

MAP NO.

ASSESSMENT REPORT

DOCUMENT NO.:

092026

PROSPECTUS

X

MINING DISTRICT:

WHITEHORSE

105 E - 2

CONFIDENTIAL

TYPE OF WORK:

POWER STATION PROPOSAL

OPEN FILE

I.S.N. 134675

REPORT FILED UNDER: Aberford Resources Ltd

DATE PERFORMED: 1982

DATE FILED: April 1982

LOCATION: LAT.: 65°30'N

AREA: Bonnet Plume and Wind Rivers

LONG.: 135°00'W

VALUE \$:

CLAIM NAME & NO.: BONNET PLUME COALFIELD

WORK DONE BY: Aberford Resources Ltd

WORK DONE FOR: Aberford Resources Ltd

DATE TO GOOD STANDING

REMARKS: #9 BONNET PLUME COALFIELD

_____ | _____ |

_____ | _____ |

_____ | _____ |

ABERFORD RESOURCES LTD.

BONNET PLUME COALFIELD

YUKON TERRITORY

A BRIEF FOR THE DEVELOPMENT
OF
A COAL FIRED THERMAL POWER STATION
TO
SUPPLY TO ELECTRICITY
TO THE
YUKON TERRITORY

OCTOBER 1982

092026

BONNET PLUME COALFIELD

Exploration Highlights

- 1977: - coal seams identified on Illtyd Creek by personnel of Pan Ocean Oil Ltd. (a predecessor company of Aberford Resources Ltd.).
- acquired 21 Coal Exploration Licences covering 339,144 hectares (838,014 acres).
- 1978: - regional mapping and 4 diamond drill holes totalling 457 metres (1,500 feet) gave inferred reserves of 96 million tonnes in two coal areas.
- acquired control of three additional Coal Exploration Licences from Canadian Aran Petroleum Ltd. bringing the total area controlled to 387,308 hectares (957,024 acres).
- 1979: - 4,420 metres (14,500 feet) of diamond drilling comprising 23 holes determined:
- measured reserves (proven) of 120 million tonnes of low sulphur, high volatile C bituminous coal in situ for the Illtyd Creek Deposit.
- indicated and inferred reserves of 261 million tonnes of low sulphur, high volatile C bituminous coal in situ within four other coal areas.
- 1980: - 26 diamond drill holes for 5,823 m (19,104 ft.) were completed on seven deposit areas. This resulted in:
- proven reserves = 120 million tonnes in situ (Illtyd Creek Deposit).
- indicated and inferred reserves = 539 million tonnes in situ.
- 1981: - preliminary mining feasibility study of the Illtyd Deposit was completed examining provision of 500,000 or 750,000 tonnes of coal per year to an on-site thermal power station (140 MW or 210 MW capacity, respectively).
- initial economic study of on-site generation of thermal-electric power and transmission to the existing Yukon power grid was carried out.
- Both reports were distributed to the Federal and Territorial Governments and Northern Canada Power Commission.
- 1982 - environmental base-line studies, begun in 1980, are continuing.

EXPENDITURES

Illtyd Deposit	\$2,075,000
Balance of Property	\$2,508,000
TOTAL	<u>\$4,583,000</u>

THE BONNET PLUME COALFIELD

Location

The Bonnet Plume Coalfield is located approximately 450 kilometres north of Whitehorse and 210 kilometres north of the town of Mayo (Figure 1). It is bounded on the north by the Peel River; on the east by the Knorr Range; on the south by the Werneke Mountains and on the west by a low series of hills lying to the west of the Wind River. The Bonnet Plume River flows through the eastern portion of the Basin.

History

A predecessor company of Aberford Resources Ltd. acquired control over 24 Coal Exploration Licences during 1977 and 1978. Since that time the Company has conducted extensive drilling programmes throughout the Basin, culminating in a Preliminary Feasibility Study of the Illtyd Creek Deposit.

Physiography

The Basin forms a topographic low bounded by the mountains described above. The area is mainly swamp with rock outcrops limited to the areas adjacent to the mountains and within the creeks and rivers flowing through the Basin.

Results of Regional Work

Coal has been discovered in areas throughout the southern, southwestern and west-central portions of the Basin. The coal is ranked as high volatile C bituminous, low sulphur coal (Table 1).

Stratigraphy

The coal is found in rocks of Cretaceous age within the Lower Bonnet Plume Formation. Five major coal horizons have been located within the middle portion of the formation.

Bonnet Plume Resources

Some 660 million tonnes of in situ coal have been located in seven coal areas (Table II). Of this total, 120 million tonnes in the Illtyd Deposit may be considered measured reserves. The remaining 540 million tonnes are drill-indicated or drill-inferred resources.

Illtyd Creek Deposit

The Illtyd Creek Deposit was chosen for detailed drilling in order to prove substantial measured reserves of coal and to study one coal area in detail (Figure 2). Only the top two seams were drilled in this Deposit. Drilling was

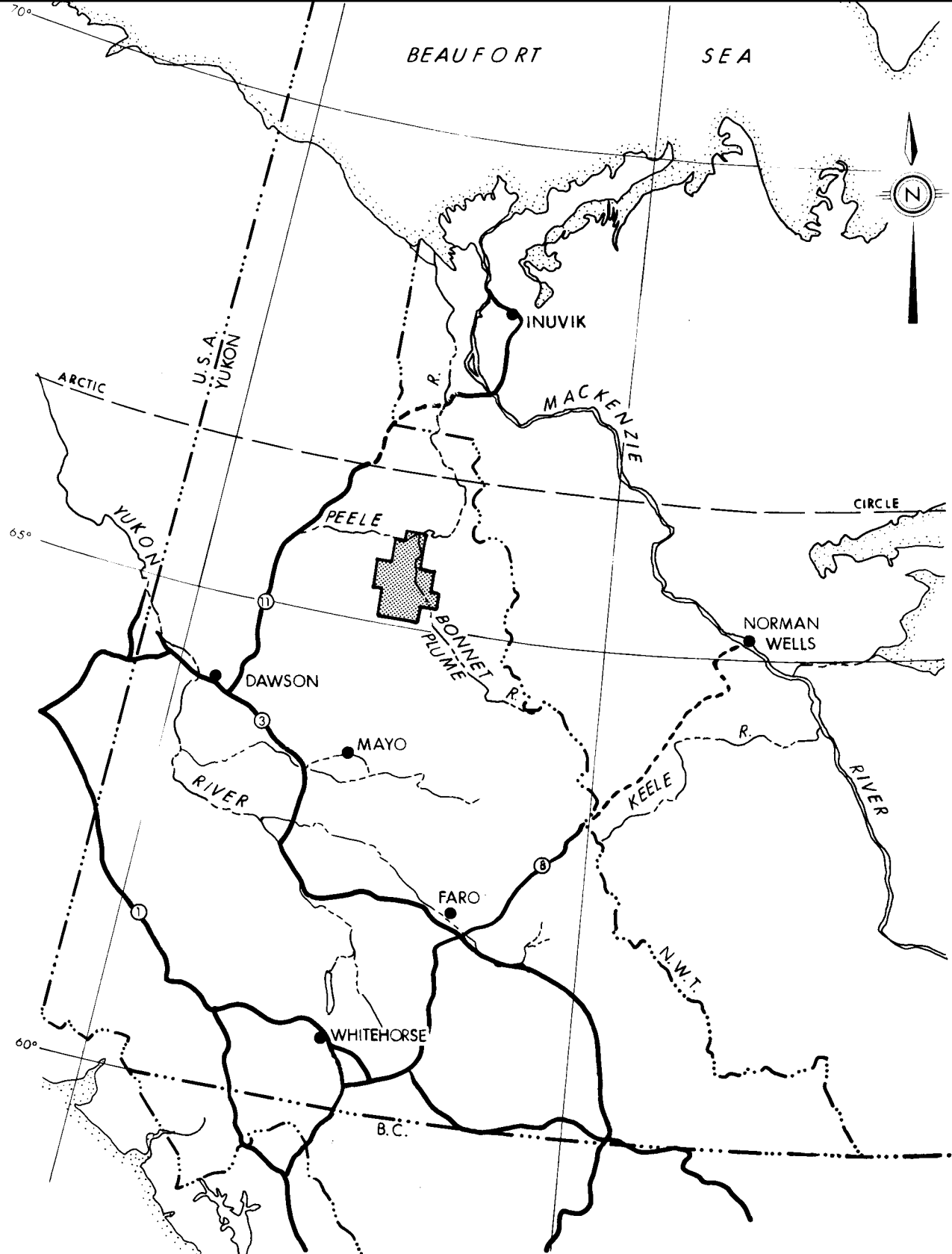


FIGURE 1


 ABERFORD RESOURCES LTD.			
PROPERTY LOCATION 092026 BONNET PLUME PROJECT			
DATE	SCALE	NTS	DRAWING NO.
APRIL, 1982	1:1,584,000	106 E	A-1723

TABLE I

ABERFORD RESOURCES LTD.

BOJNET PLUME COALFIELD

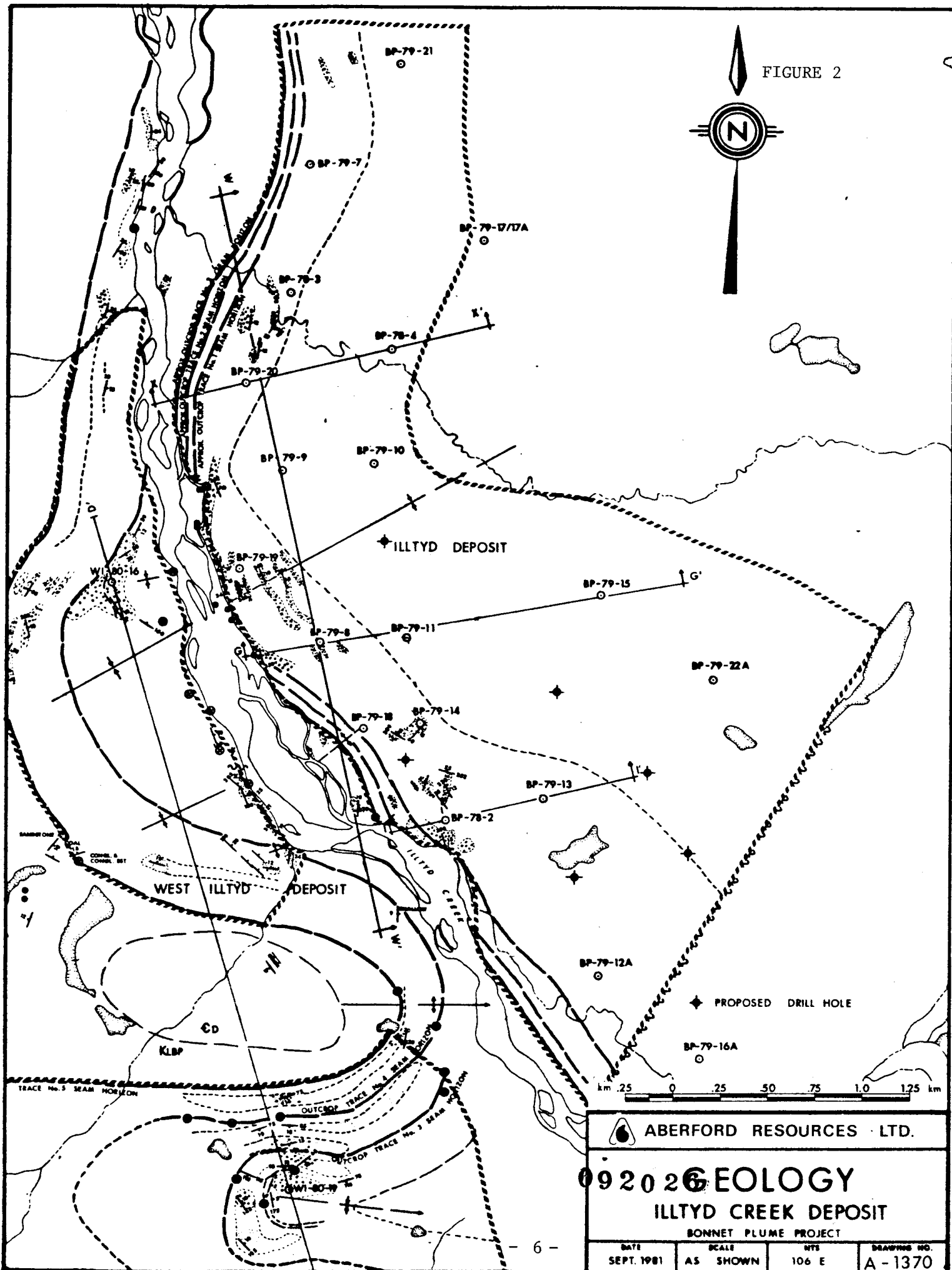
AVERAGE QUALITY - CLEAN COAL


Yield	77.1%
Moisture	5.3%
Ash	14.3%
Volatile Matter	33.0%
Fixed Carbon	47.5%
Calorific Value	10,012 BTU's/lb. (23.3 MJ/kg)
Sulphur	0.34%

TABLE II
ABERFORD RESOURCES LTD.
BONNET PLUME COALFIELD
SUMMARY OF RESOURCES

Deposit Area	Millions of Tonnes			Deposit	Cum.
	Measured	Indicated	Inferred	Total	Total
Illtyd	120.93	29.21	33.50	183.64	183.64
Wernecke		104.65	28.93	133.58	317.22
Airstrip			18.40	18.40	335.62
Wind		60.83	43.80	104.63	440.25
West Illtyd			47.56	47.56	487.81
Garlic Ring		8.60	5.55	14.15	501.96
Spaceship			157.95	157.95	659.91
TOTAL	120.93	203.29	335.69	659.91	659.91

FIGURE 2



 ABERFORD RESOURCES LTD.			
9202 GEOLOGY ILLTYD CREEK DEPOSIT BONNET PLUME PROJECT			
DATE	SCALE	NTS	DRAWING NO.
SEPT. 1981	AS SHOWN	106 E	A-1370

confined to coal having a depth of less than 300 metres. Extensions of the top two seams continue for unknown distances along strike to the north and south and downdip to the east to depths greater than 300 metres. It is presumed that the lower three seams occur within the Illtyd Deposit although they have not been drilled and are not included in resources.

Drilling revealed a coal area dipping at less than 20 degrees to the east and forming a gentle syncline from north to south. No major faulting was located within the Illtyd Deposit. Both seam horizons become more shaley to the north, with the coal portion of the horizon thinning. The average quality of clean coal within the Illtyd Deposit is indicated by Table III. Reserves are shown by Table II.

Based on these reserves and quality, Aberford Resources Ltd. then embarked on the thermal power station project study.

Illtyd Deposit - Thermal Power Project

It was decided, in view of the Yukon Territory's need for additional electric power, particularly in the near-term, that the Illtyd Deposit would form the nucleus of a reserve that would be proposed to both Federal and Territorial agencies as the site for a thermal generating station to be developed in stages of 70 megawatt units, to a total of 210 megawatts. Engineering studies by Aberford's consultants indicated that such a power station would require some 23 million tonnes of coal supply over 30 years. The reserves of No. 1 and 2 Seams in the Illtyd Deposit totalling 183 million tonnes would be more than sufficient to satisfy the requirements of the generating plant. Therefore, it was decided to proceed with a preliminary feasibility study for the mining of the Illtyd Deposit. Wright Engineers Ltd. of Vancouver conducted the study.

Mining - Illtyd Deposit

No. 1 Seam: The uppermost seam of the Deposit is immediately overlain by a conglomerate bed 100 metres thick. Although the seam itself is suited to longwall mining methods, the competency of the overlying conglomerate would preclude the extraction of this seam by this method. Therefore, room and pillar methods must be utilized to extract the No. 1 Seam. Allowance must be made to have large pillars to hold the conglomerate roof, thus reducing the coal available for extraction by about 40 percent of the mineable coal.

The seam varies from 2 to 9 metres in thickness. The upper portion is generally low grade. Only the lower portion will be mined with a layer of coal left on the floor for stability.

Production will begin in the southern portion of the Deposit; progressing to the east to a depth of 300 metres then moving to the north to the middle portion of the property. This sequence would be repeated from the depth of 300 metres back to the surface outcrop. The northern portion of the Deposit is not needed for a power station of the size contemplated.

TABLE III
ABERFORD RESOURCES LTD.
ILLTYD CREEK DEPOSIT
AVERAGE QUALITY - CLEAN COAL

Moisture	7%
Ash	15%
Volatile Matter	33.0%
Fixed Carbon	45.0%
Sulphur	0.5%
Calorific Value	9832-9791 BTU/lb.
Ash Fusion	2400°F

NOTE: Average based on weighted tonnage

When the room and pillar mine in the No. 1 Seam moves to the middle portion of the property, production will commence from the No. 2 Seam (beneath the mined-out portion of the No. 1 Seam) in the southern portion of the Deposit.

No. 2 Seam: Lying about 30 metres below the No. 1 Seam, this seam and its intervening sedimentary rock are ideally suited to longwall mining.

Longwall mining will allow maximum extraction and minimum coal waste.

The longwall unit will mine from the southern boundary of the deposit then move to the middle portion where it will mine from the 300 metre depth back to the outcrop.

The production schedule from both seams (Table IV) shows the annual rate of production, yield and BTU's to the power plant. The table allows 5 years for power plant construction.

Surface Facilities: Coal will be taken by conveyor from the mine to the plant and storage complex (Figure 3). Maintenance and personnel housing are also located at this site. Personnel will fly-in/fly-out from an airstrip on the Wind River.

The dormitories are modular, as are all units, allowing mine size to increase as the power plant expands.

Only portions of the coal will be washed, depending on the grade of mine feed. The wash plant is a standard unitized layout. Coal is stored in enclosed buildings. It is stacked and reclaimed using a spreader thus ensuring uniform quality.

Yukon Power Grid

Power would be delivered from the plant to the existing grid at Carmacks.

Production Schedule

The mine project could reach full production of 750,000 tonnes per annum within 4 years of project approval (Table IV).

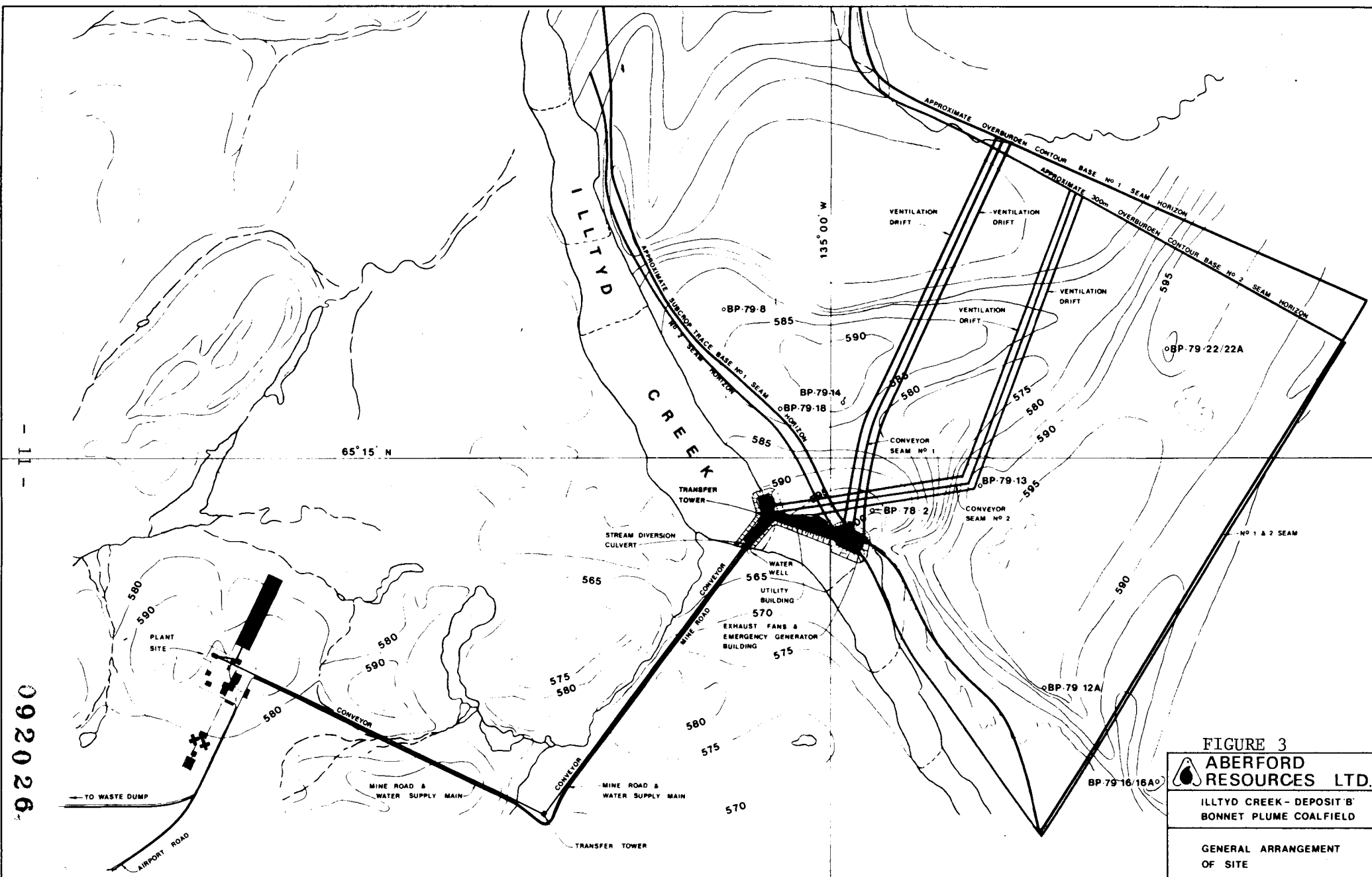
TABLE IV

ABERFORD RESOURCES LTD.

ILLTYD CREEK DEPOSIT

UNDERGROUND PRODUCTION SCHEDULE

Year	Seam 1			Seam 2			Overall Plant Recovery	BTU's/LB.
	Raw Coal (Tonnes)	Clean Coal (Tonnes)	% Plant Yield	Raw coal (Tonnes)	Clean Coal (Tonnes)	% Plant Yield		
5	825,991	750,000	90.8					10,538
6	856,774	750,000	87.5					10,318
7	900,360	750,000	83.3					10,002
8	900,360	750,000	83.3					10,002
9	900,360	750,000	83.3					10,002
10	900,360	750,000	83.3					10,002
11	900,360	750,000	83.3					10,002
12	909,403	750,000	83.1					10,002
13	923,645	750,000	81.2					10,002
14	637,904	493,393	77.3	297,087	256,607	86.4	80.2	9,702
15	628,234	446,941	71.1	303,059	303,059	100	80.5	9,777
16	628,022	450,199	71.7	299,801	299,802	100	80.8	9,653
17	660,248	480,000	72.7	271,795	270,000	99.3	80.5	9,521
18	465,517	338,431	72.7	471,983	411,569	87.2	80.0	9,532
19	481,421	350,000	72.7	452,929	400,000	88.3	80.3	9,536
20	504,096	370,000	73.4	431,648	380,000	88.0	80.2	9,521
21	577,446	425,000	73.6	353,020	325,000	92.1	80.6	9,518
22	11,500	8,898	77.4	803,624	741,102	92.2	92.0	9,805
23	Completed			796,003	750,000	94.2	94.2	9,810
24				809,120	750,000	92.7	92.7	9,795
25				826,071	750,000	90.8	90.8	9,784
26				834,461	750,000	89.9	89.9	9,795
27				850,215	750,000	88.2	88.2	9,666
28				863,625	750,000	86.8	86.8	9,619
29				914,832	750,000	82.0	82.0	9,661
30				923,057	750,000	81.3	81.3	9,632
31				874,226	750,000	85.8	85.8	9,641
32				855,591	750,000	87.7	87.7	9,716
33				819,217	750,000	91.6	91.6	9,784
34				707,338	697,681	98.6	98.6	9,831
TOTAL	12,612,011	10,112,862	80.2	13,758,702	12,334,631	90.0	-	-
				12,612,011	10,122,862	80.2	-	-
GRAND TOTAL	1 & 2 SEAMS			26,370,713	22,447,493	85.0		9,792



- 11 -

092026

FIGURE 3

ABERFORD RESOURCES LTD.

ILLTYD CREEK - DEPOSIT B
BONNET PLUME COALFIELD

GENERAL ARRANGEMENT
OF SITE



WRIGHT ENGINEERS LIMITED
VANCOUVER CANADA

DWG NO. **D 1098 100 1201**

NO.	DATE	BY	CHKD.	APP'D.	REVISION	NO.	DATE	BY	CHKD.	APP'D.	REVISION
1	10/10/88	JVO	SLC	[Signature]	ISSUED FOR						

SCALE 1:7500

Advantage of Thermal Power Station

The Company commissioned Montreal Engineering (Monenco) to conduct a capital, operating and delivered cost analyses based on a single 70 MW unit power station increasing to three 70 MW units for a total capacity of 210 MW. The Preliminary Feasibility Study was conducted based on supplying 2 or 3 units at a generating capacity of 140 or 210 MW.

Table V summarizes the results of the Monenco study. It should be noted that as units are added the levelized costs per kWh and the cost per kilowatt installed decreases dramatically.

The levelized costs per kWh indicated by Table V are based on the delivered price of coal at \$75.00 per tonne. Table VI indicated the effect on those costs if the price per tonne is varied. Naturally the price per tonne delivered is to be negotiated.

Table VII compares the Bonnet Plume Project with three potential hydro sites which were studied by the Northern Canada Power Commission in 1980. It is readily apparent that the Bonnet Plume Project is competitive and has the major advantage of growth potential at decreasing cost.

When compared to diesel generating costs the Bonnet Plume Project is outstanding. Current costs (based on rate increase April 1982) in Dawson City are 100 mils per kWh and 120 mils thereafter.

Table VIII compares cost of power from the Bonnet Plume delivered to Carmacks with those of other current power costs at towns within the Whitehorse grid. Again the project is competitive.

Conclusion

The Bonnet Plume Thermal Generating Project is competitive with all other new sources of power available in the Yukon Territory and in order to serve the public interest the Governments of Canada and the Yukon Territory should ensure that the Northern Canada Power Commission give full consideration to this alternative power source which is capable of supplying the Yukon's needs long into the future.

TABLE V

BONNET PLUME POWER STATION
Annual Cost, Cost of Power, Capital Costs

No. of Units Installed		1	2	3	3
Generated Power (Net)	MW	1 x 70	2 x 70	3 x 70	2 x 70
Annual Operating Hours at MCR	h/hr	7000	7000	7000	8760
Annual Generated Power at Plant (Net)	kWh/a	490 x 10 ⁶	980 x 10 ⁶	1470 x 10 ⁶	1226.4 x 10 ⁶
Transmission Line: Length	km	450	450	450	450
Voltage	kV	240	240	240	240
Power Loss (Max)	MW	2	7	15	7
Annual Power Delivered to Carmacks (Net)	kWh/a	475 x 10 ⁶	946 x 10 ⁶	1380.8 x 10 ⁶	1165.1 x 10 ⁶
Annual Coal consumption	thousand of tonnes	257	514	764	637
<u>Power Plant - Annual Cost</u>					
Capital Charges (1)	10 ³ \$	14,070	23,087	32,980	32,980
Operating and Maintenance Costs	10 ³ \$	1,369	2,738	4,110	3,427
Fuel at \$75.00/tonne	10 ³ \$	19,285	38,570	57,300	47,800
Total		<u>34,724</u>	<u>64,395</u>	<u>94,391</u>	<u>84,207</u>
<u>Transmission Line - Annual Cost</u>					
Capital Charges (1)	10 ³ \$	11,380	11,380	11,380	11,380
Operating and Maintenance Cost	10 ³ \$	2,860	2,860	2,860	2,860
Total		<u>14,240</u>	<u>14,240</u>	<u>14,240</u>	<u>14,240</u>
Grand Total	10 ³ \$	48,964	78,635	108,631	98,477
<u>Levelized Cost per kWh</u>					
At Power Plant	mils/kWh	71	66	64	68
At Carmacks	mils/kWh	103	83	79	84
<u>Capital Cost</u>					
Plant	10 ⁶ \$	127.950	209.885	291.840	
Transmission Line	10 ⁶ \$	103.470	103.470	103.470	
Total		231.420	313.355	395.310	
Cost per Kilowatt Installed		3305	2240	1882	
Notes: (1) Annual Capital Fixed charges assumed 11% on constant (1981) dollars - 30 year plant life.					

TABLE VI

BONNET PLUME POWER STATION

Effective of Fuel Cost on Cost of Power

				70	140	210	
Capacity MW				1	2	3	3
No. of Units				1	2	3	3
No. Units Operating				7000	7000	7000	8760
Operating Hr/Year							
LINE	COST CENTRE	LOAD DISTANCE (KM)	FUEL COST (\$/TONNE)	MILS PER KILOWATT HOUR			
240 KV	AT PLANT	NIL	65.00	66	60	59	63
			75.00	71	66	64	68
			85.00	76	71	69	74
	AT CARMACKS	450	65.00	98	75	73	79
			75.00	103	83	79	84
			85.00	105	88	84	90

TABLE VII

Comparison Unit Cost of Dependable Energy - Hydro & Thermal
 Yukon Mining Hydro Power Study - 1980
 Monenco Report - 1981

	False Canyon	Hoole Canyon	Ross Canyon	BONNET PLUME	
Installed Capacity (MW)	60	38	34	70	140
<u>Energy at Site (2)</u>					
Dependable Energy (GWh/yr)	305	195	172	490	980
Cost (mils/kWh)	67	86	95	66	60
<u>Energy at Load (3)</u>					
Dependable Energy (GWh/yr)	290	185	163	475	946
Cost (mils/kWh)	81	96	105	98	75
<u>Capital Cost (Thousands \$)</u>					
Plant	158,649	130,971	127,079	127,079	209,885
Transmission	23,909	7,218	5,286	103,470	103,470
Total	182,558	138,189	132,365	231,420	313,355
Cost per Kilowatt Installed	3,040	3,640	3,895	3,305	2,240
NOTES					
(1) Based on Fuel Cost of \$65.00/tonne.					
(2) Energy at generator terminals. Transmission costs and energy losses excluded. Fringe clearing of reservoir assumed.					
(3) Includes a 5% allowance for transmission losses. Cost of transmission to the Whitehorse system at Faro is also included for hydro sites and to Carmacks for thermal site.					

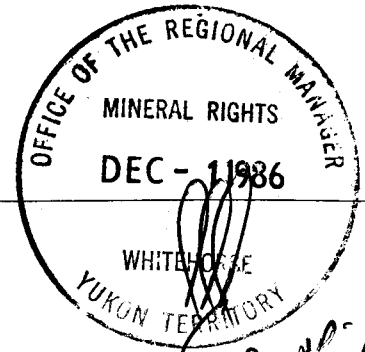
TABLE VIII

COMPARISON OF
 NORTHERN CANADA POWER COMMISSION
 CURRENT POWER COSTS (RESIDENTIAL) (1)
 AND
 ANTICIPATED BONNET PLUME COST OF POWER

<u>Location</u>	<u>Mils Per Kilowatt Hour</u>
Whitehorse	75.73
Carmacks - NCPC	126.71
<u>BONNET PLUME</u>	98.00 (2)
Carcross Marsh Lake, Tagish	126.71
Ross River	193.13
Haines Junction	133.31

(1) NCPC requested rate April 16, 1982

(2) Based on 70MW at \$65.00/tonne



November 28 1986

*I found
AND GIVE TO
Glebe ON
7 APR. 87*

Mr. B. R. Baxter
Regional Manager Mineral Rights
200 Range Road
Whitehorse Yukon Territory
Y1A 3V1

Dear Mr. Baxter:

As per your request of November 6, 1986, enclosed please find a report "Yukon Thermal Power Generating Study (Addendum 1)" which is the latest updated report on the Bonnet Plume Property (License Numbers Y391 - Y414 inclusive).

If you have any questions please contact Jim McKinney or the undersigned at this office.

Yours truly,

ABERMIN CORPORATION

Kim Jumpsen
Land Manager

/KJ
Enclosure

YUKON THERMAL POWER GENERATING STUDY
FOR
PAN OCEAN OIL LIMITED
(ADDENDUM 1)

Prepared by

MONENCO CONSULTANTS LIMITED
900 One Palliser Square
125 - 9th Avenue S. E.
Calgary, Alberta
T2G OP6
May 1981



monenco consultants limited

900 ONE PALLISER SQUARE, 125 - 9th AVENUE S.E.
CALGARY, ALBERTA, CANADA T2G 0P6

Telephone: (403) 263-1680 Telex: 038-22636

Mr. J.S. McKinney
Exploration Manager, Coal
Pan Ocean Oil Ltd.
300 Fifth Avenue S.W.
Calgary, Alberta T2P 2M4

Mailing Address
P.O. Box 2533, Sta. M
Calgary, Alberta T2P 2M7

Yukon Thermal Power
Generating Study
File: P00 7862-1

Gentlemen:

We are pleased to submit our Addendum #1 to the subject report on a study for a thermal plant located in the Bonnet Plume Area of the Yukon Territory.

This addendum presents an "Order of Magnitude" capital cost update for 3 x 75 MW mine mouth coal fired generating plant with an alternative 1 x 75 MW and 2 x 75 MW unit plant with an updated assessment of the operating and maintenance costs. The cost of power delivered at Carmacks/Faro and at the plant busbar is also given.

For the addendum we used coal at \$75.00 per tonne and showed the effect for coal of \$65.00 and \$85.00 per tonne.

We have also included some costs for an alternate transmission line route via the Bonnet Plume River, Selwyn Valley and Canol Road to Faro. However these numbers must be treated as transmission line costs and do not allow for the extreme remoteness of supply points or access routes for building this line. It is possible that actual costs could be three to four times the costs given if the transmission line cost had to bear the full expense of access and supply under the current undeveloped condition.

When you have had an opportunity to study this addendum, we shall be pleased to review it with you and to provide any additional information you may require.

Yours very truly,

D.O. Outhouse, P.Eng.
Vice President Thermal

TABLE OF CONTENTS

	<u>PAGE</u>
Letter of Transmittal	(i)
Table of Contents	(ii)
Map	(iv)
1.0 INTRODUCTION	1
2.0 SUMMARY	1
3.0 PLANT DESCRIPTION	2
3.1 LOCATION AND ACCESS	2
3.2 BRIEF DESCRIPTION	2
3.3 LIST OF ALTERNATIVES	3
3.4 ITEMS EXCLUDED FROM SCOPE OF STUDY	4
3.5 ASSUMPTIONS	4
351 Structures and Foundations	4
352 Circulating Water System	5
353 Precipitators	5
354 Operating Schedule	5
355 Electrical Systems and Equipment	6
356 Transmission to Carmarks or Faro	6
3.6 TECHNICAL DATA	8

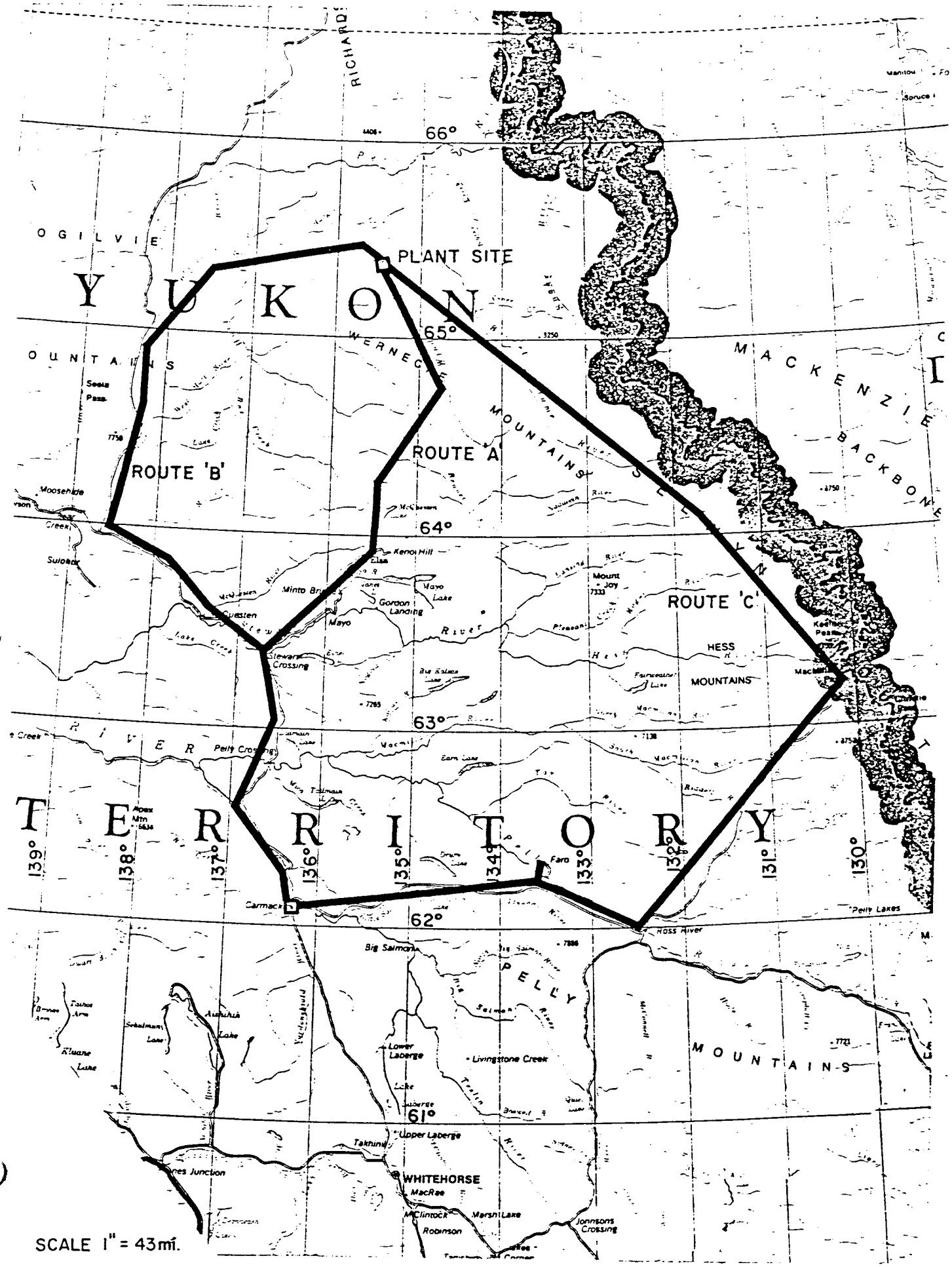
TABLES

TABLES

1	ANNUAL COST AND COST OF POWER - A ALTERNATIVE	11
2	ANNUAL COST AND COST OF POWER - B ALTERNATIVE	12
3	COST OF POWER AND FUEL	13

TABLE OF CONTENTS (Cont'd)

	<u>PAGE</u>
<u>TABLES</u> (Cont'd)	
4 COST OF POWER AND FUEL	13
5 CAPITAL COST ESTIMATE 1 UNIT	14
6 CAPITAL COST ESTIMATE 2 UNIT	15
7 CAPITAL COST ESTIMATE 3 UNIT	16
8 TRANSMISSION ESTIMATE - A ALTERNATIVES	17
9 TRANSMISSION ESTIMATE - B ALTERNATIVES	18



SCALE 1" = 43 mi.

1.0 INTRODUCTION

The first addendum to the December 1978 Study presents the cost of construction and operation at the Bonnet Plume Thermal Plant on a 1981 basis. In addition it includes the costs for a single unit plant i.e., 1 x 70 MW (net) and a 2 unit plant i.e., 2 x 70 MW (net) which would operate at the mine mouth on coal fuel and a third possible route for transmission of power. Also, we have included the effect on power costs at the plant and at the load for fuel priced at \$65.00, \$75.00 and \$85.00 per tonne.

The cost of fuel, mine, coal preparation plant, site access, land and land rights have not been included in the scope of study.

No detail design has been undertaken on any part of the study. Conditions such as permafrost, extreme temperatures, freight, construction problems, remoteness, etc., have been assumed. Further investigations and studies at the Site would be required to produce a more accurate estimate.

2.0 SUMMARY

The levelized cost of power at the power plant is estimated to be in the range of 64 to 68 mils/kWh. This is substantially higher than the previous report and is due mainly to increasing the price of coal from the previous \$30.00 per short ton and updating the capital cost of the plant to 1981.

The cost of power at the load is increased as a result, and is estimated to be in the range of 83 to 103 mils/kWh. This latter range is somewhat higher at the upper end due to the lower annual generation being carried by a transmission system that is rather lightly loaded. However, the distances involved do not permit the use of a lesser voltage to achieve lower cost.

In the previous study the fuel was priced at \$30.00 per short ton. In this study \$75.00 per ton is used which is much closer to a realistic price for fuel in the area under consideration.

The components of power cost in mils per kwhr are approximately as follows: (Alternative 2B assumed)

Capital Cost	23.4 mils/kWh ✓
Operating and Maintenance Cost	2.9 mils/kWh
Fuel Cost	40.6 mils/kWh
Transmission Line Cost	17.1 mils/kWh

Because the transmission system is not much different in original cost for Alternative 3B, but the transmitted kWh's are substantially less, the cost of transmission per kWh increases from 17.1 to 44 mils/kWh. By the same token the cost of coal could rise sharply due to a much smaller annual production. This would depend on how carefully the operation of the mine and plant were integrated.

The components of power cost in mils for a single unit plant (Alternative 3B) are approximately as follows:

Capital Cost	30.0 mils/kWh
Operating and Maintenance Cost	2.9 mils/kWh
Fuel Cost	41.2 mils/kWh
Transmission Line Cost	42.6 mils/kWh

3.0 PLANT DESCRIPTION

3.1 LOCATION AND ACCESS

These do not differ from the previous report.

3.2 BRIEF DESCRIPTION

There was no change in the 3 unit plant, however a single unit plant was estimated using the same assumed site conditions. Although some of the costs such as the major items like turbine, boiler, etc., are proportionally less, many of the costs are not significantly less. In this latter category are such items as site preparation, circulating water system, stack, coal handling, ash system, emergency generator, etc.

3.3 LIST OF ALTERNATIVES

Alternative 1A

- 140 MW net generated power at plant terminals for 8760 hours annually from 3 - 75 MW units
- transmission line 240 kV and 450 km long

Alternative 2A

- 210 MW net generated power at plant terminals for 7000 hours annually from 3 - 75 MW units
- transmission line 240 kV and 450 km long

Alternative 3A

- 70 MW net generated power at plant terminals for 7000 hours annually from 1 - 75 MW unit
- transmission line 240 kV and 450 km long

Alternative 4A

- 140 MW net generated power at plant terminals for 7000 hrs annually from 2 - 75 MW units
- transmission line 240 kV and 450 km long.

Alternative 1B

- 140 MW net generated power at plant terminals for 8760 hours annually from 3 - 75 MW units
- transmission line 240 kV and 645 km long

Alternative 2B

- 210 MW net generated power at plant terminal for 7000 hours annually from 3 - 75 MW unit
- transmission line 345 kV and 450 km long with south terminal at Carmacks or Faro

Alternative 3B

- 70 MW net generated power at plant terminals for 7000 hours from 1 - 75 MW unit
- transmission line 240 kV and 645 km long

Alternative 4B

- 140 MW net generated at the plant terminal for 7000 hours from 2 - 75 MW units
- transmission line 240 kV and 645 km long

3.4 ITEMS EXCLUDED FROM SCOPE OF STUDY

The list of items not included in the scope of the study are:

- land and land rights;
- mine;
- coal preparation plant;
- coal transportation to the plant coal handling system;
- auxiliary fuel pipeline;
- access road and air strip;
- ash lagoon (assumed that tailings pond is available for ash discharge);
- fuel costs;
- any other fuel gas cleaning systems other than precipitators;
- interest during construction; and
- supply of power to intermediate points between the thermal plant and Carmacks and/or Faro.

3.5 ASSUMPTIONS

351 Structures and Foundations

The main buildings would consist of structural steel frames clad with double skin insulated wall panels and built up roofing on a metal deck.

In the absence of detailed geotechnical information, it has been assumed that the foundations for the powerhouse, stack and main coal handling structures would be reinforced concrete slabs on forced air

ventilated pad foundations. The foundations for the other structures would be drilled steel piles with an air gap between the underside of the structure and the ground.

The working area around the power plant and the coal handling system, and the access roads for the cooling water system would consist of insulated granular fill to prevent extensive thawing of the permafrost.

The granular materials required for the ventilated pad foundations site preparation, access roads and concrete were assumed to be available in the vicinity of the site.

352 Circulating Water System

A cooling tower system has been selected for the cost estimate for the following reasons:

- a) Unknown difficulties involved in using cooling pond in permafrost areas (thawing of the permafrost).
- b) Available site information is not sufficient to locate a cooling pond and to determine its costs.
- c) Cooling towers are economically competitive with cooling ponds and their construction can be adapted to permafrost areas more easily.

Make-up would be taken from Illyd Creek for two months of the year, and discharged to the make-up storage pond. The make-up storage pond would supply the circulating water system annual requirements. A blowdown line would transport water from the circulating water system to the make-up storage pond and to the river. The make-up and blowdown lines would be in a gravel roadway with an assumed length of 12,000 feet.

353 Precipitators

It has been assumed that high efficiency electrostatic precipitators will be required for flue gas clean-up.

354 Operating Schedule

Four alternatives of power plant utilization have been evaluated.

Alternative 1 assumes that one unit serves as a standby. The power plant output would be 140 MW (net) for the 8760 hours per year.

Alternative 2 assumes typical power plant utilization; 7000 hours per year on MCR (maximum continuous rating of 210 MW net).

Alternative 3 assumes typical power plant utilization; 7000 hours per year on MCR (maximum continuous rating of 70 MW net).

Alternative 4 assumes typical power plant utilization; 7000 hours per year on MCR of 140 MW net.

355 Electrical Systems and Equipment

The plant electrical system is based on the unit principle which affords the greatest availability at least cost, and thus appears most appropriate to this application. Power for station services and systems, and for boiler/turbine auxiliaries during unit start-up would be supplied by the station service system. Following unit start-up, the boiler/turbine auxiliaries would be supplied from the associated unit service transformer.

At the unit rating of 75 MW, the generator voltage would be 13.8 kV and transformed up to the transmission voltage by individual generator transformers.

Except for the larger motor drives, which would be supplied from the 4160 volt system, utilization voltage throughout the plant would be either 600 volts or 208/115 volts ac. Emergency generators would be connected to the station service 4160 volt switchgear.

The boiler/turbine/generator units, emergency generators and auxiliary power systems would be controlled from a common central control room. The coal plant would be controlled from a local control room while the ash handling and precipitators would be controlled from the boiler-house. Wherever practicable, systems and processes would be controlled automatically and would normally require minimal operator involvement.

356 Transmission to Carmacks or Faro

A point to point 240 kV and 345 kV transmission system is assumed for delivery of power from the thermal plant to Carmacks. In view of the high cost of transmission facilities, only a single circuit line is provided; i.e., the supply is not firm. To provide a firm supply, duplicate circuits with similar capabilities would be required.

Three alternative line capability requirements have been considered, namely:

- a) 70 MW corresponding to a single unit plant;
- b) 140 MW corresponding to a 2 unit plant; and
- c) 210 MW corresponding to plant maximum output (3 units).

For each of the above, three alternative line routes have also been considered, namely:

- a) direct route south from plant to Mayo (over Selwyn Mountains) then follow highway to Carmacks (420 - 480 km, 450 km assumed);
- b) highway route west from the plant to Dempster Highway (along future plant access road) then follow highway and pipeline to Carmacks (650 km assumed);
- c) a third alternative appears possible following the Bonnet Plume River upstream to the Selwyn Valley and following this to the Canol Road. Since the distance involved is approximately the same as b) above, the estimated cost is kept the same. However, from maps of the area it would appear that the entire route is in undeveloped mountainous country until it reaches the Canol Road and this could mean substantially high cost depending on accessibility. It is also very remote from any supply points which again indicates very high costs for materials and labour.

The first of these routes is the shortest access through the mountains. This route would be by Braine Pass and the winter road which is in use at the present time. This route would also be used for construction and future maintenance. The second route is a possible alternative, particularly as the line would probably be tapped at various intermediate points along the pipeline to supply a number of compressor stations. Variations in transmission costs corresponding to alternative line capabilities and routes are based on the following assumptions. The third route would depend on future developments in the area both for construction and maintenance.

A 240 kV transmission line is capable of transmitting approximately 200 MW over 480 km (route 'a'), or approximately 160 MW over 650 km (route 'b' and route 'c'). Thus, 240 kV would appear to be appropriate for Alternatives 1A, 1B, 2A, 3A, 3B, 4A and 4B. To transmit 210 MW over 645 km, however, (Alternative 2B) would require a voltage higher than 240 kV. The next standard voltage is 345 kV which would have a capability of approximately 320 MW over 650 km. The line design has not been optimized at this stage.

It is appreciated that in the ultimate scheme, if a substantial part of the plant output is tapped off along the pipeline route it may be possible to cater for full plant output of 210 MW and still transmit at 240 KV. This would require a detailed system study at the conceptual design stage.

The cost estimates include for high voltage substations (single bus) at the thermal plant, Carmacks or Faro, with one intermediate substation. Shunt reactive compensation has been assumed as 50% for route A and 75% for route B and route C. For a single unit plant additional reactive compensation is required. Optimization of shunt reactor size and location, and the possible use of series compensation has not been considered at this stage and will require further study at the conceptual design stage. Transformation from 240 kV or 345 kV to the 138 kV system is provided by two 150 MVA transformers at Carmacks and/or Faro (150 MVA firm).

3.6 TECHNICAL DATA

Coal

Assumed proximate coal analyses as fired:

	<u>% By Weight</u>
Moisture	6.0
Volatiles	33.0
Fixed carbon	46.0
Ash	<u>15.0</u>
	100.0%
Higher heating value	9,500 BTU/lb

Heat Rates

Turbine gross heat rate (assumed)	8,900 BTU/kWh
Plant gross heat rate	10,230 BTU/kWh
Plant net heat rate	10,888 BTU/kWh

Steam Turbo-Generators (Design Data)

Steam Flow per unit	620,000 lb/hr
Steam temperature	950°F
Steam pressure	1,250 psig
Turbine back pressure	2" Hga
Number of extractions	five

Steam Generators

Efficiency	87%
Feedwater inlet temperature	420°F

Mass Balance Data

	<u>2 Units</u> <u>at MCR</u>	<u>3 Units</u> <u>at MCR</u>	<u>1 Unit</u> <u>at MCR</u>
		10 ³ lbs/hr.	
Coal consumption (including rejects)	162	243	81
Ash rate (including rejects)	26	39	13
Mill rejects	2	3	1
Air	1,400	2,100	700
Flue gases	1,536	2,304	767

Stack and Precipitators

Height	235 ft
Flue diameter (each)	8 ft
Flue gas exit velocity	100 ft/s
Precipitator efficiency	99.5%

Circulating Water System

Heat rejected to condenser per unit	400 x 10 ⁶ BTU/h
Circulating water flow per unit	40,000 USgpm
Temperature range	20°F
Circulating water inlet temperature (design)	70°F
Make-up rate per station (max.)	3,600 USgpm
Blowdown rate per station (max.)	1,800 USgpm

ANNUAL COST
AND
COST OF POWER TABLES

TABLE 1

Annual Cost and Cost of Power

Alternative		1A	2A	3A	4A
No. of Units Installed		3	3	1	2
Generated Power (Net)	MW	2 x 70	3 x 70	1 x 70	2 x 70
Annual Operating Hours at MCR	h/hr	8760	7000	7000	7000
Annual Generated Power at Plant (Net)	kWh/a	1226.4 x 10 ⁶	1470 x 10 ⁶	490 x 10 ⁶	980 x 10 ⁶
Transmission Line: Length	km	450	450	450	450
Voltage	kV	240	240	240	240
Power Loss (Max)	MW	7	15	2	7
Annual Power Delivered to Carmacks (Net)	kWh/a	1165.1 x 10 ⁶	1380.8 x 10 ⁶	475 x 10 ⁶	946 x 10 ⁶
<u>Power Plant - Annual Cost</u>					
Capital Charges (1)	10 ³ \$	32,980	32,980	14,070	23,087
Operating and Maintenance Costs	10 ³ \$	3,427	4,110	1,369	2,738
Fuel (2)	10 ³ \$	47,800	57,300	19,285	38,570
Total		<u>84,207</u>	<u>94,391</u>	<u>34,724</u>	<u>64,395</u>
<u>Transmission Line - Annual Cost</u>					
Capital Charges (1)	10 ³ \$	11,380	11,380	11,380	11,380
Operating and Maintenance Cost	10 ³ \$	2,860	2,860	2,860	2,860
Total		<u>14,240</u>	<u>14,240</u>	<u>14,240</u>	<u>14,240</u>
Grand Total	10 ³ \$	98,477	108,631	48,964	78,635
<u>Levelized Cost per kWh</u>					
At Power Plant	mils/kWh	68	64	71	66
At Carmacks	mils/kWh	84	79	103	83

Notes: (1) Annual Capital Fixed charges assumed 11% on constant (1981) dollars - 30 year plant life.

(2) Assumed fuel cost \$75/tonne at plant conveyor.

TABLE 2

Annual Cost and Cost of Power

Alternative		1B	2B	3B	4B
No. of Units Installed		3	3	1	2
Generated Power (Net)	MW	2 x 70	3 x 70	1 x 70	2 x 70
Annual Operating Hours at MCR	h/yr	8760	7000	7000	7000
Annual Generated Power at Plant (Net)	kWh/a	1226.4 x 10 ⁶	1470 x 10 ⁶	490 x 10 ⁶	980 x 10 ⁶
Transmission Line: Length	km	645	645	645	645
Voltage	kV	240	345	240	240
Power Loss (Max)	MW	10	10	2.9	10
Annual Power Delivered to Carmacks (Net)	kWh/a	1138.8 x 10 ⁶	1411.4 x 10 ⁶	468 x 10 ⁶	910 x 10 ⁶
<u>Power Plant - Annual Cost</u>					
Capital Charges (1)	10 ³ \$	32,980	32,980	14,070	23,087
Operating and Maintenance Costs	10 ³ \$	3,427	4,110	1,369	2,738
Fuel (2)	10 ³ \$	47,800	57,300	19,285	38,570
Total		<u>84,207</u>	<u>94,390</u>	<u>34,724</u>	<u>64,395</u>
<u>Transmission Line - Annual Cost</u>					
Capital Charges (1)	10 ³ \$	15,730	19,280	15,870	15,730
Operating and Maintenance Cost	10 ³ \$	4,040	4,890	4,050	4,050
Total		<u>19,770</u>	<u>24,170</u>	<u>19,920</u>	<u>19,770</u>
Grand Total		103,977	118,560	54,644	84,165
<u>Levelized Cost per kWh</u>					
At Power Plant	mils/kWh	68	64	71	66
At Carmacks	mils/kWh	91	84	117	92

Notes: (1) Annual Capital Fixed charges assumed 11% on constant (1981) dollars - 30 year plant life.

(2) Assumed fuel cost \$75/tonne at plant conveyor.

EFFECT OF VARYING FUEL PRICE

The following table shows the effect of the variation of the cost of fuel on the cost of power at the plant and at the load.

TABLE 3

Cost of Power mils/kWh for Alternatives LOAD DISTANCE 450 km								
Fuel Cost	1A		2A		3A		4A	
	3 units 2 @ 8760 h 240 kV Transm.		3 units 3 @ 7000 h 240 kV Transm.		1 unit 1 @ 7000 h 240 kV Transm.		2 units 2 @ 7000 h 240 kV Transm.	
	*1	*2	1	2	1	2	1	2
\$'s per tonne								
\$65.00	63	79	59	73	66	98	60	75
\$75.00	68	84	64	79	71	103	66	83
\$85.00	74	90	69	84	76	105	71	88

TABLE 4

Cost of Power mils/kWh for Alternatives LOAD DISTANCE 645 km								
Fuel Cost	1B		2B		3B		4B	
	3 units 2 @ 8760 h 240 kV Transm.		3 units 3 @ 7000 h 345 kV Transm.		1 unit 1 @ 7000 h 240 kV Transm.		2 units 2 @ 7000 h 240 kV Transm.	
	1	2	1	2	1	2	1	2
\$'s per tonne								
\$65.00	63	83	59	78	66	111	60	87
\$75.00	68	91	64	84	71	117	66	92
\$85.00	74	95	69	89	76	122	71	98

*1 At the Plant

*2 At the Load

PLANT CAPITAL COST

TABLES

TABLE 5

Capital Cost Estimate

(Thousands Canadian Dollars in 1981 Price Level)

(Single Unit Plant)

	Supply	Erect	Total
Site and Improvements	1,290	890	2,180
Buildings and Structures	13,250	11,980	25,230
Boilers and Auxiliaries	16,250	12,470	28,720
Turbo-generators and Auxiliaries	17,230	4,920	22,150
Electrical Systems	3,310	2,710	6,020
Control and Instruments	3,280	940	4,220
Miscellaneous Plant Equipment	570	180	750
Subtotal	55,180	34,090	89,270
General Undistributed			38,680
Total			127,950
Precipitators (included above)	1,367	1,641	3,008

TABLE 6

Capital Cost Estimate

(Thousands Canadian Dollars in 1981 Price Level)

(2 Unit Plant)

	Supply	Erect	Total
Site and Improvements	1,310	890	2,200
Buildings and Structures	19,510	17,640	37,150
Boilers and Auxiliaries	28,860	22,150	51,010
Turbo-generators and Auxiliaries	32,555	9,280	41,835
Electrical Systems	5,795	4,745	10,540
Control and Instruments	6,305	1,825	8,130
Miscellaneous Plant Equipment	755	240	995
Subtotal	95,090	56,770	151,860
General Undistributed			58,025
Total			209,885
Precipitators (included above)	2,733	3,193	5,926

TABLE 7

Capital Cost Estimate

(Thousands Canadian Dollars in 1981 Price Level)

(Three Unit Plant)

	Supply	Erect	Total
Site and Improvements	1,340	890	2,230
Buildings and Structures	25,770	23,300	49,070
Boilers and Auxiliaries	41,470	31,830	73,300
Turbo-generators and Auxiliaries	47,880	13,650	61,530
Electrical Systems	8,280	6,780	15,060
Control and Instruments	9,330	2,710	12,040
Miscellaneous Plant Equipment	940	300	1,240
Subtotal	135,010	79,460	214,470
General Undistributed			77,370
Total			291,840
Precipitators (included above)	4,100	4,790	8,890

TABLE 8

Transmission Line Cost Estimates
(Thousand Dollars - 1981 Price Level)

<u>Alternative</u>	1A	2A	3A	4A
Length (km)	450	450	450	450
Voltage	240	240	240	240
<u>Capital Cost</u>				
Transmission Line	91,300	91,300	91,300	91,300
Substations	11,900	11,900	11,900	11,900
System Engineering Studies	270	270	270	270
	103,470	103,470	103,470	103,470
<u>Annual Operating & Maintenance Costs</u>				
Transmission Line (3%)*	2,740	2,740	2,740	2,740
Substations (1%)*	120	120	120	120
Total	2,860	2,860	2,860	2,860

Note: *Percentage of capital cost estimate

TRANSMISSION LINE
CAPITAL COST TABLES

TABLE 9

Transmission Line Cost Estimates
(Thousand Dollars - 1981 Price Level)

<u>Alternative</u>	1B	2B	3B	4B
Length (km)	645	645	645	645
Voltage	240	345	240	240
<u>Capital Cost</u>				
Transmission Line	130,000	157,000	130,000	130,000
Substations	12,700	18,000	14,000	12,700
System Engineering	270	270	270	270
	142,970	175,270	144,270	142,970
<u>Annual Operating & Maintenance Costs</u>				
Transmission Line (3%)*	3,910	4,710	3,910	3,910
Substations (1%)*	130	180	140	140
Total	4,040	4,890	4,050	4,050

Note: *Percentage of capital cost estimate
Remoteness and mountain terrain could triple this cost estimate for the Selwyn Valley - Canol Road Alternative.