B.C. HYDRO

225 MW THERMAL STUDY

MINING REPORT

STATION PROJECTS DIVISION

MECHANICAL DESIGN DEPARTMENT

BR42

October 1984

225 MW THERMAL STUDY

MINING REPORT

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SECTION 1.0 - INTRODUCTION

1.1 BACKGROUND

In 1982 B.C. Hydro made the decision to defer indefinitely the development of the Hat Creek Project due to the declining load forecast. At that time a feasibility study for an 800 MW (gross) powerplant and mine complex was nearing completion and was allowed to continue. This study was carried out as an alternative to the 2240 MW (gross) powerplant and mine plan which was completed in 1979.

With the decision to defer, a major staff reduction was implemented leaving only a small thermal core group to continue studying thermal generation alternatives for the System Plan and to maintain some expertise in the Hat Creek coal resource.

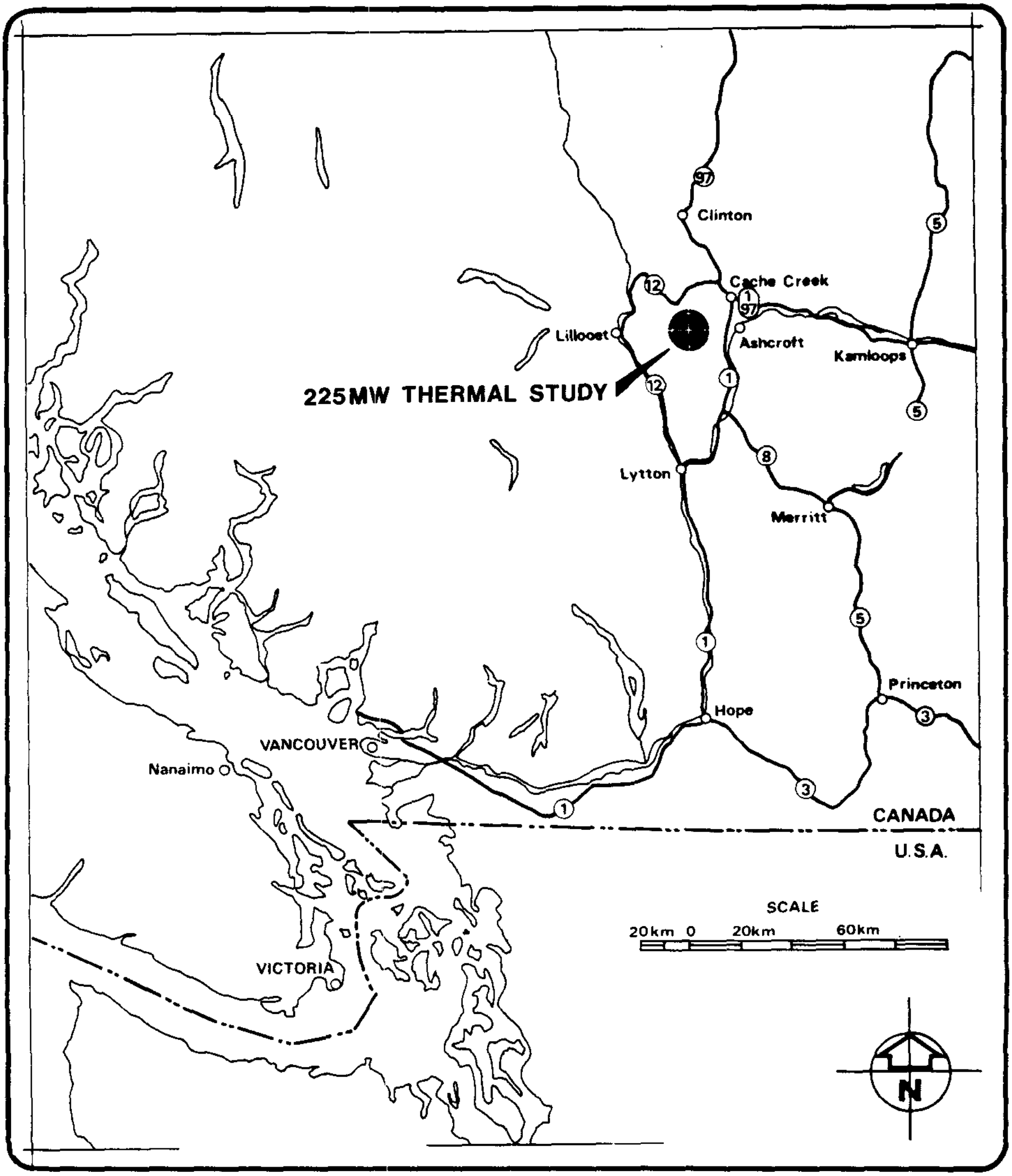
An assignment was received by this core group to carry out a study to the level of the 800 MW Feasibility Study[19] for a 150 to 200 MW (net) powerplant alternative using Hat Creek No. 1 coal deposit. Due to budget restraints the assignment was to be carried out in-house without the use of outside consultants.

With these restraints and the reduced level of manpower the mining studies were carried out relying heavily on previous studies in several areas particularly in equipment selection, coal handling, Hat Creek Diversion and costing. Mine planning was carried out manually whereas in the 800 MW[6] and 2240 MW[1] plans this was carried out by Mintec Inc. using their computer programs. Therefore, any future studies would need to review the criteria used for the 225 MW Mine Plan.

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. Fig. 1-1 shows the project location.

The Hat Creek Valley is underlain by coal deposits of unique thickness: approximately 500 m. 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 overall reserves including the inferred reserves for No. 2 deposit are estimated to be in excess of 5 Gt.



225MW THERMAL STUDY

FIG 1-1

PROJECT LOCATION

SECTION 2.0 - SUMMARY

2.1 MINING

The open pit mine to supply coal to the 225 MW Thermal Plant would be located in the Hat Creek No. 1 coal deposit at the north end of Hat Creek Valley. The No. 1 deposit contains some 740 Mt of sub-bituminous coal at an average grade of 17.71 MJ/kg (dcb). The site layout is shown in Fig. 2-1.

The coal would be mined from the open pit developed to a depth of about 95 m below the valley floor. After 35 years operation the open pit would measure about 1.4 km by 0.9 km and the disturbed area would be approximately 100 ha.

The overall pit slopes vary up to 25° depending upon the geotechnical conditions in the various materials present in the open pit area. For the proposed thermal plant and its 35 years of operation it would require the mining and handling of some 32 Mt of coal and 16 1/2 Mm^3 of waste materials over the life of the mine. The predicted quality of the coal would be 19.49 MJ/kg (dcb).

Both coal and waste would be mined using hydraulic shovels and hauled to their respective dumping points with 50 t trucks. Coal would be delivered for crushing to a dump pocket located northeast of the mine mouth and waste would be transported to the Houth Meadows disposal area.

The coal would be mined to a well controlled mining plan designed to produce a blend of coal with the required average quality of 19.49 MJ/kg to a tolerance of ±1 MJ/kg. After crushing to -150 mm in the primary crusher the coal is delivered to the coal blending area by conveyor. A slewing stacker using the windrow method of pile construction would build up stockpiles of blended coal. The blended fuel would be reclaimed from the stockpiles by front end loaders and delivered by conveyor to the secondary screening and crushing plant for sizing to -50 mm. After the secondary crushing operation the fuel would be delivered to the plant coal bunkers by conveyor.

Waste materials, including ash and FGD sludge from the powerplant operations, would be dumped into the Houth Meadows waste disposal area and spread in 10 m high lifts behind an engineered embankment.

For the successful development of No. 1 coal deposit, Hat Creek itself would need to be diverted around the developing mine area. This would be achieved by means of a pit rim dam with an outlet structure feeding a moveable twin pipeline which returns the water to the original Hat Creek downstream of the mine. The mine area would be drained by a network of diversions, ditches and wells. Other features of the drainage plan would include leachate and sedimentation lagoons. A powerplant water supply reservoir located upstream of the pit rim dam would provide flow control for Hat Creek (Ref. 20).

The mine would be serviced by a Maintenance Complex situated northeast of the mine. Facilities would include administration buildings, maintenance facilities, a mine dry, fuel island. Power for the mine and facilities would be supplied from the powerplant located adjacent to the mine mouth.

A reclamation plan would be developed that would permit progressive reclamation of disturbed areas where possible and for extensive reclamation at the completion of the mining operations.

Dust control measures would be incorporated into the design and operating procedures would be developed to minimize particulate emissions to meet the B.C. Pollution Board Objectives.

Mine operating schedules would be based on a 5-day week. Coal production is planned on a one shift/day schedule for the 35-year mine operation and waste production is planned on a two shift/day schedule until Year 15 when it reduces to one shift/day. Some flexibility will be possible to meet seasonal demands in both coal and waste production through equipment scheduling or additional production shifts could be scheduled.

2.2 COSTS

(a) Capital Costs

Capital costs have been developed in October 1983$. They are:

1.	Costs to start of commercial production	= $80.01 M
2.	Pre-production costs to start of commercial production	= 13.80 M
	TOTAL INITIAL EXPENDITURES	= $93.81 M
	Balance of capital costs and replacement capital for equipment	= $33.76 M

(b) Operating Costs

Operating costs and manpower levels fluctuate slightly over the life of the mine in response to varying coal and waste quantities. Manpower peaks at 102 by Year 6 reducing 96 by Year 16.

Direct operating costs follow a similar trend averaging $7.13/t produced over the 35 year operating period.

TABLE 2-1

225 MW THERMAL STUDY
SUMMARY OF DIRECT MINE CAPITAL AND OPERATING COSTS

Year	Capital*2 ($000's) Initial	Capital*2 ($000's) Replacement	Operating*1 ($000's) Pre-production	Operating*1 ($000's) Production	Total*1 ($000's)
-4	2,200				2,200
-3	6,830		208		7,038
-2	30,810		4,145		34,955
-1	27,010		5,365		32,375
1*3	13,160		4,082	4,293	21,535
2		2,900		8,855	11,755
3		210		8,865	9,075
4		55		8,855	8,910
5		3,275		9,475	12,750
6		130		8,935	9,065
7		120		8,935	9,055
8		595		8,935	9,530
9		1,370		8,935	10,305
10		940		9,405	10,345
11		1,950		8,610	10,560
12		575		8,610	9,185
13		535		8,610	9,145
14		515		8,610	9,125
15		2,480		9,100	11,580
16		395		8,475	8,870
17		425		8,475	8,900
18		760		8,475	9,235
19		560		8,475	9,035
20		1,140		8,570	9,710
21		490		8,475	8,965
22		2,330		8,475	10,805
23		1,985		8,475	10,460
24		1,585		8,475	10,060
25		2,175		8,565	10,740
26		1,050		8,450	9,500
27		470		8,450	8,920
28		1,625		8,450	10,075
29		1,170		8,450	9,620
30		1,180		8,450	9,630
31		120		8,420	8,540
32		470		8,420	8,890
33		45		8,420	8,465
34		85		8,405	8,490
35		45		8,250	8,295
	80,010	33,755	13,800	298,128	425,693

*1 Includes: Royalties, school taxes, contractor's allowance, contingency.
*2 Includes: Contingency
*3 Powerplant first year in-service.

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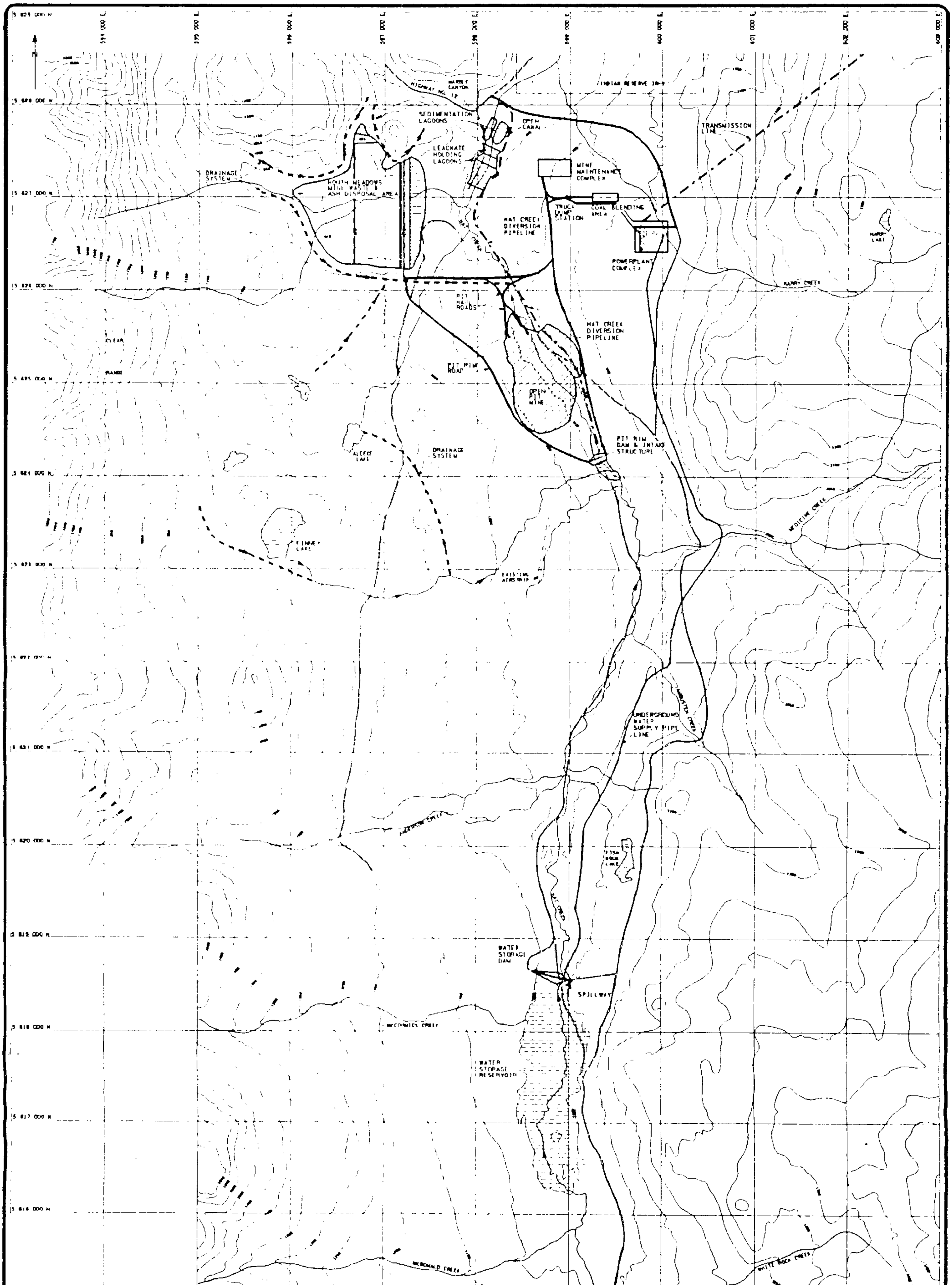

NOTES:

1. MAP BASED ON UTM PROJECTION
   - ELEVATIONS IN METRES ABOVE G.S.C.
   - NORTHINGS AND EASTINGS ARE GIVEN AT EL 0.0 m G.S.C.
2. CONTOURS AT 50 m INTERVALS

225MW THERMAL STUDY

FIGURE 2-1

PROJECT COMPLEX MAP

SECTION 3.0 - GEOLOGY

3.1 REGIONAL GEOLOGY

The upper Hat Creek Valley contains the thickest known deposit of sub-bituminous lignitic coal in the world. Two separate deposits have been located and explored by geophysical surveys. 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. Fig. 3-1 shows the regional geology.

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 coal-bearing section belongs to the Hat Creek Formation of the Eocene Epoch deposited 36 to 42 million years ago.

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 subdivision in the deposit. The problem was ultimately overcome, and the deposit has been divided into 16 sub-zones shown in Table 3-1. This was achieved using the geologists' description of the cores, the analytical results, and the geophysical logs.

Two of the 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. The thickness of the sub-zones vary from 5 to 55 m and average 20 m. In many of the sub-zones, bands of clay and carbonaceous shale are interbedded with the coal.

The primary structure in the No. 1 deposit consists of two synclines separated by an anticline, plunging at an average of 15 to 17 degrees towards the south southwest. It is truncated on the south and east by steeply dipping boundary faults.

In the northwest quadrant of the deposit, a section of coal has burned and baked the interlayered and enclosing clay beds.

3.2 COAL RESERVES

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.

Reserve calculations were performed using a computer model of the deposit developed by Mintec Inc. This model is a cross-sectional model with geologists' structural interpretation of the deposit represented on sections approximately 150 m apart. Fig. 3-2 shows one of these sections. The procedures followed in developing the calculations is given in the 800 MW Mining Report.[6]

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 (4000 Btu/lb) (dry basis) classified as waste.

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

(a) Geological Reserves

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

A summary of the geological reserves by sub-zone is shown in Table 3-2.

From this summary the geological reserves for No. 1 deposit are estimated to be:

Measured - 739.5 Mt and 17.7 MJ/kg (7600 Btu/lb), 34.8 percent ash and 0.51 percent sulphur (dcb)

Inferred - 45 Mt of undefined quality (80 percent of this tonnage occurs below the 600 m elevation).

(b) Mineable Reserves

The mineable reserves consider 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 pit slopes - 15° (north), 20° (east), 19° (south and west).

2. Minimum mining thickness 2 m.

3. Cut-off grade 9.3 MJ/kg (dcb) (4000 Btu/lb).

As a result of this study, the mineable reserves for No. 1 deposit were established as 566.6 Mt of coal at 17.7 MJ/kg (7600 Btu/lb), 34.5 percent ash and 0.51 percent sulphur (dcb). The overall strip ratio would be 1.79 m^3 waste/t of coal.

3.3 COAL QUALITY AND CONTROL

(a) Coal Quality

Systematic analytical work has been conducted on all core samples. Samples have been analyzed to provide proximate, ultimate, and sulphur analyses as well as HHV, ash fusion temperature and grindability information.

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 interbedded waste bands.

The coal quality for the entire geological reserves of the No. 1 deposit is summarized in Table 3-3.

Sulphur content of the No. 1 deposit averages 0.51 percent (dcb), of which approximately 71 percent occurs as organic sulphur, 25 percent as pyrite and 4 percent as sulphates.

(b) Quality Control

The fuel supplied to the powerplant must maintain a consistent quality to permit stable plant operation. This consistency must be achieved over both long and short-term periods. The ability to meet quality requirements on an annual basis is established in the mine plan and production schedule and through monitoring procedures.

Short-term fluctuations in coal quality are reduced by the use of a coal blending and stockpile system. Each of the two blending stockpiles has the capacity to contain 1 weeks supply of coal at full output. By constructing these piles in a series of longitudinal windrows and reclaiming them with a transverse cut, quality fluctuations from the mean value of the stockpile are minimized.

The blending process was tested in the 1982 Trench D excavation program in the preparation of a sample for testing in the EPRI Coal Cleaning Test Facility. Stockpiling and reclaiming was carried out by a front-end loader in the manner described above and the samples indicated that process was effective. The quality of the samples from the blending operation (dcb) were 15.42 MJ/kg (6630 Btu/lb). Qualities of the various sub-zones (dcb) being blended ranged from 3.79 MJ/kg (waste zone) to 20.35 MJ/kg with the calculated average quality being 15.35 MJ/kg (6600 Btu/lb) from bulk samples from the trench, and 15.34 MJ/kg (6680 Btu/lb) from channel samples.

To ensure that the mean value of the stockpile is of consistent and acceptable quality within the specified tolerance will require that the coal be excavated on a carefully monitored master plan. The detailed data needed to plan and control will be provided by close space drilling, face sampling and mapping, and the monitoring of production to maintain quality predictions.

The monitoring function is provided for in the design of the materials handling system which would contain monitoring and sampling systems.

3.4 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.

Extensive testing programs have been conducted both on a laboratory bench scale and pilot-plant scale most recently at the EPRI Coal Cleaning Test Facility at Homer City, Pa.

An evaluation of the costs and benefits of beneficiation for the 2240 MW case was conducted in 1980 and in 1982 a study of the costs of beneficiation was carried out following the EPRI test program. The conclusions reached in 1982 confirmed those reached earlier and therefore beneficiation of Hat Creek coal was not recommended. However, sufficient space exists in the layout to include a beneficiation plant and facilities should it become necessary to beneficiate the coal.

TABLE 3-1

225 MW THERMAL STUDY - MINING
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 3-2

225 MW THERMAL STUDY

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 3-3

225 MW THERMAL STUDY - MINING
COAL QUALITY NO. 1 DEPOSIT
MEASURED GEOLOGICAL RESERVES (739.5 Mt)
(Hat Creek Project)

	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 3-4

225 MW THERMAL STUDY

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. Coal	Tonnes Waste	Undef. Coal	Volumes 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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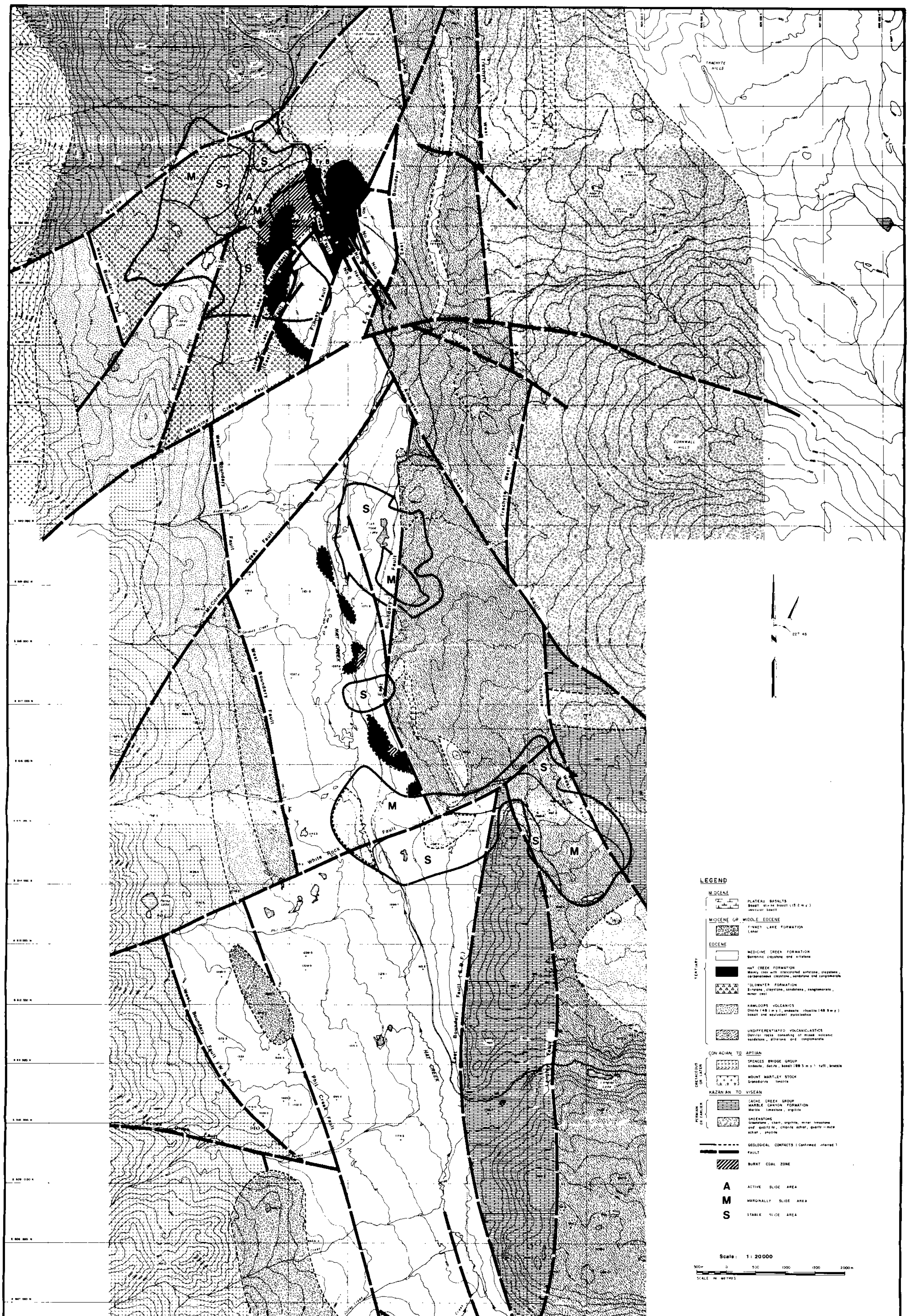
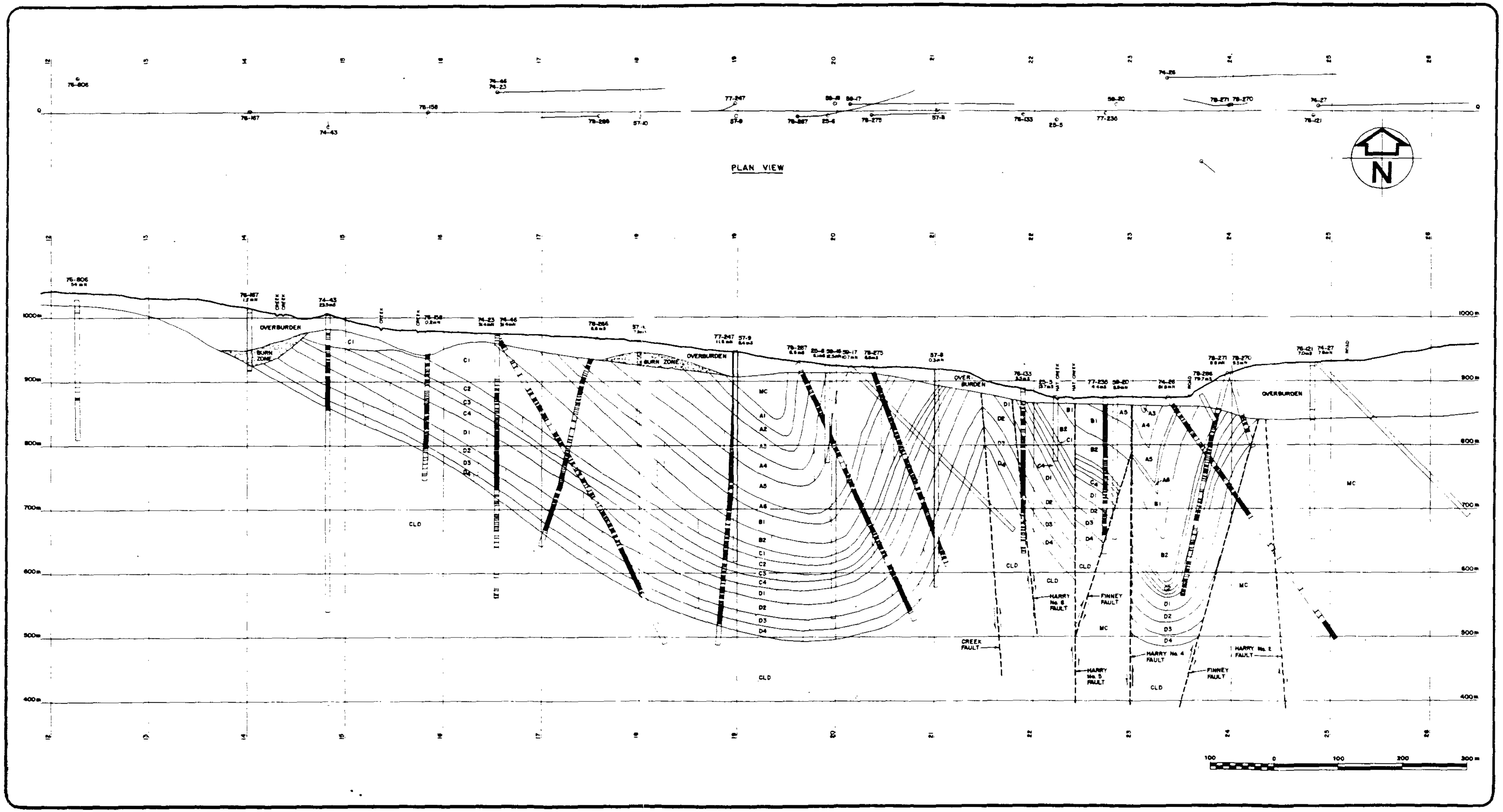


225 MW THERMAL STUDY

FIGURE 3-1

REGIONAL BEDROCK GEOLOGY

Source: B.C. Hydro & Power Authority REV June 1981



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

225MW THERMAL STUDY

FIG 3-2

GEOLOGICAL CROSS SECTION
SECTION Q

SECTION DRAWN LOOKING NORTH

SECTION 4.0 - MINING

4.1 DESIGN CRITERIA

(a) Coal Requirements

Coal requirements are developed based on 1 October in-service date for the 225 MW unit in its first production year. This commercial in-service date is preceded by a 6-month commissioning period. Coal production is assumed to build up to a peak level in the first 6 months of operation to an annual rate of 930 000 t/a based on fuel with an as-received heating value of 15.07 MJ/kg at 22.69 percent moisture (19.49 MJ/kg and 30.43 percent ash (dcb)), Table 4.1 gives the coal requirements.

In practice, the actual quantities required will vary slightly depending on the precise heating content of the coal.

(b) Material Characteristics

As described earlier 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 and haul roads.

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, i.e. burn zone and volcanic material.

The following design criteria were used in this study:

Specific Gravity

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

Swell Factors

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

(c) Selective Mining

As described in Section 3.0, non-carbonaceous sediments, usually clay, constitute waste partings in the coal sequence. These partings are particularly abundant in the A-zone and to some extent in the C-zone coal. By selectively excluding these partings from the coal the overall coal quality can be improved.

In this study it has been assumed that all partings greater than 2 m in thickness will be mined selectively and disposed of as waste.

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.

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 be water flow or pressure.

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 stable surficial materials.

The 225 MW mine design is different from the earlier 800 MW and 2240 MW designs in several respects. The 7.5 m benches in the smaller pit are located mainly in the coal. These slopes are well drained and could probably be designed at 30 degrees.

Also, the 225 MW mine plan differs from both the 800 MW and 2240 MW plans in that it does not infringe into the slide materials on the west side. Therefore in laying out the mine plan it was not necessary to use the 16 degree pit slope criteria and only the 25 degree slope was considered. This is in accordance with Golder Associates recommendations in their 1982 Geotechnical Report.[5]

However, the inactive slide would be controlled by restricting water inflows through a drainage program which will be implemented as far in advance of mining as possible and practical.

4.3 PIT DESIGN

Pit design and production scheduling in the 800 MW[6] and 2240 MW[1] mining studies carried out in 1982 and 1979 respectively were performed using a combination of computer and manual mine planning techniques. The computer pit design system was developed by Mintec Inc. However, in this 225 MW study, because of budget restraints, the mine plan and production scheduling was carried out using manual techniques with reference to the earlier designs.

Using the annual coal requirements over 35 years of the powerplant based on performance coal as specified in earlier studies, i.e. 18.1 MJ/kg (dcb), an ultimate 35-year pit was developed using the specified pit slopes. Table 4-2 shows the performance coal quality information. The coal reserves in this 35-year pit were calculated using the E-W geological cross-sections which divide the coal into the 16 sub-zones. These cross-sections are approximately 150 m apart. The sub-zones were subdivided into blocks of varying horizontal lengths depending on drill hole spacing, faults, and facies changes. Vertical limits of the blocks coincided with the boundaries of the sub-zones. Each block was then projected half way to the adjoining cross-section. Quality values were then assigned to each block using the existing quality information from the data files. From this ultimate pit design it was then possible to develop interim pits for coal production years 1, 2, 3, 4 and 5, then years 10, 15 and 25. The factors used in developing the pits was to produce a constant grade of coal at a low stripping ratio. Figs. 4-1, 4-2, 4-3 show the pit development at years 1, 5 and 35.

In developing the 35-year pit it was seen that it would be possible to produce coal with an average grade of 19.49 MJ/kg (dcb) at a stripping ratio of 0.50 m^3/t of coal. To produce coal at the 18.1 MJ/kg quality would result in a higher stripping ratio and a larger pit. Therefore, the coal requirements were adjusted to reflect the increased average coal quality whilst still delivering the total heat energy over a given period.

The interim pits shown in Table 4-1 produced coal qualities ranging between 19.44 and 19.55 MJ/kg (dcb) at strip ratios from 0.4 to 1.03 m^3/t.

The increase in coal quality was possible because of the following: The location of the pit produced coal from the various zones that was better than the respective zone average, also the mix of the various zones was different from earlier studies, e.g. 800 MW: D-zone = 27.84%; 225 MW: D-zone = 37.22%. Table 4-3 summarizes this mix.

4.4 WASTE DUMP DESIGN

Over the expected life of the 225 MW powerplant some 16.27 Mm^3 of waste materials must be excavated and disposed of outside the pit area. Previous studies established that Houth Meadows is the most economic and practical waste disposal site.

Ash from the powerplant area consisting of both fly ash and bottom ash will also be deposited in Houth Meadows together with sludges from the FGD system.

The geotechnical issues related to dump stability have been evaluated and the criteria are discussed in the 800 MW Mining Report.

All waste materials from the 35-year pit will be transported to Houth Meadows using rear-dump trucks. Fly ash, bottom ash and flue gas desulphurization system sludges from the powerplant will be transported by 20 t rear dump trucks fitted with covers for wind protection. For the purposes of this study it has been assumed that these materials will be deposited with the mine waste materials.

The dump and embankment will be raised by lifts using a fleet of mobile equipment comprising track and wheel dozers, a front-end loader, compactor and water truck. The retained waste will reach a maximum El. 920. The main embankment will reach a maximum El. 910 and a minor embankment on the north side of Houth Meadows will be constructed to El. 920.

4.5 EQUIPMENT SELECTION

(a) Background

The most efficient equipment system to mine and transport the coal and waste for this scale of operation is the truck/shovel system.

In selecting the appropriate sizes and types of equipment for the tasks to be accomplished there are a number objectives to consider i.e. standard equipment, flexibility, costs, production schedules materials, seasonal conditions, etc.

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

(b) Shovels

For the 800 MW mine plan several sizes of shovel were studied to select the most appropriate size to meet the requirements of the plan. Using the information developed and applying criteria for the smaller 225 MW mine plan it was decided to use a Poclain 600 CK electric shovel with a 6.8 m^3 bucket for waste removal. Initially waste production would be on a 5-day/week, two shift/day operating schedule using only one shovel to meet the production requirements.

In Year 15 this would revert to a one shift/day. Table 4-4 gives the productivity data.

The selection of a coal shovel is governed by the requirements for selective mining, blending and the 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.

In order to provide flexibility for quality control and to permit effective removal of 2 m partings as well as to standardize in the equipment fleet the Poclain 600 CK shovel was selected for coal production with a 7.6 m^3 coal bucket for use on a 5-day week, one shift/day operating schedule. Two shovels would be required to provide the flexibility required. The waste shovel could also provide some back-up protection.

(c) Trucks

As with shovels, the 800 MW selection studies were reviewed to select the truck most suited to work with the Poclain 600 CK. From these studies the 50 t truck was selected for both waste and coal hauling. The trucks would be fitted with the appropriate box but extra boxes would be supplied to provide increased flexibility. At the peak production period there would be ten trucks with five being required for coal hauling and five for waste hauling and road construction.

From the mine plans haul routes were determined and the truck haul cycles and productivities developed for the 800 MW plan were adjusted to account for the new haul routes. This data provided the input for calculating the truck fleet size and operating costs. Table 4-5 gives the productivity data.

4.6 MINE DEVELOPMENT AND OPERATION

The mining methods adopted for the mining of coal to supply the 225 MW powerplant are similar to those for the 800 MW plan although at a much reduced scale i.e. 32 Mt coal vs. 132 Mt. The overall stripping ratio is reduced from 0.80 m^3 waste/t of coal to 0.50 m^3/t.

(a) Pre-Production Development

Mine development would commence approximately 2 years ahead of the commercial in-service date for the powerplant. Over the project life, including pre-production development and 35 years of operation, 32 Mt of coal and 16.27 Mm^3 of waste would be mined. After the initial tuning up of operations, coal requirements remain steady. Waste volumes to be removed are high in the early years as the pit is opened up and taper off to a low level in the final years of the project.

Initial pit development would start close to the centre of the deposit west of Hat Creek. During the pre-production period the excavated waste would be used to construct ramps and roads to the coal dump station and the Houth Meadows Waste dump. As these works are completed, the waste operations would switch to the construction of the Houth Meadows embankment and waste disposal in that area.

(b) Mine Operation

During the pre-production period the mine would start up with a single shovel and three trucks operating on a single shift. As the crews were acquired and trained the operation would be expanded gradually to a two shifts/day schedule. The waste truck fleet expands to a peak five 50 t diesel trucks operating two shifts/day 5 days a week. It is planned to reduce the waste production to a one shift/day 5 days/week operation in Year 15 by which time more than half of the total waste would be removed.

The coal mining equipment would come into service with the commissioning of the coal handling system building up to a peak of two shovels with 7.6 m^3 coal buckets and five 50 t coal trucks. Coal production operations would be conducted on a 5-day week single shift schedule. During normal winter operations an average of seven shovel shifts/week would be scheduled for excavating coal out of the ten shovel shifts/week the equipment is estimated to be available. This spare shovel capacity should be sufficient to ensure reliable coal supply and provide flexibility.

The plans assume the mine would be developed using 7.5 m benches. The bench height has been standardized at this height for planning purposes and is close to optimum for the 600 CK shovel.

The shovels selected are quite capable of excavating most of the materials encountered in the No. 1 deposit without blasting.

(c) Support Equipment

A fleet of mobile equipment has been identified to provide the necessary support to the production systems. The support functions are: road construction and maintenance; bench preparation; pit cleanup; 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.

The support fleet would include dozers, front-end loaders, scrapers, graders, compactors, cranes, fuel/lube trucks, line trucks, maintenance trucks, as well as buses, pick-ups, fire trucks and an ambulance.

4.7 MATERIALS HANDLING

(a) System Design

The mine coal handling system has been designed to handle the operational requirements of the mine and powerplant, bearing in mind the material characteristics. The system flow diagram is shown in Fig. 4-4.

The peak hourly design capacity of the mine delivery system is 800 t/h or 800 x 5 x 8 = 32 000 t/5-day week. The maximum requirement for coal at the powerplant at a 100 percent capacity rating (MCR) is about 27 800 t/7-day week. Therefore, the coal handling system can meet the powerplant demand at a 86 percent availability on a 5-day/week one shift/day schedule.

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°

Design features that would be 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 would have the necessary control equipment to ensure safety and reliability. This would include emergency switches, plugged chute sensors, sequence control, fire detection and load sensors.

(b) Primary Crushing and Conveying

Run-of-mine coal will be delivered to the truck dump hopper located north-east of the mine mouth at El. 930 m. The coal will be dumped onto a grizzly mounted over a 100 t capacity hopper. A feeder discharges the coal from the hopper onto a screen. The +150 mm material is then transferred to the primary crusher for reduction to -150 mm. The screen undersize passes onto a transfer conveyor where it recombines with the crushed material. The transfer conveyor will deliver the crushed coal to the blending yard via a transfer house. The transfer house will include an automatic sampling system and ash analyser to monitor the quality of coal entering the blending system. Oversize lumps retained on the dump hopper grizzly will be broken or removed from separate disposal if they are reject material. Fig. 4-4 shows the schematic layout.

(c) Blending and Reclaiming

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; 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 selected layout of the system, shown in Fig. 4-5 comprises two stockpiles each 28 000 t capacity or 1 weeks 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 conveyor belt and tripper. The stacker travelling speed will be controlled through a weigh-scale link-up to ensure the 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.

Reclaiming from the blending pile will be by front-end loader fitted with a 5.4 m^3 coal bucket. The reclaimed coal will then be delivered to a mobile conveyor/hopper arrangement which is progressively relocated to minimize the haul distance of the front-end loader.

In order to obtain the maximum effect of the blending system this operation will be carefully controlled to ensure that the coal is reclaimed from a face that is at 90° to the direction of the layering operation. Reclaim will be at a rate of up to 250 t/h in order to have a catch-up allowance in the bunker filling operation.

The coal will be delivered to a screening and crushing plant located in the powerplant area by a conveyor installed in an elevated gallery.

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 automatic coal sampler located in the secondary screening and crushing plant monitors the quality of the coal from the blending system.

(d) Secondary Screening and Crushing

Coal delivered at -150 mm from the blending system will discharge into a 25 t surge bin located in the crusher building. Reclaim from the surge bin will be by a vibrating screen which transfers the +50 mm material to an impact crusher for sizing down to -50 mm. The undersize materials recombine with the crushed material on the powerplant feed conveyor for delivery to the plant coal bunkers via a travelling tripper arrangement. This feed conveyor would be housed in a gallery. The above system will be designed to deliver coal at a rate of up to 250 t/h.

(e) Operations

Coal mining and the delivery system to the blending facility will normally be conducted on a one shift/day, 5-day/week schedule.

Coal reclaiming operations will be on a three shift/day 7-day/week schedule.

Any shortfall in mine coal delivery quantities due to mechanical or other problems due to mining conditions could be handled by the scheduling of extra coal production shifts either during the regular production week or at weekends.

4.8 ENVIRONMENTAL PROTECTION

The mine plan would include provisions for environmental protection. These provisions are described in detail in a separate report, "225 MW

Thermal Project Study, Environmental Overview".[18] In summary the following are major areas for consideration.

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 would also be required to minimize the particulate emission.

TABLE 4-1

225 MW THERMAL STUDY
MINING PRODUCTION SCHEDULE

Production Year	Coal*1 Tonnes (x10³)	Coal Quality MJ/kg (dcb)	Waste Quantity bank m³ x 10³	Strip Ratio bank m³/t	Sulphur % (dcb)
-3	-	-	-	-	
-2	-	-	300	-	-
-1	-	-	488	-	-
1*2	500	19.46	517	1.03	0.41
2	930	19.50	592	0.64	0.42
3	930	19.45	598	0.64	0.49
4	930	19.44	594	0.64	0.45
5	930	19.44	600	0.65	0.45
6 to 10	4 650 (930/a)	19.49	2 990	0.64	0.52
11 to 15	4 650 (930/a)	19.50	2 080	0.45	0.51
16 to 25	9 300 (930/a)	19.44	3 690	0.40	0.52
26 to 35	9 300 (930/a)	19.55	3 821	0.41	0.51
	32 120	19.49	16 270	0.50	0.51

*1 Coal tonnes based on average quality of 19.49 MJ/kg (dcb).

*2 Production year 1 is the year the powerplant enters commercial service.

TABLE 4-2

225 MW THERMAL STUDY - MINING
COAL QUALITY NO. 1 DEPOSIT
MINEABLE RESERVES 800 MW 35-YEAR PIT
(Hat Creek Project)

	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 4-3

225 MW THERMAL STUDY
COAL PRODUCTION - DISTRIBUTION BY ZONE

Zone	225 MW Mine Amount (%)	225 MW Mine Quality*1 (MJ/kg)	800 MW Mine Amount (%)	800 MW Mine Quality*1 (MJ/kg)
A	20.44	15.12	29.48	15.95
B	26.43	19.79	26.23	18.55
C	15.91	15.65	16.45	14.14
D	37.22	23.30	27.84	22.21
	100.00	19.49	100.00	18.11

*1 (dcb).

TABLE 4-4

225 MW THERMAL STUDY
HYDRAULIC SHOVEL PRODUCTIVITY DATA

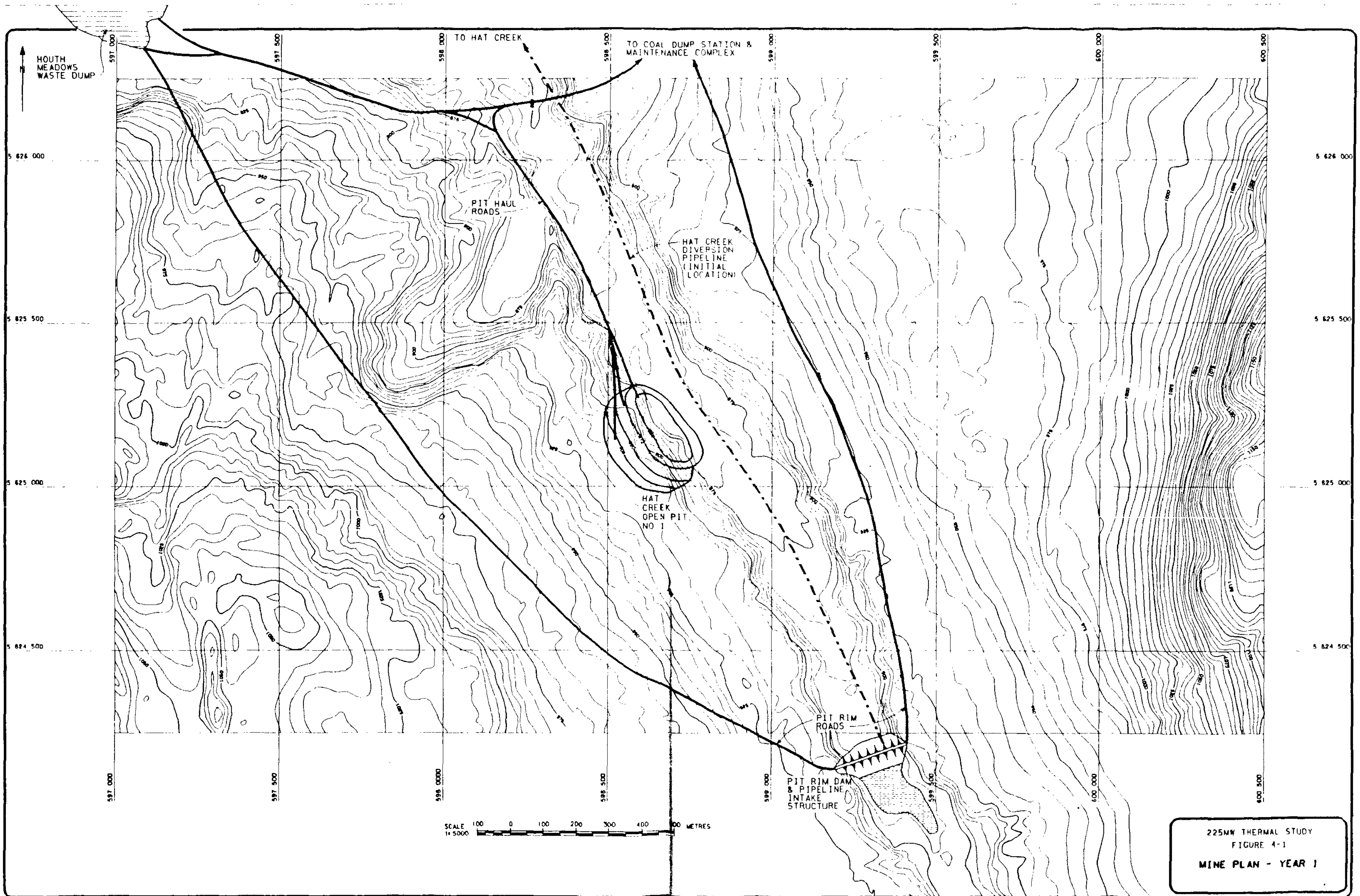
	Coal	Waste Partings	Waste
Bucket Size (m^3)	7.6	7.6	6.8
Fill Factor	0.62	0.50	0.72
Bucket Capacity (m^3)	4.71	3.80	4.90
Material Swell (%)	45	30	25
Material Density (t/m^3)	1.49	2.0	2.0
Material Wt/Load (t)	7.02	7.60	9.8
Cycle Time (secs)	32	38	32
Cycles/Hour	112.5	95	112.5
Output/Hour (m^3)	530	361	550
Output/Shift (m^3)*1	2968	2021	3080

*1 Based on 70% operating efficiency (5.6 h/shift).

TABLE 4-5

225 MW THERMAL STUDY - MINING
TRUCK SELECTION - FIXED TIMES

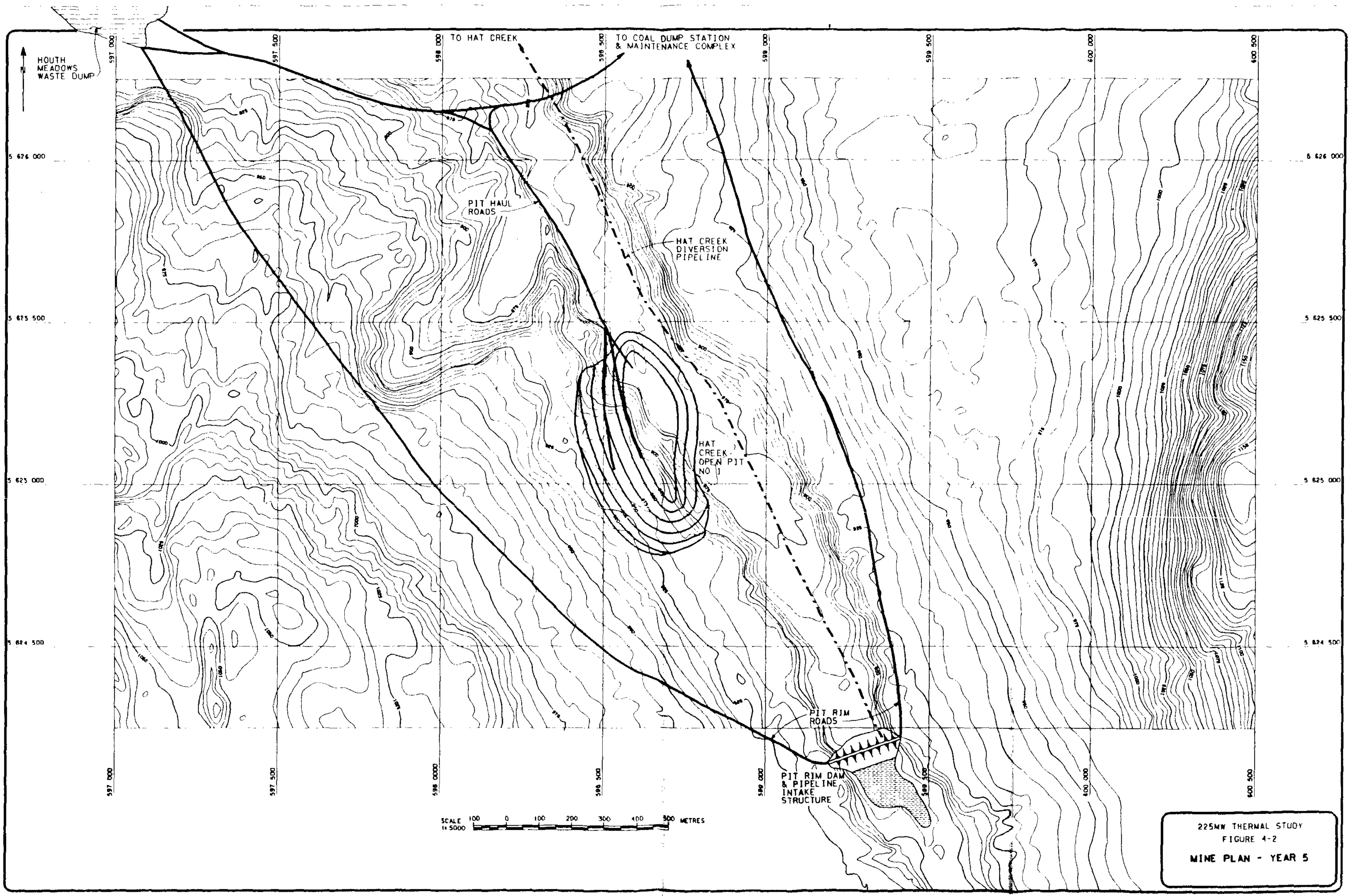
	Coal	Waste Partings	Waste
Bucket Size (m^3)	7.6	7.6	6.8
Fill Factor	0.62	0.50	0.72
Swell %	45	30	25
Material Density (t/m^3)	1.49	2.0	2.0
Bucket Capacity (m^3)	4.71	3.80	4.90
Bucket Weight (t)	7.02	7.60	9.80
Cycle Time (s)	32	38	32
Truck Capacity (t)	50	50	50
Passes/Load	7	6	5
Loading Time (min)	3.73	3.48	2.67
Spot Time (min)	0.50	0.50	0.50
Wait Time (min)	0.50	0.50	0.50
Dump Time (min)	1.00	1.00	1.00
TOTAL FIXED TIME (min)	5.73	5.48	4.67



225MW THERMAL STUDY

FIGURE 4-1

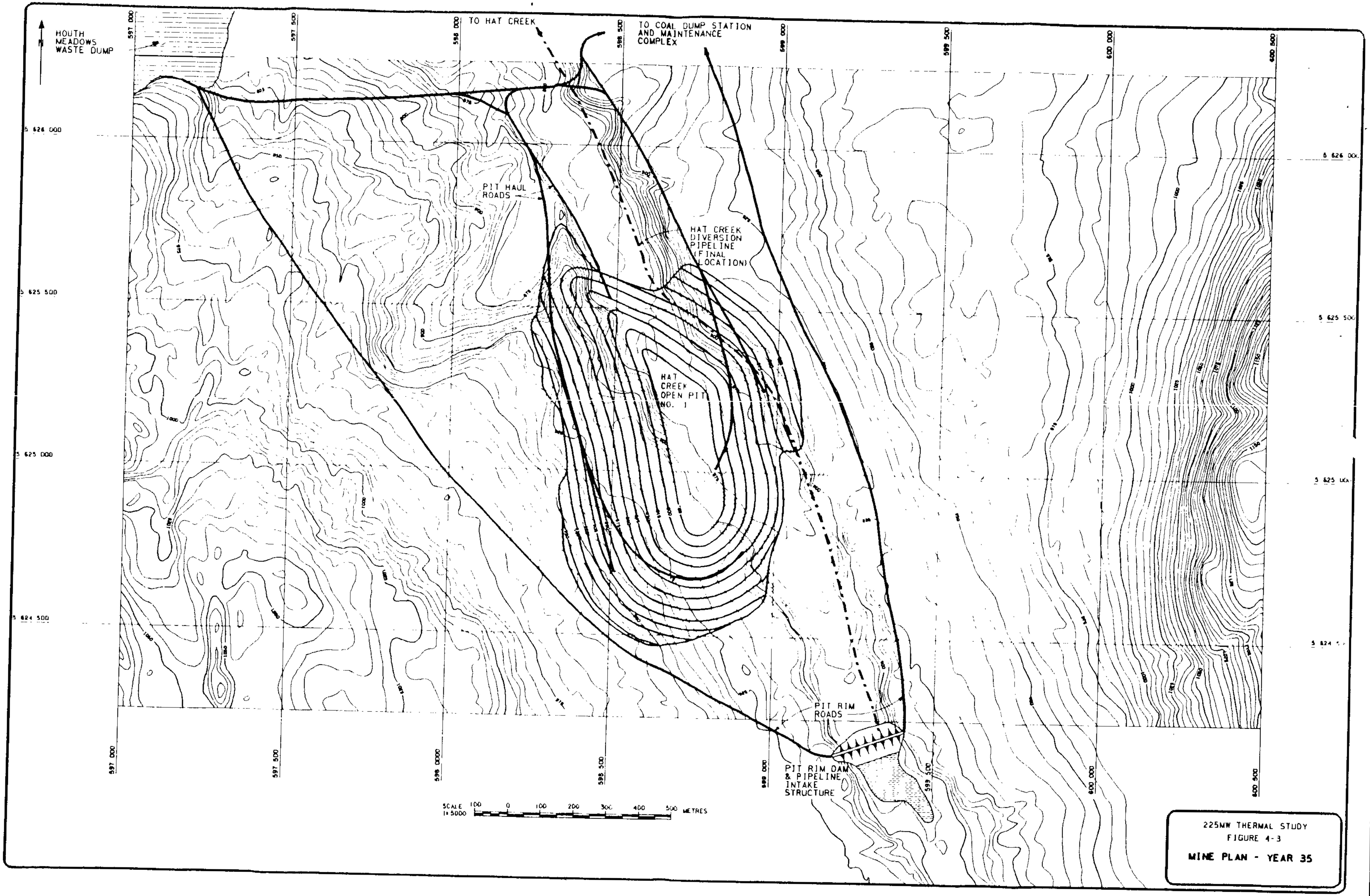
MINE PLAN - YEAR 1



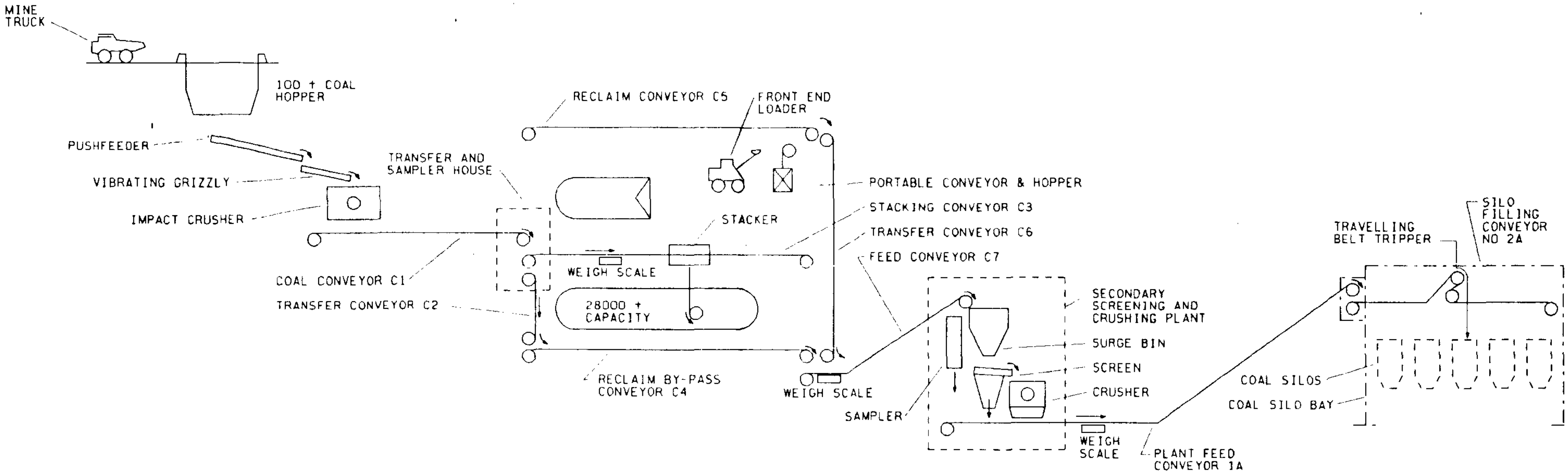
225MW THERMAL STUDY

FIGURE 4-2

MINE PLAN - YEAR 5



225MW THERMAL STUDY
FIGURE 4-3
MINE PLAN - YEAR 35

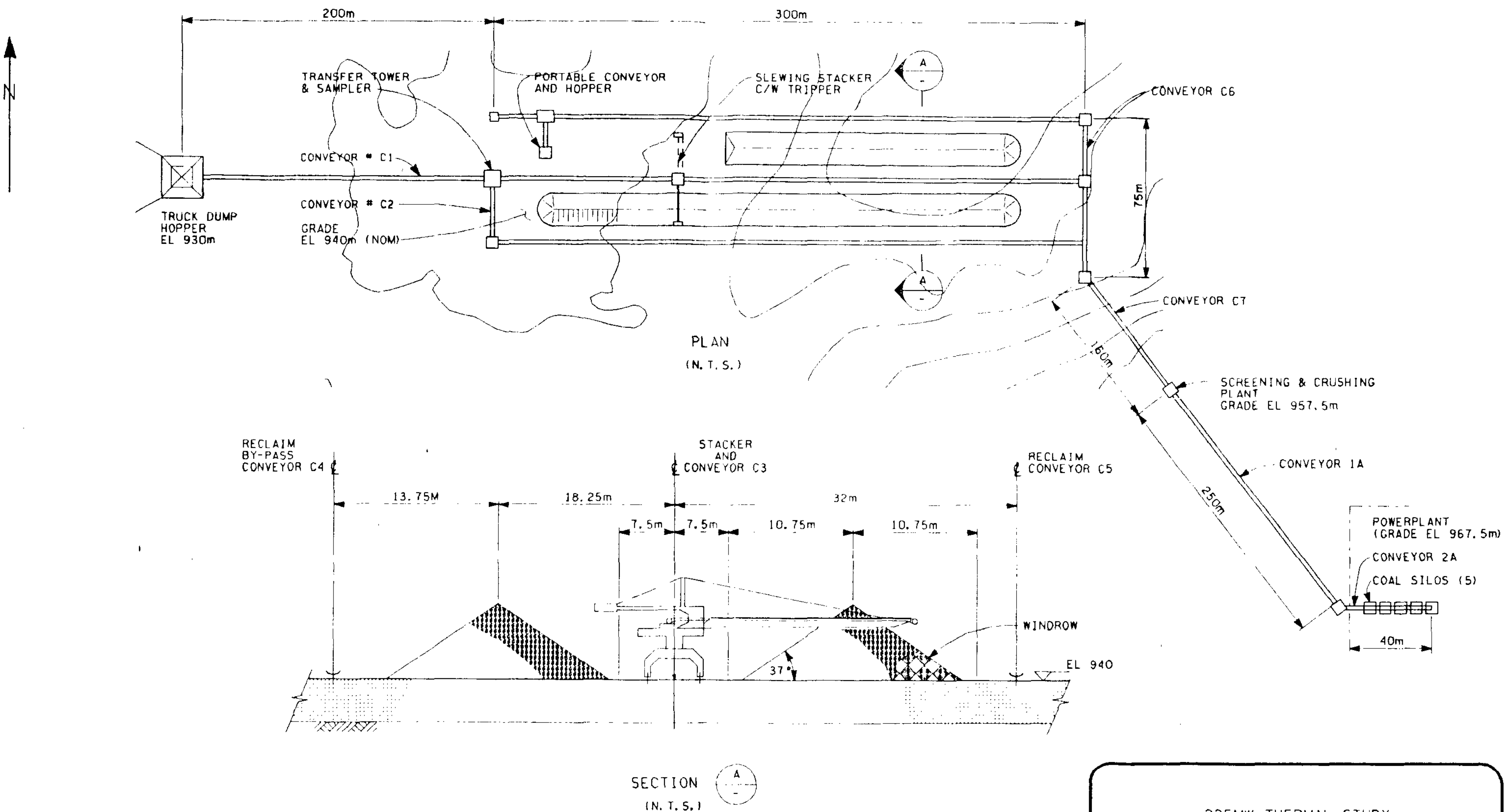


225MW THERMAL STUDY

FIGURE 4-4

COAL HANDLING FLOW DIAGRAM

053: [75.]]HCOALHAND.DGN



225MW THERMAL STUDY
FIGURE 4-5

LAYOUT OF
COAL BLENDING SYSTEM

0531 [T5.01]HCOALBLND

SECTION 5.0 - SUPPORT FACILITIES

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 snow melt period considerably greater volumes of water flow occur and major diversion works must be installed to handle these quantities. In earlier diversion studies it was decided that a diversion system would be designed to handle the 1000-year return period flood volume of 27 m^3/s. For the 225 MW mine plan it was deemed prudent to use the diversion scheme developed for the 800 MW mine plan even though a water supply reservoir located south of the open pit would act as a regulator and reduce the probable peak flood flow as noted in the B.C. Hydro Hydroelectric Generation Projects Division Report.[20]

(a) Diversion Alternatives

In 1982, as part of the 800 MW Feasibility Study,[6] Golder Associates investigated various diversion schemes and are described in detail in their report "Hat Creek Diversion Study 800 MW and 2000 MW Schemes August 1982."[4]

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.

5.2 DIVERSION SCHEME

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 fiberglass 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 25.

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 fiberglass 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.

After Year 35, two situations are conceivable which would affect the diversion of Hat Creek. First, the mine could continue operating to supply coal to other plants in which case the diversion pipes would continue to be relocated as the mine grows. 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 or could remain in the final location if considered secure enough.

This study has considered the pipes will remain within the pit area.

5.3 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 waterborne contaminants, and ensuring that all applicable regulations are observed.

For the purposes of this study it was assumed that the mine drainage plan would be essentially the same as developed for the 800 MW mine plan. Some minor modifications have been incorporated to reflect the smaller dumps and mining areas.

For the purposes of this study it has also been assumed that the sources of water will remain although some adjustments to quantities would be required in a more detailed study. The water quality projections determined for the 800 MW mine drainage plan will not be expected to change significantly and therefore would meet the environmental requirements. Table 5-2 gives design data as used in the 800 MW Mining Study.[6]

(a) 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.

(b) Mine Drainage System

The proposed mine drainage system will consist of:

1. twin pipes to divert 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 storm water 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. 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 less flood risk.

(c) 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".

The different types of drainage water and their treatment is discussed in the report by Golder Associates[4] mentioned earlier.

For the purposes of this study it was assumed that the Leachate and Sedimentation Lagoon Systems would initially be installed to 70 percent peak capacity by start-up of coal mining with the balance at staged intervals if necessary. This would require more detailed investigation in further studies.

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.

5.4 MINE SERVICES

(a) Mine Services Area

The location of the Mine Service 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. 5-2. The following structures and facilities are included:

1. Administrative Building - Located close to the proposed powerplant access road. The structure will have a total floor area of 530 m^2 with office space and storage areas for administrative and engineering departments. A gate house is included in this facility.

2. Maintenance Complex - This structure centrally located in the services area has a total floor area of 2300 m^2 and contains various areas arranged and equipped to provide the specialized services required in an integrated maintenance facility. The layout includes: equipment repair bays; steam cleaning bays; welding fabrication and machine shops; electrical repair shops; emergency vehicle garages; first aid centre; training centre; administration offices; warehouse/ storage areas; building services; cranes; tools, etc.

3. Mine Services Building - This structure, total floor area 300 m^2, includes the following: carpenters, painters and pipefitters shops, storage and packing areas.

4. Laboratory Includes areas for coal sample preparation, analysis, and sample storage as well as office areas. Total floor area will be 200 m^2.

5. Mine Dry - Provision will be made for lockers and shower facilities for up to 100 personnel. Equipment rooms and janitorial space will be included.

6. 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.

   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. Potable water would be supplied from groundwater wells.

(b) 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 total mine electrical load is estimated to be about 1.0 MW.

The permanent supply line at 6.9 kV will originate in the powerplant switchyard and will run to a main substation, near to the mine mouth, for distribution into the other areas. During powerplant shutdown at or forced outages power would be supplied from the grid system.

A 6.9 kV overhead ring main system will supply the pit area. Powerlines will run from this ring main to portable skid-mounted 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 at 6.9 kV.

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.

The principal support facilities are scheduled to be available for use in Year 1 to ensure an orderly development of the mine.

TABLE 5-1

225 MW THERMAL STUDY
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

Source: 800 MW Mining Report.[6]

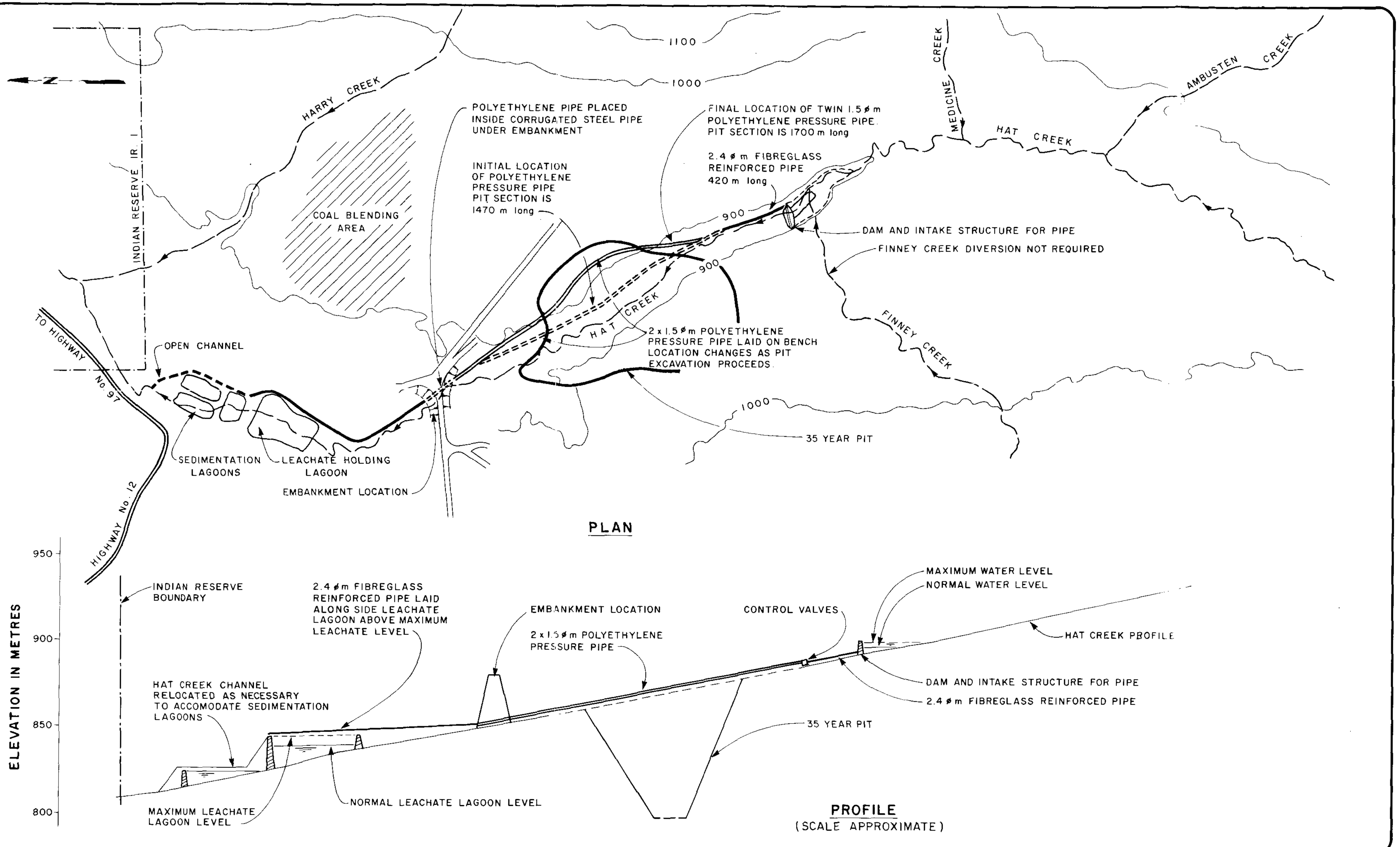
TABLE 5-2

225 MW THERMAL STUDY
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	—
Sedimentaiton 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.
Source: 800 MW Mining Report.

BR42

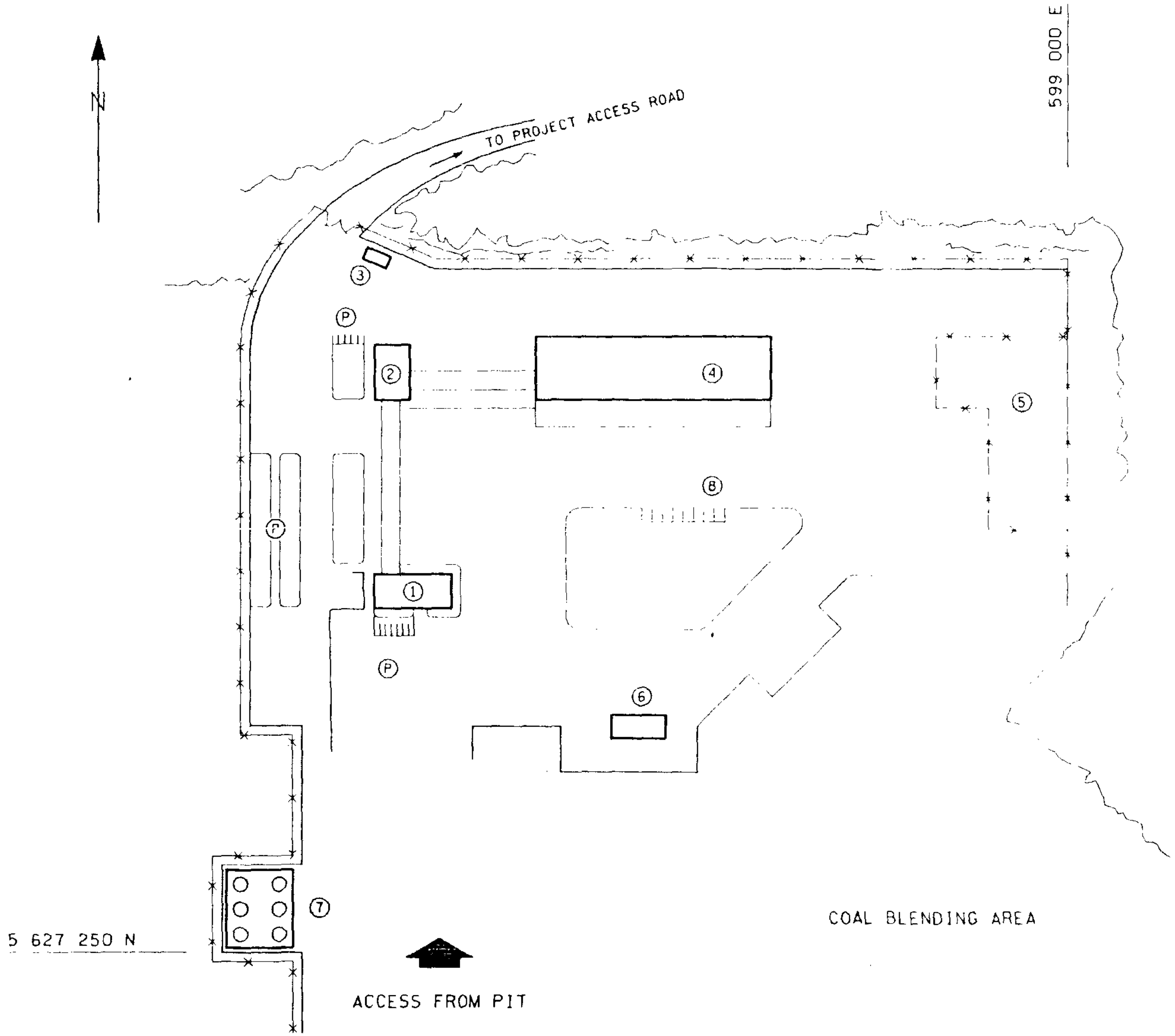


225MW THERMAL STUDY

FIG 5-1

HAT CREEK DIVERSION

SOURCE: SIGMA ENGINEERING LTD/GOLDER ASSOC.



LEGEND

① MINE DRY
② ADMINISTRATION BUILDING
③ GATEHOUSE
④ MAINTENACE COMPLEX & WAREHOUSE
⑤ FENCED STORAGE AREA
⑥ MINE SERVICES BUILDING
⑦ FUEL STORAGE & DISPENSING AREA
⑧ TRUCK READY LINE
Ⓟ PARKING

NOT TO SCALE

225MW THERMAL STUDY
FIGURE 5-2

**GENERAL ARRANGEMENT
MINE SERVICES AREA**

053: [T5.]]HMINESERV.DGN

SECTION 6.0 CONSTRUCTION SCHEDULE

6.1 SCHEDULE CRITERIA

The basis for the engineering, development and construction of the 225 MW mine and its related facilities is that adopted for the 800 MW Mining Study.[6] It was proposed that mine planning would be joint effort by B.C. Hydro and a selected Mine Operating Contractor with pit development being carried out by the Operating Contractor. Engineering of the various facilities would be by engineering consultants with construction by construction forces affiliated with B.C. Hydro Allied Council.

<u>225 MW THERMAL STUDY</u>
<u>CONSTRUCTION SCHEDULE</u>
<u>MINE</u>

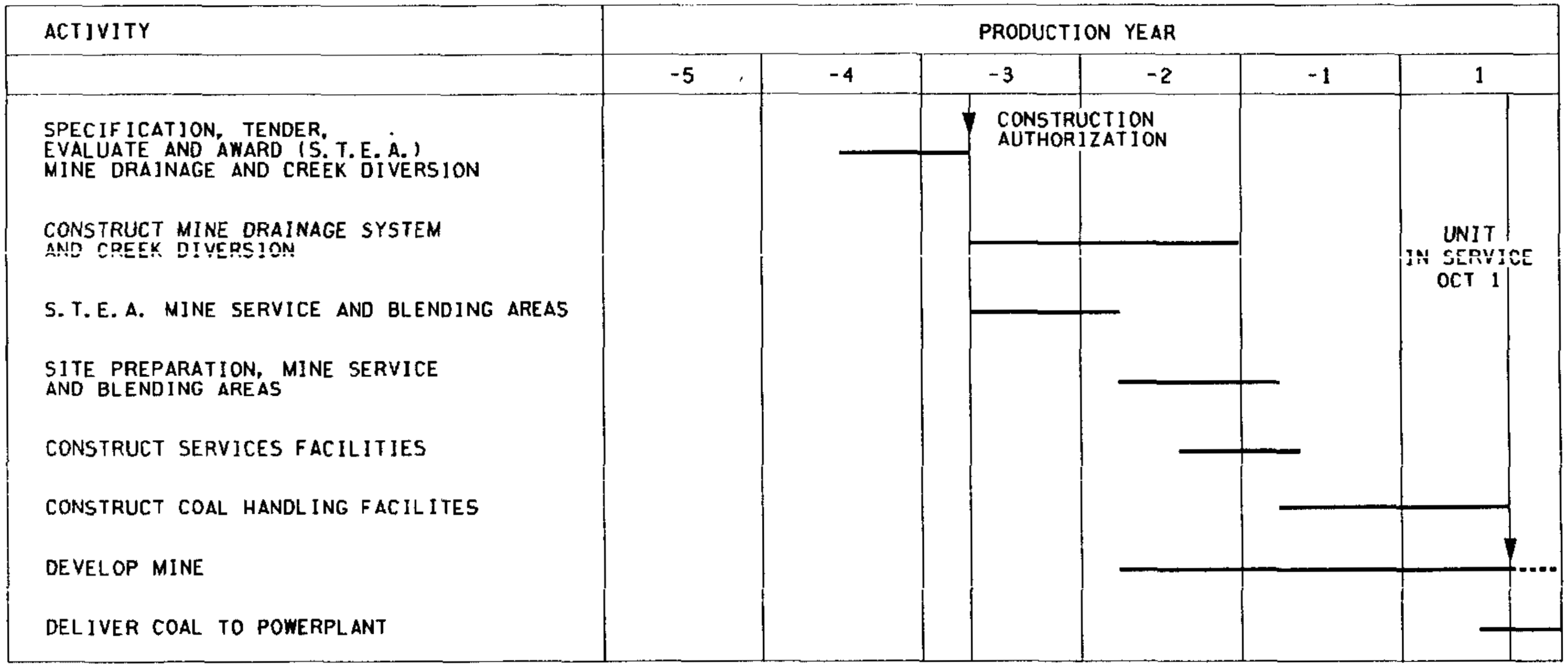


FIG 6-1

SECTION 7.0 - MANPOWER AND ORGANIZATION

7.1 CONTRACTING APPROACH

(a) 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.

Following this the B.C. Hydro Mining Group prepared a "Recommended Management Structure for the Hat Creek Mine"[7] in 1982 and determined the contracting approach summarized below. The thrust of this approach is to retain the project specific know-how within B.C. Hydro and utilize two major contractors with industry specific know-how in mine engineering and operation.

For the purposes of this study of a 225 MW mine, the organization to develop and operate the Hat Creek mine would be carried out by the integration of the following groups:

1. Operations Contractor: to provide the operational "know-how"; provide input to the engineering and design phases; supervise unionized operations personnel.

2. Engineering Consultant: manage detailed design, procurement and construction of the mine and related facilities.

3. B.C. Hydro: manage the interfaces between the operations contracts and the engineering consultant; responsible for long

term planning anc quality control functions; monitor performance of operations contractor.

7.2 LABOUR RELATIONS

(a) 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 Peace Powel Constructors.

(b) 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.

(c) 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.

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.

7.3 OPERATIONS MANPOWER

Table 7-1 shows the manpower schedule for the operating work force. The operating work force first becomes active on site in Year 3 when key staff are recruited.

Buildup 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 the peak hourly manpower of 105 is achieved.

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. 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.

Staff manpower consists of both B.C. Hydro mining staff and the operating contractor's mining staff.

7.4 CONSTRUCTION MANPOWER

The site construction manpower is assembled in Year -3 and is maintained until the end of the construction period on 31 March of Year 1. A total of 260 man years of buildings trade labour will be required to construct the mining facilities which will be supported by 20 man years of office and technical personnel and directed by 66 man years of supervisory and professional manpower.

and technical personnel and directed by 66 man years of supervisory and professional manpower.

7.5 OPERATIONS ORGANIZATION

Fig. 7-1 shows the staff organization for the mining contractor and B.C. Hydro respectively during the operations phase.

TABLE 7-1

225 MW THERMAL STUDY - MINING
OPERATIONS MANPOWER

	-3	-2	-1	1	2	3	4	5	6 to 10	11 to 15	16 to 35
<u>Hourly Operating</u>:											
Shovel, Truck Operators and Other Equipment Operators	-	7	11	20	22	22	23	23	24	21	20
Drainage Crew	-	2	2	2	2	2	2	2	2	2	2
Truck Dump	-	-	-	2	2	2	2	2	2	2	2
Coal Crushing	-	-	-	4	4	4	4	4	4	4	4
Stacking and Reclaiming	-	-	-	6	6	6	6	6	6	6	6
Warehouse	-	1	1	2	2	2	2	2	2	2	2
Misc. Other Labour 10%	-	1	2	4	4	4	4	4	4	4	4
TOTAL HOURLY OPERATING	-	11	16	39	42	42	43	43	44	41	40
<u>Hourly Maintenance</u>:											
Electrical Maintenance	-	1	1	2	2	2	2	2	2	2	2
Heavy Equipment and Auto Shop	-	6	9	13	14	14	15	15	15	14	13
Building and Yard Maintenance	-	1	1	2	2	2	2	2	2	2	2
Coal Handling Maintenance	-	-	-	9	9	9	9	9	9	9	9
TOTAL HOURLY MAINTENANCE	-	8	11	26	27	27	28	28	28	27	26
<u>Staff</u>											
Management (B.C. Hydro)	1	3	5	5	5	5	5	5	5	5	5
Management (Contractor)	-	3	5	6	6	6	6	6	6	6	6
Administration	-	4	5	8	8	8	8	8	8	8	8
Mine Engineering & Geology	-	3	5	6	6	6	6	6	6	5	5
Maintenance Shops	-	2	3	4	4	4	4	4	4	4	4
Mine Supervision	1	3	3	4	4	4	4	4	4	4	4
TOTAL STAFF	2	18	26	33	33	33	33	33	33	32	32
TOTAL MANPOWER	2	37	53	98	102	102	103	103	105	100	98

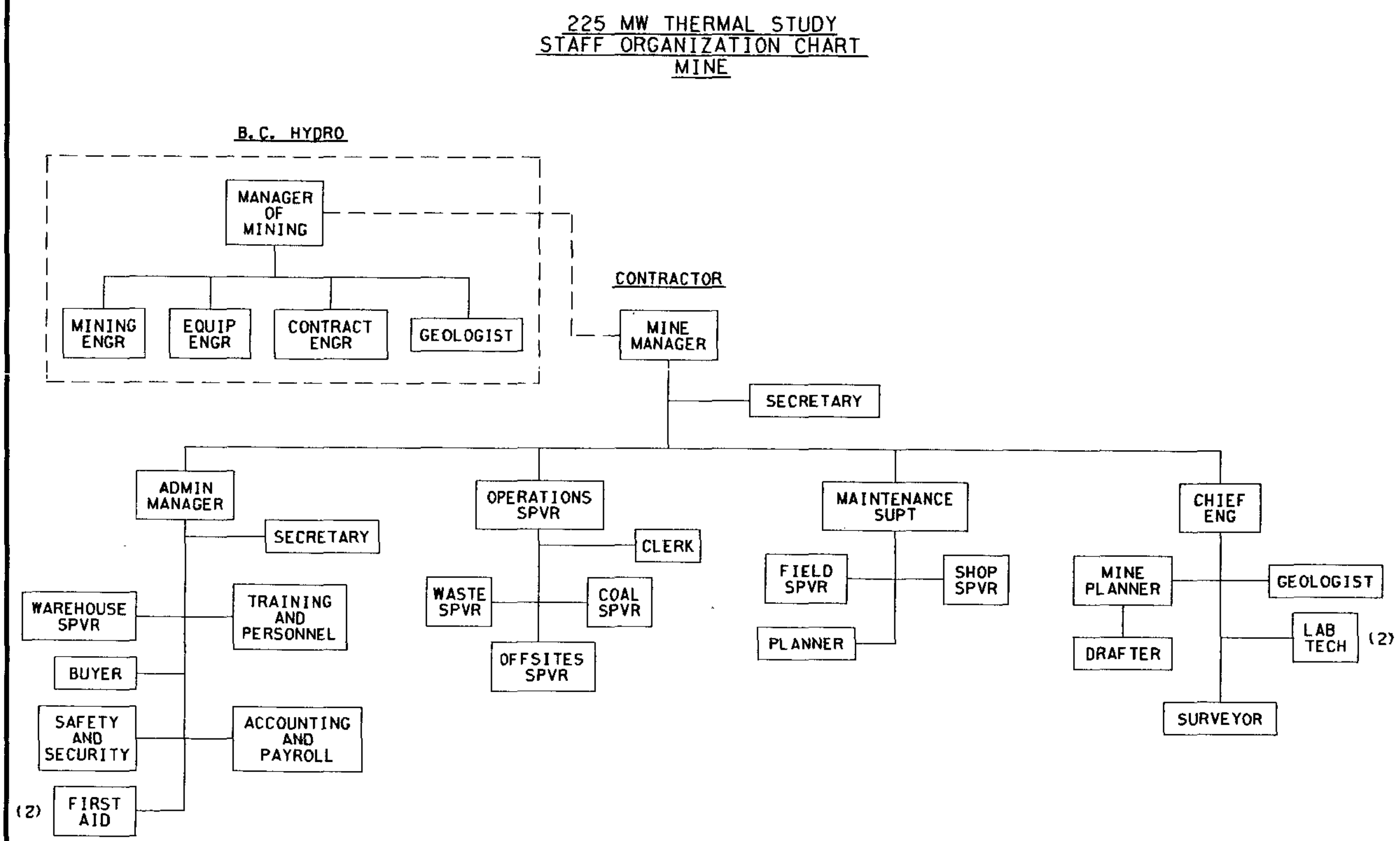

225 MW THERMAL STUDY
STAFF ORGANIZATION CHART
MINE
B.C. HYDRO
MANAGER OF MINING
MINING ENGR
EQUIP ENGR
CONTRACT ENGR
GEOLOGIST
CONTRACTOR
MINE MANAGER
SECRETARY
ADMIN MANAGER
SECRETARY
WAREHOUSE SPVR
TRAINING AND PERSONNEL
BUYER
SAFETY AND SECURITY
ACCOUNTING AND PAYROLL
(2) FIRST AID
OPERATIONS SPVR
CLERK
WASTE SPVR
COAL SPVR
OFFSITES SPVR
MAINTENANCE SUPT
FIELD SPVR
SHOP SPVR
PLANNER
CHIEF ENG
MINE PLANNER
GEOLOGIST
DRAFTER
LAB TECH (2)
SURVEYOR

FIG 7-1

SECTION 8.0 - CAPITAL COST ESTIMATE

8.1 INTRODUCTION

The capital cost estimate consists of:

- initial fixed capital
- replacement capital
- preproduction costs.

All of which total the direct capital expenditure required to develop, construct and operate the mine and its facilities over the 3 years construction period and to replace mine equipment over the 35-year operating period.

Initial fixed capital and preproduction costs represent the total direct capital required to bring the mine to full commercial operation of the powerplant. The preproduction costs consist of the mine development and operating costs incurred in the 2 years prior to the commercial power production. The basis of these costs is described in Section 9.0. Replacement capital costs include the capital required to replace mobile equipment which has served its useful life and also includes deferred capital for items such as expansion of the water treatment lagoons.

8.2 CAPITAL COST ESTIMATING CRITERIA

(a) Labour Rates

The construction trade labour rates used in the capital estimates were developed using current construction labour rates. A basic 37½-hour work week was assumed.

(b) 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 1982 800 MW Mining Report.[6]

(c) Building and Civil Works

The capital costs for buildings and civil works were developed using unit costs updated from the 1982 800 MW Mining Report.[6] Reduction factors were applied to quantities and sizes where appropriate.

(d) Major Equipment

The capital costs for the coal conveying, crushing and blending equipment were developed on the basis of manufacturers listed prices and quotations in October 1983. The capital cost estimate includes the following:

- purchase cost
- freight and insurance to site
- provincial sales tax at 7 percent
- erection costs where applicable.

(e) Mobile Equipment

The capital costs for mobile equipment were developed on the basis of manufacturer's listed prices and quotations obtained in October 1983 dollars. 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 in the service life of the equipment. Table 8-1 shows the capital costs and service life of the mobile equipment used. From this data the equipment purchase and replacement schedule (Table 8-2) was developed to provide the basis for the capital cost estimate. Replacement costs were computed at 85 percent of purchase price, assuming a 15 percent residual value for the units being retired.

(f) Contingency

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

8.3 CAPITAL COSTS

The capital costs are shown in Table 8-4 under the following major cost centres:

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

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

(a) 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
- wastewater treatment and disposal
- drainage

(b) 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 overburden, drainage and bitumen surfacing where required. Also included are the costs of buildings for equipment maintenance and servicing, an administration building, a laboratory and a mine dry.

(c) Mining

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

(d) Crushing and Conveying

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

(e) Secondary Screening and Crushing

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

(f) 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
- conveyors
- sampling system.

(g) 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.

(h) Mobile Equipment

Included in this cost centre are the capital costs for mobile equipment listed on Table 8-1.

TABLE 8-1

225 MW THERMAL STUDY
MINING

MOBILE EQUIPMENT CAPITAL COSTS AND SERVICE LIVES

Item	Capital Cost	Service Life
Hydraulic Shovel	$ 1,338,000	5000 Shifts
Haulage Truck	540,000	5000 Shifts
Front End Loader	446,000	3000 Shifts
Scrapers	541,000	2500 Shifts
Track Dozer - 343 kW	560,000	2500 Shifts
Track Dozer - 224 kW	418,000	2500 Shifts
Track Dozer - 149 kW	280,000	2500 Shifts
Wheel Dozer	316,000	3000 Shifts
Motor Grader - 186 kW	394,000	2500 Shifts
Motor Grader - 134 kW	275,000	2500 Shifts
Compactor	354,000	2500 Shifts
Vibratory Compactor	370,000	12 Years
Auger Drill	247,000	20 Years
Dump Truck	80,000	12 Years
Gradall	174,000	12 Years
Backhoe	208,000	15 Years
Water Wagon	390,000	12 Years
Mobile Crusher	300,000	Project Life
Mobile Crane - 45 t	400,000	15 Years
Mobile Crane - 14 t	230,000	10 Years
Forklift - 3 t	35,000	8 Years
Hiab Truck - 5 t	35,000	10 Years
Service Truck - 5 t	30,000	10 Years
Tire Truck	55,000	10 Years
Lube Truck	120,000	10 Years
Line Truck	90,000	10 Years
Pickup - 3/4 t	12,000	3 Years
Pickup - 1 t	15,000	3 Years
10 Passenger Bus	18,000	10 Years
Low-boy Tractor Trailer	110,000	10 Years
Compressor - 17 m^3/min	30,000	12 Years
Welders - 300 A	6,000	10 Years
Steam Cleaner	30,000	12 Years
Lighting Plants	14,000	8 Years
Diesel Pumps	10,000	8 Years
Fire Truck	35,000	Project Life
Ambulance	25,000	15 Years

TABLE 8-2

225 MW THERMAL STUDY
MAJOR MINING EQUIPMENT
PURCHASE AND REPLACEMENT SCHEDULE

Item	-3	-2	-1	1	2	3	4	5	6 to 10	11 to 15	16 to 35	Total
Hydraulic Shovel		1/		1/	1/						/2	3/2
50 t Truck		3/	1/	2/	2/			1/		1/	/8	10/8
F.E. Loader		1/		1/					/1	/1/	/3	2/5
D9 Dozer		1/							/1		/2	1/3
D8 Dozer		1/						1/1		/1	/1	2/3
824B Dozer		1/									1/	1/1
16G Grader		1/									/1	1/1
14G Grader		1/		1/					/1	/2	/3	2/6
825B Compactor		1/									/1	1/1
Gradall		1/							/1		/1	1/2
1 t Truck		1/		1/					/2	/1	/5	2/8
5 t Truck			1/						/1	/1	/2	1/4

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

TABLE 8-3

225 MW THERMAL STUDY
SUMMARY OF CAPITAL COSTS
($000's)

		($)
91000	Site and Improvements	25,850.0
92000	Maintenance, Service and Administration	9,538.0
93000	Mining	1,735.0
94000	Primary Crushing	2,554.0
95000	Secondary Screening and Crushing	3,089.0
96000	Coal Blending and Reclaim	5,818.0
98000	Construction Indirects	12,539.0
99000	Mobile Equipment Contingency	10,342.0
		$113,765.0
	Costs before commercial production	$ 80,010.0
	Replacement costs and deferred costs	33,755.0
		$113,765.0

	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	16	17
91000	SITE & IMPROVEMENTS				4,210	8,873	7,556	2,184				1,525										1,502		
92000	MAINTENANCE, SERVICE & ADMINISTRATION				1,000	4,270	4,268																	
93000	MINING					735	700	150		150														
94000	PRIMARY CRUSHING & CONVEYING					250	1,728	576																
95000	SECONDARY SCREENING & CRUSHING					250	1,986	853																
96000	COAL BLENDING & RECLAIM					1,250	3,592	976																
98000	CONSTRUCTION INDIRECTS			2,000	1,000	3,180	3,180	3,179																
99000	MOBILE EQUIPMENT					9,198	1,548	4,045	2,636	39	49	1,454	120	109	541	1,246	853	1,775	522	488	469	754	368	386
	SUB-TOTAL			2,000	6,210	28,008	24,558	11,963	2,636	189	49	2,978	120	109	541	1,246	853	1,775	522	488	489	2,256	358	386
	CONTINGENCY			200	620	2,804	2,452	1,197	264	21	6	296	10	11	54	124	87	175	53	45	46	224	37	39
	TOTAL FIXED CAPITAL			2,200	6,830	30,810	27,010	13,160	2,900	210	55	3,275	130	120	595	1,370	940	1,950	575	535	515	2,480	395	425
	CUMULATIVE TOTAL TO FULL PRODUCTION			2,200	9,030	39,840	66,850	80,010																
	PRE-PRODUCTION OPERATING COSTS:																							
	DIRECT MINE OPERATING COSTS				101	3,285	3,980	3,153																
	CONTINGENCY				10	330	400	316																
	CONTRACTORS FEE				7	215	265	208																
	SCHOOL TAXES				90	315	720	405																
	TOTAL PRE-PRODUCTION COSTS				208	4,145	5,365	4,082																
	CUMULATIVE OPERATING TO COMMERCIAL PRODUCTION				208	4,353	9,718	13,800																

	DESCRIPTION	PRODUCTION PERIOD 18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	TOTAL
91000	SITE & IMPROVEMENTS																			25,850
92000	MAINTENANCE, SERVICE & ADMINISTRATION																			9,538
93000	MINING																			1,735
94000	PRIMARY CRUSHING & CONVEYING																			2,554
95000	SECONDARY SCREENING & CRUSHING																			3,089
96000	COAL BLENDING & RECLAIM																			5,818
98000	CONSTRUCTION INDIRECTS																			12,539
99000	MOBILE EQUIPMENT	690	508	1,038	444	2,118	1,804	1,441	1,983	954	428	1,479	1,058	1,071	109	428	40	75	40	42,300
	SUB-TOTAL	690	508	1,038	444	2,118	1,804	1,441	1,983	954	428	1,479	1,058	1,071	109	428	40	75	40	103,423
	CONTINGENCY	70	51	102	46	212	181	144	192	96	42	146	112	109	11	42	5	10	5	10,342
	TOTAL FIXED CAPITAL	760	560	1,140	490	2,330	1,985	1,585	2,175	1,050	470	1,625	1,170	1,180	120	470	45	85	45	113,785
	DIRECT MINE OPERATING COSTS																			10,529
	CONTINGENCY																			1,056
	CONTRACTORS FEE																			695
	SCHOOL TAXES																			1,530
	TOTAL PRE-PRODUCTION COSTS																			13,800

NOTE:
COSTS IN $000'S

225MW THERMAL STUDY
MINING
TABLE 8-4
CAPITAL COST SCHEDULE

SECTION 9.0 - OPERATING COST ESTIMATE

9.1 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 1983 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 at the start of commercial production in Year 1.

(a) Labour Costs

Hourly labour costs were based upon wage rates paid by B.C. Coal Limited in effect in October 1983.

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

(b) 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 the costs used in the 800 MW Mining Study[6] escalated by inflation factors or from new quotations obtained from various suppliers.

(c) Materials and Supplies

Material and supply costs were based upon the 800 MW Mining Study[6] but escalated by the applicable inflation factors based on telephone inquiries to various suppliers.

(d) Outside Services

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

(e) 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.

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 the cost element (e.g. diesel, tires operating labour, etc.). This amount was then allocated to the activity costs centers.

9.2 OPERATING COST SUMMARY

The preproduction and production direct operating costs are summarized in Tables 9-1 and 9-2 by cost center and by cost element respectively. During the production period, average direct operating costs amount to $7.13/t of coal of which 47 percent is labour cost.

The direct operating costs were developed using a computer costing model developed for the 800 MW Mine Plan. Mobile equipment costs were developed from the annual operating shifts and the unit costs. All other costs such as conveying system, administration, management, etc. were developed manually and input into the model which then accumulated all costs into the various cost elements. Tables 9-7 and 9-8 show the output from the model.

9.3 OPERATIONS LABOUR

(a) Hourly Labour Costs

The wage rates used in the operating cost estimate are shown in Table 9-3. The base hourly rates and job groupings are derived from B.C. Coal Limited's labour agreement.

Adjustments were made to these hourly rates to arrive at a gross payroll cost per productive hour. Some of these were:

- a payroll burden cost as discussed below,
- a shift premium where applicable was applied to the hourly rates,
- a burden for overtime and paid off-hours was also applied.

(b) Staff Salaries

A salary survey conducted by the Mining Association of British Columbia in February 1982 was used as the basis for salary estimates. A summary of salaries appears in Table 9-4.

(c) Recruitment, Relocation and Training

An allowance was included in the operating costs to cover recruitment, relocation and for ongoing training programs.

(d) Payroll Burden

Costs for fringe benefits include pension, insurance and workers compensation premiums payable by B.C. Hydro for all its employees. 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 BURDEN - 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%

(e) 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. However, based on an analysis performed by B.C. Hydro's Socioeconomic group it was determined that in this 225 MW Study the overall requirements for housing could be supplied by the local communities without any special assistance from the Hat Creek mine.

9.4 MOBILE EQUIPMENT

(a) Annual Shifts

The annual operating shifts (8-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.).

(b) 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 9-5 while the cost per year by cost element for light mobile equipment are shown in Table 9.6.

The basis of the costs is as for the 800 MW Mining Study.[6]

9.5 FIXED EQUIPMENT

(a) Coal Handling System

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

CCAL HANDLING SYSTEM
MAINTENANCE LABOUR AND REPAIR COSTS:

	Initial Capital Cost (k$)	Percent Annual Cost		Total Annual Cost (k$)
		Maintenance Labour %	Repair Parts %	
Truck Dump & Conveying	2,235	2.5	5.0	168
Blending & Reclaim	4,154	2.0	2.0	168
Secondary Crushing	2,898	3.0	3.0	174

(b) Site Services

The cost of miscellaneous operating supplies for the mining operation is provided for in the estimate by an allowance amounting to 5 percent of total labour costs.

9.6 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 in accordance with B.C. Hydro's requirements.

B.C. Hydro will supply the capital funding and reimburse the contractor for all operating costs incurred and pay a fixed fee of 6 percent of mine operating costs for his services.

9.7 SCHOOL TAXES

These taxes 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.

9.8 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. 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.

9.9 CONTINGENCY

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

TABLE 9-1

225 MW THERMAL STUDY - MINING
DIRECT OPERATING COSTS BY COST CENTRE

	Total All Years	Pre-pro duction	Produc- tion	Unit	$/tonne
Mine Production					
Coal	32.12	-	32.12	Mt	
Waste	14.50	1.03	13.47	10^6x m^3	
Waste Partings	1.73	-	1.73	10^6x m^3	
Waste Ratio BCM/T	0.50	-	0.47		
Operating Costs $000's					
Site:					
Site and Pit Roads	12,293	664	11,629		
Power	9,005	157	8,848		
	21,298	821	20,477		0.66
Administration and Engineering:					
Management	15,450	995	14,455		
Administration	6,993	473	6,520		
Administration Services	5,514	321	5,193		
Administration Site Services	5,794	393	5,401		
Human Resources	8,014	562	7,452		
Training	5,007	315	4,692		
Mine Engineering	10,132	541	9,591		
Close Spaced Drilling	740	50	690		
	57,644	3,650	53,994		1.79
Maintenance and Services:					
Maintenance Shops	10,170	418	9,752		
Electrical Maintenance	2,926	73	2,853		
Mine Communications	720	30	690		
Mine Transportation	6,482	307	6,175		
Field Lubrication/Fueling	750	46	704		
	21,048	874	20,174		0.66

TABLE 9-1 - (Cont'd)

	Total All Years	Pre-pro duction	Produc-tion	Unit	$/tonne
Operating Costs $000's - (Cont'd)					
Mining:					
Mine Supervision	6,740	289	6,451		
General Mine Costs	4,930	153	4,777		
Auxiliary Equipment	13,664	980	12,684		
Loading Waste Partings	552	4	548		
Hauling Waste Partings	2,237	16	2,221		
Drilling Waste	318	12	306		
Blasting Waste	537	20	517		
Loading Waste	3,938	270	3,668		
Hauling Waste	17,356	1,134	16,222		
Loading Coal	5,832	46	5,786		
Hauling Coal	13,865	102	13,763		
Pit Dewatering and Drainage	10,267	1,177	9,090		
	80,236	4,203	76,033		2.49
Coal Handling:					
Primary Crushing & Conveying	7,148	71	7,077		
Stockpiling and Blending	25,666	240	25,426		
Sec Crushing & Screening	11,256	124	11,132		
	44,070	435	43,635		1.37
Waste Dumps		538	4,677		0.16
TOTAL OPERATING	229,511	10,521	218,990		7.13

TABLE 9-2

225 MW THERMAL STUDY - MINING
DIRECT OPERATING COSTS BY COST ELEMENT

	Total All Years	Pre-Production	Production	Unit	$/tonne
Mine Production:					
Coal	32.12		32.12	Mt	
Waste	14.50	1.03	13.47	$10^6 \times m^3$	
Waste Partings	1.73		1.73	$10^6 \times m^3$	
Waste Ratio m^3/t	0.50		0.47		
Operating Costs: k$					
Wages and Benefits	95,646	3,492	92,154		2.98
Salaries and Benefits	29,226	1,764	27,462		0.91
Diesel and Gasoline	21,633	1,017	20,616		0.67
Power	9,368	167	9,201		0.29
Supplies	10,073	525	9,548		0.31
Wear Parts	2,169	115	2,054		0.07
Tires	6,357	274	6,083		0.19
Repair Parts	34,461	1,193	33,268		1.07
Maintenance Allocation	-	-	-		-
Mobile Equipment	5	-	-		-
Outside Services	20,573	1,974	18,599		0.64
TOTAL OPERATING COSTS	229,511	10,521	218,990		7.13

TABLE 9-3

225 MW THERMAL STUDY - MINING
LABOUR RATES FOR MINE OPERATIONS STAFF
(October 1983$)

	Hourly Rate*1
Journeyman Tradesman	26.10
Shovel Operator	25.30
Crane Operator Rotary Driller Coal Stacker Operator Conveyor Controller	24.60
Blaster Secondary Crushing Operator Tireman	24.00
Production Truck Driver Dozer Operator Grader Operator Front-end Loader Operator	23.37
Drill Helper Service Truck Driver Airtrac Driller Primary Crushing Operator Lube Serviceman	22.73
Utility Truck Driver Blaster's Helper Warehouseman Conveyor Patrolman	22.09
Counterman	21.20
Pumpman	20.82
Labourer	20.18

*1 Hourly rates include: trade base rate; shift differential; overtime allowance; payroll burden.

TABLE 9-4

225 MW THERMAL STUDY
MINING STAFF SALARIES

Position	$ Annual Salary (October 1983)
SPC Personnel	
Engineering:	
Chief Engineer	55,000
Senior Engineer	50,000
Geologist/Laboratory Supervisor	50,000
Pit Engineer	50,000
Administration:	
Senior Site Accountant	42,000
Warehouse Supervisor	42,000
Personnel/Training Supervisor	54,000
Safety Co-ordinator	46,000
Maintenance Supervision:	
Maintenance Superintendent	50,000
Supervisor	47,000
Operating Supervision:	
Operations Superintendent	55,000
Supervisor	50,000
OTEU Personnel	
Secretary	23,000
Draftsman	31,000
Laboratory Technician	28,000
Clerk	21,000
Scheduler	32,000
Paymaster	30,000
Buyer	25,000
Recruiter	30,000
Security Guard	30,000
Surveyor	31,000

TABLE 9-5

225 MW THERMAL STUDY
MINING
MAJOR MOBILE EQUIPMENT UNIT COSTS
($/Shift)

	Operating Labour	Diesel Fuel	Gasoline	Power	Oil and Grease	Repair Labour	Service Labour	Wear Parts	Tires	Repair Parts	Total
Auger Drill	354.30	65.50	-	-	22.00	109.10	-	156.00	-	104.00	810.90
Crawler Mounted Drill	354.30	65.50	-	-	22.00	109.10	-	156.00	-	104.00	-
Hydraulic Shovel	189.60	-	-	25.20	16.70	119.60	11.50	40.00	-	240.00	643.20
Front End Loader - 5.4 m³	175.30	105.60	-	-	18.80	81.60	11.50	5.80	58.00	69.90	524.50
50 t End Dump Truck	175.30	97.78	-	-	17.73	80.80	11.50	-	48.74	149.76	579.60
20 t End Dump Truck	165.90	48.60	-	-	-	65.50	-	-	18.60	31.20	329.80
Scraper - 24 LCM	175.30	136.90	-	-	18.80	132.80	11.50	-	82.90	125.80	684.00
Track Dozer - 343 kW	175.30	159.90	-	-	25.00	102.10	11.50	70.00	-	116.50	660.30
Track Dozer - 224 kW	175.30	115.00	-	-	12.50	84.30	11.50	52.40	-	87.40	538.40
Track Dozer - 149 kW	175.30	84.90	-	-	9.40	63.80	11.50	46.60	-	69.90	461.40
Wheel Dozer	175.30	107.90	-	-	18.80	66.40	11.50	5.80	42.00	58.00	485.90
Motor Grader - 186 kW	175.30	65.00	-	-	12.50	79.10	11.50	17.50	44.80	92.10	498.50
Motor Grader - 134 kW	175.30	45.20	-	-	9.40	68.90	11.50	11.60	33.60	52.40	407.90
Gradwall	165.90	32.00	-	-	-	66.40	-	8.30	8.00	46.80	327.00
Blackhoe - 3/4 cy.	165.90	28.50	-	-	5.30	86.80	11.50	5.00	5.00	83.20	391.20
Sand Truck	165.90	28.50	-	-	-	44.00	-	-	12.00	41.60	291.80
Water Wagon	175.30	45.60	-	-	-	109.00	-	-	18.00	83.20	431.10
Compactor	175.30	107.80	-	-	18.80	66.40	11.50	3.00	42.00	58.20	483.00
Compactor - Vibratory	-	28.60	-	-	6.50	75.00	11.50	-	-	136.00	257.60
Mobile Crusher	175.30	44.00	-	-	-	130.00	-	40.00	-	60.00	449.30
Fuel/Lube Truck	-	22.80	-	-	-	43.00	-	-	4.60	35.60	106.00

TABLE 9-6

225 MW THERMAL STUDY
MINING
LIGHT MOBILE EQUIPMENT UNIT COSTS
($/Annum)

	Operating Labour	Diesel Fuel	Gasoline	Power	Oil and Grease	Repair Labour	Service Labour	Wear Parts	Tires	Repair Parts	Total
Pick-up - Assigned	-	-	1,900	-	-	1,350	-	-	500	2,080	5,830
Pick-up - Unassigned	-	-	11,000	-		11,400	-	-	1,000	3,000	26,300
0 Passenger Bus	-	-	3,800	-	-	2,750	-	-	1,000	4,160	11,710
1 Ton Flatdeck	-	-	7,800	-	-	2,750	-	-	1,000	2,080	13,630
3 Ton Truck W/Hiab	-	6,900	-	-	-	2,300	-	-	1,300	1,770	12,270
5 Ton Service Truck	-	6,900	-	-	-	3,500	-	-	2,000	2,600	15,000
Tire Truck	-	3,470	-	-	-	1,090	-	-	600	880	6,040
Line Truck	-	2,300	-	-	-	600	-	-	400	420	3,720
Lo-Boy Tractor Trailer	-	5,700	-	-	-	7,870	-	-	3,600	5,820	21,910
45 Ton Crane	-	1,340	-	-	-	3,060	-	-	280	2,080	6,760
16 Ton Crane	-	1,790	-	-	-	4,800	-	-	480	2,290	9,360
3 Ton Forklift	-	-	1,100	-	-	1,200	-	-	200	940	3,440
Compressor 17 cm/min	-	-	1,000	-	-	1,430	-	-	80	750	3,260
Welder - 300 A	-	2,900	-	-	-	1,000	-	-	200	1,040	5,140
Steam Cleaner	-	-	2,780	-	-	1,440	-	-	520	1,400	6,140
Lite Tower	-	-	4,750	-	-	5,450	-	-	-	5,800	16,000
Pump - Diesel	-	4,500	-	-	-	3,240	-	-	-	4,020	11,760

REFERENCES

Mining Reports and Studies Associated With The 225 MW Thermal Study 1984

1. B.C. Hydro, Hat Creek Project Mining Report Volumes 1 and 2. December 1979 (including associated studies).

2. Paul Weir Company, Review of Coal Fuel Specification, Hat Creek Project, November 1979.

3. CMJV/Simon Carves of Canada Ltd., Hat Creek Project, Mining Feasibility Report, Appendix "B", Hat Creek Coal Beneficiation, October 1978.

4. Golder Associates, Hat Creek Diversion Study, 800 MW and 2000 MW Schemes, August 1982.

5. Golder Associates, Geotechnical and Hydrogeological Update, Fall 1982.

6. B.C. Hydro, 800 MW Mining Report, Volumes 1, 2 & 3, October 1982.

7. B.C. Hydro, Report on a Recommended Management Structure for the Hat Creek Mine, April and October 1982.

8. B.C. Hydro, Mining Field Program 1982 Summary Report, June 1983.

9. B.C. Hydro, Mining Field Program 1982, Trench D Report, January 1983.

10. B.C. Hydro, 800 MW Coal Preparation Report, January 1983.

11. BCH Thermal Division, Final Report - Bulk Sample Program - Hat Creek No. 1 Deposit, 1977.

12. Church, B.N., "Geology of the Hat Creek Basin", in Geology in British Columbia, B.C. Ministry of Mines Publication, 1977.

13. BCH Hydroelectric Design Division, Report No. 913, Diversion of Hat and Finney Creeks, Preliminary Design Report, March 1978.

14. Golder Associates. Hat Creek Project Preliminary Engineering Work, Geotechnical Technical Study 1977/78, Volumes 1 to 6, final report, December 1978.

15. BCH Hydroelectric Generation Project Division, memorandum on Proposed Waste Disposal Embankment Studies, Report No. H1129, October 1979.

16. BCH, Geostatistical Study of sulphur Variations in the Hat Creek Deposit, 1979.

17. BCH, Depositional Environment and Stratigraphic Subdivision, Hat Creek No. 1 Deposit, October 1979.

18. BCH, 225 MW Thermal Project Study, Environmental Overview ESSD, August 1984.

19. BCH, Hat Creek Project, 800 MW Thermal Generation Facility, Feasibility Study, August 1982.

20. BCH, Hat Creek Project 225 MW Thermal Plant Water Supply System. Feasibility Sutdy HGPD No. H 1694, May 1984.

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