BRITISH COLUMBIA HYDRO
THERMAL GENERATION PROJECTS DIVISION
MINING DEPARTMENT

HAT CREEK PROJECT

800 MW
MINING REPORT

VOLUME 1

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800 MW MINING REPORT

VOLUME 1

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Glossary of Terms

G	Giga (Billion)
M	Mega (Million)
k	Kilo (Thousand)
MW	Megawatt
kW	Kilowatt
kg	Kilogram
J	Joules
MJ/kg	Megajoules per kilogram
Btu	British Thermal Unit
m	Metre
m^3	Cubic Metre
m^3/s	Cubic Metre per Second
mm	Millimetre
t	Tonne
t/wk	Tonnes per Week
Mt/a	Megatonnes per Year
kPa	Kilopascals
S.G.	Specific Gravity
V.B.M	Variable Block Model
ROM	Run-of-mine
dcb	Dry Coal Basis
arb	As Received Basis
H.M. Bath	Heavy Media Bath
W.O.C.	Water Only Cyclones
MCR	Maximum Continuous Rating
FRP	Fiberglass Reinforced Pipe

Conversion Factors and Abbreviations

	Imperial Unit	Abbreviation	x Factor	=	Metric Unit	Abbreviation
Area	1 acre	acre	0.404 685 6		hectare	ha
	1 square foot	ft^2	929.0304		$centimetre^3$	cm^2
	1 square inch	in^2	645.16		$millimetre^2$	mm^2
	1 square mile	mi^2	2.589 988		$kilometre^2$	km^2
	1 square yard	yd^2	0.836 127 4		$metre^2$	m^2
Energy	1 British Thermal Unit [Btu] [International Table]	Btu	1.055 06		kilojoule	kJ
	1 calorie [International]	cal	4.1871		joule	J
	1 British Thermal Unit per Pound	Btu/lb	0.002326		Megajoule per kilogram	MJ/kg
	429.92 British Thermal Unit per Pound	Btu/lb	1		Megajoule per kilogram	MJ/kg
	1.8003 British Thermal Unit per Pound	Btu/lb	1		kilocalorie per kilogram	kCal/kg
Length	1 foot	ft	0.3048		metre	m
	1 inch	in	25.4		millmetre	mm
	1 mile	mi	1.609 344		kilometre	km
	1 yard	yd	0.9144		metre	m
Mass	1 hundredweight [100 lb]	cwt	45.359 237		kilogram	kg
	1 ounce [avoirdupois]	oz	28.349 523		gram	g
	1 pound [avoirdupois]	lb	0.453 592 37		kilogram	kg
	1 ton [long, 2240 lb, UK]	lt	1.016 046 908 8		tonne	t
	1 ton [short, 2000 lb]	st	.907 184 74		tonne	t
Power	1 horsepower [550 ft. lbf/s]	hp	745.6999		Watt	W
Temp	Fahrenheit temperature	°F	1.8 (Celsius tem.) +32		degree Celsius	°C
Time	year	a				
	month	month				
	week	week				
	day	d				
	hour	h				
	minute	min				
	second	s				
Volume and Capacity	1 cubic foot	ft^3	28.316 85		$decimetre^3$	dm^3
	1 cubic inch	in^3	16.387 064		$centimetre^3$	cm^3
			.016 387 064		litre	L
	1 cubic yard	yd^3	0.764 555		$metre^3$	m^3
	1 gallon	gal.	.00454609		$metre^3$	m^3
			or 4.54609		litre	L
Sieves	mesh	M	(converted by tables)		millimetres	mm

* 1 U.S. gallon (U.S.G.) = 0.83224174 Imperial gallons.

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SECTION 1

INTRODUCTION

1.1 BACKGROUND

In view of the continuing downtrend of the electricity load forecast in British Columbia in 1982 the Hat Creek Project Team was assigned the task of replanning the previous thermal powerplant from 2240 MW (gross) to 800 MW (gross) in April 1982. This mine mouth powerplant would consist of two 400 MW (gross) generator units to begin commercial service in October 1992 and 1993 respectively and would operate for 35 years. A Feasibility Study for the combined powerplant mine complex was completed and presented to B.C. Hydro's senior management in August 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 feasibility study for the overall project was concluded in August 1982, at a point in time when not all mine design criteria had yet been optimized. As mentioned in this study, specifically the selection of mobile equipment and its impact on the economics of the project were to be finalized after the feasibility study had been delivered.

This mining report presents the final conclusions and the results of a mining feasibility study for the development of the Hat Creek No. 1 Deposit to supply coal to a proposed 800 MW powerplant. It is primarily concerned with the mining aspects of the project; but the key interfaces with the powerplant are fully recognized and incorporated. The impact of the mining operation on the environment has been assessed and protective measures incorporated into the design to minimize any negative effects on the land, air and water resources.

The execution of this study was based upon the solid foundation provided by the extensive investigations, evaluations and reports completed earlier by B.C. Hydro's Mining Group and their consultants. The most important supporting documents for this study were:

(1) The Hat Creek Project 1979 Mining Report, which established the technical and economic feasibility of supplying coal for a 2240 MW (gross) powerplant;

(2) The Hat Creek No. 1 Deposit Geological Report with its supporting plans and computerized data base.

1.2 PROJECT LOCATION

The project is based on the development of the extensive coal deposits located in the Hat Creek Valley in the Southern Interior of British Columbia. The valley is situated approximately 200 km northeast of Vancouver, midway between the towns of Lillooet and Ashcroft. Railroad access is available at Pavilion (B.C. Railway) 24 km to the northwest and at Ashcroft (Canadian National and Canadian Pacific). Road Access is available from Highway 12 at the north end of the valley. Highway 12 joins the Trans Canada Highway (via Highway 97) at Cache Creek approximately 30 km away by road. Regular airport service is available at Kamloops approximately 90 km to the east. Fig. 1-1 shows the project location and Fig. 1-2 shows the site layout.

The Hat Creek Valley is underlain by coal deposits of unique thickness: approximately 500 m. Although first identified in 1877 the extent and scale of the deposits has only been recognized in the last few years. Recent exploration has identified two coal deposits, and possibly a third and fourth. No. 1 and No. 2 Deposits are amenable to open pit mining. For No. 1 Deposit the proven mineable coal reserves are 567 Mt at a stripping ratio of 1.78 m^3 waste/t of coal. Further mineable coal reserves of approximately 340 Mt at a stripping ratio of 3.0 m^3 waste/t of coal are indicated for the No. 2 Deposit. The total mineable reserves could be increased significantly by further exploration and evaluation. The overall reserves including the inferred reserves for No. 2 Deposit are estimated to be in excess of 5 Gt.

1.3 ACKNOWLEDGEMENTS

This study was executed by B.C. Hydro's Mining Department in close cooperation with other members of the Hat Creek Project Team and strengthened by the integrated efforts of the following consultants:

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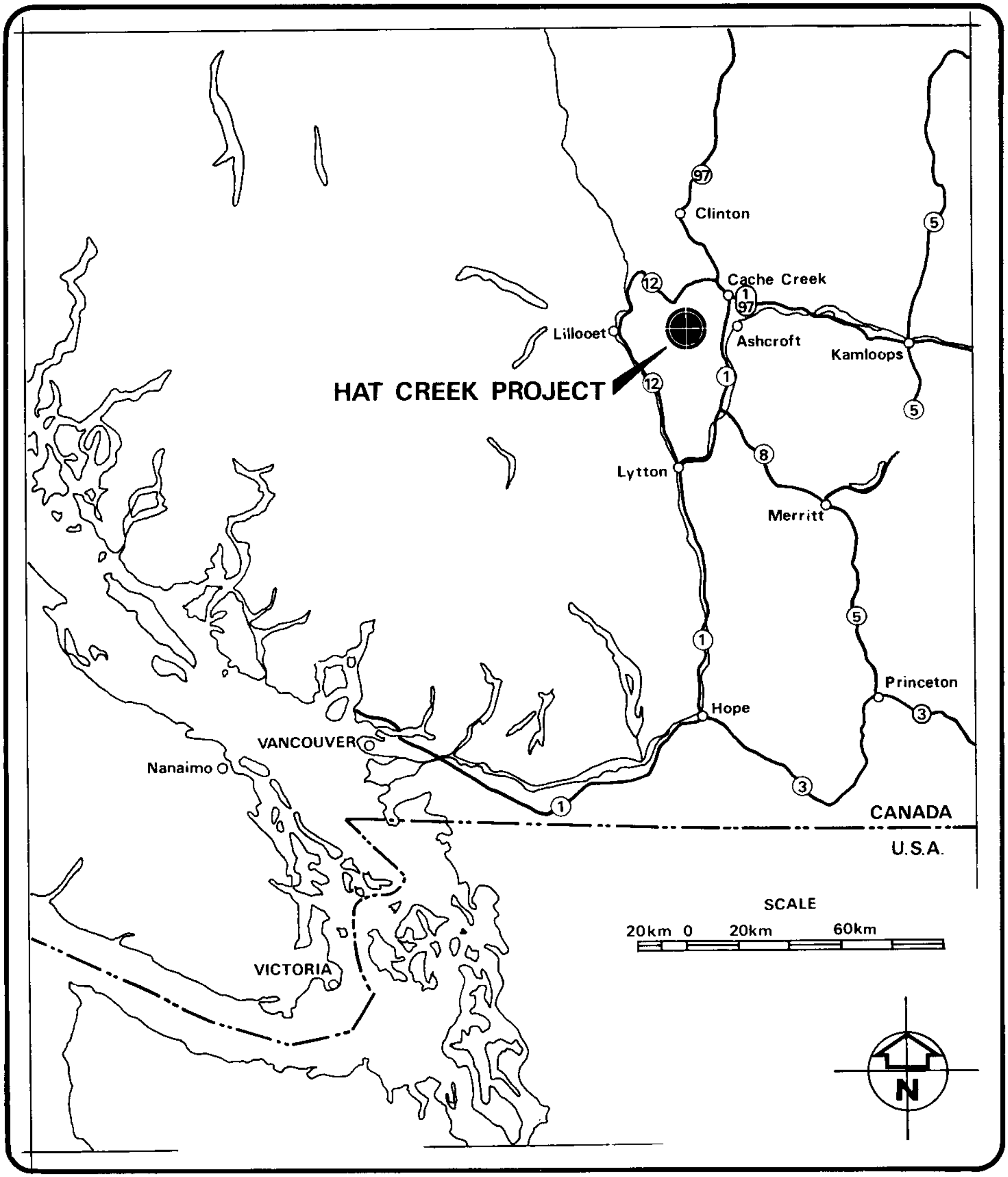
Golder Associates and their subconsultants Sigma Engineering Ltd.

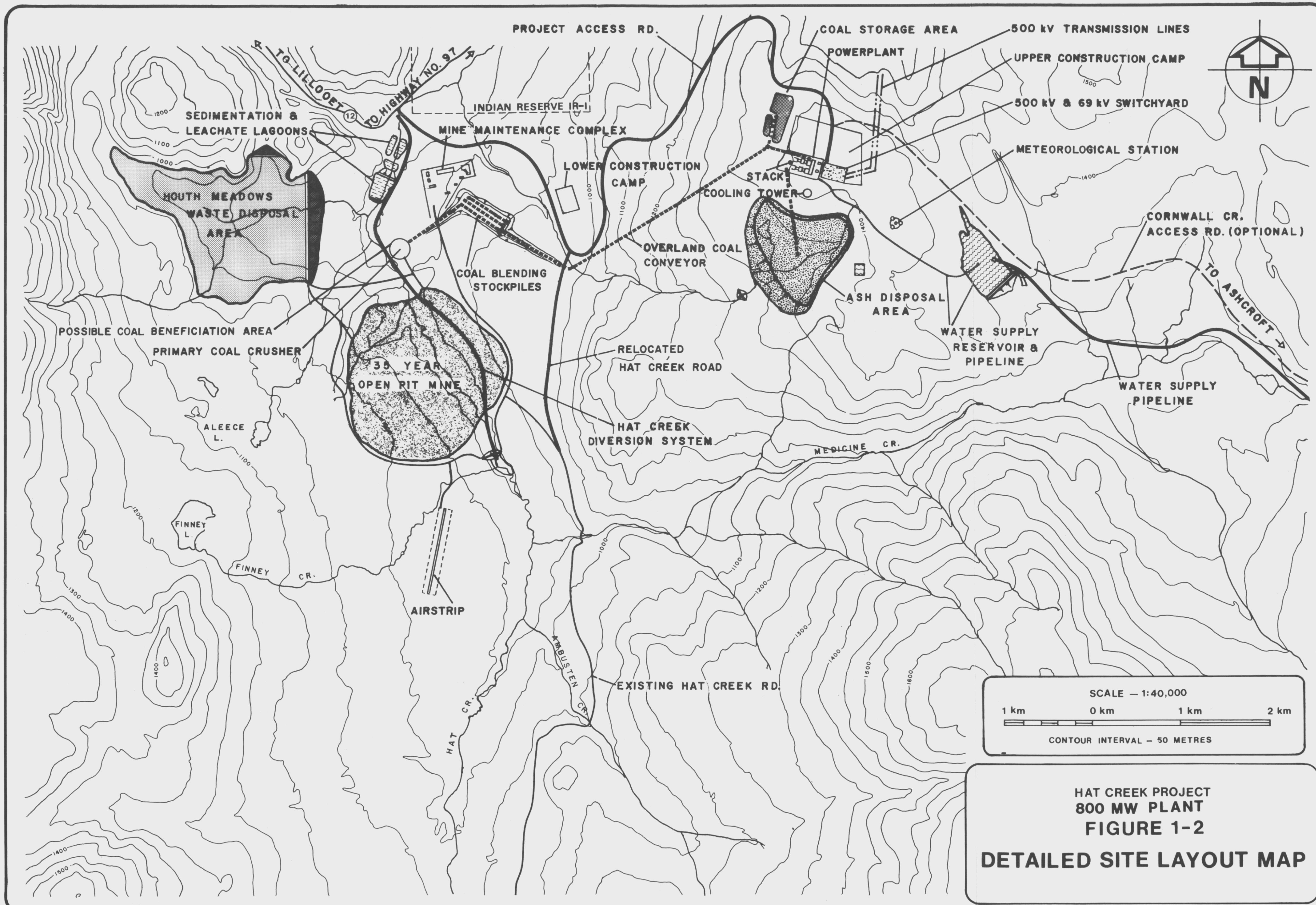
The close cooperation of all the members of the team is gratefully acknowledged.



HAT CREEK PROJECT
800 MW PLANT

FIGURE 1-1

PROJECT LOCATION



HAT CREEK PROJECT
800 MW PLANT
FIGURE 1-2
DETAILED SITE LAYOUT MAP

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SECTION 2

SUMMARY

2.1 MINING

Within the framework of this report 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. The units are scheduled to start commercial production in October 1992 and 1993 respectively.

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. The equipment fleet can be made interchangeable by the provision of spare buckets and 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 m). 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 m) by a 3.5 km two flight overland conveyor. At the powerplant facilities will be provided for live and compacted storage and secondary crushing.

During the pre-production period (1989 to 1992) Hat Creek must be diverted before any significant mining excavation can take place. The diversion works include a low diversion dam to control the flow and channel it into a system of pipes that carries the water through the pit area and returns it to the creek bed downstream of the mine facilities. Through the pit area the water would be carried through one or both of two 1.5 m diameter polyethylene pressure pipes that can be relocated to accommodate mine development.

In parallel with the creek diversion a mine drainage scheme will be developed. Numerous small ponds along the west side of the valley must be drained to reduce the risk of potentially unstable slide masses being activated. In addition, a network of drainage ditches to intercept surface runoff to divert it away from the working areas and a series of settling and holding lagoons will be constructed.

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. During the peak waste removal years (1993 to 1999) waste production would be scheduled for 7 days a week of 3-shift operation. Thereafter the schedule would be progressively reduced to a 5 days a week 3-shift operation then to two shifts and ultimately to a 1-shift or alternatively a seasonal operation in the latter years.

2.2 ENVIRONMENTAL PROTECTION

The mining plan includes provisions for protecting the environment. The major areas for attention that have been identified are:

1. Water Quality

The mine dewatering and drainage scheme provides for handling three separate types of water. The first is the water suitable for simple diversion without any form of treatment. The second requires sedimentation to bring it to an acceptable quality for discharge. The third type is unsuitable for discharge and will be routed to holding lagoons and disposed of by evaporation in dust control application.

2. Land Reclamation

Significant field testing has been done by B.C. Hydro to establish a sound basis for reclamation. Reclamation will be conducted on a progressive basis throughout the life of the project.

3. Dust Control

Dust control measures to meet the objectives have been incorporated into the design. These include: covering certain conveyors, construction of windbreak berms, orientation of the coal piles and installation of water sprays. Specific operating procedures will also be required to minimize the particulate emissions.

2.3 CAPITAL COSTS

Capital cost estimates have been developed to cover the total life of the proposed project in fourth quarter 1982 Canadian dollars.

In summary these costs are:

(1)	Fixed capital costs to full production capacity in Year 2	$176.3 million
(2)	Pre-production operating costs to start of commercial production (Year 1)	44.6 million
	TOTAL INITIAL CAPITAL EXPENDITURES	$220.9 million

Over the life of the project further capital expenditures totalling $87 million will be incurred primarily for the replacement of mobile equipment.

2.4 OPERATING COSTS

Operating costs and manpower requirements for the operation of the mine fluctuate over the 36-year production period in response to variations in the annual quantities of waste removal. Most of the waste material is removed during the first 15 years.

Operating manpower peaks at 314 in production Year-4, declines to 240 by Year 20 and remains at about that level until the end of planned operations.

Direct mine operating costs follow the same trend, and average $5.35/t of coal produced over the 36-year production period.

Mine Production, Operating Costs and Manpower For Selected Production Years

		Year 4	Year 21	Average Year
Annual Production				
Coal	kt	3,800	3,844	3,741
Waste	km^3	6,212	1,631	2,577
Waste Partings	km^3	380	384	374
Operating Manpower				
Hourly		243	169	181
Staff		71	71	70
TOTAL		314	240	251
Direct Mine Operating Costs: $/t				
Administration and Engineering		1.53	1.43	1.48
Maintenance and Services		1.08	0.92	0.98
Mining		2.90	1.68	2.00
Coal and Waste Handling		1.04	0.85	0.89
TOTAL		6.55	4.88	5.35

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SECTION 3

COAL RESERVES AND QUALITY

3.1 REGIONAL GEOLOGY

The upper Hat Creek Valley contains the thickest known deposit of sub-bituminous lignitic coal in the world. Within the valley, two separate deposits have been located and explored by drilling, and a third is drill indicated. Detailed exploration activities to date have been directed at the No. 1 Deposit, located at the north end of the valley, because of its proximity to the surface and hence its greater potential for open pit mining. The No. 2 Deposit to the south contains a much larger coal resource but is less economic because of the greater thickness of waste that covers the deposit. The No. 3 Deposit has only been identified by two drill holes.

The Tertiary sediments in the upper Hat Creek Valley were deposited in a north-south trending topographic depression in the southwest part of the Intermontane Belt of the Canadian Cordillera. The mountains bordering the valley range in age from Permian to Tertiary. The valley floor is underlain by tills and glacio-fluvial deposits subsequent to the Pleistocene glaciation. Table 3-1 summarizes the general stratigraphy of the region.

The coal-bearing section belongs to the Hat Creek Formation of the Eocene Epoch deposited 36 to 42 million years ago. It is underlain by the Coldwater Formation consisting of detrital sediments and overlain by poorly consolidated bentonitic claystone and siltstone beds of the Medicine Creek Formation. These beds were subjected to glaciation and subsequently overlain by glacio-fluvial material.

The unique thickness of the Hat Creek coal deposits and the wide range of coal quality encountered presented a difficult problem in establishing continuity and a systematic stratigraphic sub-division in the deposit. The problem was ultimately overcome, and the deposit has been divided into 16 sub-zones (layers), see Table 3-2. This was achieved using the geologists' description of the cores, the analytical results, and most significantly, the geophysical logs.

Geophysical logs are obtained by raising a geophysical instrument containing an emission source through the length of a drill hole and recording the response from the formations electronically. The response is recorded continuously as a trace on a strip chart to provide a permanent record of the formations encountered in the hole. The most useful data on the Hat Creek deposits was provided by the Gamma Ray and Neutron Bulk Density logs. The interpretation of these logs identified characteristic signatures for marker horizons and various grades of coal, which could not be differentiated visually.

Two of the 16 sub-zones identified are essentially waste bands with localized sections of coal. The remaining 14 sub-zones represent layers of varying coal quality, but demonstrate good continuity within the layers. The thickness of the sub-zones vary from 5 m to 55 m and typically average 20 m. In many of the sub-zones, bands of clay and carbonaceous shale are inter-bedded with the coal.

The regional structure of the Hat Creek Coal Basin is a north-south trending graben flanked on both sides by gravity faults, thus bringing the older Cretaceous and Permian rocks in contact with the Tertiary sediments. Transverse faults have offset the graben in places (see Fig. 3-1).

The primary structure in the No. 1 Deposit consists of two synclines separated by an anticline, plunging at an average of 15 degrees to 17 degrees towards the south southwest. It is truncated on the south and east by steeply dipping boundary faults. Repetition of stratigraphic sections has been observed in some of the drill cores. Such overturning is due to local reverse faulting, which is probably also responsible for the anomalous thickness of detrital sediments encountered in the western sector. These compressive forces do not appear to be strong enough to cause a major regional uplift. Undoubtedly, the general facies change in this direction has significantly contributed to the thickening of the waste material zone (see Fig. 3-2).

In the northwest quadrant of the deposit, a section of coal has burnt and baked the interlayered and enclosing clay beds. The "Burn Zone" is characterized by pink to yellowish-brown coloration in an exploration trench, in outcrops, and in several of the drill cores. The red coloration is due to the formation of iron-oxide by baking of ferrous oxide and hydroxide of the clay. The coals were probably ignited by forest fires, though the volcanic activity in the adjoining area could also have been responsible. The burnt claystones form excellent road material.

3.2 COAL RESERVES

3.2.1 Computer Modelling

The coal reserves for the No. 1 Deposit were calculated using the data gathered from 206 core holes totalling 54 000 m. Geophysical logs were obtained on most of these holes. Coal sections of the core were sampled and submitted for proximate, ultimate and ash analyses. A series of cross-sections through the deposit were developed using the data from surface mapping and subsurface geological logging.

Reserve calculations were performed using the variable block modelling (VBM) technique developed by Mintec Inc. This is a cross-sectional model with the geologists' structural interpretation of the deposit represented on sections approximately 150 m apart. On each cross-section, the sub-zones were divided into "blocks" of 200 m maximum horizontal lengths. The upper and lower limits of each block coincide with the sub-zone boundaries (see Fig. 3.2). Each block is projected halfway to the adjoining cross-sections: 75 m north and south. Quality values are assigned to each of these reserve blocks by the inverse square of the distance method using drill holes within a search distance of 175 m north-south and 500 m on the east-west sections. Blocks beyond the search distance were classified as "undefined" and no quality values were assigned. Undefined materials in the A6 and C1 sub-zones were assumed to be waste and to be coal in the remaining sub-zones. A lower confidence level is assigned to these undefined reserves.

The principal criteria used in calculating the coal reserves are:

(1) A 2 m minimum mining thickness for coal or waste;

(2) Carbonaceous material with a heating value below 9.3 MJ/kg (dry basis) classified as waste;

(3) The specific gravity of coal was calculated using the formula: SG = 1.221 + 0.00738 (% dry ash), see Fig. 3-3.

3.2.2 Geological Reserves

Geological reserves are estimates of the total coal of heating value above 9.3 MJ/kg (dry basis) that exists in the deposit. No consideration is given to economics or practical mining requirements.

A summary of the geological reserves by sub-zone and elevation are shown in Tables 3-3 and 3-4. From this summary the geological reserves for No. 1 Deposit are estimated to be:

1. Measured

739.5 Mt at 17.7 MJ/kg, 34.8 percent ash and 0.51 percent sulphur on a dry coal basis.

2. Indicated

45 Mt of undefined quality (80 percent of this tonnage occurs below the 600 m elevation: in excess of 300 m below the valley bottom).

For comparison the geological reserves for the No. 2 Deposit are estimated at 4.56 Gt indicated and inferred above the 400 m elevation.

3.2.3 Mining Reserves

The calculation of mineable reserves considers the practical pit slope angles required, the quantity of waste to be removed and the economics of mining.

In a 1980 pit design study to establish the total mineable reserves the following criteria were used:

(1) Final overall pit slopes - 15° (north), 20° (east), 19° (south and west);

(2) Minimum mining thickness 2 m;

(3) Cut-off grade 9.3 MJ/kg.

As a result of this study, the mineable reserves for No. 1 Deposit were established as 566.5 Mt of coal at 17.7 MJ/kg, 34.5 percent ash and 0.51 percent sulphur on a dry coal basis. To mine this quantity of coal would require the removal of 1012 Mm^3 of waste giving an overall stripping ratio of 1.79 m^3 of waste per tonne of coal. The bottom of this pit is at 580 m elevation. To increase the mineable reserves significantly would raise the incremental stripping ratio well above 10:1, which is uneconomic in this type of operation and by current economic projections.

The mine plan reserves for the 35-year pits of the 2240 MW and 800 MW cases were determined by pit planning and scheduling. These results are shown in Table 3-5 along with the total mineable reserves for comparative purposes.

The total mineable reserves of 566.5 Mt would support operation of a 2240 MW powerplant for about 55 years or an 800 MW plant for 150 years. Substantial additional coal reserves exist in the No. 2 Deposit and to the south which could extend these lifetime figures considerably.

3.3 COAL QUALITY

Systematic analytical work has been conducted on all core samples. The length of each core sample analyzed has varied over the years but more recently the procedure has been standardized to provide a 6 m maximum sample length for proximate, heating value and sulphur analyses. Ultimate and ash mineral analysis together with ash fusion temperature and grindability tests are performed using 12 m to 18 m maximum sample lengths.

Coal quality for the No. 1 Deposit is well defined because of the large number of drill samples (in excess of 4000), obtained from a 150 m grid drilling program. The quality varies between the sub-zones, but within the sub-zones there is continuity with a trend of decreasing heating value from the northeast to the southwest coinciding with an increase in the thickness of the inter-bedded waste bands.

The coal quality for the entire geological reserves of the No. 1 Deposit is summarized in Table 3-6. The coal quality for the mineable reserves of the 800 MW 35-year pit is shown in Table 3-7. This is the quality of the fuel that will be supplied to the powerplant.

Sulphur content of the whole No. 1 Deposit averages 0.51 percent (dry basis) compared to 0.56 percent for the 800 MW pit. Approximately 71 percent of the sulphur occurs as organic sulphur, 25 percent as pyrite and 4 percent as sulphates. The lower, D-zone contains significantly less sulphur than the three upper zones. A geostatistical study of the total sulphur distribution in the deposit produced good variograms, which indicate continuity and predictability, for 10 of the 16 sub-zones. The remaining six sub-zones showed random sulphur distribution.

3.4 FUEL QUALITY CONTROL

3.4.1 Introduction

The fuel supplied to the powerplant must maintain a consistent quality in heating value to permit stable boiler operation, and in sulphur 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. This work showed that on an annual basis, the 18.1 MJ/kg can be produced with a tolerance of 1.0 MJ/kg and that the 0.57 percent sulphur content can be met with a tolerance of 0.06 percent.

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 smooth out the variations that occur in nature. The selected mining methods and equipment make 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 consistent grade of fuel. The blending scheme is specifically designed to provide a stream of reclaimed coal to the powerplant with minimal variation from the mean of the blending pile. All of these factors combine to form an effective variance-reduction system.

3.4.2 Control Program

The control program has two primary elements: planning and monitoring. During operations, each week's production will be planned and scheduled to deliver the quantity and quality of coal required to the blending plant. This coal will be laid down in a blending pile to be reclaimed to meet the powerplant's fuel requirment for the succeeding week. Shovel operating locations will be scheduled based on the quality of coal available to meet the required average over the week. The stacker will normally lay this material down in 100 windrows to ensure that the variability of the reclaimed fuel is minimized. The reclaimer recovers the coal, taking slices perpendicular to the direction in which the pile was constructed.

The key to being able to prepare useful weekly production schedules is the ability to predict the quality of the coal to be mined. Based on the data available from the diamond drill holes at 150 m spacing, the heating value for an individual block of coal can be predicted with a standard error of 5 percent, and the sulphur, which shows greater variability has a standard error of prediction of 10 to 12 percent. When a number of different blocks are combined, as in a weekly production schedule, these standard errors would be reduced.

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. Composite samples will be collected once or twice a shift for laboratory analysis to provide verification of the results of the ash monitor. Sulphur monitoring would be provided by laboratory analysis of the composite samples.

The monitoring results on a shift or daily basis provide an opportunity for comparing actual versus forecast quality, which is useful for improving the prediction process and for initiating modifications to the current week's production schedule where required. The monitoring data would be a key item on daily production reports to management. This system provides timely data for corrective action and control.

The quality of coal reclaimed and conveyed to the powerplant will be monitored in a similar manner on the Overland Conveyor as a confirmatory check on quality.

3.4.3 Predicted Fuel Quality

In their 1979 report "Review of Coal Fuel Specification Hat Creek Project", the Paul Weir Company reported:

"Based on Weirco's review of the data ...., we estimate maximum annual fluctuations of ±3.0 percentage points in the dry ash content in the ROM coal. The effect of these variations would be to raise or lower the annual average heating value (dry coal basis) by approximately 1.0 MJ/kg from the field average.

In our opinion, if access to all of the coal zones is maintained as detailed in the annual mining plan, on a weekly basis the dry ash content can probably be controlled to approximately ±1.5 percentage points."

In the 1979 Mining Report the mine production schedule developed by B.C. Hydro staff using computerized scheduling confirmed that the annual average heating value could be maintained within approximately ±1.0 MJ/kg as predicted.

For this 800 MW study the production schedule, developed using the same computer methods, also shows that the annual average heating value can be produced within the same ±1.0 MJ/kg tolerance identified above. With more detailed planning and the application of the control program discussed above, it should be practical to reduce this tolerance. During regular production operations it is projected that a weekly control criteria of ±1.5 percentage points on dry ash content (equivalent to 0.5 MJ/kg) would be feasible.

3.5 COAL BENEFICIATION

Coal beneficiation is a broad term which includes any process that improves the quality of coal. In dealing with boiler fuels, this generally implies raising the heating value and reducing the ash content of the coal. Beneficiation, however, can also be used to reduce the moisture or sulphur content. The majority of the proven beneficiation processes in use are wet and gravity-separation processes. Dry processes have been used in the past, and new dry processes are under development.

3.5.1 Testing

Extensive testing programs have been conducted both on a laboratory bench scale and pilot-plant scale. 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 process efficiency is due to the clay partings and transitional coal materials that interfere with the gravity separation processes.

Some Hat Creek coals are subject to severe breakdown in water which results in more fine coal and high levels of tailings production. The efficiency of fine coal cleaning processes is always lower than for the coarse size fractions. The tailings produced by any washing process on Hat Creek coal would be a clay-water suspension and would be extremely difficult and costly to dewater. The design of a practical tailings disposal scheme would require pilot-plant work and further research.

3.5.2 Alternative Processes Considered

Based on the test results obtained a wide range of processes were reviewed for suitability. Six practical schemes were selected for evaluation. These schemes included processes for cleaning coarse or both coarse and fine coal from the A, B and C-zones. The D-zone coal was not considered for cleaning because of the insignificant improvement that was obtained in testing.

Simon Carves of Canada prepared a preliminary modular plant design and capital and operating cost estimates for each of these schemes. Predictions of plant performance were made based on the available test data. The results are summarized in Table 3-8.

3.5.3 Conclusions

An evaluation of the costs and benefits for the 2240 MW case was conducted in 1980 based upon the estimated capital and operating costs and the predicted plant performance of the selected schemes (see Table 3-8). The conclusions which are applicable in principle to the 800 MW case as well were:

(1) Hat Creek coal can be beneficiated to produce a fuel averaging 21.0 MJ/kg (dcb), compared to 18.0 MJ/kg (dcb) for run-of-mine coal. There would be a detrimental increase in the moisture content of the fuel delivered to the powerplant which will reduce boiler efficiency.

(2) Due to the high percentage of organic sulphur (71 percent of the total sulphur) the possibility of reducing the overall sulphur content is limited to the pyritic (and sulfate) sulphur, only. Pyritic sulfur removal could average 50 percent. This means that a net reduction of 11 percent total sulphur can be expected (Canmet 1978; Paul Weir Co. 1979). The effective sulphur emission could be reduced by 20 to 35 percent using washed A, B and C-coal and unwashed D-coal with sulphur expressed on the basis of mass per unit heat (e.g. lb/M BTU).

(3) Beneficiation of the coal is not sufficient to reach the federal emission guidelines or the upper level of the pollution control objectives for coal fired powerplants in British Columbia. It is inferred that to achieve the proposed level of emissions (0.26 mg/kJ), the costs of beneficiation plus supplemental flue gas desulphurization would be of the same order of magnitude as flue gas desulphurization alone.

(4) The disposal of clay tailings remains a major technical and economic problem.

(5) Resource utilization would be reduced by 5 to 8 percent because of process losses to tailings (cut-off grade 4000 BTU). This is partially offset by an improved plant heat rate, but the remaining losses must be made up by mining additional tonnages of coal at higher marginal stripping ratios.

(6) The estimated capital and operating costs of the beneficiation plant exceed the anticipated savings in the powerplant, because the improvement in coal quality is not sufficient to permit a significant reduction in the size of the boilers and ancillary equipment (see Table 3-9).

Based upon these conclusions, it was decided to eliminate beneficiation from the current plan.

As recommended by Simon Carves in 1978 and by the Hat Creek Project's Board of Review in 1981, further pilot-plant testing on a wider range of processes and with low grade coal (A-zone) is currently in progress. Upon completion of this testing the whole issue will be reassessed and, if warranted, the plans revised accordingly.

TABLE 3-1

HAT CREEK PROJECT
800 MW PLANT
REGIONAL STRATIGRAPHY - HAT CREEK COAL BASIN

Period	Epoch	Million Years	Formation or Group	Thickness (m)	Rock Types
Quaternary	Recent			Not Determined	Alluvium, Colluvium, fluvial sands and gravels, slide debris, lacustrine sediments.
	Pleistocene	1.5 - 2			Glacial till, glacio-lacustrine silt, glacio-fluvial sands and gravels, land slides.
	Unconformity				
Tertiary	Miocene	7 - 26	Plateau Basalts	Not Determined	Basalt, olivine basalt (13.2 m.y.), vesicular basalt.
	Unconformity (?)				
	Miocene or Middle Eocene ?		Kamloops Group: Finney Lake Formation	Not Determined	Lahar
			Unconformity		
	Late Eocene		Kamloops Group: Medicine Creek Formation	550	Bentonitic claystone and siltstone.
			Paraconformity		
	Late Eocene to Middle Eocene	*36 - 42	Kamloops Group: Hat Creek Coal Formation	500	Mainly coal with intercalated siltstone, claystone, carbonaceous claystone, sandstone and conglomerate.
			Kamloops Group: Coldwater Formation	Not Determined	Siltstone, claystone, sandstone, conglomerate, minor coal.
			Fault Contact or Nonconformity		
	Middle Eocene	43.6-49.9	Kamloops Group	Not Determined	Dacite (49.1 m.y.), andesite, rhyolite(49.9 m.y.) basalt and equivalent pyroclastics.
	Unconformity (McKay 1925; Duffell & McTaggart 1952)				
Cretaceous or Later	Coniacian to Aptian**	88.3±3 m.y.	Spences Bridge Group	Not Determined	Andesite, dacite, basalt (88.3 m.y.), tuff, breccia.
	Erosional Unconformity (Duffell & McTaggart 1952)				
		98	Mount Martley Stock	Not Determined	Granodiorite, tonalite.
	Intrusive Contact (Duffell & McTaggart 1952)				
Pennsylvanian to Permian or Earlier		250-330	Cache Creek Group: Marble Canyon Formation	Not Determined	Marble, limestone, argillite.
			Cache Creek Group: Greenstone	Not Determined	Greenstone, chert, argillite, minor limestone and quartzite, chlorite schist, quartz-mica, schist, phyllite.

* Based on palynology by Rouse 1977.

** Based on plant fossils by Duffell & McTaggart 1952.

TABLE 3-2

STRATIGRAPHIC SUBDIVISION IN HAT CREEK COAL FORMATION

Zones	Sub-Zones
A	A1 A2 A3 A4 A5 A6 (Waste Zone)
B	B1 B2
C	C1 (Waste Zone) C2 C3 C4
D	D1 D2 D3 D4

TABLE 3-3

HAT CREEK PROJECT
800 MW PLANT
GEOLOGICAL RESERVES NO. 1 DEPOSIT BY SUBZONE

THE CUT-OFF IS 9.30 MJ/kg
WASTE BANDS ABOVE 2 m MIN. THICKNESS ARE EXCLUDED
COAL BANDS ABOVE 2 m MIN. THICKNESS ARE INCLUDED

Zone	Coal Tonnes	Ash%	HHV MJ/kg	Sul%	Total Volume	Coal Volume	Waste Tonnes	Undef. Tonnes Coal	Undef. Tonnes Waste	Undef. Volumes Coal	Undef. Volumes Waste
Burn	0	0.00	0.00	0.00	6 769	0	14 620	0	0	0	0
A1	27 223	31.18	18.74	0.75	28 365	18 905	18 921	0	0	0	0
A2	41 408	39.60	15.88	0.77	40 524	27 566	25 915	0	0	0	0
A3	35 944	45.50	13.96	0.65	41 833	23 244	37 178	0	0	0	0
A4	49 558	40.75	15.58	0.66	57 099	32 794	48 611	0	0	0	0
A5	58 665	44.42	14.47	0.74	56 168	38 139	36 056	0	0	0	0
A6	7 041	50.48	12.32	0.63	65 940	4 450	122 745	0	235	0	117
B1	72 681	38.06	16.55	0.65	56 301	48 816	14 317	488	0	327	0
B2	60 561	37.78	16.66	0.71	63 751	46 075	33 836	1 129	0	758	0
C1	10 245	48.83	12.89	0.54	160 095	6 527	286 629	0	20 507	0	10 253
C2	19 842	47.06	13.37	0.51	24 326	12 740	22 515	512	0	328	0
C3	20 058	46.09	13.77	0.36	23 116	12 940	17 272	2 388	0	1 540	0
C4	32 405	45.01	13.90	0.35	31 660	21 013	18 457	2 188	0	1 418	0
D1	70 005	31.35	18.82	0.29	56 075	48 594	4 150	7 799	0	5 407	0
D2	89 306	25.18	21.09	0.27	70 072	64 010	0	9 585	0	6 862	0
D3	70 476	19.70	23.08	0.29	59 822	51 984	389	10 367	0	7 643	0
D4	66 106	24.84	21.50	0.38	55 313	47 436	668	10 518	0	7 543	0
TOTAL	739 523	34.82	17.71	0.51	898 027	505 233	702 279	44 973	20 742	31 825	10 371

Notes:

1. Tonnages are thousands of metric tonnes.
2. Volumes are thousands of cubic metres.
3. 17.71 MJ/kg = 7600 Btu/lb.

Source: Mintec Geological Model, March 1979.

TABLE 3-4

HAT CREEK PROJECT
800 MW PLANT
GEOLOGICAL RESERVES NO. 1 DEPOSIT BY ELEVATION

THE CUT-OFF IS 9.30 MJ/kg
WASTE BANDS ABOVE 2 m MIN. THICKNESS ARE EXCLUDED
COAL BANDS ABOVE 2 m MIN. THICKNESS ARE INCLUDED

Bench	Coal Tonnes	Ash%	HHV MJ/kg	Sul%	Total Volume	Coal Volume	Waste Tonnes	Undef. Tonnes		Undef. Volumes	
								Coal	Waste	Coal	Waste
1. 1 200	0	0.00	0.00	0.00	0	0	0	0	0	0	0
2. 1 100	235	35.08	17.80	0.42	1 489	161	2 657	0	0	0	0
3. 1 000	40 344	40.41	15.64	0.56	79 369	26 791	105 050	341	0	244	0
4. 900	183 099	34.81	17.56	0.54	194 776	125 031	135 066	3 476	227	2 443	114
5. 800	209 334	33.47	18.15	0.51	206 531	143 973	122 767	1 632	8	1 177	4
6. 700	139 151	34.87	17.76	0.53	156 375	95 061	120 642	1 373	0	994	0
7. 600	90 910	35.82	17.50	0.50	118 810	61 816	110 798	2 116	134	1 528	67
8. 500	53 480	35.75	17.57	0.41	80 907	36 400	77 968	5 791	2 821	4 113	1 410
9. 400	21 455	30.64	19.52	0.33	44 104	14 982	26 946	12 713	13 578	8 859	6 789
10. 300	1 514	37.50	17.16	0.34	15 666	1 019	386	17 530	3 974	12 467	1 987
11. 200	0	0.00	0.00	0.00	0	0	0	0	0	0	0
TOTAL	739 523	34.82	17.71	0.51	898 027	505 233	702 279	44 973	20 742	31 825	10 371

Notes:

1. Tonnages are thousands of metric tonnes.
2. Volumes are thousands of cubic metres.
3. 17.71 MJ/kg = 7600 Btu/lb.

Source: Mintec Geological Model, March 1979.

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TABLE 3-5

HAT CREEK PROJECT
800 MW PLANT
HAT CREEK NO. 1 DEPOSIT
MINING RESERVES SUMMARY

		Mine Plan Reserves 35-Year Pit		Mineable Reserves Ultimate Pit
		800 MW Case	2240 MW Case	
Coal	- Mt	132.2	358.4	566.5
Heating Value (dcb)	- MJ/kg (Btu/lb)	18.1 (7800 approx.)	18.1 (7800 approx.)	17.7
Ash (dcb)	- %	33.3	33.5	34.5
Sulphur (dcb)	- %	0.57	0.51	0.51
Moisture (arb)	- %	23.5	23.5	23.5
Waste Volume	Mm^3	108.5	444.8	1012
Stripping Ratio	m^3/t	0.82	1.24	1.79

TABLE 3-6

HAT CREEK PROJECT
800 MW PLANT
COAL QUALITY NO. 1 DEPOSIT
MEASURED GEOLOGICAL RESERVES (739.5 Mt)

	As Received %	Dry %
Proximate Analysis		
Moisture	23.5	-
Ash	26.6	34.8
Volatile Matter	24.8	32.4
Fixed Carbon	25.1	32.8
Ultimate Analysis		
Carbon	34.6	45.2
Hydrogen	2.8	3.6
Nitrogen	0.7	0.9
Chlorine	0.02	0.02
Oxygen (by difference)	11.8	15.5
Ash	26.6	34.8
Sulphur Forms		
Pyritic	0.10	0.13
Sulphate	0.01	0.02
Organic	0.28	0.36
Higher Heating (MJ/kg) (Dry Basis)	13.55	17.7
(BTU/lb, approximately)	5800	7600
Heating Value (MJ/kg) (Moisture Ash Free Basis)		27.1
Hardgrove Grindability Index (at 10 percent moisture)	45.0	

TABLE 3-7

HAT CREEK PROJECT
800 MW PLANT
COAL QUALITY NO. 1 DEPOSIT
MINEABLE RESERVES 800 MW 35-YEAR PIT

	As Received %	Dry %
Proximate Analysis		
Moisture	23.5	
Ash	25.5	33.3
Volatile Matter	25.3	33.1
Fixed Carbon	25.7	33.6
Ultimate Analysis		
Carbon	35.4	46.3
Hydrogen	2.8	3.6
Nitrogen	0.7	0.9
Chlorine	0.02	0.03
Oxygen (by difference)	12.1	15.8
Ash	25.5	33.3
Sulphur Forms		
Pyritic	0.11	0.14
Sulphate	0.01	0.02
Organic	0.31	0.41
Heating Value (MJ/kg) (Dry Basis)	13.85	18.1
(BTU/lb, approximately)	6000	7800
Heating Value (MJ/kg) (Moisture Ash Free Basis)		27.1
Hardgrove Grindability Index (at 10 percent moisture)	45.0	

TABLE 3-8

HAT CREEK PROJECT
800 MW PLANT
SUMMARY OF BENEFICIATION SCHEMES

BASED ON SIMON CARVES HAT CREEK COAL BENEFICIATION REPORT 1978 (SECTION 1, TABLE 2; 2240 MW CASE)
(QUALITY DATA INDICATIVE OF 800 MW CASE, DOLLAR FIGURES APPLY TO 2240 MW CASE ONLY)
(ALL COSTS IN 1978 DOLLARS)

	Target Fuel Specification (BCH)	Raw Coal (C-MJV Mining Scheme)	Results and Costs of Processing C-MJV Raw Coal A, B and C Zone coals (1000 MTPH) cleaned and blended with D Zone coal (741 MTPH) which does not need cleaning					
TREATMENT SCHEME			1	2	3	4	5	6
Coarse Coal (+13 mm)			H.M. Bath	H.M. Bath	Baum Jig	None	W.O.C.	H.M. Bath
Fine Coal (-13 mm)			W.O.C.	None	None	Dryer/ Classifier	W.O.C.	Dryer/ Classifier
PRODUCT - Dry Basis Analysis								
Calorific Value, Btu/lb	7875	7327	9043	7882	7853	7683	9136	8333
MJ/kg	18.31	17.04	21.03	18.33	18.27	17.87	21.25	19.38
% Ash	33.7	36.3	24.5	32.5	32.7	33.9	23.8	29.4
% Sulphur	0.45	0.48	0.39	0.47	0.47	0.45	0.39	0.43
lb Ash/10^6 Btu	42.8	49.5	27.1	41.2	41.6	44.1	26.1	35.3
lb Sulphur/10^6 Btu	0.57	0.66	0.43	0.60	0.60	0.59	0.43	0.52
- As Received Analysis								
Calorific Value, Btu/lb	6300	5495	6686	5891	5870	5796	6693	6266
MJ/kg	14.65	12.781	15.55	13.70	13.65	13.48	15.57	14.57
% Ash	27.0	27.3	18.1	24.3	24.4	25.6	17.5	22.4
% Moisture	20.0	25.0	26.1	25.3	25.3	24.6	26.7	24.8
Yield % Weight (as received)	-		75.0	91.1	90.5	91.0	73.0	82.1
Yield Btu %	-	Base	91.2	97.6	96.6	96.0	88.9	93.6
Degree of Beneficiation	-	Case	1.83	1.20	1.19	1.13	1.90	1.39
MTPH of Dewatered Tailings for Disposal		0	365	83	83	0	548	83
Capital Costs of Beneficiation and Tailings Plant $000,000's	-	0	32.7	19.2	16.0	6.3	*1	25.5
Operating Costs for Total Average Product $ per tonne	-	0	1.10	0.45	0.38	0.24	*1	0.76

*1 Scheme 5, which is equivalent to the EMR Canmet proposal, has not been costed.

H.M. = Heavy Medium
W.O.C. = Water Only Cyclones
C-MJV = Cominco-Monenco Joint Venture
1000 Btu/lb = 2.326 MJ/kg

TABLE 3-9

HAT CREEK PROJECT
800 MW PLANT
COAL BENEFICIATION EVALUATION
ON THE BASIS OF THE HAT CREEK COAL BENEFICIATION REPORT AND
POWERPLANT AND MINE PLANNING IN 1979 (2240 MW CASE)

	Partial Washing (Heavy Media Bath Only)	Full Washing (Heavy Media Bath Water Only Cyclones)	Unwashed
Powerplant Benefits	-48 Million Dollars	-117 Million Dollars	Base
Reduced Powerplant Capital	-23	-55	
Reduced Operating and Maintenance Costs	-21	-51	
Reduced Powerplant Auxiliary Energy	-4	-11	
Mine Costs	+128 Million Dollars	+317 Million Dollars	Base
Beneficiation Plant Capital	+23	+38	
Beneficiation Plant Operating	+87	+177	
Resource Loss	+18	+102	
Net Costs	+80 Million Dollars	+200 Million Dollars	Base

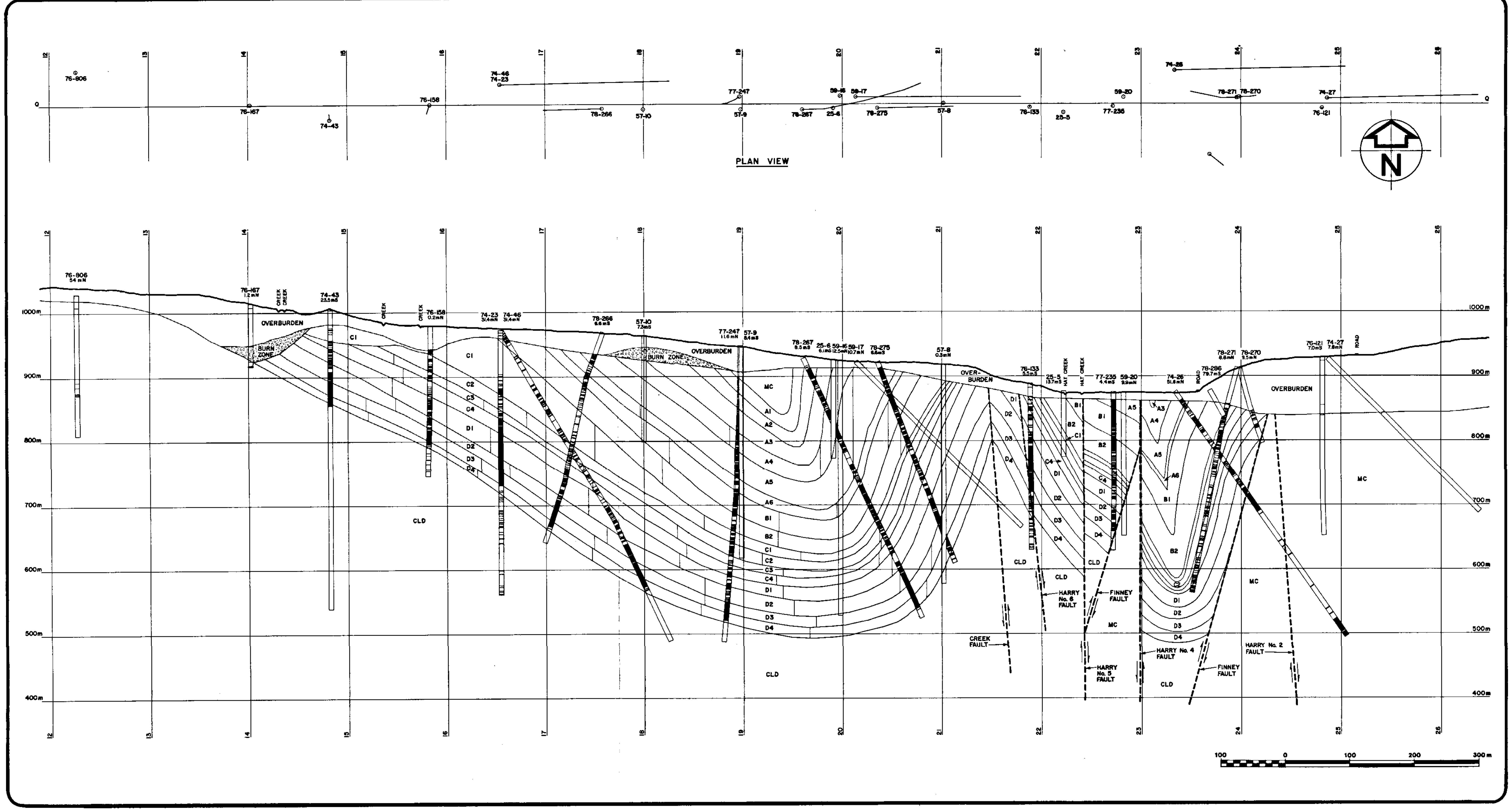
Notes:

1. All financial values are present worth 1980 dollars (discount rate 3 percent).
2. Moisture of washed coal will probably be higher than indicated.
3. The cost of lagoons is not included.
4. Based on a 4000 BTU/lb cutoff (9.3 MJ/kg).

Sources:

1. Working files of the Powerplant Engineering Department.

2. Hat Creek Project Report "Summary of Estimates for Air Quality Control Systems - April 1981". EIS Reference 44.



(M1)

LEGEND

MC	MEDICINE CREEK FORMATION
CLD	COLDWATER FORMATION
	BURN ZONE
A6	A6 SUB-ZONE
C1	C1 SUB-ZONE
— — —	FAULT
——- - -	CONTACT
⇄	RELATIVE MOVEMENT

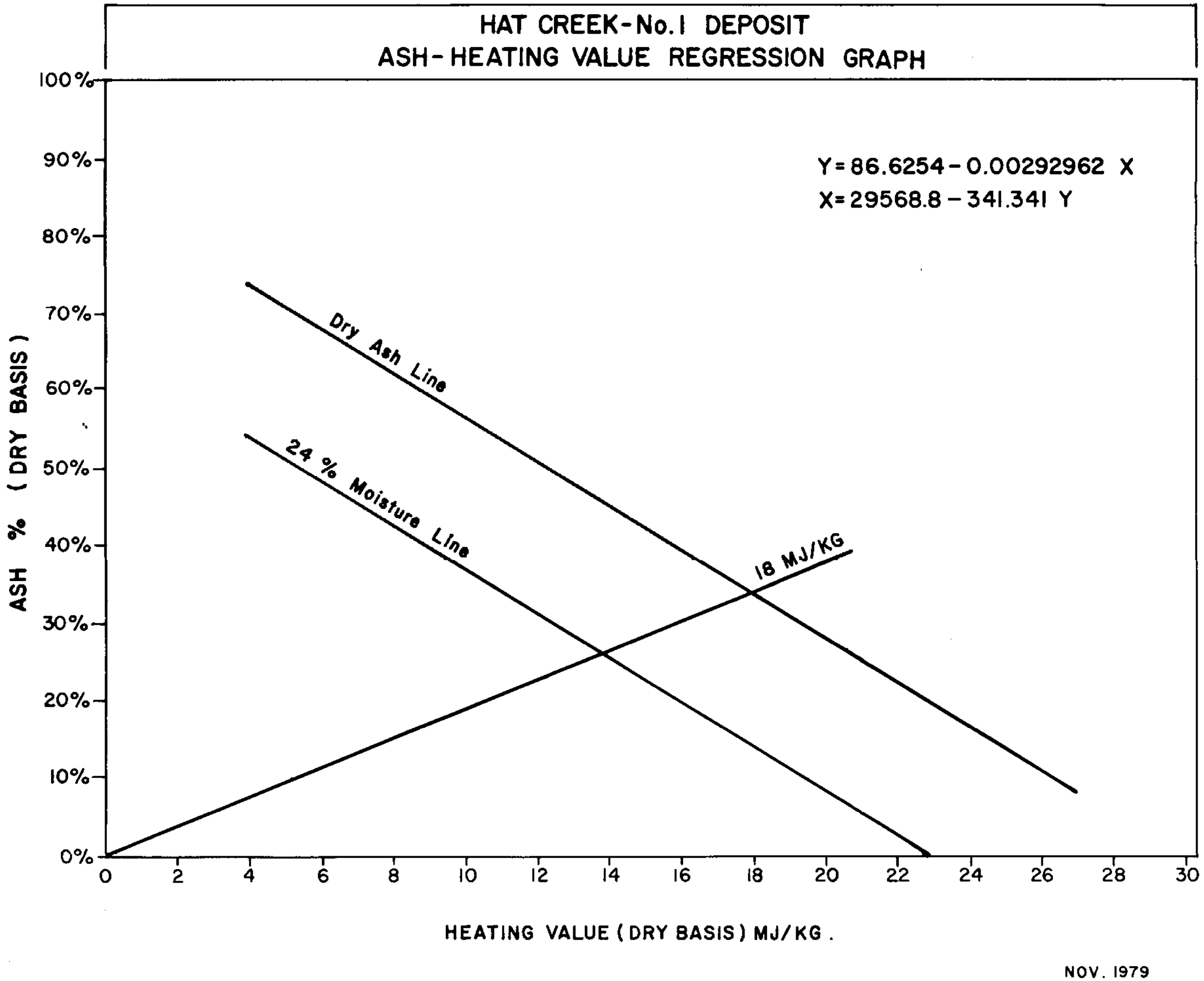
SUBZONE & THICKNESS

A1	15 - 35m	C1	0 - 170m
A2	20 - 55m	C2	5 - 20m
A3	25 - 45m	C3	5 - 15m
A4	20 - 45m	C4	5 - 20m
A5	30 - 45m	D1	15 - 25m
A6	0 - 90m	D2	15 - 30m
B1	25 - 35m	D3	15 - 25m
B2	25 - 35m	D4	15 - 20m

HAT CREEK PROJECT
800 MW PLANT
FIGURE 3-2

GEOLOGICAL CROSS SECTION
SECTION Q

SECTION DRAWN LOOKING NORTH



(M2)

HAT CREEK PROJECT
800 MW PLANT

FIGURE 3-3

REGRESSION CURVE
ASH-HEATING VALUE
(Ash ‹ 60%)

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SECTION 4

MINE DESIGN

4.1 DESIGN CRITERIA

4.1.1 Coal Requirements

Coal requirements are developed based on 1 October 1992 and 1993 in-service dates for Units 1 and 2 respectively. These commercial in-service dates are preceded by an 8-month commissioning period.

The operating regime requires that the powerplant operate at an annual average capacity factor of 67 percent. The annual capacity factor can be expected to vary in the range of 60 percent to 75 percent. In order to achieve the average annual capacity factor the plant would have to operate at a maximum average load of 85 percent of full capacity from October to March to compensate for the boiler maintenance program and lower output requirements during the summer. In certain circumstances the powerplant could operate at 100 percent of the maximum continuous rating (MCR) during the six winter months. The mine must have the production capability and the flexibility to adjust to these varied output requirements for an extended period if necessary.

Average Annual Coal Requirements (67 percent Capacity Factor)

Based on fuel with an as-received heating value of 13.85 MJ/kg at 23.5 percent moiture (18.1 MJ/kg on a dry basis).

Fiscal Years	Kilotonnes
1992/93	1325
1993/94	3057
1994/95	3588
1995/96	3770
1996 to 2027 (31 years)	3828
2027/28	1914

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

Summer	-	70 000 t/wk
Summer (boiler turnaround period)	-	35 000 t/wk
Winter	-	93 000 t/wk
Winter (100 percent MCR)	-	110 000 t/wk

The annual quantities required will vary slightly (±5 percent) depending on the precise heating content of the coal encountered.

4.1.2 Material Characteristics

The materials to be handled in the mining operation comprise a variety of unconsolidated surficial deposits, slide debris and the consolidated coal and claystone formations. The moisture content of the materials to be mined will remain close to the in-situ saturation level which must be recognized in the design of equipment.

Based on bulk sampling experience most of the materials encountered can be excavated using hydraulic shovels without prior blasting. Some local exceptions have been identified where it may be necessary to blast prior to excavation: burn zone and volcanic material. The surficials on the west side of the deposit contain boulders from 1 m to 2 m in diameter. Freezing of saturated clays changes the diggability of the material, but should not be a serious problem when mining faces are kept active.

The properties of the materials are summarized in Tables 4-1 and 4-2.

The abundance of soft materials will require that good haul roads be constructed to maintain the productivity of the truck fleet. Under winter conditions the low temperatures will stabilize the weak foundation materials and improve the operating condition of the haul roads.

The following design criteria were used in this study:

1. Specific Gravity

Coal	-	1.49
Burn Zone	-	2.16
Surficials and Waste Rock	-	2.0

2. Swell Factors

Excavated material occupies a greater volume than in its in-situ state which must be recognized in the selection of equipment and the design of waste dumps and stockpiles.

Material	% Swell As mined	% Swell Dumped or Stockpiled
Coal	45	45
Granular Surficials	20	15
Cohesive Waste	30	25

4.1.3 Selective Mining

The Hat Creek coal deposits are unique, because of the immense thickness of the coal formation, which is due to the existence of a favourable depositional environment for an extended period of time. However, this period of coal deposition was frequently interrupted by episodes of flooding, which introduced non-carbonaceous sediments into the basin. These sediments produced waste partings, usually clay, in the coal sequence. The break between coal and clay is not always sharp, but includes a transition zone which grades from good coal through a phase where the coal and clay materials combine to form a low-grade coal (silty coal), to a succeeding phase where the clay predominates (carbonaceous claystone), and finally to the clay.

These periodic inundations were particularly significant during the deposition of the A and C coal zones. The C-zone depositional environment appears to have been particualarly turbulent, judging by the widespread occurrence of the lower grades of coal and the relative absence of substantial bands of good quality coal. The A-zone was deposited in an environment that alternated between relative calm and severe flooding. This has resulted in bands of good coal interbedded with clay grading to coaly shale. Within the A-zone 30 of these interbeds (which reach a thickness in excess of 2 m) have been identified. The thickness of a given parting increases towards the southwest and are not of mineable width in all areas. The D-zone coal was deposited during a stable period. Few waste partings were formed and the best, most consistent quality of coal, is contained in the D-zone. The B-zone was also deposited under relatively stable conditions although there were a few incursions of sediment-laden floods to produce some waste bands.

Similarly, within the predominantly waste zones, there are occasional bands of acceptable coal.

The larger waste and low-grade partings are readily identified and easily mined as waste material. The separation of smaller partings from the coal, while more difficult to accomplish, improves fuel quality and improves utilization of the resource. This is the essence of the selective mining process.

Studies have indicated that significant improvements in fuel quality could be obtained with selective mining. This improvement would be particularly significant in the A-zone. In the C-zone the quality improvement would be small, but more coal would be recovered.

Experience gained during bulk sampling has shown that a wide variety of situations can arise that affect the application of selective mining:

1. Colour

Partings vary in colour over a range from creamish-white to blackish-brown.

2. Contact

The contact between coal and waste varies between a sharp, clean breaking separation and a gradual transition.

3. Altitude

The inclination of the beds covers the range between flat and almost vertical.

4. Hardness

The only consistent feature of the waste partings that has been identified is that they are softer than the coal bands.

From these facts it is difficult to define reliable criteria for selective mining at this stage. In addition, the interpretation of geophysical logs indicates that there are more partings in the deposit than were identified in the earlier sampling programs or incorporated into the evaluation which provides further scope for improvement in the run-of-mine coal quality.

Based on all these factors it was assumed for this study that selective mining techniques would be employed to remove bands of coal and waste down to 2 m in thickness. The selective mining of 2 m bands is considered to be a conservative estimate of the minimum mining thickness. Therefore, no additional allowance was made for dilution or coal loss.

4.2 GEOTECHNICAL AND HYDROLOGICAL CONSTRAINTS

The angle at which pit slopes can be excavated safely has a major impact on the economics of the mining operation. The steeper the slopes can be excavated, the less waste that must be removed. The stability of the slopes is controlled by the strength of the materials and the groundwater conditions in the area. Most materials represent saturated weak rocks that were originally deposited in a lacustrine environment and are softened when wet.

Several slide areas have been identified in the Hat Creek Valley. The slides have been classified into three categories: stable, marginally stable and active. These relate to present conditions. Movement of these slide masses could be reactivated along preexisting slide planes due to excavation disturbances of their equilibrium, or by water flow or pressure. Experience has shown that movement of these slides would be of a slow, creeping nature.

Extensive field investigations have established safe working slope angles for the different materials ranging from 16 degrees for slide debris to 25 degrees in coal and some of the more stable surficial materials.

The 800 MW design is different from the 2240 MW design in several respects. The benches in the smaller pit are located mainly in the coal. These slopes are well drained and could probably be designed as steep as 30 degrees. In addition, the 800 MW pit bottom is at El. 730 m compared to 640 m. The reduced pit wall height permits an increased pit slope angle. The 800 MW mine design intersects some slide material in the west area of the pit. A reduction in pit slopes to 16 degrees would be required in this location. An analysis of the above factors has resulted in the selection of the following slope angles to be used in the 800 MW mine design:

Overall Pit Slope (other than slide debris)	25 degrees
Slide debris	16 degrees

The bench design criteria for the ultimate pit slope angles are shown below:

<u>25 Degree Pit Slope</u>

Bench height	15 m
Berm width	16 m
Bench face slope	45 degrees

16 Degree Pit Slope

Bench height	15 m
Berm width	36 m
Bench face slope	45 degrees

The inactive slide should be controllable by restricting water inflows through establishing and maintaining a drainage program. This program requires the drainage of several ponds and water holes on the west side of the deposit and the interception of surface water flows with a network of drainage ditches. The drainage program will be implemented as far in advance of mining as possible and practical.

Waterflows in the surficial materials will be controlled by a network of water wells.

4.3 PIT DESIGN AND PRODUCTION SCHEDULING

4.3.1 Computer Methods

Pit design and production scheduling were performed making extensive use of computer software developed by Mintec Inc. This software was also used in preparing the mining plan for the 2240 MW case in 1979. At that time extensive checks were performed to confirm the reliability of the results obtained.

Because the pit design and production scheduling routines are designed to operate using blocks of equal size a block matrix model was developed from the variable block model (described in Section 3.2.1). The block matrix model is a regular three dimensional closely spaced grid which is superimposed on the three dimensional VBM. Blocks of 25 m x 25 m in plan and 7.5 m high are defined in space by the grid. These blocks define the coal deposit with the tonnes of coal, heating value of the coal and the waste volume calculated for each block. A block of coal of this size represents approximately 7000 t. The block matrix provides a model of the deposit that can easily be manipulated by adding or subtracting whole blocks to simulate mining of any part of the deposit utilizing a computer. The use of smaller blocks permits the pit slope design criteria to be met with a more practical pit geometry during the pit design stage.

4.3.2 Pit Design

An open pit design is generated by simulating the mining of a series of truncated cones with the center of a cone coinciding with the center of a block. The center of any block within the cone limits is included in the volume mined. To mine a quantity of coal from the deposit the engineer must specify the location, dimensions of the base and side slopes of the cone. Fig. 4-1 illustrates the principles of the use of the cones in pit design.

The design of the pit is controlled by the requirement to meet certain criteria. Typical parameters that can be varied in the pit design system include:

(1) Mining cost;

(2) Minimum average heating value for each cone;

(3) Maximum stripping ratio for each cone;

(4) Required coal tonnage in a pit increment.

When these criteria have been specified, the pit limits are determined by evaluating the cones within the boundaries defined by the engineer. The parameters of all blocks contained by a cone are accumulated and the results tested against the criteria. The cone is mined if the criteria are met and rejected if they are not. The process is repeated for another cone until the required tonnage is mined or no further cones meet the criteria. Fig. 4-1 shows how the geometry of the cone and the blocks relate.

A number of ultimate pit designs were developed on the computer. Each pit contained sufficient coal to supply an 800 MW powerplant for 35 years. However, the average heating value of the coal and the quantity of waste to be removed varied. The most satisfactory pit met the performance coal quality target of 18.1 MJ/kg and had the lowest stripping ratio. This pit was selected for more detailed design and production scheduling.

The next step is to break the ultimate pit down into smaller increments that provide a guide to the sequence of developing the pit. This was achieved by generating a series of seven intermediate pits of decreasing size. The development of these pits was based upon maintaining a practical mining width between them. Because these pits are computer generated, some impractical mining situations can occur. This was corrected by the preparation of computer plotted maps for each pit, making manual adjustments and entering the revisions into the computer. The coal and waste quantities were then calculated for each pit increment as summarized below:

Incremental Pit Quantities

Pit Increment	Tonnes Coal (x 10^3)	HHV-MJ	BCM Waste (x 10^3)	Stripping Ratio
1	9 498	18.66	9 253	0.974
2	12 855	18.66	17 206	1.338
3	13 476	19.74	15 545	1.154
4	23 102	18.80	12 817	0.555
5	18 573	17.86	13 166	0.709
6	17 619	17.49	11 486	0.652
7	23 622	17.74	17 850	0.756
8	15 136	16.49	11 443	0.756
ULTIMATE PIT TOTAL	133 881	18.12	108 776	0.812

These incremental pits represent practical major stages in the development of the mine with each increment containing sufficient coal tonnage for approximately 3 to 6 years. These increments are still too large for the preparation of an annual production schedule and must be sub-divided further. This is achieved by computing the coal and waste quantities for each bench within each pit increment. This data is then ready for input to the production scheduling computer programs. Fig. 4-2 shows the development of these incremental pits.

4.3.3 Production Scheduling

Working within the incremental design pits, production scheduling selects the coal to be mined in a given time period. This is accomplished by examining the pit bench by bench from the top down, removing the coal until the production requirements are met, and identifying the waste that must be removed to permit mining that coal. This process is repeated for succeeding years until all the coal in the pit increment is mined. Scheduling then continues from the next increment and progresses until the pit is mined out.

This simplified approach to production scheduling, illustrated in Fig. 4-3(a), resulted in unacceptable variations in the quality of coal and the quantity of waste to be removed on a year by year basis. The problem develops because of the nature of the deposit: the coal on the higher benches is generally poorer quality than on the lower benches; similarly the upper benches tend to be mainly waste. Following the mining sequence shown in Fig. 4-3(a) the pattern that develops is:

(1) High waste volume, poorer coal quality (Year 1-2);

(2) Lower waste volume, improving coal quality (Year 3-4);

(3) Mining then shifts into the third pit increment and the pattern is accentuated as the pit deepens Year 5-7 with quality improving and waste decreasing as the pit deepens;

(4) The swings become wider with each successive increment with greater swings from pit bottom to pit crest.

An analysis of the problem indicated that if the high quality coal in the pit bottom could be blended with the lower quality from the upper benches in future incremental pits a better balance in both coal quality and waste quantities could be obtained. An option in the production scheduling program permitted this to be done. This option illustrated in Fig. 4-3(b) provides increased flexibility in the scheduling of production.

After a number of trials, an acceptable production schedule was developed that: with the exception of the pre-production period and the first and last years of the project life; can deliver a fuel with a heating value of 18 MJ/kg within a tolerance of ±1 MJ/kg. It was not possible however to achieve the ideal balanced waste removal quantities over the life of the project. This is similar to the experience gained in developing the production schedule for the 2240 MW plan: there is an early peak in the volume of waste that must be removed in order to open up the pit. The production schedule, which forms the basis for establishing the mining equipment requirements and the cost estimates, is presented in Table 4-3.

Following completion of the production schedule a series of pit plans were computer plotted. These plans, which correspond to the materials identified in the production schedule to the nearest full bench, were produced at yearly intervals for the first 5 years and at 5 and 10 year intervals thereafter. The required access roads and ramps were then incorporated manually into the plans. The final plans showing the pit configuration at the end of Years 5, 15 and 36 are shown in Fig. 4-4 to 4-6 respectively.

4.4 WASTE DUMP DESIGN

Over the expected life of the 800 MW powerplant almost 110 Mm^3 of waste materials must be excavated and disposed outside the pit area. Previous studies have established that Houth Meadows is the most economic and practical waste disposal site because of its proximity to the pit, ease of access and safety. The ultimate capacity of Houth Meadows exceeds 400 Mm^3.

There are two general categories of waste materials that will be excavated in the pit:

(1) Unstable and weak bentonitic claystones, siltstones and slide debris;

(2) Stable and relatively strong material consisting primarily of sand, gravel and till.

The geotechnical issues related to dump stability have been evaluated and the following criteria established:

(1) For long term stability the unstable materials must be retained behind engineered embankments;

(2) The weak retained materials can be kept stable within a surface slope of five percent;

(3) The embankments will be constructed of free draining sands or gravel and be located on a firm foundation;

(4) Design slopes for the embankments are 2½:1 (22 degrees) on the outside face and 4:3 (37 degrees) on the upstream side;

(5) No interaction between the dump and the pit slopes is anticipated.

Based upon these design criteria a dump location and development plan was prepared. The alignment of the embankment was rotated to the west about the south abutment to provide additional flexibility in the location of project facilities. For the waste produced from the 800 MW pit the embankment was designed to a maximum El. 950. To preserve the option for the future expansion of the dump to its maximum planned capacity of 400 Mm^3 at El. 1005, the embankment presently planned could be expanded by widening on the downstream side and increasing the height.

All waste material from the 35-year pit will be transported to Houth Meadows using rear-dump trucks. The dump and embankment will be raised by lifts. The main embankment requires 13 Mm^3 of the 14 Mm^3 of construction material available in the pit. In addition there is approximately 4 Mm^3 of burn zone material available that could be used if required. The retained waste, 95 Mm^3, will reach a maximum El. 985. A minor embankment on the north side of Houth Meadows will be constructed to El. 985 (see Fig. 4-7).

TABLE 4-1

HAT CREEK PROJECT
800 MW PLANT
DESCRIPTION OF SURFICIAL MATERIALS

TYPE	DESCRIPTION	LOCATION	RANGE OF HYDRAULIC CONDUCTIVITY m/sec	GEOTECHNICAL COMMENTS	MOISTURE CONTENT ON DRY WEIGHT BASIS	UNIAXIAL STRENGTH	ATTERBERG LIMITS
Till	Glacial deposit composed of cobbles and gravels with occasional boulders up to 1 m dia. maximum but generally much less, in a matrix of sand, silt and clay. Locally variable, depending on matrix. Seen in base of Clay-Cut.	West and southeast sides of valley	10^{-10}-10^{-8}	Generally dense or compact, boulder size may locally inhibit digging although usually will be able to be dug by hydraulic excavator. Where gravelly, may make water.	15% - 50% Average 26%	0 - 300 kPa	LL = 86 PL = 42 (avg. from a small number of tests)
Lacustrine Deposits	Bedded silts, silty sand with coarse sand and occasional gravel may be also clayey, laminated and/or highly disturbed. Overconsolidated. Glacial origin.	Locally through-out glacial deposits. Houth Meadows embankment foundations.	10^{-7}-10^{-6}	Unusually dense. Where laminated, easy to dig but uniform heavily overconsolidated silts of Houth Meadows could give difficulties. Surface materials in Dry Lake and Houth Meadows are soft.	18% - 32% Average 25%	200 - 500 kPa	LL = 48 PL = 26 (avg. from a small number of tests)
Glacio-fluvial Deposits	Interbedded rounded-subrounded sands and sandy gravels with cobbles and boulders up to 0.7 m dia. (approx.). Much variation in grading. Some interbedded tills. Glacial meltwater deposit.	East side of valley, locally on west also.	10^{-7}-10^{-5}	Dense, possibly slightly cemented, free draining. Will not generally present digging problems. Boulder size smaller than till. Rounded materials. Some ironpans present.	Depends on drainage	non-cohesive	Non-plastic
Colluvium	Coarse, angular, roughly bedded perhaps with variable proportion of fines formed on slopes by erosion. May comprise volcanics, limestone or granodiorite.	Widespread at base of steeper slopes.	10^{-7}-10^{-4}	Variable depending on local rock type. Angular, abrasive, maximum rock size large although generally gravel to cobble sizes. Free draining, locally unstable during digging.	11% - 60% Highly dependent on composition average 30%	100 - 500 kPa, depending on composition	Varies over full range because of composition variability.
Slide Debris (Stable)	Composed of variable assortment of glacial and glacio-fluvial materials Coldwater sediments and granodioritic material often in a bentonite matrix. Seen in upper part of Trench A and Clay-Cut. Mostly post glacial.	West side of valley especially NW.	not known	Variable. Generally moderately dense. Handling characteristics similar to Clay-Cut material.	11% - 60% Highly dependent on composition average 30%	100 - 500 kPa, depending on composition.	Varies over full range because of composition variability.
Slide Debris (Active)	As above, but some softer zones. Currently unstable.	Active slide in NW and minor slides elsewhere in W.	not known	Broken locally softened and weak rock probably sticky. Some seepages. Contains some proportion of gravel. Could give some handling and trafficking problems. Occasional boils.	11% - 60% Highly dependent on composition average 30%	100 - 500 kPa, depending on composition.	Varies over full range because of composition variability.
Alluvium	Rounded sands and gravels probably with silt interbeds as seen in Trench B. Mostly reworked glacials.	Predominantly in Hat Creek Valley bottom.	10^{-6}-10^{-4}	Generally loose and free draining. Maximum size say 0.4 m. Gravel subsidiary to sand.	Depends on drainage	Usually not cohesive	Usually non-plastic but could go up to about LL = 40, PL = 15 (no test results).
Burn Zone	Varies from an irregular mass of red-brown partly-fused claystone and siltstone with some coal to well bedded slightly baked in situ Coldwater materials.	Dry Lake area. May be obscured by glacial or slide deposits in subcrop on W. side.	highly variable	Hard abrasive generally breaking up into gravel sized fragments, easy to dig. Difficult or impossible to dig where completely fused (as in part of Trench A). Some blasting locally necessary.	Insufficient data for characterization; properties highly variable.		

TABLE 4-2

HAT CREEK PROJECT
800 MW PLANT
DESCRIPTION OF ROCK MATERIALS

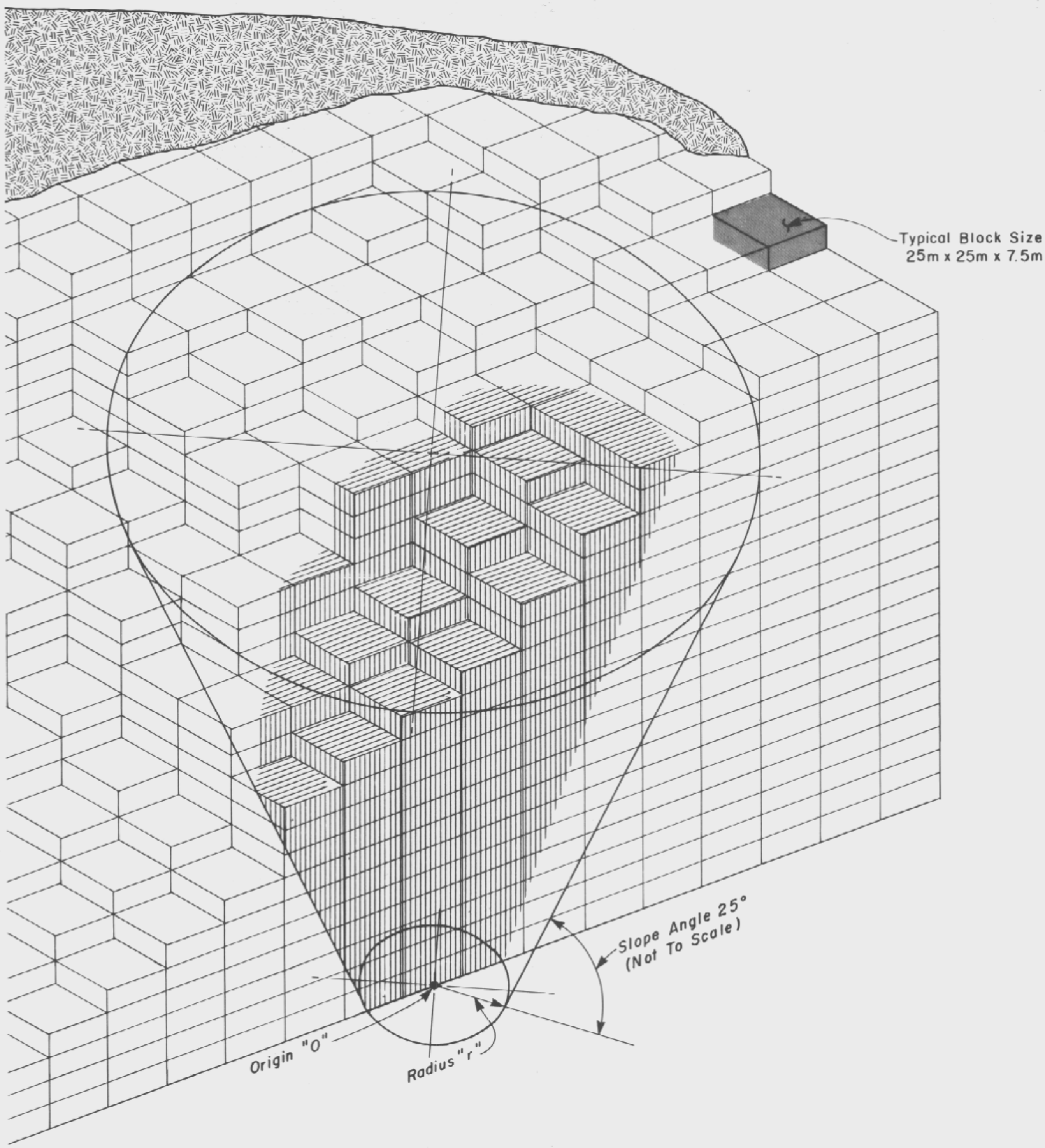
TYPE	DESCRIPTION	LOCATION	RANGE OF HYDRAULIC CONDUCTIVITY m/sec	GEOTECHNICAL COMMENTS	MOISTURE CONTENT ON DRY WEIGHT BASIS	UNIAXIAL STRENGTH	ATTERBERG LIMITS
Claystone/ Siltstone	Very weak to moderately weak clayrich rocks in which bedding often hard to discern. Rock breaks along joints. Where softened or reworked, material highly plastic and tenacious. Zones of shearing and brecciation. Possibly tuffaceous near margins of basin. Generally dark grey or dark brown colour. Distinct tuff bands present.	Stratigraphically above the coal (Unit Tcu). Subcrops in an arc from NE to SW in final pit slopes.	10^{-12}-10^{-10}	Should be considered as a hard clay rather than a rock for excavation purposes. Easily dug where joints are present. Very uniform beds may be troublesome to hydraulic excavator. Handling and trafficking problems will occur in wet conditions due to presence of montmorillonite. Only slakes where sheared or brecciated.	13% - 32% Average 24% May tend to decrease with depth from 29% at subcrop to 18%, 150 m deeper.	400 - 12,000 kPa Average 3,700 kPa May tend to increase from 1,000 kPa to 8,000 kPa after 150 m.	LL = 95 PL = 35 (average)
Siltstone/ Sandstone	Interbedded siltstone and sandstone with subsidiary conglomerate, claystone and coals. Generally light grey in colour, highly anisotropic but bedding planes often difficult to find. Much facies variation.	W and NW pit slopes. Stratigraphically below the coal. Also occurs as interbeds in the conglomerate.	10^{-11}-10^{-10}	Should be considered as a stiff clay rather than a rock for excavation purposes. Easily dug where joints are present. Handling and trafficability problems will occur in wet conditions due to presence of montmorillonite. Dispersive, highly erodible, will form gullies, and sub-surface cavities. Slakes readily.	23% - 70% Average 31%	600 - 3,500 kPa As interbeds in conglomerate, 3,500 - 7,000 kPa	LL = 143 PL = 34 (average)
Sandstone	Varies from weak silty sandstone through to moderately strong fine grained conglomerate. Matrix usually composed of silt/clay and granular material may be tuffaceous and weak. Locally cemented especially immediately below the coal. Generally greenish.	W and NW Pit slopes. Stratigraphically below the coal. Forms interbeds in Lower siltstone/sandstone (Unit Tcl) and in conglomerate (Unit Tco_1).	10^{-10}-10^{-9}	Generally weak rock whose excavation characteristics may differ little from the siltstones. Some trafficking problems as material breaks down. Often highly bentonitic. Characterized by west face of Trench A.	19% - 32% Average 25%	Some tendancy to increase from 1,000 kPa at surface to 10,000 kPa at 300 m depth. Interbeds in conglomerate range from 3,500 kPa to 10,000 kPa and vary similarly with depth.	LL = 80 PL = 30 (based on only a few results)
Conglomerate	Highly variable in character depending on relative proportions of granular material and matrix. Coarse gravel fragments rounded to subrounded but also angular where tuffaceous. Matrix may be bentonitic. Often clacite cemented. Not yet seen in outcrop or excavation. Contains interbeds of siltstone and sandstone.	S abutment of Houth Meadows Embankment. Forms ridge between Houth Meadows and pit (Unit Tco_1). Also occurs as interbeds in Lower siltstone/sandstone (Unit Tcl) and at base of whole sequence (Unit Tco_2).	10^{-10}	Harder and more abrasive to dig. Where weathered could be disaggregated and behave as gravel. Will break down with much rehandling except where cemented. Calcite cemented conglomerate could not be dug without blasting.	Average 15%, based on few test results. Note that interbeds will raise overall average.	Depends on cementation; up to 43,600 kPa has been measured locally. Some zones almost uncemented.	LL = 60 PL = 27 (based on very few results)
Coal	Thinly bedded moderately strong but highly fractured. Interbedded with siltstone partings and beds, often highly sheared. Some cleating. Much variation from clean to dirty coal except in D-Zone. Some zones of complete fragmentation.	Centre of pit and limited area in SW wall.	10^{-11}-10^{-6}	Easily dug due to multitude of weak joints and partings. Bench failures common especially where bedding unfavourably oriented. Seepages from face, generally no sizable water inflows.	See DCA report	1,000 - 17,000 kPa	See DCA report
Coal Interbeds	Generally thinly bedded claystone/siltstone of moderate plasticity. Some bentonitic material in A-Zone and near margins of basin. May be highly sheared or brecciated.	Centre of pit and limited area in SW wall.	10^{-12}-10^{-10}	Easily dug and similar to coal in some respect although will not break up as much. Impermeable locally softened. Thinner beds may be difficult to separate from coal.	12% - 36% Average 23%	No data	LL = 59 PL = 33 (average)
Volcanics	Includes an assortment of basalts, dacites, rhyolites, agglomerates, breccias and tuffs. Closely jointed.	E and W of pit.	10^{-11}-10^{-6}	May require blasting or ripping. Generally hard and abrasive. Permeable. Generally drained.	No data	Up to 23,000 kPa has been measured. Strength may often be much greater.	N/A
Limestone	Massive or brecciated limestone with phyllite interbeds.	Underlying Houth Meadows.	10^{-9}-10^{-4}	Will require blasting. Generally strong phyllite bands weaker. Dry.	No data	No data	N/A

TABLE 4-3

HAT CREEK PROJECT
PRODUCTION SCHEDULE 800 MW PLANT
SHOWING COAL QUANTITIES (TONNES), HEATING VALUE (MJ/kg) WASTE QUANTITIES
INCLUDING PARTINGS (BCM) AND STIPPING RATIO (S.R. = BCM WASTE/TONNE COAL)

Yearly Schedule					Cumulative Schedule			
Year	Coal	MJ/kg	BCM	S.R.	Coal	MJ/kg	BCM	S.R.
0	603.	16.50	3 291.	5.456	603.	16.50	3 291.	5.456
1	1 251.	16.57	3 818.	3.053	1 251.	16.57	3 818.	3.053
2	2 875.	18.11	5 760.	2.003	4 126.	17.64	9 578.	2.321
3	3 447.	18.84	5 902.	1.712	7 573.	18.19	15 480.	2.044
4	3 800.	17.96	6 592.	1.735	11 373.	18.11	22 071	1.941
5	3 760.	18.43	5 532.	1.471	15 134.	18.19	27 603.	1.824
6	3 708.	18.69	5 582.	1.505	18 842.	18.29	33 186.	1.761
7	3 720.	18.62	6 753.	1.815	22 562.	18.34	39 939.	1.770
8	3 658.	18.94	4 161.	1.138	26.220.	18.43	44 100.	1.682
9	3 686.	18.80	4 852.	1.316	29 906.	18.47	48 952.	1 637
10	3 851.	17.99	4 255.	1.105	33 757.	18.42	53 207.	1.576
11	3 923.	17.66	3 776.	0.962	37 681.	18.34	56 982.	1.512
12	3 783.	18.32	3 362.	0.889	41 463.	18.34	60 344.	1.455
13	3 657.	18.95	3 476.	0.950	45 120.	18.39	63 820.	1.414
14	3 811.	18.18	2 880.	0.756	48 931.	18.37	66 700.	1.363
15	3 945.	17.56	2 075.	0.526	52 876.	18.31	68 774.	1 301
16	4 060.	17.06	2 276.	0.560	56 937.	18.22	71 050.	1.248
17	3 907.	17.73	2 382.	0.610	60 844.	18.19	73 432.	1.207
18	3 835.	18.07	2 345.	0.612	64 679.	18.18	75 778.	1.172
19	3 904.	17.75	2 562.	0.656	68 583.	18.16	78 340.	1.142
20	3 871.	17.90	2 475.	0.639	72 454.	18.14	80 815.	1.115
21	3 844.	18.02	2 015.	0.524	76 299.	18.14	82 829.	1 086
22	3 707.	18.69	2 025.	0.546	80 006.	18.16	84 854.	1 061
23	3 887.	17.83	1 907.	0.491	83 893	18.15	86 762.	1.034
24	3 679.	18.83	2 498.	0.679	87 571.	18.18	89 260.	1.019
25	3 955.	17.52	2 368.	0.599	91 526.	18.15	91 628.	1.001
26	3 974.	17.44	1 879.	0.473	95 500.	18.12	93 508.	0.979
27	3 933.	17.62	1 734.	0.441	99 433.	18.10	95 241.	0.958
28	3 751.	18.47	1 933.	0.515	103 184.	18.11	97 175.	0.942
29	3 988.	17.37	2 102.	0.527	107 171.	18.08	99 276.	0.926
30	4 016.	17.25	1 472.	0.367	111 187.	18.05	100 749.	0 906
31	3 822.	18.13	1 173.	0.307	115 009.	18.06	101 921.	0.886
32	3 812.	18.18	1 102.	0.289	118 821.	18.06	103 024.	0.867
33	3 859.	17.96	676.	0.175	122 679.	18.06	103 700.	0.845
34	3 735.	18.55	611.	0.164	126 414.	18.07	104 311.	0.825
35	3 700.	18.73	589.	0.159	130 114.	18.09	104 901.	0.806
36	1 451.	20.13	293.	0.202	131 565	18.11	105 194.	0.800

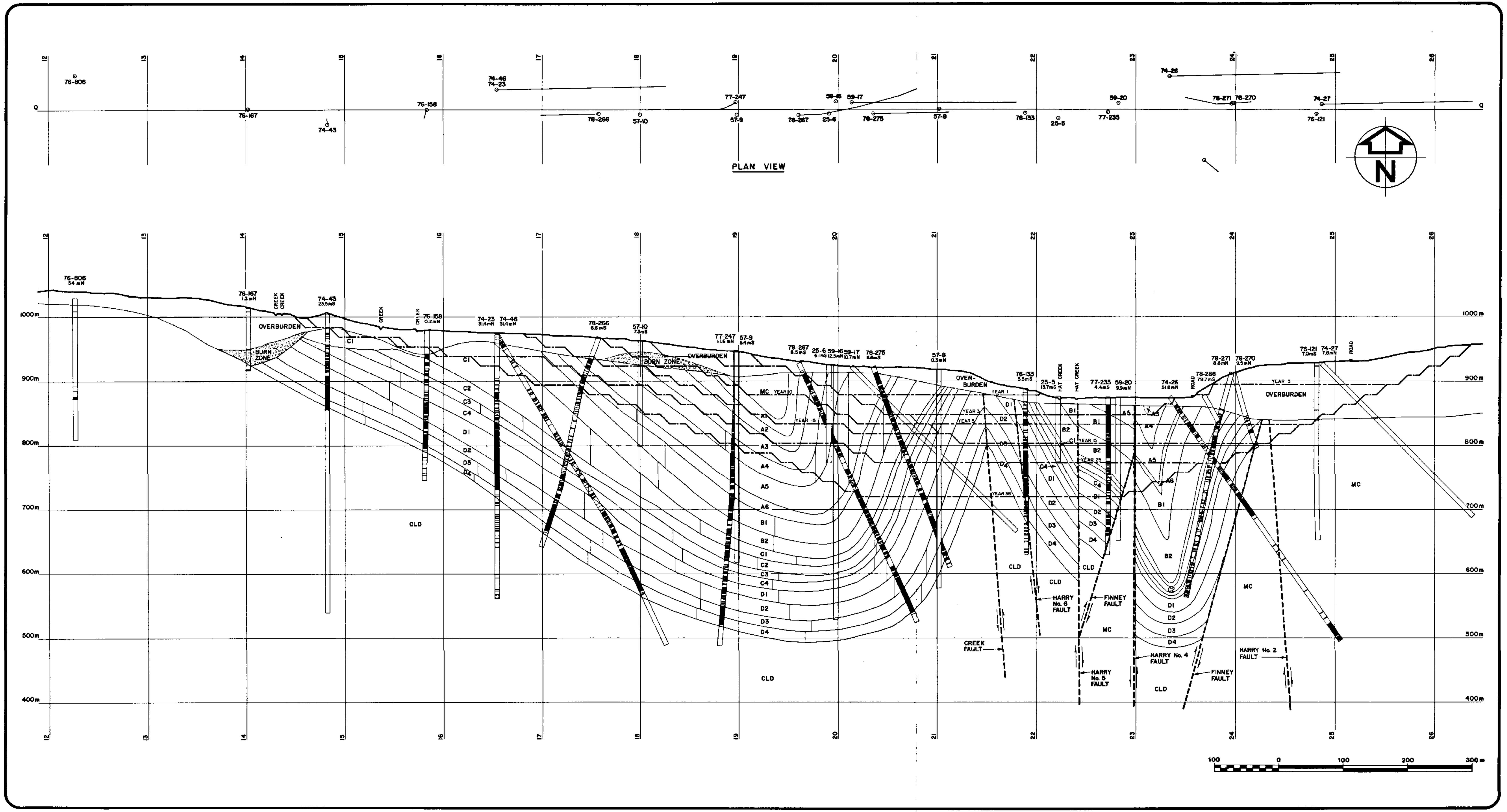
Note:
1. Year 0 is pre-production and is not included in the cumulative totals.
2. BCM = Bank Cubic Metre.
3. S.R. = Stripping Ratio.



HAT CREEK PROJECT
800 MW PLANT

FIGURE 4-1

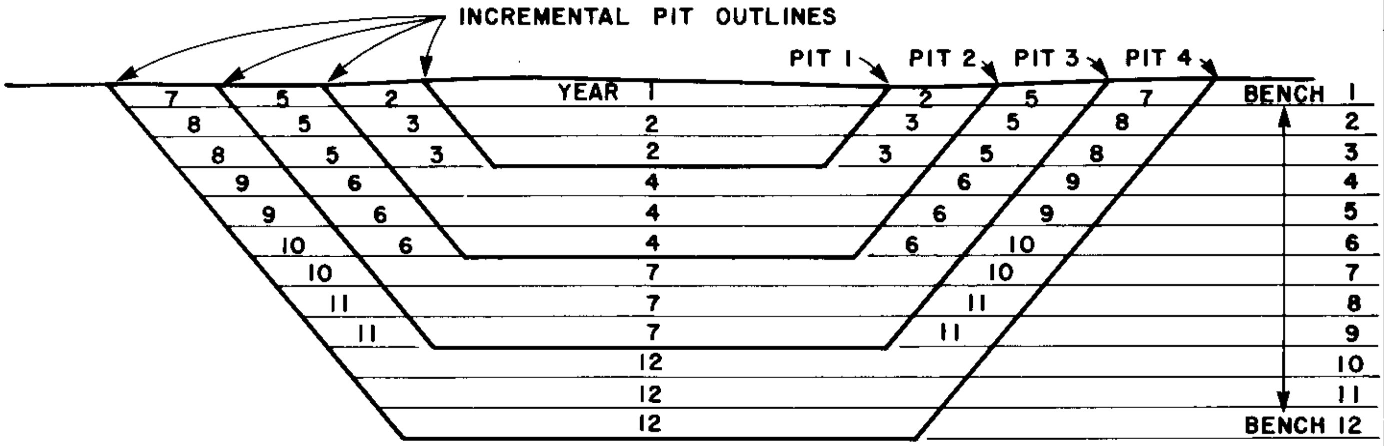
CONE GEOMETRY



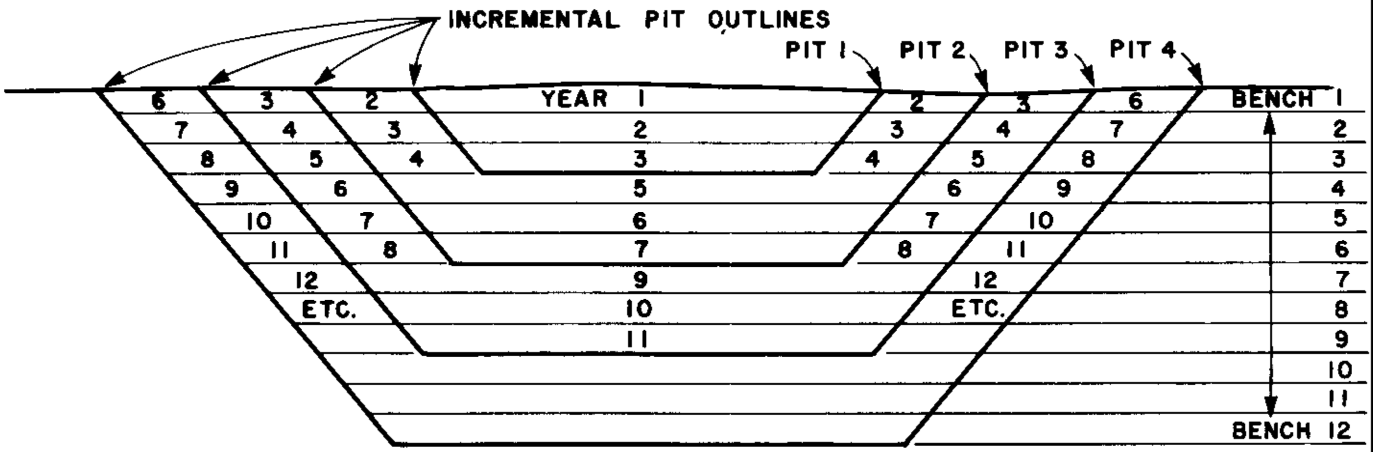
HAT CREEK PROJECT
800 MW PLANT
FIGURE 4-2

INTERIM PIT DEVELOPMENT CROSS SECTION Q

(a) SIMPLIFIED APPROACH TO PRODUCTION SCHEDULING



(b) OPTIONAL APPROACH TO PRODUCTION SCHEDULING PERMITTING ADVANCED STRIPPING AND SCHEDULING FOR CONSISTENT COAL QUALITY.

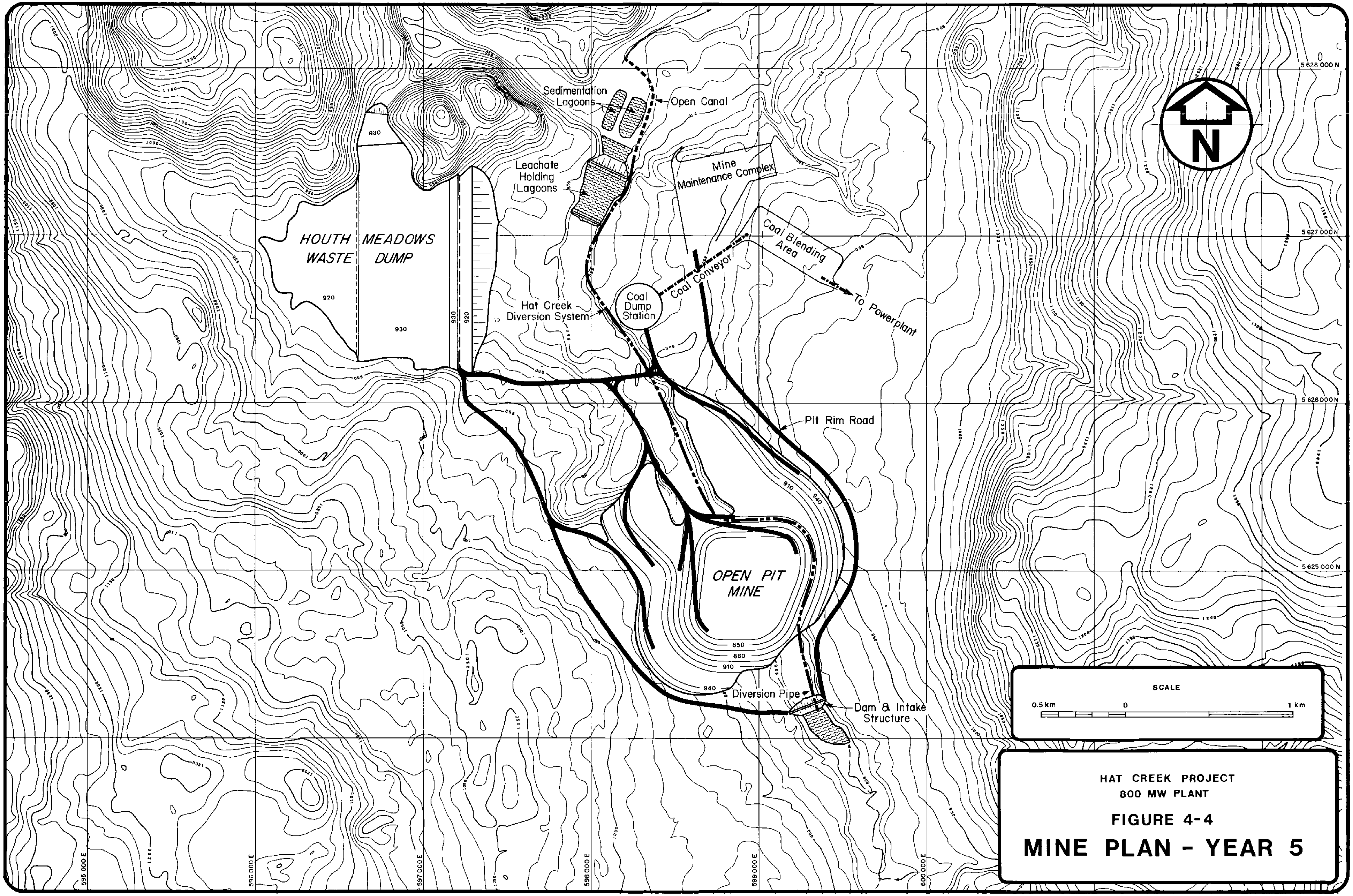


HAT CREEK PROJECT

800 MW PLANT

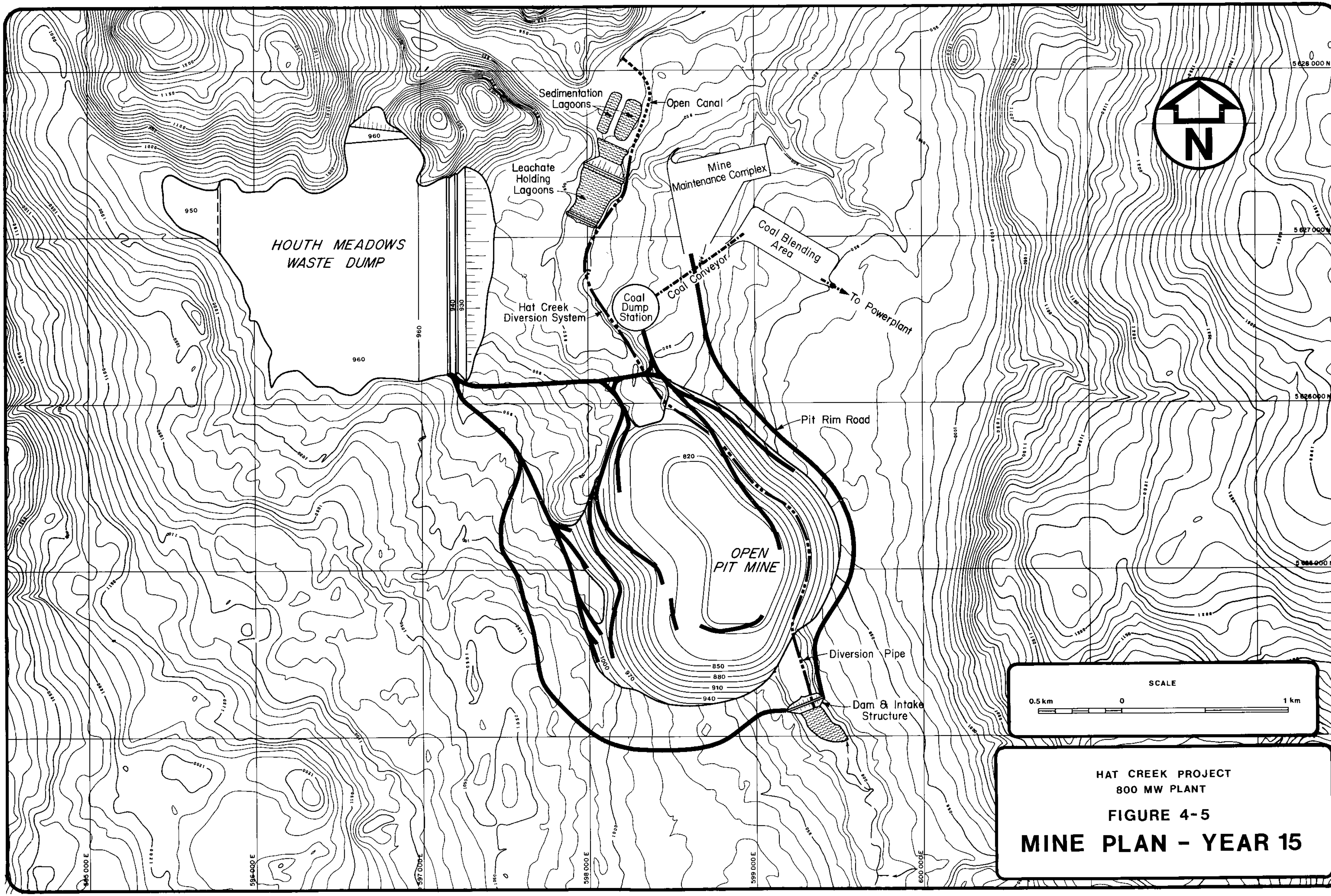
FIGURE 4-3

PRODUCTION SCHEDULING APPROACH



HAT CREEK PROJECT
800 MW PLANT

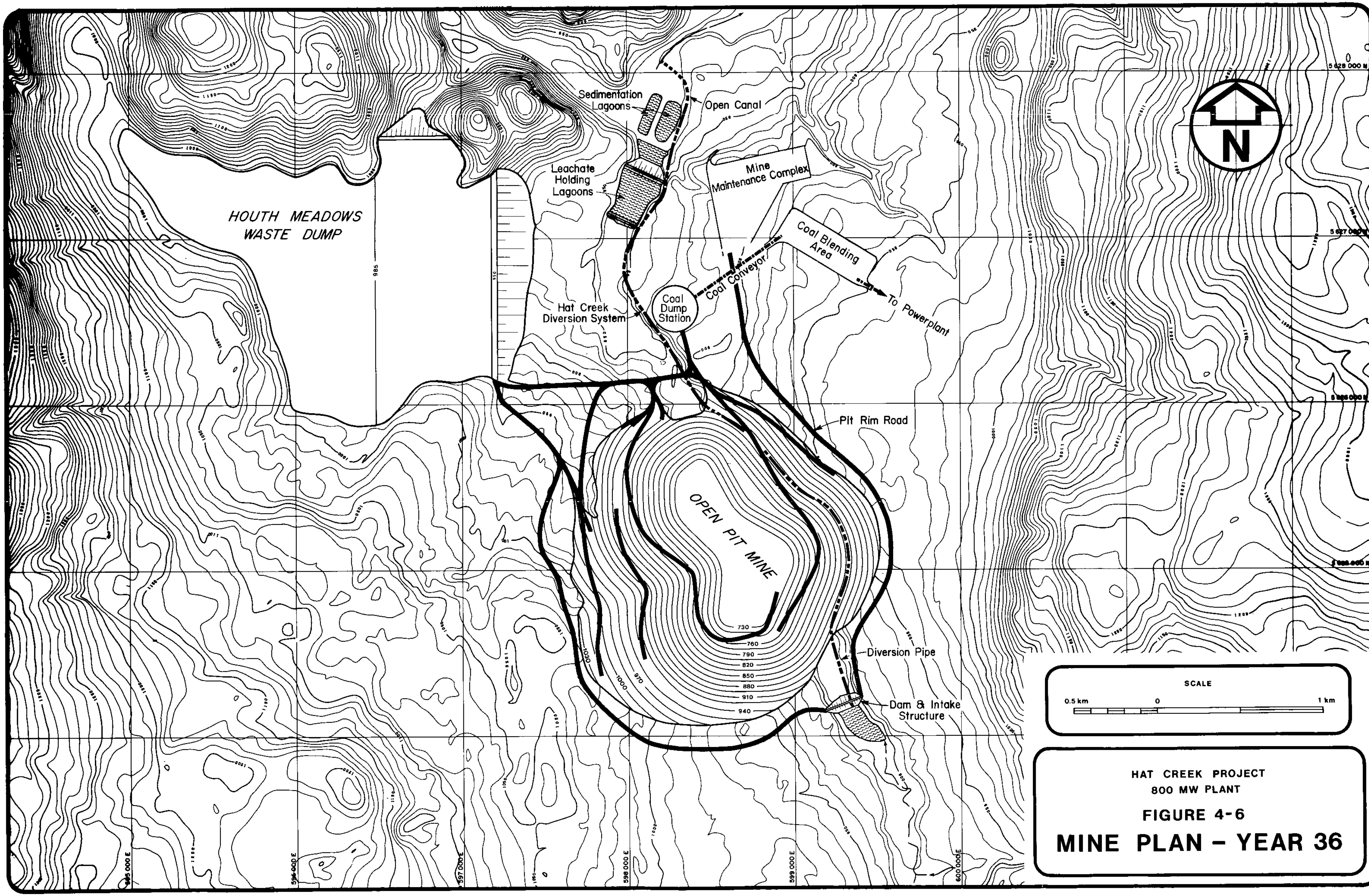
FIGURE 4-4
MINE PLAN - YEAR 5



HAT CREEK PROJECT
800 MW PLANT

FIGURE 4-5

MINE PLAN - YEAR 15



HAT CREEK PROJECT
800 MW PLANT

FIGURE 4-6

MINE PLAN - YEAR 36

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SECTION 5

MINE DEVELOPMENT

5.1 HAT CREEK DIVERSION

Hat Creek is the central watercourse in the Hat Creek Valley and is fed by numerous tributary streams draining an area of some 363 km^2. The creek flows across the No. 1 deposit area and must be diverted or contained within a pipe system before any significant mine development can begin.

For much of the year Hat Creek is a rather small stream, having an average annual discharge of 0.67 m^3/s, that in a dry year can dry up completely. During the annual snowmelt period considerably greater volumes of water flow occur and major diversion works must be installed to handle these quantities. A diversion system would be designed to handle the 1000-year return period flood volume of 27 m^3/s.

5.1.1 Diversion Alternatives

Several diversion schemes have been examined. The principal alternatives were:

(1) A diversion canal around the pit;

(2) A canal - tunnel - pipe system;

(3) Twin, relocatable polyethylene pipes through the pit.

The lower cost and practical twin pipe scheme was selected (see Fig. 5-1 and Table 5-1). This scheme utilizes a low diversion dam south of the open pit area incorporating intake and emergency overflow structures. From the dam the water is carried in a buried 2.4 m diameter fibreglass reinforced plastic pipe to the edge of the pit where it is diverted through one or both of two 1.5 m diameter polyethylene pressure pipes. Initially these two pipes would be laid alongside Hat Creek and as the mine developed would be relocated three times before reaching their permanent position on the east wall of the pit in Year 10.

Once past the pit area the pipes would be run through an embankment inside a corrugated steel pipe. The water would then be transferred to a 2.4 m diameter fibreglass reinforced pipe running alongside the leachate lagoon above the maximum planned leachate storage level. The water would be returned to the Hat Creek stream bed via a discharge conduit with an energy dissipation structure.

Should future changes in plan require the mining of additional quantities of the mineable coal reserves, this twin pipe system can be extended and relocated. A substantial increase in the coal requirement could necessitate relocating the diversion dam upstream.

5.1.2 Pipe Types

Sclairpipe is a polyethylene pressure pipe manufactured by Dupont. It comes in diameters of up to 1.5 m (63 inches O.D.) and is designed for internal pressures up to 310 kPa (45 psi). Lengths of pipe can be joined by butt fusion into continuous lengths or by flanged couplings. Sclairpipe is widely used in the mining industry and has the advantage that it can be left on the surface and readily moved as necessary.

Fiberglass Reinforced Pipe (FRP) consists of a tape made of continuous glass strands impregnated in resin wound around the pipe. The pipe is smooth on the inside and the maximum pressure capacity of the pipe is determined by the thickness of the pipe wall, and can be specified over a wide range.

The advantage of FRP is that it comes in larger diameters than Sclairpipe and therefore friction losses can be minimized. However, it is not quite as robust as Sclairpipe, and it would either have to be supported on the sides by earth berms, or buried in a shallow trench. FRP would therefore be most suitable for conveying Hat Creek flows at the approaches to the pit and downstream of the pit where the pipe would not have to be moved during pit expansion. Large diameter FRP has been frequently used for penstocks in hydroelectric projects. As an example, 1500 feet of 9-foot diameter FRP was recently supplied to Ontario Hydro for use as a penstock.

5.1.3 Diversion Location - Year 35

After Year 35, two situations are conceivable which would affect the diversion of Hat Creek. First, the mine could continue operating until all of the mineable coal is removed and the No. 2 deposit is developed. The waste from the No. 2 deposit would be used to backfill the open pit No. 1 and Hat Creek would eventually relocate to its original creek bed location. Second, the mine could stop operating and the twin pipe diversion within the pit may have to be relocated into a secure area outside the pit which would not be affected by any surface movements. Such a situation is deemed to be hypothetical though feasible and the probability of such relocation occurring has been estimated to be 25 percent. Funds have been provided in the cost estimate for such probability of this event occurring.

5.2 MINE DRAINAGE

Without effective mine drainage, no open-pit mining operation on the scale of Hat Creek could hope to succeed; nor could it satisfy today's stringent environmental requirements. The objectives of the Mine Drainage Plan are:

(1) to keep the mine dry enough to ensure continuous operation;

(2) to prevent flood damage to both excavations and equipment;

(3) to ensure the stability of slopes and embankments;

(4) to protect the environment by providing for the continuity of existing streams, preventing the discharge of harmful water-borne contaminants, and ensuring that all applicable regulations are observed.

For planning purposes it was assumed that the mine drainage plan for the 800 MW pit would be essentially the same as the 2240 MW plan prepared in 1979. Golder Associates are currently developing a drainage plan for the 800 MW project incorporating recent hydrological and field data.

5.2.1 Mine Water: Source and Quantity

The principal sources of drainage flow within the mining area are:

(1) Direct precipitation and runoff;

(2) Creeks entering the mine site;

(3) Standing surface water in lakes and ponds;

(4) Groundwater flow;

(5) Wastewater from mine operations.

5.2.1.1 Direct Precipitation and Runoff

Annual precipitation at the mine site is low, averaging 317 mm/a, of which 55 percent is received as rain and the balance as snow. Summer and winter are the wettest seasons, with spring and fall being somewhat drier. Fig. 5-2 shows the seasonal variation of precipitation and the frequency of annual and 24-hour precipitation. Roughly 16 percent of the annual precipitation which falls in the valley appears as streamflow, which indicates a high loss of moisture to infiltration and evapotranspiration. Most runoff occurs in spring and early summer, the most intense rainstorms in mid-summer. Flood hydrographs show that only 24 percent of the precipitation appears as direct runoff due to the high storage potential of the surface cover and high losses to evapotranspiration (Beak 1978). Mining activities are expected to reduce this surface storage capability and increase the runoff, resulting in increased peak flow rates from the watersheds. Maximum flow rates are expected during high intensity rainfall in summer, calculated by the method used by the USDA Soil Conservation Service (1964). This volume of runoff is correlated to peak flow rates which have been assembled from field data for small agricultural watersheds (USDA SCS 1975).

Surface runoff at the top of the active waste dumps is expected to be negligible. Leachate from waste dumps, which is expected to be low due to the low hydraulic conductivity of dumped waste, will be collected at the toe of the downstream waste embankments. Seepage and runoff from the coal and waste rock strata within the pit will be of similar quality to the stockpile and waste dump effluents. An average water yield of 80 mm has been assumed for these areas, giving mean annual flows of 0.003 m^3/s to 0.01 m^3/s during the lifetime of the mine.

5.2.1.2 Creeks

The principal creeks flowing through the proposed mine area are Hat Creek, Medicine Creek, Houth Creek, and Finney Creek. Of these, Hat Creek is the largest, and flows have been continuously recorded since 1960. Fig. 5-2 shows the range of monthly variation of Hat Creek. Flow gauges established in four other creeks in 1977 have as yet produced insufficient data to provide statistical analysis of flows, but such data as do exist indicate that the flow regimes are similar to that of Hat Creek. Flood frequency curves derived from regional streamflow data are shown on Fig. 5-3.

The proposed development of the open pit will require diversion of flows from various small watersheds and tributary creeks.

Regional streamflow data shown as a flood nomograph gives estimates of flood flows for watersheds greater than 10 km^2 in area.

5.2.1.3 Ponds and Lakes

Most ponds and lakes in the project area occur on the west side of Hat Creek Valley. There are two small lakes and 80 ponds to the west of the proposed pit perimeter.

Geotechnical studies of this area have identified both active and inactive slide masses in the overburden which may cause instability of the west pit slope during mining (Golder, 1977, 1978/79). Stabilization measures require that Aleece Lake and 61 ponds be drained. Finney Lake and 15 other small ponds lie in a more stable and remote area, and therefore drainage is not considered essential at the outset of the project. Monitoring of the slide during mining should give an advance indication of any need to drain Finney Lake and these other ponds. Fifteen to 20 ponds in the Houth Meadows Waste Dump Area should be drained prior to being covered with waste.

5.2.1.4 Groundwater

Studies to date have identified three major geohydrologic units within the general mine area (Golder, 1978) which comprise:

(1) the surficial deposits, which vary from slide debris and till in the west to gravels in the east. This is the major waterbearing unit of highest average conductivity 10^{-6} m/s;

(2) the coal, which exhibits highly variable conductivity, estimated to average 5 x 10^{-9} m/s;

(3) the upper and lower Coldwater sediments which are essentially impermeable with an average conductivity of 5 x 10^{-11} m/s.

General groundwater flow within the upper Hat Creek Valley recharges in upland areas and discharges in the valley bottom. Most of the groundwater flows through surficial deposits. Less than 2 percent is estimated to move through clastic sediments in the valley bottom.

The eastern areas are reasonably well drained due to the greater depths of surficial deposits, whereas they are thinner in western areas in addition to being of lower permeability.

The two main aquifers in the pit area are a small alluvial aquifer along the central valley and a buried bedrock channel on the east side of the valley, flow of which is estimated to be in the area of 3×10^{-2} m^3/s.

Due to the low permeability of the coal and bedrock units, water yield from seepage and draining operations during mining is predicted to be minimal (Golder, 1978). Extensive depressurization of pit slopes is not likely, and dewatering wells will therefore be selectively located in pervious zones, where higher benefits can be realized.

5.2.1.5 Mine Wastewater

Three main sources of wastewater produced by the mining operations have been identified:

(1) effluent from the Mine Services Area;

(2) runoff and leachate from coal-handling areas, waste dumps, and low-grade stockpiles;

(3) runoff and seepage from coal and bedrock strata in the open pit.

The major source of waste from the Mine Services Area will be sanitary effluent from the daily work force peaking at about 300 persons.

Runoff and leachate from coal and low-grade stockpiles will require special drainage and disposal systems due to the predicted high levels of dissolved salts (B.C. Hydro Thermal Division 1979 - 1978 Environmental Field Program).

The overburden and waste rock material from the open pit will be retained in valley-fill type dumps in Houth Meadows. Any runoff and leachate from mine waste disposal areas will require a special drainage system because of the predicted level of dissolved solids and trace elements in excess of regulatory guidelines for discharge to streams (Beak, 1978/79).

5.2.2 Mine Drainage System

The proposed mine drainage system will consist of:

(1) Twin pipes to divert the Hat Creek;

(2) Diversion canals to divert small creeks which flow through the mine site;

(3) Perimeter drains around the open pit, slide area, and waste dumps;

(4) Dewatering wells around the pit perimeter and the unstable slide area;

(5) Surface water drains to collect stormwater in the pit and mine service areas;

(6) Field drains to collect leachate from waste dump and stockpiles;

(7) Sanitary sewers to collect sewage from the Mine Services Areas.

The calculation of system capacity has taken into account the risk of flood damage, should the system fail. Design criteria are shown on Table 5-2. The larger drains or diversions have been designed on the basis of the 1000-year average return period flood. Smaller components are designed to withstand lesser flood risk.

5.2.2.1 Perimeter Drainage

The open pit will be surrounded by approximately 13 km of open perimeter drainage ditches. The drain to the northeast will collect runoff from areas of heavy traffic for discharge to sedimentation lagoons north of the mine. Northwest of the open pit, an open drain will discharge to the buried drainage pipe located in the conveyor causeway. To the south of the mine there will be three similar drains: the upper and lower southwest perimeter drain and southeast perimeter drains, which discharge to the pit rim dam.

5.2.2.2 In-Pit Surface Water Drainage

Surface water and seepage will be collected in open bench drains alongside bench haul roads. Runoff and seepage from surficial material above the mouth of the mine will flow by gravity to the north end of the pit, where it will be collected and discharged to sedimentation lagoons. Runoff from surficials below the mouth of the mine will be collected by bench drains, discharged to small pump sumps and raised to upper gravity bench drains by portable pumps. The lining of major bench drains will probably be required. Runoff and seepage from coal and bedrock strata in the base of the pit will drain via bench drains to sumps located near the main pit access. Temporary sumps and pumps will be placed in low areas on the floor of the pit to collect and remove accumulations of water. This system will discharge to a leachate storage lagoon to the north of the pit. During summer, water tankers used for dust suppression on bench and haul roads will be filled directly from sumps within the pit.

5.2.2.3 Dewatering Wells

A program of groundwater withdrawal is planned for the open pit. Around the pit perimeter and in the slide area 41 wells will be drilled. In addition, fifteen wells will be drilled in the coal and ten for observation purposes. The total water yield from these wells is expected to be low and average less than 2000 m^3/d. Water from wells in coal or clastic sedimentary rock will have to be collected in drainage sumps along with surface runoff and pumped to leachate storage lagoons.

5.2.2.4 Coal Blending Area

This covers an area of 10 ha and consists of two stockpiles totalling 5 ha. A compacted till blanket overlain by a pervious sand and gravel drainage layer will form the foundation of the stockpiles. Surface water and leachate will be drained to the northwest perimeter, from where it will be collected and piped to a leachate holding pond for temporary storage before final disposal by re-cycling for dust control within the mine.

5.2.2.5 Mine Services Area

To collect surface runoff from the Mine Services Area, yards will be sloped to open drains at the perimeter, and drainage around buildings will be handled in buried stormwater drains. Drainage will be channelled west to the main sedimentation lagoons via primary treatment to remove sediment and oil.

5.2.2.6 Mine Roads

Major roads in the northwest and northeast quadrants of the mine area and within the pit will drain to the sedimentation lagoons for primary treatment. Roads to the south will drain to a temporary sedimentation lagoon.

Small service and access roads will drain to local watercourses by sidehill drains. Particular care will be taken to limit erosion and scour by the use of stable drains and by early replanting of disturbed areas.

5.2.2.7 Sewage

Sanitary effluent from the Mine Services Area will be biologically treated and directed to the Zero Discharge System where it will be recycled to dust-control use in the mine.

5.2.3 Wastewater Disposal

To protect the environment in compliance with applicable government regulations, the quality of water discharged from the Hat Creek Mine should be within the British Columbia Ministry of the Environment Pollution Control Board's 'Level "A" Effluent Discharge Guidelines for the Mining Industry'.

5.2.3.1 Projected Quality of Mine Drainage

Chemical analyses of groundwater from surficial materials would seem to indicate that it is of very similar quality to that of Hat Creek during low flow periods. Hence drainage and seepage from surficials is considered suitable for direct discharge except for sediment control.

Based on present data, seepage and well-drainage from bedrock is expected to be unsuitable for direct discharge. Projections of water quality from various sources are given in Table 5-3.

1. Slide Area

Drainage from the wells will have high suspended solids concentrations. As a consequence, surface water and drainage from the wells will require sedimentation if the bentonitic slide debris is disturbed.

2. Waste Dumps

Runoff from the waste dump surface will be controlled in a series of local ditches and directed to the sedimentation lagoons for treatment prior to discharge.

Tests of leachate from waste materials has shown it to be of a quality unsuitable for discharge to surface waters. Leachate collected from the toe of the waste retaining embankment will be routed to the zero discharge system.

3. Coal-Blending Stockpiles

Leachate will be unsuitable for discharge due not only to high concentrations of chemical contaminants, but also to low pH. Runoff and leachate will be virtually inseparable due to the semipervious nature of the stockpiles.

4. Disturbed Land

Projections have been made on the basis of previous mining experience. Runoff from stripped or disturbed land will contain high concentrations of suspended sediment. Average sediment yield may increase by a factor of three. Experience in North Dakota has shown that, even after replanting, erosion rates may remain high. Sedimentation lagoons should therefore be kept in service until sediment has fallen to acceptable concentrations.

5.2.3.2 Leachate Lagoon

Seepage and leachate flows of quality unsuitable for discharge from, for example, the pit, waste dumps, coal stockpiles and sewage treatment plant, will be stored in a "Zero Discharge" lagoon system and evaporated in summertime by recycling the water for dust-control operations on coal stockpiles and pit roads. A large lagoon will be constructed in stages at the bottom of Hat Creek Valley, which will store 100 percent of the annual leachate production.

The selection of the required capacity depends on three factors: the acceptable risk of a leachate spill; the quantity and time distribution of annual inflow; and the quantity and time distribution of annual outflow. In this feasibility study, sufficient capacity has been allowed to cope with the maximum projected groundwater flow plus twice the projected mean inflow from surface runoff. The total leachate lagoon capacity is 560 000 m^3.

5.2.3.3 Sedimentation Lagoon System

This is required to reduce projected high sediment concentrations in runoff otherwise fit for discharge. This runoff comes from natural rangeland stripped of soil-cover during construction and operation, pit surficials, permanent stormwater drainage, and regraded and reclaimed waste dumps.

The sediment removal efficiency of the lagoon system takes into account the Level"A" discharge objectives of the Pollution Control Board.

During larger flood flows, the efficiency of sediment removal will decrease, but as the natural suspended sediment concentration in Hat Creek itself will rise (especially during the freshet), the net effect on receiving water quality should be low.

The three-lagoon system to be constructed north of the pit will consist of a primary sedimentation and flow balancing lagoon of

1.5 ha and two secondary lagoons totalling 4.5 ha. Total storage volume will be 250 000 m^3. The materials for the retaining dams and dykes will be excavated from deposits in the mine area. Test drilling reveals that conditions may be encountered during construction which require that a low permeability till lining be applied to the bottom of the lagoons.

Inflow to the primary pond will be via a stilling basin and inlet manifold, and outflow will be controlled by two decant towers. Inflow to the secondary lagoons will be via a pipe manifold and outflow via an overflow weir. When chemical treatment is required, chemicals will be added at two mixing points.

5.2.3.4 Lagoon Discharge

The effect of lagoon discharges on water quality have been assessed for three cases:

Case 1: where, under dry weather condition, Hat Creek would be at its lowest and the main inflow would be from dewatering wells.

Conclusion:

Water discharged will meet Pollution Control Board's "A" guidelines except for a higher sulphate concentration. The total dissolved solids concentration of receiving water will increase by less than 2 percent.

Case 2: where, under spring runoff conditions, the main inflow would be from surface water in the lower pit. Hat Creek flows would be high.

Conclusion:

The lagoon effluent will be suitable for discharge; only the sulphate concentration would exceed Level "A" discharge objectives. The total dissolved solids concentration in receiving water would rise by 2 percent.

Case 3: where, under summer rainstorm conditions, a large amount of surface runoff may occur in proportion to the rest of Hat Creek Valley.

Conclusion:

These are essentially the same as in Case 2 above, except that the solids concentration in receiving waters would increase by less than 5 percent.

After the mine has closed, the lagoon system will remain in operation until land reclamation has reduced sediment concentration in runoff to acceptable levels. During this time, the stored water may be used for irrigation.

5.3 SUPPORT FACILITIES

5.3.1 Mine Services Area

The location of the Mine Services Area, to the north of the open pit was selected for its proximity to the open pit, waste disposal area and coal blending yard. The proposed layout is shown in Fig. 5-4. The following structures and facilities are included:

1. Administration Building

Located close to the proposed powerplant access road. The structure will have a total floor area of 1300 m^2 with office space and storage areas for administrative and engineering departments.

2. Maintenance Complex

This structure centrally located in the services area has a total floor area of 7708 m^2 and contains various areas arranged and equipped to provide the specialized services required in an integrated maintenance facility. The layout includes: haul truck repair bays; tractor repair bays; auto repair and steam cleaning bays; welding fabrication and machine shops; electrical and electronic repair shops; component repair and assembly areas; emergency vehicle garages; first aid centre, training centre; administration offices; warehouse/storage areas; and building services.

All areas will be fully equipped with overhead cranes, machine tools and services such as air, water, power, oxyacetylene, etc. as required.

3. Mine Services Building

This structure, total floor area 900 m^2, includes the following: carpenters, painters and pipefitters shops; storage area for small equipment; and a storage area for service equipment, i.e. cranes, backhoes, etc.

4. Rubber Repair Shop

Includes work areas for the repair of tires, conveyor belting and electrical trailing cables. The total floor area will be 300 m^2.

5. Laboratory

Includes areas for coal sample preparation, analysis, and sample storage as well as office areas. Total floor area will be 500 m^2.

6. Mine Dry

Provision will be made to provide lockers and shower facilities for up to 300 personnel. Equipment rooms and janitorial space will be included. Total area will be 1450 m^2.

Other buildings provided will include fuel and lubricant storage and dispensing facilities; security offices and gate house; field service buildings, as well as laydown and storage areas for construction and operations. All buildings will be supplied with the normal services such as power and water supply, waste disposal, etc. and will be equipped with air conditioning, extractor fans, dust control, etc.

The area will be complete with storm and sanitary sewers and drainage ditches. A sewerage treatment plant will also be provided with treated water being routed to the leachate lagoon.

5.3.2 Water Supply

The mine area, service area, coal handling system and other facilities will be supplied, as required, with potable and fire protection water systems; washdown water; dust control water; and irrigation water. Potable and fire protection water will be supplied by a buried water supply line from the powerplant water supply reservoir. This waterline will initially supply construction water to the powerplant area from waterwells in the Hat Creek Valley until the water reservoir is in operation.

Dust control and washdown water will be supplied from the leachate lagoon at the north end of the valley. Irrigation water would be taken from the pit rim reservoir at the south of the open pit.

5.3.3 Power Supply

An electrical power distribution network has been developed to supply power to the open pit, mine services area and coal handling facilities. The layout is shown in Fig. 5-5.

The permanent supply line at 69 kV will originate in the powerplant switchyard and will run alongside the overland conveyor to a main substation, near to the mine mouth, for distribution into the other areas.

A 69 kV overhead ring main system will supply the pit area. Powerlines will run from this ring main to portable skid-mounted 69/6.9 kV substations which in turn supply the loading shovels through trailing cables. A 600 V supply will also be available from these substations. The mine services area will be supplied by underground 6.9 kV cables and the supply stepped down to 600/347 or 120 V as required for the various buildings or equipment. The coal handling system will also be supplied from local substations at 6.9 kV or other voltages as required.

Construction power will be provided by a temporary 69 kV line installed from the junction of Highway 12 and the Hat Creek Valley road into the main substation. Reliability of the system will be provided by using the ring main system.

The estimated installed power and the average annual loads are given in Table 5-4.

The principal support facilities are scheduled to be available for use in Year-2 to ensure an orderly development of the mine.

TABLE 5-1

HAT CREEK PROJECT

800 MW PLANT

DIVERSION PARAMETERS

Description	Quantity
Intake and diversion dam	
Max reservoir water elevation	896 m
Average dam height	11 m
Intake to pit rim	
Pipe type	FRP
Pipe diameter	2.4 m
Length	420 m
Within pit	
Pipe type	twin sclair pipe
Pipe diameter	1.5 m
Initial pipe length	2 x 1470 m
Final pipe length	2 x 1700 m
Pipe moves	3
Embankment section	
Number of embankments	1
Pipe type	twin sclair pipe
Pipe diameter	1.5 m
Length	2 x 500 m
Embankment to past leachate lagoon	
Pipe type	FRP
Pipe diameter	2.4 m
Length	1155 m
Discharge conduit after leachate lagoon	
Pipe type	FRP
Pipe diameter	2.1 m
Length	135 m
Open channel	
Approximate length	600 m
Total length of diversion	
Initial length	4280 m
Final length	4510 m

TABLE 5-2

HAT CREEK PROJECT
800 MW PLANT
DESIGN CRITERIA FOR PLANNING OF MINE DRAINAGE SYSTEM

Type of Drainage Element	Description	Design Flood	Probability of Exceedence In 35-Year/Mine Life
Major Creek Diversions	Hat Creek	1000 year*[1]	3%
	Finney Creek	1000 year*[1]	3%
	Houth Creek	1000 year	3%
	Upper Medicine Creek	Probable Max. Flood*[1]	---
Perimeter Drains	Around Pit	100 year	30%
	Waste Dumps and Slide Area		
Surface Water Drains Within Mine Development	Permanent Major Drains	100 year	30%
	Temporary Minor Drains	10 year	97%
Leachate Collection Systems	Field Drains	Max. Seepage Rate	---
Dewatering Wells	Collection Systems	Max. Pumping Rate	---
Sedimentation Lagoons	Emergency Spillways	1000 year	3%
	Treatment Capacity	10 year	97%
Leachate Storage Lagoons	Emergency Spillways	1000 year	3%
	Storage and Disposal Capacity	2 x Mean Annual Flow	---

*[1] Refer BCH HEDD 1978 and Monenco 1977 for Design Criteria.

TABLE 5-3

HAT CREEK PROJECT
800 MW PLANT
PROJECTIONS OF WATER QUALITY OF MINE DRAINAGE

	NATURAL SURFACE WATER				MINE DRAINAGE						DISCHARGE GUIDELINES
Parameter (mg/L)	Hat Creek*[2]	Medicine Creek Area	Finney Lake	Aleece Lake	Ash Leachate	Mine Waste*[3] Leachate	Coal Leachate	Slide Debris Groundwater	Pitwater*[4] Bedrock	Pitwater*[3] Surficials	PCB Level "A" Objectives
PH (units)	8.4	8.3	8.2	7.6	8.0-9.0	8.1	5.0*[1]	8.0	7.8	7.9	6.5-8.5
Filterable Residue	336	275	17.9	N.A.	4800-8900*[1]	1125	8400*[1]	1070	1950	350	<2500
Non-Filterable Residue	8-	0-110	N.A.	N.A.	N.A.	N.A.	N.D.	N.D.	N.D.	N.D.	<50
BOD_5	<1	N.A.	N.A.	N.A.	<35-195	137	N.D.	N.A.	N.D.	N.D.	N.D.
TOC	8	19	18	N.A.	N.A.	N.A.	N.A.	50	50	21	N.D.
Alkalinity	212	221	123	217	1120-1260	123	<27	570	1185	310	N.D.
Chloride	1.2	0.4	0.5	<0.5	175-190	27	14	28	42	4	N.D.
Fluoride	0.14	0.12	0.22	N.A.	3.3-4.9*[1]	0.06	0.1	0.16	0.2	0.2	2.5
Nitrate (as N)*[3]	<0.06	0.04	<0.02	N.A.	2.4-3.3	4.4	N.D.	<0.14	<0.06	<0.2	10
Kjeldahl Nitrogen (as N)	0.19	0.26	0.83	N.A.	N.A.	N.A.	N.A.	<11	14	<0.2	N.D.
Ortho Phosphate (as P)	0.038	0.01	0.025	N.A.	0.14-0.31	0.3	0.01	<0.03	<0.03	<0.03	2
Sulfate	50	20	5	52*[1]	1500-1580*[1]	21	3700*[1]	380*[1]	<321*[1]	270*[1]	50(3)
Arsenic	<0.005	<0.005	<0.005	N.A.	<0.6-2.4*[1]	0.07*[1]	<0.005	<0.005	0.006	<0.005	0.05
Boron	<0.01	<0.1	<0.1	N.A.	<3.0-3.6	0.04	0.31	<0.21	0.31	<0.1	N.D.
Cadmium	<0.005	<0.005	<0.005	N.A.	<0.1	<0.002	N.D.	<0.005	<0.005	<0.005	0.005
Calcium (as $CaCO_3$)	145	130	60	85	1050-1130	48	1900	208	180	200	N.D.
Chromium	<0.01	<0.01	<0.01	N.A.	<0.12-0.20*[1]	0.13*[1]	<0.01	<0.01	<0.01	<0.01	0.05
Copper	<0.005	<0.005	<0.005	N.A.	<0.23-0.33*[1]	1.5*[1]	0.04	<0.008	<0.008	<0.005	0.05
Iron	<0.018	<0.02	<0.04	<0.05	1.95-2.05*[1]	1.25*[1]	0.26	<0.06	<0.075	<0.031	0.3
Lead	<0.01	<0.01	<0.01	N.A.	<0.05	0.02	N.D.	<0.03	<0.013	<0.01	0.05
Magnesium (as $CaCO_3$)	74	85	33	100	220-230	33	2240*[1]	118	124	116	652 (as $CaCO_3$)
Mercury	<0.00038	<0.0005	<0.00033	N.A.	<0.0013-0.0023*[1]	0.0015*[1]	<0.0003	<0.0003	<0.0003	<0.0003	0.001
Sodium	20	11	15	38	325-335	63	190	230	412	93	N.D.
Vanadium	<0.005	<0.005	<0.005	N.A.	<0.18-0.22	0.01	<0.04	<0.006	<0.007	<0.005	N.D.
Zinc	0.008	0.009	<0.006	N.A.	0.82-2.5*[1]	0.15	0.11	<0.36	0.52*[1]	<0.03	0.5

Source: Beak 1978, 1979

Note:
*[1] Indicates parameter is in excess of PCB Level "A" Guideline.
*[2] Mean of measurements taken September 1976/77 during a low flow year.
*[3] Surface runoff has been projected to be of this quality (Beak, 1979).
*[4] Subject to review.

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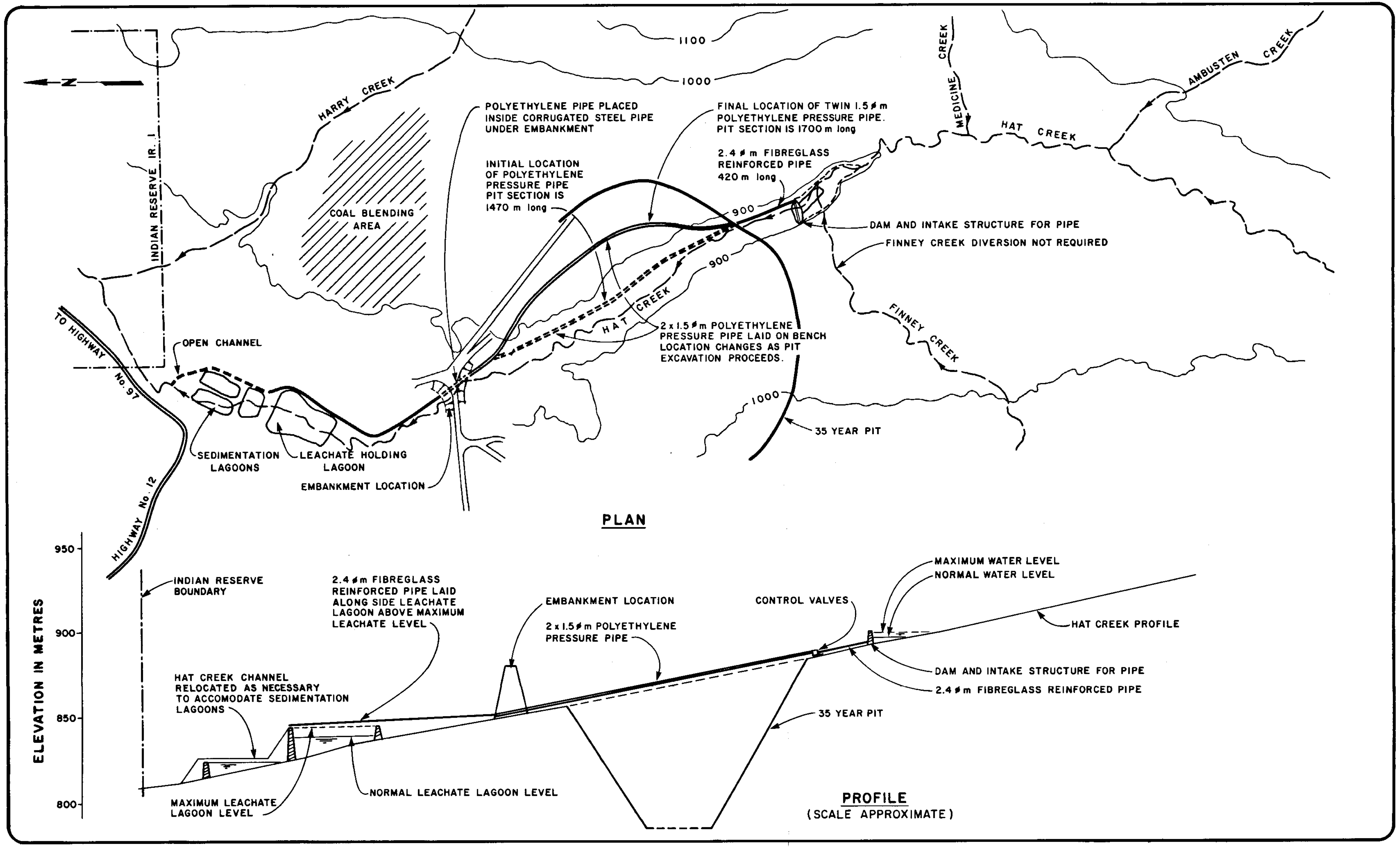
TABLE 5-4

HAT CREEK PROJECT

800 MW PLANT

ESTIMATED MINE POWER LOAD

	Peak Connected Load (kW)	Typical Load (kW)	Average Load (kW)
Mine Services Area and Ancilliary Equipment	5 250	2 120	1 690
Coal Handling System	5 803	3 480	2 020
Excavators	2 550	1 400	1 050
TOTAL	13 603	7 000	4 760



MH

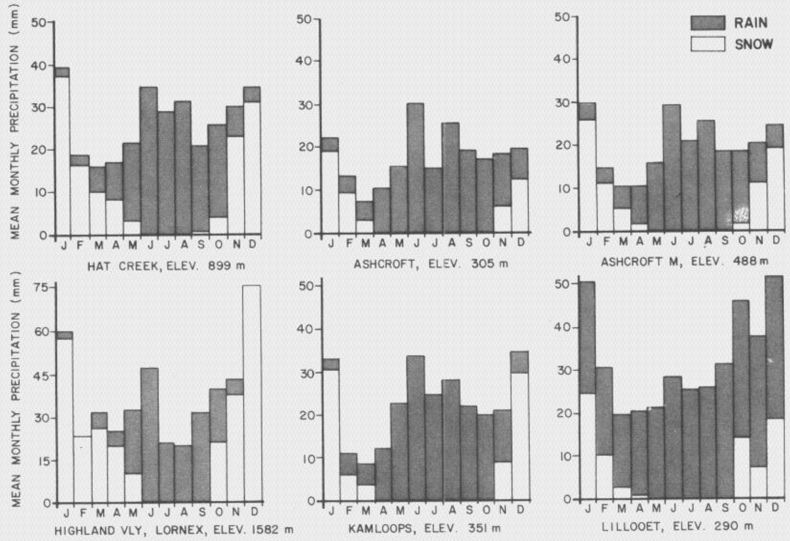
500 0 500 1000

HAT CREEK PROJECT
800 MW PLANT

FIGURE 5-1

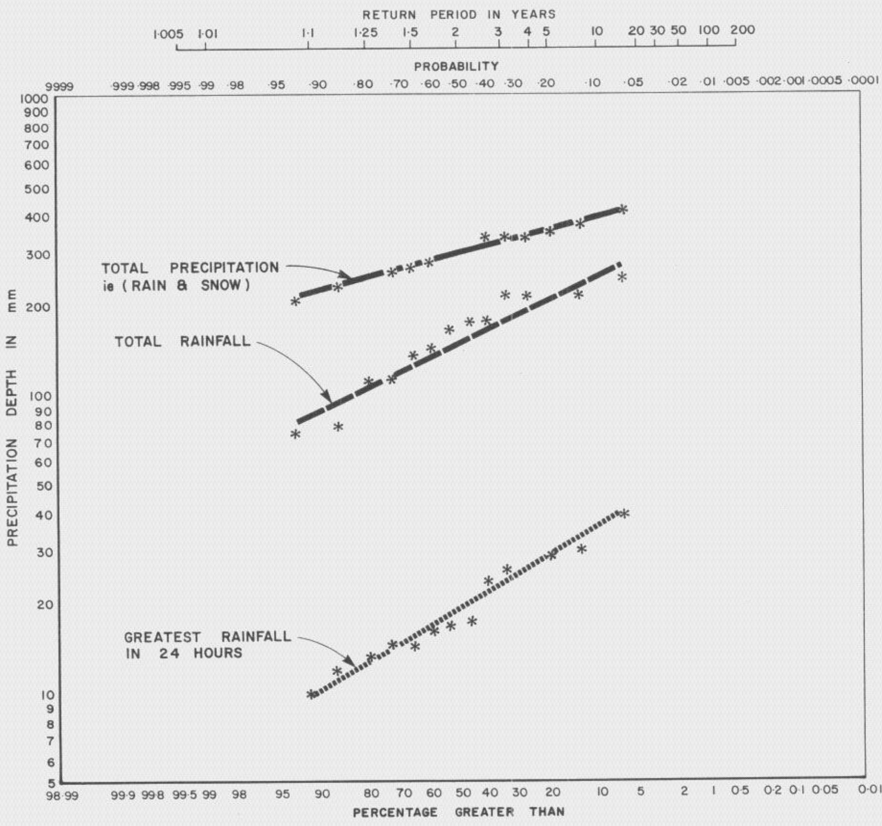
HAT CREEK DIVERSION

SOURCE: SIGMA ENGINEERING LTD/GOLDER ASSOC.



SEASONAL DISTRIBUTION OF MEAN MONTHLY PRECIPITATION IN THE HAT CREEK REGION

from Atmospheric Environment Service
Canadian Normals, 1973



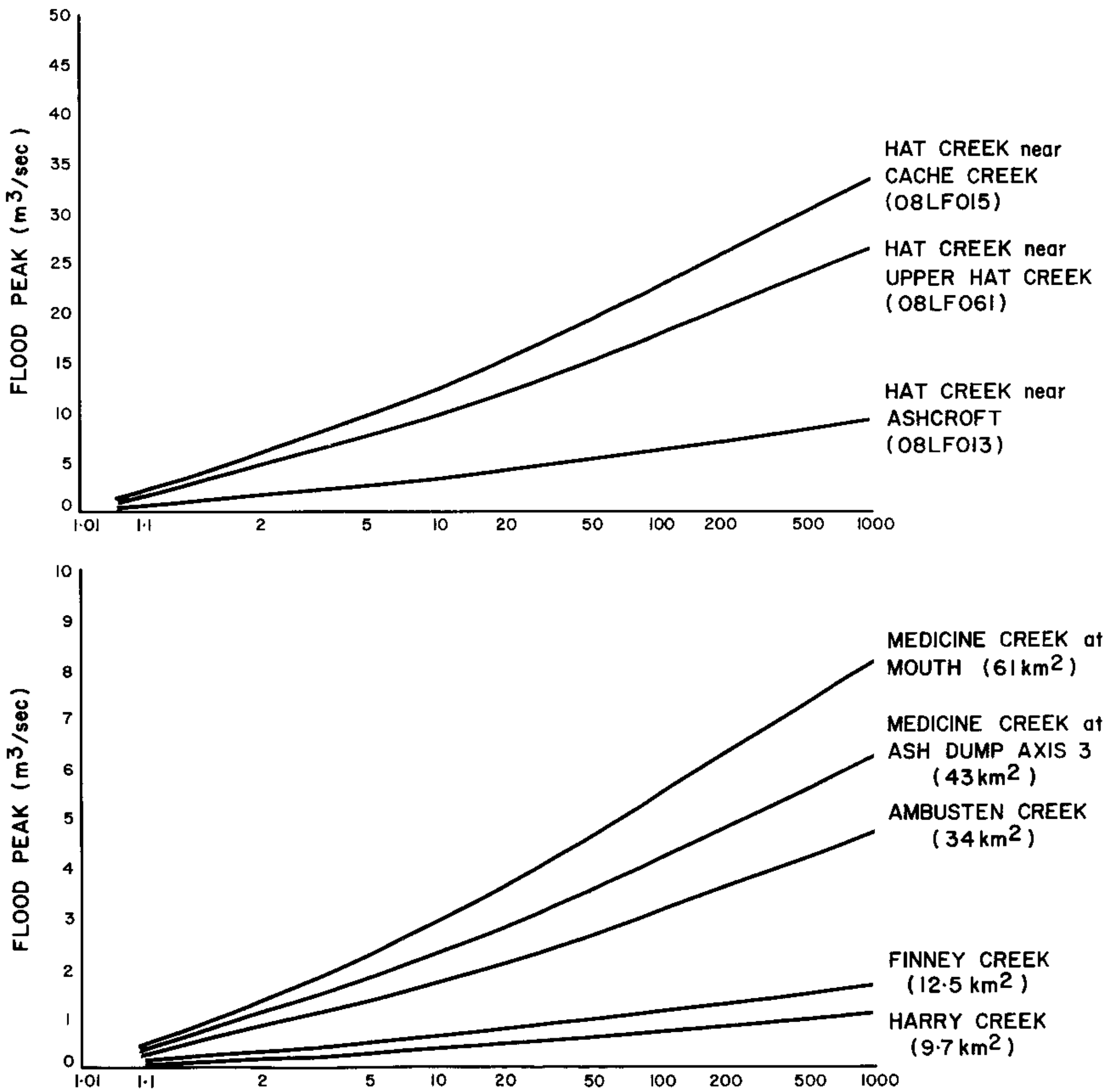
DISTRIBUTION OF PRECIPITATION DATA FOR HAT CREEK VALLEY

from Atmospheric Environment Service, Climatological Station Data

Source: Beak Hydrology Inventory Study, Draft March 1978

HAT CREEK PROJECT
800 MW PLANT
FIGURE 5-2
PRECIPITATION DATA

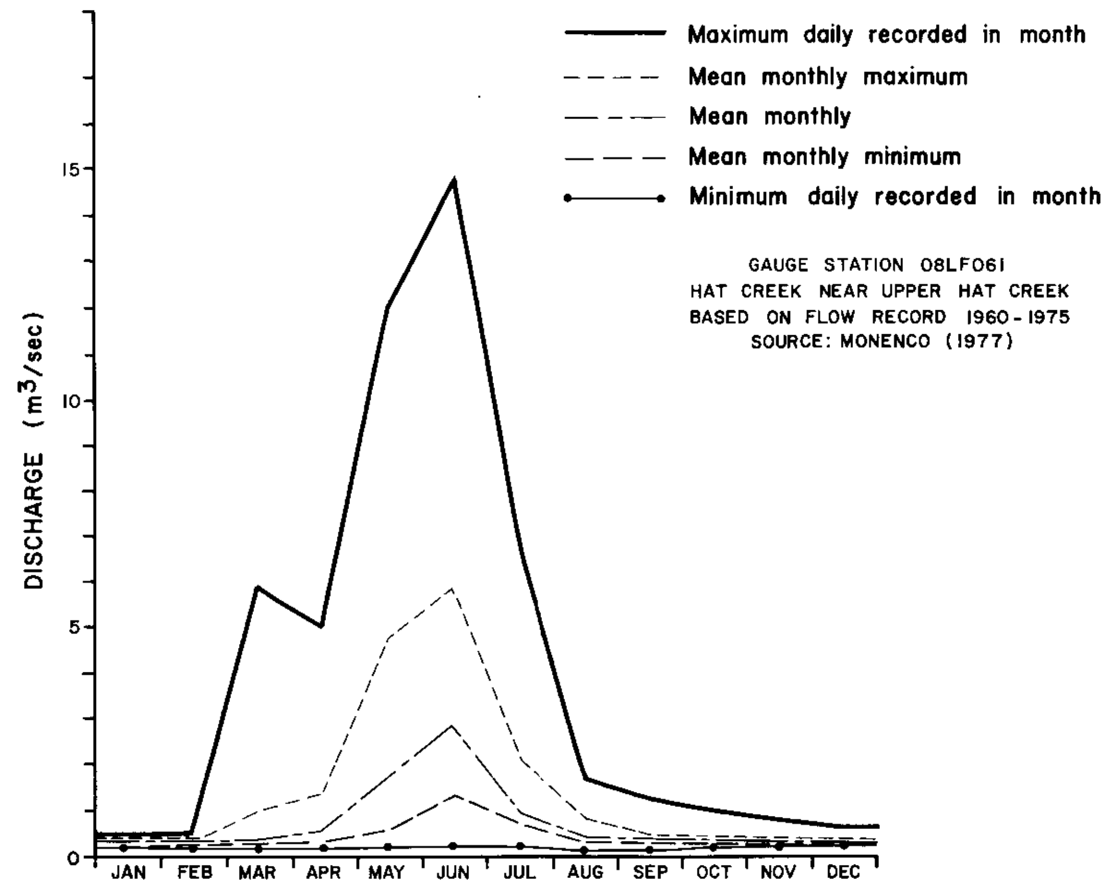
FLOOD FREQUENCY CURVES DERIVED FROM REGIONAL DATA



NOTE:
CURVES SHOWN ARE FOR ANNUAL SNOWMELT FLOODS

Source: B.C. Hydro H.E.D.D. Report 913, 1978.

MONTHLY FLOW IN HAT CREEK JUST ABOVE THE MINE SITE

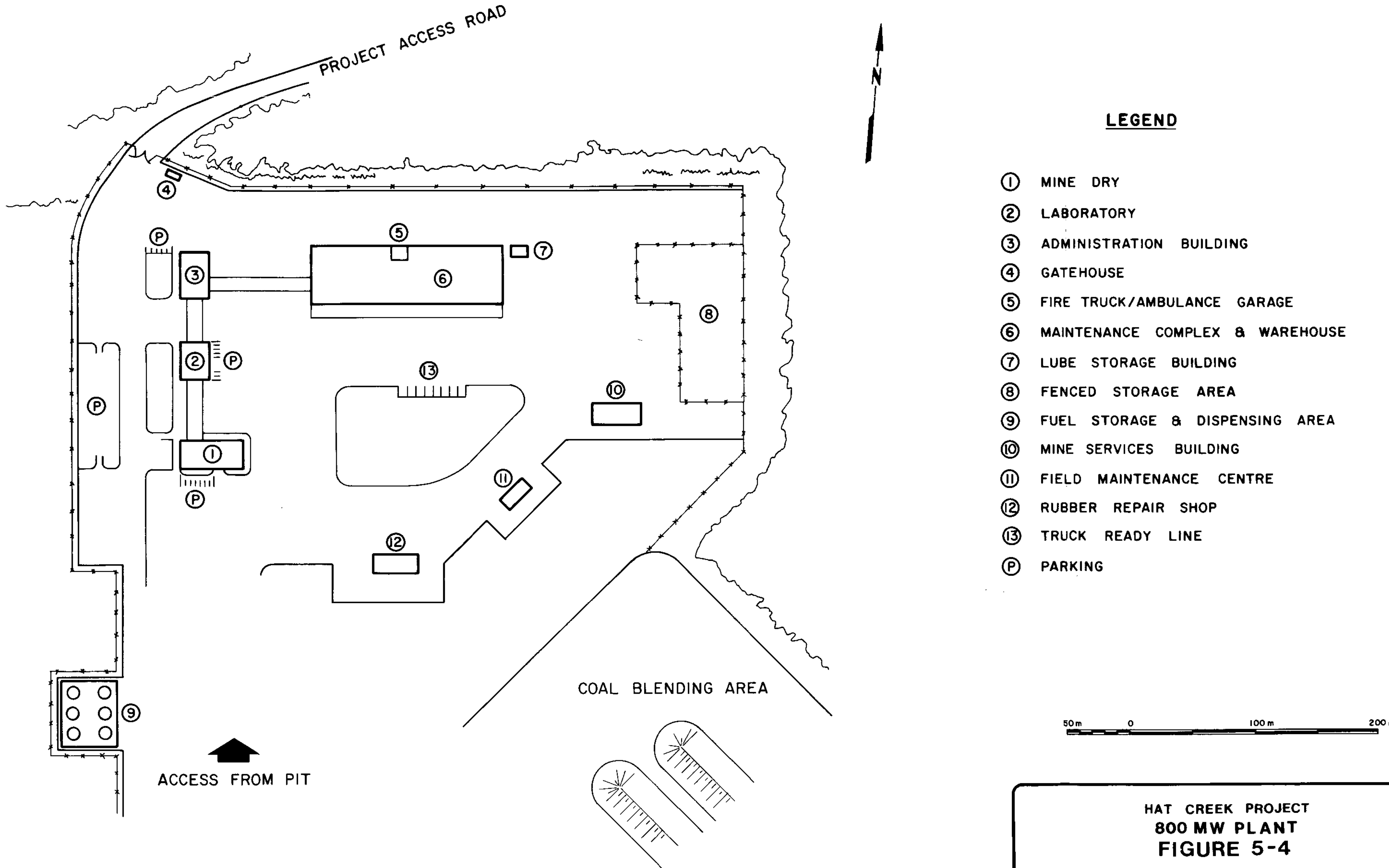


HAT CREEK PROJECT

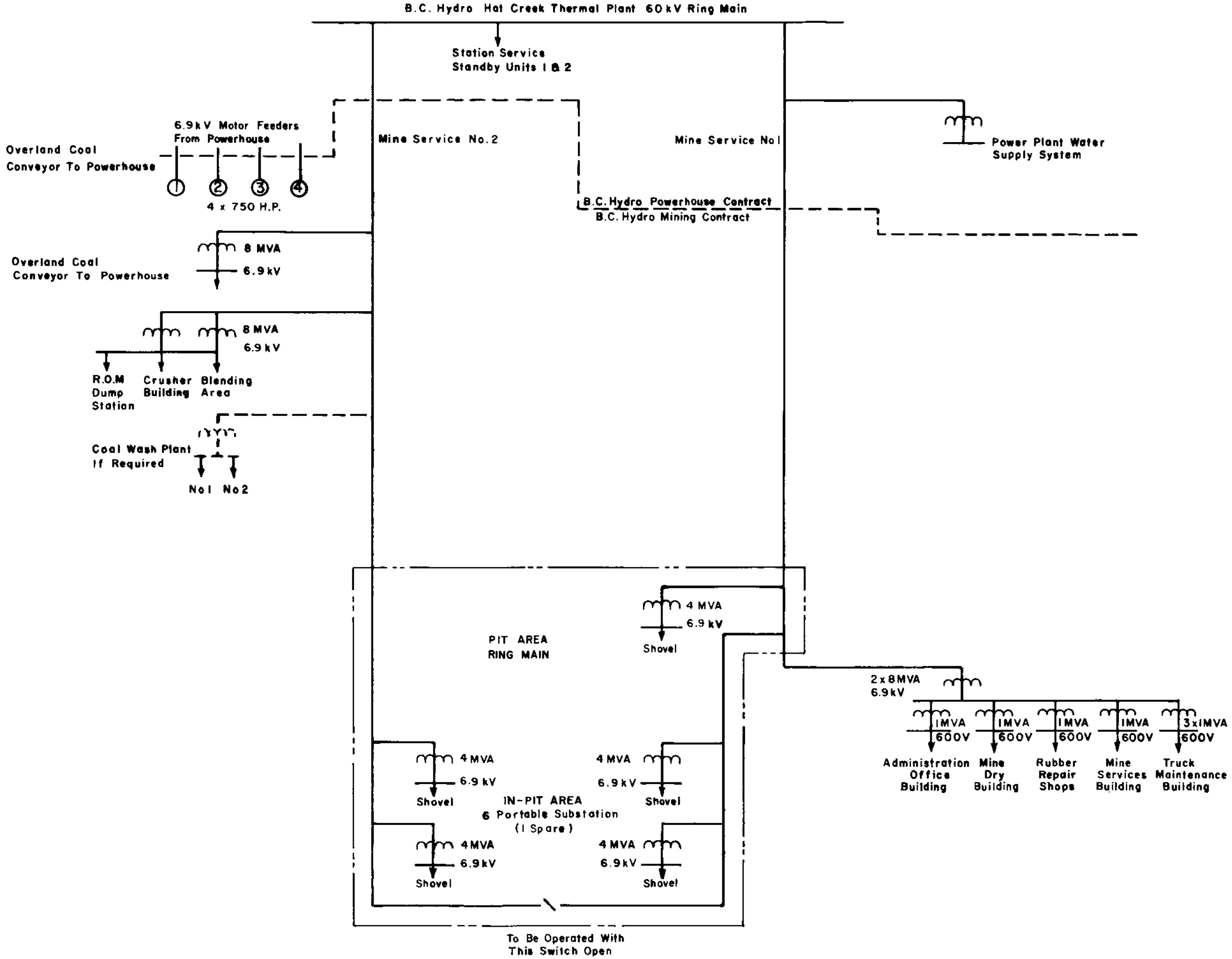
800 MW PLANT

FIGURE 5-3

STREAMFLOW DATA



HAT CREEK PROJECT
800 MW PLANT
FIGURE 5-4
GENERAL ARRANGEMENT MINE SERVICES AREA



HAT CREEK PROJECT
800 MW PLANT
FIGURE 5-5
MINE POWER
DISTRIBUTION NETWORK

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Figure No.

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6-2	Primary Coal Crusher
6-3	Layout of Coal Blending System
6-4	Screening and Crushing Plant

SECTION 6

MINING OPERATION

6.1 EQUIPMENT SELECTION

6.1.1 Background

The mining methods adopted for the supply of coal to an 800 MW powerplant follow similar principles as those used in the 2240 MW plan. However, there are some differences because of the reduced scale of operation. The peak annual total material volumes to be handled have been reduced from 24 Mm^3 to 9 Mm^3. The overall stripping ratio is reduced from 1.24 m^3 waste per tonne of coal to 0.82. The lower waste volume can all be stored in the Houth Meadows waste disposal area. These changes have had a major impact on the method of removing waste from the pit. The waste conveyor system has been eliminated from the mining method and replaced by a truck-shovel system.

In selecting the appropriate sizes and types of equipment for the tasks to be accomplished there are a number of conflicting objectives to be met:

(1) Equipment types should be standardized as far as possible;

(2) Capital and operating costs should be minimized;

(3) Sufficient flexibility must be maintained to permit the production of a variety of coal qualities needed to produce an acceptable blended fuel;

(4) A practical balance between trucks and shovels must be maintained.

In addition, the production schedule, different material characteristics and the seasonal variations in coal production must be accommodated.

In evaluating the equipment, specific manufacturers' models were assumed to be representative of the type and size of machinery required.

6.1.2 Truck Evaluation

Preliminary evaluations were conducted on four truck types with capacities ranging from 50 t to 136 t. The main objective of the evaluation was to select the truck size that provided a low operating and capital cost as well as a practical fleet size.

Over the 36 year life of the mine the rear dump trucks must haul 132 000 000 t of coal and 108 000 000 m^3 of waste material. The coal haul distance varies from 1.5 km to 3 km and the waste haul distance ranges from 3 to 6 km over the life of the mine. The annual quantity of waste removed peaks at 6.4 Mm^3 in Year 7 and gradually reduces to 150 000 m^3 in Year 36. The truck capacity and fleet size must be compatible with these changes in haul distance and the annual volumes of material moved.

To evaluate the performance of each type of truck the quantities of material to be moved, their destination and the haul road profile for the route were determined from the mine plan. Using a computer program and the performance specifications of the equipment, truck haul cycles and productivity were calculated for each of the first 6 years and at 5 and 10 year intervals thereafter. The criteria used in these calculations are listed below. The load, spot, wait and dump times were fixed for each size of truck.

Criteria for Truck Evaluation

Load Time	3.2 min.
Spot Time	0.5 min.
Wait Time	0.5 min.
Dump Time	1.0 min.
Maximum Road Grade	8%
Rolling Resistance	
Roads	3%
Bench Areas	5%
Dump Areas	5%
Maximum Speed	40 km/h
Availability	72%
Operating Shifts per Year - 3 shifts, 5 day week	540
- 3 shifts, 7 day week	750
Operating Efficiency (6 hours per shift)	75%
Truck Life	6000 shifts

Using the above criteria, productivities and operating costs were calculated for the following four cases:

(1) Coal: 50 t Trucks
Waste: 50 t Trucks

(2) Coal: 91 t Trucks
Waste: 91 t Trucks

(3) Coal: 91 t Trucks
Waste: 109 t Trucks

(4) Coal: 91 t Trucks
Waste: 136 t Trucks

The maximum size of coal truck used in Cases 2, 3 and 4 is 91 t. In this open pit mining operation, coal trucks are required to operate on 8 percent road grades. Large bottom dump trailer units which can carry 150 t or more of coal would not be able to operate safely or efficiently on these road grades, especially under bad weather conditions. Therefore, the maximum size of coal haulers was limited to 91 t rear dump trucks.

The maximum size of waste truck considered in this evaluation is 136 t. The volume of waste material handled each year would be relatively small for trucks larger than 136 t. The selection of larger trucks would result in a small fleet which is difficult to schedule efficiently.

These four alternatives were evaluated in a detailed cost and productivity analysis. The results of this analysis are summarized in Table 6-1.

Case 2 (91 t trucks for both coal and waste) was selected for the following reasons:

(1) The unit cost per tonne for Case 2 is within 91 percent of the lowest cost alternative (Case 4).

(2) In Case 2 savings in operating costs would be realized by having the same type of truck hauling both coal and waste. Parts inventory would be reduced and the quality of maintenance work would be improved because of standardization.

(3) The Case 4 waste truck fleet size is small and this factor would cause scheduling difficulties particularly in the latter years of the mine plan. In Year 30 the number of trucks required for waste removal is three. This size of fleet would be inefficient to operate.

After the 91 t trucks were selected for coal and waste transportation further detailed studies were carried out to optimize the fleet size and operating costs. The truck productivities were adjusted to reflect the final shovel selection. The fleet size was also adjusted to ensure adequate hauling capacity is available to handle the seasonal fluctuations in powerplant coal requirements.

6.1.3 Shovel Evaluation

The selection of the type of shovel to be used is dictated by the characteristics of the materials to be excavated and the necessity for the selective mining of waste partings to improve run-of-mine coal quality. In waste the major concern is the ability to dig consolidated claystone and siltstone without being forced into drilling and blasting. These materials would be difficult to blast effectively because of their cohesive nature. The digging action of the hydraulic shovel enables it to excavate both the coal and consolidated waste more effectively than cable shovels. The hydraulic shovel has additional advantages: lower capital cost; greater mobility; and can be converted quite readily to operate as a backhoe. The backhoe configuration could be particularly useful for selective mining and excavating sinking cuts. Electric powered hydraulic shovels were selected.

Two types of hydraulic shovels were evaluated to find a satisfactory match for the 91 t truck fleet in both coal and waste. The first shovel evaluated can be equipped with a 14 m^3 bucket in the higher density waste material and an 18 m^3 bucket in coal. The second shovel can be equipped with a 10 m^3 and an 11.5 m^3 bucket respectively. The bucket sizes were selected from the range of standard sizes provided by the manufacturers as being most suitable for the material. In the detailed design phase it is quite possible that custom made buckets could be available to improve the machine capability.

There are three principal factors that govern the number of shovels required to meet the output requirements: shovel productivity, efficient scheduling and coal quality control. The criteria and productivity for the two types of shovels are shown in Table 6-2.

In the peak waste production years (Years 2 to 7) three shovels with 10 m^3 buckets would be required to ensure continuous efficient utilization of the truck fleet. With the larger 14 m^3 shovel a fleet of two, with only one operating at a time, would keep the truck fleet operating at maximum efficiency.

The number of coal shovels required is governed by the need for selective mining, a consistent blended product and seasonal fluctuations in production levels. To maintain a consistent coal quality in a variable deposit, several coal faces will have to be available for proper blending. To provide this flexibility in operation a fleet of three shovels is required for the excavation of coal and waste partings. Both types of shovel evaluated would provide excess capability under these conditions.

A preliminary evaluation of the economic impact of excess shovel production capability was made. The results showed that the underutilized capital cost of the shovels was more than offset by the improved truck productivity.

A comparison of the total capital and operative costs for loading and hauling over the life of the project for each shovel alternative is shown in Table 6-3. The use of the 91 t trucks in both coal and waste is assumed. This table shows the total costs of the larger shovel to be approximately $10 million less over the project life. The following conclusions were made:

(1) Operating costs are lower for the larger shovel because of its higher productivity;

(2) The higher shovel capital cost is more than offset by the lower operating cost;

(3) Truck operating costs are reduced because of the higher productivity generated by a faster loading time;

(4) The increased truck productivity reduces the size of the truck fleet required with a consequent decrease in the initial and replacement capital expenditures.

As a result of this evaluation the larger shovel equipped with a 14 m^3 bucket in waste and an 18 m^3 bucket in coal was selected for this mine plan.

6.2 MINING METHODS

6.2.1 Pre-production Development

The development of the mine commences 2½ years ahead of the commercial in-service date of the first generator unit. By the time this activity starts it is planned that the creek diversion, drainage system and the mine administration and maintenance facilities will be completed.

Initial pit development starts close to the centre of the deposit to establish side-hill mining benches west of Hat Creek. These benches will be 15 m high and will be mined using electric powered hydraulic shovels equipped with 14 m^3 buckets loading 91 t diesel-electric rear dump trucks. Waste excavated during this period will be used to construct ramps and roads to the coal dump station and the Houth Meadows waste disposal area. Material unsuitable for road construction will be transported directly to the waste dump. Coal encountered during the early development phase that must be removed will be stockpiled until it can be used for building the base layer for coal stockpiles. Any excess coal will be blended in with coal extracted during regular mining operations. The transition from development to operations comes with the completion of the coal handling system and the first delivery of coal to the powerplant.

During the first year of mine development (1990) the major mining equipment fleet will comprise one 14 m^3 shovel and four 91-t waste trucks. Initially the operation will be on a single shift five day week with a second shift added as crew training proceeds. In the second year a second shovel and five additional trucks are added to the fleet.

6.2.2 Waste Removal and Disposal

The transition to regular waste removal operations occurs in Year 1 (1992). The fleet acquired during the pre-production period continues in this service with the addition of a third shift five days a week. Starting in 1993 for a period of 6 years waste production runs at a high level averaging 5.7 Mm^3 per year. During this peak period operations will be scheduled to run three shifts per day seven days a week. The operations schedule will provide for one of the two shovels to be operating each shift with six or seven of the fleet of nine 91 t trucks. Based on the estimated productivity of the trucks and shovels this size of fleet would be well matched.

The peak production period is followed by 6 years with an average waste removal requirement of 3.6 Mm^3. The operation would be adjusted by cutting back to a five day week three shift schedule. At this level of operation the shovel would be slightly underutilized, while the truck fleet would be operating at full capacity because of the longer haul distances. Further reduced quantities beyond Year 14 (2005) would permit the operation to be cut back to two shifts a day until in the final 6 years of the project the waste quantities become insignificant compared to the coal output and could be handled as required by the coal fleet.

Two waste shovels would be required until Year 10 (2001). At this time both would be scheduled for replacement. However one would be retired and only one replaced. The logic for this approach is that the coal shovels have significant excess capacity and by this time an increasing proportion of the waste is mined on the same benches as the coal. In the earlier years the excavation of the two types of material occurs at substantially different elevations. The remaining waste shovel would be retired in Year 29. The truck fleet would be maintained at nine trucks through to Year 29, although operating on a varied shift schedule as outlined above. In the final years of the project the truck fleet size tapers off.

All waste from the mine will be disposed of in Houth Meadows. The waste retaining embankment will be constructed primarily with the sands and gravels that occur to the east of Hat Creek. These materials will be spread with D-8 bulldozers in lifts 1-2 m thick. Truck and bulldozer travel should provide adequate compaction to ensure a stable embankment.

The weaker waste materials will be placed in lifts 10 m thick. It may be possible, with experience, to increase this lift thickness safely; but the savings in bulldozer spreading time must be evaluated against the cost of raising the material the additional height prior to dumping. Travel conditions on the dump will vary widely depending on the material being handled and the weather conditions. When handling the weak clay materials in substantial quantities it will be necessary to confine truck travel to well-defined, constructed roads.

It is planned to reclaim the dump on a progressive basis. In placing the final lift the material must be carefully selected. In areas where the claystones are dumped a 1 m capping of colluvium or other suitable reclamation material is required.

6.2.3 Coal Mining

The initial supply of commissioning coal for the powerplant is scheduled for delivery eight months ahead of the commercial in-service date. This coal will be supplied from the stockpile produced during the pre-production development phase. A pre-requisite to delivery of coal to the powerplant is the completion of the installation of the coal handling system, which is discussed in Section 6.3.

The outstanding feature of Hat Creek coal is its variability. Successful powerplant operation is dependent upon a reliable supply of fuel of reasonably consistent quality (see Section 3.4.3). The mining system is designed to meet this requirement. The blending facilities are adequate to ensure that 110 000 t batches of coal can be delivered with an acceptable variance from the mean quality of the pile. To ensure the capability of constructing a coal pile with an acceptable mean quality requires that waste partings be selectively rejected and that sufficient shovels are located in the mine to provide access to a range of coal quality. To provide this degree of flexibility in meeting coal quality requirements it is judged that three shovels should be provided for coal operations.

The size of the truck fleet to be provided for coal operations is determined by the requirement to meet average winter production levels of 93 000 t per week. This truck fleet also provides the capability to haul the average expected quantity of waste partings to Houth Meadows.

Using the selected hydraulic shovels with an 18 m^3 bucket the winter production level of coal and partings can be excavated and loaded on a three shift per day five day a week schedule with one shovel operating. Over the course of the week it is anticipated that each of the three shovels provided would be operated in coal of a different quality for sufficient shifts to meet specifications. After the initial production build-up the truck fleet consists of five coal trucks until Year 10. Because of the increasing depth of the pit the fleet increases to six and finally for the last 10 years of the project life to seven trucks.

The sizing of the fleet to meet winter production levels generates surplus equipment capability during the summer. This surplus can be used for road construction, miscellaneous pit clean-up tasks or to boost waste production capability. To meet these alternative applications it is strongly recommended that spare truck boxes and shovel buckets of the appropriate size be provided to protect the equipment against abuse.

On occasion it may be necessary to produce coal at a rate in excess of the planned winter production level. Adequate shovel capacity is available for this purpose however, additional trucks from the waste fleet would have to be diverted to coal transportation.

6.2.4 Support Equipment

A fleet of mobile equipment has been identified to provide the necessary support to the major production systems. The principal support functions are: road construction and maintenance; mine support which includes pit clean-up, waste spreading and mine pumping and drainage; and transportation and maintenance equipment.

Because of the weakness of much of the material at Hat Creek, considerable road construction will be required on virtually every bench to ensure that the production trucks and service equipment can operate efficiently. Truck haul roads will generally be constructed 25 m wide, with a 1 m base topped with 20 cm of crushed gravel. In some cases the roads will be built on more stable material which will permit the building of less substantial roads. Major haul road construction will be restricted to the summer months to avoid the problems that winter-built roads have due to trapped excess moisture and poor compaction. The major part of the materials required for road construction will be handled by equipment from the coal production fleet during the summer months.

Regular maintenance of haul roads will be provided by a fleet of 14-G Graders supplemented by other equipment when required. During wet weather it will be critical to prevent the build-up of slick bentonitic clay on the roads because of the safety hazard. In these circumstances the road surface must be bladed clear of wet material and a top dressing of crushed gravel applied.

Provision has been made in the estimates for the purchase and operation of road construction and maintenance equipment including snow removal, dust and ice control, gravel crushing and ditch maintenance.

Routine mine support is provided as follows:

(1) Shovel clean-up - 824 rubber tired dozers supplemented by D-9 rippers when required;

(2) Bench pioneering, ramp construction - 631 Scrapers with D-9 pushcat;

(3) Waste spreading - D-8 dozers;

(4) General clean-up - 988 front end loaders;

(5) Conveyor system clean-up - 953 traxcavator equipped with clean-out rake;

(6) Blending stockpile support - 988 loader; 825 B compactor; vibratory compactor.

The transportation and maintenance fleet includes pickups, buses, cranes, maintenance service vehicles, a fire truck and an ambulance. A summary of the peak requirements for mobile equipment is shown in Table 6-4.

6.3 MATERIALS HANDLING

6.3.1 System Design

6.3.1.1 Design Criteria

The mine coal handling system has been designed to handle the operational requirements of the mine and powerplant, bearing in mind costs, safety, environmental aspects and material characteristics. The system layout is shown in Fig. 6-1, and Table 6-5 lists all mine conveyors. The requirements of the system are to provide a reliable supply of fuel to the powerplant at a consistent quality and in the quantities shown in Table 4-3.

The peak hourly design capacity of the system is 1180 t/h or 1180 x 5 x 24 = 141 600 t/5-day week. The maximum requirement for coal at the powerplant at a 100 percent capacity rating (MCR) is 110 000 t/7-day week. Therefore, the coal handling system can meet the powerplant demand at a 77 percent availability on a 5 day/week (or 15 shift/week) basis.

The design criteria used are as follows:

- bulk density for capacity = 800 kg/m^3
- maximum conveyor slopes = 14°
- idler troughing angle = 35°
- angle of surcharge = 20°

6.3.1.2 Design Features

The design features incorporated into the system to handle the coal, which contains varying amounts of clay materials, include: chutes, hoppers, and bins designed with steep slopes to prevent material build-up; horizontal conveyor loading points with skirtboards fitted for lump control; dust suppression and/or collection equipment; fire protection systems. Coal stockpiles will be compacted where necessary to minimize the danger of spontaneous combustion.

The coal handling system also must have certain control equipment to ensure safety and reliability, this will include: overload protection devices; sequential starting and stopping logic control;

chute and bin plugging switches; holdbacks on inclined conveyors; emergency safety trip cords; low speed and side travel switches etc. Conveyors will be fitted with dust covers where practical and enclosed in galleries where necessary.

6.3.2 Coal Handling System

6.3.2.1. Primary Crushing and Conveying

Run-of-mine coal will be delivered to the truck dump station (El. 880 m) located at the mine mouth. The coal will be dumped onto a grizzly, with 450 mm square openings, mounted over a 300 t capacity hopper. An apron feeder discharges the coal from the hopper onto a roller screen working in conjunction with a Siebra swivel arm crusher. The roller screen will permit coal at a nominal -200 mm to pass through, while larger pieces are crushed by the overhead crusher arm. Uncrushable materials, such as petrified wood, lift the crusher arm and are carried through to a rejects conveyor for stockpiling. Fig. 6-2 illustrates the layout of the installation. The -200 mm coal that passes through the roller screen is directed by a chute onto the mine conveyor for transportation to the blending area.

Oversize coal lumps retained on the grizzly will be broken with a hydraulically powered hammer. Oversize waste material will, along with the stockpiled rejects, be removed and transported to the waste disposal area using front end loaders and trucks.

The mine conveyor, 1050 mm wide, will deliver the crushed coal to the coal blending area via a transfer house at the blending yard. The transfer house will contain an automatic sampling system and an on-stream ash analyzer to monitor the quality of coal entering the blending system. This will enable adjustments to be made in the mining plan to ensure the coal blend meets the specifications.

6.3.2.2 Blending, Reclaiming and Coal Delivery

The blending system provides two functions: to smooth out the variations in run-of-mine coal quality, i.e. 9.3 MJ/kg to 22.0 MJ/kg averaging 18.1 MJ/kg (dcb); and to provide surge capacity between the mine and powerplant. The blending system selected uses the windrow method of pile construction, this method gives a better blending efficiency by reducing particle segregation and reduces dusting potential.

The chevron method was the other construction technique considered for this study.

The selected layout of the system, shown in Fig. 6-3, comprises two stockpiles each 110 000 t capacity or one week supply of coal to the powerplant at maximum capacity rating.

The coal will 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. The stacker travelling speed will be automatically controlled through a weighscale link-up to ensure that windrows of uniform cross-section are built. After building one stockpile the stacker slews through 180° and will be ready to commence stockpiling on the other pile.

The major specifications of the stacker are:

Capacity:	1180 t/h
Boom Length:	34 m
Lifting Height:	15 m

Reclaiming of the blended coal will be by a single bridge mounted bucket wheel reclaimer fitted with twin bucket wheels for better blending efficiency when the lump size is considered, i.e. -200 mm. A moving rake fitted to the reclaimer aids in the blending of the coal and improves the safety of the working face.

The reclaimed coal will be delivered to the 1050 mm wide reclaim conveyor for transfer to the overland conveyor. On completion of the reclaiming of one stockpile the reclaimer is transferred by a transporter car to the other pile.

The features of the reclaimer are:

Bridge Span:	38 m
Number of Wheels:	2
Capacity:	variable up to 1180 t/h

The coal will be delivered to a screening and crushing plant located in the powerplant area, some 3.5 km away and 500 m higher in elevation, by a 1050 mm wide overland conveyor consisting of two flights. The conveyor, mounted at ground level over cut and fill sections, will be fitted with dust covers. A 5 m wide service road will be provided alongside the conveyor to facilitate maintenance.

Normally all coal will be processed through the blending system, however provision will be made to allow coal to bypass the system in emergencies. An emergency reclaim conveyor and hopper will be provided in the blending yard for such times when the reclaimer is out of commission.

An automatic coal sampler located in the transfer house at the tail end of the overland conveyor monitors the quality of the coal leaving the blending system.

6.3.2.3 Secondary Screening and Crushing

The overland conveyor will discharge the blended coal at -200 mm into a 300 t surge bin located ahead of the screening and crushing plant as shown in Fig. 6-4. Reclaim from the surge bin will be by apron feeder at 1180 t/h feeding onto a 1200 mm wide screen feed conveyor delivering to the screening and crushing plant. The coal will be discharged onto a vibrating screen fitted with 50 mm square woven wire screen decks. Overflow at +50 mm will be discharged into an impact crusher for reduction to -50 mm. Screen underflow recombines with the crushed product on the powerplant feed conveyors which form part of the powerplant coal handling system.

Provision will be made at the 300 t surge bin to allow diversion of the blended coal to the powerplant live and dead coal storage area. Coal reclaimed from this storage area will be delivered to the surge bin for secondary screening and crushing. An emergency unloading system will be provided for the surge bin.

6.3.2.4 Operations

Coal handling operations will normally be conducted on a 5-day week schedule. On weekends the options available for meeting the powerplant requirements are:

(1) The live stockpile at the powerplant.

(2) The dead stockpile at the powerplant.

(3) Schedule extra shifts for reclaiming coal from the blending piles in the mine.

In general option (1) should be followed to ensure the regular turnover of the live uncompacted pile.

TABLE 6-1

HAT CREEK PROJECT
800 MW PLANT
TRUCK EVALUATION - COST COMPARISON
(WEIGHT OF MATERIAL HANDLED OVER 35 YEARS = 349 156 000 t)

Case	(1) Coal 50 t	(1) Waste 50 t	(2) Coal 91 t	(2) Waste 91 t	(3) Coal 91 t	(3) Waste 109 t	(4) Coal 91 t	(4) Waste 136 t
Fleet Size:								
50 t New	7	27						
Replacement	10	13						
91 t New			4	15	4		4	
Replacement			5	8	5		5	
109 t New						12		
Replacement						7		
136 t New								10
Replacement								5
Initial Capital	$17,102,000		$ 14,934,000		$ 13,656,000		$ 14,054,000	
Replacement Capital	$ 9,844,000		$ 8,684,000		$ 8,555,000		$ 7,975,000	
Operating Costs	$178,534,000		$127,115,000		$121,869,000		$116,893,000	
Total Costs	$205,480,000		$150,733,000		$144,080,000		$138,922,000	
Cost/Tonne	$0.589		$0.432		$0.413		$0.398	

TABLE 6-2

HAT CREEK PROJECT
800 MW PLANT
HYDRAULIC SHOVEL CRITERIA AND PRODUCTIVITY

	Coal	Waste	Partings
Bucket Sizes (m^3)	11.5/18	10/14	11.5/18
Fill Factor	90%	90%	75%
Material Swell	45%	25%	30%
Material Density	1.49	2.0	2.0
Cycle Time (sec.)	32/35	32/35	40
Shovel Availability	80%	80%	80%
Annual Operating Shifts			
- 3 shift, 5 day week	600	600	600
- 3 shift, 7 day week	850	850	850
Operating Efficiency (5.6 Operating Hours per Shift)	70%	70%	70%
Equipment Life (Shifts)	6000	6000	6000
Output Per Shift	6681/9681 t	4536/5819 m^3	3352/5242 m^3

TABLE 6-3

HAT CREEK PROJECT
800 MW PLANT
SHOVEL COST COMPARISON

	$14\ m^3/18\ m^3$ Bucket	$10\ m^3/11.5\ m^3$ Bucket
Truck Shifts		
Coal	66,278	71,507
Partings	20,985	21,500
Waste	128,272	130,016
TOTAL	215,535	223,023
Shovel Shifts		
Coal	13,783	19,783
Partings	2,514	3,925
Waste	16,397	21,017
TOTAL	32,694	44,725
Trucks		
Initial Units Purchased	15	16
Replacement Units Purchased	26	28
Shovels		
Initial Units Purchased	5	6
Replacement Units Purchased	4	4
Cost Comparison		
1. Operating Costs (x $1,000)		
Trucks	150,439	155,666
Shovels	35,261	41,512
TOTAL	185,700	197,178
2. Capital Costs (x $1,000)		
Trucks		
Initial	11,790	12,576
Replacement	17,368	18,704
Shovels		
Initial	12,500	10,944
Replacement	8,480	6,200
TOTAL	50,138	48,424
TOTAL CAPITAL AND OPERATING	$235,838	$245,602

TABLE 6-4

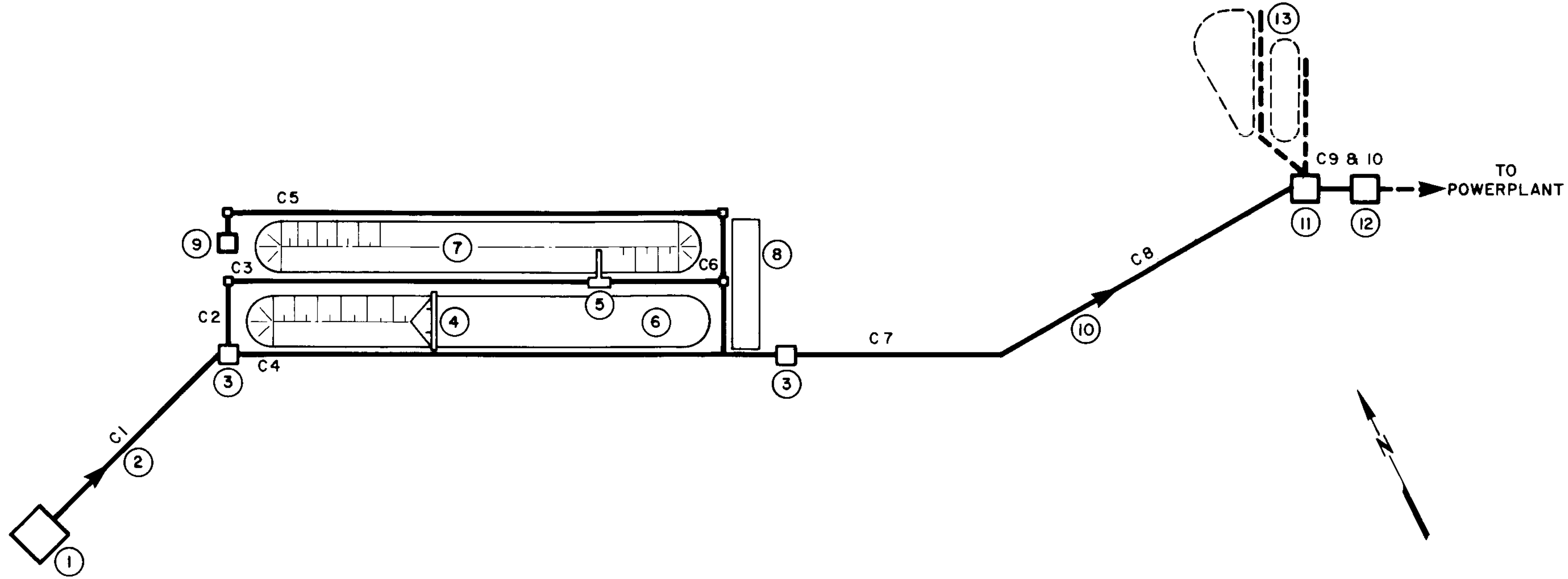
HAT CREEK PROJECT
800 MW PLANT
MOBILE EQUIPMENT SUMMARY
PEAK REQUIREMENTS

Item	Number
Hydraulic Shovel - 14 m^3	2
Hydraulic Shovel - 18 m^3	3
Coal Truck - 91 t	7
Waste Truck - 91 t	9
Front End Loader - 5.4 m^3	1
Scrapers - 24 LCM	2
Track Dozer - 343 kw	2
Track Dozer - 224 kw	4
Track Dozer - 149 kw	1
Wheel Dozer - 231 kw	2
Motor Grader - 186 kw	1
Motor Grader - 134 kw	2
Traxcavator	1
Compactors	2
Auger Drill	1
Airtrac	1
Dump Truck - 7.6 m^3	2
Gradall	1
Backhoe - 1 m^3	1
Water Wagons	2
Mobile Crusher	1
Mobile Cranes - 15-75 t	3
Forklifts - 3-5 t	2
Mobile Service Vehicles	10
Light Vehicles	30
Passenger Buses	3
Low-boy Tractor Trailer	1
High-boy Tailer	1
Compressor - 17 m^3/min.	1
Welders - 300 amp	5
Steam Cleaner	1
Lighting Plants	4
Diesel Pumps	7
Fire Truck	1
Ambulance	1

TABLE 6-5

HAT CREEK PROJECT
800 MW PLANT
MINE COAL HANDLING CONVEYORS

Conveyor	Length (m)	Lift (m)	Capacity (t/h)	Speed (m/s)	Installed HP
Mine Coal C1	750	70	1180	3.0	500
Transfer C2	50	-	1180	3.0	50
Stacking C3	540	10	1180	3.0	300
Reclaim C4	550	10	1180	3.0	200
Reclaim C5	540	-	1180	3.0	200
Collecting C6	100	-	1180	3.0	100
Overland C7	850	60	1180	3.0	600
Overland C8	2500	430	1180	3.0	2800
Screen Feed C9	115	25	1180	2.5	150
Screen Feed C10	115	25	1180	2.5	150
TOTAL INSTALLED	6110				5050

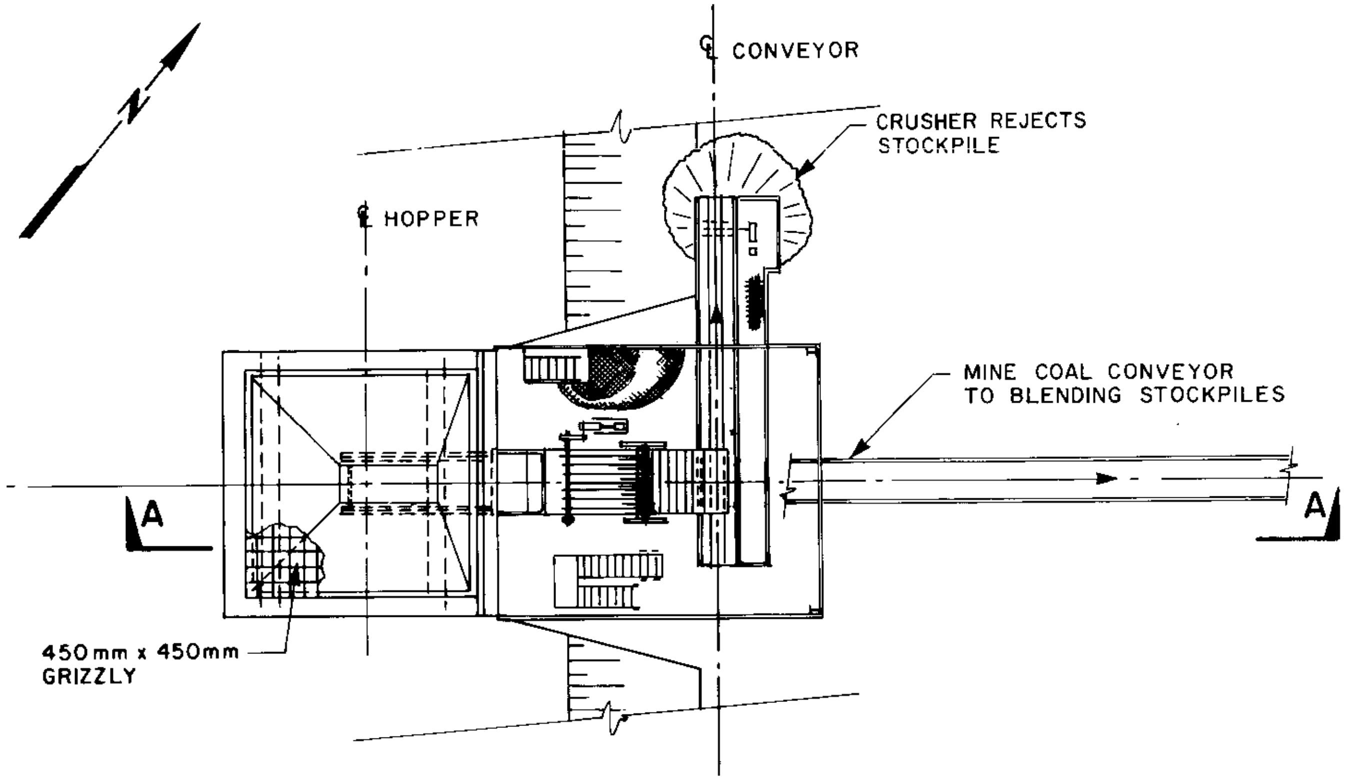


(1) COAL DUMP STATION
(2) COAL CONVEYOR
(3) TRANSFER HOUSE AND SAMPLING STATION
(4) BUCKET WHEEL RECLAIMER
(5) SLEWABLE STACKER
(6) BLENDING PILE BEING RECLAIMED
(7) BLENDING PILE BEING STACKED
(8) RECLAIMER TRANSFER CAR
(9) PORTABLE EMERGENCY CONVEYOR AND HOPPER
(10) OVERLAND COAL CONVEYOR
(11) COAL SURGE BIN
(12) SCREEN AND CRUSH HOUSE
(13) POWERPLANT LIVE AND EMERGENCY STOCKPILES

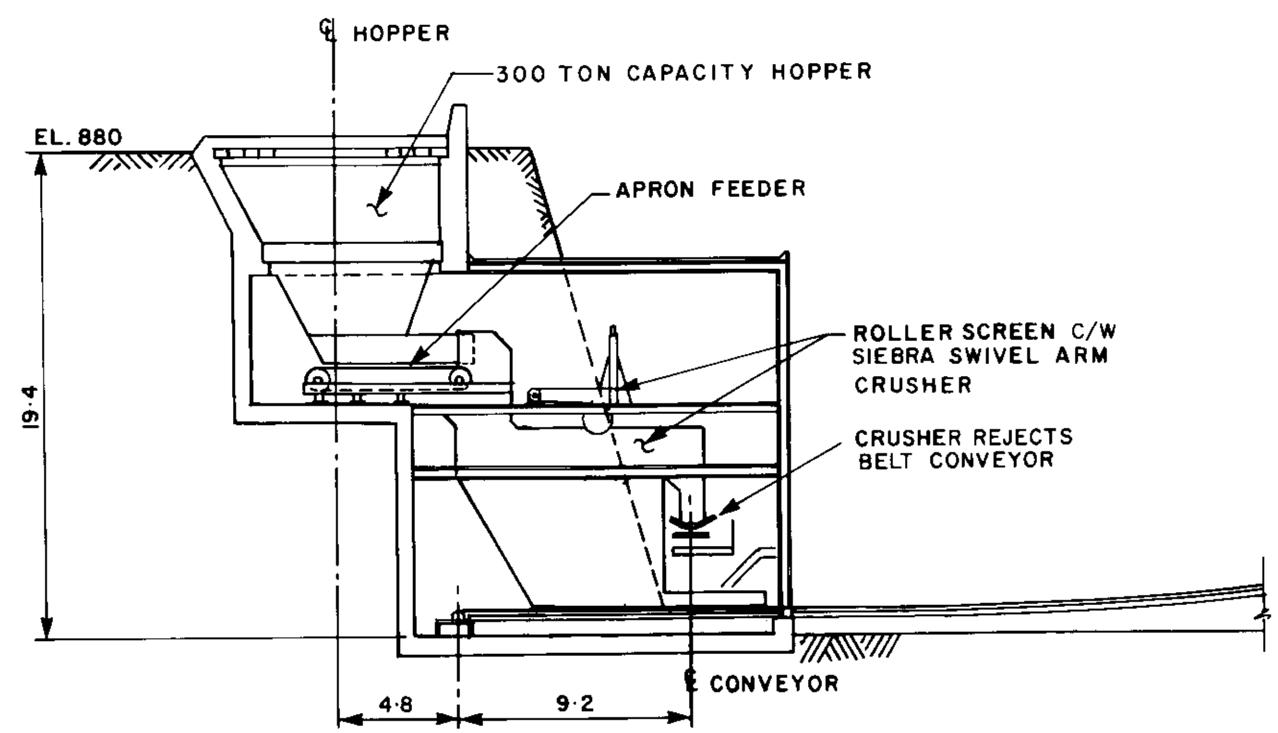
* This drawing is not to scale.

HAT CREEK PROJECT
800 MW PLANT
FIGURE 6-1

LAYOUT OF MINE COAL HANDLING SYSTEM

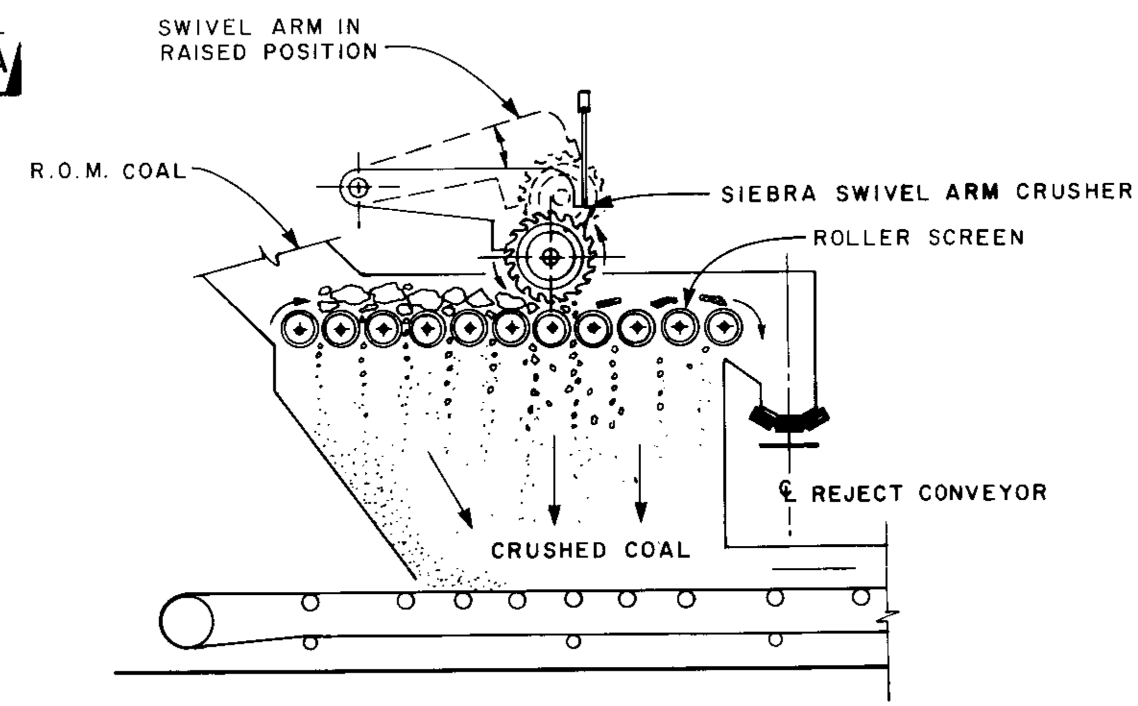


PLAN



SECTION A-A

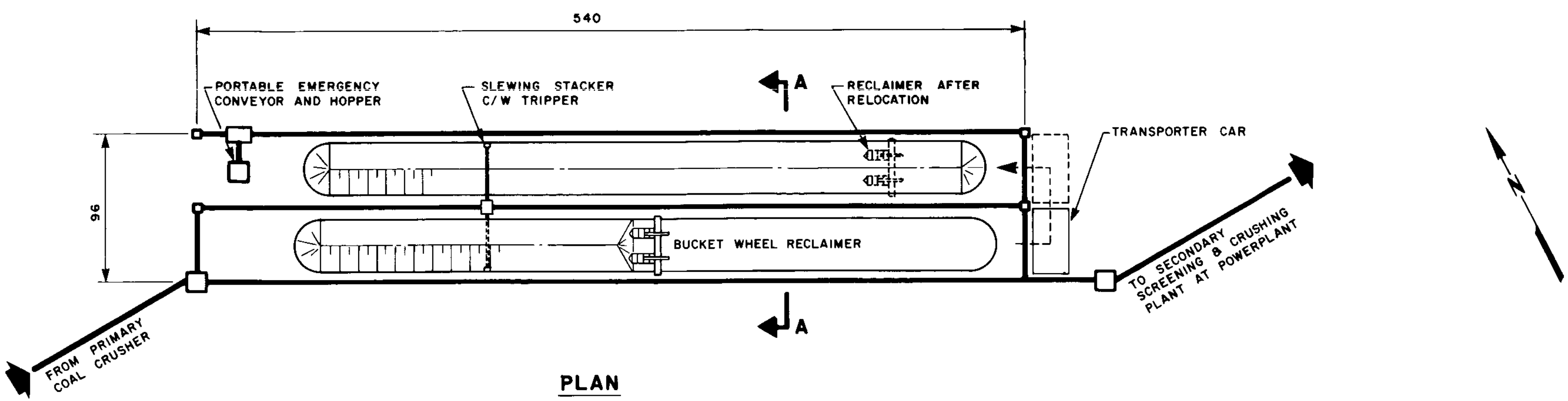
0 5 10 15m
SCALE IN METRE



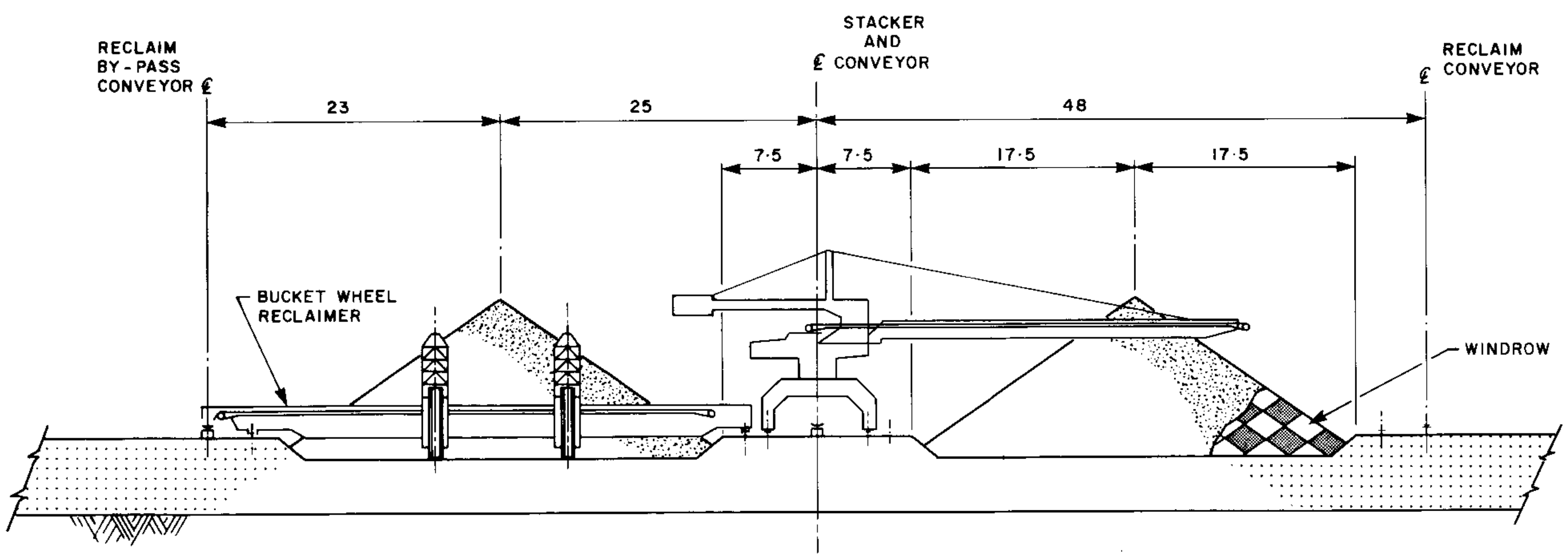
DETAIL OF PRIMARY CRUSHING OPERATION
(NOT TO SCALE)

HAT CREEK PROJECT
800 MW PLANT
FIGURE 6-2

PRIMARY COAL CRUSHER



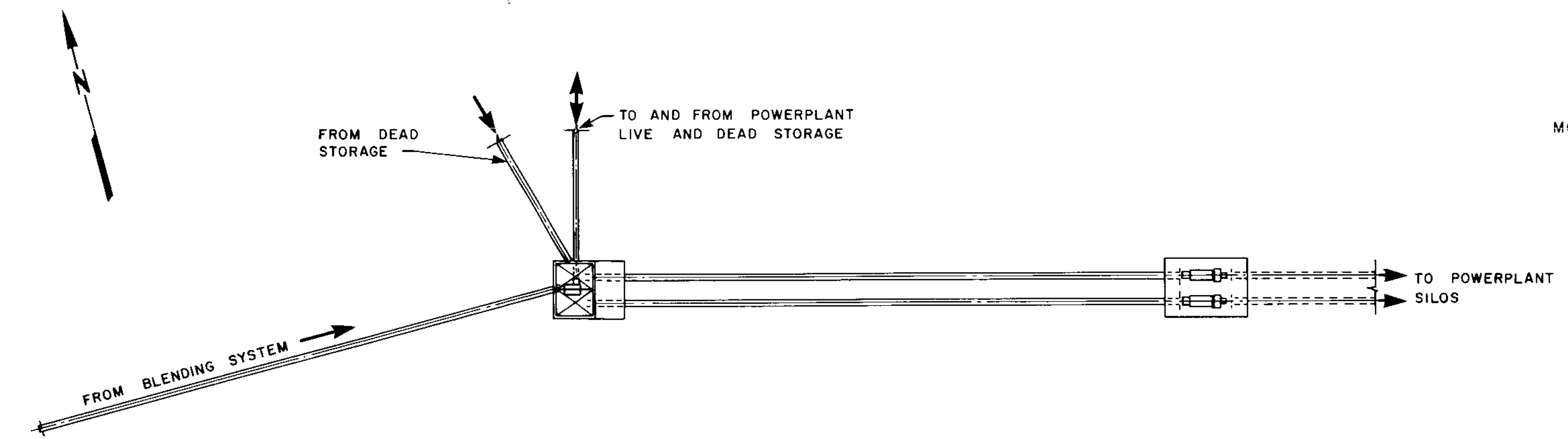
PLAN
(N.T.S)



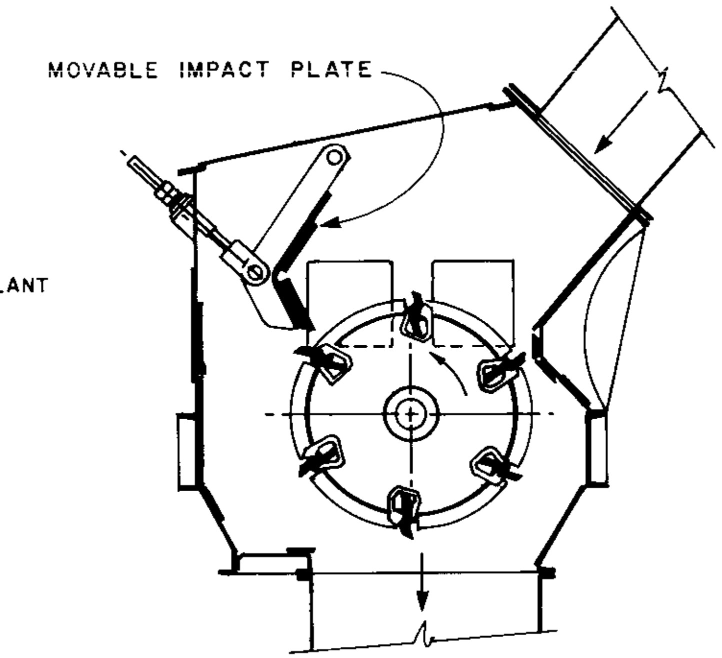
SECTION A - A

0 10 20 30 40 m
SCALE IN METRE

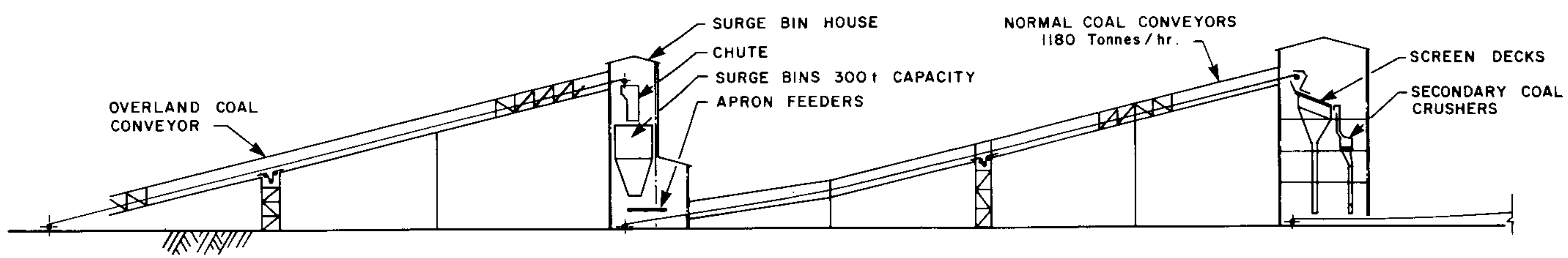
HAT CREEK PROJECT
800 MW PLANT
FIGURE 6-3
LAYOUT OF
COAL BLENDING SYSTEM



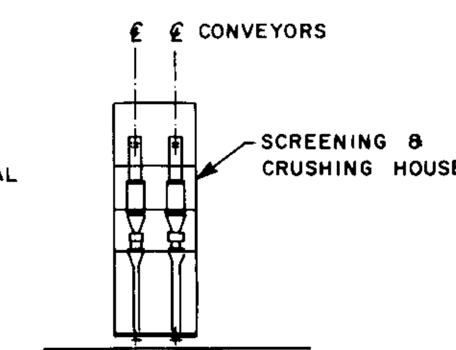
PLAN



TYPICAL IMPACT CRUSHER



ELEVATION



END ELEVATION

HAT CREEK PROJECT
800 MW PLANT
FIGURE 6-4
SCREENING & CRUSHING PLANT

CONTENTS

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TABLES

Table No.

7-1 Preliminary Estimate of Major Areas Disturbed

SECTION 7

ENVIRONMENTAL PROTECTION AND RECLAMATION

7.1 INTRODUCTION

The project area is situated within the Hat Creek drainage basin. Several small creeks, Medicine, Finney, Ambusten, Houth, Anderson, McCormick and McDonald drain into Hat Creek, which flows north and then east to the Bonaparte River, which in turn joins the Thompson River just north of Ashcroft. The waterbodies of significance in the general project area are Aleece Lake, Finney Lake and Fishhook Lake.

The regional climate is classified as continental, and is typified by long, cold winters and short, warm summers. Semi-arid conditions prevail; average precipitation is 317 mm/a, of which about half falls as snow. Winds behave according to the mountain/valley topography and are channelled predominantly upslope from the north to the south and southwest during the day, and the reverse at night.

A comprehensive program to protect land, water, and air during the construction and operation of the mine has been developed. After the mine closes, it is planned, within practical limits, to restore the land to the same conditions as it was before mining started. While the mine is being built and operated, the control of drainage will be of paramount importance in order to protect the aquatic environment downstream. In addition, it would be necessary to control noise and dust.

Accordingly, the plan makes provision for both restoration and extended care under three major reclamation and environmental protection priorities:

(1) Drainage control during and after mining;

(2) The effective replanting of disturbed land areas; and

(3) The development of a safe pit abandonment scheme.

7.2 DUST

Previous studies have indicated that the B.C. Pollution Control Board Objectives for total suspended particulates of 60 $\mu g/m^3$ and 150 $\mu g/m^3$ for annual and 24-hour averages respectively could be met. In order to meet the objectives specific design and operating requirements were established, for example:

(1) Material Handling System:

- (a) The coal blending area would be cut into the hillside and oriented to minimize the potential for wind erosion.
- (b) Windbreak berms would be constructed.
- (c) Water spray guns would be installed.
- (d) The blending pile would be constructed using telescopic chutes.
- (e) Dust suppression equipment would be provided at transfer points.
- (f) Conveyors would be covered where practical, e.g. the overland conveyors from the mine.

(2) The area stripped of surface soils will at all times be minimized to reduce erosion potential. In addition, overburden removal would be continued until non-friable (i.e. low dusting potential) material was reached if possible.

(3) Road dust would be suppressed by water with binding agents being used to control erosion where appropriate.

(4) Areas that would remain exposed after overburden removal for extended periods of time would be revegetated.

7.3 NOISE

Noise impacts associated with construction and operation of the proposed mine are expected to be most significant at the southwest end of Bonaparte Indian Reserve No. 1 near the mine mouth and the Hat Creek Valley ranches located closest to the mine. Detailed calculations of noise impact have not yet been completed for the 800 MW scheme but preliminary estimations of potential noise impact at these areas of primary concern have been made. The primary effect of project noise on local residents would be annoyance. Therefore, the possible degrees of impact have been categorized as insignificant, slightly annoying, moderately annoying, very annoying or extremely annoying.

At the southwest end of Bonaparte Indian Reserve No. 1, most dwellings are located adjacent to Highway 12 and the Yearly Day Night Average Noise Levels (YDNL) are, as a result, in the 40 to 50 dBA range. Although truck traffic will increase both along Highway 12 and along the access road to the plant the effect on noise levels will not be significant at existing residences. Noise from construction of the access road, maintenance facility and coal preparation area could be slightly to moderately annoying at the closest residence, as would noise from the mine mouth and the coal preparation area during mine operation.

The effect of mine operations on the ranches in the Hat Creek Valley would depend on their distances from the mine. Ranches less than 2 km south of the mine would experience noise levels rated as extremely to very annoying while 3 to 4 km to the south noise would be slightly annoying. During mine construction, noise levels and hence annoyance will be somewhat less severe. No significant impact is expected at ranches located further south.

Although some annoyance due to project noise has been predicted, this is partially due to the fact that present noise levels are not particularly high and residents are accustomed to the present environments. In a more general context, all of the locations discussed above would remain compatible with residential land use except at the two closest ranches.

7.4 MINE DRAINAGE AND WATER QUALITY

Drainage measures insofar as they affect reclamation may be summarized by noting that all lagoons, diversions, ditches, and reservoirs linked with wetland and riparian habitats will be left intact and revegetated wherever possible within the constraints imposed by mining. Drainage control structures will be grass-seeded, and, where erosion or flow capacity is not involved, with a mixture of shrubs, trees and grasses.

Laboratory and field tests on materials which would be encountered during mining have been run to determine the concentrations of leachable materials. Based on these data and the water quality and hydrology of the waterbodies to be affected by this project, the main drainage plan has been devised. Essential elements of the plan are:

(1) All water suitable for simple diversion without any treatment, such as Hat Creek, would be redirected around the project and returned to its natural downstream watercourse;

(2) Runoff contaminated with suspended solid material would undergo sedimentation to reduce the concentration of suspended solids to less than 50 mg/L;

(3) All water of unsuitable quality for discharge would be collected in a leachate pond and disposed of on site by reuse in dust control or by spray evaporation on waste dumps.

This drainage scheme would remain in service during the 10-year post-abandonment period to ensure that water quality values downstream of the project would be maintained. All drainage ditches would be revegetated to reduce suspended solids contamination.

7.5 LAND RECLAMATION

On-site Reclamation Testing

Both laboratory and on-site testing has been undertaken to determine the properties of the waste materials as growth media and to evaluate a variety of grass and legume species for revegetation at Hat Creek.

Initial laboratory (greenhouse) studies were followed by detailed on-site reclamation testing, making use of materials generated during the 1977 Bulk Sample Program. These latter tests have demonstrated most effectively that the revegetation of waste materials is feasible at Hat Creek consistent with proposed goals for reclamation. These may be summarized as follows:

(1) Short-term goals - Control of wind and water-borne erosion,
- Aesthetics,
- Stablilization of waste;

(2) Long-term goals - Self-sustaining vegetation,
- Suitable end use - mixed agriculture and wildlife.

The field tests comprised two major programs, one to examine the revegetation potential of slopes at different angles of repose, and the other to examine the different materials and determine their characteristics as growth media. All waste dumps associated with the 1977 Bulk Sample Program were also reseeded and provided facilities for further testing.

Results of tests on simulated embankment slopes at Houth Meadows and Medicine Creek demonstrate that slopes up to 30° are stable and can be reclaimed.

Revegetation of surficial materials such as colluvium (till), gravel, and baked clay can be readily achieved. Further, these soils are suitable for reclamation purposes without the addition of topsoil. Plants were healthy and showed little sign of nutrient deficiency. Detailed evaluations after four growing seasons have demonstrated that the productivity of waste materials could be at least as great as that presently obtained in the area of the proposed waste dump.

Revegetation of non-seam mine waste, gritstone (sandstone/claystone), and bentonitic clay proved to be more difficult to achieve in the short term.

It is considered that a surface capping of surficial materials would be required to satisfactorily revegetate these waste materials.

Vegetation Species

In total 16 different species of grass and legume have been tested in these revegetation trials. The species were selected on the basis of their known characteristics and adaptation to the soils and climatic conditions at Hat Creek. To ensure that the species were both viable and available, only agronomic species were considered. Seed mixed of four and five species were devised and, in some instances, species were used individually.

Results of these field tests have identified eight species including two legumes which could be used for reclamation purposes at Hat Creek.

Native shrubs and forbs considered essential in the reclamation of wildlife habitats would be obtained from contract nurseries.

The selection of species for revegetation of waste dumps and related areas at Hat Creek will be largely based on these results. Mixes of approximately five species, of which three would be grasses, would be selected and seeded, mostly by harrow-seeding methods. Only in areas too steep for harrow-seeding would hydro-seeding be used. Due to the low precipitation, seeding would be carried out in late fall (September to November) or early spring (April and May), the former period being favoured in order that maximum use could be made of moisture accumulating over the winter months. Legumes may benefit from early spring seeding to reduce losses by winter kill.

Waste Dumps and Embankments

Rapid revegetation of embankments and waste dumps will stabilize exposed surfaces against erosion. Temporary reclamation will be carried out on all areas of dump surfaces left inactive for a number of years. Retaining embankments will be constructed in lifts which allow for long-term reclamation concurrently with construction. Waste dump surfaces will be reclaimed as soon as the final surface elevation is reached, to an end use similar to that which now exists: mixed wildlife and agriculture.

Areas disturbed due to construction of facilities such as the transportation corridors will be reclaimed as soon as possible following construction. Trees will be planted where appropriate to screen the development and enhance the aesthetic appearance of the project.

Reclamation Upon Project Termination

All above-ground developments not required for other purposes will be dismantled and removed. The disturbed areas will be contoured to blend into the surrounding terrain and revegetated.

At the end of the proposed project life, in the case that further development of the extensive remaining coal reserves is not planned, the upper benches in the No. 1 pit area will be resloped to 26° to provide a safer perimeter and lessen the visual impact. After resloping fertilizer and seed will be broadcast on the pit benches. No resloping will be done in the lower levels of the pit. In time revegetated overburden and slide areas may be expected to creep and slide into the pit.

A protective fence to restrict access will surround the pit perimeter and those areas which may be susceptible to failure. Trees will be planted at selected points on the perimeter to screen the pit.

A more likely scenario is that mining would continue in the Hat Creek valley to recover the economic coal in the No. 1 and No. 2 deposits. Following the completion of mining in No. 1 pit this area would serve as a waste disposal area for the No. 2 pit operation. The No. 1 pit would be gradually filled; the surface contoured and revegetated; and Hat Creek and other streams re-established to flow through the area. Trees will be planted to blend the reclaimed area into the natural surroundings. However, the primary use planned for the reclaimed land is agricultural.

7.6 DISTURBED LAND

In the case of abandonment of the project after 35 years, it is expected that some 724 ha of land will have been disturbed by mining and waste disposal operations. It is anticipated that ultimately over 60 percent of this land will be reclaimed and returned to productive use - much of this reclamation will be accomplished by Year 36 of the project. The largest portion of the land that will not be reclaimed is represented by the open pit benches, which would still contain economically recoverable coal resources. Other unreclaimed areas include water quality control lagoons.

A summary of disturbed land is shown in Table 7-1.

TABLE 7-1

HAT CREEK PROJECT
800 MW PLANT
PRELIMINARY ESTIMATE OF MAJOR AREAS DISTURBED

	Area (ha)
Open Pit No. 1	274
Houth Meadows Waste Disposal Area	263
Miscellaneous (facilities, lagoons, conveyor ways, roads, etc.)	187
TOTAL	724

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8-1 Mine Department Schedule

SECTION 8

PROJECT DEVELOPMENT PLAN AND SCHEDULE

8.1 DEVELOPMENT PLAN AND SCHEDULE CRITERIA

The Development Plan and Schedule is based on the overall project objective of commercial production from the first 400 MW unit in October 1992. Engineering for site preparation, drainage, maintenance and service facilities, and coal blending and handling facilities will be performed by outside consultants under the supervision of the B.C. Hydro Mining Group. Detailed mine planning and design will be a co-ordinated effort of the B.C. Hydro mining engineers and the Mine Operating Contractor. Site preparation, drainage and the construction of maintenance, service and coal handling facilities will be carried out by contractors using construction labour affiliated with the B.C. Hydro Allied Council. Open pit development and pre-production work will be carried out by the Mine Operations Contractor using labour affiliated with the certified operating union.

The engineering, construction and development of the mining facilities and the open pit mine are not on the critical path of the overall Hat Creek Project. However, the mining group should be assembled concurrently with the start of powerplant design to facilitate mine engineering input into such critical items as fuel quality, design co-ordination and the integration of management principles and philosophy (for details see Section 9).

8.2 PLANNING PHASE I (1 JANUARY 1986 TO 31 DECEMBER 1987)

8.2.1 Management

During this period the main efforts of B.C. Hydro will concentrate on determining the organization and recruiting the staff for the mangement and control of the project. Other critical activities during this period will be the analysis and selection of the contracting alternatives for engineering, construction and the operation of the mine and the development and implementation of the management control systems to be used in the later phases of the development and operation.

8.2.2 Procurement

Procurement activities during this period will include the preparation of contract documents, the prequalification of engineer ing counsultants and operating contractors and the tendering and award of these contracts.

8.3 DESIGN PHASE II (1 JANUARY 1988 TO 31 MARCH 1990)

8.3.1 Management

The major Mining Department activities during the Design Phase II will be the direction, supervision and progress monitoring of the engineering consultants and the mine operating contractor in addition to the administration of the mining group.

8.3.2 Procurement

The following major construction contracts will be tendered and awarded:

(1) Civil works including Hat Creek Diversion, drainage, site preparation and site roads;

(2) Buildings including maintenance complex, administration building, mine dry and services;

(3) Material handling including crushing, screening, conveying and coal blending.

Contracts will also be tendered and awarded for the supply of the major mobile mining equipment.

8.3.3 Engineering

Field investigations to gather design requirements for geological, geotechnical and hydrological data will be conducted during 1988. Detailed mine planning and design will be carried out throughout the period together with the equipment selection studies. Detailed engineering of the Hat Creek Diversion and the mine area drainage system will be completed by 31 March 1989 also the design of the service and support facilities so that construction activity in these areas can commence in spring 1989. Studies on the coal handling facilities will be carried out and detailed engineering completed for a construction start in summer 1990.

8.4 CONSTRUCTION PHASE III (1 APRIL 1989 TO 31 JANUARY 1992)

8.4.1 Management

Management activities during this phase will be similar to the activities during the Design Phase II, namely, direction, supervision and monitoring of consultants and contractors and the administration of the B.C. Hydro mining group.

8.4.2 Engineering

Major engineering activities during the Construction Phase III will be inspection of construction, design changes and interpretation of engineered drawings and specifications.

8.4.3 Construction

The construction of the Hat Creek Diversion, the mine area drainage system, site preparation, site roads and the maintenance and service facilities will be completed by mid 1990 to allow the use of these facilities by the operating contractor for the development of the open pit which will commence at that time. Construction of the coal handling, crushing, screening and blending facilities will take place during 1990 and 1991 and will be completed in time for the first coal production required for commissioning of the powerplant in February 1992.

8.5 DEVELOPMENT AND PRE-PRODUCTION PHASE IV (1 APRIL 1990 TO 30 SEPTEMBER 1992)

8.5.1 Management

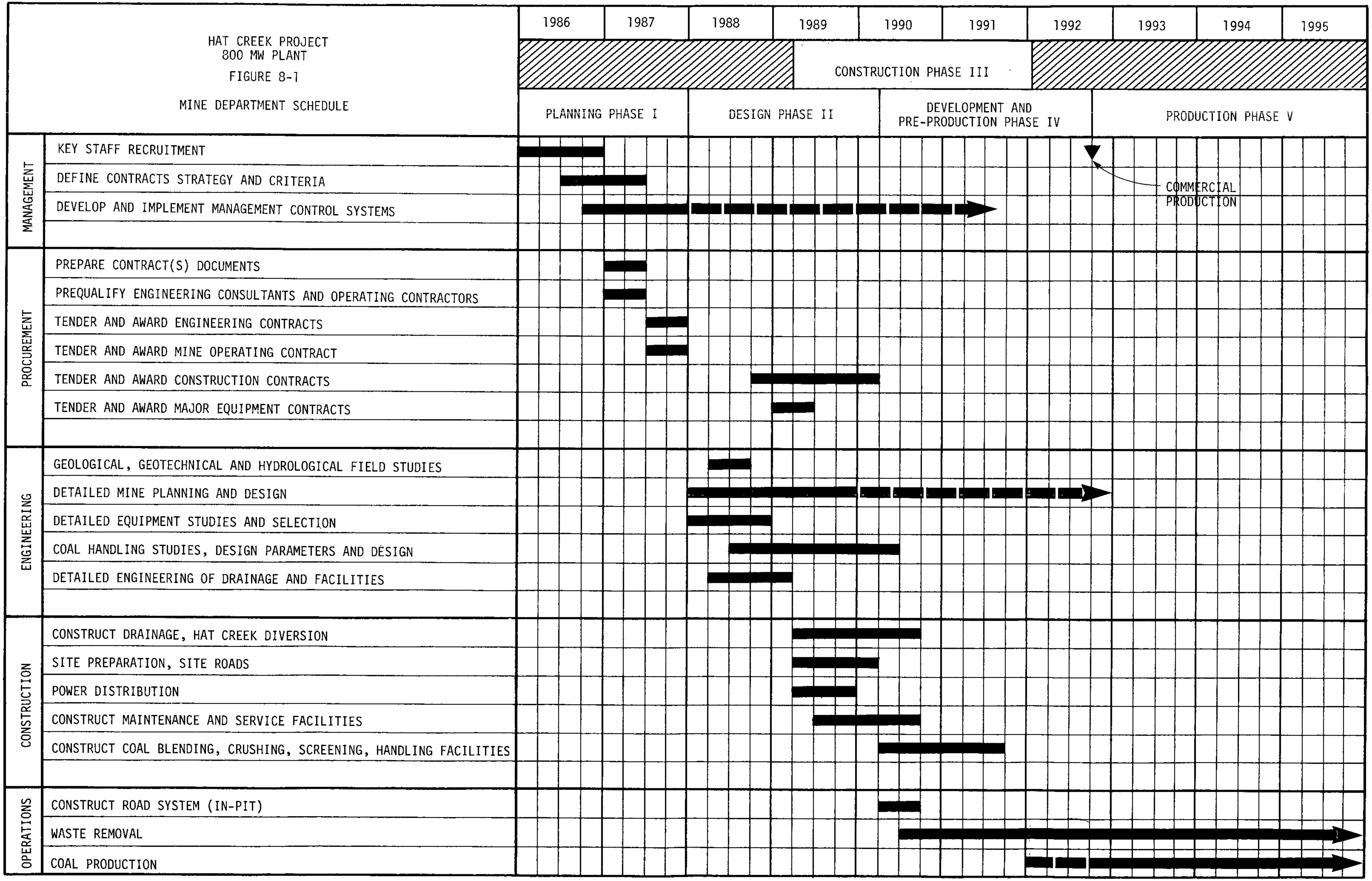
Management functions during this phase will be similar to those in Phases II and III with the emphasis on the performance of the Mine Operating Contractor.

8.5.2 Operations

The operating contractor will commence pit development in April 1990 with the construction of the in-pit road system which will be followed by prestripping and waste removal. Coal mined during this period will be used for packing the blending bed and stockpiled for use as powerplant commissioning coal.

8.6 PRODUCTION PHASE IV (1 OCTOBER 1992 TO 30 SEPTEMBER 2027)

Commercial production of coal will commence in October 1992 reaching the powerplant peak requirement of 3.8 Mt/a in 1996.



HAT CREEK PROJECT
800 MW PLANT
FIGURE 8-1
MINE DEPARTMENT SCHEDULE

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9-3 B.C. Hydro Staff, Organization During Construction and Development, 800 MW Plant

SECTION 9

MANPOWER AND ORGANIZATION

9.1 CONTRACTING APPROACH

9.1.1 Contracting Objectives

B.C. Hydro management have adopted a policy of contracting the mining portion of the Hat Creek Project. This decision was made after seeking advice from several consultants including Arthur Anderson and Company who prepared a formal "Hat Creek Management Plan" in 1981. At the time this policy was adopted it was recognized that certain technical functions and controls such as geology, mine planning and control as well as labour relations must be retained by B.C. Hydro.

On the basis of this direction, the B.C. Hydro Mining Group prepared a "Recommended Management Structure for the Hat Creek Mine" in 1982 which expanded upon these concepts and determined the contracting approach described below. The thrust of this approach is to retain the project specific knowhow within B.C. Hydro and utilize two major contractors with industry specific knowhow in mine engineering and operation.

9.1.2 Development and Operations Contractor

A contractor will be employed to develop and operate the Hat Creek mine in accordance with certain technical specifications supplied by B.C. Hydro. The mine operating contractor would preferably be retained prior to the detail design phase. During detailed planning and design the contractor would contribute mining industry specific know how to the specifications for the mobile mining equipment, provide conceptual engineering for coal and waste handling systems and assist in developing design specifications for maintenance facilities and services. Since the operating contractor will be responsible for successfully operating these systems and facilities, it is essential that his input be incorporated into their design.

During development and operations the mine operating contractor would manage the mining operation and supervise the unionized work force, applying the required industry related expertise to achieve the best possible execution of Hydro's objectives.

The contractor would operate under a Management Services agreement, and would supply competent personnel to fill the management, supervisory and professional positions required for the ongoing operations. He will also supply systems and procedures for cost control, maintenance planning, production scheduling, safety and training required to ensure effective operational performance.

This contract would be cost reimbursable with a fixed fee subject to premium and penalty adjustments based on specific performance.

9.1.3. Engineering, Procurement and Construction Management Consultant

Different qualifications will be required to manage the detailed design, procurement and construction work of the mine facilities. An engineering, procurement and construction management consultant, experienced in the design and construction of coal mine facilities and material handling equipment, will be retained for this work.

This engineering consultant will translate the conceptual plans and specifications for site facilities and equipment as developed by B.C. Hydro and the operations contractor into detailed engineering design, and prepare contract packages and tender documents. B.C. Hydro will issue the tender documents and receive bids which will be evaluated and recommended upon by the engineering consultant. Throughout this engineering and procurement process, B.C. Hydro will control the scope, cost and progress of these activities.

Once contracts have been awarded, the engineering consultant will manage these agreements under the monitoring supervision of B.C. Hydro. As construction is completed, the facilities and equipment will be turned over to the operations contractor.

9.1.4 Role of B.C. Hydro

B.C. Hydro will manage the interfaces between the engineering, procurement and construction management consultant and the mine development and operations contractor. This will ensure that corporate objectives and specific requirements with respect to the reliability of fuel supply are reflected in all engineering, design and construction activities.

During the development and operations phases, B.C. Hydro's technical mining staff will be responsible for long and intermediate term mine planning, geology and quality control. Hydro staff will also monitor the performance of the mining contractor ensuring adherence to B.C. Hydro's directions as to mining areas, extraction sequences, coal qualities and coal quantities.

9.2 LABOUR RELATIONS

9.2.1 Construction Labour

During the construction phase, contracts let for the construction of facilities, services and equipment will probably be performed utilizing building trades unionized labour supplied through Constructors. If this approach is taken, a project site agreement, similar to previous B.C. Hydro projects will be negotiated which should ensure no legal strikes or lockouts during the construction of the plant.

9.2.2 Operating Labour

In order to ensure labour stability and for strategic reasons, it is essential that B.C. Hydro be the employer of the mine operating work force with supervision by the operating contractor. This approach is consistant with the findings of Arthur Anderson and Company in the "Hat Creek Mine Organization Study" of June 1981.

The costs estimates for the operating mine work force were compiled utilizing the terms and conditions of the current B.C. Hydro collective agreements.

9.2.3 Construction/Operations Interface

From the viewpoint of union jurisdiction, the mining project consists of two segments, i.e. construction work and operations work. All of the work will be divided between these two union jurisdictions in accordance with criteria established by negotiated agreements. Generally all work in the initial pit prior to and after the start of commercial production will be done by the operating work force and all work outside the pit area on the construction of roads, ditches, dams, buildings, material handling systems, etc. will be done by the construction work force.

It will be very important to minimize the possibility of jurisdictional disputes between the two work forces by establishing clear geographic boundaries between them when they are on the site at the same time. A project agreement between Constructors and the Allied Hydro Council would also help to avoid jurisdiction disputes if the interfaces are defined within the agreement prior to the commencement of field activities.

The capital and preproduction operating cost estimates reflect the most likely split of work between the two work forces.

9.3 OPERATIONS MANPOWER

Table 9-1 shows the manpower schedule for the operating work force. The operating work force first becomes active on site in Year-3 (1989) when key staff are recruited. B.C. Hydro staff requirements will be filled to a large extent through transfer from the Vancouver planning group.

Build-up of the hourly paid operating work force will commence in Year-2 when the first of the waste material is removed from the pit, and is augmented each year as annual mass movements increase until Year 4 when the peak hourly manpower of 243 is achieved. Annual waste quantities decrease after this point and the hourly work force decreases accordingly to 139 in Year 35 and 70 in Year 36.

Operating manpower requirements were computed in accordance with the terms of B.C. Hydro's existing operating labour agreements. These agreements contain supplementary time off with pay provisions which have the effect of reducing the scheduled work week to 35 hours. Allowing for statutory holidays, vacation, sick days and training time, the average employee can be expected to be on the job for 1587 hours per year including an estimated 64 hours of overtime. The 1587 hours is somewhat lower than that which would be achieved under the terms of a "typical" mining labour agreement and would require 5.35 employees to provide continuous coverage for a position.

The average annual working hours per employee are summarized in Table 9-2, and the detailed assumptions and basis are explained in the Appendix. Manpower estimates were based upon the 1587 hour per employee assumption in the case of both hourly and supervisory staff, taking into consideration the scheduled number of shifts per week for each activity.

Hourly equipment operating manpower was computed directly from the operating hours for the mobile equipment, while coal handling equipment operating manpower was computed from the number of positions to be manned and the planned operating schedule of 15 shifts per week. An allowance of 10 percent of the total identified operating manpower requirements is included to cover miscellaneous tasks (e.g. labourers).

Hourly maintenance labour was derived primarily from the hourly equipment operating costs. A 10 percent allowance was added to the "identified" maintenance manpower to cover miscellaneous maintenance (e.g. portable water pumps, air handling etc.).

Staff manpower consists of both B.C. Hydro mining staff and the operating contractor's mining staff. The B.C. Hydro staff is shown under "Administration" and four B.C. Hydro positions are included in "Management". The total staff count was governed by the general rule of thumb that the ratio of hourly manpower to staff should be in the range of 3 to 4:1.

9.4 CONSTRUCTION MANPOWER

Table 9-3 shows the construction manpower for the Hat Creek mine and related offsites.

The site construction manpower is assembled in Year-4 (1988) and is maintained until the end of the construction period on 31 March of Year-1 (1992). A total of 560 man years of buildings trade labour will be required to construct the mining facilities which will be supported by 69 man years of office and technical personnel and directed by 138 man years of supervisory and professional manpower.

Engineering design manpower for the mining facilities will be located elsewhere and is therefore not included in Table 9-3.

9.5 OPERATIONS ORGANIZATION

Figs. 9-1 and 9-2 show the staff organizations for the mining contractor and B.C. Hydro respectively during the operations phase.

The operating contractor's organization follows a normal functional breakdown for the mining industry into operations, maintenance, engineering, personnel and office services. The restricted scope of the contractor's responsibilities in the engineering and administrative areas is reflected in a lower than normal staffing level in those areas. The contractor would have a supervisory and administrative staff of 50 controlling the operating workforce which peaks at 243 in year 4.

B.C. Hydro's mining staff during the operating phase totals 21 positions including the Director of Mining and the Site Manager Mine. The engineering group of 10 persons including geotech nical, geological, coal quality and long-term mine planning control on the mining operation assisted by the production co-ordination group of three who observe field activities on all operating shifts. The control group of four monitors mining costs and supervises procurement for the mine.

9.6 CONSTRUCTION AND DEVELOPMENT ORGANIZATION

Fig. 9-3 shows B.C. Hydro's organization during construction and development. The organization is based on the structure required during mine operations augmented by the positions necessary to monitor and control construction and development (operations) activities and to control the engineering and procurement work being done in Vancouver.

A total of 12 additional positions are required during this phase, most of which are in the Controls and Site Management groups.

TABLE 9-1

HAT CREEK PROJECT

800 MW PLANT

OPERATIONS MANPOWER

	-3	-2	-1	1	2	3	4	5	6 to 10	11 to 15	16 to 20	21 to 25	26 to 30	31 to 35	36
HOURLY OPERATING:															
SHOVEL & TRUCK OPERATORS OTHER EQUIPMENT OPERATORS		25	40	63	87	91	99	90	86	68	62	58	58	41	17
TRAINERS	-	1	1	2	2	2	2	2	2	2	2	2	2	2	-
DRAINAGE CREW	-	2	2	2	2	2	2	3	3	3	3	3	3	3	1
TRUCK DUMP	-	-	-	2	4	4	4	4	4	4	4	4	4	4	2
COAL CRUSHING	-	-	-	3	4	4	4	4	4	4	4	4	4	4	3
STACKING & RECLAIMING	-	-	-	9	12	12	12	12	12	12	12	12	12	12	9
COAL CONVEYOR	-	-	-	3	4	4	4	4	4	4	4	4	4	4	3
WAREHOUSE	-	3	3	4	4	4	4	4	4	3	3	3	3	3	2
MISC. OTHER LABOUR 10%		3	5	9	12	12	13	12	12	10	9	9	9	7	4
TOTAL HOURLY OPERATING		34	51	97	131	135	144	135	131	110	103	99	99	80	41
HOURLY MAINTENANCE:															
ELECTRICAL MAINTENANCE	-	1	1	3	5	5	5	5	5	5	5	5	5	5	3
HEAVY EQUIPMENT MAINTENANCE	-	15	26	38	51	51	57	51	49	39	37	34	34	25	12
AUTO SHOP	1	2	3	4	6	6	6	6	5	4	4	4	4	3	1
SERVICE CREW	-	2	2	4	5	5	6	5	5	4	4	3	3	2	1
BUILDING & YARD MAINTENANCE	-	1	4	4	4	4	4	4	4	4	4	4	4	4	3
COMMUNICATIONS	-	-	-	-	-	1	1	1	1	1	1	1	1	1	-
PLANT MAINTENANCE	-	-	-	11	19	20	20	20	20	19	19	19	19	19	9
TOTAL HOURLY MAINTENANCE	1	21	36	64	88	92	99	92	89	76	74	70	70	59	29
STAFF															
MANAGEMENT	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
ADMINISTRATION	12	12	13	15	16	17	17	17	17	17	17	17	17	17	11
ADMINISTRATION SERVICES	2	8	8	8	8	8	8	8	8	8	8	8	8	8	7
HUMAN RESOURCES	2	9	10	10	10	10	10	10	10	10	10	10	10	10	9
TRAINING	-	1	1	1	1	1	1	1	1	1	1	1	1	1	-
MINE ENGINEERING & GEOLOGY	1	5	5	5	6	8	8	8	8	8	8	8	8	8	6
MAINTENANCE SHOPS	2	4	9	9	9	10	10	10	10	10	10	10	10	10	7
MINE SUPERVISION	2	5	8	10	10	10	11	11	11	11	11	10	10	10	7
TOTAL STAFF	27	50	60	64	66	70	71	71	71	71	71	71	71	71	51
TOTAL MANPOWER	28	105	147	225	285	297	314	298	291	257	248	240	240	210	121

TABLE 9-2

HAT CREEK PROJECT
800 MW PLANT
ANNUAL WORKING HOURS PER EMPLOYEE
(IN ACCORDANCE WITH HYDRO UNION CONTRACTS)

		Shift Workers 5 Shift Basis	Shift Workers 4 Shift Basis	Day Workers
	Scheduled crew regular hours	1763 3)	2022 2)	1957½ 1)
	Scheduled crew overtime	- 5)	102 4)	-
	Emergency overtime	64	64	64
Less:	Statutory holidays (11)	-	(22) 6)	(82½)
	S.W.P. days	-	(136)	(127½)
	Q.V. days	-	(101) 7)	
	Vacation days (15)	(120)	(120)	(112½)
	Sick days (7)	(56)	(56)	(56½)
	Training days (8)	(64)	(64)	(60)
	Scheduled O'time not worked		(102)	-
	Total Hours On The Job	1587 hr	1587	1586½

Notes:

1. (52 wk X 5 days + 1 day) X 7½ h/day = 1957½ h.

2. 1957½ h X (8 h/7½ h) = 2022 h.

3. 2022 h - 22 h - 136 h - 101 h = 1763 h.

4. crew coverage required = 8496 h ÷ 4 shifts
   = 2022 h + 102 h

5. crew coverage required = 8496 h ÷ 5 shifts + 64 h for training = 2763 h.

6. The shift alternatives are based upon the mine working 354 days per year (i.e. statutory holidays not worked) for a total of 8496 hours per year.

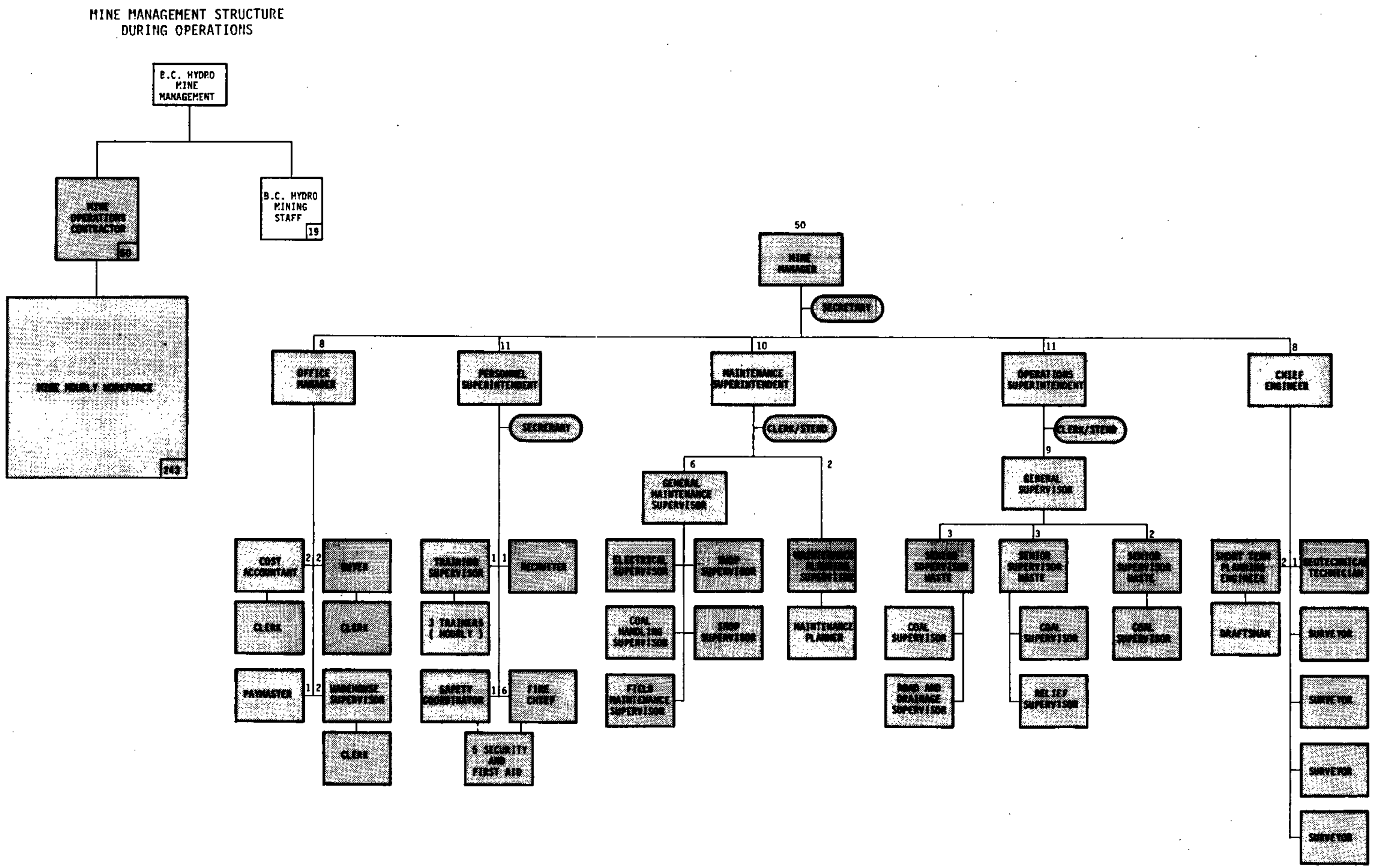
7. ((1587 h + 64 h) ÷ 8 h/shift) x ½ h/shift.

8. (11 days x 8 h) ÷ 4 crews.

TABLE 9-3

HAT CREEK PROJECT
800 MW PLANT (1992/93 IN SERVICE)
CONSTRUCTION, DEVELOPMENT AND OPERATING MANPOWER

	1987/88 -5	1988/89 -4	1989/90 -3	1990/91 -2	1991/92 -1	1992/93 1	1993/94 2	1994/95 3	1995/96 4	1996/97 5	1997/98 6	1998/99 7	Total
PLANNING AND DEVELOPMENT													
B.C. Hydro	18	16	-	-	-	-							34
CONSTRUCTION													
SPC													
Engineering Consultant		12	15	18	18								63
Construction Contractors		9	11	16	16								52
B.C. Hydro - Site		3	4	6	6								19
- Vancouver		1	1	1	1								4
TOTAL SPC		25	31	41	41								138
OTEU													
Engineering Consultant		5	8	8	8								29
Construction Contractors		4	5	8	8								25
B.C. Hydro - Site		1	2	3	3								9
- Vancouver		1	1	2	2								6
TOTAL OTEU		11	16	21	21								69
BUILDING TRADES													
Construction Contractors		80	100	200	180								560
TOTAL CONSTRUCTION		116	147	262	242								767
DEVELOPMENT AND OPERATIONS													
SPC													
Contractor			7	21	27	28	29	30	30	30	30	30	
B.C. Hydro			10	10	11	12	13	13	13	13	13	13	
TOTAL			17	31	38	40	42	43	43	43	43	43	
OFFICE AND TECHNICAL													
Contractor			4	13	16	17	17	19	20	20	20	20	
B.C. Hydro			6	6	6	7	7	8	8	8	8	8	
TOTAL			10	19	22	24	24	27	28	28	28	28	
OPERATIONS UNION													
Contractor			1	55	87	161	219	227	243	227	220	220	
TOTAL DEVELOPMENT AND OPERATIONS			28	105	147	225	285	297	314	298	291	291	
TOTAL MINING MANPOWER	18	132	175	367	389	225	285	297	314	298	291	291	



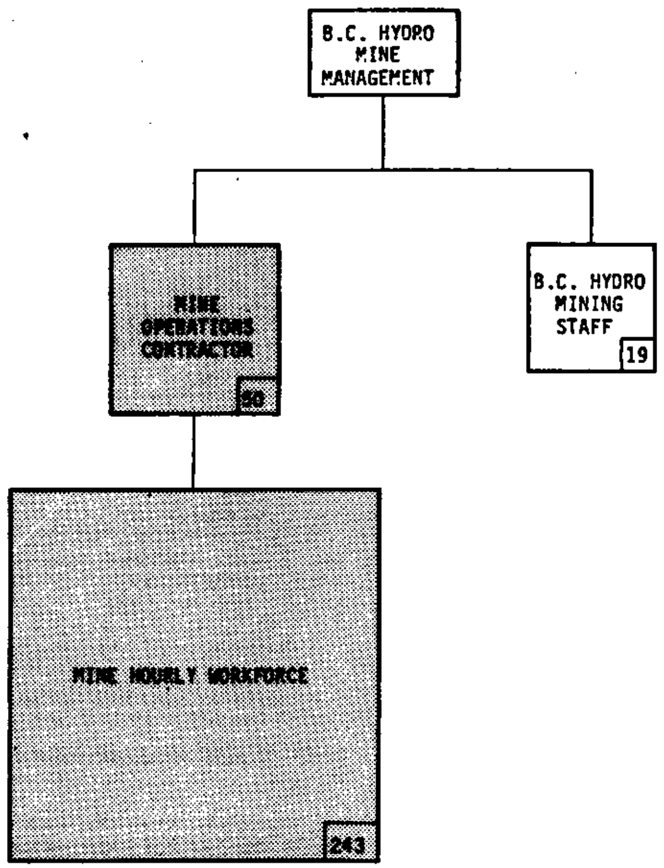
25 October, 1982.

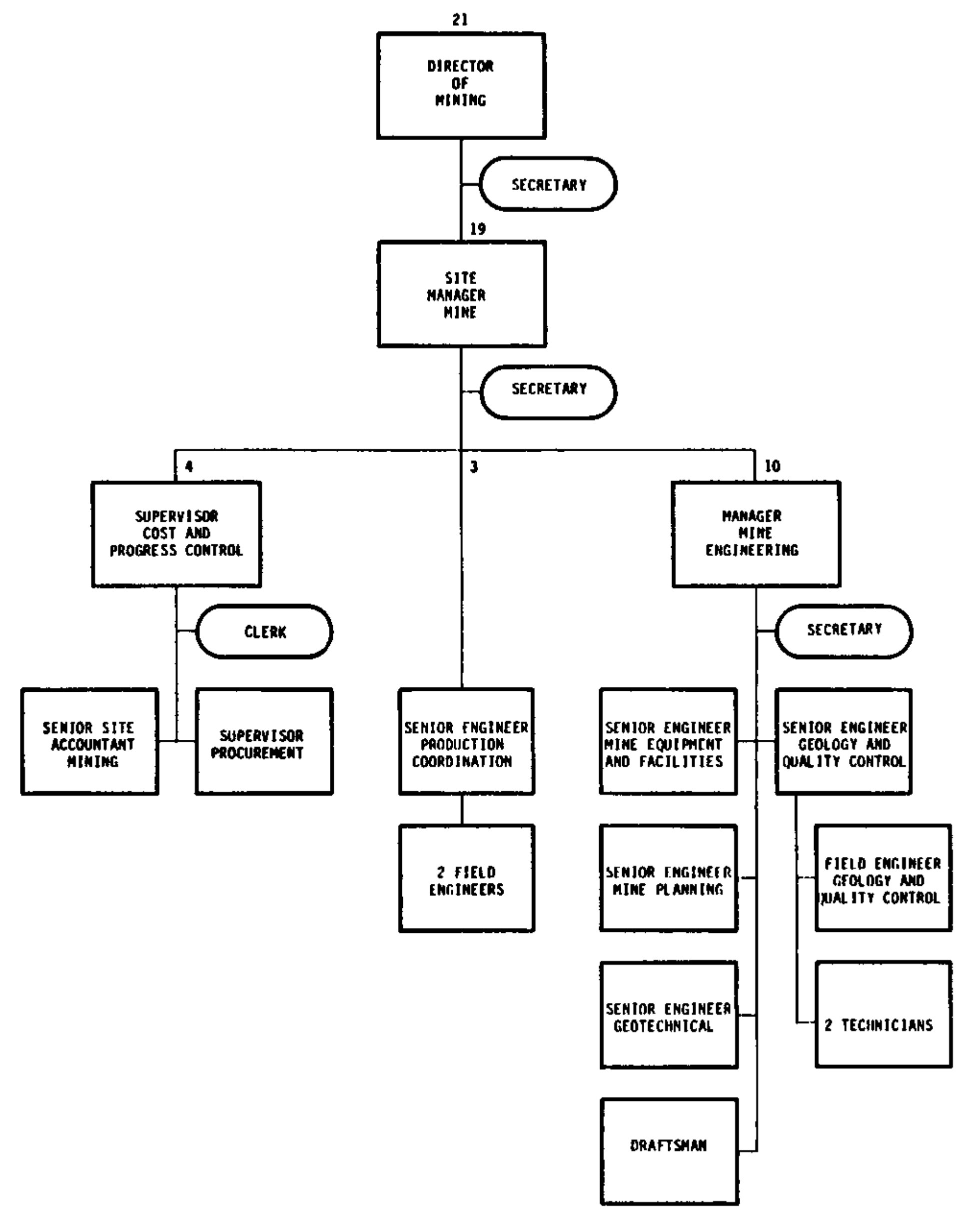
HAT CREEK PROJECT
800 MW PLANT

FIGURE 9-1

MINING CONTRACTOR'S STAFF ORGANIZATION DURING OPERATIONS

MINE MANAGEMENT STRUCTURE
DURING OPERATIONS





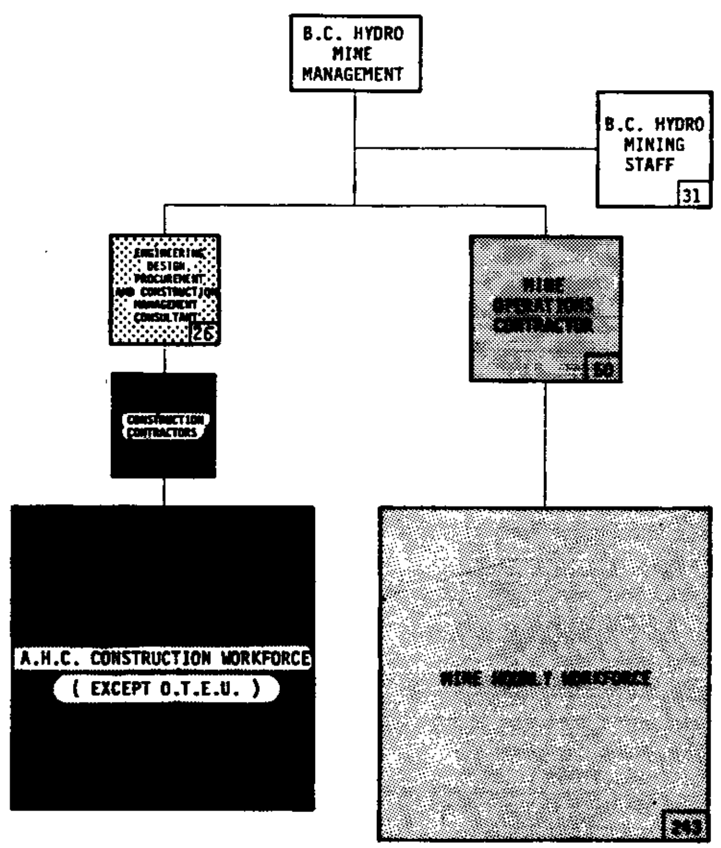
25 October, 1982.

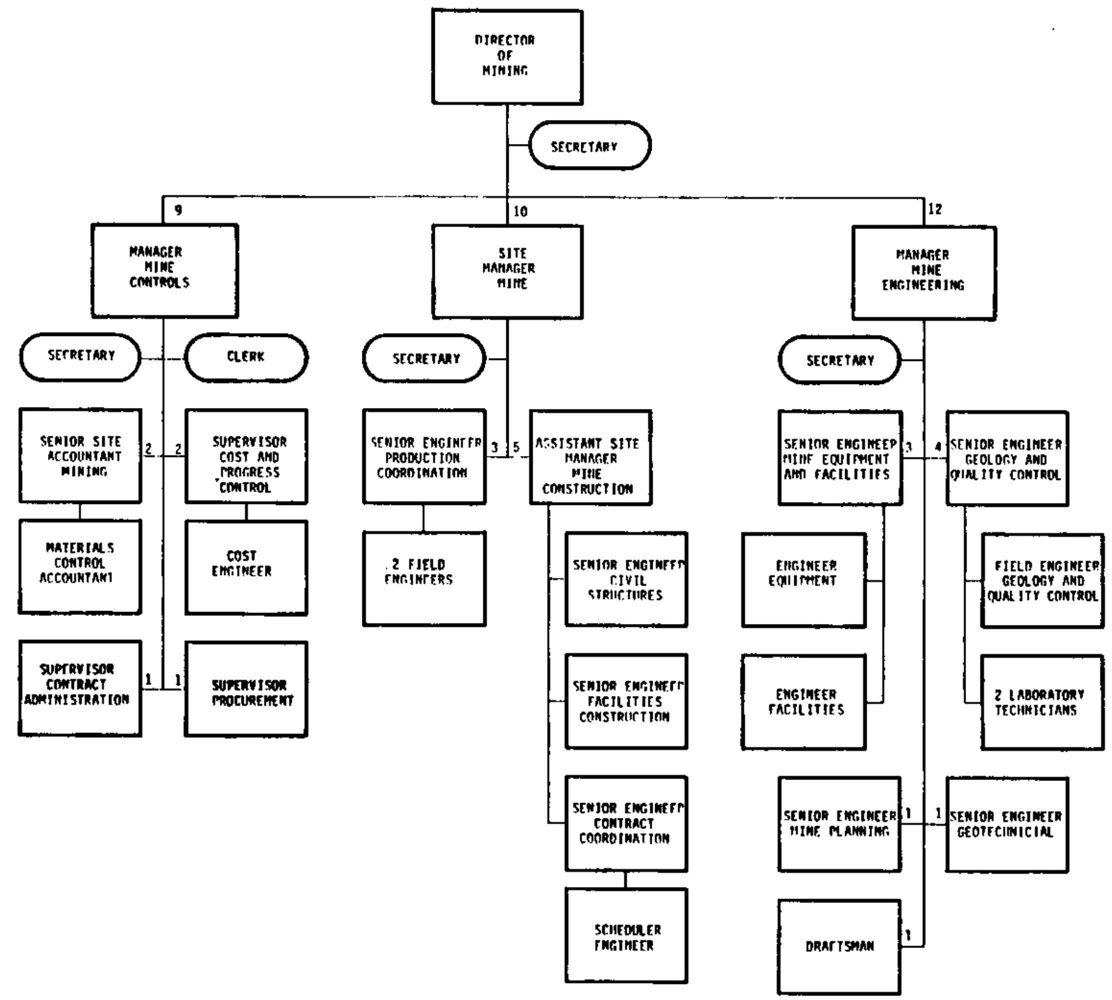
HAT CREEK PROJECT
800 MW PLANT

FIGURE 9-2

B.C. HYDRO STAFF ORGANIZATION DURING OPERATIONS

MINE MANAGEMENT STRUCTURE
DURING CONSTRUCTION AND DEVELOPMENT





25 October, 1982.

HAT CREEK PROJECT
800 MW PLANT

FIGURE 9-3

B.C. HYDRO STAFF ORGANIZATION DURING CONSTRUCTION AND DEVELOPMENT

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SECTION 10

CAPITAL COST ESTIMATE

10.1 INTRODUCTION

The capital cost estimate consists of:

- Initial fixed capital;
- Replacement capital (for fixed assets);
- Preproduction costs.

All of which total direct capital expenditure required to construct, develop and operate the mine. These expenses as summarized in Table 10-3 would commence 5 years prior to the start of commercial operation of the powerplant.

Preproduction costs consist of site operating and development costs incurred in the 3 years prior to the start of commercial power production. The basis for these costs is described in Section 11.

Other capital costs are allocated to the mine in the computation of the total cost of coal, e.g.

- Construction insurance and bonds;
- Land acquisition;
- Prior development expenses, etc.

These are described in Section 11.11.

10.2 CAPITAL COST ESTIMATING CRITERIA

10.2.1 Labour Rates

The construction trade labour rates used in the capital estimates were escalated by 11 percent from October 1981 to reflect October 1982 rates. Included in the rates are supervision costs, payroll taxes and fringe benefits. Also included in the rates are premium time for a 44-hour work week but not including payroll taxes and fringe benefits in the premium portion of premium time rate. The standard work week is Monday to Friday inclusive.

10.2.2 Quantities

Quantities were estimated from drawings and sketches produced during the course of this study. Where applicable and necessary a reduction factor was applied to the quantities used in the 1979 report.

10.2.3 Building and Civil Works

The capital costs for buildings and civil works were developed using prevailing productivity rates in the B.C. construction industry. Unit costs were prepared with the assistance of major trade contractors.

10.2.4 Major Equipment

The capital costs for the coal conveying, crushing and blending equipment were developed on the basis of manufacturers listed prices and quotations during the period February to July 1982. The capital cost estimate includes the following:

- Purchase cost;
- Freight and insurance to site;
- Provincial sales tax at 6 percent;
- Erection costs where applicable.

10.2.5 Mobile Equipment

The capital costs for mobile equipment were developed on the basis of manufacturer's listed prices and quotations obtained between February and July 1982. Freight, insurance and provincial sales tax were included in the estimate.

The initial and replacement capital costs were determined based upon the annual equipment usage required to achieve the production schedule and the service life of the equipment. Table 10-1 shows the capital costs and service life of the mobile equipment used. From this data the equipment purchase and replacement schedule (Table 10-2) was developed to provide the basis for the capital cost estimate. Replacement costs were computed assuming a 15 percent residual value for the units being retired.

10.2.6 Contingency

A contingency of 10 percent has been applied to the total capital investment included in the cost centres described in Sections 10.3.1 to 10.3.8.

10.3 CAPITAL COSTS

The capital costs are summarized in Table 10-3 under the following major cost centres:

91000	Site and Improvements
92000	Maintenance, Service and Administration
93000	Mining
94000	Crushing and Conveying
95000	Secondary Screening and Crushing
96000	Coal Blending and Delivery
98000	Construction Indirects
99000	Mobile Equipment

The individual items and their costs that are included in the major cost centres are described in the following sections:

10.3.1 Site and Improvements

This cost centre includes the cost of those items required for accessing and servicing the mine site and facilities. Specifically estimated were the costs of the following items:

- Site roads;
- Primary and potable water distribution;
- Fire and potable water distribution;
- Sewage collection and treatment;
- Waste water treatment and disposal;
- Drainage.

10.3.2 Maintenance Service and Administration

Included in this cost centre is the capital cost of preparing the site for the mine service buildings which basically involves the cut and fill of 400 000 M^3 of overburden, drainage and bitumen surfacing where required. Also included are the costs of buildings for equipment maintenance and servicing totalling 8908 M^2. An administration building of 1300 M^2, a laboratory of 500 M^2 and mine dry of 1450 M^2 area are also included in the costs.

10.3.3 Mining

Costs for mine communications including stationary and mobile radios, and for pit power distribution comprise this cost centre.

10.3.4 Crushing and Conveying

Costs for a structure, including a truck dump station for run-of-mine coal, crushing and screening equipment, and a rejects conveyor are included in this cost centre. Also included are the costs for a coal conveyor to the blending area and a transfer house with a sampling system.

10.3.5 Secondary Screening and Crushing

The cost of a structure and the costs for crushing screening and conveying equipment are included in this cost centre.

10.3.6 Coal Blending and Delivery

This cost centre includes the capital costs for a coal blending system and coal delivery conveyor to the powerplant. Specific items include:

- Blending bed;
- Stacker/tripper/bucket wheel reclaimer;
- Conveyors;
- Overland conveyors;
- Sampling system.

10.3.7 Construction Indirects

This cost centre includes the following miscellaneous construction costs:

- Temporary offices and other buildings;
- B.C. Hydro staff;
- Office services;
- Site investigation;
- Minor construction equipment;
- Materials management
- Utilities;
- Camp operating costs.

10.3.8 Mobile Equipment

Included in this cost centre are the capital costs for mobile equipment listed on Table 10-1.

TABLE 10-1

HAT CREEK PROJECT
800 MW PLANT
MOBILE EQUIPMENT CAPITAL COSTS AND SERVICE LIVES

Item	Capital Cost	Service Life
Hydraulic Shovel	$2,500,000	6000 Shifts
Haulage Truck	697,000	6000 Shifts
Front End Loader	425,000	2000 Shifts
Scrapers	523,000	2000 Shifts
Track Dozer - 343 kw	546,000	2000 Shifts
Track Dozer - 224 kw	407,000	2000 Shifts
Track Dozer - 149 kw	270,000	2000 Shifts
Wheel Dozer	305,000	2500 Shifts
Motor Grader - 186 kw	377,000	2500 Shifts
Motor Grader - 134 kw	264,000	2500 Shifts
Traxcavator	127,000	2000 Shifts
Compactor	340,000	2500 Shifts
Vibratory Compactor	361,000	12 Years
Auger Drill	247,000	20 Years
Airtrac	162,000	15 Years
Dump Truck	60,000	12 Years
Gradall	168,000	12 Years
Backhoe	200,000	12 Years
Water Wagons	375,000	12 Years
Mobile Crusher	403,000	Project Life
Mobile Crane - 68 t	563,000	18 Years
Mobile Crane - 14 t	206,000	5 Years
Forklift - 5 t	68,000	8 Years
Forklift - 3 t	34,000	8 Years
Hiab Truck - 3 t	33,000	5 Years
Service Truck - 5 t	24,000	5 Years
Tire Truck	48,000	5 Years
Fuel Truck	75,000	3 Years
Lube Truck	114,000	5 Years
Line Truck	88,000	6 Years
Pickup - 3/4 t	11,200	3 Years
Pickup - 1 t	13,700	1 Year
10 Passenger Bus	15,000	3 Years
24 Passenger Bus	25,000	5 Years
Low-boy Tractor Trailer	108,000	10 Years
High-boy Trailer	54,000	10 Years
Compressor - 17 M^3/min	78,000	10 Years
Welders - 300 amp	30,000	10 Years
Steam Cleaner	80,000	8 Years
Lighting Plants	13,700	5 Years
Diesel Pumps	8,700	5 Years
Fire Truck	82,000	Project Life
Ambulance	22,500	10 Years

10. CAPITAL COST ESTIMATE

HAT CREEK PROJECT

800 MW PLANT

TABLE 10-2

MOBILE EQUIPMENT PURCHASE AND REPLACEMENT SCHEDULE

Item	-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	36
Hydraulic Shovel - 14/18 M^3		1/	1/	2/	1/											/1			/2	/1																			
Haulage Truck		4/	5/	2/	1/	1/						/4	/7	1/1	/1				1/								/4	/8		/1									
Front End Loader - 5.4 M^3		1/					/1					/1					/1					/1					/1					/1							
Scrapers - 24 LCM		2/					/2									/2										/2													
Track Dozer - 343 kw		2/			/2					/2						/1					/1							/1											
Track Dozer - 224 kw		2/			1/2		1/	/3								/2					/2					/2					/2								
Track Dozer - 149 kw				1/						/1						/1						/1						/1						/1					
Wheel Dozer - 231 kw		1/		1/						/2						/2								/2									/2						
Motor Grader - 186 kw				1/												/1												/1											
Motor Grader - 134 kw		1/			1/1				/2				/2					/2					/2					/2					/2						
Traxcavator				1/										/1										/1										/1					
Compactor		1/											/1													/1													
Vibratory Compactor		1/										/1												/1															
Auger Drill		1/																				/1																	
Airtrac			1/																/1																				
Drump Truck		2/												/1												/1													
Gradall		1/													/1												/1												
Backhoe - 1 M^3		1/													/1												/1												
Water Wagons		1/		1/								/1	/1											/1	/1														
Mobile Crusher		1/																																					
Mobile Crane - 68 t		1/																			/1																		
Mobile Crane - 14 t		1/		1/			/1		/1			/1		/1			/1		/1			/1		/1			/1		/1			/1		/1			/1		
Forklift - 5 t		1/								/1								/1								/1								/1					
Forklift - 3 t			1/								/1								/1								/1								/1				
Hiab Truck - 3 t		1/		1/			/1		/1			/1		/1			/1		/1			/1		/1			/1		/1			/1		/1			/1		
Service Truck - 5 t			1/					/1					/1					/1					/1					/1					/1						
Tire Truck		1/					/1					/1					/1					/1					/1					/1					/1		
Fuel Truck		1/		1/	/1		/1	/1		/1	/1		/1	/1		/1	/1		/1	/1		/1	/1		/1	/1		/1	/1		/1	/1		/1	/1		/1		
Lube Truck		1/		1/			/1		/1			/1		/1			/1		/1			/1		/1			/1		/1			/1		/1			/1		
Line Truck		1/						/1						/1						/1						/1						/1							
Pickup - 3/4 t	3/	5/	4/	3/3	3/5	/4	/6	/8	/4	/6	/8	/4	/6	/8	/4	/6	/8	/4	/6	/8	/4	/6	/8	/4	/6	/8	/4	/6	/8	/4	/6	/8	/4	/6	/8	/4	/6	/5	
Pickup - 1 t		4/	4/4	2/8	2/10	/12	/12	/12	/12	/12	/12	/12	/12	/12	/12	/12	/12	/12	/12	/12	/12	/12	/12	/12	/12	/12	/12	/12/	/12	/12	/12	/12/	/12	/12	/12	/12	/12	/12	/8
10 Passenger Bus		1/		1/1				/2			/2			/2			/2			/2			/2			/2			/2			/2			/2			/1	
24 Passenger Bus			1/					/1					/1					/1					/1					/1					/1						
Low-boy Tractor Trailer			1/									/1										/1										/1							
High-boy Trailer			1/									/1										/1										/1							
Compressor - 17 M^3/min		1/										/1										/1										/1							
Welders - 300 amp		1/	2/			2/						/1	/2			/2						/1	/2			/2						/1	/2			/2			
Steam Cleaner		1/								/1								/1								/1								/1					
Lighting Plants		2/		2/		/2			/2			/2		/2			/2		/2			/2		/2			/2		/2			/2		/2			/2		
Diesel Pumps	4/					/4					/4			1/		/4			2/1		/4			/3		/4			/3		/4			/1		/4			
Fire Truck	1/																			/1										/1									
Ambulance	1/									/1																													

Note: 1/ = Initial Purchase
/1 = Replacement Purchase

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TABLE 10-3

HAT CREEK PROJECT
800 MW PLANT
SUMMARY OF CAPITAL COSTS

91000	Site and Improvements	$ 38,632.0
92000	Maintenance, Service and Administration	23,607.4
93000	Mining	3,397.5
94000	Crushing and Conveying	5,564.0
95000	Secondary Screening and Crushing	8,447.5
96000	Coal Blending and Delivery	28,571.9
97000	In 99000	
98000	Construction Indirects	26,273.4
99000	Mobile Equipment	105,072.6
	Contingency	23,956.3
		$263,522.6

HAT CREEK PROJECT
800 MW PLANT
TABLE 10-4
CAPITAL COST SCHEDULE

	DESCRIPTION	PRE-PRODUCTION PERIOD -6	-5	-4	-3	-2	-1	PRODUCTION PERIOD 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
91000	SITE AND INVESTIGATIONS			2020.0	15666.8	11786.0	459.8	133.6		102.9							437.0					25.9
92000	MAINTENANCE, SERVICE AND ADMINISTRATION			900.0	5945.1	13762.3	3000.0															
93000	MINING				285.0	1341.3	335.0	424.9	41.3	22.3	15.8	27.6					16.2	780.0				46.6
94000	CRUSHING AND CONVEYING			100.0	200.0	984.0	4280.0															
95000	SECONDARY SCREENING AND CRUSHING				1000.0	4183.6	3263.9															
96000	COAL BLENDING AND DELIVERY				7282.1	14857.8	6432.0															
98000	CONSTRUCTION		630.0	8862.2	5109.2	5975.6	5696.4															
99000	MOBILE EQUIPMENT				93.7	13770.7	6992.6	9054.0	5408.7	1968.6	2450.3	1547.1	1057.6	2233.4	354.9	5484.2	5844.2	2339.8	1147.5	5932.0	1123.8	842.0
	SUB TOTAL		630.0	11882.2	35581.9	66661.3	30459.7	9612.5	5450.0	2093.8	2466.1	1574.7	1057.6	2233.4	354.9	5484.2	6297.4	3119.8	1147.5	5932.0	1123.8	914.5
	CONTINGENCY		63.0	1188.2	3558.2	6666.1	3046.0	961.2	545.0	209.4	246.6	157.5	105.8	223.3	35.5	548.4	629.7	312.0	114.7	593.2	112.4	91.5
	TOTAL FIXED CAPITAL		693.0	13070.4	39140.1	73327.4	33505.7	10573.7	5995.0	2303.2	2712.7	1732.2	1163.4	2456.7	390.4	6032.6	6927.1	3431.8	1262.2	6525.2	1236.2	1006.0
	PRE-PRODUCTION COSTS:																					
	DIRECT MINE PRE-PRODUCTION				2015.0	8843.0	12934.0	9776.0														
	CONTRACTOR'S FEE - 4%				81.0	354.0	517.0	391.0														
	COAL ROYALTY						175.0	181.0														
	CONTINGENCY - 10%				210.0	920.0	1363.0	1035.0														
	TOTAL PRE-PRODUCTION COST				2306.0	10117.0	14989.0	11383.0														
	CORPORATE OVERHEAD		17.3	326.8	1036.2	2086.1	1212.4	416.7														
	CONSTRUCTION INSURANCE AND BONDS		0.6	12.4	57.3	153.9	245.7	279.0														
	TOTAL CAPITAL		710.9	13409.6	42539.6	85684.4	49952.8	22652.4	5995.0	2,303.2	2,712.7	1,732.2	1,163.4	2,456.7	390.4	6,032.6	6,927.1	3,431.8	1,262.2	5,525.2	1,236.2	1006.0

	DESCRIPTION	PRODUCTION PERIOD 16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	TOTAL
91000	SITE AND INVESTIGATIONS																						8000.0	38632.0
92000	MAINTENANCE, SERVICE AND ADMINISTRATION																							23607.4
93000	MINING										8.9											52.6		3397.5
94000	CRUSHING AND CONVEYING																							5564.0
95000	SECONDARY SCREENING AND CRUSHING																							8447.5
96000	COAL BLENDING AND DELIVERY																							28571.9
98000	CONSTRUCTION																							26273.4
99000	MOBILE EQUIPMENT	6115.1	2654.9	1970.9	1761.7	851.1	1931.4	614.0	2675.0	3862.4	6895.0	739.5	816.5	1059.4	1445.5	1265.2	1167.0	353.7	245.1	693.3	212.0	98.8		105072.6
	SUB TOTAL	6115.1	2654.9	1970.9	1761.7	851.1	1931.4	614.0	2675.0	3862.4	6903.9	739.5	816.5	1059.4	1445.5	1265.2	1167.0	353.7	345.1	693.3	212.0	151.4	8000.0	239566.3
	CONTINGENCY	611.5	265.5	197.1	176.2	85.1	193.1	61.4	267.5	386.2	690.4	73.9	81.6	105.9	144.5	126.5	116.7	35.4	24.5	69.3	21.2	15.1	800.0	23956.3
	TOTAL FIXED CAPITAL	6726.6	2920.4	2168.0	1937.9	936.2	2124.5	675.4	2942.5	4248.6	7594.3	813.4	898.1	1165.3	1590.0	1391.7	1283.7	389.1	269.6	762.6	233.2	166.5	8800.0	263522.6
	PRE-PRODUCTION COSTS:																							
	DIRECT MINE PRE-PRODUCTION																							33,568.0
	CONTRACTOR'S FEE - 4%																							1,343.0
	COAL ROYALTY																							356.0
	CONTINGENCY - 10%																							3,528.0
	TOTAL PRE-PRODUCTION COST																							38,795.0
	CORPORATE OVERHEAD																							5,095.5
	CONSTRUCTION INSURANCE AND BONDS																							748.9
	TOTAL CAPITAL	6,726.6	2,920.4	2,168.0	1,937.9	936.2	2,124.5	675.4	2,942.5	4,248.6	7,594.3	813.4	898.1	1,165.3	1,590.0	1,391.7	1,283.7	389.1	269.6	762.6	233.2	166.5	8,800.0	308,162.0

11. OPERATING COST
ESTIMATE

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SECTION 11

OPERATING COST ESTIMATES

11.1 OPERATING COST BASIS

11.1.1 Estimating Criteria

Direct mine operating costs were estimated by fiscal year (commencing April 1) with the start of commercial power production on October 1 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 September 30 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.

11.1.2 Manpower

Operating manpower requirements were computed in accordance with the terms of B.C. Hydro's existing IBEW and OTEU operating labour agreements.

11.1.3 Labour Costs

Hourly labour costs were based upon wage rates paid by B.C. Coal Limited in effect in October 1982. These wage rates were found to be representative of wages paid by B.C.'s open pit mining industry.

Staff salaries were based upon a compensation survey for salaried mine site positions conducted by the Mining Association of British Columbia published in February 1982.

Labour benefits were based upon B.C. Hydro's actual costs in early 1982.

11.1.4 Mobile Equipment

Mobile equipment operating costs were computed from the estimated costs of operating each unit for one shift. The estimates consist of 12 cost elements (operating labour, diesel, service labour etc.) and were based upon source data from other mining operations, manufacturers cost standards (e.g. fuel consumption), and estimates of the life of major components given the probable conditions at Hat Creek (e.g. tire life).

11.1.5 Materials and Supplies

Material and supply costs were based upon telephone quotations for major items (e.g. tires) and information provided by B.C. Hydro procurement (e.g. diesel fuel) wherever the cost of specific commodities could be identified in the estimate. General costs for repair parts were otherwise based upon the initial capital cost of the relevant equipment.

11.1.6 Outside Services

The costs for outside services (e.g. relocation, telephone and travel) were normally based upon an estimated unit cost per employee.

11.1.7 Cost Allocations

The direct operating cost estimate was broken into a number of cost centers, some of which relate to mining activities (e.g. hauling coal) while others relate to responsibility areas (e.g. training). Wherever possible, direct costs were allocated to activity cost centers.

Two cost elements were used to provide a mechanism for such allocations - maintenance allocation and mobile equipment.

Maintenance allocation was used to allocate maintenance labour from the cost centers "Maintenance Shop" and "Electrical Maintenance" where the total maintenance labour costs were computed from the total maintenance manpower. Negative maintenance allocation costs in these two home cost centers match the positive amounts charged to the activity costs centers. The total over all cost centers for maintenance allocation is zero.

Mobile equipment is both a cost element and a cost center in the estimate. The cost of operating all the mobile equipment is captured in the mobile equipment cost center by cost element (e.g. diesel, tires operating labour etc.) This amount was then allocated to the activity costs centers using the mobile equipment cost element.

11.2 OPERATING COST SUMMARY

The preproduction and production direct operating costs are summarized in Tables 11-1 and 11-2 by cost center and by cost element respectively. During the production period, average direct operating costs amount to $5.35/t of coal of which 47 percent is labour cost.

Because most of the waste material is moved in the first 15 years of production and annual coal production remains relatively constant, costs are higher in the early years and lower towards the end of the production phase.

11.3 OPERATIONS LABOUR

11.3.1 Hourly Labour Costs

The wage rates used in the operating cost estimate are shown in Table 11-3. The base hourly rates and job groupings are derived from B.C. Coal Limited's labour agreement with the United Mineworkers of America.

B.C. Hydro's operating labour agreement with the IBEW was used as the basis for grossing up the base wage rates to arrive at a gross payroll cost per productive hour.

The payroll burden cost is discussed in Section 11.3.4

The shift premium where applicable amounts to $0.42 per paid hour and is derived from $8.00 per shift worked on night shift and $4.00 per shift worked on afternoons.

The burden for overtime and paid off-hours was derived by difference from the total rate per productive hour. This latter rate is in turn derived from each worker being paid for 1957½ regular hours per year (under the IBEW agreement) and an assumed 64 hours per year of overtime at double time plus the payroll burden and shift premium divided by 1587 productive hours per year.

11.3.2 Staff Salaries

It was assumed that staff salaries at the Hat Creek Mine would be consistent with those in the mining industry despite the shorter work week (35 hours per week) than what is normal in the mining industry.

A salary survey conducted by the Mining Association of British Columbia in November 1981 was used as the basis for salary estimates. Specific salaries were derived by taking the salary for the closest job title at the 50th percentile level for open pit mines. A 12 percent escalation was assumed for the period 1 November 1981 to 1 October 1982. A summary of salaries appears in Table 11-4.

11.3.3 Recruitment and Relocation

Recruitment and relocation costs will vary significantly in accordance with the type of position to be filled, and will also be affected by the need to fill some positions more than once due to high turnover in the early years of the project.

Recruitment and relocation expense would cover:

- advertising
- recruitment agency charges
- interview expenses
- relocation expenses
- temporary accommodation expenses prior to family relocation

The operating cost estimate includes a $20,000 per man allowance for staff recruitment and relocation per new position in the build-up years, and the same allowance for six positions per year (6 percent turnover after the build-up is complete. Costs for hourly recruitment and relocation assistance were estimated at $5,000 per new position during the manpower build-up phase, and $5,000 on 16 positions per year thereafter.

11.3.4 Payroll Benefits

Costs for fringe benefits include pension, insurance and workers compensation premiums payable by B.C. Hydro for all its employees. The amount payable was based upon the actual cost for benefits for B.C. Hydro's full-time regular IBEW employees as computed on 21 April 1982. A burden rate of 12 percent of paid salaries and wages was included in the estimate. A breakdown of the burden is shown below.

Payroll Benefits - All Employees

	Percent of Payroll Cost
Income Continuance	0.57
Hydro Pension	6.63
Canada Pension	0.78
Unemployment Insurance	1.23
Workers Compensation	0.90
Medical Service Plan	0.75
Extended Health Care	0.09
Dental Plan	0.50
Group Life	0.27
Other	0.28
TOTAL	12.00%

11.3.5 Housing Assistance

It is normal in the mining industry for employers located more than 40 km from a major population center to become involved in the financing of housing for their employees. This involvement is especially necessary in the early years to ensure that quality housing is constructed and made available to the work force at an affordable cost: Once constructed, this housing stock has a stabilizing influence on the work force for the life of the mine. If no assistance was available from the employer, mobile homes would predominate in the community and tend to attract a younger, single, less qualified and more transient work force.

The financing assistance can take various forms:

- interest free loans
- forgiveable interest free loans
- low interest loans
- monthly housing subsidies
- controlled housing prices
- mortgage guarantees
- guaranteed buybacks

The assistance is provided for rental housing as well as for homes purchased by employees.

The basic principle governing the amount of housing assistance is that the average hourly paid workers should be able to afford a single family home, and the lowest paid worker should be able to afford apartment accommodation. On this basis, given the wage rates assumed for the Hat Creek mine, the amount of assistance required is the equivalent of $427.50 per month on all housing units. Since more than one employee may occupy a single residence, the number of housing units required would be only 81.1 percent of the number of employees. These assumptions are the basis for the housing assistance estimate in the operating costs, which amounts to $0.28/t.

11.4 MOBILE EQUIPMENT

11.4.1 Annual Shifts

The annual operating shifts (eight hour basis) for each piece of major mobile equipment were calculated based upon the productivity factors and annual coal and waste quantities to be handled or on other factors which apply for support and maintenance equipment. These operating shift requirements were calculated separately for each cost center where the equipment is utilized.

The requirements for small mobile equipment were estimated on the number of units required rather than the number of operating shifts (e.g. number of pickups required, pumps, welders etc.).

Table 11-5 shows the total number of operating shifts for each type of major mobile equipment unit for production Year +5.

11.4.2 Unit Running Costs

The cost of operating each piece of major mobile equipment was broken into ten cost elements:

- operating labour
- diesel fuel
- gasoline
- power
- oil and grease
- repair labour
- service labour
- wear parts
- tires
- repair parts

The costs per shift by cost element for major mobile equipment are shown in Table 11-6, while the costs per year by cost element for light mobile equipment are shown in Table 11-7.

Operating labour costs per shift are the gross payroll costs for eight productive hours of operator time, except in the case of the H241 shovel where 10½ hours were assumed, and the drills where two operators for eight hours per shift are required.

Both diesel fuel and gasoline were estimated at $0.337/l, and based on fuel consumption rates derived from industry standard information and equipment handbooks.

Oil and grease costs include lube and hydraulic oils and filters. Costs were based on industry data.

Repair labour costs were computed from the number of repair manhours expected per operating manhour as experienced at other operations on similar equipment operating in similar conditions.

Service labour was based on one half hour per shift of service time.

Wear parts costs were based on the expected wear rate of drill bits, grader blades etc.

Tire costs were computed from an expected tire life (4,000 operating hours in the case of trucks) and the price of replacement tires.

The costs for repair parts were derived from costs experienced at other operations for similar equipment.

11.5 FIXED EQUIPMENT

11.5.1 Coal Handling System

The costs for maintenance labour and repair parts for the coal handling system were based upon a percentage of the inital capital cost of the facilities. The basis is summarized below.

Coal Handling System
Maintenance Labour and Repair Costs

	Initial Capital Cost (k$)	Percent Annual Cost: Maintenance Labour %	Percent Annual Cost: Repair Parts %	Total Annual Cost (k$)
Truck dump	3,029	2.5	5.0	227.2
Conveyor to blending	2,535	2.5	2.5	126.8
Crushing	8,448	1.25	2.5	316.8
Stacker/Reclaimer	12,617	2.0	2.0	504.7
Overland Conveyor	9,223	2.5	2.5	461.2

11.5.2 Site Services

The cost of miscellaneous materials for the mining operation (e.g. stationery, protective clothing, rags, etc.) is provided for in the estimate by an allowance for supplies amounting to 5 percent of total labour costs.

11.6 CONTRACTOR'S ALLOWANCE

The mine operating contractor will undertake responsibility for managing the day to day operation of the mine by providing experienced key supervisors and professionals. They should be familiar with the management systems and procedures which the contractor will utilize for the Hat Creek mine in co-ordination with B.C. Hydro's requirements.

B.C. Hydro will supply the capital funding and reimburse the contractor for all operating costs incurred. In addition, B.C. Hydro will pay the contractor a fixed fee for his services. This management fee has been estimated to be 4 percent of all mine operating costs.

11.7 SCHOOL TAXES

Under the terms of the Hydro and Power Authority Act, B.C. Hydro would be subject to school taxes on the mine installations at Hat Creek on the same basis as all other taxpayers in the province. In addition, grants in lien of taxes are paid to municipalities and the Provincial Government. These grants are the equivalent of general, local improvement and regional district tax levies.

These taxes and grants are based on the assessed value of land and improvements including machinery. For this study estimates of the taxes payable were computed in accordance with the capital cost schedules.

11.8 PROVINCIAL COAL ROYALTY

The Government of British Columbia levies a royalty on all coal produced in the Province at the rate of 3.5 percent of the mine head value of coal production. B.C. Hydro is liable for the payment of this tax on Hat Creek coal. In the operating cost estimate the total cost of delivering coal to the powerplant has been assumed to be the mine head value of the coal.

11.9 CONTINGENCY

The contingency on mine operating costs is meant to cover unforseen conditions which may occur in the mining operation or be imposed on the operation. Examples of such conditions are:

- lower than expected coal quality
- shallower than expected slope angles on ultimate pit walls
- new environmental constraints
- changing manpower requirements

A contingency of 10 percent on total operating costs has been included in the estimate to provide for the possibility of such unforseen conditions.

11.10 B.C. HYDRO CORPORATE OVERHEAD

The direct mine operating costs were estimated on the basis of a stand alone operating entity at the Hat Creek mine requiring only minor support and assistance from B.C. Hydro's corporate offices. Areas where such support will be required are:

1. Labour Relations

B.C. Hydro will have the responsibility for negotiating and providing overall administration of operating labour agreements.

2. Legal

B.C. Hydro's corporate office will be required to provide legal support for the mine.

3. Purchasing

Because of conditions in the Power Act, it may be necessary for corporate personnel to monitor and provide support for the mining procurement. The estimate includes procurement personnel on the staff of both B.C. Hydro and the contractor in the field.

4. Accounting and Data Processing

The estimate does not include provision for data processing costs (e.g. payroll), or accounting costs other than at the field level (e.g. no provision for audit expenses).

These expenses are meant to be covered by an overhead allowance of 2.5 percent of the initial capital costs of mining facilities and equipment.

11.11 TOTAL COST OF COAL

The computation of the total cost of coal is the sum of all capital and operating costs attributable to the mine, including expenses prior to the decision to procede with the project and capitalized interest since the inception of the project.

The total costs of coal in 1982/83 dollars is shown in Table 11-8 for two sets of data. The first set of data was submitted to the cost of service study in August 1982 prior to the completion of the mining cost estimates, and is somewhat higher ($12.50/t) than the final numbers presented in this Mining Report ($12.10/t). Important scope differences between the two computations are:

(1) Housing assistance for operating personnel was not included in the August 1982 figures ($0.28/t) because it does not conform to current B.C. Hydro policy, but has been included in the Mining Report figures to be consistent with basic assumptions for performance standards.

(2) Base operating costs shown in the Mining Report are much lower than those submitted in August 1982 because the selection of mobile mining equipment had not been optimized at the time the earlier numbers were submitted.

(3) The contingency on operating costs was not included in the August 1982 figures because it was recognized that the final operating costs would be lower.

The total cost of coal including all pertinant capital and operating costs is $12.10/t produced over the 36-year planned life of the mine.

TABLE 11-1
HAT CREEK PROJECT
800 MW PLANT
DIRECT OPERATING COSTS BY COST CENTRE

	Total All Years	Pre-pro duction	Produc- tion	Unit	$/Unit
Mine Production					
Coal	132,168	1,228	130,940	kt	
Waste	95,335	5,138	90,197	km³	
Waste Partings	13,159	63	13,096	km³	
Waste Ratio BCM/T	0.82	4.24	0.79		
Operating Costs $000'S					
Site:					
Site and Pit Roads	46,659	2,013	44,646		
Power	34,331	635	33,696		
	80,990	2,648	78,342	t	0.60
Administration and Engineering:					
Management	19,609	1,646	17,963		
Administration	58,939	4,063	54,876		
Administration Services	16,061	1,206	14,855		
Administration Site Services	12,085	479	11,606		
Human Resources	26,702	2,337	24,365		
Training	14,332	578	13,754		
Housing Assistance	38,483	1,634	36,849		
Mine Engineering	18,833	907	17,926		
Close Spaced Drilling	1,925	145	1,780		
	206,969	12,995	193,974	t	1.48
Maintenance and Services:					
Maintenance Shops	29,977	1,529	28,448		
Electrical Maintenance	331	7	324		
Mine Communications	2,576	22	2,554		
Mine Transportation	15,115	611	14,504		
Field Lubrication/Fueling	3,720	109	3,611		
	51,719	2,278	49,441	t	0.38
Mining:					
Mine Supervision	21,100	1,075	20,025		
General Mine Costs	11,926	429	11,497		
Auxiliary Equipment	29,419	2,358	27,061		
Loading Waste Partings	2,719	13	2,706	m³	0.21
Hauling Waste Partings	14,650	50	14,600	m³	1.11
Drilling Waste	849	40	809	m³	0.01
Blasting Waste	1,971	43	1,928	m³	0.02
Loading Waste	21,671	1,183	20,488	m³	0.23
Hauling Waste	89,532	3,937	85,595	m³	0.95
Loading Coal	20,331	161	20,170	t	0.15
Hauling Coal	46,262	336	45,926	t	0.35
Pit Dewatering and Drainage	12,648	1,487	11,161		
Limestone Quarry	-	-	-		
	273,078	11,112	261,966	t	2.00
Coal Handling:					
Conveying to Mine Mouth	17,310	114	17,166		
Crushing	16,065	132	15,933		
Stockpiling and Blending	39,490	414	39,076		
Conveying to Powerplant	21,012	167	20,845		
	93,877	857	93,020	t	0.71
Waste Dumps	26,348	1,896	24,452	m³	0.24
TOTAL OPERATING	732,981	31,786	701,195	t	5.35

TABLE 11-2

HAT CREEK PROJECT
800 MW PLANT
DIRECT OPERATING COSTS BY COST ELEMENT

	Total All Years	Pre-Production	Production	Unit	$/Unit
Mine Production:					
Coal	132,168	1,228	130,940	kt	
Waste	95,335	5,138	90,197	km^3	
Waste Partings	13,159	63	13,096	km^3	
Waste Ratio m^3/t	0.82	4.24	0.79		
Operating Costs: k$					
Wages and Benefits	231,317	7,843	223,474	t	1.71
Salaries and Benefits	115,660	7,500	108,160	t	0.83
Diesel and Gasoline	65,879	2,808	63,071	t	0.48
Power	36,539	704	35,835	t	0.27
Supplies	26,916	1,140	25,776	t	0.20
Wear Parts	8,161	459	7,702	t	0.06
Tires	22,076	788	21,288	t	0.16
Repair Parts	122,873	3,577	119,296	t	0.91
Maintenance Allocation	16	(2)	18	t	0.00
Mobile Equipment	10	1	9	t	0.00
Outside Services	103,534	6,968	96,566	t	0.74
TOTAL OPERATING COSTS	732,981	31,786	701,195	t	5.35

TABLE 11-3

HAT CREEK PROJECT
800 MW PLANT
HOURLY WAGE RATES

	Base Hourly Rate	Payroll Burden*2	Shift Premium	Overtime And Paid Off Hours	Total Per Productive Hour*1
Journeyman Tradesman	16.10	1.93	0.42	5.77	24.22
Shovel Operator	15.58	1.87	0.42	5.58	23.45
Crane Operator Rotary Driller Stacker Reclaimer Operator Conveyor Controller	15.18	1.82	0.42	5.44	22.86
Blaster Secondary Crusher Operator Tireman	14.79	1.77	0.42	5.31	22.29
Truck Operator Dozer Operator Grader Operator Front End Loader Operator	14.39	1.73	0.42	5.16	21.70
Shovel Helper Driller Helper Service Truck Operator Airtrack Driller Primary Crushing Operator Lube Serviceman	13.99	1.68	0.42	5.02	21.11
Utility Truck Operator Blaster Helper Warehouseman Conveyor Patrolman Equipment Learner Operator	13.59	1.63	0.42	4.88	20.52
Counterman	13.04	1.56	0.42	4.69	19.71
Pumpman	12.80	1.54	0.42	4.60	19.36
Labourer	12.40	1.49	0.42	4.46	18.77

Notes: *1 Gross Payroll Cost Per Productive Hour (1587 Hours Per Year)

*2 Medical Plans, UIC, CPP, Retirement, etc.

TABLE 11-4

HAT CREEK PROJECT
800 MW PLANT
STAFF SALARIES

Position	$ Annual Salary
SPC Personnel	
Engineering:	
Manager Mine Engineering	57,000
Senior Engineer	47,000
Field Engineer	33,000
Laboratory Supervisor	38,000
Engineer	38,000
Manager Mine Controls	52,000
Supervisor Procurement	47,000
Chief Engineer	53,800
Pit Engineer	50,000
Administration:	
Senior Site Accountant	38,000
Office Manager	46,000
Accountant	30,000
Warehouse Supervisor	39,000
Personnel Superintendent	54,000
Training Supervisor	42,000
Safety Co-ordinator	42,000
Fire Chief	42,000
Maintenance Supervision:	
Maintenance Superintendent	54,300
General Supervisor	47,300
Supervisor	43,000
Maintenance Planning Supervisor	47,300
Operating Supervision:	
Operations Superintendent	63,000
Shift Supervisor	53,000
Supervisor	43,400
OTEU Personnel	
Secretary	20,000
Draftsman	30,000
Technician	33,000
Clerk	18,000
Scheduler	30,000
Analyst	25,000
Paymaster	30,000
Buyer	25,000
Recruiter	30,000
Security Guard	30,000
Surveyor	29,900

TABLE 11-5

HAT CREEK PROJECT
800 MW PLANT
OPERATING SHIFTS FOR MAJOR MOBILE EQUIPMENT
PRODUCTION YEAR 5

Major Mobile Unit	Year 5 Operating Shifts
Auger Drill	75
Crawler Mounted Drill	52
Hydraulic Shovel	1404
Front End Loader - 5.4 M^3	442
Traxcavator	210
91 t End Dump Truck	8487
10 yd End Dump	120
Scraper - 24 LCM	677
Track Dozer - 343 kw	936
Track Dozer - 224 kw	1980
Track Dozer - 149 kw	200
Wheel Dozer - 231 kw	770
Motor Grader - 186 kw	200
Motor Grader - 134 kw	1350
Gradall	200
Backhoe 3/4 cy.	105
Sand Truck	120
Water Wagon	400
Compactor	144
Compactor - Vibratory	102
Mobile Crusher	80
Fuel Truck	735
Lube Truck	490

TABLE 11-6

HAT CREEK PROJECT
800 MW PLANT
MAJOR MOBILE EQUIPMENT UNIT COSTS
$/SHIFT

	Operating Labour	Diesel Fuel	Gasoline	Power	Oil and Grease	Repair Labour	Service Labour	Wear Parts	Tires	Repair Parts	Maintenance Overhead	Total
Auger Drill	339.36	58.55	-	-	20.00	100.00	-	150.00	-	100.00	-	767.91
Crawler Mounted Drill	339.36	58.55	-	-	20.00	100.00	-	150.00	-	100.00	-	767.91
Hydraulic Shovel	237.51	-	-	65.00	28.00	261.86	10.16	84.00	-	392.00	-	1,078.53
Front End Loader - 5.4 M^3	167.12	94.36	-	-	16.80	74.82	10.16	5.60	56.00	67.20	-	492.06
Traxcavator	167.12	28.65	-	-	5.60	46.72	10.16	33.60	-	39.20	-	331.09
91 t End Dump Truck	167.12	127.39	-	-	23.63	102.58	10.16	-	67.70	199.40	-	697.98
10 Yd End Dump Truck	167.12	43.40	-	-	-	60.00	-	-	18.60	30.00	-	319.12
Scraper - 24 LCM	167.12	122.33	-	-	16.80	121.58	10.16	-	82.94	120.96	-	641.89
Track Dozer - 343 kw	167.12	142.89	-	-	22.40	93.52	10.16	67.20	-	112.00	-	615.29
Track Dozer - 224 kw	167.12	102.79	-	-	11.20	77.15	10.16	50.40	-	84.00	-	502.82
Track Dozer - 149 kw	167.12	75.83	-	-	8.40	58.45	10.15	44.80	-	67.20	-	431.96
Wheel Dozer	167.12	96.38	-	-	16.80	60.79	10.16	5.60	42.00	56.00	-	454.85
Motor Grader - 186 kw	167.12	58.98	-	-	11.20	72.48	10.16	16.80	44.80	88.59	-	470.13
Motor Grader - 134 kw	167.12	40.44	-	-	8.40	63.13	10.16	11.20	33.60	50.40	-	384.45
Gradall	167.12	28.60	-	-	-	60.00	-	8.00	8.00	45.00	-	316.72
Backhoe - 3/4 Cy.	167.12	25.51	-	-	4.80	79.50	10.16	5.00	5.00	80.00	-	377.09
Sand Truck	167.12	25.50	-	-	-	40.00	-	-	12.00	40.00	-	284.62
Water Wagon	167.12	40.80	-	-	-	100.00	-	-	18.00	80.00	-	405.92
Compactor	167.12	96.38	-	-	16.80	60.79	10.16	3.00	42.00	56.00	-	452.25
Compactor - Vibratory	167.12	25.61	-	-	5.80	68.64	10.16	-	-	130.80	-	408.13
Mobile Crusher	-	400.00	-	-	-	160.00	-	80.00	-	160.00	-	800.00
Fuel Truck	-	20.40	-	-	-	40.00	-	-	4.60	34.00	-	99.00
Lube Truck	-	17.00	-	-	-	26.00	-	-	3.10	20.00	-	66.10

TABLE 11-7

HAT CREEK PROJECT
800 MW PLANT
LIGHT MOBILE EQUIPMENT UNIT COSTS
$/ANNUM

	Operating Labour	Diesel Fuel	Gasoline	Power	Oil and Grease	Repair Labour	Service Labour	Wear Parts	Tires	Repair Parts	Maintenance Overhead	Total
Pick-up - Assigned			1,700			1,250			500	2,000		5,450
Pick-up - Unassigned			9,900			10,500			1,000	12,000		23,400
10 Passenger Bus			3,400			2,500			1,000	4,000		10,900
24 Passenger Bus		2,300				5,000			1,000	5,000		13,300
1 Ton Flatdeck			7,000			2,500			1,000	2,000		12,500
3 Ton Truck W/Hiab		6,200				2,100			1,300	1,700		11,300
5 Ton Service Truck		6,200				3,200			2,000	2,500		13,900
Tire Truck		3,100				1,000			600	850		5,550
Line Truck		2,050				550			400	400		4,400
Lo-boy Tractor Trailer		5,100				7,200			3,600	5,600		21,500
Hi-boy Trailer									2,000	2,000		4,000
75 Ton Crane		1,200				4,000			400	2,800		8,400
15 Ton Crane		1,600				4,400			480	2,200		8,680
5 Ton Forklift		1,500				1,800			400	1,400		5,100
3 Ton Forklift			1,000			1,100			200	900		3,200
Compressor 17 cm/min			920			1,320			80	720		3,040
Welder - 300 amp		1,860				700			140	700		4,400
Steam Cleaner			2,480			1,320			520	1,360		5,680
Lite Tower			4,250			5.000				5,600		14,850
Pump - Diesel		4,018				2,970				3,870		10,858

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TABLE 11-8

HAT CREEK PROJECT
800 MW PLANT
TOTAL COST OF COAL

	800 MW Feasibility August 1982 (1982 k$)	800 MW Mining Report October 1982 (1982 k$)
Initial Capital Costs		
Capital Costs to Full Production	184,204	176,305
Pre-production Operating Costs	34,921	36,363
Discretionary Expenses	3,000	3,000
Construction Insurance and Bonds	749	749
Land Acquisition	5,414	5,414
Other Ongoing Studies	27,414	27,414
Mine Cost System (Cost Centre)	22,237	22,237
Corporate Overhead	6,948	6,787
Interest During Construction	105,478	110,811
Project Total Cost	390,365	389,080
Per Tonne	2.95	2.94
Replacement Capital	82,800	87,218
Per Tonne	0.63	0.67
Operating Costs		
Direct Operating	819,652	701,195
Contingency - 10%	-	70,120
Contractor's Allowance	32,786	30,853
School Taxes	98,000	88,800
Provincial Coal Royalty	52,700	47,400
Interest and Insurance	175,797	184,567
Total Operating	1,178,935	1,122,935
Per Tonne	8.92	8.50
Total Costs	1,652,100	1,599,233
Per Tonne	12.50	12.10
Tonnes Produced (k$)	132,168	132,168

12. REFERENCES

SECTION 12

REFERENCES

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