. Also, they are methods which nonetheless fall quite close to the cost structures attainable by alternate methods of excavation and transportation. Most of the alternative methods would appear at first examination to yield modest cost savings, but, for various reasons, they cannot be relied upon with the same degree of certainty as the basic method that has been costed for this report. In any case, the costs attainable by the "tried and proven" methods, presented earlier in this report, serve as common denominators against which possible cost savings of the various alternate methods can be measured.

With the exception of a few highly weathered and very limited outcrops of coal in the vicinity of the old Hat Creek underground workings, there are essentially no exposures of either the coal beds or the intervening and enclosing beds of waste. Hence the only information available to the authors on the characteristics of the various beds of coal and waste to be excavated is that derived from examination of the diamond drill cores. Nowhere have any excavations extended to fresh, unweathered coal or waste rock of the types which will constitute virtually all of these materials to be excavated in the Hat Creek pit. Information from cores does however indicate that the coals are in part soft and friable, in part firm and brittle; while the waste beds are in part fairly firm and competent, and in part very soft, broken and incompetent. Some of the shales are indeed little or no more than wet, sticky clays. Hence, the methods contemplated for excavation and transportation of coal and waste must be capable of dealing with an unusually broad range of types; i.e., hard and soft, free handling and sticky. Drilling and blasting, loading with shovels and front-end loaders and haulage with heavy trucks would surely accommodate all of the various types of coal or waste contemplated. Most alternate methods would suit some types of materials but would have difficulty in handling others.

Drilling and Blasting

The soft, broken coal intervals can certainly be excavated with power shovels without drilling and blasting. The firm intervals might possibly be excavated without pre-breaking but this is not a certainty at this time. Possibly only a light, "shake-up" blast would be required. Similarly some of the softer waste beds could be excavated without blasting but the more indurated beds will probably require pre-breaking to one extent or another.

In view of the uncertainty in determining now how much drilling and blasting will be required in coal and waste it is felt prudent to include it now for all types and regard the possible cost saving as an additional contingency in the estimates, of which an indeterminate part may be realized. This part could amount to the order of one-half of all material to be excavated. During the final development drilling and bulk sampling in the proposed pit much information will be gained regarding the physical characteristics of many of the coal and waste intervals and this information will likely be sufficient for detailed planning and costing of what drilling and blasting will actually be necessary. At that time the use of crawler-drawn rippers as an alternate method of pre-breaking could also be investigated.

Bucketwheel Excavation

The use of large bucketwheel excavators has been investigated as an alternative to drilling, blasting and loading by shovels. At this time it appears that use of bucketwheels would result in a saving of <u>$0.02 per short ton of coal</u>, predicated on excavating all coal and pit waste by this method. An additional advantage would result from the coal arriving at the loading point broken to a finer top size than would be the case for blasting and shovelling. This could obviate the need of crushing the coal before entering the thermal plant crushing set-up. Also, the coal and waste would be fine enough to transport by belt conveyors.

Bucketwheels however, while suitable for excavating the coal, could involve serious disadvantages. Firstly, and of greatest consequence, is the uncertainty of their suitability for excavating the firmer and harder beds of waste rock. It is possible that some of the waste intervals are just too firm or hard to employ this type of excavator. In others less firm and hard, the machine might do the job but costs resulting from wear, tear and interruption of production could be excessive. In the soft, wet, clayey shales this sticky material might clog the buckets to the extent that the usefulness of the machine might be seriously impaired.

As these machines are not very portable, the cost of moving from one suitable bed to another could also be a prohibitive factor. Employing them could necessitate extensive duplication of excavating equipment and result in a more complicated and less flexible mining scheme than is desired. Also, to realize fully the advantages of bucketwheel excavation the very large units must be employed, possibly only one or two in the pit. This being the case, production would rest on only one or two key units and in the event of serious breakdowns interruption of production would become intolerable.

Finally, such large units are manufactured "on order" and very long delivery times must be anticipated.

Conveyors

As an alternative to truck haulage, the use of belt conveyors has been investigated for transporation of coal to the thermal plant and for transportation of waste to the dumps.

In the case of transporting coal to the plant the coal would be trucked from the pit faces to the feed terminus of the conveyor which would necessarily be a permanent (or at least semi-permanent) installation. The indicated potential saving by conveying from pit to plant stockpile would be $0.09 per ton of coal. This would be a viable and desirable alternative. The coal would of course require primary crushing prior to conveying and this function would be located in the process at the feed terminus of the conveyor. Cost of crushing and type of equipment are covered later in this section of the report. This is an essential function and the choice of equipment and costs would be identical whether it is to be located at the feed terminus in a conveying alternative or at the feed end of the stockpiling set-up in a scheme involving truck transportation to the stockpile. Hence conveying coal to the plant would involve no additional cost because of the necessity of crushing prior to conveying.

Conveying of all pit waste to dumps is quite a different matter. Firstly, conveying would require some primary crushing of the coarse oversize lumps of all rock types; hard, soft or sticky. The type of crushing installation would involve scalping of undersize and a type of crusher quite different from that used for coal. Feed to such a plant would still be by truck so that such a scheme would not only involve additional handling of wa ste but also an expensive screening and crushing operation which would be of no benefit. It would reduce flexibility of the operation and add complication and probably an additional cost in levelling at the dump. These costs would probably absorb any possible saving over truck transportation so the alternative does not appear promising. It is possible that a scheme involving grizzly sizing of coarse lumps in the pit with trucking of oversize and conveying of undersize might be a desirable alternative particularly as mining progresses to greater depths.

Draglines

Large walking draglines, like bucketwheel excavators, are units uniquely suited to strip mining of coal seams of relatively flat attitude in relatively flat terrain and are widely used for such applications in Canada, the United

States and elsewhere. Similar to large bucketwheels they are not truly mobile and really find their application where waste is both excavated and disposed of by the same machine. Such is not the case at Hat Creek and in fact use of draglines for excavating coal and waste would involve most of the disadvantages of bucketwheels discussed earlier in this section of the report hence this alternative is not regarded as very promising and has not been costed out.

ALTERNATE METHODS - OVERBURDEN

In and around Upper Hat Creek valley there are abundant exposures of gravel, sand, silt, clay and till. These materials are all typical glacial deposits, no different from those occuring throughout the province and present no unusual problems in choice of excavating and transporting equipment. The scraper and dozer method chosen would surely accommodate these materials satisfactorily. So also would shovels and trucks.

In the immediate vicinity of DH18, and to the west and northwest, a relatively small area of the coal measures is overlain by volcanic deposits (tuff and agglomerate) rather than by soils. These of course are rocks and it is most unlikely that scrapers would be suitable for them. It seems possible this material can be excavated by power shovels without blasting, however some light pre-breaking may be necessary. It is important to note that only a very minor portion of the known coal deposits is overlain by such volcanics, possibly of the order of 5 percent. Hence while scrapers might not be suitable for this function and shovels and trucks would be required, this would not constitute a duplication sufficiently serious to significantly detract from the economics of scrapers on the main portion of the overburden.

Shovels and Trucks

All overburden types at Hat Creek can readily be removed by use of shovels and trucks. The indicated cost saving over use of bulldozers and scrapers is estimated at $0.02 per ton of coal. Such a scheme would have the added operating advantage of using the same equipment for overburden as is most likely to be used for excavating and transporting waste. Use of shovels and trucks for overburden appears to be a viable and desirable alternative.

Conveyors

The use of conveyors has been investigated as an alternative to transporting overburden to dumps by scrapers or trucks. The indicated cost saving could amount to about $0.005 per ton of coal. However, employment of conveyors would introduce inflexibility into the operation and the indicated cost saving, while small, might also prove illusory. Unless it is found that overburden cannot be disposed of close to the pit and must be transported a long distance to avoid disposal over ground containing coal deposits at depth, it is unlikely that use of conveyors would be desirable.

Draglines

The possibility of using large draglines for overburden excavation has been looked into as an alternative to scraper or shovel excavation. However the draglines are employed, trucks would still be required for final transport and no cost saving could be realized. Added disadvantages of lack of portability, large size key-unit considerations, long delivery times and lack of flexibility render use of draglines undesirable from almost all points of view.

CRUSHING

Among the terms of reference for this report was one which stipulated delivery of "run of mine" coal to a thermal plant stockpile. This implied that no further beneficiation or preparation of the coal would be involved beyond selective mining of waste intervals within the coal seams, and costs of crushing would be included in the operation of the thermal plant. Such "run-of-mine" coal would however include coarse lumps of coal, some coarse lumps of waste rock principally from interbands too thin to be selectively removed in the pit, and a very small amount, possibly of the order of one percent, of lumps of very hard silicified (petrified) wood. This product will require primary crushing to a top size of 3-4" prior to feeding into normal thermal plant crushing and pulverizing equipment. The most promising choice for primary crushing is the "Bradford breaker" a unique rotary drum screen unit which sizes the pit run product, crushes only the coarse lumps of coal and soft rock and eliminates cobble and boulder size harder materials (hard rock and silicified wood) without crushing them. This type of equipment would only eliminate a portion of the waste rock since very soft rock would crush along with the coal. However, elimination of the silicified wood is particularly desirable as this material, even in small quantities, will cause considerable trouble with conventional thermal plant crushing equipment. The amount of ash reduction of overall plant feed to be gained by use of these units is difficult to estimate at this time.

Two Bradford breakers of 700 tons/hour capacity would handle the crushing task if located in the overall process between the stockpile and the plant. However it is likely more desirable to locate such a function within the transportation link of the mining process, (to avoid plant feed rate fluctuation), either in or adjacent to the pit or near the plant site immediately prior to stockpiling. In this event the equipment would operate only 250 days per year and three units would be required.

Capital cost of three units installed would be of the order of $500,000. A preliminary overall cost of crushing (based on limited data now on hand) including amortization of capital costs is estimated at <u>$0.06 per ton of coal</u>.

PART 6

CONCLUSIONS

PART 7

ILLUSTRATIONS

DOLMAGE CAMPBELL & ASSOCIATES LTD.
CONSULTING GEOLOGICAL & MINING ENGINEERS
1000 GUINNESS TOWER
VANCOUVER I, B.C.

CONCLUSIONS

COAL RESERVES

Drilling to date has established sufficient coal reserves (480 mill.tons) available for surface mining at the No. 1 Openpit deposit at the north end of the Upper Hat Creek valley to readily sustain the proposed 2000 MW thermal plant for a minimum of 30 years.

The established reserves plus the inferred (possible) reserves of this deposit total approximately 620 million short tons. Since approximately 350 million tons of this coal is required for a 2000 MW plant for a 30 year life, it is evident that the No. 1 Openpit deposit may well be able to support either a 4000 MW plant for almost 30 years, or a 2000 MW plant for upwards of 60 years.

The calorific value of the above reserves is presently estimated to be approximately 6000 B.T.U.'s/lb. with an ash content of 28%.

COAL RESOURCES

The ultimate coal resources of the remainder of the Upper Hat Creek valley are unknown because the entire valley is blanketed by thick overburden; however, exploration to date indicates that most of the valley is underlain by Tertiary Coldwater sedimentary strata in which the coal measure at the north end of the valley occurs. It is geologically possible that the coal measure, containing minable coal, occurs throughout the length of the valley; however, it is also geologically possible that, because of faulting, erosion or depositional changes, the coal measure does not occur elsewhere in the valley or that it may not be commercially as coal bearing as it is at the north end of the valley.

Thus, the commercial coal resources of the valley, aside from the known reserves, could range from nil to many billions of tons. Investigation of all sensible means of subsurface exploration for coal in the Hat Creek valley indicates that the best method is by drilling; therefore, the program of reconnaissance drilling just started by B.C. Hydro & Power Authority will provide the first indication of the scale of the coal potential in the remaining 12-mile length of the valley.

COAL COSTS, NO. 1 OPENPIT:

Because the No. 1 Openpit deposit has not been completely defined, the mining cost estimate prepared for this study may be subject to some subsequent changes as a result of future development drilling; however, it is anticipated from the available data that such changes will most probably have the effect of decreasing costs if anything. For the purpose of present cost estimates a preliminary openpit, with average slopes of approximately 45°, has been laid out and costed to encompass most of the 480 million tons of coal in the No. 1 Openpit deposit. The configuration of this pit will be changed, but the anticipated changes will tend to lower the slopes and decrease the ratio of waste to coal.

The mining method and equipment proposed is very basic and its effectiveness has been demonstrated in a very large number of operations.

Costing out of this proven method with proven equipment does give a higher degree of assurance to the validity of the cost figures than would the use of possibly more sophisticated methods and equipment which do not have the extensive history of success as that used.

The total operating cost per ton of coal delivered from No. 1 Openpit to a stockpile at the thermal plant over an average of 30 to 33 years is estimated to be in the range of:

$1.7724 to $1.7978 per ton of coal

$0.1477 to $0.1498 per million BTU's

The total estimated capital cost for the complete mining plant is estimated to be in the range of:

$24,242,500 to $25,947,000

The above costs include all expenditures except taxes to the Authority to place the coal in a stockpile at a plant located at the north end of Upper Hat Creek valley.

RECOMMENDATIONS:

The precise coal reserves of the No. 1 Openpit coal deposit require to be established by a definitive drill program. Such a program will also provide the data for specific pit design and for coal grade control to the plant. It is estimated that such a program will cost approximately $500,000.00, exclusive of any test pitting or bulk sampling. Such a program is a requisite to a final mining feasibility study and policy decisions as to how the mine should be managed or operated.

The determination of the coal resources in the remaining 80 percent of the valley of Upper Hat Creek must be determined by the drill exploration program just begun. If this reconnaissance indicates the existence in the valley of a coal deposit comparable to No. 1 Openpit in size, it should be drilled off in 1975 to determine if it may not be more economical to exploit for a thermal plant than is the No. 1 deposit.

Respectfully submitted,

DOLMAGE CAMPBELL & ASSOCIATES LTD.

R S Sloan per

Douglas D. Campbell, P.Eng., Ph.D.

H. Howey

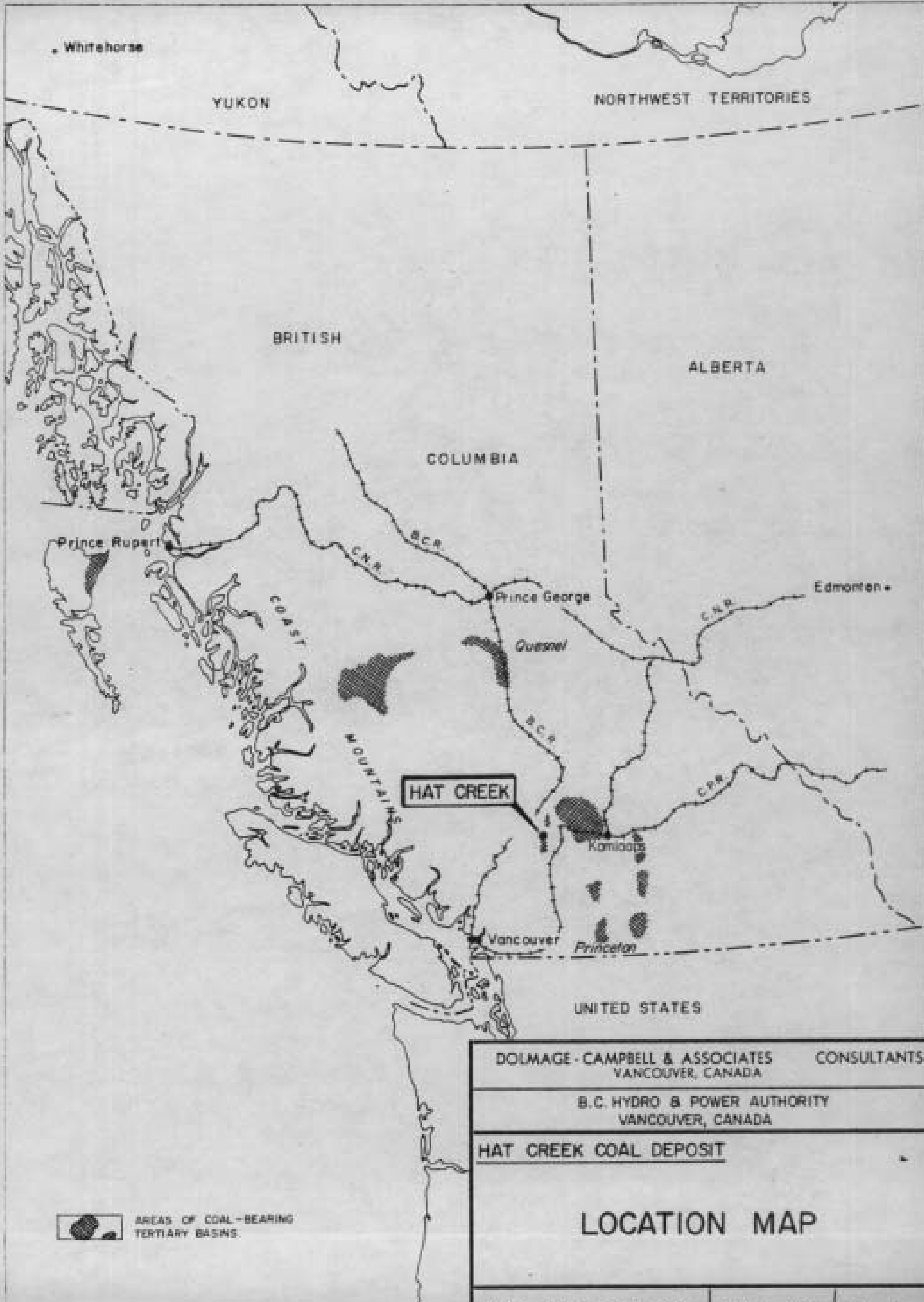
H. O. Howey, P.Eng.

Lisle T. Jory

Lisle T. Jory, P.Eng., Ph.D.

PART 7

ILLUSTRATIONS



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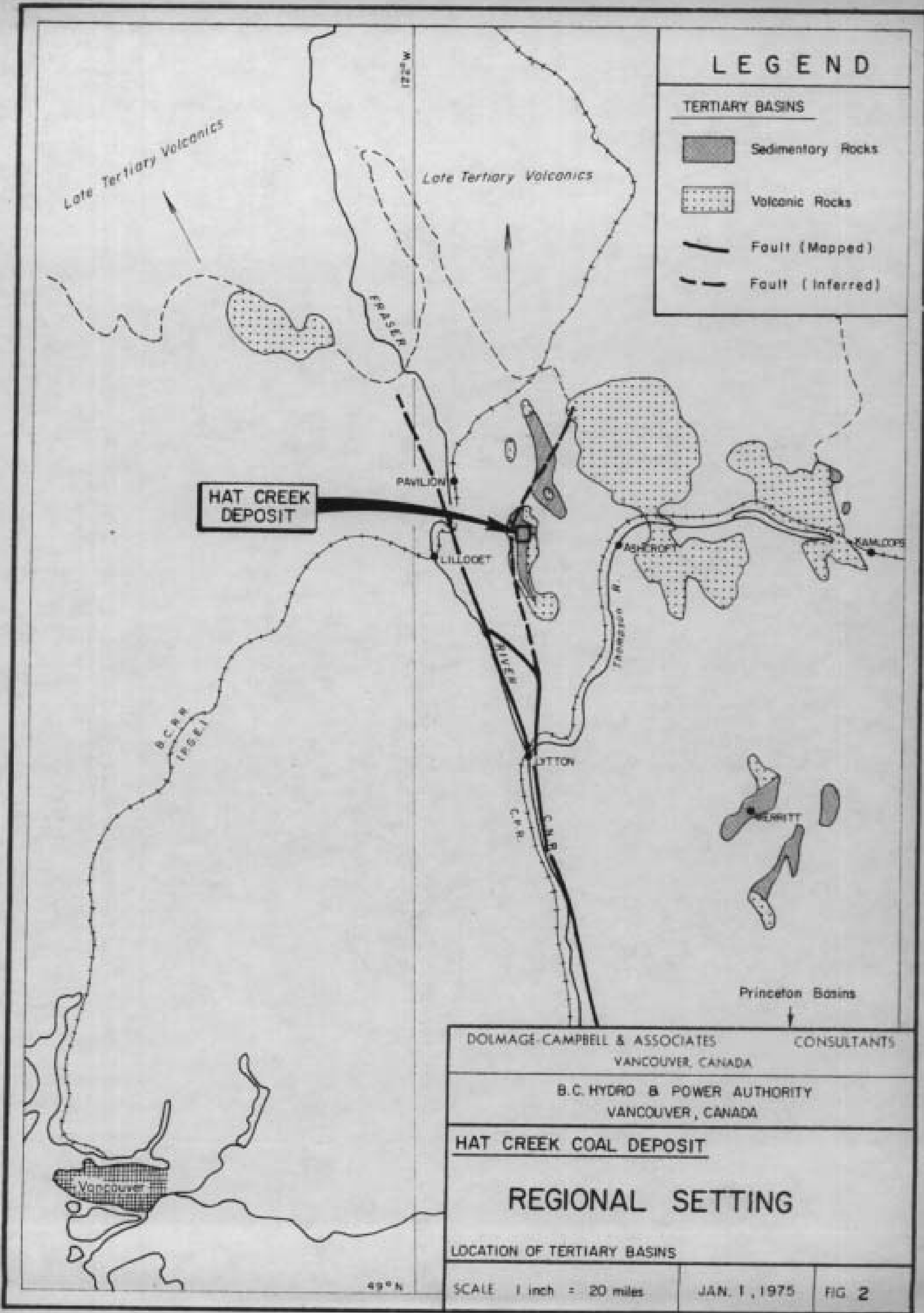
VANCOUVER, CANADA

HAT CREEK COAL DEPOSIT

LOCATION MAP

SCALE: 1 inch = 120 miles	JAN. 1, 1975	FIG. 1

DWG. 674 - 45 A



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VANCOUVER, CANADA

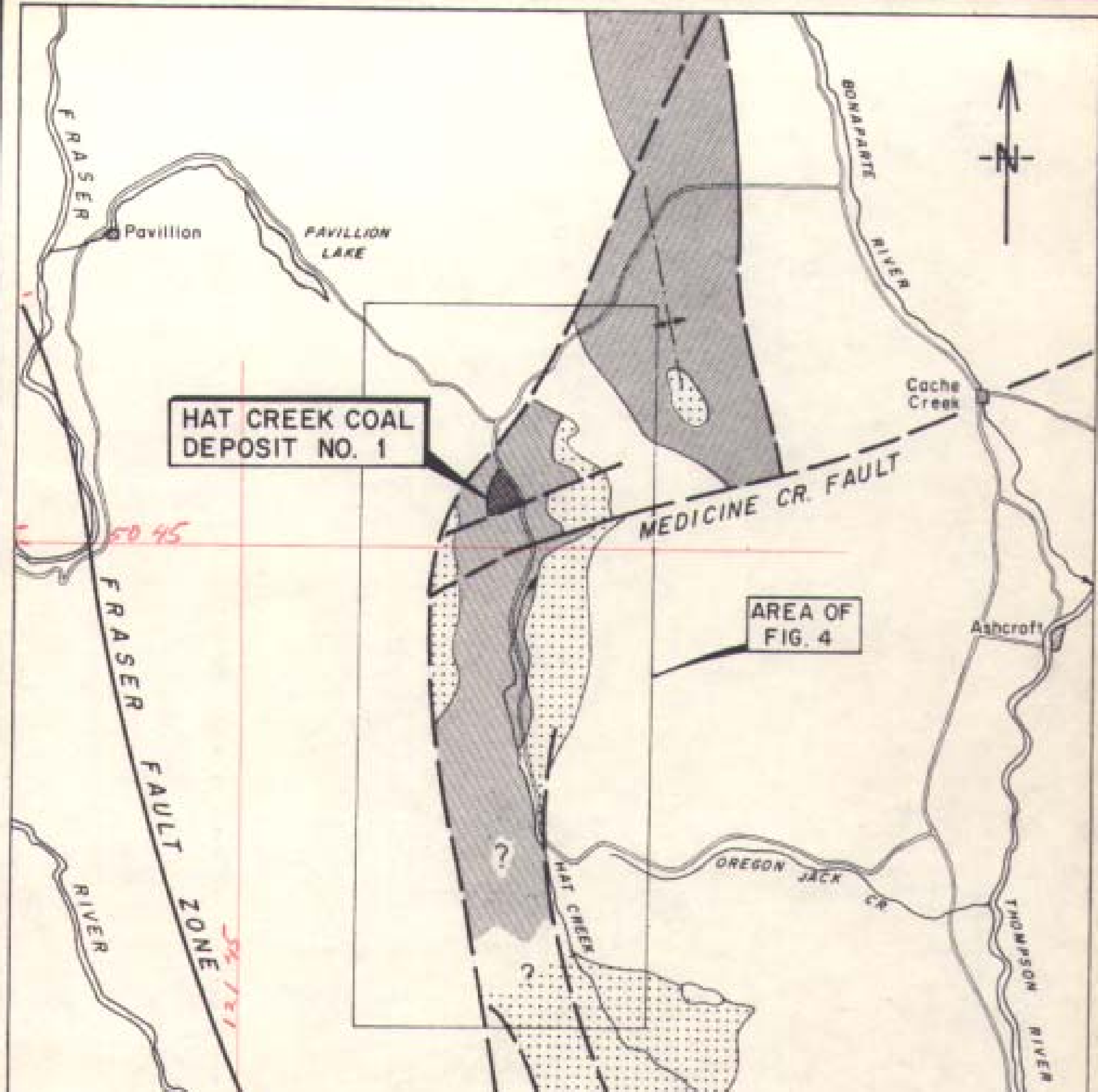
HAT CREEK COAL DEPOSIT

REGIONAL SETTING

LOCATION OF TERTIARY BASINS

SCALE 1 inch = 20 miles | JAN. 1, 1975 | FIG. 2

DWG. 674-46 A



LEGEND

- Tertiary - Late Volcanic Rocks
- Tertiary - Sedimentary Rocks
- Pre - Tertiary Formations
- Fault - Mapped and Inferred.

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HAT CREEK COAL DEPOSIT

DISTRICT GEOLOGY

Modified from GSC Ashcroft Sheet, Map 10-10A

SCALE 1" = 4 MILES	JAN. 1, 1975	FIG. 3

DOLMAGE CAMPBELL & ASSOCIATES LTD CONSULTANTS
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B.C. HYDRO & POWER AUTHORITY
VANCOUVER, CANADA

HAT CREEK PROJECT

SECTION 11,500' N. (No. 4)

SCALE: Hor. 1" : 400' Vert. 1" : 400'	JAN. 1, 1975	FIG. 6

DOLMAGE CAMPBELL & ASSOCIATES LTD. CONSULTANTS
VANCOUVER, CANADA

B.C. HYDRO & POWER AUTHORITY
VANCOUVER, CANADA

HAT CREEK PROJECT

SECTION 10,000' N. (1)

SCALE: Hor. 1" : 400' Vert. 1" : 400'

JAN 1, 1975

FIG. 7

DOLMAGE CAMPBELL & ASSOCIATES LTD. CONSULTANTS
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B.C. HYDRO & POWER AUTHORITY
VANCOUVER, CANADA

HAT CREEK PROJECT

SECTION 9000'N (2)

SCALE: Hor. 1" : 400' Vert. 1" : 400' | JAN. 1, 1975 | FIG. 8

00125 (3)

00125 4

DOLMAGE CAMPBELL & ASSOCIATES LTD. CONSULTANTS
VANCOUVER, CANADA

B.C. HYDRO & POWER AUTHORITY
VANCOUVER, CANADA

HAT CREEK PROJECT

SECTION 8000' N (3)

SCALE: Hor. 1" : 400' Vert. 1" : 400'	[illegible], 1975	FIG. 9

DOLMAGE CAMPBELL & ASSOCIATES LTD. CONSULTANTS
VANCOUVER, CANADA

B.C. HYDRO & POWER AUTHORITY
VANCOUVER, CANADA

HAT CREEK PROJECT

SECTION 7000' N.

SCALE: Hor. 1" : 400' Vert. 1" : 400' | JAN. 1, 1975 | FIG. 10

00125 5

DOLMAGE CAMPBELL & ASSOCIATES LTD. CONSULTANTS
VANCOUVER, CANADA

B.C. HYDRO & POWER AUTHORITY
VANCOUVER, CANADA

HAT CREEK PROJECT

SECTION 4500' N.

SCALE: Hor. 1" : 400'
Vert. 1" : 400'

JAN [illegible], 1975

FIG. 11

(6)

LEGEND

COAL RESERVE SECTIONS

PROVEN COAL

PROBABLE COAL

POSSIBLE COAL

FAULT

INFERRED FAULT

DOLMAGE CAMPBELL & ASSOCIATES LTD CONSULTANTS
VANCOUVER, CANADA

B.C. HYDRO & POWER AUTHORITY
VANCOUVER, CANADA

HAT CREEK PROJECT

SECTION 11,500' N. (No. 4)
COAL RESERVES

00 125 7

SCALE Hor. 1" 400' Vert. 1" 400'	JAN. 1, 1975	FIG 13

DOLMAGE CAMPBELL & ASSOCIATES LTD. CONSULTANTS
VANCOUVER, CANADA

B.C. HYDRO & POWER AUTHORITY
VANCOUVER, CANADA

HAT CREEK PROJECT

SECTION 10,000' N. (1)
COAL RESERVES

SCALE Hor 1" 400' Vert 1" 400'	JAN. 1, 1975	FIG. 14

00125 8

DOLMAGE CAMPBELL & ASSOCIATES LTD CONSULTANTS
VANCOUVER, CANADA

B.C. HYDRO & POWER AUTHORITY
VANCOUVER, CANADA

HAT CREEK PROJECT

SECTION 9000'N (2)
COAL RESERVES

SCALE: Hor. 1" : 400' Vert. 1" : 400' | JAN. 1, 1975 | FIG. 5

00125 9

00 125 (10)

DOLMAGE CAMPBELL & ASSOCIATES LTD CONSULTANTS
VANCOUVER, CANADA

B.C. HYDRO & POWER AUTHORITY
VANCOUVER, CANADA

HAT CREEK PROJECT

SECTION 8000' N (3)
COAL RESERVES

SCALE Hor 1" = 400' Vert 1" = 400'	JAN. 1, 1975	FIG. 16

DOLMAGE CAMPBELL & ASSOCIATES LTD CONSULTANTS
VANCOUVER, CANADA

B.C. HYDRO & POWER AUTHORITY
VANCOUVER, CANADA

HAT CREEK PROJECT

SECTION 7000' N.
COAL RESERVES

SCALE: Hor. 1" : 400' Vert. 1" : 400' | JAN. 1, 1975 | FIG. 17

00 125 (11)

PART 8

APPENDICES

APPENDIX 1

HAT CREEK COAL

COST PER TON OF COAL DELIVERED TO STOCK PILE AT THE PLANT

45° PIT WALLS 85 TON HAULPAK

Elevations	2800 ft–3000 ft	2600 ft–2800 ft	2400 ft–2600 ft	2200 ft–2400 ft	2000 ft–2200 ft	1800 ft–2000 ft	1800 ft–3000 ft average
Item / Approximate Years	0–6th incl.	7th–13th incl.	14th–19th incl.	20th–24th incl.	25th–29th incl.	30th–33rd incl.	0–33rd incl.
Drilling	$0.0371						
Blasting	$0.1188	$0.2488	$0.2488	$0.2488	$0.2488	$0.2488	$0.2488
Loading	$0.0929						
Hauling	$0.3344	$0.3555	$0.4112	$0.5098	$0.5796	$0.6575	$0.4568
Pit Cleanup–roads	$0.0826						
Pit pumping and lighting	$0.0028						
Loading surcharge selected wastebands	$0.0300						
Coal Stockpiling–Packing	$0.0441						
Waste dump levelling	$0.0441						
Overburden, Load, Haul and Level	* $0.4571						$0.0825
Support vehicles	$0.0590	$0.8463	$0.8463	$0.8463	$0.8463	$0.8463	$0.8463
Amortization–Pumping, lighting, road buildings 30 years @ 10%	$0.0270						
Royalties, Taxes Creek Diversion	$0.4684						
Supervision and plant overhead	$0.0862						
Insurance on amortized installation (1%)	$0.0021						
Sub-total	$1.8866	$1.4506	$1.5063	$1.6049	$1.6657	$1.7526	$1.6344
Contingency surcharge 10%	$0.1887	$0.1451	$0.1506	$0.1605	$0.1666	$0.1753	$0.1634
Total cost per ton at plant stockpile	$2.0753	$1.5957	$1.6569	$1.7654	$1.8323	$1.9279	$1.7978
Cost per million B.T.U.'s @ 6000 B.T.U.'s per lb.	$0.1729	$0.1330	$0.1381	$0.1471	$0.1527	$0.1606	$0.1498

* Total cost charged to the first 6 years

APPENDIX I (continued)

HAT CREEK COAL

COST PER TON OF COAL DELIVERED TO STOCK PILE AT THE PLANT

45^{o} PIT WALLS 120 TON HAULPAK

Elevations	2800 ft-3000 ft	2600 ft-2800 ft	2400 ft-2600 ft	2200 ft-2400 ft	2000 ft-2200 ft	1800 ft-2000 ft	1800 ft-3000 ft+ average
Item Approximate Years	0-6th incl.	7th-13th incl.	14th-19th incl.	20th-24th incl.	25th-29th incl.	30th-33rd incl.	0-33rd incl.
Drilling	$0.0371						
Blasting	$0.1188	$0.2488	$0.2488	$0.2488	$0.2488	$0.2488	$0.2488
Loading	$0.0929						
Hauling	$0.3571	$0.3541	$0.4068	$0.4838	$0.5396	$0.6111	$0.4438
Pit Cleanup-roads	$0.0826						
Pit pumping and lighting	$0.0028						
Loading surcharge selected wastebands	$0.0300						
Coal Stockpiling-Packing	$0.0441						
Waste dump levelling	$0.0441						
Overburden, Load, Haul and Level	* $0.4571						$0.0825
Support vehicles	$0.0590	$0.8463	$0.8463	$0.8463	$0.8463	$0.8463	$0.8463
Amortization-Pumping, Lighting, road buildings 30 years @ 10%	$0.0270						
Royalties, Taxes, Creek Diversion	$0.4684						
Supervision and plant overhead	$0.0862						
Insurance on amortized installation (1%)	$0.0021						
Sub-total	$1.9093	$1.4492	$1.5019	$1.5789	$1.6347	$1.7062	$1.6214
Contingency surcharge 10%	$0.1909	$0.1449	$0.1502	$0.1579	$0.1635	$0.1706	$0.1621
Total cost per ton at plant stockpile	$2.1002	$1.5941	$1.6521	$1.7368	$1.7982	$1.8768	$1.7835
Cost per million B.T.U.'s @ 6000 B.T.U.'s per lb.	$0.1750	$0.1328	$0.1377	$0.1447	$0.1499	$0.1564	$0.1486

* Total cost charged to the first 6 years

APPENDIX I (continued)

HAT CREEK COAL

COST PER TON OF COAL DELIVERED TO STOCK PILE AT THE PLANT

45° PIT WALLS 150 TON HAULPAK

Elevations	2800 ft-3000 ft	2600 ft-2800 ft	2400 ft-2600 ft	2200 ft-2400 ft	2000 ft-2200 ft	1800 ft-2000 ft	1800 ft-3000 ft+ average
Item Approximate Years	0-6th incl.	7th-13th incl.	14th-19th incl.	20th-24th incl.	25th-29th incl.	30th-33rd incl.	0-33rd incl.
Drilling	$0.0371						
Blasting	$0.1188	$0.2488	$0.2488	$0.2488	$0.2488	$0.2488	$0.2488
Loading	$0.0929						
Hauling	$0.3542	$0.3536	$0.3893	$0.4760	$0.5285	$0.5837	$0.4337
Pit Cleanup-roads	$0.0826						
Pit pumping and lighting	$0.0028						
Loading surcharge selected wastebands	$0.0300						
Coal Stockpiling-Packing	$0.0441						
Waste dump levelling	$0.0441						
Overburden, Load, Haul and Level	* $0.4571						$0.0825
Support vehicles	$0.0590	$0.8463	$0.8463	$0.8463	$0.8463	$0.8463	$0.8463
Amortization-Pumping, lighting, road buildings 30 years @ 10%	$0.0270						
Royalties, Taxes, Creek Diversion	$0.4684						
Supervision and plant overhead	$0.0862						
Insurance on amortized installation (1%)	$0.0021						
Sub-total	$1.9064	$1.4487	$1.4844	$1.5711	$1.6236	$1.6788	$1.6113
Contingency surcharge 10%	$0.1906	$0.1449	$0.1484	$0.1571	$0.1624	$0.1679	$0.1611
Total cost per ton at plant stockpile	$2.0970	$1.5936	$1.6328	$1.7282	$1.7860	$1.8467	$1.7724
Cost per million B.T.U.'s @ 6000 B.T.U.'s per lb.	$0.1748	$0.1328	$0.1361	$0.1440	$0.1488	$0.1539	$0.1477

* Total cost charged to the first 6 years

APPENDIX II

TRUCK ACQUISITION TABLES
(45° Pit)

85 TON

Pit Elevations ft.	Operating Years	Truck Acquisition -Coal				Truck Acquisition- Waste				Truck Acquisition -Total				Total Trucks Acquired	Truck Ratio
		Period		Cumulative		Period		Cumulative		Period		Cumulative			
		Active	Spare	Active	Spare	Active	Spare	Active	Spare	Active	Spare	Active	Spare	Active & Spare	Active & Spare
2800 to 3000+	0 - 6th incl.	7	1	7	1	7	1	7	1	14	2	14	2	16	7.00:1
2600 to 2800	7th - 13th incl.	1	1	8	2	1	1	8	2	2	2	16	4	20	4.00:1
2400 to 2600	14th - 19th incl.	3	-	11	2	2	-	10	2	5	-	21	4	25	5.25:1
2200 to 2400	20th - 24th incl.	3	1	14	3	3	1	13	3	6	2	27	6	33	4.50:1
2000 to 2200	25th - 29th incl.	3	-	17	3	2	-	15	3	5	-	32	6	38	5.33:1
1800 to 2000	30th - 33rd incl.	2	1	19	4	3	-	18	3	5	1	37	7	44	5.29:1

120 TON

2800 to 3000+	0 - 6th incl.	6	1	6	1	5	1	5	1	11	2	11	2	13	5.50:1
2600 to 2800	7th - 13th incl.	-	-	6	1	1	-	6	1	1	-	12	2	14	6.20:1
2400 to 2600	14th - 19th incl.	2	1	8	2	2	1	8	2	4	2	16	4	20	4.00:1
2200 to 2400	20th - 24th incl.	2	-	10	2	1	-	9	2	3	-	19	4	23	4.75:1
2000 to 2200	25th - 29th incl.	2	-	12	2	2	-	11	2	4	-	23	4	27	5.75:1
1800 to 2000	30th - 33rd incl.	2	1	14	3	2	1	13	3	4	2	27	6	33	4.50:1

150 TON

2800 to 3000+	0 - 6th incl.	5	1	5	1	5	1	5	1	10	2	10	2	12	5.00:1
2600 to 2800	7th - 13th incl.	-	-	5	1	-	-	5	1	-	-	10	2	12	5.00:1
2400 to 2600	14th - 19th incl.	2	-	7	1	1	-	6	1	3	-	13	2	15	6.50:1
2200 to 2400	20th - 24th incl.	1	1	8	2	2	1	8	2	3	2	16	4	20	4.00:1
2000 to 2200	25th - 29th incl.	1	-	9	2	1	-	9	2	2	4	18	4	22	4.50:1
1800 to 2000	30th - 33rd incl.	2	-	11	2	1	-	10	2	3	-	21	4	25	5.25:1

APPENDIX II

WEIGHTED TRUCK HAULAGE COSTS FOR 85-120 AND 150 TON TRUCK
COST PER TON OF COAL

85 TON TRUCKS

PIT INTERVAL	COAL 1000 TONS	WASTE 1000 TONS	C O A L		W A S T E		COAL&WASTE TOTAL AMOUNT $1000	UNIT COST PER TON OF COAL
			UNIT COST	AMOUNT $1000	UNIT COST	AMOUNT $1000		
2800-3000+	65,988	107,231	0.1381	9,113	0.1208	12,953	22,066	0.3344
2600-2800	80,406	100,184	0.1686	13,556	0.1500	15,028	28,584	0.3555
2400-2600	74,847	68,817	0.2273	17,013	0.2000	13,763	30,776	0.4112
2200-2400	64,913	56,270	0.2908	18,877	0.2526	14,214	33,091	0.5098
2000-2200	56,313	42,774	0.3494	19,676	0.3031	12,965	32,641	0.5796
1800-2000	46,146	31,807	0.4149	19,146	0.3520	11,196	30,342	0.6575
TOTALS & AVE.	388,613	407,083		97,381		80,119	177,500	0.4568

HAT CREEK - 45° PIT

120 TON TRUCKS

PIT INTERVAL	COAL 1000 TONS	WASTE 1000 TONS	COAL UNIT COST	COAL AMOUNT $1000	WASTE UNIT COST	WASTE AMOUNT $1000	COAL&WASTE TOTAL AMOUNT $1000	UNIT COST PER TON OF COAL
2800-3000+	65,988	107,231	0.1611	10,631	0.1206	12,932	23,563	0.3571
2600-2800	80,406	100,184	0.1789	14,385	0.1406	14,086	28,471	0.3541
2400-2600	74,847	68,817	0.2311	17,297	0.1911	13,151	30,448	0.4068
2200-2400	64,913	56,270	0.2782	18,059	0.2372	13,347	31,406	0.4838
2000-2200	56,313	42,774	0.3264	18,380	0.2807	12,007	30,387	0.5396
1800-2000	46,146	31,807	0.3827	17,660	0.3314	10,541	28,201	0.6111
TOTALS & AVE.	388,613	407,083		96,412		76,064	172,476	0.4438

150 TON TRUCKS

PIT INTERVAL	COAL 1000 TONS	WASTE 1000 TONS	COAL UNIT COST	COAL AMOUNT $1000	WASTE UNIT COST	WASTE AMOUNT $1000	COAL&WASTE TOTAL AMOUNT $1000	UNIT COST PER TON OF COAL
2800-3000+	65,988	107,231	0.1555	10,261	0.1223	13,114	23,275	0.3542
2600-2800	80,406	100,184	0.1762	14,168	0.1424	14,266	28,433	0.3536
2400-2600	74,847	68,817	0.2202	16,481	0.1839	12,655	29,136	0.3893
2200-2400	64,913	56,270	0.2747	17,832	0.2322	13,066	30,898	0.4760
2000-2200	56,313	42,774	0.3207	18,060	0.2736	11,703	29,763	0.5285
1800-2000	46,146	31,807	0.3655	16,866	0.3165	10,067	26,933	0.5837
TOTALS & AVE.	388,613	407,083		93,668		74,871	168,539	0.4337

APPENDIX III

SUPERVISION & PLANT OVERHEAD

1 Manager	$ 2,500./month
5 Engineers	5,500.
1 Geologist	1,200.
1 " Helper	800.
1 Accountant	1,100.
1 Time Keeper	800.
1 First Aid	900.
1 Purchasing Agent	1,000.
3 Warehouse	2,700.
3 Secretarial	2,100.
2 Bldg. Maintenance	1,500.
1 Pit Supt.	1,500.
3 " Foreman	3,750.
3 Shift Boss	3,300.
1 Blaster Foreman	1,000.
2 " Helpers	1,600.
3 Dump Man O.B.	3,000.
3 " " Waste	3,000.
1 Surface Foreman	1,200.
1 Master Mech.	1,500.
1 Chief Electrician	1,500.
1 Water Truck Driver	1,000.
6 Bus Drivers	6,000.
4 Mechanics	5,200.
4 Electricians	5,200.
4 Welders	4,000.
6 Labours Surface	4,800.
1 Pipe Fitter	1,100.
1 " " Helper	900.
3 Heating plant operators	3,300.
	$70,450.
15% Benefits approx.	10,550.
	$81,000.

Personnel allowed for under Operating:
40 Mechs. & Electricians
12 Oilers - (shovels)
12 Shovels Opers.
6 Drillers
6 " Helpers
93 Truck Drivers
27 Scraper Opers.
24 Cat opers.
6 Front end opers.
6 Grader operators

Other Costs:

Power - Air, Comp., Lights	$2,500./m.
Office Supplies & Eng. Supp.	500.
	$3,000./m.

Total: $84,000./month

Costs per ton of Coal:

$$\frac{\$84,000.}{975,000 \text{ T/Mo.}} = \$0.0862$$

2000 1000 0 2000 4000 6000

SCALE 1" = 2000'

NOTE : ORIGINAL MAP 1:50,000

RECENT

OVERBURDEN – Includes Recent (?) or Late Tertiary (?) Volcanic rubble.

TERTIARY

VOLCANICS – Basalts & agglomerates
Evidently overlie sedimentary strata unconformably.

SEDIMENTARY ROCKS – Poorly indurated siltstone, sandstone, congl. & coal.

CRETACEOUS

SPENCES BRIDGE GROUP – Volcanics.

MT. LYTTON BATHOLITH – Granodiorite - diorite

PERMIAN (?)

CACHE CREEK GROUP – Greenstone and metasediments.

CACHE CREEK GROUP – Marble Canyon limestone.

AREA UNDERLAIN BY COAL.

STRUCTURE

80 Attitude of bedding.

Fault

Inferred fault.

P/C

HC 74(1)C

GEOLOGY

UPPER HAT CREEK VALLEY

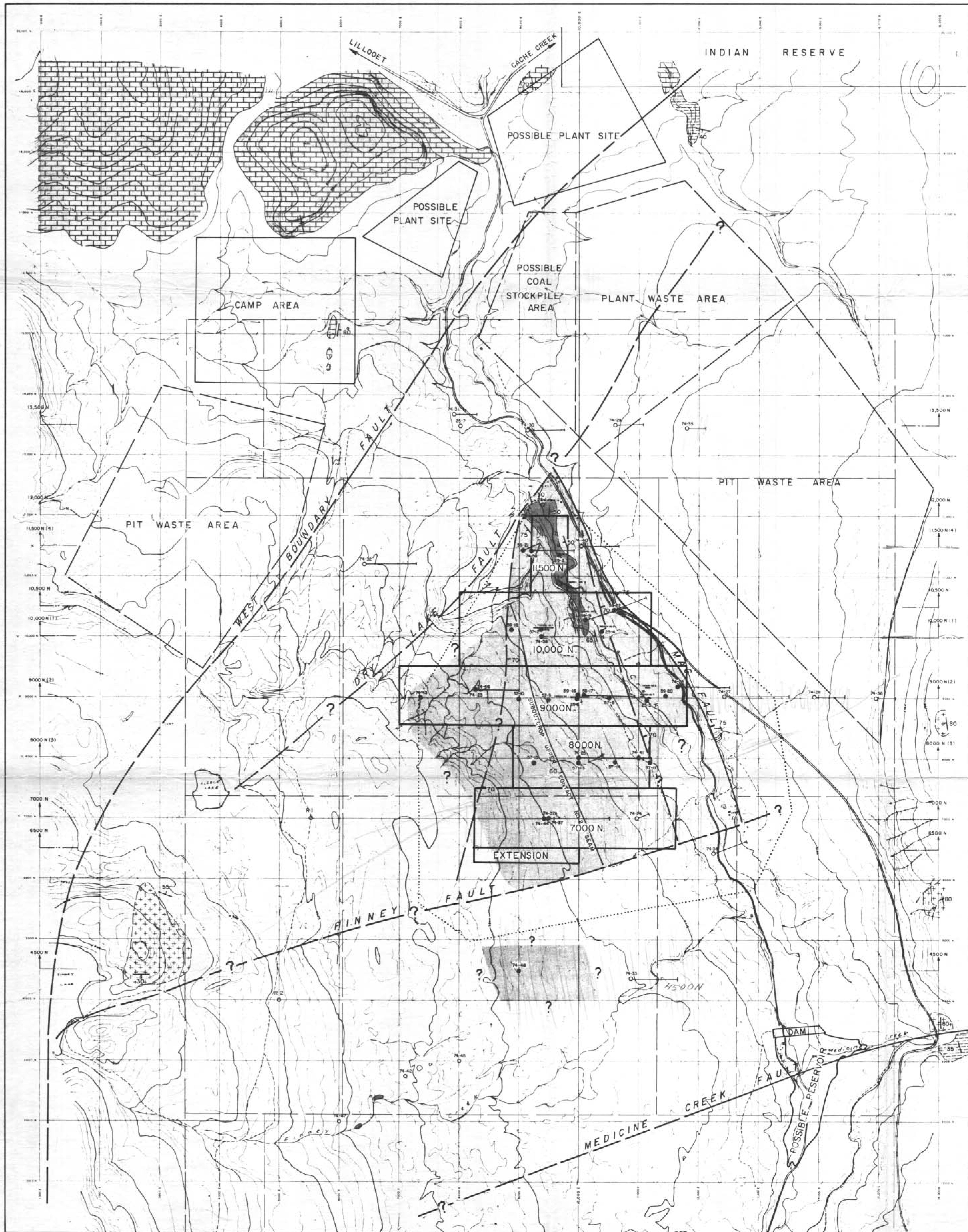
DOLMAGE CAMPBELL & ASSOCIATES LTD.

1974

125 (12)

FIGURE 4

JAN. 1, 1975



N

SCALE 1" = 800'

0 800 1600 2400 FEET

LEGEND

OVERBURDEN

(TERTIARY ?) VOLCANIC ROCKS

TERTIARY SEDIMENTARY ROCKS (Coldwater Fm.)

COAL

AREA UNDERLAIN BY STRIPPABLE COAL

PRE-TERTIARY

CACHE CREEK GROUP (Marble Canyon Limestone)

BEDDING ATTITUDE

FAULT (Known)

FAULT (Inferred)

DRILLING

DIAMOND DRILL HOLE IN COAL (Mineable from surface)

DIAMOND DRILL HOLE (No surface mineable coal)

57-12 YEAR DRILLED — HOLE NUMBER

R2 ROTARY DRILL HOLE (1974 - 1975)

8000N AREA OF INFLUENCE OF COAL RESERVE CROSS SECTION

OUTLINE OF SURFACE PERIMETER OF PRELIMINARY OPENPIT.

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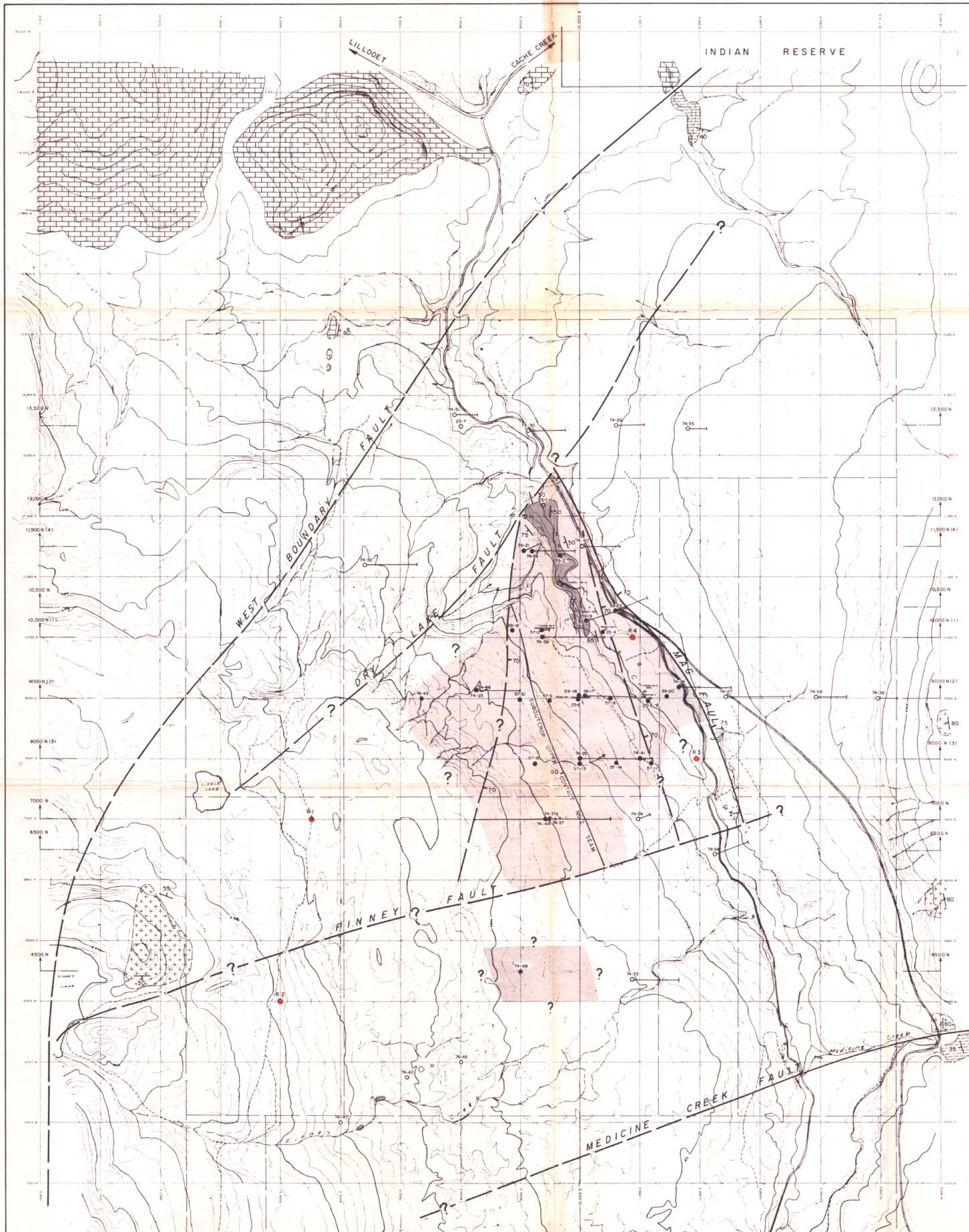
B.C. HYDRO & POWER AUTHORITY
VANCOUVER, CANADA

HAT CREEK COAL DEPOSIT

NO. 1 OPENPIT DEPOSIT ESTIMATED RESERVES

SCALE 1" = 800'	JAN. 1/1975	FIG. 12



SCALE 1" = 800'

0 800 1600 2400 FEET

LEGEND

OVERBURDEN

(TERTIARY ?) VOLCANIC ROCKS

TERTIARY SEDIMENTARY ROCKS (Coldwater Fm.)

COAL

AREA UNDERLAIN BY STRIPPABLE COAL

PRE-TERTIARY

CACHE CREEK GROUP (Marble Canyon Limestone)

BEDDING ATTITUDE

FAULT (Known)

FAULT (Inferred)

DRILLING

DIAMOND DRILL HOLE IN COAL (Mineable from surface)

DIAMOND DRILL HOLE (No surface mineable coal)

57-12 YEAR DRILLED - HOLE NUMBER

R2 ROTARY DRILL HOLE (1974 - 1975)

HC 74(1)C

(14) 125

DOLMAGE CAMPBELL & ASSOCIATES LTD., CONSULTANTS
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B.C. HYDRO & POWER AUTHORITY
VANCOUVER, CANADA

HAT CREEK COAL DEPOSIT

NO. 1 OPENPIT DEPOSIT
DRILL HOLE PLAN

SCALE 1" = 800' | JAN. /1975 | FIG. 15

DOLMAGE CAMPBELL AND ASSOCIATES LTD.

(15)

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT — DRILL RECORD

Coordinates :	74,322' N 20,914' E	Length :	1386'	Hole Nº. :	74-33
Reference Elev. :	3196'	Azimuth :	090°	Date :	JULY 1974
Ground Elev. :	3196'	Dip :	35°	Logged by :	P.J. Street
		Core Size :	NQ	Sheet :	1 of 7

ELEVATION IN FEET	DEPTH IN FEET	STRATIGRAPHY: STRAT PLOT	STRATIGRAPHY: MAJOR ROCK UNITS	DETAIL & STRUCTURE: SYMBOL	DETAIL & STRUCTURE: DESCRIPTION	CORE LOSS	SAMPLE Nº	ASH AT 20% MOISTURE

Datum

Note : Original ground elev. 3195.5'

OVERBURDEN
Mixed gravel, boulders and sand

SILTSTONE
Medium to light grey, ultra-fine grained though occasionally granular. Massive poorly bedded. Wet core blocky but dry core rubbly to pulverized. Unindurated. Fractures 40°-50° to C.A., parallel to bedding, and also random, ranging from parallel to perpendicular to C.A.

Note: Core from 440'-1386' soaked by a rainstorm and almost totally disintegrated

Pulverized

Soft, muddy plastic
Soft muddy
(1.0) very friable
Soft muddy
Muddy and friable
Muddy and friable
(1.0) soft muddy

White

(0.5) 6" pale buff grey
(1.0) buff slt
(0.5) buff
(0.5) white
(0.4) darker buff fine sst
(0.5) buff grey
(0.5) buff grey
(0.1) white
(0.4) buff
(0.5) buff
(0.2) buff
(0.2) buff
(0.5) grey with buff splotches
(0.2) Very pale grey
(0.25) buff slt
(1.0) buff slt
(0.2) grey slt
(0.5) buff slst
(0.2) buff
Splotchy buff
(0.2) buff
(0.2) buff
(0.2) buff
(0.2) light grey, with dark grey flecks (Rhodent fecal)
2 (0.2) buff
(0.2) buff
(0.2) very pale grey
(0.5) pale grey

END OF HOLE AT 1386 feet

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DRILL HOLE : 74-33
SHEET Nº : 7 OF 7