B.C. HYDRO

800 MW COAL PREPARATION REPORT

HAT CREEK PROJECT

CR41

January 1983

800 MW COAL PREPARATION REPORT

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SECTION 1.0 - INTRODUCTION

1.1 BACKGROUND

The Hat Creek coal deposit consists of four major coal zones in a complex geological setting. The four zones, labelled "A", "B", "C" and "D" zones have been further subdivided into 16 subzones, each exhibiting different quality characteristics. "D" zone and in some areas "B" zone contain relatively few partings and can be mined to fuel quality specifications using conventional mining practices. "A" and "C" zones contain numerous partings of variable thicknesses and cannot be mined to consistent quality specifications. Careful selective mining practices and appropriate blending with "D" coal are required to produce adequate quality fuel from the deposit. Coal preparation of "A", "B" and "C" coal could considerably contribute to and improve a consistent quality specification of the overall blend.

The economic viability of coal preparation for the Hat Creek Project has been questioned since the major exploration work was completed in 1978. A report entitled Hat Creek Coal Beneficiation, prepared by Simon Carves of Canada Ltd. in July 1978 concluded that coal preparation was not economically beneficial to the project. These conclusions, which were drawn mainly on the basis of "B" zone coal zones ("A" and "C" zones) were reiterated in the 1979 Mining Report and again in the 1982 800 MW Mining Report. It was generally agreed however, that further bulk sampling and pilot plant testing were required to assess the economics and some technical aspects in appropriate detail.

The Board of Review recognized the deficiencies in the information regarding coal preparation and at their 11 December 1981 meeting made the following recommendations:

"New test pits are being investigated and located to obtain large samples of coal from the "A" and "C" coal zones. Samples from these test pits would be available for large scale pilot washing tests. It has been mentioned that 1000 ton samples of these coals may be processed at the new Electric Power Research Institute Coal Cleaning Test Facility in Homer City, Pennsylvania. The Board encourages a full investigation of this programme to identify the yield and quality of coal that may be produced by beneficiating these lower grade portions of the coal deposit. Coal from these zones were not included in various coal washing tests made on samples from the test pits prepared for the Battle River Plant tests.

We also note that arrangements have been made for a review of the coal beneficiation, blending and material handling schemes. We favour such a review. However, it must be realized that there is a minimum amount of data available on which to base the studies regarding wet washing the whole or part of the mine product. It was our understanding that additional 200 mm exploration drill holes were to be completed in 1980, however, this programme was not implemented. It is our recommendation that a programme be arranged to obtain additional samples from the deposit and studies made to determine more definitely the washing characteristics of the material."

A work plan was developed by B.C. Hydro's Mining Department and their consultant Jackson-Payne Energy Consultants Ltd. in February 1982. The program was designed to provide practical design information for selective mining and material handling and to confirm the stratigraphy, coal quality and coal preparation characteristics of the "A" and "C" zone coals.

Previous exploration and studies indicated that the "A" and "C" zone coals could be selectively mined, but no bulk sample test work had been conducted. It was first planned to dig 6.5 m high benches in the coal using a 3 to 5 m^3 shovel, but financial constraints caused the program to be reduced to "A" zone coal only with a single 2.5 m high bench excavated using a less expensive 2 m^3 backhoe. These changes eliminated the opportunity to collect quantitative data on dilution, mining loss, face slope stability and minimum mining thickness (e.g. parting removal).

The 1982 Mining Field program, to obtain bulk samples of "A" zone coal was conducted from early May to late August. Detailed stratigraphic information was obtained using geophysical logs, channel samples and detailed geological mapping. Representative samples of "A" zone were taken for coal quality and coal preparation studies, material handling characteristics were observed and tested, and various geotechnical and environmental studies were undertaken.

The coal washing tests performed on the Trench D, "A" zone bulk sample by the Electric Power Research Institute Coal Cleaning Test Facility (EPRI-CCTF) were the primary source of coal preparation data for this report. A follow-up report on the EPRI-CCTF test work by Phillips Barratt Kaiser provides the cost estimate for the coal preparation facility proposed in this report.

1.2 OBJECTIVES

The main thrust of this study is to produce a revised final specification with an accompanying order of magnitude cost estimate for an integrated mine and coal preparation complex. The information is intended to be used in a cost-benefit analysis for the construction and operation of a 800 MW powerplant with and without coal preparation.

1.3 SOURCES OF INFORMATION

Information used in preparing this report was obtained from the following sources:

1. B.C. Hydro:

   - 800 MW Mining Report, October 1982
   - Mining Field Program 1982 - Trench D, October 1982

2. Electric Power Research Institute (EPRI), Coal Cleaning Tests on Hat Creek Raw Coal, December 1982.

3. Phillips Barratt Kaiser - Coal Preparation Plant Cost Estimate - Hat Creek Project, December 1982.

4. Simon Carves of Canada Ltd. - Hat Creek Coal Beneficiation, July 1978.

5. Paul Weir Company (Weirco) - Review of Coal Fuel Specification Hat Creek Project, November 1979.

1.4 PROJECTION OF COAL QUALITY

For the purposes of this report it has been assumed that the Trench D, "A" zone bulk sample represents the average coal from "A", "B" and "C" zones for the 35 year life of the mine in the 800 MW study. It should be recognized that although "A" and "B" zones have been bulk sampled, the only samples available for "C" zone are core samples. The coal quality data for the fuel specifications were taken from the 1978 Weirco Report which were applied in the 1979 2240 MW Mining Report. It was assumed that Weirco's conclusions were also valid for the 1982 800 MW Mining Report.

The assumption that the washability characteristics of "A", "B" and "C" zone coals can be represented by a single sample is not valid in a strict technical sense, "A", "B" and "C" zone coals were all influenced by the facies change that occurred from southwest to northeast in the Hat Creek deposit. Core sample results show that different types of waste material exist in different areas of the deposit within any given zone or subzone. Since the washabilities of coals are influenced by the characteristics of the associated waste materials, it follows that washabilities will vary within zones or subzones.

It would be impractical to attempt to bulk sample the entire range of possiblities in the Hat Creek deposit. The 1982 Trench D, "A" zone bulk sample total ash content is close to the calculated ash content for the composite of "A", "B" and "C" zones. Bench scale tests on strategically located 150 mm diameter core samples would provide the necessary data to assess the representivity of the Trench D sample.

SECTION 2.0 - SUMMARY

2.1 STUDY CONCEPTS

The 800 MW Mining Report prepared by the B.C. Hydro mining group and their consultants prepared in October 1982 provides the base case for the coal preparation study. The inclusion of a preparation plant into this production scheme does not alter the equipment selection for the mining operations. The 10.8 million additional raw tonnes which are required to make up for process losses in the coal preparation plant over the life of the project can be mined with the proposed 800 MW base case equipment. The changes in the material handling systems reflect the changes in production philosophy. The coal preparation plant becomes the main regulator of coal quality and the blending facility becomes a buffer between the mine and the preparation plant. "D" zone coal is handled in a separate storage facility and mixed with washed coal for delivery to the powerplant. This reduces the risk of mining failures having an adverse effect on boiler feed quality.

2.2 MATERIALS HANDLING

The introduction of a coal preparation plant into the mine coal handling system results in the following changes:

1. Revised size of blending facility to handle "A", "B" and "C" zone coals for plant feed.

2. Revised equipment selection for stacking and reclaiming to provide a less sophisticated system.

3. Relocation of the blending facility to a location closer to the mine mouth.

4. Addition of storage and handling facility for "D" zone coal.

5. Realignment and extension of the overland coal conveyor to the powerplant.

6. Relocation of the mine services area.

The basic design criteria applied in the 800 MW Mining Report have been applied to the revised layout.

2.3 COAL PREPARATION

The preparation plant flowchart is designed on the assumption that the blend of "A", "B" and "C" zone coals will exhibit similar washability characteristics to the Trench D, "A" zone bulk sample which was processed at EPRI-CCTF. The assumed 1000 t/h plant consists of dual 500 t/h circuitry utilizing the following process circuits for cleaning the 150.00 mm x 0.15 mm raw coal.

1. Heavy media drum separators for processing the 150.00 mm x 19.0 mm raw coal.

2. Heavy media cyclones for processing the 19.0 mm x 0.6 mm raw coal.

3. Two stage water only cyclones for processing the 0.60 mm x 0.15 mm raw coal.

4. Classification of 0.15 mm x 0 raw coal to refuse.

The 0.6 mm x 0 refuse material is dewatered using continuous belt filter presses and conveyed to the waste disposal bin with the coarse reject materials.

The preparation plant produces clean coal with 26.0 percent total moisture, 17.9 percent ash (a.r.b.) and 15.09 MJ/Kg calorific value (a.r.b.). The material yield is 73.7 percent (a.r.b.) and the calorific recovery is 92.2 percent.

2.4 FUEL SPECIFICATIONS

The fuel supplied to the powerplant must maintain a consistent quality in heating value to permit stable boiler operation and in sulfur content to meet emission standards. This consistency must be achieved over long and short-term periods.

In previous schemes, the consistency of the boiler fuel was governed by the mining sequence in all four zones and by the blending facility. The addition of the preparation plant for "A", "B" and "C" zone coals to the production scheme coupled with the systematic addition of "D" zone coal, reduces the risk of quality fluctuations and results in a higher average quality in the powerplant fuel.

It is anticipated that the average fuel quality for the 35 year life of the mine will increase in calorific value from 18.0 MJ/Kg (d.b.) to 21.3 MJ/Kg and decrease in sulfur content from 0.57 percent to 0.48 percent (d.b.).

2.5 CAPITAL COSTS

The capital costs to full production are shown in Table 2-1 entitled "Capital Costs to Full Production - Summary". It can be seen that the addition of the preparation plant and revisions to the materials handling layout increases the capital costs by $73,237,000 over the 800 MW base case.

2.6 OPERATING COSTS

The net result of adding coal preparation to the 800 MW production scheme is an increase in the total cost of delivered coal from $12.10/t to $18.67/t. This figure includes all capital and operating costs for the life of the project and takes into account material losses in the preparation plant. The cost on a calorific value basis increases from 0.08736¢/MJ to 0.1174¢/MJ, an increase of approximately 34 percent.

The direct operating cost for the preparation plant is estimated to be $3.09/t. This cost is approximately 30 percent higher than for a comparable plant without continuous belt filter presses for dewatering the fine tailings.

A final evaluation of the economic viability of coal preparation for the Hat Creek Project cannot be performed without first evaluating the impacts of coal quality improvements on powerplant operations. The costs of the coal quality improvements are known but the potential savings must now be determined by the powerplant experts. Final justification or final abandonment of coal preparation will be decided only when the total increase in capital and operating costs can be composed to the total savings.

TABLE 2-1

CAPITAL COSTS TO FULL PRODUCTION

SUMMARY

Description	800 MW Base Case (k$)	800 MW Coal Preparation Case (k$)
Site and Improvements	30 066.2	30 316.2
Maintenance, Service and Administration	23 607.4	23 607.4
Mining	2 427.5	2 427.5
Crushing and Conveying	5 564.0	4 538.0
Secondary Screening and Crushing	8 447.5	8 447.5
Coal Blending and Delivery	28 571.9	32 145.3
Coal Preparation		52 060.0
Construction Indirects	26 273.4	26 273.4
Mobile Equipment	35 319.7	35 319.7
Contingency	16 027.7	29 322.7
TOTAL FIXED CAPITAL	176 305.3	244 457.7
Total Preproduction Costs	38 795.0	42 996.8
Corporate Overhead	5 095.5	5 978.3
Construction and Insurance Bonds	748.9	748.9
TOTAL CAPITAL	220 944.7	294 181.7

SECTION 3.0 - STUDY CONCEPTS

3.1 800 MW BASE CASE

The technical and economic feasibility of different sizes of power plants have been studied for the Hat Creek deposit. A feasibility study for the combined powerplant and mine complex for a 800 MW (gross) capacity was completed and presented to B.C. Hydro's senior management in August 1982. The "800 MW Mining Report" was finalized by the B.C. Hydro Mining Group and their consultants in October 1982. This mining report serves as a backup report which supplements the summarized content of the August Feasibility Study by documenting and comprehensively explaining how the results of this study were derived.

The coal preparation study is considered to be a supplement to the 800 MW Mining Report. The following passages were excerpted from Section 2.1 of the 800 MW Mining Report and serve to outline the base operating case for the coal preparation study.

"The Hat Creek No. 1 deposit is planned to be developed as an open pit mine to supply fuel to a proposed 800 MW coal fired powerplant located in the Trachyte Hills overlooking the Hat Creek Valley. The plant will contain two 400 MW generator units each with an expected life of 35 years.

A mine plan has been developed to supply coal of a consistent quality for the 36 year project life. At the full planned production level the powerplant will consume an average of 3.828 Mt/a of coal with a heating value of 13.85 MJ/kg at 23.5 percent moisture and 18.1 MJ/kg on a dry coal basis. Actual annual production rates fluctuate within a narrow range to compensate for variation in the quality of the coal encountered. A total of 132.2 Mt of coal are mined over the project life at a stripping ratio of 0.82 m^3 of waste per tonne of coal. The stripping ratio is higher in the early years of operation averaging 1.64 m^3/t of coal over the first 10 years.

Coal and waste materials will be mined using electric powered hydraulic shovels and 91 t rear dump diesel electric trucks. The hydraulic shovels will be equipped with 14 m^3 buckets for waste and 18 m^3 for coal and partings removal. Waste trucks will be equipped with 52 m^3 struck capacity boxes (64 m^3 heaped) and the coal trucks with 77 m^3 struck (93 m^3 heaped) boxes.

Waste will be delivered to the Houth Meadows waste disposal area and placed in lifts. Because of the weak nature of much of the waste an engineered retaining embankment constructed of free draining material will be constructed. Typical haul distance for waste is 2.5 km.

Waste partings in the coal zones that exceed 2 m in thickness will be segregated by the coal shovels and trucked to Houth Meadows. Run-of-mine coal will be delivered to the truck dump station hopper at the mine mouth (El. 880). Coal will then be crushed to -200 mm and delivered by conveyor to the coal blending area. Blending piles (110 000 t) will be constructed in windrows and reclaimed with a bridge mounted bucket wheel reclaimer. This system provides good blending efficiency to minimize the quality variation in run-of-mine coal and also reduces the potential for dust emission. An emergency reclaim conveyor and hopper are provided as a back-up system.

Reclaimed coal will be delivered to the powerplant (El. 1410) by a 3.5 km two flight overland conveyor. At the powerplant facilities will be provided for live and compacted storage and secondary crushing.

The mine services area is located to the north of the open pit adjacent to the coal blending area. Facilities to be constructed in this area include repair and maintenance facilities for the mining and other mobile equipment, warehouse, laboratory, administration building and fuel storage.

Mine operating schedules will vary considerably both on a seasonal basis and to match the changes in waste production levels as the project proceeds. Coal production requirements range from 35 000 t/wk during boiler turnaround to 93 000 t/wk at the normal winter operation level. It is planned to restrict coal production to a 5 day week and vary the number of shifts worked on a seasonal basis."

3.2 MINING

The insertion of a preparation plant into the production scheme does not alter the equipment selection for the mining operation. To provide the degree of flexibility needed to meet the stringent weekly coal quality requirements for the 800 MW base case, it was judged that three shovels should be provided for coal operations. Using the selected hydraulic shovels with a 18 m^3 bucket the winter production levels of coal and partings can be excavated and loaded on a 3-shift per day 5 day a week schedule with one shovel operating. Over the course of any week it was anticipated that each of the three shovels would be operated in coal of a different quality for sufficient shifts to meet specifications.

The scheduling of coal production becomes simpler with the addition of the preparation plant. There is no longer a need to produce weekly blends of exactly the same coal quality. Changes in the quality of coal in the preparation plant feed blends will change the plant yield but they will not significantly influence the clean coal quality. Selective mining, although still important, is no longer the primary factor in quality control. Production scheduling becomes a matter of maintaining the long term extraction ratios and maintaining some access to "D" zone coal.

Sufficient capacity exists in the 800 MW base case mine plan to accommodate the additional 10.8 million tonnes of raw coal required over the life of the mine to make up for preparation plant process losses. Although adequate shovel capacity exists at all times, additional trucks from the waste fleet will have to be diverted to coal transportation during peak winter requirements.

3.3 MATERIALS HANDLING

The changes in the material handling system reflect the basic changes in concept required to integrate a preparation plant into the mining complex. In the 800 MW base case all of the raw coal from "A", "B", "C" and "D" zones was delivered to the blending bed.

The blending system provided two functions: it smoothed out the variations in run-of-mine coal quality, and provided surge capacity between the mine and powerplant. The blending system selected used the windrow method of pile construction, this method gave a better blending efficiency by reducing particle segregation.

The selected layout of the system was comprised of two stockpiles each with 110 000 t capacity or 1 week supply of coal to the powerplant at maximum capacity rating.

The coal was to be deposited into the blending piles by a slewing-luffing, rail mounted stacker receiving the coal from a 1050 mm wide conveyor belt and tripper. After building one stockpile the stacker slewed through 180° in order to be ready to commence stockpiling on the other pile.

Reclaiming of the blended coal was to be by a single bridge mounted bucket wheel reclaimer fitted with twin bucket wheels for better blending efficiency.

The reclaimed coal was delivered to the 1050 mm wide reclaim conveyor for transfer to the overland conveyor for delivery to the secondary crushing plant at the powerplant site.

This system of blending ensured that the reclaimed coal was uniform to within ±50 Btu on an hourly basis. However, stringent blending control required by the boiler when the fuel is comprised of raw coals, is not needed for the preparation plant under the new scheme.

The blending facility serves a different purpose when "A", "B" and "C" zone coals are to be washed. "D" zone coal bypasses the preparation plant and is handled in a separate storage facility. The blending facility becomes a buffer between the mine and the preparation plant which permits greater flexibility in mine planning and still ensures that the plant will maintain steady state operation. This permits optimization of both the mine operation and the preparation plant operation.

SECTION 4.0 - RAW COAL BLENDING AND STORAGE

4.1 INTRODUCTION

The introduction of a coal preparation plant into the mine coal handling system would make it necessary to revise the base case 800 MW site layout. A preliminary review identified some changes and modifications which would be required. These are:

1. Revised size of blending facility to handle ROM "A", "B" and "C" zone coals.

2. Revised equipment selection for stacking and reclaiming.

3. Relocation of the blending facility to a position close to the mine mouth.

4. Addition of a storage and handling facility for ROM "D" zone coal.

5. Realignment and extension of the overland coal conveyor.

6. Relocation of the Mine Services area.

These changes formed the basis for developing costs for this review but more detailed studies would be necessary to optimize equipment sizing, site selection etc. Fig. 4.1 shows the revised layout. The basic design criteria and features identified in the 800 MW Mining Report have been applied in the revised layout.

4.2 PREPARATION PLANT FEED BLENDING FACILITY

Run-of-mine "A", "B", "C" and "D" coal at -200 mm will be conveyed from the truck dump hopper and primary crusher to the plant feed blending facility.

The "A", "B" and "C" zone coal would be transferred via a sampling station and a stacking conveyor, to a rail mounted stacker for discharge onto one of two 90 000 t capacity stockpiles. The chevron method of pile construction will be used in this system. "D" zone coal will be routed through this facility to a separate storage facility described in Section 4.3. Reclaim from stockpile at up to 1000 t/h will be carried out by a crawler mounted bucket wheel excavator complete with a bridge conveyor loading onto one of the reclaim conveyors. The reclaimed blended coal will then be conveyed to the 2000 t capacity raw coal silo for storage prior to processing in the preparation plant.

The selection of 90 000 t as the capacity of a stockpile was based on the peak requirement of coal, i.e. 100 percent MCR as described in Section 5.2.

4.3 "D" ZONE COAL STORAGE

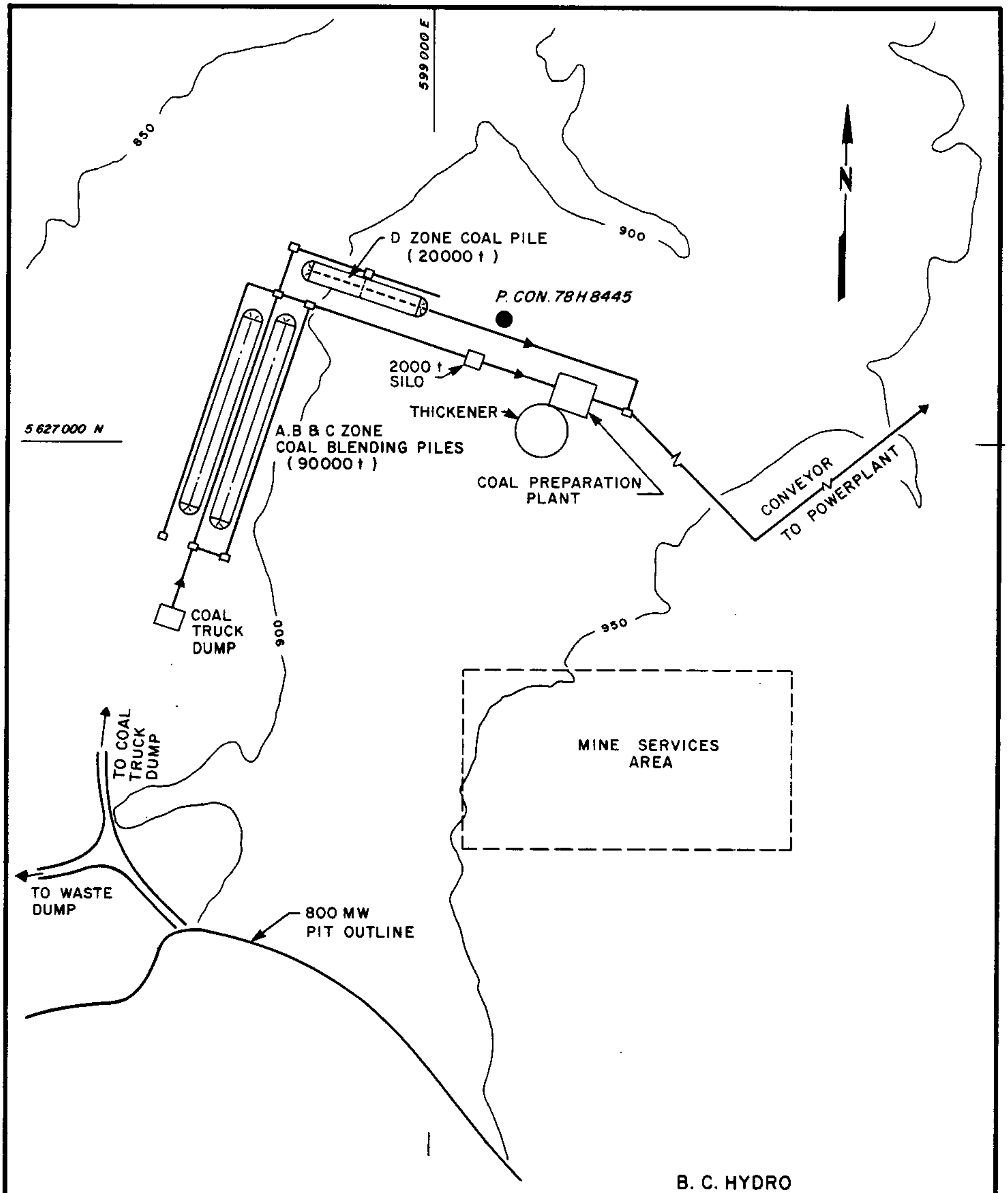
As noted earlier, "D" zone coal will be mined and handled separately from "A", "B" and "C" zone coal. Therefore a separate storage and handling facility will be required to accept and store the ROM-200 mm "D" coal in sufficient quantities to permit an efficient mining operation. It must also deliver the required quantity and quality of "D" zone coal to the overland coal conveyor which together with the washed "A", "B" and "C" zone coal would meet the requirements of the powerplant. In order to satisfy the peak requirement for "D" zone coal, i.e. at 100 percent MCR (see Section 5.2) the maximum capacity was established at 20 000 t.

The "D" zone coal will be routed through the plant feed blending facility and will be delivered via a sampler and conveyor to a rail mounted fixed arm stacker for depositing into a stockpile. Reclaim from stockpile will be by gravity feed ground reclaim hoppers. Apron feeders will feed the coal at the required rates onto the reclaim conveyor for delivery to the overland conveyor via a transfer conveyor and hopper. Assistance by auxiliary equipment would be necessary to ensure a complete turn-over of coal to prevent spontaneous combustion.

4.4 COAL DELIVERY

Coal from both the preparation plant and "D" zone storage will be delivered to the powerplant on the overland conveyor.

The respective qualities and quantities will be monitored to ensure that the powerplant requirements are strictly maintained.



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800 MW

FIGURE 4 - 1

COAL HANDLING SYSTEM WITH COAL PREPARATION PLANT

SECTION 5.0 - COAL PREPARATION

5.1 INTRODUCTION

A review of all previous coal quality and coal preparation test data indicated that Hat Creek coals are very difficult to wash. Large amounts of near gravity material, variability in raw coal characteristics and the presence of bentonitic clays require a sophisticated preparation plant with special considerations for tailings disposal. The heavy media and water only cyclone processes proposed in this report offer the maximum efficiency available for processing this type of coal. The continuous belt filter presses, although expensive in terms of operating and capital costs, provide the only proven technology available today for handling this type of tailings with a closed water circuit.

5.2 RAW COAL QUALITY

The preparation plant feed consists of weekly blends of raw coal produced from "A", "B" and "C" zones. Table 5-1 shows the dry basis ash, sulfur and calorific values for the subzones contained in "A", "B" and "C" zones for the 35 year life of the mine in the 800 MW study. It can be seen that the subzones (with all partings greater than 2 m removed) vary in ash from 30.47 percent (d.b.) to 44.88 percent (d.b.) and average 37.69 percent (d.b.).

The work done in Trench D during the 1982 mining field program confirmed that the subzones are made up of smaller lithologic units with even greater variations in ash percents. In Trench D, for example, when "A" zone coal was mined in a simulated production sequence, the R.O.M. ashes varied between 26.3 percent (d.b.) and 52.0 percent (d.b.).

The blending system described in Section 4.2 reduces the variability in the preparation plant feed to an acceptable level. The preparation plant flow chart design assumes that the blend of "A", "B" and "C" coals will exhibit similar washability characteristics to the Trench D, "A" zone sample which was processed at EPRI's Coal Cleaning Test Facility (CCTF).

The CCTF washability data from the 150 mm raw coal sample was not applied directly in the development of the preparation plant flowchart. The size consist and ash distribution data was modified to reflect the effects of degradation which were experienced during the pilot plant test runs. Products and refuses from various fine coal streams were combined to calculate a reconstituted feed sample. The following data adjustments were justified in this manner:

	CCTF Raw Coal Sample (Dry Basis)		Projected Plant Feed (Dry Basis)	
Size	Weight (%)	Ash (%)	Weight (%)	Ash (%)
150.00 mm x 19.00 mm	26.7	25.9	25.0	25.9
19.00 mm x 0.60 mm	63.3	36.4	55.0	36.4
0.60 mm x 0.15 mm	4.4	55.2	12.0	40.6
0.15 mm x 0	5.6	60.1	8.0	68.0
	100.0	35.8	100.0	36.8

5.3 DESIGN CRITERIA

The inclusion of a preparation plant into the Hat Creek production scheme reduces the tonnage of coal to be consumed by the powerplant and increases the tonnage required to be mined. The additional tonnage is mined from all four major coal zones in order to maintain the appropriate reserves extraction ratios.

The average tonnage requirements for the life of the mine cannot be used to calculate the preparation plant capacity because of the large difference between summer and winter requirements. As is the case with the mine, the coal preparation facility must have the capacity and flexibility to adjust to varied output requirements for an extended period if necessary.

Based on fuel with an as-received heating value of 13.85 MJ/kg at 23.5 percent moisture (raw coal) the powerplant average annual tonnage requirements are as follows:

Project Year	Kilotonnes	Megajoules
Year 1	1325	1.835×10^{10}
Year 1	3057	4.234×10^{10}
Year 2	3588	4.969×10^{10}
Year 3	3770	5.221×10^{10}
Years 4 to 34	3828	5.302×10^{10}
Year 35	1914	2.651×10^{10}

During a 1 year period the average planned powerplant requirements fluctuate as follows:

	Tonnes	Megajoules
Summer	70 000	9.6985×10^{8}
Summer (boiler turnaround period)	35 000	4.8475×10^{8}
Winter	93 000	1.2880×10^{9}
Winter (100 percent MCR)	110 000	1.5235×10^{9}

The following calculations and assumptions were used to develop design criteria for the preparation plant.

(a) Powerplant Energy Requirements

The winter tonnages from the 800 MW study were:

110 000 t/wk at 13.85 MJ/Kg (a.r.b.) with 64 percent contribution from "A", "B" and "C" zones, i.e. 110 000 t/wk x 13.85 MJ/Kg x 1000 Kg/t x 0.64 = 9.7152×10^8 MJ/wk.

(b) Preparation Plant Clean Coal Requirements

Clean coal quality assumptions:

Ash	-	24.2 percent (d.b.)
Total Moisture	-	26.0 percent
C.V.	-	20.39 MJ/Kg (d.b.)
C.V.	-	15.09 MJ/Kg (a.r.b.)

Therefore:

$$\frac{9.7152 \times 10^8 \text{ MJ/wk}}{15.09 \text{ MJ/Kg} \times 1000 \text{ Kg/t}} = 64\ 380 \text{ t/wk}$$

(c) Raw Coal Requirements

Yield assumptions:

1. Dry basis yield 71.3 percent.

2. As received basis yield at 23.5 percent raw coal total moisture.

Therefore:

$$\frac{(0.713/0.74)}{(1.00/0.765)} = 0.737 \text{ (a.r.b. recovery)}$$

Raw coal required:

$$\frac{64\ 380}{0.737} \text{ t/wk clean coal} = 87\ 350 \text{ t/wk raw coal}$$

(d) Plant Capacity

Operating assumptions:

1. 5 day per week operation.
2. three shifts per day.
3. weekend maintenance shutdowns.
4. 0.83 availability = 20 hours/day.

Therefore:

$$\text{hourly tonnage} = \frac{87\ 350}{100}\ \frac{\text{t/wk}}{\text{h/wk}} = 874 \text{ t/h}$$

Tonnage required with a design factor of 1.15:

874 t/h x 1.15 = 1005 t/h

Nominal Design Capacity - 1000 t/h

(e) Plant Feed Screen Analysis

The following average distribution and design sizes were established:

Size	Average Weight (%)	Maximum Design Weight (%)
150.00 mm x 19.00 mm	25	35
19.00 mm x 0.60 mm	55	65
0.60 mm x 0.15 mm	12	15
0.15 mm x 0	8	15

(f) Process Equipment Performance Yields by Size

Equipment Name	Size	Weight (d.b.) (%)	Theor. Yield (%)	Org. Eff. (%)	Yield (d.b.) (%)	C.C. Ash (d.b.) (%)	C.V. MJ/Kg (d.b.)
H.M.D.	150.00 mm x 19.00 mm	25	92.8	97.5	90.5	21.7	21.39
H.M.C.	19.00 mm x 0.60 mm	55	79.0	97.5	77.0	25.1	20.09
C.W.O.C.	0.60 mm x 0.15 mm	12	71.2	73.9	52.6	26.1	18.81
Ref. Th.) B. Filt.)	0.15 mm x 0	8	N/A	N/A	N/A	N/A	N/A
Average Plant Performance					71.3	24.2	20.39

It should be noted that all equipment performance efficiencies were derived from the EPRI-CCTF test data from the 1982 Trench D, "A" zone sample. It was assumed that the organic efficiencies determined during these pilot plant runs for separating at 1.83 density were applicable for separation at 1.90.

5.4 PROCESS DESCRIPTION

Extensive testing programs were conducted both on a laboratory bench scale and pilot plant scale during the original exploration efforts in 1977 and 1978. From this testing it was concluded that practical beneficiation plants could be designed and operated to clean Hat Creek coal, although the degree of improvement in coal quality would be lower for the effort expended than is usually achieved with other coals. This reduced efficiency was thought to be a result of interference with the gravity separation processes from clay partings and transitional coal materials. The disposal of clay tailings also created a major technical and economic problem at that time.

The 1982 mining field program pilot plant tests at EPRI's coal cleaning test facility demonstrated that conventional heavy media processes could be utilized in treating Hat Creek coals. Based on this verification an assumed conceptual heavy media process plant circuit was developed. The CCTF test work indicated satisfactory performance of the belt filter press in dewatering high clay content fines. As a result, belt filter presses have been selected for dewatering all 0.6 mm x 0 solids.

For purposes of this study, the assumed 1000 t/h coal preparation plant consists of dual 500 t/h circuitry utilizing the following process circuits for cleaning the 150 mm x 0.15 mm raw coal:

1. Heavy media drum separators for processing 150 mm x 19.0 mm raw coal.

2. Heavy media cyclones for processing the 19.0 mm x 0.6 mm raw coal.

3. Two stage water only cyclones for processing the 0.6 mm x 0.15 mm raw coal.

4. Classification of 0.15 mm x 0 raw coal to refuse.

A flowsheet shown on Figure 5-1, included at the end of this section, outlines the process circuitry.

A brief description of the selection and function of the process equipment follows:

1. Raw coal screens for classification of the raw coal at 19.0 mm.

a. Plus, 19.0 mm material reports to heavy media drum separators.

b. Minus, 19.0 mm material reports to the deslime screens.

2. Heavy media drum separators for processing the 150 mm x 19.0 mm raw coal.

3. Coarse product and refuse drain and rinse screens for media recovery.

   a. Drained media reports to heavy media sump.

   b. 150 mm x 19.0 mm product reports to the clean coal conveyor.

   c. 150 mm x 19.0 mm refuse reports to the refuse conveyor.

4. Deslime sieve bends and screens for classifying 19.0 mm x 0 raw coal.

   a. 19.0 mm x 0.6 mm oversize reports to the heavy media cyclone feed sump.

   b. 0.6 mm x 0 undersize reports to the water only cyclone feed sump.

5. Heavy media cyclones for processing 19.0 mm x 0.6 mm raw coal.

6. Product drain and rinse screens for media recovery.

   a. Drained media reports to heavy media sump.

   b. 19.0 mm x 0.6 mm product reports to dewatering centrifuges.

   c. 19.0 mm x 0.6 mm refuse reports to dewatering centrifuges.

7. Centrifuges for dewatering 19.0 mm x 0.6 mm product and refuse.

   a. Dewatered 19.0 mm x 0.6 mm product reports to the clean coal conveyor.

   b. Dewatered 19.0 mm x 0.6 mm refuse reports to the refuse conveyor.

8. Two stage water only cyclones for treating 0.6 mm x 0 raw coal.

   a. Primary water only cyclone overflow reports to vibrated classifying sieve bends.

   b. Primary water only cyclone underflow feeds secondary water only cyclone feed sump.

   c. Secondary water only cyclone overflow reports to primary water only cyclone feed sump.

   d. Secondary water only cyclone underflow reports to refuse thickener.

9. Vibrated classifying sieve bends for treating primary water only cyclone overflow.

   a. 0.6 mm x 0.15 mm sieve bend overflow reports to product continuous belt filter presses.

   b. 0.15 mm x 0 sieve bend effluent reports to the refuse thickener.

10. Continuous belt filter presses for dewatering 0.6 mm x 0.15 mm clean coal.

a. 0.6 mm x 0.15 mm cake reports to the clean coal conveyor.

11. Refuse thickener for thickening 0.6 mm x 0 refuse.

    a. Thickened 0.6 mm x 0 thickener underflow reports to refuse continuous belt filter presses.

12. Continuous belt filter presses for dewatering 0.6 mm x 0 refuse.

    a. 0.6 mm x 0 cake reports to the refuse conveyor.

5.5 CLEAN COAL QUALITY

The impact of coal preparation on coal quality cannot be predicted with certainty for all coal quality characteristics. Total ash, moisture, calorific value and to a certain extent sulfur can be accurately predicted assuming that the feed coal characteristics of the "A", "B" and "C" zone coals are accurately represented by the Trench D, "A" zone sample. Ash characteristics on the other hand, cannot be readily predicted because of the extremely complex nature of minerals that make up the ash. The mineralogical composition of the waste material from "A", "B" and "C" zones are all different due to the differences in depositional environments.

Table 5-2 shows the proximates, ultimates, calorific values, Hardgrove Grindability Index and sulfur forms for the EPRI-CCTF raw coal and clean coal samples and for the projected washed coal. The percent ash in the projected washed coal has been increased from the EPRI-CCTF result of 19.9 percent (d.b.) to 24.2 percent (d.b.) in order to increase the preparation plant yield to an acceptable level. The calorific recovery for the plant was calculated to be 92.2 percent with 26.0 percent total moisture and 17.9 percent (as received basis) ash in the clean coal.

The EPRI-CCTF raw coal and clean coal sulfur forms data cannot be rationalized in terms of relative proportions of organic and pyritic sulfur before and after washing. It appears that the pyritic sulfur in this particular area of the deposit does not occur in discrete bands but as a finely disseminated component in the coal seams. "Normal" or "predictable" results were not obtained during the pilot plant tests, and although the data is currently being rechecked, no significant improvement is anticipated.

Due to the high percentage of organic sulfur (historical data indicates 71 percent of the total sulfur) the possibility of reducing the overall sulfur content is limited. Normal reduction of pyritic sulfur by heavy medium and water only cyclone processes averages 50 percent. This means that a net reduction of 11 percent total sulfur can be expected (Canmet 1978; Paul Weir Co. 1979). The average total sulfur of "A", "B" and "C" zones raw coal was calculated to be 0.48 percent (a.r.b.) (Weir Co. 1979) leading to an estimated total sulfur content of 0.43 percent (a.r.b.) for the washed coal.

The composition and characteristics of the raw and clean coal samples from two different processes employed during the EPRI-CCTF pilot plant runs are shown on Table 5-3.

TABLE 5-1

"A", "B" AND "C" SUBZONE QUALITY

(35 YEAR PIT - 800 MW STUDY)

(ALL RESULTS DRY BASIS)

Subzone	Kilotonnes	Ash (%)	Calorific Value (MJ/Kg)	Sulfur (%)
A_1	5 069	32.75	18.09	0.81
A_2	5 332	31.75	17.94	0.80
A_3	6 670	44.07	14.41	0.70
A_4	9 196	38.17	16.42	0.66
A_5	13 248	42.27	15.08	0.83
A_6	1 380	48.63	13.00	0.65
B_1	17 029	30.47	18.97	0.68
B_2	19 356	32.78	18.18	0.67
C_1	2 543	48.32	12.95	0.66
C_2	7 309	44.88	14.05	0.58
C_3	5 643	44.29	14.22	0.40
C_4	7 314	42.45	14.59	0.34
TOTAL	100 089	37.69	15.52	0.66

TABLE 5-2

CLEAN COAL QUALITY

(As Received Basis)	EPRI-CCTF Samples: 150 mm x 0 Raw Coal	EPRI-CCTF Samples: Plus 0.6 mm Clean Coal	Projected Average Washed Coal
Moisture, Total %	23.21	26.56	26.00
Volatile Matter %	24.53	31.86	29.00
Fixed Carbon %	20.95	26.97	27.10
Ash %	31.31	14.61	17.90
Carbon %	25.13	38.47	37.33
Hydrogen %	2.17	2.81	2.72
Nitrogen %	0.46	0.93	0.60
Chlorine %	-	-	0.02
Sulfur %	0.61	0.61	0.43
Oxygen % By Difference	17.11	16.01	15.00
Gross Calorific Value, MJ/Kg	11.86	16.09	15.09
Hardgrove Grindability Index	58.00	52.00	54.00
Sulfur Forms %:			
Pyritic	0.49	0.25	0.11
Organic	0.08	0.35	0.31
Sulfate	0.04	0.01	0.01

TABLE 5-3

IMPACT OF COAL PREPARATION ON ASH CHARACTERISTICS

		EPRI-CCTF Samples	
		Phase II-Test 2	Phase II-Test 1
Mineral Analysis of Ash (%)	150 mm x 0 Raw Coal	Plus 0.6 mm Clean Coal	Head Sample Clean Coal
SiO_2	53.66	50.39	50.47
Al_2O_3	27.08	28.28	29.66
TiO_2	2.21	2.96	2.79
Fe_2O_3	8.36	6.26	4.99
CaO	2.88	4.21	4.08
NgO	1.50	1.70	2.08
Na_2O	0.96	1.48	0.32
K_2O	0.83	0.64	0.75
P_2O_5	-	-	-
SO_3	2.24	3.60	4.62
Mn_3O_4	0.17	0.10	0.09
V_2O_5	-	-	-
Undetermined	0.11	0.38	0.15
Ash Fusibilities (Range) (°C)			
IT (Reducing)	1410	1240	1440
ST	1480	1460	1490
HT	1500	1480	1510
FT	1510+	1502	1510+
IT (Oxidizing)	1410	1280	1450
ST	1510+	1490	1510+
HT	1510+	1510	1510+
FT	1510+	1510+	1510+

Phase II-Test 2 - HMC plus WOC circuits.

Phase II-Test 1 - WOC circuit only.

SECTION 6.0 - FUEL SPECIFICATION

6.1 INTRODUCTION

The fuel supplied to the powerplant must maintain a consistent quality in heating value to permit stable boiler operation, and in sulfur content to meet emission standards. This consistency must be achieved over both long and short-term periods. The ability to meet quality requirements over the life of the project has been established in developing the mine plan and production schedule. By upgrading "A", "B" and "C" zone in the preparation plant and blending with raw "D" zone, 21.3 MJ/Kg (d.b.) coal with 0.48 percent (d.b.) (0.43 percent a.r.b.) sulfur can be supplied to the powerplant for the life of the project.

Having established that control can be maintained in the long-range plan, short-range control can be achieved through the selection of appropriate mining systems and the design and implementation of planning and monitoring procedures.

The key to reducing short-term fluctuations in coal quality is to smoothe out the variations that occur in nature. The addition of the preparation plant makes this practical. The application of selective mining techniques eliminates much of the poor quality material from the fuel. The number of shovels provided in the proposed mining scheme and the development of several pit faces of different quality ensure the availability of a "D" zone coal. The control programs in the preparation plant are specifically designed to provide a stream of coal to the powerplant with minimal variation from the mean. All of these factors combine to form an effective variance-reduction system.

6.2 CONTROL PROGRAM

The inclusion of a coal preparation plant changes the emphasis of the quality control program from the mine to the preparation plant. Each weeks production does not need to be planned and scheduled to the same strict tolerances as without coal preparation to deliver a consistent grade of fuel. Deficiencies in the blending pile coal quality will reduce the preparation plant recovery but will not significantly alter the quality of the boiler feed.

While the level of predicting the quality of coal is very good at this stage of the project, it can be improved upon considerably as more data becomes available when the mine is opened up. As the mine develops, it is planned to acquire additional data through geological mapping, close spaced drilling, face sampling and monitoring actual production to improve quality predictions.

Provision has been made in the design of the material handling system for continuous ash monitors, which, when integrated with signals from the weightometers, can produce a record of the status of the blending pile and composite samples will be collected periodically to provide verification of the results from the ash monitor.

Monitoring various product and refuse streams in the coal preparation plant on a shift basis will provide an opportunity to maximize the plant efficiency while producing a uniform, specification grade product. Corrective action and control can be effected very quickly and easily by changing the separating gravity in the heavy media circuits.

The quality of the combined plant product and "D" zone coal conveyed to the powerplant will be continuously monitored as a confirmatory check on quality.

6.3 PREDICTED FUEL QUALITY

Table 6-1 lists the projected fuel specifications for the performance blend, worst coal and best coal ("D" zone coal).

The performance blend is made up of 64 percent washed coal from the preparation plant and 36 percent "D" zone coal from the storage bunker. This blend represents the long-term average condition for the life of the mine. During regular production operation it is projected that a weekly control criteria of ±1.0 percentage ash points on a dry ash basis (equivalent to 0.3 MJ/Kg would be feasible). The homogenizing effects of the materials handling system and the secondary crushing ensure that variance is minimal on a daily and hourly basis.

The worst coal specification would arise if the preparation plant was out of commission for an extended period of time. The blending facility would then be used to produce blends of raw coal to be reclaimed directly to the powerplant. In this production scenario, the raw coal would be comprised of 50 percent "D" zone coal and 50 percent combined "A", "B" and "C" zone coals. The increased percentage of "D" zone would enhance the quality of the raw coal and partially offset the loss of the preparation plant. When the plant was back in service, the washed coal quality could be increased until the production scheduling of "D" zone coal was back to normal.

6.4 POWERPLANT FUEL REQUIREMENTS

The fuel requirement projections in this report assume that the same total energy required by the powerplant for the 800 MW base case will also be needed to produce 800 MW using washed coal. Since this does not account for possible increases in boiler efficiency due to improvements in coal quality, the estimate is considered to be slightly conservative.

The 800 MW base case called for 132.2 million tonnes of coal at 13.85 MJ/Kg or 1.8309×10^{12} MJ over the 35 year life of the project. If 132.2 million tonnes of raw coal were produced and "A", "B" and "C" zones were washed, then blended with raw "D" zone coal, the resulting product would contain 1.6938×10^{12} MJ. The shortfall of 0.13710×10^{12} MJ requires the following additional tonnages of raw coal to be mined over the life of the project:

$$\text{"A", "B" and "C" zones} = \frac{0.13710 \times 10^{12} \text{ MJ} \times 0.64}{1000 \text{ Kg/t} \times 15.09 \text{ MJ/Kg} \times 0.737}$$

= 7 889 704 tonnes

= 7.9 million tonnes

$$\text{"D" zone} = \frac{0.13710 \times 10^{12} \text{ MJ} \times 0.36}{1000 \text{ Kg/t} \times 16.99 \text{ MJ/Kg}}$$

= 2 905 003 tonnes

= 2.9 million tonnes

Therefore, total raw coal required:

132 000 000 + 10 800 000 = 143 000 000 tonnes

TABLE 6-1

FUEL SPECIFICATIONS

	Worst Coal	Performance Blend	"D" Zone (Best Coal)
Total Moisture, %	23.50	25.50	24.50
Volatile Matter, %	26.20	28.70	28.10
Fixed Carbon, %	27.50	29.00	32.50
Ash, %	22.80	16.80	14.90
Carbon	36.30	39.90	44.60
Hydrogen	2.80	2.80	3.00
Nitrogen	0.70	0.60	0.60
Chlorine	0.02	0.02	0.02
Sulfur	0.37	0.36	0.23
Oxygen	13.51	14.02	12.15
Gross Calorific Value (MJ/Kg)	14.40	15.90	17.40
Hardgrove Grindability Index	45.00	48.00	38.00
Sulfur Forms, %:			
Pyritic	0.09	0.08	0.03
Organic	0.27	0.27	0.18
Sulfate	0.01	0.01	0.02
Mineral Analysis of Ash, %:			
SiO_2	52.60	53.40	54.10
Al_2O_3	28.10	27.40	27.50
TiO_2	1.00	1.00	1.00
Fe_2O_3	8.50	7.90	7.20
CaO	3.50	3.70	3.90
MgO	1.50	1.40	1.20
Na_2O	2.31	2.60	2.95
K_2O	0.52	0.44	0.35
P_2O_5	0.17	0.14	0.09
SO_3	1.75	1.78	1.80
Mn_3O_4	0.16	0.18	0.20
V_2O_5	0.06	0.06	0.06
Ash Fusibilities, °C:			
IT (reducing)	1170-1500+	1200-1500+	1160-1500+
ST	1210-1500+	1240-1500+	1200-1500+
HT	1250-1500+	1270-1500+	1230-1500+
FT	1290-1500+	1310-1500+	1270-1500+
IT (oxidizing)	1310-1500+	1350-1500+	1330-1500+
ST	1330-1500+	1360-1500+	1340-1500+
HT	1340-1500+	1370-1500+	1350-1500+
FT	1360-1500+	1380-1500+	1360-1500+

SECTION 7.0 - CAPITAL COST ESTIMATE

7.1 INTRODUCTION

The capital cost estimate, which was established in co-operation with Phillips Barratt Kaiser, consists of:

- initial fixed capital,
- replacement capital (for fixed assets), and
- preparation costs.

These expenditures comprise the total direct capital required to construct, develop and operate the mine. These expenses would commence 5 years prior to the start of commercial operations of the powerplant.

The changes required in the coal blending and delivery systems and the crushing and conveying systems were costed in accordance with the cost estimating criteria outlined in the 800 MW base case and the expenditures rescheduled in the preproduction period.

A 3 year construction period was assumed for the coal preparation plant and the costs were distributed accordingly in the preproduction period. The cost estimating criteria for the preparation plant differ from the 800 MW base case and are described in detail in Section 7.2 below.

7.2 COAL PREPARATION CAPITAL COSTS

A factored capital cost estimate summary is shown in Table 7-1 and was developed for a 1000 t/h coal preparation plant and associated raw coal storage facilities. Equipment selection was based on the conceptual flowsheet as outlined in the Section 3.4. The estimated cost of the raw coal storage facilities, plant feed conveyor and coal preparation plant is $65,075,000.00. A general description of this Type 1 estimate is included at the end of this section.

1. This estimate has been developed from an approximate equipment list which was factored by various percentages based on previous work in similar facilities to arrive at an estimated capital cost. The estimate includes raw coal storage capacity, plant feed conveyor and the coal preparation plant. It was assumed that the limits of the preparation plant would be the building walls and that all power, water, sewage, fire protection, communication, and other utilities in sufficient quantities would be available at the wall line. Facilities outside the wall line, with the exception of the raw coal storage area and plant feed conveyor, are estimated elsewhere in the report.

2. The site has not been located and no soils investigation has been made. Therefore, a level cleared site with foundations of at least 3000 lb/ft^2 has been assumed.

3. All conveyors from the building were estimated separately and have not been included.

4. Although a 3 year construction schedule has been established, escalation has been excluded. In addition, the following items have been excluded in the capital cost in this section of the report:

   a. land and rights-of-way,

   b. owner administrative or management costs,

   c. interest or financing charges,

d. training of operating personnel,

e. permits and licenses,

f. spare parts other than installed capital spares, lubrication, and operating supplies,

g. startup assistance,

h. all other costs except those specifically stated as being included, and

i. construction camp.

5. The estimates are in Canadian dollars and are based on prices in effect as of the last quarter of 1982.

A Type 1 estimate is based on assumed flowsheets and assumed process requirements. No design drawings are prepared beyond "scratch pad" sketches. Equipment lists are prepared based on the assumed flowsheet and priced on updated former quotations, telephone quotes from vendors' representatives, and, occasionally, letter quotes. No equipment specifications are prepared, nor formal vendors' proposals are solicited. Total facility costs are determined by roughly estimating the shelter volume and applying experience unit costs. Percentage factors are used for installation of equipment. Electrical costs, other than motors and substations, are estimated as unit costs per installed horsepower or percentage of total cost. Percentage factors are used for contractor's field overhead, construction plant and construction camp. Additional percentage factors are used for engineering, design and procurement. Contingency and escalation evaluations are also prepared.

A Type 1 estimate contains heavy contingencies. These range from 20 percent to 25 percent on structures and 15 percent to 20 percent on equipment. A Type 1 estimate may frequently be suitable to reject a project but it is seldom adequate for positive acceptance of a project. A Type 1 generally describes a hypothetical installation and seldom becomes the basis for conceptual design.

7.3 COMPARISON TO 800 MW BASE CASE

The total capital costs to full production for the 800 MW base case and for the 800 MW coal preparation case are shown on Table 7-2. The preparation plant fixed capital costs are incurred over a 3 year period during preproduction. The contingency on the coal preparation facility is 25 percent as opposed to 10 percent for the remainder of the estimate. The remaining changes in the fixed capital cost result from the changes to the blending system and the addition of the "D" zone bunker facility. Replacement costs for the coal handling and coal preparation facility have been treated as expenses rather than replacement capital costs. The preproduction costs have been increased for year minus one to account for preparation plant start up costs.

TABLE 7-1

CAPITAL COST ESTIMATE SUMMARY

1000 t/h COAL PREPARATION PLANT

Construction Costs	
Buildings and Structures	$15,124,000.00
Installed Equipment	17,398,000.00
Piping, HVAC, Instrumentation	6,437,000.00
Electrical	5,045,000.00
Subtotal	$44,004,000.00
Taxes on Material and Equipment	1,265,000.00
Estimated Total Construction Costs	$45,269,000.00
Engineering, Supervision, Procurement, and Contracts Management	6,790,000.00
Subtotal	$52,059,000.00
Escalation	Excluded
Subtotal	$52,059,000.00
Contingency	13,016,000.00
Total Estimated Cost	$65,075,000.00

TABLE 7-2

CAPITAL COST SCHEDULE TO FULL PRODUCTION ($000)

Description	800 MW Base Case								800 MW Coal Preparation Case								Net Difference
	-6	-5	-4	-3	-2	-1	1	2	-6	-5	-4	-3	-2	-1	1	2	
Site and Investigations			2 020.0	15 666.8	11 786.0	459.8	133.6				2 020.0	15 916.8	11 786.0	459.8	133.6		+250.0
Maintenance, Service and Administration			900.0	5 945.1	13 762.3	3 000.0					900.0	5 945.1	13 762.3	3 000.0			--
Mining				285.0	1 341.3	335.0	424.9	41.3				285.0	1 341.3	335.0	424.9	41.3	--
Crushing and Conveying			100.0	200.0	984.0	4 280.0					100.0	200.0	684.0	3 554.0			-1 026.0
Secondary Crushing and Screening				1 000.0	4 183.6	3 263.9						1 000.0	4 183.6	3 263.9			--
Coal Blending and Delivery				7 282.1	14 857.8	6 432.0						8 473.3	16 049.0	7 623.0			+3 573.4
Coal Preparation				--	--	--						13 015.0	26 030.0	13 015.0			+52 060.0
Construction		630.0	8 862.2	5 109.2	5 975.6	5 696.4				630.0	8 862.2	5 109.2	5 975.6	5 696.4			--
Mobile Equipment				93.7	13 770.7	6 992.6	9 054.0	5 408.7				93.7	13 770.7	6 992.6	9 054.0	5 408.7	--
Subtotal		630.0	11 882.2	35 581.9	66 661.3	30 459.7	9 612.5	5 450.0		630.0	11 882.2	50 038.1	93 582.5	43 939.7	9 612.5	5 450.0	+54 857.4
Contingency		63.0	1 188.2	3 558.2	6 666.1	3 046.0	961.2	545.0		63.0	1 188.2	6 956.3	13 263.0	6 346.0	961.2	545.0	+13 295.0
Total Fixed Capital		693.0	13 070.4	39 140.1	73 327.4	33 505.7	10 573.7	5 995.0		693.0	13 070.4	56 994.4	106 845.5	50 285.7	10 573.7	5 995.0	+68 152.4
Preproduction Costs																	
Direct Mining Preproduction				2 015.0	8 843.0	12 934.0	9 776.0					2 015.0	8 843.0	13 934.0	12 596.0		+3 820.0
Contractors Fee - 4 percent				81.0	354.0	517.0	391.0					81.0	354.0	517.0	391.0		--
Coal Royalty						175.0	181.0							175.0	181.0		--
Contingency - 10 percent				210.00	920.00	1 363.0	1 035.0					210.0	920.0	1 463.0	1 316.8		+381.8
Total Preproduction Cost				2 306.0	10 117.0	14 989.0	11 383.0					2 306.0	10 117.0	16 089.0	14 484.8		+4 201.8
Corporate Overhead		17.3	326.8	1 036.2	2 086.1	1 212.4	416.7			17.3	326.8	1 424.9	2 535.5	1 257.1	416.7		+882.8
Construction Insurance and Bonds		0.6	12.4	57.3	153.9	245.7	279.0			0.6	12.4	57.3	153.9	245.7	279.0		--
Total Capital		710.9	13 409.6	42 539.6	85 684.4	49 952.8	22 652.4	5 995.0		710.9	13 409.6	60 782.6	119 651.9	67 877.5	25 754.2	5 995.0	+73 237.0

SECTION 8.0 - OPERATING COST ESTIMATES

8.1 INTRODUCTION

Direct mine operating costs were developed in co-operation with Phillips Barratt Kaiser, estimated by fiscal year (commencing 1 April) with the start of commercial power production on 1 October of production Year 1.

The estimate was prepared in October 1982 dollars.

The estimate of operating costs comprises two components: preproduction costs and production costs. Preproduction costs include all direct operating costs incurred for mine development commencing in production Year-3 and ending on 30 September of production Year 1. Fifty percent of Year 1 operating costs were assigned to preproduction.

Costs incurred by the B.C. Hydro planning staff prior to Year-3 are included in the capital cost estimate.

The cost estimating criteria employed in the 800 MW base case were used in the coal preparation case for all areas of the operation except for the coal preparation plant itself. The operating costs for the preparation facility were prepared separately and are described in detail in Section 8.2 below.

The cost of mining the additional coal required for the coal preparation case was assumed to be the full $12.10/t calculated in the 800 MW base case.

8.2 COAL PREPARATION

An operating cost estimate based on 1982 dollars was developed for a 1000 t/h coal preparation plant. The summarized unit cost based on raw coal throughput is as follows:

Item	$ Per Tonne of Raw Coal
Hourly Labour	0.55
Salaried Supervision	0.30
Maintenance Supplies	0.26
Refuse Disposal	0.29
Power	0.05
Rentals and Contracts	0.06
Laboratory Costs	0.04
Environmental	0.04
Miscellaneous	0.04
Flocculants	0.71
Magnetite	0.13
Contingency at 25 percent	0.62
TOTAL	$3.09

The operating cost estimate was based on the following process plant operating parameters:

- 3 000 000 t/a raw coal throughout
- 3480 operating hours per year

A brief description outlining the assumptions and methods used in the calculation of each item follows.

(a) Hourly Labour

1. Total manpower of 40.

2. Labour distribution:

a. 21 plant operators (7 per shift).

b. 19 maintenance personnel:

- 10 millwrights
- 3 electricians
- 3 pipefitters
- 2 welders
- 1 instrument mechanic

3. Average wage of $24,000/a.

4. Fringe benefits at 73 percent.

(b) Salaried Supervision and Annual Wages

1. Total manpower of 11.

2. Supervision distribution:

a.	Plant superintendent	$58,000
b.	Two senior foremen:	
	operating	50,000
	maintenance	50,000
c.	Plant engineer	50,000
d.	Five foremen:	
	three operating	45,000
	two maintenance	45,000
e.	Maintenance planner	45,000
f.	Senior analyst	45,000

3. Fringe benefits at 73 percent.

(c) Maintenance Supplies

Cost distribution:

1.	Replacement parts, mechanical consumables and lubricants	\$0.24/t raw coal
2.	Filter cloth	\$0.20/t raw coal

(d) Refuse Disposal

1. Based on 71.3 percent plant yield.
2. Assumed refuse disposal cost of \$1.00/t.

(e) Power

1. Based on 2000 connected horsepower.
2. Assumed power cost of \$0.30/kWh.
3. Cost distribution:

a.	Process equipment	\$0.40/t raw coal
b.	Other (lighting, maintenance)	\$0.01/t raw coal

(f) Rentals and Contracts

Assumed at \$15,000/mo.

(g) Laboratory Costs

Assumed at \$10,000/mo.

(h) Environmental

Based on an allowance of $10,000/mo.

(i) Miscellaneous

1. Assumed at $10,000/mo.

2. Includes items such as travel, plant heating and miscellaneous consumables.

(j) Flocculants

1. Thickener:

   a. High MW flocculant dosage of 0.4 lb/t at $3.60/lb.
   b. Low MW flocculant dosage of 1.2 lb/t at $0.48/lb.

2. Belt Filter Press:

   a. High MW flocculant dosage of 0.9 lb/t at $3.60/lb.

(k) Magnetite

1. Assumed consumption of 6 lb/t of raw coal processed.
2. Magnetite cost of $55.00/t delivered.

(l) Contingency

Twenty-five percent of above costs.

8.3 COMPARISON TO 800 MW BASE CASE

The total cost of coal is shown on Table 8-1 for both the 800 MW base case and the 800 MW coal preparation case. The total cost per tonne of coal delivered to the powerplant increases from $12.10 to $18.67 with the addition of the preparation plant. This translates to a change from 0.08736¢/MJ to 0.1174¢/MJ on an equivalent calorific value basis.

The increases in the total per tonne cost of coal results from the following increased costs:

1. Capital costs to full production are increased from $176,305,000 to $244,458,000 (see Section 7.3 for a detailed explanation).

2. Preproduction operating costs increase from $36,363,000 to $36,699,000 due to preparation plant start up costs in Year 1.

3. Corporate overhead increases from $6,787,000 to $7,670,000 to cover the administration costs of preparation plant construction.

4. Direct operating costs increase from $701,950,000 to $1,016,300,000 to incorporate the $3.09/t operating costs for the 102 000 000 t of raw coal processed over the life of the mine.

5. Provincial coal royalty increases from $47,400,000 to $51,350,000 because of the additional 10 800 000 t of coal mined during the project.

6. Additional mining costs of $130,680,000 are incurred in mining the additional 10 800 000 t of raw coal.

The "per tonne" cost of delivered coal is further increased because of preparation plant losses. The preparation plant recovery is estimated to be 73.7 percent on an as received basis. The increased calorific value in the product coal means, however, that less total tonnes are required by the powerplant.

TABLE 8-1

TOTAL COST OF COAL

	800 MW Mining Report October 1982 (1982 k$)	800 MW Coal Preparation case (1982 k$)
Initial Capital Costs		
Capital Costs to Full Production	176,305.00	244,458.00
Preproduction Operating Costs	36,363.00	36,699.00
Discretionary Expenses	3,000.00	3,000.00
Construction Insurance and Bonds	749.00	749.00
Land Acquisition	5,414.00	5,414.00
Other Ongoing Studies	27,414.00	27,414.00
Mine Cost System (Cost Centre)	22,237.00	22,237.00
Corporate Overhead	6,787.00	7,670.00
Interest During Construction	110,811.00	129,553.00
Project Total Cost	389,080.00	477,194.00
Per Tonne	2.94	4.11
Replacement Capital	87,218.00	87,218.00
Per Tonne	0.67	0.75
Operating Costs		
Direct Operating	701,195.00	1,016,300.00
Contingency - 10 percent	70,120.00	101,630.00
Contractor's Allowance	30,853.00	30,853.00
School Taxes	88,800.00	88,800.00
Provincial Coal Royalty	47,400.00	51,350.00
Interest and Insurance	184,567.00	184,567.00
Additional 10.8 million tonnes raw coal		130,680.00
Total Operating	1,122,935.00	1,604,180.00
Per Tonne	8.50	13.81
Total Costs	1,599,233.00	2,168,592.00
Per Tonne	12.10	18.67
Kilotonnes Produced	132,168	116,174

GLOSSARY

a.r.b.	-	As Received Basis
B.Filt.	-	Continuous Belt Filter Press
Btu	-	British Thermal Unit
c.c.	-	Clean Coal
c.v.	-	Calorific Value
d.b.	-	Dry Basis
HMB	-	Heavy Media Bath
HMC	-	Heavy Media Cyclones
J	-	Joules
k	-	Kilo (Thousand)
kg	-	Kilogram
kPa	-	Kilopascals
kW	-	Kilowatt
m	-	Metre
mm	-	Millimetre
M	-	Mega (Million)
MJ/kg	-	Megajoules per kilogram
Mt/a	-	Megatonnes per Year
MW	-	Megawatt
Ref.th.	-	Refuse Thickener
ROM	-	Run-of-Mine
S.G.	-	Specific Gravity
t	-	Tonne
t/wk	-	Tonnes per Week
W.O.C.	-	Water Only Cyclones