cominco-monenco joint venture

monenco

Mr. M.A. Favell,
Manager, Thermal Division,
B.C. Hydro and Power Authority,
555 W. Hastings Street,
Vancouver, B.C.
V6B 4T6

August 29, 1978

Dear Mr. Favell:

Re: Hat Creek Project - Mining Feasibility Report

The Cominco-Monenco Joint Venture is pleased to submit our Mining Feasibility Report, completed in accordance with the terms of assignment by B.C. Hydro. The Report comprises eight volumes as noted on the title page.

We consider that the technical and economic results presented in this Report will form an adequate basis on which to commit the mining portion of the Hat Creek Project to the license application and final design stages.

In our opinion, the estimated cost of Hat Creek coal delivered to the generating station is economically attractive in comparison to alternate fuels such as residual fuel oil and natural gas, at presently prevailing world prices.

A number of recommendations for further work are contained in the Report. Also, it is suggested that consideration of some items, such as selective mining and alternate strategies for dealing with the low-grade coal fractions, should be deferred until some operational experience is gained.

Please feel free to contact the Joint Venture in the event that any questions arise from B.C. Hydro's consideration of this Report.

...continued...

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It has been a pleasure for the Joint Venture to work with B.C. Hydro and its representatives in the preparation of this Report and we wish Hydro every success in the further development of the Hat Creek Project.

Yours very truly,

O.I. Johnson,
Project Manager.

OIJ:11

HAT CREEK PROJECT

MINING FEASIBILITY REPORT

HAT CREEK PROJECT

MINING FEASIBILITY REPORT

VOLUME I

SUMMARY

prepared for

British Columbia Hydro and Power Authority

by

Cominco-Monenco Joint Venture

1978

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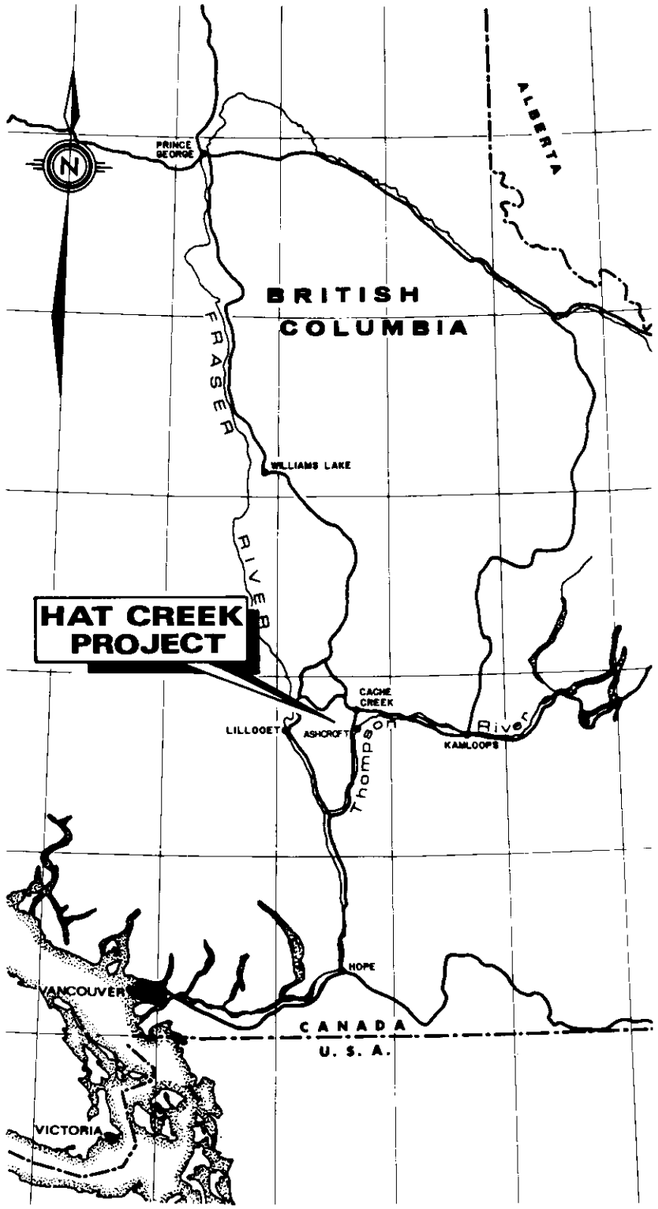

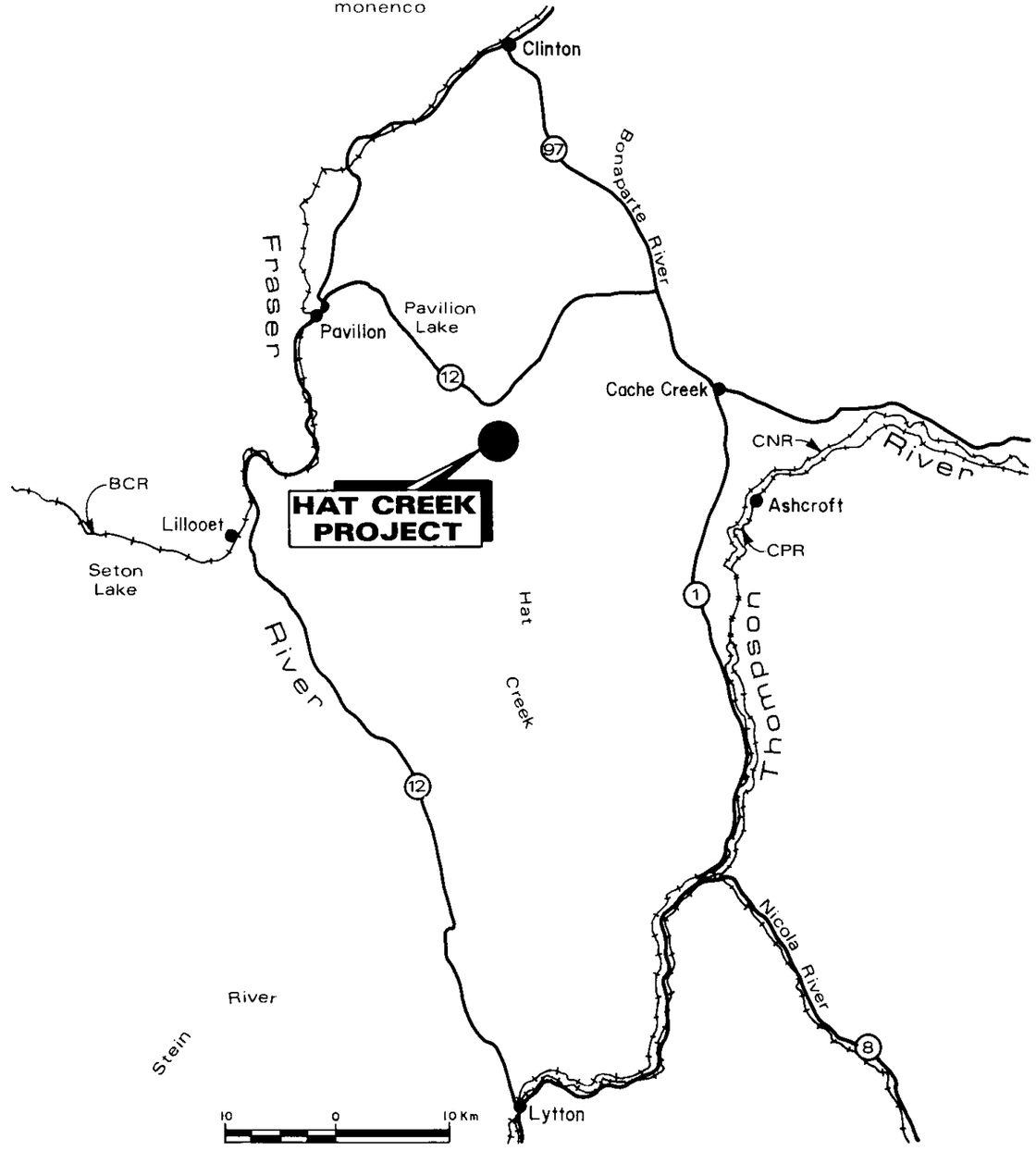

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT

PROJECT LOCATION

VOLUME I

SUMMARY

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SECTION 1

INTRODUCTION

1.1 BACKGROUND

Although reports were made of the Hat Creek coal deposits as early as 1877, only minor exploration and development activities were undertaken prior to 1957. At that time, a certain amount of drilling was done on behalf of B.C. Electric Co., who subsequently purchased the property in 1960. However, no further drilling was undertaken until 1974 when B.C. Hydro initiated comprehensive geological investigations.

Preliminary engineering studies related to the mining of Hat Creek coal for use in the generation of thermal power were conducted by B.C. Hydro between 1975 and 1977. For the next stage of investigations, B.C. Hydro invited proposals for preliminary engineering and final design for mining the No. 1 Deposit at Hat Creek to supply a 2000 MW generating station over a period of 35 years. The invitation together with terms of reference was dated 17 February 1977.

On 16 May 1977 the Cominco-Monenco Joint Venture (CMJV) was engaged for Phase I, Preliminary Engineering, and a Contract for Services was subsequently drawn up, signed, and executed.

1.2 TERMS OF REFERENCE

The complete details of services to be performed by CMJV for B.C. Hydro are described in the Contract for Services.

In general, the services comprise further preliminary engineering work within B.C. Hydro's Phase I of the mine portion of the project. Phase II or Final Design Work leading into construction is not included in the present contract.

The purpose of this Mining Feasibility Report is initially to assist Hydro in seeking project authorization. Also the scope description and cost estimates contained herein are intended to provide assistance for planning and control of the detailed design, mine development, and construction phases.

1.3 CONSULTANTS EMPLOYED

Cominco-Monenco Joint Venture acted as the prime mining consultant and, with B.C. Hydro's approval, utilized the following sub-consultants:

1. North American Mining Consultants Inc. (NAMCO); bucket wheel mining technology.

2. Simon-Carves of Canada Ltd.; coal beneficiation studies.

3. MBB Mechanical Services; specialized boiler fuel advice.

1.4 BASIC DATA PROVIDED BY B.C. HYDRO

1. A preliminary fuel specification, Issue (2), dated 13 April 1977.

2. Powell-Duffryn - National Coal Board Design Reports Nos. 2,8, and 9. (Preliminary mining feasibility and conceptual design studies, No. 1 deposit) dated March 1977.

3. Milestone schedule dates for the total Hat Creek Project, periodic revisions from March 14, 1977 to April 7, 1978 (Base Plan).

4. An initial geological interpretation of the coal deposit by Dolmage-Campbell & Associates, as well as results from all drilling programs up to and including the 1977 program.

5. The geotechnical interpretation of the coal deposit as given by B.C. Hydro and the geotechnical consultant, Golder Associates, up to and including the 1977 program.

6. 1976 Coal Washability Testwork. A report to BCH on the analysis and beneficiation of bulk samples A, B and C from Hat Creek, by Birtley Canada.

7. 1976 Pilot Scale Burn Test Results at Ottawa by CANMET Energy Research Labs.

8. 1977 Plant Scale Burn Test Results at Battle River, by B.C. Hydro.

9. Economic and Financial Criteria.

1.5 SITE DESCRIPTION

As shown on the general location plan which precedes the text of this report, the project area is roughly 240 kilometres northeast of Vancouver and 30 kilometres west of Cache Creek, British Columbia, on Highway 12.

Mine development is confined to the No. 1 Deposit, the shallowest and most northerly of two major deposits at the north end of the Hat Creek Valley. Elevation at this point is about 900 metres above sea level.

Coal would be delivered to a proposed 2000 MW generating station located some 4 kilometres east of and 500 metres higher in elevation than the minesite.

The project area is situated within the Hat Creek drainage basin. Medicine, Finney, Ambusten, and Houth Creeks generally drain northwards into Hat Creek, which also flows north and then east to the Bonaparte River, hence joining the Thompson River system. The water bodies of significance in the general project area are Aleece and Finney Lakes.

The Hat Creek Valley in the region of the minesite is considered to be semi-arid, having minimal topsoil cover and containing sparsely distributed grass and woodland vegetation. Annual mean precipitation is about 30 centimetres of which 14 centimetres falls as snow. Most of the precipitation occurs in the summer and winter months, while spring and fall are notably drier.

1.6 ACKNOWLEDGEMENTS

We wish to acknowledge the assistance and cooperation of Mr. J.J. Fitzpatrick, Manager, Mining Department, B.C. Hydro and members of his staff, some of whom worked directly on the Project team.

The close cooperation of other B.C. Hydro consultants, particularly Golder Associates, Dolmage-Campbell, and Integ-Ebasco, is also recognized and appreciated.

SECTION 2

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

Listed below are some of the major findings that have resulted from this feasibility study:

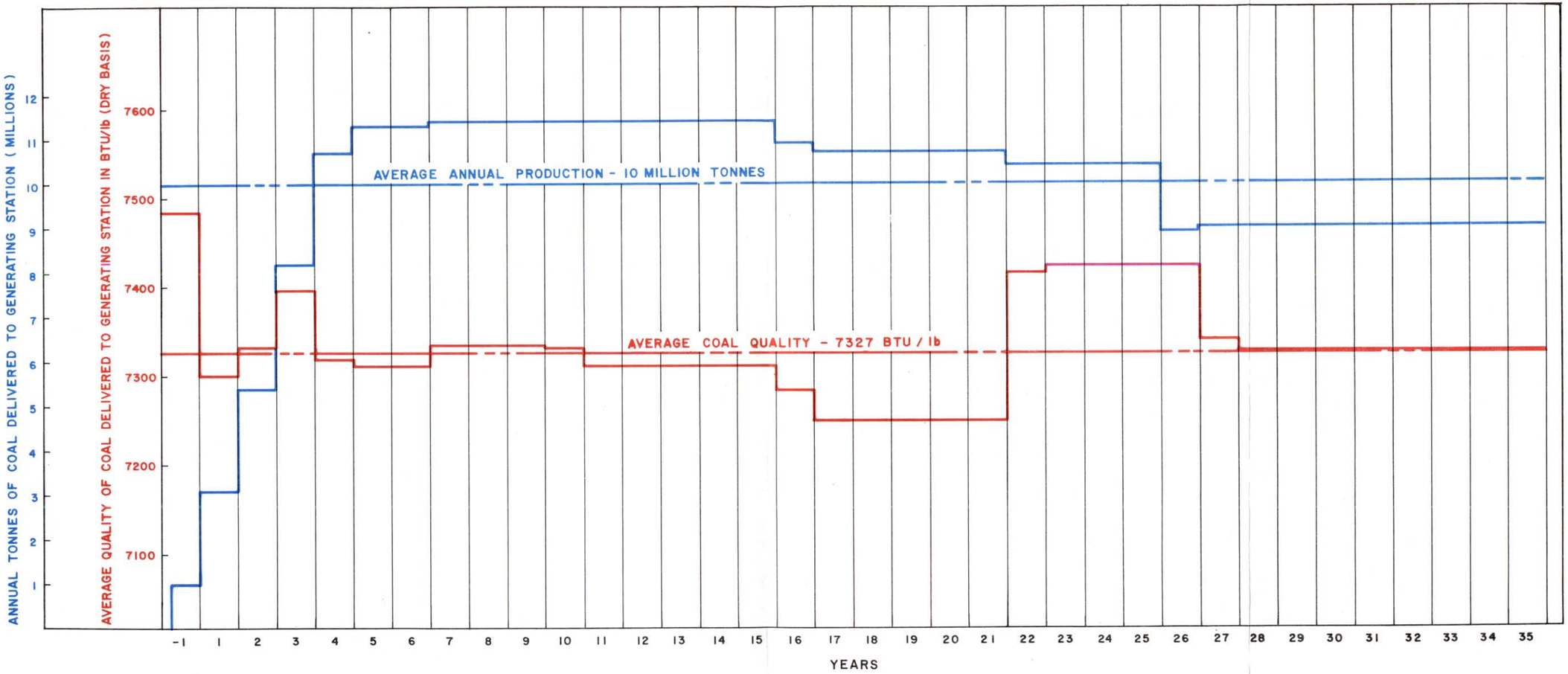
1. Although the deposit is geologically complex, comprising 12 identified subzones of coal of widely varying quality, plus two intervening major waste bands, it is indicated that No. 1 Deposit contains approximately twice as much coal as required for operation of a 2000 MW generating station for 35 years. Proven and probable geological reserves above a cut-off calorific value of 4000 Btu/lb (dry basis) in No. 1 Deposit are estimated to be in excess of 700 million tonnes of coal.

2. A mining plan considered technically feasible under present-day regulations and well suited to the Hat Creek conditions has been developed to deliver production rates and qualities shown in Table 2-1 following. A summary of calculated average quantities and qualities is as follows:

Total Coal Delivered	350 million tonnes
Average Quality Delivered	
Calorific Value	
- as delivered (25% moisture)	5495 Btu/lb (12.7 MJ/kg)
- dry basis	7327 Btu/lb (17.0 MJ/kg)
Ash Content (dry basis)	36.3%
Sulphur Content	0.48%
Total Moisture	25%
Total Waste Handled	452 million bank cubic metres (BCM) (900 million tonnes)
Average Strip Ratio	1.3 bank cubic metres per tonnes of coal

TABLE 2-1

SUMMARY OF COAL PRODUCTION & QUALITY



COAL – TONNES x 10^6	1·0	3·1	5·4	8·2	10·7	11·3	11·3	11·4	11·4	11·4	11·4	11·4	11·4	11·4	11·4	11·4	10·9	10·7	10·7	10·7	10·7	10·7	10·4	10·4	10·4	10·4	8·9	9·0	9·0	9·0	9·0	9·0	9·0	9·0	9·0	349·5 TOTAL
QUALITY – BTU/lb (DRY BASIS)	7484	7301	7333	7397	7319	7312	7312	7335	7335	7335	7331	7312	7312	7312	7312	7312	7284	7250	7250	7250	7250	7250	7417	7424	7424	7424	7424	7341	7328	7328	7328	7328	7328	7328	7328	7327 AVERAGE

3. In order to meet both the average and short-term fuel quality requirements of the generating station, the mine incorporates:

   (a) a mine development scheme which allows ready access to the better-quality, low-sulphur coals in the deposit for product blending requirements and assistance in plant atmospheric emission control;

   (b) a mining system utilizing proven and practical equipment, with maximum flexibility wherein a number of excavating units operate concurrently over several mining faces; and

   (c) a sophisticated coal blending and reclaiming facility.

4. Some investigation was given to selective removal of in-seam partings; however, the costs and potential benefits have not been included in the results of this study because the benefits, particularly in the early years, do not appear to be significant. Experience gained during actual operations however may indicate the desirability of further partings removal considerations.

5. For the following reasons, it was concluded that beneficiation of run-of-mine coal cannot be justified at this time:

   (a) beneficiation processes are expensive and relatively ineffective due to the very difficult washability characteristics of Hat Creek coals;

   (b) technical and operating problems, particularly in tailings disposal, would be substantial;

   (c) only minor sulphur improvement could be anticipated;

   (d) positive results were obtained from the 1977 plant-scale burn tests using raw coal; and

   (e) economic effects on the mine and the generating station strongly favour burning blended raw coal.

The possibility of upgrading low-grade coals (at or near the cut-off grade) as a resource conservation measure might be considered after operational experience is gained.

6. Provision is made to store approximately 16 million tonnes of low-grade coal with a calorific value of between 3000 to 4000 Btu/lb in such a manner and location as to allow future utilization.

7. The mine plan has incorporated the recommendations of B.C. Hydro's specialist geotechnical consultant in dealing with problems related to slope stability, groundwater, waste dump construction, etc.

   Pit slopes of between 16° and 25° have been adopted, in contrast to 16° used in previous studies. This has had considerable impact upon the overal project, reducing the strip ratio from 2.1 to 1.3, while requiring acceptance of the possibility of limited bench failures during operations.

8. A brief description of the recommended mining system is as follows:

   (a) The recommended mining system employs electric shovels and diesel-electric haulage trucks within the pit to excavate and move materials to a central conveyor ramp (see Figure 3-5 of Section 3 of this volume). At a distribution point near the northern rim of the pit, the coal is directed through a secondary crushing plant to a blending facility.

   (b) Provision is made for stockpiling and reclaiming low-sulphur, better-quality coal separately from average quality coals. All coal destined for the generating station is reclaimed by bucket wheel reclaimers and conveyed to the generating station.

   (c) Waste materials are initially conveyed to the Houth Meadows dump area, and are deposited by spreaders either into engineered retaining embankments or behind them into waste dumps, depending on material quality. After approxi-

mately Year 15 primary waste disposal is carried out at both the Houth Meadows and the Medicine Creek dumps.

(d) The major equipment employed for the recommended mining system comprises:

- seven 16.8 cubic metre electric shovels
- 27 coal and waste trucks of 109 and 136 tonnes capacity
- approximately 27 000 metres of conveyors with 1200-mm (48") wide belts
- two 40-metre boom, self-propelled waste spreaders
- two rail-mounted coal stackers
- two bridge-type bucket wheel reclaimers

The mining equipment complement is designed to accommodate the average generating station operating regime, including periods of up to five months wherein the generating station may be operating at a capacity of 85%. Short periods of 100% operating capacity can be accommodated by shifting emphasis between waste and coal.

(e) After 35 years the pit dimensions will be roughly 3 x 2.5 kilometres, and its depth will be about 250 metres below the average valley floor elevation.

9. Of the six alternative mining systems considered, a combined bucket wheel/shovel truck/conveyor scheme received considerable study. However, for the following reasons, this system was not selected to form the basis of this report:

(a) the total levelized costs of this scheme are estimated to be higher than those of the recommended shovel/truck/conveyor system, due to the effect of the heavy initial capital expenditures required for mining equipment to excavate large quantities of material in the early years;

(b) the system requires an early and significant commitment, and would be relatively inflexible to change should the coal quality and structure encountered be different than expected; and

(c) it appears difficult for the system to mine constant annual quantities of material and, at the same time, to meet the average fuel quality requirements of the generating station.

10. Extensive reclamation and environmental protection plans have been developed in accordance with Section 8 of the Coal Mines Regulation Act as at this date, and the present Pollution Control Objectives for the Mining, Mine-Milling and Smelting Industries of British Columbia (November 1973).

11. Capital and operating costs were estimated from first principles and in accordance with current standards of the mining industry in British Columbia. The cost data are summarized below.

Summary of Estimated Costs (Canadian $ October 1977)

A. Capital cost to full production in Year 4 ..... $ 258 million

Additional pre-production operating costs to the commencement of production in Year 1 ..... $ 78 million

Total Cost to Full Production ..... $ 336 million

B. Additional equipment purchases, including replacements during the project life ..... $ 251 million

C. Typical operating costs during full production are approximately $60 million per year and in the order of $5.50/tonne of coal delivered.

D. Peak annual manpower requirements (after Year 4) .....approximately 1000 persons

In order to assess the economic feasibility of the Hat Creek mine and make comparisons with other generating station fuels, it is desirable to examine the estimated capital and operating costs on a levelized basis over the project life.

Using the present CMJV estimates in 1977 dollars (which exclude BCH Corporate Overhead but include power costs) calculations were made at two discount rates to compute the present worth of estimated future costs.

	Levelized Cost of Coal	
Discount Rate	$/million Btu's	$ per tonne
6% *per annum	0.741	8.96
10%	0.867	10.50

*Considered to be a reasonable estimate of the "inflation-free" cost of capital to electric utilities in Canada.

In both cases the estimated life time cost for Hat Creek coal per unit of heat on a levelized basis is significantly lower than the costs of alternate fuels.

12. Recommendations for Further Work

Some areas requiring consideration prior to or during Phase II, Final Design Work, are as follows:

(a) further study of mine slope depressurization as recommended by the geotechnical consultant;

(b) some broad geological fill-in drilling at roughly 150-metre spacing to complete the quality definition and to test specific structural interpretations;

(c) closer spaced drilling in the area where the initial mining operation will begin to better define coal quality and structure for detailed mine planning;

(d) if any further bulk samples are contemplated for any reason, such as burn tests, fluid-bed combustion pilot programs, etc., careful consideration should be given to locating such samples so as to provide the maximum geological information including the exposure of coal/waste contact zones to better study their continuity;

(e) crushing tests on some of the coals containing a high clay content; and

(f) various soils, vegetation, and air-borne dust studies related to reclamation and environmental protection need further consideration

SECTION 3

DESCRIPTION OF THE PROJECT

3.1 GEOLOGY AND COAL QUALITY

311 INTRODUCTION

The geological interpretations and coal reserve estimates made during the course of this study were generally based on the following available data which were considered adequate for the purposes of this report:

(a) diamond drill holes at roughly 150-metre spacing, most of which were drilled during programs in 1974, 1976, and 1977. To date, 207 holes have been drilled, totalling approximately 54 000 metres. Inclusion of sample data from the 1977/78 drilling program was not originally envisaged due to the time constraints of the study; however, because of the significant amount of information that became available, it was decided at the end of 1977 to incorporate these drilling results;

(b) 1976 auger samples for washability testing and pilot scale burn tests;

(c) 1977 bulk trench samples for plant scale burn tests, as well as further washability and bulk wash test programs; and

(d) geophysical surveys including down-the-hole electrologs which have been recorded for more than 90% of the holes since 1973.

Figure 3-1 shows the location of all No. 1 Deposit drilling and trenching done to date relative to the planned open pit mine.

312 GEOLOGICAL SETTING

The Hat Creek No. 1 Deposit consists of a thick, complex series of alternating coal and sedimentary rockbeds located in a topographic and structural depression in the Upper Hat Creek Valley. Coal measures and intercalated sediments were deposited in a basin formed by faulting.

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35 YEAR PIT OUTLINE

DRY LAKE

CLAY CUT

HAT CREEK

A

B

N°1

N°2

7

8

LEGEND

- VERTICAL DRILL HOLE
- 10 DRILL HOLE NUMBER
- INCLINED HOLE SHOWING DIRECTION OF DRILLING
- ADIT
- TRENCH
- CREEK
- BAH-1 BUCKET AUGER HOLE Nº 1
- RH 75-4 ROTARY HOLE Nº 75-4

100m 0 200m 400m

FIGURE 3-1

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
HAT CREEK PROJECT
MINING FEASIBILITY REPORT

DRILLHOLE LOCATION PLAN

The upper portion of the coal deposit contains a higher proportion of alternating layers of coal and clastic debris than does the lower portion which is somewhat cleaner and contains fewer partings.

From near surface in the northeast corner and plunging southward, No. 1 Deposit extends over a strike length of about 2000 metres with a maximum width of about 1500 metres. The maximum aggregate thickness is in the order of 450 metres, under a cover of overburden and waste ranging in thickness from 0 to 150 metres within the proposed pit area.

A typical geological cross-section looking north is shown on Figure 3-2.

313 STRATIGRAPHY OF THE HAT CREEK COAL FORMATION

Figure 3-2 also shows the initially interpreted broad coal zones A, B, C, and D as well as the 14 sub-zones subsequently established for coal quality and mine planning purposes.

The four major coal zones and two predominantly waste sub-zones (A-2 and C-1) are readily identified by their distinctive electrolog profiles as well as the varied lithology noted in the drill core itself. Brief lithological descriptions of the coal zones are as follows:

A-Zone consists of up to 170 metres of coal seams and interbedded claystone and carbonaceous mudstone, with minor siltstone and sandstone. The interbedded partings form up to 25% of the total sections in beds varying in thickness from a few centimetres to 6 metres.

B-Zone contains about 75 metres of better-quality coal with generally minor claystone or siltstone partings; towards the western and southwestern flanks of the main syncline however, there is an obvious gradational increase in the number and thickness of claystone interbeds. Bulk sample Trench A (see Figure 3-1) is located in this western fringe area where the coal is of below average quality.

C-Zone consists of lenticular coal seams of variable thickness, interbedded with lenses and wedges of siltstone to coarse sandstone, grit, and pebble conglomerate. C-2 sub-zone shows

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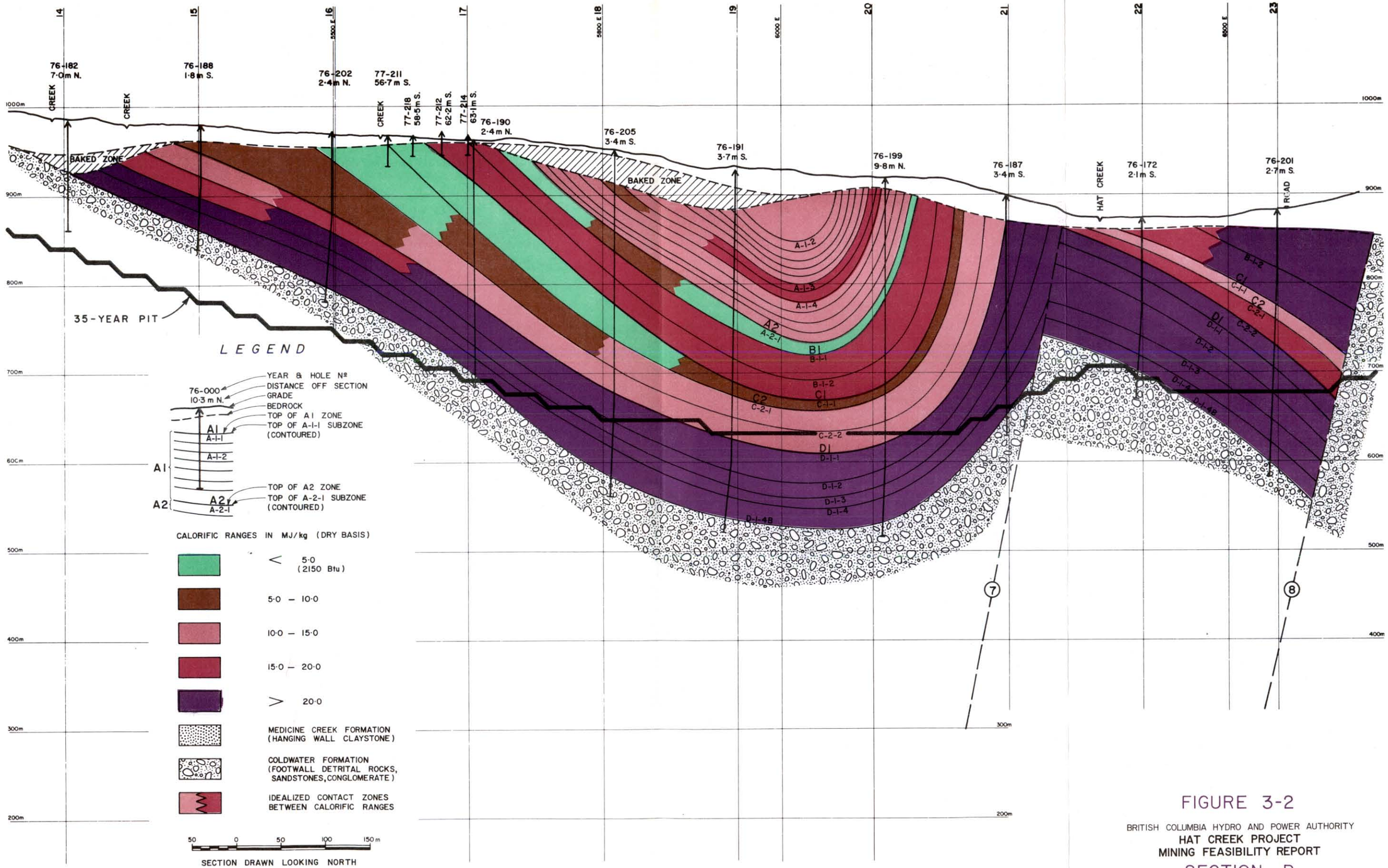

FIGURE 3-2

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT

MINING FEASIBILITY REPORT

SECTION P

evidence of an obvious western shale-out fringe, with pronounced thickening of detrital rock units and corresponding thinning of the coal sequences.

D-Zone contains the most consistent better-quality coal of the entire deposit, with a calorific value usually in excess of 8000 Btu/lb. The coal varies from 60 metres to slightly over 100 metres in thickness, containing virtually no partings, with a gradual westward thinning evident in the western limb of the main syncline.

314 COAL RESERVES

All reserve data have been derived from a computer model, the development of which is described in Volume II of this report. Coal quality interpolations have been calculated on the basis of a modified inverse distance squared procedure.

314.1 Geological Reserves

Geological reserves have been divided into categories of proven, probable, and marginal as defined below.

Proven Reserves are those contained within the proposed 35-year pit that have a calorific value in excess of 4000 Btu/lb (dry basis).

Probable Reserves are those contained in No. 1 Deposit beyond the 35-year pit limits, and whose quality exceeds the cut-off grade. These reserves are as well-defined geologically as the proven reserves but there is no definitive mining plan for their extraction.

Marginal Reserves comprise the estimated quantities of low-grade coal with calorific values between 3000 and 4000 Btu/lb which lie within the same boundaries as the proven and probable reserves.

Table 3-1 summarizes the in situ proven and probable reserves, totalling 717 million tonnes above the 4000 Btu/lb cut-off grade. These reserves are considered to be well-defined for blocks of coal greater than 20 million tonnes but are subject to errors of geological correlation in smaller tonnages.

TABLE 3-1

Summary of Estimated Proven and
Probable Coal Reserves in No. 1 Deposit

Hat Creek Project Mining Feasibility Report 1978

	Tonnes* ($\times 10^6$)	% of Total	Calorific Value (Btu/lb)	Ash Content (%)	Sulphur Content (%)
PROVEN RESERVES (35-year pit reserves cutoff >4000 Btu/lb, undiluted, dry basis)					
Zone A-1)	77.5	22.5	5613	47.8	0.72
A-2)				-	-
B-1	57.2	16.6	7373	35.6	0.68
C-1)	60.4	17.6	6061	44.4	0.44
C-2)					
D-1	149.1	43.3	9147	24.5	0.31
Total.....	344.2				
Weighted Average			7515	35.1	0.49
PROBABLE RESERVES (beyond 35-year pit, calorific value cutoff >4000 Btu/lb, undiluted, dry basis)					
Zone A	139.5	37.4	5227	50.0	0.69
B	66.8	17.9	6310	43.6	0.72
C	31.6	8.5	5157	51.1	0.43
D	134.9	36.2	8627	27.9	0.30
Total	372.8				
Weighted Average			6645	40.9	0.53
TOTAL PROVEN + PROBABLE RESERVES (calorific value cutoff >4000 Btu/lb, undiluted, dry basis)					
Zone A	217	30.3	5365	49.2	0.70
B	124	17.3	6800	39.9	0.70
C	92	12.8	5750	46.7	0.42
D	284	39.6	8900	26.1	0.31
Total	717				
Weighted Average			7060	38.0	0.51

* Specific gravities used to compute tonnages reflect in situ moisture. The average in situ moisture is 25% for the total in place reserves.

Corresponding marginal reserves are estimated to be 83 million tonnes between 3000 and 4000 Btu/lb, 16 million tonnes of which are contained within the proposed 35-year pit.

314.2 Reserve Estimating Parameters

In Situ Moisture - an in situ moisture content of 25% was estimated.

Specific Gravity - a regression equation relating specific gravity of coal to ash content was developed as follows:

$$\text{Specific gravity of coal (tonnes per } m^3) = 1.1704 + (.009577 \times \% \text{ ash, dry basis})$$

Cut-Off Grades

Coal	>4000 Btu/lb (9.3 MJ/kg)
Low-Grade Coal	3000 to 4000 Btu/lb (7.0 to 9.3 MJ/kg)
Waste	<3000 Btu/lb (7.0 MJ/kg)

Dilution and Mining Losses

Dilution	2.5% by weight of material having no heat value
Mining Losses (mining and handling)..	1% of mined tonnage

Partings - all coal and waste partings in each sub-zone are included in the coal reserve calculations, selective mining of partings having been studied and the results reported elsewhere in this report.

314.3 Mineable Reserves

In applying the above criteria to the proposed 35-year pit, the estimated mineable reserves by zone are as follows:

Coal Zone	Tonnes x 10^6	% of Total	Calorific Value (Btu/lb Dry)	Ash (%)	Sulphur (%)
A-1	78.61	22.5	5473	49.3	0.70
B-1	58.09	16.6	7188	37.0	0.66
C-1	9.32	2.7	5390	46.8	0.48
C-2	51.99	14.9	6002	44.2	0.41
D-1	151.48	43.3	8918	26.1	0.31
Total	349.49	100.0			
Average			7327	36.3	0.48

Corresponding waste and low-grade coal quantities are 443 million bank cubic metres and 9 million bank cubic metres (16 million tonnes), respectively.

The average strip ratio for the 35-year mine is 1.3 bank cubic metres of waste and low-grade coal per tonne of coal delivered.

314.4 Verification of Coal Reserve Calculations

Independent manual checks of computer produced data were performed, and tonnages and grade differences were found to be within acceptable limits.

A study of classical statistics indicated that the true average calorific values for the various zones will fall within the following ranges:

A Zone ..... ±300 Btu

B and C zones ..... ±600 Btu

D Zone ..... ±200 Btu

Regional coal quality trending has been recognized and incorporated in the computer model by the method chosen to interpolate the data between drill holes. Thus, the actual deviations are expected to be less than those noted above in those zones displaying pronounced trends.

315 PROPOSED BOILER FUEL SPECIFICATIONS

Initially, the preliminary draft specifications prepared by B.C. Hydro in April 1977 and based essentially on analytical data from two special test holes 135 and 136 were used for planning purposes. After evaluating the following:

(a) preliminary run-of-mine coal quality data,

(b) the effects on the generating station of burning raw coal; and

(c) the costs and benefits of coal beneficiation,

it was jointly concluded by B.C. Hydro, CMJV, and Hydro's powerplant consultants that as a basis for this study, boiler fuel should consist of a blended raw coal product (reference March 3, 1978 meeting).

The boiler fuel specification was then finalized utilizing all the drill hole analytical data stored in the B.C. Hydro computer, together with the CMJV mine plans and production schedule. A summary of the proposed specifications is provided on Table 3-2.

TABLE 3-2

Summary of Proposed Fuel Specifications
for Performance Blend

Hat Creek Project Mining Feasibility Report 1978

Property		Value	Deviation
COAL QUALITY (dry Basis)			
Calorific Value	- dry basis	7327 Btu/lb	±300
	- as delivered	5495 Btu/lb	±225
Fixed Carbon		31.4 %	±4.2
Ash		36.3 %	±1.8
Volatile Matter		32.2 %	±4.17
Sulphur	- pyritic	0.13%	
	- sulphate	0.01%	
	- organic	0.34%	
	Total	0.48%	±0.25
Nitrogen		0.89%	±0.15
Chlorine		0.03%	±0.02
Moisture	(as delivered)	25.0 %	±10
Hardgrove Grindability Index		50	±10
COAL SIZE (as delivered)		50 mm x 0	
ASH CHARACTERISTICS			
Fusibility	- Initial Deformation Temperature	1300°C	±200
Titania (TiO_2)		0.92%	±0.26
Iron Oxide (Fe_2O_3)		7.62%	±4.97
Potassium (K_2O)		0.52%	±0.21
Sodium (Na_2O)		1.18%	±0.51

3.2 MINE PLANNING

321 GENERAL APPROACH

321.1 Objective

The objective of the mine planning portion of the Phase I engineering studies was to develop an optimum mine plan to:

(a) provide a reliable source of fuel over the projected 35-year life of the 2000 MW generating station;

(b) deliver a consistent fuel quality at least cost to the total thermal/mine project over the 35-year life;

(c) efficiently utilize the coal resource with particular regard to coal conservation and future development;

(d) utilize a mining system that is proven and dependable; and

(e) place special emphasis on the safety of men and equipment with particular regard to stability of mine wall slopes and waste dumps.

Mine planning is optimized to the extent that detailed engineering can proceed immediately upon project commitment on the basis of the recommended system.

321.2 Alternatives Considered

To meet the objectives a number of alternative methods of mine development, equipment combinations, and coal quality assessment were evaluated prior to selection of a recommended scheme. In particular, the following aspects were investigated:

(a) varying pit configurations in order to select the optimum mining depth and development sequence;

(b) two alternative exits from the pit - north and south;

(c) six alternative equipment systems comprising:

- shovel/truck
- shovel/truck/conveyor
- shovel/conveyor
- bucket wheel excavator/conveyor
- continuous excavator/truck and/or conveyor
- dragline/truck and/or conveyor;

(d) removal of differing quantities of partings and resultant effects on quality of delivered coal;

(e) selection of cut-off quality grades; and

(f) alternative coal beneficiation systems.

321.3 Planning Approach

A discussion of the mine design factors, including geological and geotechnical considerations, generating station requirements, partings removal, computer applications, etc., is presented in Volume III.

The steps that led to the recommended mine plan and mining system are listed below:

1. Geological and coal quality data were reviewed and incorporated into a computer data bank.

2. Computer outputs were used to prepare bench plans.

3. Manual pit designs were developed using different mine development approaches, but observing geotechnical constraints in all cases.

4. Resultant quantity and quality data for each design were produced from the computer model.

5. In parallel with mine development planning, layouts were prepared for the alternative mining equipment schemes.

6. Six schemes were first reduced to three on the basis of general practical and economic considerations, and then to two following more detailed investigations.

7. The recommended shovel/truck/conveyor scheme was chosen over the combined bucket wheel/shovel/truck/ conveyor system after considerably more economic and technical study.

8. Waste dump layouts, and conveying and spreading arrangements were developed.

9. Production schedules were finalized.

In the approach adopted (refer to the overall project layout on Figure 3-3), development begins in the northeast corner of the pit, proceeding downwards fairly rapidly to uncover adequate quantities of better-quality coal for blending to an average grade. Sufficient lateral development is planned to sustain both average annual quality and average total materials handled. The proposed plan defers mining in the active slide area as long as possible, in order that experience in handling these materials, slope behaviour, etc., may be gained. In addition, three major road access locations have been planned for flexibility and safety reasons.

The northern conveyor exit location offers the distinct advantages of:

(a) access to better-quality, low-sulphur D-Zone coal close to the surface;

(b) competent footwall rocks for conveyor and truck unloading station foundations;

(c) located closer to the generating station and permanent blending and service facility sites; and

(d) clear of future mine expansion which would follow the coal to the south.

The presently proposed pit bottoms-out at 632 metres ASL. In order to assess the implications of pit expansion for the location of surface facilities, waste dumps, drainage facilities, etc., some preliminary planning was done on an "expanded pit" to elevation 450 metres ASL. Such a pit, with its perimeter as shown on Figure 3-3, would mine over 90% of No. 1 Deposit reserves.

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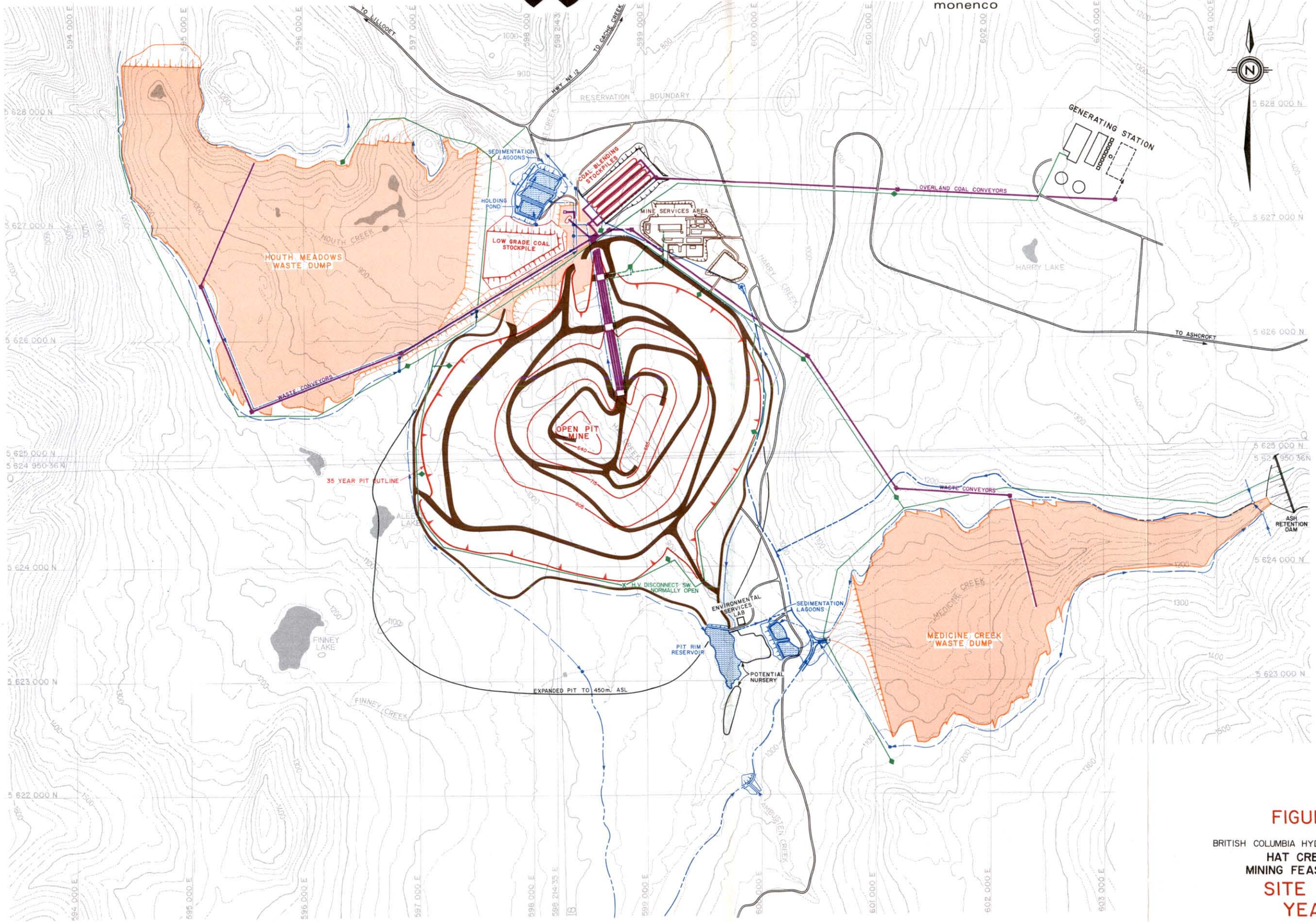
monenco



LEGEND

- HAUL ROAD
- SERVICE ROAD
- PUBLIC ROAD
- WASTE DUMP AREA
- CONVEYOR
- POWER SYSTEM
- DRAINAGE SYSTEM

0.1 0 0.5 1.0 km

FIGURE 3-3

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT

MINING FEASIBILITY REPORT

SITE LAYOUT
YEAR 35

322 MINING OPERATIONS

Figure 3-3 shows the overall project layout based on the recommended truck-shovel mining scheme, while Figure 3-4 provides a schematic flowsheet of the mining operation. The following sections describe the major features of the recommended scheme.

322.1 Pre-Production Development

Following certain prerequisite activities such as diversion of Hat Creek, drainage of small ponds on the west slope, and clearing of timber from a portion of the site, mining-related activities can be initiated as follows:

(a) Close-Spaced Drilling
To better define coal structure and quality for detailed mine planning in the early years, a program of close-spaced holes in the vicinity of the mine opening is recommended.

(b) Dewatering Wells
Provision has been made to drill and operate a number of perimeter wells during pre-production, the location and extent of the program to be confirmed by ongoing geotechnical programs.*

(c) Topsoil Removal
An estimated 250 000 cubic metres of topsoil is to be removed and stockpiled for use in future reclamation work.

(d) Bench Development
Initial scraper work would involve removal of about 2 million cubic metres of overburden, followed by shovel/truck activity in Year -2 as production units are received and erected. A total of 21 million cubic metres of waste and low-grade coal is planned to be removed prior to the start of production.

(e) Truck Unloading Stations
The first of three in-pit receiving stations located over the exit-conveyor ramp should be

* Golder Associates 1978 Report to B.C. Hydro.

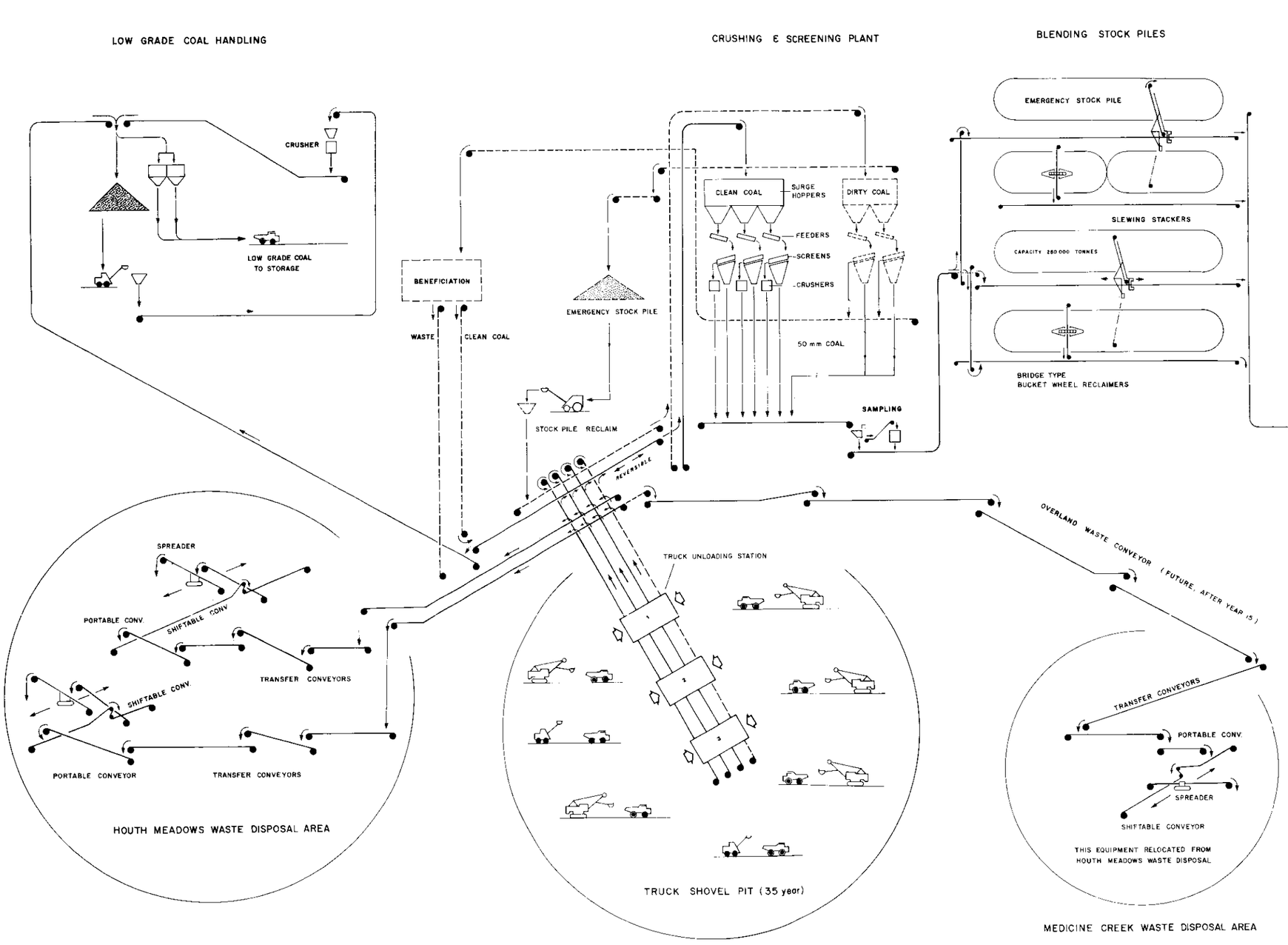


FIGURE 3-4

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
HAT CREEK PROJECT
MINING FEASIBILITY REPORT

SYSTEM FLOW SHEET

established as part of pre-production.

(f) Dump Preparation
Approximately 1.5 million cubic metres of construction grade material will be trucked to the Houth Meadows dump area for embankments and ground preparation and 7 million cubic metres will be trucked into the causeway forming the conveyor access across the Hat Creek Valley.

322.2 Mining and In-Pit Haulage and Conveying

After the pre-production period, coal and waste will be excavated primarily by 16.8-cubic metre electric shovels loading into 109-tonne coal trucks and 136-tonne waste trucks of end-dump configuration. A fleet of 7 shovels, 18 waste trucks, and 9 coal trucks is envisaged to move the required peak annual materials quantities of approximately 24 million bank cubic metres. The shovel fleet will be supported by 11.5-cubic metre front-end loaders. Topsoil and minor amounts of construction materials will be excavated and handled by scrapers, front-end loaders, and smaller trucks.

Each shovel is expected to move around within a domain encompassing four 15-metre benches. This provides a great deal of flexibility within the total mining operation, particularly with respect to grade control.

It is anticipated that advance drilling and blasting of most materials will not be required. However, a certain amount of hardpan and baked zone materials have been identified, and digging conditions for D-Zone coal are expected to be more difficult; thus provision is made for light blasting of approximately 136 million cubic metres of material, i.e., about 50% of the coal and 10% of the waste.

After the pre-production period, trucks will haul all materials to unloading stations over a mine conveyor system at the north edge of the pit. Allowances have been made for a significant amount of in-pit road construction and maintenance due to the weak foundation conditions indicated by the geotechnical studies.

The truck unloading stations are located so as to minimize haul distances on adverse grades. Three stations are planned as the mine deepens, to be constructed in Years -1, 5, and 20 at elevations 895, 820, and 730 metres ASL, respectively. Each station consists of three dump hoppers, each feeding a primary crusher which sizes material to -300 mm; the crushed material then passes onto a 1200-mm wide exiting conveyor. Low-profile, Krupp-Siebre roller screen lumpbreakers have been chosen for this study but, due to the high clay content anticipated, further investigation of sizing methods is recommended in the final design stage.

Each of the three conveyors is designed to handle about 3000 loose cubic metres of material per hour, equivalent to 3200 tonnes per hour of coal or 5000 tonnes per hour of waste. Estimated overall utilization is planned at less than 50% in order to accommodate the scheduling of different materials taken out of the pit. At the pit rim, material is discharged from the three conveyors at a distribution point, from where materials are redirected onto one of three overland conveyors, two of which will be used for wastes, and one for a combination of coal and low-grade coal.

322.3 Coal Handling

Coal is conveyed to the crushing and sampling plant on a 1200-mm wide belt with a carrying capacity of 3200 tonnes per hour. Secondary crushing to -50 mm is accomplished by three impact-type crushers; however, further testing is required to confirm the applicability of this type of equipment.

Automatic sampling is planned both before and after blending in order to verify the quality of coal delivered to the generating station. Provision is made for instantaneous ash analysis to assist in dispatching coal to the proper location within the blending facility.

322.4 Coal Blending and Delivery

Simulation studies were undertaken to estimate the short-term quality variations that would likely result from normal mining sequences and that would require evening-out prior to shipment to the generating station.

It was determined that, in addition to careful advance planning of the mining sequences and in-pit grade control, a blended stockpile of about 100 to 200 layers with a capacity of one week's plant feed should be provided. This would limit hourly variations in generating station feed to ±150 Btu/lb. For occasions when the quality of coal from the mine might fall below the average minimum target of 7000 Btu/lb, and to assist the sulphur emission regime of the generating station, it is recommended that separate stocking of better-quality, low-sulphur D-Zone coal be undertaken.

Thus, the blending facility provides for two 280 000-tonne average-quality piles, one being built while the other is reclaimed, plus two 135 000-tonne D-Zone piles. Space for a fifth blending pile is provided for emergency or overflow purposes.

Blending is accomplished by layering the coal in windrows with either of two rail-mounted slewing and luffing stackers. It is within the design capabilities of each machine to deposit up to 200 layers at a rate of 3200 tonnes per hour. The possibility of spontaneous combustion has been considered and, while normal operation envisages short-term coal storage, provision is made for turning over or compacting potentially dangerous piles.

Coal is normally reclaimed by either of the two bridge-type bucket wheel reclaimers onto the main overland conveyor which runs to the generating station. However, if circumstances require an "average" pile to be upgraded by the addition of D-Zone coal, both reclaimers would operate simultaneously. Reclaiming capacity is at 2500 tonnes per hour to match peak generating station demands.

The 1200-mm wide main conveyor to the generating station rises 500 metres in elevation and has a total length of 4000 metres over two flights. It is estimated that 8000 H.P. of driving capacity is required. A hinged dust cover is provided for most of the distance and estimates allow for a certain amount of total gallery enclosure near the top where snowdrifting may be a problem. Fire protection is provided by means of a buried water main servicing hydrants at regular intervals. Drive houses will be sprinkler-protected.

322.5 Waste Handling

Two 1200-mm wide waste conveyors, each with a design capacity of 5000 tonnes per hour are destined for the Houth Meadows area. An

extensive causeway (45 m high x 900 m long) will form part of the conveyor routing across the Hat Creek valley, utilizing about 7 million cubic metres of material excavated during pre-production stripping prior to conveyor construction.

One conveyor system, including shiftable extensions, a tripper, and a 40-metre boom spreader, will handle construction grade materials to be deposited into the retaining embankment at the dump. The second identical waste conveyor system will discharge weaker waste rock materials behind the engineered embankment in a predetermined sequence of 35-metre lifts. It is improbable that these materials will support heavy truck traffic; thus operation of the recommended conveyor/spreader system is very critical to the ultimate success of the entire mine.

After approximately Year 15 one of the waste conveyor systems is expected to be relocated to the Medicine Creek dump area for similar service.

322.6 Low-Grade Coal

Although it is expected that all of the low-grade coal extracted during the project life can be accommodated at the Houth Meadows site, the alternative routing to an area near Medicine Creek is available in later years.

Provision for crushing of the low-grade coal to -50 mm has been made, as well as for trucking from the conveyor discharge and compaction to prevent spontaneous combustion. Periodic reclamation is planned, should this material not be utilized within a relatively short time.

The true economics of this exercise relative to burning, wasting or beneficiating, can only be assessed after some operational experience has been gained.

322.7 General

A substantial organization of engineering, geological and exploration, geotechnical, and supervisory staff will be required to effectively operate the Hat Creek mine. Extensive equipment and labour resources will be devoted to such activities as road maintenance, pit clean-up, dewatering, dust control, power line extensions, etc. The major support facilities to be constructed are

described in the following section, while manpower schedules and major equipment listings are provided in Section 4 of this volume.

323 PRODUCTION SCHEDULE

A schedule of annual production rates and qualities is shown on Table 3-3. The minor annual variations in total quantities of material to be moved as well as coal quality over the project life are indicative that the recommended mine plan and equipment selections are a good choice for the particular conditions at Hat Creek.

ANNUAL PRODUCTION STATISTICS

MATERIALS MINED QUANTITIES IN MILLIONS (10^6)	PRE-PRODUCTION YEARS				PRODUCTION YEARS																																	TOTAL
	-4	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	
COAL DELIVERED TO GENERATING STATION (tonnes)				1·03	3·08	5·43	8·20	10·66	11·30	11·32	11·36	11·36	11·36	11·36	11·40	11·40	11·40	11·40	11·40	10·92	10·68	10·68	10·68	10·68	10·68	10·41	10·41	10·41	10·41	8·89	9·02	9·02	9·02	9·02	9·02	9·02	9·02	9·02	9·02	349·49
COAL																																							
Fuel above cut-off (bank cubic metres)				0·70	2·07	3·64	5·50	7·14	7·57	7·59	7·62	7·62	7·62	7·62	7·65	7·65	7·65	7·65	7·65	7·31	7·15	7·15	7·15	7·15	7·15	6·97	6·97	6·97	6·97	5·97	6·06	6·06	6·05	6·05	6·05	6·05	6·05	6·05	6·05	234·32
Low grade coal (bank cubic metres)				0·01	0·12	0·14	0·13	0·45	0·65	0·49	0·15	0·15	0·15	0·20	0·42	0·42	0·41	0·41	0·41	0·25	0·09	0·09	0·09	0·09	0·09	0·20	0·22	0·22	0·22	0·22	0·27	0·27	0·27	0·27	0·27	0·28	0·28	0·28	0·28	8·96
Sub-total coal (bank cubic metres)				0·71	2·19	3·78	5·63	7·59	8·22	8·08	7·77	7·77	7·77	7·82	8·07	8·07	8·06	8·06	8·06	7·56	7·24	7·24	7·24	7·24	7·24	7·17	7·19	7·19	7·19	6·19	6·33	6·33	6·32	6·32	6·32	6·33	6·33	6·33	6·33	243·28
WASTE																																							
Waste above bedrock (bank cubic metres)		2·05	6·55	11·45	12·59	12·93	10·88	10·02	9·10	9·60	10·57	10·57	10·57	9·74	7·97	7·97	7·97	7·97	7·97	9·14	10·32	10·32	10·32	10·31	10·31	9·98	8·88	8·88	8·88	7·98	1·50	1·07	1·07	1·07	1·07	1·07	1·07	1·07	1·07	281·85
Bedrock waste (bank cubic metres)				0·30	0·70	0·63	0·94	1·41	2·76	2·66	2·40	2·40	2·40	2·77	4·27	4·27	4·27	4·27	4·27	5·52	6·72	6·72	6·71	6·71	6·71	7·55	7·87	7·87	7·87	7·87	5·06	4·66	4·67	4·67	4·66	4·65	4·65	4·65	4·64	161·15
Sub-total waste (bank cubic metres)		2·05	6·55	11·75	13·29	13·56	11·82	11·43	11·86	12·26	12·97	12·97	12·97	12·51	12·24	12·24	12·24	12·24	12·24	14·66	17·04	17·04	17·03	17·02	17·02	17·53	16·75	16·75	16·75	15·85	6·56	5·73	5·74	5·74	5·73	5·72	5·72	5·72	5·71	443·00
TOTAL MATERIALS MINED (bank cubic metres)		2·05	6·55	12·46	15·48	17·34	17·45	19·02	20·08	20·34	20·74	20·74	20·74	20·33	20·31	20·31	20·30	20·30	20·30	22·22	24·28	24·28	24·27	24·26	24·26	24·70	23·94	23·94	23·94	22·04	12·89	12·06	12·06	12·06	12·05	12·05	12·05	12·04	686·28
STRIP RATIO (bank cubic metres waste plus low grade coal per tonne of coal delivered)				11·4	4·3	2·5	1·4	1·1	1·0	1·1	1·1	1·1	1·1	1·1	1·1	1·1	1·1	1·1	1·1	1·3	1·6	1·6	1·6	1·6	1·6	1·7	1·6	1·6	1·6	1·8	0·7	0·2	0·2	0·2	0·2	0·2	0·2	0·2	0·2	1·3

FUEL QUALITY																																							AVERAGE
COAL DELIVERED TO GENERATING STATION																																							
Btu / lb (dry basis)				7484	7301	7333	7397	7319	7312	7312	7335	7335	7335	7331	7312	7312	7312	7312	7312	7284	7250	7250	7250	7250	7250	7417	7424	7424	7424	7424	7341	7328	7328	7328	7328	7328	7328	7328	7328	7327
MJ / kg (dry basis)				17·4	17·0	17·1	17·2	17·0	17·0	17·0	17·1	17·1	17·1	17·1	17·0	17·0	17·0	17·0	17·0	16·9	16·9	16·9	16·9	16·9	16·9	17·3	17·3	17·3	17·3	17·3	17·1	17·0	17·0	17·0	17·0	17·0	17·0	17·0	17·0	17·0
Ash content (%) (dry basis)				35·2	36·5	36·3	35·8	36·4	36·4	36·4	36·3	36·3	36·3	36·3	36·4	36·4	36·4	36·4	36·4	36·6	36·9	36·9	36·9	36·9	36·9	35·7	35·7	35·7	35·7	35·7	36·2	36·3	36·3	36·3	36·3	36·3	36·3	36·3	36·3	36·3
Sulphur content (%) (dry basis)				0·53	0·58	0·51	0·50	0·47	0·53	0·52	0·50	0·50	0·50	0·49	0·47	0·47	0·47	0·47	0·47	0·49	0·51	0·51	0·51	0·51	0·51	0·46	0·46	0·46	0·46	0·46	0·43	0·42	0·42	0·42	0·42	0·42	0·42	0·42	0·42	0·48
Sulphur (lb / million btu's)				0·70	0·79	0·69	0·67	0·64	0·72	0·71	0·68	0·68	0·68	0·67	0·64	0·64	0·64	0·64	0·64	0·67	0·71	0·71	0·71	0·71	0·71	0·62	0·62	0·62	0·62	0·62	0·58	0·57	0·57	0·57	0·57	0·57	0·57	0·57	0·57	0·65
HEAT UNITS DELIVERED																																							TOTAL
Btu x 10^{13}				1·3	3·7	6·6	10·0	12·9	13·7	13·7	13·8	13·8	13·8	13·8	13·8	13·8	13·9	13·8	13·8	13·2	12·8	12·8	12·8	12·8	12·8	12·8	12·8	12·8	12·8	10·9	10·9	10·9	10·9	10·9	10·9	10·9	10·9	10·9	10·9	423·43
MJ x 10^{10}				1·3	3·9	6·9	10·6	13·6	14·4	14·4	14·5	14·5	14·5	14·5	14·5	14·5	14·5	14·5	14·5	13·9	13·5	13·5	13·5	13·5	13·5	13·5	13·5	13·5	13·5	11·5	11·5	11·5	11·5	11·5	11·5	11·5	11·5	11·5	11·5	446·72
(based on 25% delivered moisture and coal cut-off at 4000 btu / lb or 9·3 MJ / kg)																																							

3.3 MINE SUPPORT FACILITIES

331 INTRODUCTION

The facilities required in support of the Hat Creek mine include an administration building, maintenance, emergency and service facilities, mine area drainage provisions, and utilities supply and distribution. The proposed layout of these facilities is shown on Figure 3-5.

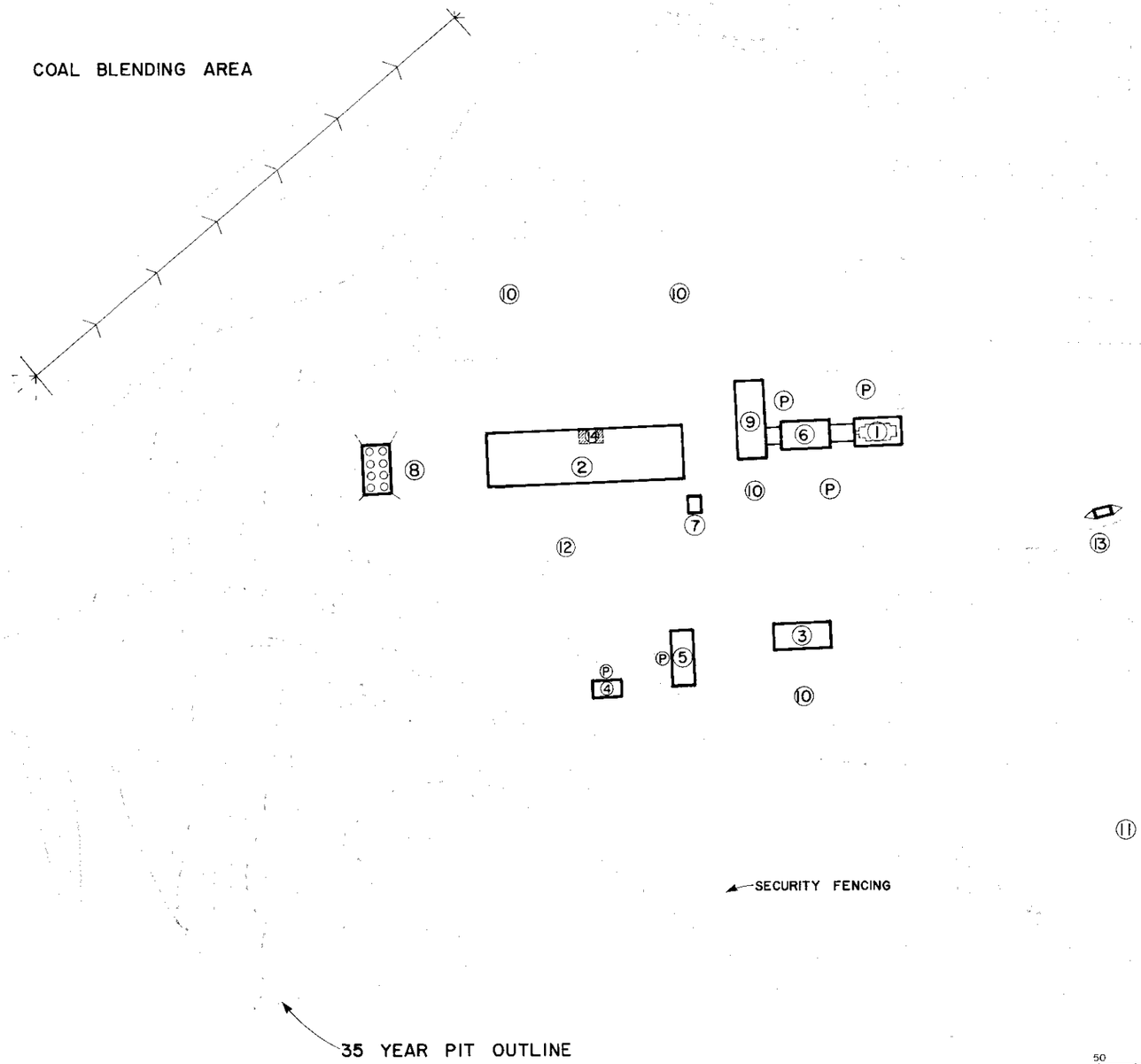
In all cases, consideration has been given to functionality, safety, fire protection, and provision for expansion. A brief description of the facilities and their purpose is provided below.

332 BUILDINGS AND STORAGE FACILITIES

Administration Building - a two-storey building to house staff in administration, accounting, data processing, personnel, purchasing, geology, and mine planning.

Maintenance Complex - a large structure which will contain the following facilities:

- equipment maintenance ..... 7 truck repair bays
  4 tractor repair bays
  8 light vehicle bays
  2 cleaning bays
- shops ..... welding and fabrication
  machine
  electrical
  radio and instrument repair
  hydraulic component repair
- warehouse and tool crib
- supervisory and planning offices
- emergency services ..... fire truck
  ambulance
  first aid



LEGEND

1. ADMINISTRATION BUILDING
2. MAINTENANCE COMPLEX & WAREHOUSE
3. MINE SERVICES BUILDING
4. FIELD MAINTENANCE CENTRE
5. RUBBER REPAIR SHOP
6. LABORATORY
7. LUBE STORAGE BUILDING
8. FUEL STORAGE & DISPENSING AREA
9. MINE DRY
10. STORAGE AREAS
11. CONSTRUCTION STORAGE AREA
12. TRUCK READY LINE
13. GATEHOUSE
14. FIRE TRUCK / AMBULANCE GARAGE

FIGURE 3-5

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
HAT CREEK PROJECT
MINING FEASIBILITY REPORT

MINE SERVICE AREA
GENERAL ARRANGEMENT

- training centre
- lunchroom facilities

Mine Services Building - includes provisions for:

- sheet metal and pipefitting shops
- carpenters' shop
- painters' shop
- vehicle storage
- material storage

Field Maintenance Centre - headquarters for maintenance crews assigned mainly to servicing equipment in the pit; contains little major equipment.

Rubber Repair Shop - facilities for repairs to tires, conveyor belting, and trailing cables.

Laboratories - two facilities are envisaged:

- Assay/Environmental lab, to be used by both environmental and analytical staff for work on coal samples, drill cores, etc.; and

- Environmental Services, to be located away from the central core on presently developed agricultural land, and which will provide greenhouse and experimental growth facilities.

Mine Dry - the main point of dispatch and return for the mine workers. Provision is made for 700 "double" lockers, shower and sanitary facilities, marshalling area, and offices for mine supervisory staff.

Lubricant Storage - a heated and insulated building which houses bulk lube oils and greases pumped on demand to the various dispensing racks in the shops.

Fuel Storage and Dispensing Area - bulk loading and unloading facilities, tank farm, and dispensing pumps for diesel oil, gasoline,

waste oil, and antifreeze; a satellite station is to be provided in the pit.

Storage Areas - several open storage areas located and sized for various uses; consideration in each case has been given to accessibility, ease of materials handling, security, and need for future expansion.

333 MINE AREA DRAINAGE

Preliminary engineering studies were carried out to evolve an overall area drainage plan, the objective of which was to protect the mining operation from major flood damage while preserving the necessary continuity and quality of the existing natural drainage system in accordance with existing environmental guidelines.

The major elements of this study were:

(a) the estimation of drainage flows from natural watersheds and future disturbed watersheds in the mining area;

(b) diversion of runoff from minor creeks and natural watersheds entering the mine and waste disposal area;

(c) collection and disposal of surface runoff from precipitation falling directly on the mine site;

(d) disposal of sub-surface water from pit dewatering operations or seepage from stockpiles and waste dumps; and

(e) disposal of sewage from the mine service complex.

Baseline data covering the project area were extracted from previous and parallel studies by other consultants. Previous studies of the diversion of Hat and Finney creeks were adopted and the recommended canal scheme on the east flank of the mine was incorporated into overall drainage planning.

333.1 Description of the Mine Drainage System

Figure 3-6 attached shows an overall plan of the drainage system that has been developed. Main components of the system are:

Diversion of Creeks - Hat and Finney creeks must be diverted away from the proposed open pit; the necessary diversion canals are described and estimated by others (B.C. Hydro H.E.D.D. Report, 1978). Other smaller creeks and watersheds which drain to the pit and the two waste dump areas are planned to be diverted clear of the mine by perimeter ditches and pipes which will be progressively relocated as the mine perimeter expands.

Drainage of Lakes - In order to improve stability on the west perimeter of the pit, Aleece Lake and 20 to 30 small ponds and sloughs are planned to be drained prior to commencement of mining.

Drainage within the Mine Area - Surface water drainge from the pit, waste dumps, and other areas of the mine development will be collected by ditches and sumps and will be directed to lagoons for settlement prior to discharge to Hat Creek.

Leachates from waste dumps, coal stockpiles, the low-grade coal stockpile, poor-quality seepage into the pit, and pre-treated sewage from the mine service complex is planned to be collected in separate drains and recycled for use in dust control on pit haul roads and coal stockpiles.

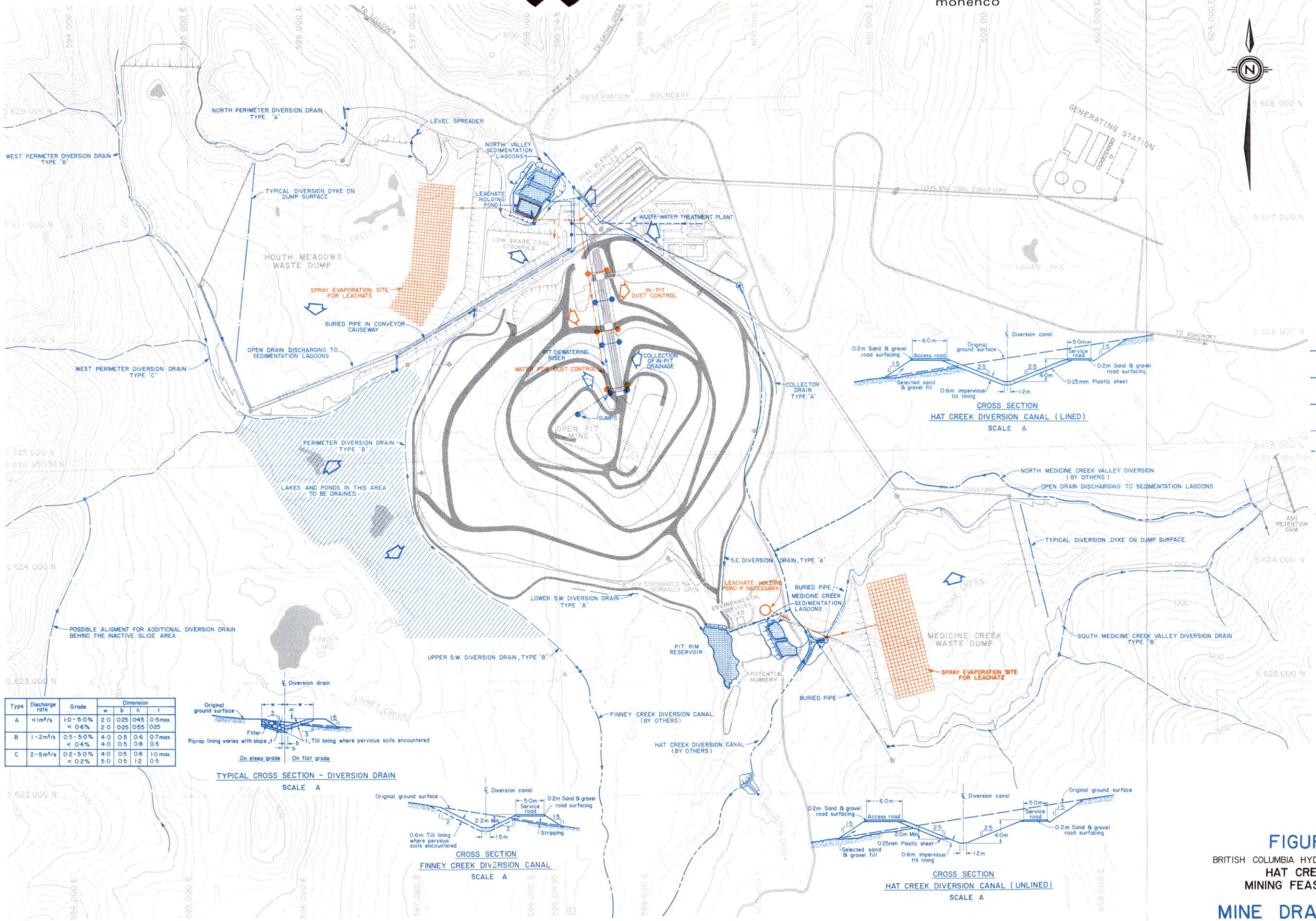
334 UTILITIES

334.1 Power Supply and Distribution

Supply of power to the pit, waste dumps, and support facilities is included in the project. The network developed includes all electrical equipment required to supply power from the 60 kV busbars of the proposed Hat Creek generating station to the open pit and dump areas, and to distribute the power within these areas to the shovels, conveyors, spreaders, and the crushing and blending equipment. The developed network also includes supply for the various service buildings and provides the construction power required during the development phase of the mine. Provision of

cominco-monenco joint venture

monenco



Type	Discharge rate	Grade	Dimension			
			w	b	h	t
A	$<1 m^3/s$	1·0 - 5·0%	2·0	0·25	0·45	0·5 max.
		< 0·6%	2·0	0·25	0·55	0·25
B	$1-2 m^3/s$	0·5 - 5·0%	4·0	0·5	0·6	0·7 max.
		< 0·4%	4·0	0·5	0·8	0·5
C	$2-5 m^3/s$	0·2 - 5·0%	4·0	0·5	0·8	1·0 max.
		< 0·2%	5·0	0·5	1·2	0·5

TYPICAL CROSS SECTION - DIVERSION DRAIN
SCALE A

CROSS SECTION
FINNEY CREEK DIVERSION CANAL
SCALE A

CROSS SECTION
HAT CREEK DIVERSION CANAL (LINED)
SCALE A

CROSS SECTION
HAT CREEK DIVERSION CANAL (UNLINED)
SCALE A

LEGEND

- MAJOR CREEK DIVERSION CANAL (BY OTHERS)
- DIVERSION DRAIN
- MINE SURFACE WATER COLLECTOR DRAIN
- SEEPAGE COLLECTION
- SANITARY SEWER
- DRAINAGE FLOW
- DRAINAGE SYSTEM
- WATER DISPOSAL SYSTEM

5 0 5 10 15m
SCALE A

0·1 0 0·5 1·0 km

FIGURE 3-6

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
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MINE DRAINAGE PLAN

the actual source of power is not included.

A single-line schematic diagram of the distribution network is shown on Figure 3-7. Consideration has been given to the load fluctuations resulting from electric shovel cycles and start-up of large motors.

A summary of estimated load requirements is given in Table 3-4 below.

TABLE 3-4

Total Estimated Power Requirements During Peak Years

	Connected Load	Typical Load	Annual Average Load
Out-of-Pit Loads			
Conveyor Loads	53 500	31 500	15 600
Maintenance Complex	2760	1681	1320
Mine Dry Building	841	427	363
Rubber Repair Building	359	165	125
Mine Service Building	805	383	278
Administration Building	644	349	178
	58 909 kW	34 505 kW	21 618 kW
In-Pit Loads			
8 Shovel Sub-Stations (1 spare)	12 000	5900	2268
Pumping and Miscellaneous	455	180	126
	12 455 kW	6080 kW	2394 kW
TOTAL	71 364 kW	40 585 kW	24 012 kW

334.2 Water Supply and Sewerage

The total water requirements of the mine are not large in that no significant process consumption is involved. Potable water, fire protection, irrigation, and dust control are the main requirements.

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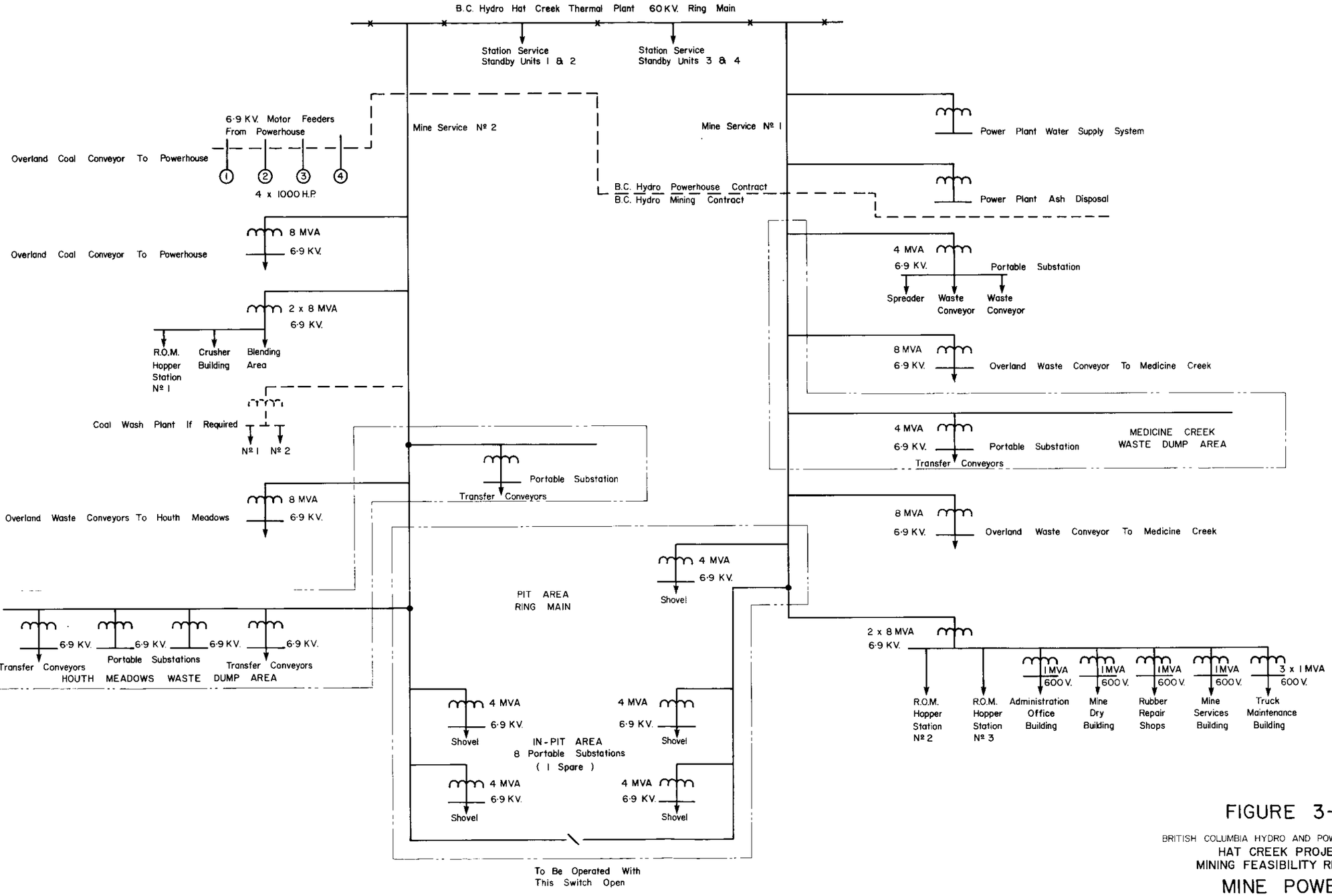

FIGURE 3-7

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
HAT CREEK PROJECT
MINING FEASIBILITY REPORT

MINE POWER DISTRIBUTION NETWORK SINGLE LINE DIAGRAM

Estimated quantities and sources of supply are indicated below:

Facility and Major Use	Daily* Requirements (cubic metres)	Source
MINE SERVICE AREA - potable water and fire protection	350	Offsite construction supply/Hat Creek
REVEGETATION NURSERY -irrigation and potable water	505	Pit rim reservoir on Hat Creek
ROADS AND STOCKPILES -dust control.....	2000	Mine area drainage and de-watering

* Maximum average daily summer demand at full mine development

Sanitary sewage is to be pre-treated by an oxidation ditch system and recycled to dust control use on haul roads and coal stockpiles.

3.4 COAL BENEFICIATION

341 OBJECTIVES

1. To extend and interpret the coal washability and size consist data. This was necessary to validate the 1976 tests.

2. To examine the costs and benefits associated with a number of alternative methods of upgrading the Hat Creek coal. Beneficiation was to be considered in relation to its effects on:

   (a) calorific value and ash content
   (b) smoothing out variations in coal quality
   (c) control of sulphur
   (d) product size distribution, moisture and handling characteristics
   (e) ultimate disposal of ash constituents; and
   (f) resource utilization

These effects were to be considered together with the overall impact of beneficiation, on the design and operation of the mine and powerplant. From this, a project decision would be made whether or not to recommend a beneficiation scheme at this time.

3. To obtain all data necessary for the selection, preliminary design, and costing of a complete process plant scheme should beneficiation be deemed necessary.

342 BENEFICIATION CHARACTERISTICS

All Hat Creek coals examined have very difficult beneficiation characteristics:

   (a) in addition to normal partings, there are clay and shale inclusions in fine bands as well as in the smallest of fissures;

(b) the coarser size fractions contain coals of comparatively low ash while the finer size fractions are all comparatively high in ash, the reverse of situations where conventional coal beneficiation techniques are most effective;

(c) liberation of high ash fines by wet attrition could facilitate a useful degree of beneficiation but would result in a formidable tailings dewatering and disposal problem.

343 BENEFICIATION REQUIREMENTS

Evaluation of the data indicated that:

(a) D-Zone coals would not require beneficiation;

(b) even the most sophisticated beneficiation scheme would not by itself provide the required degree of quality control. A substantial degree of mine planning to produce the correct ratios of D to A, B, and C-Zone coals at all times would be essential, together with a sophisticated blending facility;

(c) any relatively useful degree of beneficiation of A, B, and C-Zone coals, say halving the ash weight for a given heat input, would result in a relatively high loss of heat yield potential to tailings and plant rejects (in excess of 10%); and

(d) total washing of A, B, and C-Zone coals could effect a 20% reduction in the sulphur dioxide emission per unit calorific value from these coals, while the more practical partial washing would result in a reduction of only about 8%.

344 ALTERNATIVE BENEFICIATION SCHEMES CONSIDERED

Six possible beneficiation schemes were evaluated on a common basis of design for the A, B, and C-Zone coals:

Scheme 1. Total Washing: heavy medium bath plus water-only cyclones

Scheme 2. Partial Washing: using heavy medium bath (coarse coal only)

Scheme 3. Partial Washing: using Baum Jigs (coarse coal only)

Scheme 4. Fines Dryer/Classifier

Scheme 5. Total Washing: water-only cyclone washing

Scheme 6. Partial Washing: of coarse coal plus Dryer/Classification of fines (Schemes 2 and 4)

In each case some or all of the following drawbacks are evident:

(a) ineffective relative to cost;

(b) loss of heat value to tailings;

(c) tailings disposal problems at or beyond current limits of current technology plus lack of space for large lagoons.

Products of beneficiation would then be blended with D-Zone coal.

A preliminary estimate of the costs of Scheme 2., partial washing of coarse coals, was developed for comparison with the effects on the generating station of burning blended raw coal. The results were found to be as follows:

(a) Scheme 2. capital and operating costs over the project life*, including cost of mining extra coal to compensate for losses to tailings	$140 million
(b) Incremental generating station costs associated with burning blended raw coal	$ 20 million

* Discounted at 10% to give a net present value.

The apparently overwhelming difference suggested that further refinement of the estimates was not warranted at this time.

345 CONCLUSIONS AND RECOMMENDATIONS

1. There is no beneficiation scheme which can be recommended for inclusion in the Hat Creek Project at this stage.

2. After operational experience is gained, particularly with respect to selective mining and optimization of low-grade coal strategies, some form of beneficiation may be considered. Provision has been made in site layout plans to accommodate this possibility.

3.5 RECLAMATION AND ENVIRONMENTAL PROTECTION

The results of the extensive reclamation and environmental protection studies undertaken for this project are presented in Volume V of this report in a format considered convenient for use in subsequent license applications.

Mine planning is presently based on 35 years of production; any decision on further operations past Year 35 would logically be made during the later years of mining in light of conditions prevailing at that time. The major alternatives would likely be continuation of mining, a temporary closure of the mine, or abandonment. The reclamation and environmental program has, for the purposes of planning, assumed that the mine will be abandoned following a production period of 35 years.

A summary of the study findings and plans is provided in the following sections.

351 OBJECTIVE

The objective of the reclamation and environmental protection plan is to protect land, water, and air during the construction and operational phases of mining, and on completion of mining to re-establish, where practical, land uses of similar type and productivity as existed prior to mining.

Over the long term, the objective will be to establish a self-sustaining vegetative cover consistent with specified land uses for the period following completion of mining operations. Rangeland, both native and improved, wildlife habitat, and forestry constitute the present major land uses in the mine area and are therefore proposed as the end land uses as well. Drainage control sources would be stabilized such that operation of mine collection and treatment facilities would no longer be necessary after mining ceases.

352 DISTURBANCES AND ENVIRONMENTAL LOSSES

Environmental disturbance of the Upper Hat Creek Valley during the 35-year mining project will result in the loss to present use of

approximately 1930 hectares of land area due to: stockpiles (3%), support facilities (6%), drainage and transportation systems (8%), open pit (31%), and waste dumps (52%).

The reclamation and environmental protection plan is based in part on identification of major environmental losses due to the proposed mine plan. These losses include agriculture, forestry, wildlife habitat, and wetland habitat; the effects on each by the mining operation have been tabulated during this study.

353 SITE CONDITIONS AFFECTING RECLAMATION AND ENVIRONMENTAL PROTECTION

Three major reclamation and environmental protection priorities were identified: development of a safe pit abandonment scheme, effective revegetation of waste dumps and disturbed land areas, and drainage control during and after mining.

Before developing the plan it was necessary to examine the available site-specific data regarding: chemical and physical properties of the soils and waste materials, together with their revegetation potential; the quality of mine drainage, dust, and noise; and the potential for spontaneous combustion of carbonaceous materials.

353 PROPOSED RECLAMATION AND PROTECTION PLAN

Consideration was given to creating a lake in the pit void after mining operations shut down; however, due to instability of the surrounding ground materials and the anticipated poor quality of pit water this option is no longer favoured. The open pit, after a 35-year period of mining, would still contain a significant coal resource; filling up the pit with water (or alternatively with waste material) could affect the viability of future extraction. Planned reclamation of the open pit will therefore comprise: regrading and revegetating the upper benches, seeding the remainder of the open pit, maintaining diversion ditches and canals to prevent undue water entry, and fencing the entire pit perimeter including adjoining areas of unstable materials to restrict public access.

The limited data available to date indicate that the sodium content of final waste dump surfaces and low-grade coal stockpiles may be elevated. Depending on the nature and extent of sodic conditions, a surface crust could form on mine waste resulting in reduced seedling emergence, a restriction of water infiltration, an increase in surface runoff, and a reduction in available moisture for plant growth. Additionally, upward migration of sodium to non-sodic surface soils and utilization by plants could result in a marked decline in growth.

In order to alleviate potential growth problems, mine planning has allowed for progressive removal and stockpiling of approximately four million bank cubic metres of surface soil and ten million bank cubic metres of non-sodic glacial till and gravels during the 35-year period of mining. Sodic wastes will be buried in order to ensure satisfactory plant growth on revegetated areas. The non-sodic materials will form a buffer zone between sodic waste and replaced surface soil. Depth of non-sodic material required will be determined by site specific research conducted during mining.

Reclamation of disturbed areas will be carried out progressively over the life of the mine; it is expected that between 35% and 40% of disturbed areas could be successfully reclaimed prior to the completion of mining. In total, 69% of disturbed lands are expected to be returned to productive use following reclamation.

Throughout the life of the project, it is planned to protect watercourses surrounding the mine area from runoff and sediment transport through a comprehensive drainage control system established in all disturbed areas. While the topography and native species diversity existing prior to mining cannot be duplicated, reclamation is designed to provide a stable surface of materials which are similar to those on adjacent lands at similar elevations, and which are revegetated with self-sustaining plant communities. With implementation of the proposed reclamation plan, the abandoned mine site will comprise improved grazing land on valley side slopes and waste dump surfaces, selected areas of productive forest and diverse wildlands, and wetland habitat around reservoirs and drainage sytems.

SECTION 4

CAPITAL AND OPERATING COSTS

4.1 INTRODUCTION

The final step of this mining feasibility study is the development of an estimated cost of delivering coal to the generating station as one component of the cost of producing power at Hat Creek.

Having developed what CMJV believes is a technically feasible mining scheme the associated capital and operating costs have been estimated in accordance with the following financial and economic criteria as determined by B.C. Hydro:

(a) October 1977 Canadian dollars are used throughout.

(b) Annual cost estimates are developed for the pre-production period (Years -6 to -1, inclusive), the 35-year production period, and the 10-year period of post-production reclamation activity.

(c) Pre-production mining activity is classed as an operating cost.

(d) Specific exclusions are escalation, interest during construction, B.C. Hydro corporate overhead, land and mineral rights purchase or lease costs, housing, and other non-mining infrastructure costs.

(e) No financial or sensitivity analyses were required. These were done on a project basis by BCH.*

Further details on the bases for cost estimating are presented in Section 4.3 of this volume.

The estimates have been developed in accordance with present-day engineering standards utilizing a variety of available information sources. The results are judged to represent realistic estimates, in 1977 dollars, of the expenditures both during the preproduction period and throughout the project life.

*While no levelized coal cost calculations were requested, CMJV did develop some numbers, the results of which appear in Section 2 of this Volume. These may differ slightly from analyses by B.C. Hydro in that their normal practice is to include Corporate Overhead while excluding power costs.

4.2 SUMMARY OF ESTIMATED CAPITAL AND OPERATING COSTS

The total estimated capital and operating costs over the life of the project are summarized according to major cost centres in Table 4-1. Table 4-2 summarizes the annual cash flow and contains some of the significant unit costs.(on an annual basis, not levelized).

TABLE 4-1

Breakdown of Estimated Capital and Operating Costs
by Major Cost Centres
($000 October 1977)

Cost Centre	Amount
CAPITAL COSTS	
Engineering and General	$ 45,831
Mine Property Development	79,379
Buildings and Structures	15,581
Pit Services	2,308
Mining Equipment	178,146
Coal Conveying, Crushing, and Blending Equipment	45,034
Waste Disposal Equipment	81,312
Reclamation and Environmental Protection	1,879
Contingency	59,509
TOTAL	$ 508,979
OPERATING COSTS	
Direct Mining	$1,032,605
General Mine Expense	157,092
Local Overheads	284,229
Power	86,784
Royalties	255,130
Contingency	261,774
TOTAL	$2,077,614

TABLE 4-2

Annual Cost Summary
Canadian $ 000's October 1977
Hat Creek Project Mining Feasibility Report 1978

Year	COAL tonnes x 10^6	COAL Btu x 10^{12}	Annual Operating Cost	Annual Operating Cost/tonne	Annual Operating Cost/ million Btu	Annual Capital Costs	Total Annual Capital + Operating Cost	Annual Operating + Capital Cost per million Btu	Total Cumulative Operating + Capital Cost
-6						2,350	2,350		2,350
-5			2,402			6,057	8,459		10,809
-4			2,211			15,398	17,609		28,418
-3			10,764			65,473	76,237		104,655
-2			27,505			89,197	116,702		221,257
-1	1.03	13	35,116	34.09	2.701	48,060	83,176	6.398	304,533
1	3.08	37	45,662	14.82	1.234	12,231	57,893	1.565	362,426
2	5.43	66	47,957	8.83	0.726	13,235	61,192	0.927	423,618
3	8.20	100	50,686	6.18	0.507	5,989	56,675	0.567	480,293
4	10.66	129	54,822	5.14	0.425	9,946	64,768	0.502	545,061
5	11.30	137	57,230	5.06	0.417	16,968	74,198	0.542	619,259
6	11.32	137	57,938	5.12	0.423	3,884	61,822	0.451	681,081
7	11.36	138	57,304	5.04	0.415	6,826	64,130	0.465	745,211
8	11.36	138	58,322	5.13	0.423	9,303	67,625	0.490	812,836
9	11.36	138	58,023	5.11	0.420	12,958	70,981	0.514	883,817
10	11.36	138	59,225	5.21	0.429	7,464	66,689	0.483	950,506
11	11.40	138	59,505	5.22	0.431	9,034	68,539	0.497	1,019,045
12	11.40	138	59,895	5.25	0.434	2,625	62,520	0.453	1,081,565
13	11.40	139	59,499	5.21	0.428	14,766	74,265	0.534	1,155,830
14	11.40	138	60,964	5.34	0.442	7,740	68,704	0.498	1,224,534
15	11.40	138	60,162	5.27	0.436	7,150	67,312	0.488	1,291,846
16	10.92	132	71,388	6.53	0.541	9,315	80,703	0.611	1,372,549
17	10.68	128	69,263	6.48	0.541	5,078	74,341	0.581	1,446,890
18	10.68	128	61,520	5.76	0.481	12,159	73,679	0.576	1,520,569
19	10.68	128	63,033	5.90	0.492	21,399	84,432	0.660	1,605,001
20	10.68	128	61,971	5.80	0.484	22,926	84,897	0.663	1,689,898
21	10.68	128	61,457	5.75	0.480	2,505	63,962	0.500	1,753,860
22	10.41	128	61,892	5.94	0.484	2,938	64,830	0.506	1,818,690
23	10.41	128	61,930	5.95	0.484	9,173	71,103	0.555	1,889,793
24	10.41	128	62,066	5.96	0.485	4,502	66,568	0.520	1,956,361
25	10.40	128	62,577	6.01	0.489	5,394	67,971	0.531	2,024,332
26	8.89	109	53,405	6.00	0.490	5,037	58,442	0.536	2,082,774
27	9.02	109	50,325	5.58	0.462	6,787	57,112	0.524	2,139,886
28	9.02	109	50,648	5.62	0.465	5,020	55,668	0.511	2,195,554
29	9.02	109	50,128	5.56	0.460	11,371	61,499	0.564	2,257,053
30	9.02	109	51,240	5.68	0.470	3,801	55,041	0.505	2,312,094
31	9.02	109	49,978	5.54	0.459	7,461	57,439	0.527	2,369,533
32	9.02	109	49,966	5.54	0.459	4,486	54,452	0.500	2,423,985
33	9.02	109	49,987	5.54	0.459	685	50,672	0.465	2,474,657
34	9.02	109	49,981	5.54	0.459	1,232	51,213	0.470	2,525,870
35	9.02	109	49,998	5.54	0.459	693	50,691	0.465	2,576,561
36			2,319			98	2,417		2,578,978
37			2,319			29	2,348		2,581,326
38			1,924			24	1,948		2,583,274
39			1,350			98	1,448		2,584,722
40			584			46	630		2,585,352
41			371			10	381		2,585,733
42			371			34	405		2,586,138
43			299			2	301		2,586,439
44			66			21	87		2,586,526
45			66			1	67		2,586,593
TOTAL	349.49	4234.3	2,077,614	5.94	0.491	508,979	2,586,593	0.611	

4.3 ESTIMATING CRITERIA

431 CAPITAL

- Major equipment costs are based on manufacturers' budget estimates.
- Equipment service lives are estimated from in-house experience.
- A U.S./Canadian exchange rate of $1.08 is used where applicable.
- Labour rates and fringes are taken from B.C. Construction agreements in effect at September 1977.
- Building costs are estimated using in-house unit rates.

432 OPERATING

- Staff salaries are taken from published B.C. mining industry survey.
- Hourly wages and benefits are taken from September 1977 B.C. mining agreements, with appropriate allowances for absenteeism, shift work, overtime, etc.
- Equipment productivities, availabilities, and materials and supply rates are derived primarily from in-house sources.
- The mine operating schedule assumes continuous, 365 days per year operations.
- Working shifts are 8 hours per day.

4.4 MAJOR MINING EQUIPMENT LIST

The estimated peak number of units required at any one time during the total project life are tabulated below:

MINING EQUIPMENT	Number of Units
16.8-cubic metre electric shovels	7
109-tonne haulage trucks	9
136-tonne haulage trucks	18
Waste spreaders - 40-metre boom, self-propelled	2
Bulldozers, various sizes	18
Road graders	6
Front-end loaders	5
Scrapers and small haulage trucks	16
CRUSHING, STACKING, AND BLENDING	
Bridge-type bucket wheel reclaimers	2
Self-propelled rail-mounted stackers	2
Crushers: in-pit primary	9
out-of-pit secondary	3

CONVEYORS	Length in Metres
Central out-of-pit conveyors	4290
Overland coal conveyor (to generating station)	4000
Waste conveyors: Houth Meadows	13 005
Medicine Creek	2850
Coal crushing and blending area	3290
TOTAL	27 435 Metres

4.5 ESTIMATED MANPOWER SCHEDULE

Separate forecasts for construction and operating manpower have been developed. The estimated peak requirements are:

Construction and Project Management	320 (Year -3)
Operations	varies from 945 to 1005 after full production is reached in Year 4

Tables 4-3 and 4-4 show the details of these requirements.

TABLE 4-3

Summary of Manpower Requirements
for Mine Construction and Project Management

Hat Creek Project Mining Feasibility Report 1978

	YEAR -6	YEAR -5	YEAR -4	YEAR -3	YEAR -2	YEAR -1	YEAR 1
Project Management and Design Engineering	10	40	65	45	45	20	10
Field Engineering	-	-	20	40	40	20	10
Construction Labour	-	-	210	235	140	65	50
TOTAL MANPOWER REQUIREMENTS	10	40	295	320	225	105	70

TABLE 4-4

Summary of Peak Operating Manpower Requirements

Hat Creek Project Mining Feasibility Report 1978

		Pre-Production	YEAR 1	2	3	4	5	PROJECT 6-15	16-25	26-35	36-45
A.	Administration	72	90	90	90	90	90	90	90	90	-
B.	Reclamation and Pollution Control	12	19	19	19	19	19	19	23	23	13
C.	Mine Supervision and Engineering	72	85	85	85	85	85	85	85	85	-
D.	Mine Operating Labour	285	328	335	339	351	370	386	412	347	-
E.	Maintenance Supervision	46	50	50	50	50	50	50	50	50	-
F.	Maintenance Labour	262	316	322	324	328	331	332	345	293	-
TOTAL	MANPOWER REQUIREMENTS	749	888	901	907	923	945	962	1005	888	13

SECTION 5

SCHEDULE OF CONSTRUCTION AND PRE-PRODUCTION DEVELOPMENT

SCHEDULE OF CONSTRUCTION AND PRE-PRODUCTION DEVELOPMENT

A schedule of activities from the date of construction authorization in Year -6 (1 April 1980) through Year 1 of production (1986) is shown on Figure 5-1.

This time frame is largely determined by procurement and installation of major generating station components, and is considered to be more than adequate for mine development purposes.

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CONSTRUCTION SCHEDULE

FIGURE 5-1