(3) Industry Sector

As discussed in Section 5-3-1, Energy Supply and Demand Forecast, energy use in the industrial sector, particularly in the manufacturing sector, is expected to grow. Cement companies, which have now completed conversion to coal with two exceptions, will continue to be the major user of coal. Consumption of natural gas by new chemical plants will contribute to the diversification of energy sources in the sector. In addition, through the gradual shift of electric power supply by small captive power generators to PLN, the consumption of fuel and diesel oil in the sector is expected to decline. Methanol can also contribute to the diversification of oil sources by providing fuel for diesel oil power generation.

(4) Household Sector

A large part of final energy consumption in the household sector is for cooking and the remainder is for lighting and electric appliances. Firewood and agricultural residue will continue to be the major source of energy for cooking. However, given the country's worsening deforestation problem, use of alternative fuels, such as LPG and briquettes may be promoted.

As for lighting, more households are expected to be connected to a power grid system by PLN. However, those households in isolated areas will continue to depend on small captive power plants. For such households fuel methanol has significant potential for electricity generation.

5-4 MARKETS FOR DERIVATIVES OF COAL

Coal and its derivatives through coal gasification are shown in Fig. 7-2-1. The purpose of this section (5-4) is mainly to focus the markets on coal derivatives, methanol and ammonia/urea in particular.

5-4-1 Electricity Generation Sector

Methanol can be applied for power stations of gas turbines, or 0.1~5 MW class diesel engines. There are still many isolated small power stations of 100 kW class needed in Indonesia, although the interconnection of the electric grid has been extended.

On the other hand, typical boiler type power generators are not expected to have a bigger market share for fuel methanol because natural gas and coal are produced in Indonesia and their economy for power generation use in a boiler is superior to that of fuel methanol.

5-4-2 Transportation Sector

Implementing the widespread use of neat methanol in the transportation sector needs the rapid expansion of the distribution network system. The existing distribution network for petroleum products is not compatible with methanol use. In addition, installing a parallel distribution system would mean significant investment costs. For automobile manufacturers, there is no significant impetus at present towards large-scale production of large quantities of methanol-fueled cars.

For aforementioned reasons, low level methanol blending seems to be the likely solution to introducing methanol in the medium term because the existing distribution network can be used without modification. However, the use of methanol as a direct blending component in transportation fuels has been limited to a maximum 3% of gasoline mixture.

Introducing neat methanol to replace gasoline and diesel fuel oil does not seem realistic for the time being in Indonesia because of the low price of petroleum products. Gasoline and diesel fuel oil substitution, however, must be done over the longer term by neat methanol. Decline in the crude oil supply for the domestic market can occur in the future to keep export oil with level-off of oil production. It must be considered that 99% of transportation fuel is produced from oil, and that the production/reserves ratio in Indonesia was 18 years at the end of 1985. The details of the expected demand of fuel methanol are discussed in Section 5-5.

5-4-3 Chemical Feedstocks

(1) Methanol

Methanol is one of the most important chemicals to be directly synthesized from synthesis gas, and is used as raw material for other chemicals and as solvent without any further processing (Fig. 7-2-2). In Indonesia, methanol is used widely for wood glue and as an ingredient for plastic and pharmaceutical goods. But wood glue is the biggest industrial user of methanol in Indonesia. Consumption of methanol in Indonesia was 140,000 t in 1987 (Table 5-4-1).

Methanol imports by country of origin is shown in Table 5-4-2. Breakdown of demand for methanol in 1987 and world methanol balance are shown in Table 5-4-3 and Fig. 5-4-1 respectively.

(2) Fertilizer

Demand for urea is highly prospective in Indonesia. Economic feasibility of coal gasification system, however, seems to depend upon the Government's decision on the price of natural gas, which is ordinary feedstock for urea for the time being. Utilizing natural gas in South Sumatra as feedstock for urea will also greatly influence demand for synthesis gas produced from Banko coal.

Figures on demand and suppy of fertilizers in Indonesia are shown in Table 5-4-4 through 5-4-6.

Table 5-4-1 Methanol Demand and Supply in Asian Countries

(Unit : 10^3 t)

Items		JAPAN	KOREA	TAIWAN	PHILIPPINES	THAILAND	MALAYSIA	SINGAPORE	INDONESIA	INDIA	CHINA	BURMA	OTHERS	TOTAL
1986	Consumption	1,280	120	170	15	18	30	15	130	110	255	0	16	2,159
	Production	219	0	55	0	8	400	0	29	65	259	0	0	1,035
	Import	1,061	120	115	15	10	0	115	125	45	0	0	16	1,622
	Export	0	0	0	0	0	370	100	24	0	4	0	0	498
1987	Consumption	1,400	150	200	18	18	30	10	140	115	265	0	16	2,362
	Production	150	0	50	0	8	500	0	220	70	280	10	0	1,288
	Import	1,250	150	150	18	10	0	30	70	45	0	0	16	1,739
	Export	0	0	0	0	0	470	20	150	0	15	10	0	665
1988	Consumption	1,431	160	214	20	19	31	10	150	117	275	0	16	2,443
	Production	190	0	55	0	8	500	0	300	75	290	70	0	1,488
	Import	1,241	160	159	20	11	0	10	0	42	0	0	16	1,659
	Export	0	0	0	0	0	469	0	150	0	15	70	0	704
1989	Consumption	1,500	165	227	21	19	31	10	155	121	285	0	16	2,550
	Production	170	0	60	0	8	500	0	300	80	300	120	0	1,538
	Import	1,330	165	167	21	11	0	10	0	41	0	0	16	1,761
	Export	0	0	0	0	0	469	0	145	0	15	120	0	749
1990	Consumption	1,560	170	244	21	20	32	10	160	124	295	0	16	2,652
	Production	140	0	60	0	8	530	0	300	85	320	125	0	1,568
	Import	1,420	170	184	21	12	0	10	0	39	0	0	16	1,872
	Export	0	0	0	0	0	498	0	140	0	25	125	0	788

Table 5-4-2 Indonesian Methanol Imports by Country of Origin
1984 - 1986

(Unit: t)

Year	1984	1985	1986
Saudi Arabia	46,011	56,700	54,043
Singapore	8,786	16,718	37,243
Mexico	2,770	11,212	33,700
New Zealand	1,785	15,940	13,939
Canada	31,579	6,750	49
Japan	93	3,417	904
Other countries	2,820	6,027	1,816
TOTAL	93,844	116,764	141,693

Source : Central Bureau of Statistice (BPS)

Table 5-4-3 Breakdown of Demand for Methanol in 1987

	U.S.A	W. Europe	Japan
Formaline	31.3%	41.6%	48.0%
Chloreomethane	7.7	6.8	4.5
DMT	3.1	3.1	2.8
Methylamine	2.8	3.8	4.0
MMA	3.4	3.0	7.3
Acetic acid	9.4	6.1	8.5
Solvent	7.7	3.5	3.3
MTBE	21.5	6.1	-
Gasoline blend	0.2	9.9	-
Others	12.9	16.1	21.6
TOTAL	100.0	100.0	100.0
Demand (10^3 t/y)	4,800	4,347	1,436

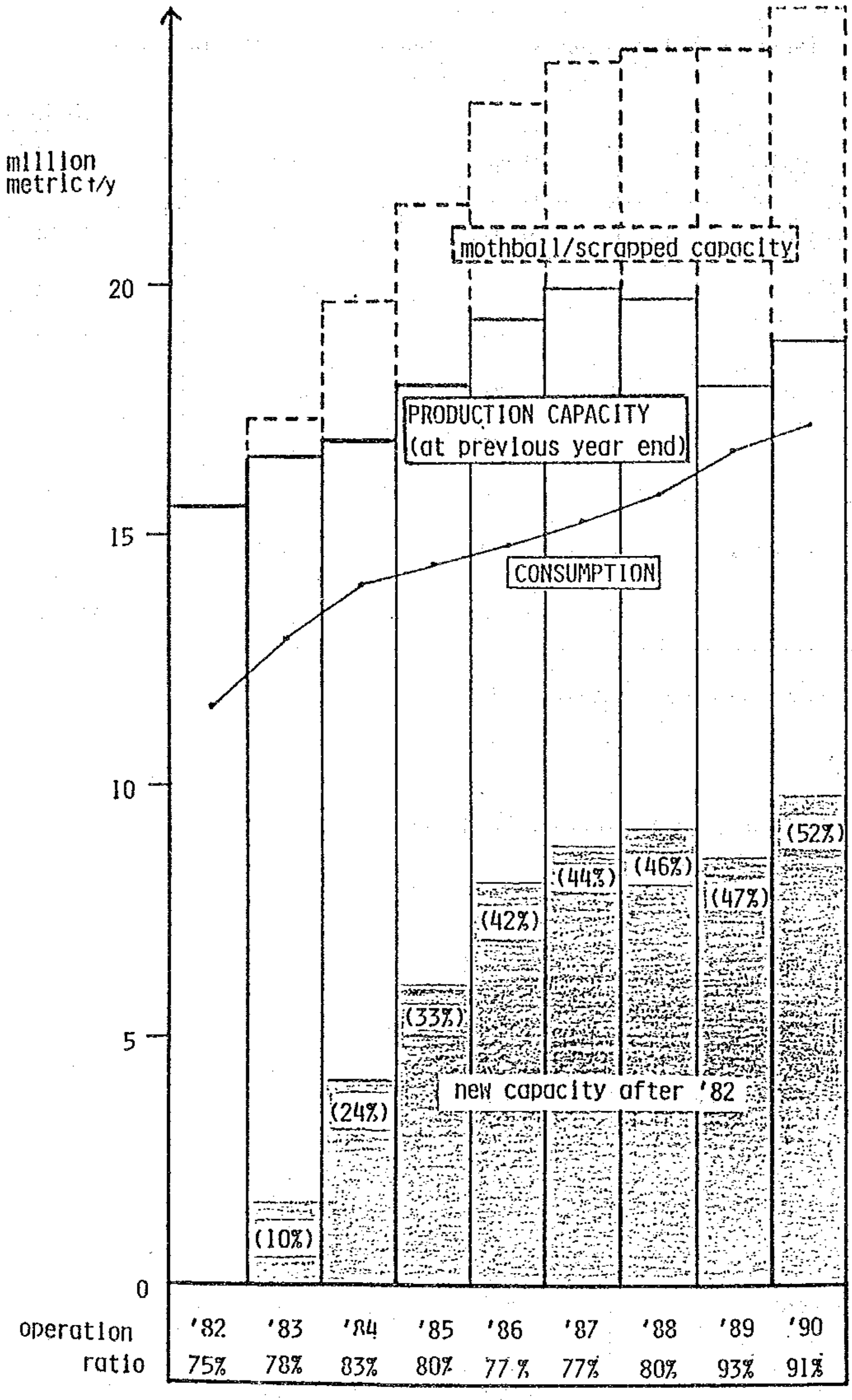


Fig. 5-4-1 World Methanol Balance

Table 5-4-4 Projected Fertilizer Consumption
1983 - 1988

(Unit: 1000 t)

Year	Urea	TSP/DAP	ZA	KCL	Other NPK	Total
1988	3,290	1,255	589	592	37	5,763
1989	3,454	1,318	618	621	39	6,050
1990	3,627	1,384	649	652	41	6,353
1991	3,809	1,453	681	686	43	6,672
1992	3,999	1,526	715	720	45	7,005

Data processed by Data Consult Inc.

Table 5-4-5 Fertilizer Production
1983 - 1987

(Unit: t)

Year	Urea	TSP/DAP	ZA	Total
1983	2,206,133	783,616	108,021	3,197,770
1984	2,764,648	1,001,781	302,127	4,068,556
1985	3,457,673	1,007,070	475,581	4,940,324
1986	4,019,225	1,116,909	581,648	5,717,782
1987	4,041,076	1,203,606	560,601	5,805,283

Source : Directorate General of Basic Chemical Industries.

Table 5-4-6 Fertilizer Production by Company
1983 - 1987

(Unit: t)

Company	Urea	TSP/DAP	ZA	Total
PT. P U S R I	1,466,712	-	-	1,466,712
PT. PUPUK KUJANG	552,089	-	-	552,089
PT. ASEAN ACEH FERTILIZER	572,190	-	-	572,190
PT. PUPUK ISKANDAR MUDA	588,742	-	-	588,742
PT. PUPUK KALTIM	861,343	-	-	861,343
PT. PETROKIMIA GRESIK	-	1,203,606	560,601	1,764,207
TOTAL	4,041,076	1,203,606	560,601	5,805,283

Source : Directorate General of Basic Chemical Industries.

5-5 PROSPECTS FOR INTRODUCING FUEL METHANOL

5-5-1 Introduction

The purpose of this section (5-5) is to clarify the prospects for introducing fuel methanol into future Indonesian energy markets. The section has two main parts. The first one deals with the possibility of introducing fuel methanol into the market through assuming two scenarios as discussed in Section 5-3. The second one presents the prospects for introducing fuel methanol mainly based upon the forecast on crude oil prices.

5-5-2 Methodology of Evaluation

The possibility of introducing fuel methanol in the future is evaluated by using LP model, following BPPT report. In other words, introducing methanol is evaluated to be possible (or justifiable) only if profits retained from supplying fuel methanol manufactured from Banko coal are larger than those from supplying only petroleum products (gasoline, kerosene and diesel fuel oil) from the view point of the Indonesian economy.

The profits are defined as an amount given from the difference between sales revenues (including exports) and supply cost. In addition, foreign exchange earnings are used for evaluating the possibility of introducing methanol, which means that a case is evaluated to be possible from the national view point if it shows earning a larger amount of foreign currency than other.

An LP model, containing a flow of crude oil and petroleum products in Indonesia, has been developed to evaluate the advantages (or dis-advantages). Main matrix of the model consists of around 2,000 equations and 3,500 variables (Table 5-5-1). The flow of the model has four main parts, including crude oil production, refineries, domestic demand for petroleum products, and methanol production (Fig. 5-5-1, 5-5-2). Explanation of the model in more details is found in the Appendix.

Table 5-5-1 Main Matrix of LP Model

Equation \ Structural Variables	Crude Oil: Production	Crude Oil: Export	Crude Oil: Domestic Trans-portation	Refineries: Crude Oil Input	Refineries: Refining Unit	Refineries: Refining Unit	Refineries: Blending	Refineries: Oil Products	Refineries: Oil Products Export	Products trans-portation	Domestic Demand	Methanol Trans-portation	Methanol Production	(Type)
Objective Function (Profit)	- Production Cost	+ Export Price	- Trans-portation Cost		- Refining Cost	- Refining Cost			+ Export Price	- Trans-portation Cost	+ Sales Price	- Trans-portation Cost	- Production Cost	= Max.
Crude Oil Volume Balance														
Crude Oil Volume	+	-	-											= 0
Material Balance in Refineries														
Material Balance 1				+	-									= 0
Material Balance 2					+	-								= 0
Unfinished Products						+	-							= 0
Oil Product Production							+	-						= 0
Oil Product Delivered								+	-	-				= 0
Refining Unit														
Processed Volume					+	+								< Capa.
Own use					-	-								= 0
Product Specification														
Max.							+	-						< 0
Min.							+	-						> 0
Balance of Transported Volume														
Crude Oil			+	-										= 0
Oil Products										+	-			= 0
Methanol											-	+		= 0
Methanol														
Methanol Production												-	+	= 0
Constraint Conditions	Production Level	Exports Level			Processing Capacity	Processing Capacity		Product Specifi-cation			Demand Level		Production Level	

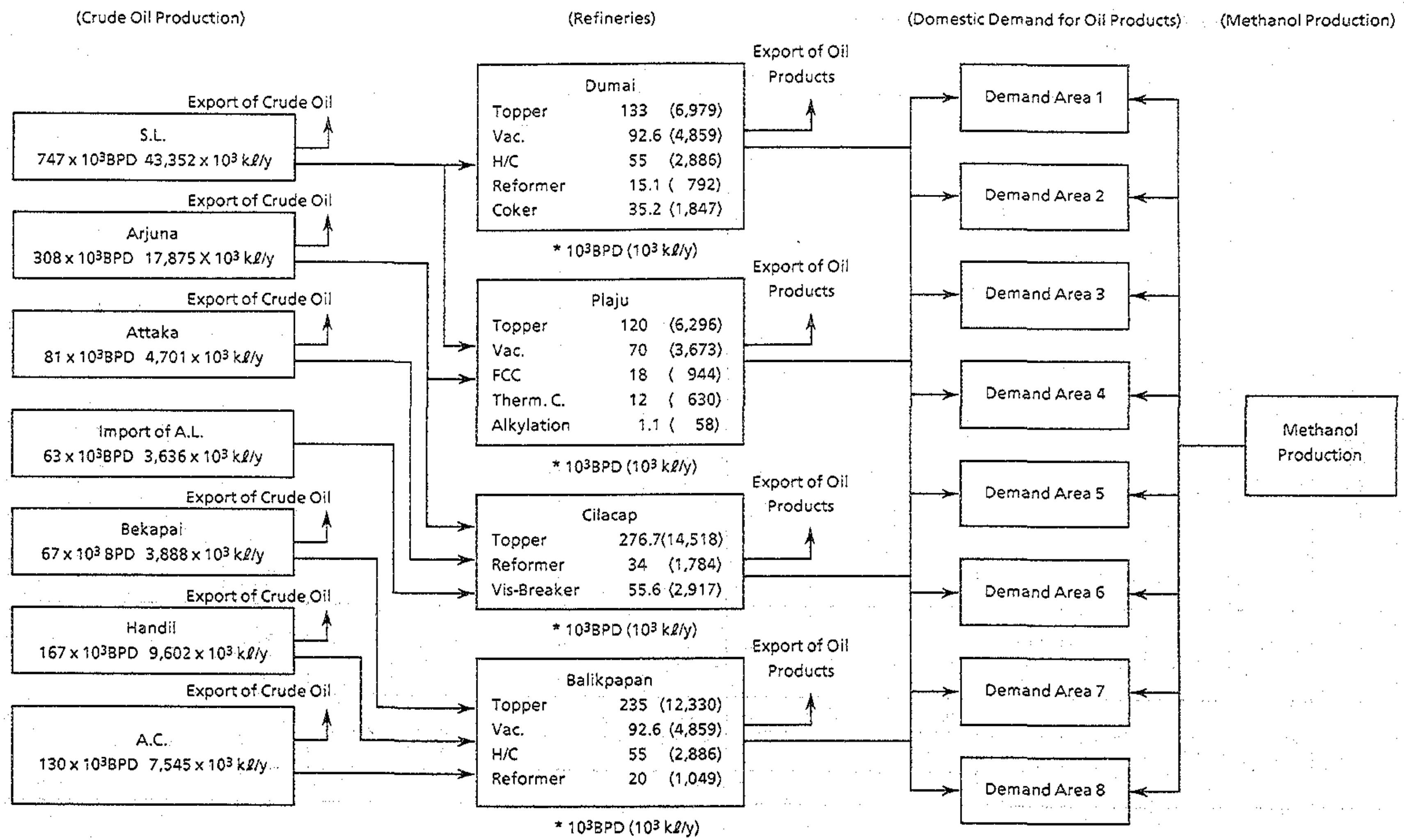
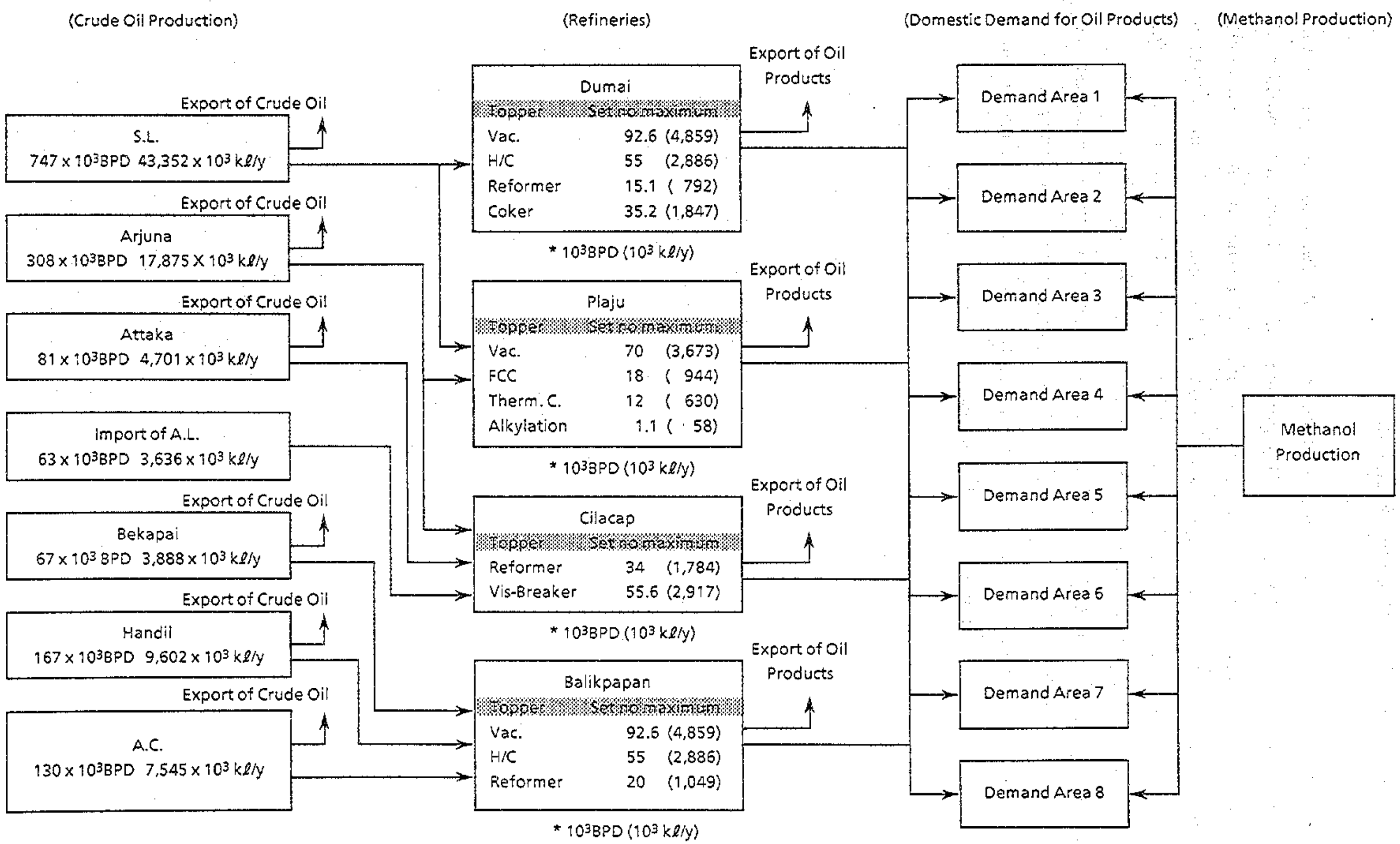


Fig. 5-5-1 Flow of LP Model in Indonesia (Existing Capacity Case)



NOTE: Refining capacity were expanded in dotted part (░░░░)

Fig. 5-5-2 Flow of LP Model in Indonesia (Expanded Capacity Case)

5-5-3 Forecast on Demand for Petroleum Products

The BPPT report mentioned above gives us four cases of demand for petroleum products in Indonesia for the future. For the purpose of our study, we consider it appropriate to use two "reduced oil use" cases of both H scenario and L scenario mainly because "reduced oil use" is supposed to be one of the most important criteria for the Indonesian Government evaluating energy projects. Figures on demand for petroleum products in 2000, 2005, and 2010 are shown in Table 5-5-2, 5-5-3.

In the BPPT report, introducing CNG is recommended to save petroleum products. To observe LPG possibilities is also recommended. And further studies are suggested to check option such as methanol for cars. This study can be one of the most useful ones to be connected to the BPPT study on fuel methanol.

Table 5-5-2 Domestic Demand for Petroleum Products by Area (1/2)

H Scenario

(Unit: 1,000 kℓ/y)

(H2000)

	LPG	Gasoline	Kerosene	ADO	IDO	Fuel Oil	Total
Demand Area 1	151.3	773.7	1,089.1	1,350.9	286.5	238.8	3,890.3
Demand Area 2	53.9	465.6	612.6	948.3	201.1	39.8	2,321.3
Demand Area 3	1,146.5	2,636.1	3,403.3	2,782.2	590.2	573.1	11,131.4
Demand Area 4	209.4	807.9	1,351.6	957.2	203.0	115.4	3,644.5
Demand Area 5	433.3	1,287.2	2,187.8	1,476.1	313.1	801.9	6,499.4
Demand Area 6	0	335.5	427.8	751.5	159.4	0	1,674.2
Demand Area 7	80.9	438.2	515.4	465.2	98.7	220.9	1,819.3
Demand Area 8	0	95.9	136.1	214.7	45.5	0	492.2
Total	2,075.3	6,840.1	9,723.7	8,946.1	1,897.5	1,989.9	31,472.6

(H2005)

	LPG	Gasoline	Kerosene	ADO	IDO	Fuel Oil	Total
Demand Area 1	238.7	861.3	1,055.8	1,548.7	328.5	269.0	4,302.0
Demand Area 2	85.0	518.3	593.9	1,087.2	230.6	44.8	2,559.8
Demand Area 3	1,808.4	2,934.6	3,299.2	3,189.8	676.6	645.6	12,554.2
Demand Area 4	330.3	899.4	1,310.3	1,097.5	232.8	130.0	4,000.3
Demand Area 5	683.4	1,433.0	2,120.9	1,692.3	359.0	903.4	7,192.0
Demand Area 6	0	373.5	414.8	861.6	182.8	0	1,832.7
Demand Area 7	127.5	487.8	499.6	533.3	113.1	248.8	2,010.1
Demand Area 8	0	106.7	132.0	246.2	52.2	0	537.1
Total	3,273.3	7,614.6	9,426.5	10,256.6	2,175.6	2,241.6	34,988.2

(H2010)

	LPG	Gasoline	Kerosene	ADO	IDO	Fuel Oil	Total
Demand Area 1	214.3	1,007.2	1,150.6	1,793.4	380.4	316.9	4,862.8
Demand Area 2	76.3	606.1	647.2	1,258.9	267.0	52.8	2,908.3
Demand Area 3	1,623.6	3,431.8	3,595.6	3,693.6	783.5	760.5	13,888.5
Demand Area 4	296.5	1,051.8	1,427.9	1,270.8	254.4	153.2	4,454.6
Demand Area 5	613.6	1,675.8	2,311.4	1,959.6	415.7	1,064.2	8,040.3
Demand Area 6	0	436.8	452.0	997.6	211.6	9	2,098.0
Demand Area 7	114.5	570.5	544.5	617.6	131.0	293.1	2,271.2
Demand Area 8	0	124.8	143.8	285.0	60.5	0	614.1
Total	2,938.8	8,904.7	10,273.0	11,876.5	2,504.1	2,640.7	39,137.98

Table 5-5-2 Domestic Demand for Petroleum Products by Area (2/2)

L Scenario

(Unit: 1,000 kℓ/y)

(L2000)

	LPG	Gasoline	Kerosene	ADO	IDO	Fuel Oil	Total
Demand Area 1	152.5	680.4	1,062.8	1,127.4	239.1	220.7	3,482.9
Demand Area 2	54.3	409.4	597.8	791.4	167.8	36.8	2,057.5
Demand Area 3	1,155.3	2,318.1	3,321.0	2,321.8	492.5	529.7	10,138.4
Demand Area 4	211.0	710.4	1,318.9	798.8	169.4	106.7	3,315.2
Demand Area 5	436.6	1,131.9	2,134.9	1,231.9	261.3	741.2	5,937.8
Demand Area 6	0	295.0	417.5	627.2	133.0	0	1,472.7
Demand Area 7	81.5	385.3	502.9	388.2	82.4	204.2	1,644.5
Demand Area 8	0	84.3	132.8	179.2	38.0	0	434.3
Total	2,091.2	6,014.8	9,488.6	7,466.9	1,583.5	1,839.3	28,483.3

(L2005)

	LPG	Gasoline	Kerosene	ADO	IDO	Fuel Oil	Total
Demand Area 1	267.6	697.0	967.0	1,191.7	252.7	232.5	3,608.5
Demand Area 2	95.3	419.4	543.9	836.5	177.4	38.7	2,111.2
Demand Area 3	2,027.7	2,374.8	3,021.7	2,454.3	520.7	557.9	10,957.1
Demand Area 4	370.3	727.8	1,200.1	844.4	179.1	112.3	3,434.0
Demand Area 5	766.3	1,159.6	1,942.5	1,302.1	276.2	780.7	6,227.4
Demand Area 6	0	302.2	379.8	662.9	140.6	0	1,485.5
Demand Area 7	143.1	394.8	457.6	410.4	87.1	215.0	1,708.0
Demand Area 8	0	86.4	120.8	189.4	40.1	0	436.7
Total	3,670.3	6,162.0	8,633.4	7,891.7	1,673.9	1,937.1	29,968.4

(L2010)

	LPG	Gasoline	Kerosene	ADO	IDO	Fuel Oil	Total
Demand Area 1	248.8	753.0	1,002.3	1,244.6	264.0	235.2	3,747.9
Demand Area 2	88.6	453.1	563.8	873.7	185.3	39.2	2,203.7
Demand Area 3	1,885.3	2,565.6	3,132.0	2,563.3	543.8	564.6	11,254.6
Demand Area 4	344.3	786.3	1,243.8	881.9	187.0	113.7	3,557.0
Demand Area 5	712.5	1,252.8	2,013.4	1,359.9	288.5	790.0	6,417.1
Demand Area 6	0	326.5	393.7	692.4	146.9	0	1,559.5
Demand Area 7	133.0	426.5	474.3	428.6	90.9	217.6	1,770.9
Demand Area 8	0	93.3	125.2	197.8	41.9	0	458.2
Total	3,412.5	6,657.1	8,948.5	8,242.2	1,748.3	1,960.3	30,968.9

Table 5-5-3 Demand for Petroleum Products in Indonesia

(H Case)

(Unit: 1,000 kℓ)

	1986	(%)	1991	(%)	2000	(%)	2005	(%)	2010	(%)	1986-2000 (%/y)	2000-2010 (%/y)
LPG	453.9	2.1	758.3	3.0	2,075.3	6.6	3,273.3	9.4	2,938.8	7.5	11.5	3.5
Gasoline	4,491.6	21.0	5,652.5	22.0	6,840.1	21.7	7,614.6	21.8	8,904.8	22.8	3.0	2.7
Kerosene	8,437.6	39.4	9,418.5	36.7	9,723.7	30.9	9,426.5	26.9	10,273.0	26.2	1.0	0.6
ADO	5,474.4	25.6	6,884.4	26.8	8,946.1	28.4	10,256.6	29.3	11,876.5	30.3	3.6	2.9
IDO	1,161,.2	5.4	1,460.3	5.7	1,897.5	6.0	2,175.6	6.2	2,504.1	6.4	3.6	2.8
Fuel Oil	1,397.8	6.5	1,472.0	5.7	1,989.9	6.3	2,241.6	6.4	2,640.7	6.7	2.6	2.9
Total	21,416.5	100.0	25,646.0	100.0	31,472.6	100.0	34,988.2	100.0	39,137.9	100.0	2.8	2.2

(L Case)

(Unit: 1,000 kℓ)

	1986	(%)	1991	(%)	2000	(%)	2005	(%)	2010	(%)	1986-2000 (%/y)	2000-2010 (%/y)
LPG	453.5	2.1	704.2	2.8	2,091.2	7.3	3,670.3	12.2	3,412.5	11.0	11.5	5.0
Gasoline	4,484.9	21.1	5,511.2	22.2	6,014.8	21.1	6,162.0	20.6	6,657.1	21.5	2.1	1.0
Kerosene	8,434.4	39.8	9,413.2	37.8	9,488.6	33.3	8,633.4	28.8	8,948.5	28.9	0.8	-0.6
ADO	5,280.0	24.9	6,406.0	25.8	7,465.9	26.2	7,891.7	26.3	8,242.2	26.6	2.5	1.0
IDO	1,180.0	5.6	1,383.1	5.6	1,583.5	5.6	1,673.9	5.6	1,748.3	5.6	2.1	1.0
Fuel Oil	1,376.1	6.5	1,453.9	5.8	1,839.3	6.5	1,937.1	6.5	1,960.3	6.3	2.1	0.6
Total	21,208.9	100.0	24,871.6	100.0	28,483.3	100.0	29,968.4	100.0	30,968.9	100.0	2.1	0.8

5-5-4 Possibility of Introducing Fuel Methanol

As mentioned in Section 5-5-2, advantages (or dis-advantages) depend upon the difference between the cost of introducing fuel methanol (supply cost of methanol) and the profits of expanded exports of crude oil and petroleum products caused by introducing methanol into the domestic market.

Two kinds of calculations are made in this study.

The first one is made to know how the amount of methanol introduced is changing according to crude oil prices.

Fig. 5-5-3 shows the results of the calculation. It is made through using figures on demand for petroleum products in H2000, and does not take into account the expansion of refining capacity in 2000. In other words, the evaluation is made on importing petroleum products and supplying fuel methanol, not on expanding refineries.

In the case of 155 $/t of methanol supply price, 881,000 kℓ of gasoline is substituted for methanol at the crude oil price of 29 $/bbl, 996,000 kℓ at 30 $/bbl, and more than 1,000,000 kℓ at 31, 32 and 33 $/bbl. At more than 30$ of crude oil prices, kerosene is substituted for methanol with increasing volume according to higher prices.

In the case of 165 $/t of methanol supply price, 881,000 kℓ of gasoline is substituted for methanol at the crude oil price of 30 $/bbl and 31 $/bbl, 996,000 kℓ at 32 $/bbl, and more than 1,000,000 kℓ at 33, 34 and 35 $/bbl. At more than 32 $/bbl of crude oil prices, substitution of kerosene for methanol begins.

In the case of 175 $/t of methanol supply price, 881,000 kℓ of gasoline is substituted for methanol at the crude oil price of 33 $/bbl, 996,000 kℓ at 34 $/bbl, and more than 1,000,000 kℓ at 35, 36 and 37 $/bbl. At more than 34 $/bbl of crude oil prices, kerosene is substituted for methanol.

The second calculation is for comparing the profits of cases, including one (or two) case of supplying only petroleum products and three cases of supplying fuel methanol in addition to petroleum products for 2000, 2005, and 2010 (see Table 5-5-4, 5-5-5). Crude oil prices used here are the same as those shown in H scenario and L scenario in the BPPT report. On the other hand, 155, 165 and 175 $/t are used as methanol supply price (FOB Palembang) for each year.

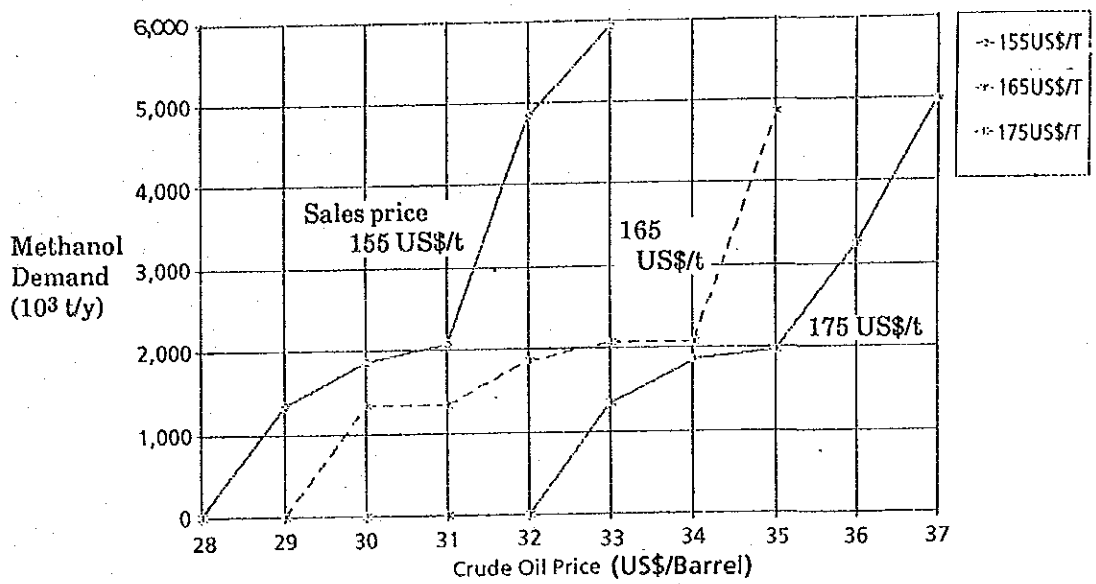


Fig. 5-5-3 Fuel Methanol Demand vs Oil Price

Table 5-5-4 Fuel Methanol Introduced

(H Scenario)

Case	H2000-0	H2000-1	H2000-2	H2000-3	H2000-4	H2005-0	H2005-1	H2005-2	H2005-3	H2005-4	H2010-0	H2010-1	H2010-2	H2010-3	H2010-4
	(Reference)				Expanding refinery	(Reference)				Expanding refinery	(Reference)				Expanding refinery
Demand for Petroleum Products	H-2000	H-2000	H-2000	H-2000	H-2000	H-2005	H-2005	H-2005	H-2005	H-2005	H-2010	H-2010	H-2010	H-2010	H-2010
Crude Oil Price (US$/bbl)	28	28	28	28	28	36	36	36	36	36	45	45	45	45	45
Methanol Supply Cost (US$/t)		175	165	155			175	165	155			175	165	155	
Amount of Profits (US$ million)	12,908	12,872	12,889	12,906	12,930	17,144	17,210	17,280	17,405	17,189	21,753	22,643	22,895	23,148	21,852
Fuel Methanol Introduced (1,000 kℓ/y)	0	2,091	2,096	2,096	0	0	7,282	11,744	20,849	0	0	31,169	31,630	31,630	0

Table 5-5-5 Fuel Methanol Introduced

(L Scenario)

Case	L2000-0	L2000-1	L2000-2	L2000-3	L2005-0	L2005-1	L2005-2	L2005-3	L2010-0	L2010-1	L2010-2	L2010-3
	(Reference)				(Reference)				(Reference)			
Demand for Petroleum Products	L-2000	L-2000	L-2000	L-2000	L-2005	L-2005	L-2005	L-2005	L-2010	L-2010	L-2010	L-2010
Crude Oil Price (US$/bbl)	21	21	21	21	25	25	25	25	29	29	29	29
Methanol Supply Cost (US$/t)		175	165	155		175	165	155		175	165	155
Amount of Profits (US$ million)	9,228	9,225	9,226	9,226	11,408	11,398	11,401	11,404	13,542	13,525	13,536	13,536
Fuel Methanol Introduced (1,000 kℓ/y)	0	48	48	48	0	330	330	330	0	1,281	1,348	1,370

In H2005 and H2010, introducing methanol shows larger profits in all cases of methanol supply costs than the case of supplying only petroleum products in Indonesia. This means the introduction of methanol into the market will be possible in 2005 and 2010 from the economic view point of Indonesia.

In H2000, foreign exchange earnings in the case of introducing fuel methanol are bigger than the case of supplying only petroleum products mainly because it does not have any importation of petroleum products, although its profit are slightly smaller than the case of petroleum products only. Also, at least the profits of H2000-3 is almost as large as that of H2000-0. Such comparisons can justify the Indonesian Government to introduce fuel methanol into the market in 2000 to save foreign currency.

On the other hand, the profits of introducing methanol are larger only in L2010-3 than the case of supplying only petroleum products (In L scenario, there will be no need to expand refining capacity in 2000, 2005, and 2010). The profits of all cases in L scenario of introducing methanol, however, are almost the same as the cases of supplying only petroleum products. Therefore, introducing methanol can be justified by the energy policy of the Indonesian Government.

Fig. 5-5-4 shows the possible amount of introducing fuel methanol in 2000, 2005, and 2010.

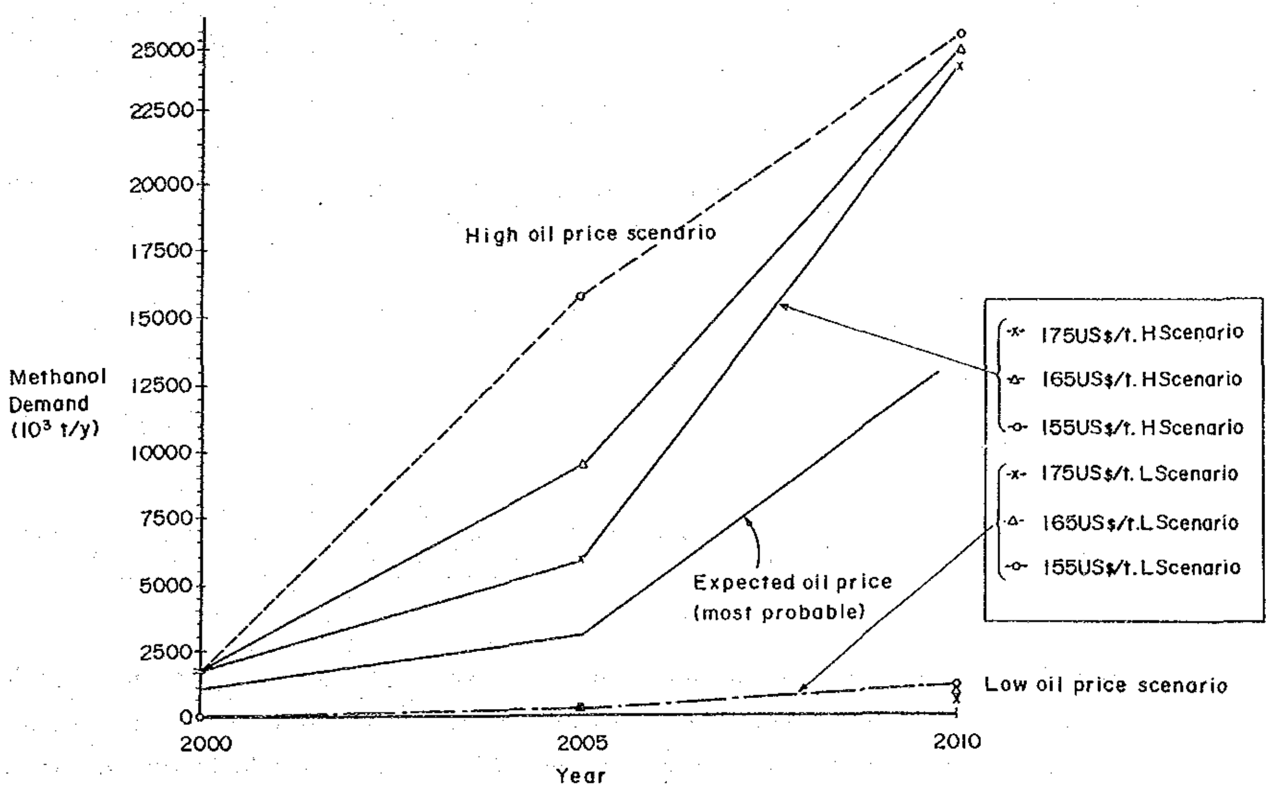


Fig. 5-5-4 Fuel Methanol Demand by Year

5-5-5 Prospects for Introducing Fuel Methanol

Although recent crude oil price has been kept at a low level, it is generally forecast to go up again in the 1990s, mainly due to the expanding share of future OPEC oil supply. Issues arise from the differences in experts' views on how fast it is going up.

USDOE (the U.S. Department of Energy) disclosed the report entitled "Long Range Energy Projections to 2010" in July, 1988, in which crude oil prices were forecast as follows:

Table 5-5-6 Summary of Long Range Energy Scenarios

	World Oil Price ($1986 per barrel)			Economic Growth 1986-2010 (%/y)	
	1990	2000	2010	U.S.	Free World
Reference Case					
Assumes no unusual decline in world energy or oil demand and midrange energy supply and efficiency potential.	$20	$33	$53	2.8%	2.8%
Low Free World Economic Growth					
Reference Case assumptions but free world economic growth exogenously decreased by about 0.5 percen per year.	$19	$29	$44	2.3%	2.3%
High Free World Economic Growth					
Reference Case assumptions but free world economic growth exogenously increased by about 0.5 percent per year.	$22	$37	$62	3.3%	3.3%
Low Free World Energy Efficiency					
Reference Case assumptions but free world overall end-use energy efficiency decreased by 10 percent.	$21	$36	$61	2.7%	2.7%
High Free World Energy Efficiency					
Reference Case assumptions but free world overall end-use energy efficiency increased by 10 percent.	$18	$29	$46	2.8%	2.8%
Low Free World Energy Resources					
Reference Case assumptions but free world undiscovered oil and natural gas resources decreased by 20 percent.	$21	$35	$56	2.7%	2.7%
High Free World Energy Resources					
Reference Case assumptions but free world undiscovered oil and natural gas resources increased by 20 percent.	$19	$31	$50	2.8%	2.8%

Crude oil prices presented in the table result from the different seven scenario assumptions. Explanations can be found in the table. According to the projection, world oil prices will rise slowly in real terms until the early to middle 1990's. After the period, a tighter international oil market is projected to place significant upward pressure on world oil prices. By 1990, oil prices are expected to between $18 and $22 per barrel (US$1986). Beyond 1990, price projections are much more uncertain, but prices are expected to be between $29 and $37 in 2000 and between $44 and $62 in 2010.

IEE, Japan (the Institute of Energy Economics, Japan) made a forecast on demand and supply of energies and their prices in the world in December, 1988. According to the forecast, crude oil price will rise to $37.7 in 2000 and $50.3 in 2010 in Case A, and to $28.4 in 2000 and $48.4 in 2010 in Case B. In Case A, it assumed that OPEC's production capacity will increase moderately, electric power generated by nuclear and hydro will expand according to present development plans, and oil export from CPEs will decrease. In Case B, it is assumed that OPEC's production capacity will increase rather rapidly, electric power generated by nuclear and hydro will reach the maximum level expected at the present time, and oil export from CPEs will decrease slightly.

Crude oil prices used for projecting demand for fuel methanol were the results of the average of the H scenario and the L scenario of BPPT report mentioned before. It is considered to be the most probable prediction of oil prices (Table 5-5-7). As can be seen, the average prices are lower than projected prices of USDOE and IEE, Japan, and therefore these prices are considered to be the more conservative ones among recently projected prices. It may be appropriate to estimate that the most probable demand for fuel methanol will be around the average demand for both H scenario and L scenario if crude oil prices are the average of those of two scenarios.

Table 5-5-7 Forecasts on Crude Oil Prices

(Unit: $/bbl)

	2000	2005	2010
L Scenario	21.0	25.0	29.0
H Scenario	28.0	36.0	45.0
Average (most probable)	24.5	30.5	37.0
USDOE	29 - 37		44 - 62
IEE, Japan	28 - 38		48 - 50

In a little more details, the most probable prices of crude oil are 24.5 $/bbl in 2000, 30.5 $/bbl in 2005, and 37 $/bbl in 2010, and they are the mean of crude oil prices in H scenario and L scenario mentioned above. Demand for fuel methanol is considered in this study to be corresponding to the average of demand for fuel methanol in H scenario and L scenario and the results are shown in Table 5-5-8. They are 850,000 t in 2000, 3,030,000 t in 2005, and 12,915,000 t in 2010.

Table 5-5-8 Prospects for Fuel Methanol Introduced

(Unit: 1,000 kℓ)

	2000	2005	2010
L Scenario	48	330	1,281
H Scenario	2,091	7,282	31,169
Average (*)	1,070	3,806	16,225
Average (1,000 t)	850	3,030	12,915

(*) In the case of 175 $/t

5-5-6 Issues for the Introduction of Fuel Methanol into Indonesian Market

Discussion in this section has so far identified the market potential for the fuel methanol. Discussion on the conditions for introducing fuel methanol included cost assumptions for various energy sources to present the competitive edge of the Project vis-à-vis other options.

There are however several points to be clarified to justify the implementation of the Project. These include: environmental implications, financial implications and economic implications of the project. Chapters 12, 14, 15 and 16 will be devoted to a discussion of such issues.

6. COAL RESOURCES AND CONCEPTUAL ESTIMATED MINING COST OF SELECTED AREA IN BANKO COAL FIELD

6-1 COAL RESOURCES IN BANKO COAL FIELD

6-1-1 Outline of Exploration Activity Performed by Shell and Summary of Their Survey Results

(1) Outline of the South Sumatra Coal Field

The Central and South Sumatra Neocene Coalfield Basins are considered to be parts of one very large depositional environment.
These basins are interpreted as "foreland basins" or "backdeeps" of the Alpidic fold chain ("island arc") and are parallel to the subduction zone on the plate boundary from south-west of Sumatra to south of Java.
The development of these foreland basins started locally at the Oligocene/Miocene boundary. During the lower Miocene, the basins developed as a whole, with continental fluvial, limnic lagoonal and open marine phases. Much of the sedimentary material filling the basins is derived from the contemporaneous volcanicity of the "volcanic arc" south-west of the basins.
The very extensive and economically interesting coal deposits in this region were deposited during the Tertiary epoch of geological history by a rising and subsiding landmass controlled and influenced by comparatively young events related to plate tectonics, young volcanicity within the region of present Sumatra island, worldwide sea level fluctuations and climatic changes. There are two center coal mining areas in Sumatra, now. One of them is Ombilin Coal Mine and the other one is Bukit Asam Coal Mine.
South Sumatra coalfield is one of the most important coalfields in Indonesia together with Central Sumatra. It exists in the south of Tigapuluh and extends to the eastern coast of Sumatra Island through an openfield sharing the borders with the Barisan Mountains Range by fault, which uplifted in the Tertiary epoch.
The coalfield is drawn the line of demarkation with Lampung High in south-east part and Sunda mass is close to the coalfield at east-northeast part. The basin is found within the above area and divided into two parts, that is, Central Palembang sub-basin and South Palembang sub-basin of Lematang depressed ground, based on basement structure. (see Fig. 3 of Attachment 6-1)

Almost all of coal deposits are formed within the above mentioned sub-basins. Tertiary sedimentary formation is lifted up by fault, the formation is thickest at the fringe of the Barisan Mountains Range, and there is general tendency to be getting thiner and thiner toward north-east direction.

Coal seams exist among any formations, however, the most minable coal seams belong to the Muara Enim formation.

The Muara Enim formation is sub-divided into four units, i.e. M_1 - M_4 of which the M_2 and M_4 sub-divisions of Upper Miocene age are most important economically. The M_1 sub-division of which thickness is 100 - 300 meters is the oldest unit of the said formation geologically two coal seams, Merapi (D) and Kladi coal seam exist among the M_1 sub-division, both of them have no economic value.

The rocks of M_1 sub-division are brown and gray sand, silt and, clay with minor glaucanitic sand.

The M_2 sub-division is the most important one, from the economical point of view. It contains the Mangus (A), the Suban (B) and the Petai (C) coal seam complex (from the top to the bottom) which varys in thickness from 30 meters to 50 meters.

Several good marker features in the form of characteristically positioned clay bands in the Suban (B) coal seam and pelletoidal clay horizon (volcanic tuff) between A_1 and A_2 coal seam are found in the coal seams of M_2 sub-division. The accompanying rocks are limnic water sediments with brown to brown-gray clay and sandy clay, brown-grey fine to medium sand and some green-grey fine-grained sand in lower parts, and only minor participational volcanic components.

The M_3 sub-division (40 - 120 meters thickness) is basically a sand and silt complex, more fluvial than limic or lagoonal/brockish in the upper part, underlain by blue-green clay, containing a characteristic siderite module horizon just above the A_1 coal seam. There are a few thin coal seams (Burung, Benuang) and thin coal layers, but those coal seams and layers have no economic value.

The M_4 sub-division (120 - 200 meters thickness) is the uppermost and stratigraphically youngest sequence of the Muara Enim Foundation. It contains the so-called "hanging layers" including the Lematang coal seams (the Jelawatan coal seam in the eastern part) and 10 - 30 meters thickness of the Enim coal seam complex. Both coal seams have an interesting resource potential within reacheable range by surface mining.

The predominant rocks are blue-green tuffaceous (volcanics) clay and sandy clay, some dark-brown coaly clay, some white and grey fine to coarse sand with occasional glauconite, indicating marine deltaic-fluvial conditions. A characteristic marker is a sand body, just below the Enim coal seam.

The M_4 coal contains about two third of the total coal resource of the South Sumatra Basin, however, those coal have higher moisture contents (up to 60% of the total volume) and are of a lower rank in terms of heating value, generally. On the contrary, the M_2 coal is lower in moisture content and has a higher heating value i.e. it has of a higher rank in coal maturity.

The geological and physical characteristics of the coal deposits in the South Sumatra basin are determined by the following tectonical structures.

a) The Lematang Valley between Gedong Agung and Gunung Agung follows a major tectonical zone probably a NE-SW striking transfer fault.

b) The Enim Valley is also the place of some tectonic lineament; as is the Air Niru Valley.

c) These linearment dissect the area across the "general strike of folding into four segments."

d) The following tectonic structures exist in the "West of Lematang segment (from south to north).

   Air Serelo Syncline (outside the project area)

   Lahat anticline
   South Arahan Syncline
   North Arahan Synclinorium
   North Arahan Syclinal Area
   Rather unknown structures north and west of Arahan Village

The Lematang-Enim Segment has moved relatively on the Lematang transfer fault about 3.3 km toward NE. There are the following tectonic structures. (from south to north).

a) The volcanic area of Bukit Serelo-Bukit Kendi, which appears to occupy anticlinal positions.

b) The large South Air Lawai Syncline, a direct easterly extension of the South Arahan Syncline

c) The anticlinal central structure of Muara Tiga Besar and Kecil, extending into the Bukit Asam dome structure in the east. This anticline bifurcates towards the west (about halfway south of Muara Tiga Besar), into southern, west to east striking, and northern north-west to south-east striking, branches. The synclinal structure of North Arahan exists in between. The south branch of the Muara Tiga anticline extends into the Arahan anticline from 2 km offset at the Lematang transfer fault.

d) The North Air Lawai synclinorium is complex and influenced by the western downward plunging extension of the Klawas anticline, and by the Air Lawai dome.

e) The Klawas anticline has a short (3.5 km) east north-east to west south-west strike, with steep flanks, and is developed only in the eastern portion of the Lematang-Enim segment; it sharply plunges down in the middle of the segment, causing some suspected anticlinal and dome structures within the North Air Lawai synclinorium.

f) The Air Laya domelike structure with north to south extension is connecting the Muara Tiga Anticline in the south with the Klawas anticline in the north. It is caused by an andesitic intrusion into the M_1 formation below the M_2 coal.

g) The Muara Lawai anticlinorium is poorly defined and appears to plunge and disappear towards the east, prior to reaching the Enim River.

h) The Muara Enim synclinorium is the most northern feature.

i) Fault zone is not so clear in the "Air Enim Lime" same as that in the Lematang lineament, but it seems as if the changing place of tectonic chracter and the anticlines and synclines hold more south-easterly directions.

j) The south-west part of the segment forms a synclinorium which strikes north-west - south, south-east largely, following the Upper Enim River, and, connecting the North to the South Air Lawai syncline and to the synclinal structures of West, Central and North West Banko.

k) The short NNW-SSE striking anticline of South Banko

l) There is a wide synclinorium at South East Banko - South Banko and Central Banko.

m) The domelike roundish anticlines of South West Banko and Kiahan - Banko lie on the north side.

n) A more distinct linear set of NE-SW striking anticlines stretches from Talang-Babat to Sungai Lilling, continuing to Klawas.

o) The Talang-Babat Anticline follows the Sungai-Tahan Syncline and the Sungai-Tahan domelike anticline (suspected of magmatic intrusion).

p) The Sungai Jeriji syncline and northerly adjacent anticline have NW-SE strike, but change strike to west and south-west, and then disappear in the west of the Suban Jeriji coal area.

q) The large but shallow northern synclinorium is a continution of the North Air Lawai and the Muara Enim synclinoriums to the west side.

r) There are several NNW-SSW and NNW-SSE striking faults, presumably transform faults.

The results of survey carried out by Shell are summarized in the following paragraphs.

(2) Outline of Exploration Activity Performed by Shell

The first systematic investigation on Banko coal field was carried out by the hands of Shell Mijonbow N.V., one of Indonesian Corporation of Royal Dutch Shell group which engaged in exploitation and export of Indonesian coal (hereinafter, referred to as Shell), under two years agreement on coal exploration work in South Sumatra concluded with Perum Tambang Batubara, the state-owned Coal Corporation (hereinafter, referred to as PTB) in October 1973.
Shell carried out a geological and geophysical survey, and drove 588 boreholes (about 9,000 meters in total length) on huge area of 71,450 km^2 at an enormous cost of about U.S.$ 20 million in 1974 and 1975.
Thereafter, Shell released the exploration right on 75% of the above-mentioned licensed area and concentrated their exploration activities into the following most promising area in May 1976 on the expiry of the contract. (see Fig. 1 and Fig. 2 of Attachment 6-1)

Northern Prospect
Pendopo Prospect

Southern Prospect
Enim Prospect

490 boreholes (about 12,000 meters in total length) were driven, 50 of pits and trenches were dug and mining tests were also performed in several places at a cost of U.S.$ 48 million through June 1976 to May 1978.
The exploration activities were concentrated upon Banko area especially North-West Banko area, and preliminary survey was carried out on Suban Jeriji area.

(3) Summary of Survey Results Performed by Shell

1) Banko Coal Area (in the narrow sense)

The coal area is situated between 3 - 9 km south-east of Tanjung Enim and has an advantage in existing in the closest area to the railway at Tanjung Enim over other areas explored by Shell. Banko coal area is subdivided into three blocks (see Fig. 5 of Attachment 6-1), i.e.

block A	:	North West Banko
block B	:	West Banko, the southern (south-westerly) extension of NW Banko
block C	:	Central Banko, east of the western part of West Banko and south of NW Banko

South and South East Banko coal area is 8 km further south and clearly separated from the above mentioned three blocks, therefore, described separately.

A) North West Banko, West Banko and Central Banko

The area is characterized by smooth hills in the northwest and low-lying swampy regions in the south-east. Small creeks drain to the Air Selingking or the Air Niru (river). Most of the area are covered by secondary forest but grasslands are dominant in the western and eastern regions. Only quite limited parts in some places within the said area are cultivated.

i) Exploration activity performed by Shell

The following number of holes, pits, trenches and test mining pits were driven or dug by Shell

		NW Banko	W Banko	C Banko
	cored	88		
	non-cored	49		
Boreholes	partially cored	6		
	re-drilled	18		
	Total	143	34	68
pit, trenches and test mining pits		37		1

ii) Tectonic structure

Major structural features, striking NW-SE and plunging to the NW influence the configuration of the deposit and the quality of the coal seams, i.e.

a) The Sungai Lilling (Killing) anticline adjoining the NW Banko Syncline
b) The North West Banko syncline
c) The Kiahan (or Banko) anticline with NW-SE-strike and with a steep NE-flank, showing dips up to 55° - the anticline is overthrusted to the north-east with an approximate maximum horizontal displacement of 150 meters.
d) The SW-Banko anticline, a circular domelike structure with pronounced plunge to the west and east
e) The synclinal, westerly dipping area of block B which is actually the eastern margin of the large South Air Lawai - Air Enim synclinorium.
f) The Talang-Babat anticline as a south-western extension of the Sungai Lilling anticlinal structure is asymmetric with a steep NE-flank showing dips up to 78° and a moderately inclined SW flank,

north-west and south-east plunging. Transverse major faults severly affect the SW flank.

g) The Central Banko syncline is surrounded by the Talang-Babat anticline in the north-east and the SW Banko anticline in south-west, whereas the south-east plunging Kiahan anticline causes undulations at the bottom of the syncline. The north-east part is also affected by a group of wrench faults which display a right-hand horizontal displacement of several hundred meters.

Major faulting is aligned on a north-east, south-west pattern. Intensive normal faulting with varying amounts of horizontal displacement is evident in the south-eastern part of the North-West Banko syncline and along the western flank of the Banko anticline.

Although the prevailing pattern of faulting shows a radial configuration NW-SE and NE-SW striking fault patterns predominate. Intense jointing and fracturing is also known to be present and will have consequence on mine slope stability.

NW Banko is probably one of the most severely structurally disturbed blocks in the South Sumatra coal field.

Dips of strata and coal seams within mining area will change between 6^{o} and 15^{o} and average will be about 8^{o}. The expected mining area in NW Banko is bounded by steep dip of coal seam (more than 15^{o}) in the north, and by faulting in the south, coal seam outcrops and faulting is exposed on the ground in the east, and minable area is limited by the thickness of overburden in the west.

Central Banko is structually very complicated. The average dip of the coal bearing sequence of the M_2 division of the Muara Tiga Formation are recorded by Shell to be within the range of 0^{o} to 15^{o}. Horizontal dislocation and vertical displacement of faulted blocks can be expected. West Banko, however, is structually less complex than Central and NW Banko.

iii) Coal and interburden thickness

Shell estimated coal and interburden thickness based on their survey results as follows:

	NW Banko (block A)						W Banko (block B)		C Banko (block C)			
	Max. (m)		Min. (m)		Average (m)		Western Part (m)		Northern Part (m)		Shouthern Part (m)	
Coal seam	Coal	Inter-burden	Coal	Inter-burden	Coal	Inter-burden	Coal	Inter-burden	Coal	Inter-burden	Coal	Inter-burden
Mangus 1 A_1	12.1		4.6		9.2		9.2		-		-	
		22.8		10.3		16.7		-		-		-
Mangus 2 A_2	11.8		8.4		10.4		6.3		-		-	
		15.3		11.4		13.3		-		-		-
Suban 1 B_1	13.7		9.5		12.5		10.3		18.7		13.4	
		12.3		1.3		6.9		-		-		-
Suban 2 B_2	5.5		4.2		-		13.7					
		43.5		28.1		36.3		-		-		-
Petai C	12.4		10.4		11.5		C_1 5.2 C_2 6.9		13.5		11.9	
Total (Coal)	55.1		37.1		43.6		51.6		32.2		25.3	

Preconditions:

Shell set the following conditions forth as a premise in calculating the above-mentioned thickness of coal and interburden.

a) final pit slope : less than 15°

b) coal seam exists among main faults continuously.

c) maximum sunk depth below the footwall of Petai coal seam is 100 meters.

d) extremely complicated structures are not in existence.

iv) Coal Quality

Average coal quality data of the said area and ash component analysis results presented by Shell are shown in Table 6-1-1 and Table 6-1-2, respectively. Shell pointed out that the coal quality deteriorates regionally from the north-west to the south and south-east.

v) Coal Reserves

Coal reserves are as follows:

a) NW Banko

	Coal reserves				Minable coal reserves					
	Final pit slope: 15°		Final pit slope: 20°		Final pit slope: 15°		Final pit slope: 20°		Average thickness	
	Coal million t	Waste million M^3	Coal million t	Waste million M^3	Coal million t	Waste million M^3	Coal million t	Waste million M^3	Coal (m)	Waste (m)
		147.37		126.78		147.37		126.78		41.7
Mangus 1 (A_1)	23.66		23.17		23.66		23.17		8.1	
		34.55		33.22		34.35		33.32		13.6
Mangus 2 (A_2)	28.50		28.02		28.50		28.02		8.6	
		27.91		27.19		27.91		27.19		10.6
Suban 1 (B_1)	39.48		38.58		39.48		38.52		10.2	
		20.18		19.98		20.18		19.98		6.7
Suban 2 (B_2)	14.95		14.90		14.95		14.90		3.8	
		107.53		105.77		51.57		51.40		26.3
Petai (C)	41.45		40.81		18.43		18.38		9.8	
Total	148.04	337.54	145.48	313.04	125.02	281.38	122.99	258.67		
Considering safety factor of 85%	128.5	354.7	123.7	330.1	106.3	296.0	104.6	273.1		
Stripping ratio	2.82 : 1		2.67 : 1		2.78 : 1		2.61 : 1			

b) W Banko (block B) and C Banko (block C)

	W Banko Million t	C Banko Million t
Mangus (A)	3.0	-
Suban (B)	77.0	51.0
Petai (C)	98.5	76.5
Total	178.5	127.5
Stripping ratio	Optimistic 1.5 : 1 Probable 2.5 : 1	2.5 : 1

Table 6-1-1 Summary of Proximate Analysis Results (Banko Area)

Coal seam \ Area			NW Banko (1983 Shell)	NW Banko (1978 Shell) (1980 Geoservices)	W Banko	C Banko
Manguas 1 (A1) (or) combined A	total moisture	(calculated) %	29.00			
		(analysed) %	30.00(?)	28.50		
	sulphur (d) %		0.57	0.54		
	ash (d) %		8.20	8.45		
	Volatile matter (d.a.f.) %		49.70	50.50		
	calorific value	(d.a.f.) Kcal/kg	7,240	7,329		
		net Kcal/kg	4,310	4,460		
Manguas 2 (A2)	total moisture	(calculated) %	29.40	-	30.80	
		(analysed) %	30.00	29.00	-	
	sulphur (d) %		0.23	0.25	0.23	
	ash (d) %		5.00	6.90	9.40	
	volatile matter (d.a.f.) %		48.60	49.40	49.20	
	calorific value	(d.a.f.) Kcal/kg	7,275	7,304	72.5	
		net Kcal/kg	4,490	4,485	4,180	
Suban 1 (B1)	total moisture	(calculated) %	29.00	-	32.50	(test pit)
		(analysed) %	30.00(?)	28.50	-	38.30
	sulphur (d) %		0.27	0.27	0.23	0.24
	ash (d) %		5.90	5.85	6.25	4.98
	volatile matter (d.a.f.) %		48.80	48.60	49.10	49.80
	calorific value	(d.a.f.) Kcal/kg	7,295	7,323	7,145	7,105
		net Kcal/kg	4,460	4,590	4,170	3,790
Suban 2 (B2)	total moisture	(calculated) %	28.50	-	31.80	33.20
		(analysed) %	30.00(?)	28.00	-	-
	sulphur (d) %		1.09	1.18	0.78	0.88
	ash (d) %		6.50	7.60	9.50	10.50
	volatile matter (d.a.f.) %		47.90	49.30	48.50	47.60
	calorific value	(d.a.f.) Kcal/kg	7,310	7,319	7,175	7,115
		net Kcal/kg	4,440	4,530	4,085	3,900
Petai C	total moisture	(calculated) %	26.20	-	28.70	30.90
		(analysed) %	30.00(?)	27.50	-	-
	sulphur (d) %		0.97	1.13	0.90	0.87
	ash (d) %		8.00	8.85	11.25	11.74
	volatile matter (d.a.f.) %		48.40	49.50	49.60	49.00
	calorific value	(d.a.f.) Kcal/kg	7,410	7,457	7,305	7,210
		net Kcal/kg	4,430	4,595	4,290	4,060

Table 6-1-2 Summary of Ash Component Analysis Results (%)

	Average	Range	Standard deviation
SiO_2	44.4	20.0 - 61.0	6.4
Fe_2O_3	4.7	0.8 - 17.0	3.7
Al_2O_3	28.5	19.0 - 41.0	5.7
CaO	7.0	0.6 - 13.0	4.1
MgO	3.7	0.2 - 6.6	2.3
Na_2O	6.2	0.2 - 20.0	6.4
K_2O	0.5	0.2 - 0.6	0.2
SO_3	4.4	0.6 - 13.0	3.5
TiO_2	1.0		0.3
P_2O_5	0.4	0.04 - 0.8	0.2

B) South and South East Banko

The NNW-SSE striking anticlinal structure of South Banko is situated at about 6 to 11 km south of West Banko.

i) Exploration Activity Performed by Shell

The area was investigated geologically and five boreholes which penetrated A, B and C coal seam have been drilled.

A_1 coal seam is considered uneconomical one thickness of A_2, B and C coal seam are 6 - 8 m, 15 m and 6 - 8 m respectively, and total coal thickness reaches 30 meters. The Kladi coal seam (thickness is unknown) outcrops in the center of the anticline.

The Enim coal seam at the north-east flank of the South Banko anticline has been mapped and was caught by 2 of 4 boreholes. The Enim seam (3.6 meters thickness) is apparently deteriorated, (moisture 46%, low C.V) but an improvement towards the east may be expected.

ii) Coal Quality

Analysis result of only one borehole shows that coal quality is rather low, i.e. CV (d.a.f.) : 6,700 - 7,000 kcal/kg, total moisture: 41 -43%, net CV : 3,400 - 3,500 kcal/kg, average ash (d) : 3 - 3.5 %.

iii) Coal Reserves

The coal reserves 100 meters below the surface is estimated at 170 million tons, adding up A_2, B and C coal seam. Enim coal seam may be uneconomical because of the thickness.
The said area has only secondary importance because of steep dip, large number of faults, suspected faults and comparative inaccessible area.

2) Suban Jeriji

The large coal area of Suban Jeriji extends to maximum 4 km near Tanjung Enim. The Air Niru flows through the area from south to north dividing the area into two parts i.e. eastern part and western part.
The area is covered by dense secondary forest in the north and the west. The south-western section which forms highly elevated area, drains to the north-west. The north-eastern part is located smooth ground high land with small creeks draining to the south-east and north-east.
The northern part of Suban Jeriji East is mostly covered by grass and bush land with minor patches of forest and most of the southern part, glasslands with minor dense vegetation along the bank of Air Niru predominant.

i) Exploration Activity Performed by Shell

Five boreholes were drilled in the Suban Jeriji West, however, only two boreholes of them intersected coal seams. 13 boreholes in total were drilled in the north, however, only seven of them were relevant for defining the interest area.
Although 18 boreholes were drilled by Shell at Suban Jeriji East, effective holes were only four.

ii) Tectonic Structure

a) The Suban Jeriji North area is located on the north-west flank of the North Suban Jeriji anticline. The area is divided by a major NNW-SSE striking fault which laterally displaces both parts of the deposit by 300 to 400 meters. The southern boundary of the area is defined by the outcrop/sub-outcrop lines of the Jelawatan and Enim coal seam.

b) The down-dip boundary in the north-west and north-east of the semi-circular prospect area was defined on the basis of 100 meters overburden cutoff to the top of the Enim coal seam. Side boundaries were defined arbitrarily and significant lateral extension is possible.

c) Coal seam dips are reported to range from horizontal to 8^{o} to the north-west and north.

d) The northern part of Suban Jeriji East lies along the northern flank of the North Suban Jeriji anticline. The Jelawatan coal seam and the Enim coal seam complex are present in the area and show low dip angle of 4^{o} to 5^{o} to the north.

e) A major NNW-SSE fault with a lateral displacement of about 50 to 100 meters divides the area. Another major transverse fault with an even greater lateral displacement and similar strike direction, bounds the area to the west. The eastern boundary is defined by the Air Niru, which probably also follows a fault zone.

f) From the structural point of view and based on the average geological waste to coal ratio the northern part appears more favourable than the southern part in Suban Jeriji East.

g) The center of Suban Jeriji East demonstrates a minor doming effect caused by the Sungai-Taham anticlinal structure, the center of which is situated about 3 km of the north-west.
In the southern part, a synclinal development is indicated, which is related to the major Sungai-Taham syncline. This syncline strikes NW-SE with a south-easterly plunge.

h) The overall fracture of fault patterns in Suban Jeriji East is not known well because of the limited number of boreholes and lack of detailed structural analysis.

i) The coal seam dips at very low angles (3^{o} To 7^{o}) to the south-east.

j) Suban Jeriji West is a small area with M_2 coal (A, B and C coal seams) close to the surface. It is located on the north-eastern flank of the south-west plunging Sungai-Liling anticline between Suban Jeriji and North West Banko, immediately west of a major fault line and south-west of the Sungai-Taham syncline and the Sungai-Taham anticline structure.

k) Moderately steep dip angles (10^{o} or more) are dominant. Major and minor faulting have not been recorded, but probably exist, judging from the proximity of the major structural features surrounding the area.

l) The area is not considered attractive from the structural point of view and due to the limited size of the area.

iii) Coal and Interburden Thickness

a) M_2 coal Seam (Suban Jeriji West only)

The coal and interburden thickness in the said area are estimated based on the drilling results of only 2 boreholes, as follows:

	Average (m)		Range (m)	
Coal seam	Coal	Waste	Coal	Waste
		50.00		0-10.0
Mangus 1 A_1	9.50		9.0-10.0	
		3.75		3.5-4.0
Mangus 2 A_2	12.25		12.0-12.5	
		13.50		13.0-14.0
Suban 1 B_1	12.75		12.5-13.0	
		26.00		26.0
Suban 2 B_2	4.00		4.0	
		33.00		33.0
Petai C	13.50		13.5	
Total	52.0		51.0-53.0	

(Note) Shell suggested to adopt 75% of safety factor because the above estimation is based on only 2 boreholes.

b) M_4 coal (Suban Jeriji North and East)

	Suban Jeriji North				Suban Jeriji East: Northern part		Suban Jeriji East: Southern part	
	Average (m)		Range (m)		Average (m)		Average (m)	
Coal seam	Coal	Waste	Coal	Waste	Coal	Waste	Coal	Waste
		75.0		0-124.0		-		0-60.0
Upper coal seam*1	9.0		-		-		-	
		-		-		-		-
Jelawatan	13.5		10.0-17.7		5.0*2		3.0*2	
		43.4		29.0-60.0		40.0		32.0
Enim (upper split)	13.1		9.5-17.7		11.0		13.0	
		4.7		1.0-9.6		8.0		6.0
Enim (middle split)	4.4		2.8-5.2		-		-	
		5.3		4.4-6.0		-		-
Enim (lower split)	7.4		5.9-8.3		6.0		6.0	
Total (Jelawatan Enim)	38.4		28.2-48.9		22.0		22.0	
Jelawatan	13.5		10.0-17.7		5.0		3.0	
Enim	24.9		18.2-31.2		17.0		19.0	

(Note 1) North-Central part only

(Note 2) *High ash*

(Note 3) Shell suggested that the Jelawatan coal seam will not be economical because of high ash content.

iv) Coal Reserves

Shell classifies all coal reserves in Suban Jeriji area as inferred category.

a) *M_2 coal (Suban Jeriji West only)*

Shell had not computed the coal reserves in the said area however, assigned coal thickness of 33 meters and 13 meters to Mangus-Suban coal complete and Petai respectively and 20 million tons of coal reserves are estimated in 0.5 km^2 of the said area. Cutoff depth of 100 m overburden to the top of the A_1 coal seam and specific gravity of 1.3 were applied.

Average and maximum geological stripping ratio was estimated at 3 : 1 and 5 : 1 respectively.

b) M_4 coal (Suban Jeriji North and East)

Overburden cutoff parameter of 100 meters to the top of the Enim coal seam was applied. Coal reserve in the area (including the area of east of Air Niru river) is as follows:

		Suban Jeriji North		Suban Jeriji East	
		SW block	NE block	N part	S part
				2.3	5.4
Area (km^2)		6.5		7.7	
Coal reserves	Jelawatan	13	39	-	-
	Enim	61	129	65.5	154.5
		74	168	65.5	154.5
	Total	242		219.9	
Geological stripping ratio		2.9 : 1			
Specific gravity		1.3		1.3	

v) Coal Quality

Coal quality data (air-dry basis) are shown in Table 6-1-3 (1) and (2). Thermal upgrading of the coal was considered possible and account for the comparatively high calorific values determined in place in Suban Jeriji North. Such upgrading could possibly originate from a hidden intrusive body beneath one of anticline features in the vicinity of the area (e.g. in the dome-like feature of the Sungai Takam Anticline).

Table 6-1-3 (1) Summary of Proximate Analysis Results (Suban Jeriji Area) (1)

			North	West	East		
					N part	S part	S part BH SU 51
Jelawatan	total moisture	(calculated) (%)	41.50				
		(analysed) (%)	-				44.40
	sulphur (d)	(%)	0.18		0.54	0.48	0.23
	ash (d)	(%)	11.08		30.98	28.45	2.54
	volatile matter (d.a.f.)	(%)	55.40				52.10
	calorific value	(d.a.f.) Kcal/kg	6,780				6,663
		net Kcal/kg	3,140				3,215
Enim	total moisture	(calculated) (%)	40.60		42.90		-
		(analysed) (%)	-		-		42.00
	sulphur (d)	(%)	0.22		0.23		0.89
	ash (d)	(%)	5.39		7.24		6.60
	volatile matter (d.a.f.)	(%)	51.40		56.80		51.90
	calorific value	(d.a.f.) Kcal/kg	6,810		6,710		6,778
		net Kcal/kg	3,450		3,170		3,290
Mangus 1 A_1	total moisture	(calculated) (%)		31.40			
		(analysed) (%)		-			
	sulphur (d)	(%)		0.60			
	ash (d)	(%)		4.58			
	volatile matter (d.a.f.)	(%)		49.70			
	calorific value	(d.a.f.) Kcal/kg		7,040			
		net Kcal/kg		4,255			
Mangus 2 A_2	total moisture	(calculated) (%)		30.90			
		(analysed) (%)		-			
	sulphur (d)	(%)		0.23			
	ash (d)	(%)		2.64			
	volatile matter (d.a.f.)	(%)		49.80			
	calorific value	(d.a.f.) Kcal/kg		7,100			
		net Kcal/kg		4,400			

Table 6-1-3 (2) Summary of Proximate Analysis Results (Suban Jeriji Area) (2)

			North	West	East N part	East S part	East S part BH SU 51
Suban 1 B_1	total moisture	(calculated) (%)		33.10			
		(analysed) (%)		-			
	sulphur (d) (%)			1.13			
	ash (d) (%)			5.80			
	volatile matter (d.a.f.) (%)			47.80			
	calorific value	(d.a.f.) Kcal/kg		7,185			
		net Kcal/kg		4,400			
Suban 2 B_2	total moisture	(calculated) (%)		33.10			
		(analysed) (%)		-			
	sulphur (d) (%)			1.13			
	ash (d) (%)			5.80			
	volatile matter (d.a.f.) (%)			47.80			
	calorific value	(d.a.f.) Kcal/kg		7,120			
		net Kcal/kg		4,130			
Petai C	total moisture	(calculated) (%)		26.70			
		(analysed) (%)		-			
	sulphur (d) (%)			0.43			
	ash (d) (%)			5.49			
	volatile matter (d.a.f.) (%)			48.60			
	calorific value	(d.a.f.) Kcal/kg		7,265			
		net Kcal/kg		4,700			

Shell also shows only the following ash component analysis data on Enim coal seam.

SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO	Na_2O	K_2O	SO_3	TiO_2	P_2O_5
22.1	9.4	25.3	19.5	3.0	2.7	0.4	11.4	1.3	0.3

The report prepared by Kinhill-Otto Gold Joint Venture, "South Sumatra Coal Exploration Project - Review Report, May 1984, was consulted and quoted mostly to compose this section.

6-1-2 Outline of Exploration Activity Performed by the Government of Indonesia and Summary of Their Survey Results

(1) Outline of Exploration Activity Performed by Directorate of Coal (D.O.C.) and Kinhill-Otto Gold Joint Venture

The World Bank has granted a loan to the Government of Indonesia to undertake a programme to assess the coal resources in South Sumatra coalfield and to carry out feasibility studies on each area which might be considered as the coal supply sources for the expansion of the Suralaya Power Station.

The above-mentioned programme was composed of mapping, surveying, core-drilling, geophysical wireline logging, coal analysis, geotechnical testing, flowing water volume measurements in rivers and a well drilling programme including pumping tests.

When the field works had been completed, the feasibility study reports on the North West Banko area and the Muara Tiga Besar, and the pre-feasibility study report on the Banjarsari have been submitted to the Government of Indonesia.

Besides the study report on the Arahan area is preparing by the foreign consultanting company, Kinhill-Otto Gold Joint Venture which was entrusted the work by the Government of Indonesia.

The above additional work was carried out to take over the exploration work done by Shell.

Some information on the investigated results on the Banko-Suban Jeriji area were utilized to prepare the report through the courtesy of Directorate of Coal.

Although several boreholes were driven at surrounding areas such as Arahan, Banjarsari and Suban Jeriji coal area, the said exploration activities were concentrated upon North West Banko, North Suban Jeriji and Muara Tiga Besar (especially North West Banko), then, feasibility study and pre-feasibility study were done covering North West Banko and Muara Tiga Besar, and, North Suban Jeriji and Banjarsari respectively, for the purpose of securing coal supply sources for Suralaya Power Station.

The survey results of each area as follows, to our knowledge.

(2) Summary of Survey Results Performed by Directorate of Coal and Kinhill-Otto Gold Joint Venture

1) North West Banko

27 boreholes were driven extending the boundary of drilled area by Shell, Kinhill-Otto Gold Joint Venture draws the following conclusion, after considering their own and Shell's survey results. (see Fig. 11, 12 and 13 of Attachment 6-1)

i) Tectonic structure

The explorated area lies at the flanks of the North-West Banko syncline, Lilling anticline and Banko anticline. The fold axes stike and plunge to the north-west. Dips are generally to the west and range from about 6^{o} to 16^{o} (average 8^{o}).

The Banko Barat coalfield is terminated in the south by the Noman-Kiahan fault zone. This fault zone has north-easterly-south-westerly strike. The fault has a vertical displacement of about 120 m, with the southern side uplifted. The northern and central zones of the coalfield were selected for mine planning due to more favourable structural conditions (gentle dips) and absence of large faults.

ii) Coal reserves

The Tertiary Muara Enim Formation has its origin from the Upper Miocene and is primarily encountered in limnic-telmatic facies. The thickness of the formation reaches about 650 meters, which is divided into four divisions M_1 -M_4.

Sub-Divisions M_2 contains A_1, A_2, B_1, B_2 and C coal seam which are minable economically. Thickness of Sub-Division M_2 is about 110 meters and accumulated thickness of coal seams is estimated at about 46 meters.

The individual thickness (average) of coal seams are as follows.

Coal seam	A_1	A_2	B_1	B_2	C_1	C_2
Thickness (m)	7.3	9.8	12.7	4.5	5.1	6.2

The drilling data on 142 boreholes in total were used to estimate the geological coal reserves. The statistical spacing of boreholes is 252 meters and standard deviation was 76.8 meters. The top of the uppermost coal seam (A_1) is generally within 150 meters from the ground surface, for the most part.

The total geological measured reserves in Banko Barat amount to 560 million tons at 250 meters depth (maximum 150 meters overburden above uppermost coal seam) the geological W:C ratio (m^3/t vertical in situ) is 2.31:1. In the geological model, deduction of coal loss caused by weathering was not considered.

(million tons)

Coal seam	A_1	A_2	B_1	B_2	C_1	C_2	Total
Coal reserves	63.8	104.0	152.3	60.3	79.8	99.8	560.0

iii) Coal Quality

The Banko Barat coal is sub-bituminous B and C (corresponding to hard brown coal) with mainly low ash percentages (average in situ 6.3%, including C coal seam), low sulphur content (0.4%) relatively low volatiles (33%), low bed moisture (total moisture 25-26%), medium hardness (37-54 Hardgrove Index) and relatively high calorific values (4,300-4,778 Kcal/kg).

The sodium content averages 4.5-6% throughout the whole deposit, but Na_2O content may be over 6% locally.

iv) Hydrology and Hydrogeology

The average yearly rainfall is about 3,200 mm, the actual evaporation is approximately 1,400 mm, the mean temperature is 28°C.

The outer catchment area (10.4 km^2) of the Air Kiahan Besar/Air Bintan system will yield approximately Qmax = 140 m^3/sec after 100-year, 3-hours downpour at the point where the creeks enter the mining area.

Six stream gauges were set and the maximum runoff rate observed in the Air Kiahan Besar was about 70 m^3/sec. Channels, dams and pumping stations are to be planned for mine protection.

All strata are water-saturated. The overburden/coal seam sequence forms a multi-aquifer system of low to very low permeability the coal seams likely having the highest. Pressure heads of about 1.4 MPa are expected to prevail in the B/C interburden at the deepest point of the mine, and pressure relief will be required. Inflow of large groundwater quantities is not likely, but installation of dewatering measures will be required to maintain the stability of the pit slopes.

v) Geotechnics

The wastes have a specific character between hard soil and soft rock. Long-term slope angles in all sterile wastes section will be 21-22° at 20 meters height, when drainage is enough and 14° at 100 meters hight in the overburden above A_1 coal seam.

Coal slope will be kept standing at 60-70°. Overall slope angles of 25-30° between the A_1 and B_2 coal seam are probably stable with effective drainage.

Heaping of waste is possible at an overall slope inclination of 5:1 (H:V), if supported by an external layer and base drainage.

vi) Further Investigation

For detailed mine planning, the following further investigation are necessary:

Subcrop drilling (1,200 meters); exploration drilling (1,000 meters) geomechanical testing; runoff and water level measurements with permeability test; sieve analysis on samples of additional exploration drilling.

vii) Outline of the Production Plan

Coal production in the initial year will be 2.5 million tons increasing 4 million tons in year 2 and 5.4 million tons thereafter.

The production level will be maintained until year 30, then annual production will be decreased to 4.6 million tons in year 31 and 4.7 million tons in year 32.

The needed coal tonnage for Suralaya Power Plant No. 3 and No. 4 unit with generating capacity for 400 MW, which will start operation in February and November 1989 respectively, is 2.7 million tons per year.

The commencement date of operation of No. 5 and No. 6 unit, has not been decided yet, however the planned capacity of each unit is also 400 MW.

Therefore, NW Banko supplies the coal demand for Suralaya Power Plant from No. 3 to No. 6 unit, if the production at N.W Banko progresses satisfactorily, as scheduled.

164 million tons of coal and 386 million M^3 of waste will be excavated over the mine life.

Coal will only be recovered from the A_1, A_2, B_1 and B_2 coal seam, because incremental W:C ratio to remove interburden between B_2 and C coal seam will exceed the economical limit at the present. The average W:C ratio over the mine life will be 2.34 M^3 : 1 ton.

The average property of the mined coal will be 4,563 Kcal/kg of calorific value, 25.9% of moisture content, 6.7% of ash content, 0.3% of sulphur content and 3.8% of sodium-in-ash. Sodium-in-ash values will increase during mining and reach the peak of 7.2% in the last year.

The report prepared by Kinhill Otto-Gold Joint Venture, "Banko Barat Feasibility Study Volume VIII" was consulted and quoted mostly to compose this section.

2) Central Banko

D.O.C. and Kinhill Otto-Gold Joint Venture drilled four boreholes in the said area, however, further attractive progress has not been made in the investigation on the Central Banko since then.

Some persons in the administrative post of D.O.C. vent opinions that the said area has no appeal for exploitation because of quite complicated structural conditions.

3) Suban Jeriji

Suban Jeriji Utara coal deposit lies about 5 km east of Tanjung Enim, within the co-ordinates of 9,585,500 mN to 9,590,000 mN, and 372,000 mE to 378,000 mE. The area is hilly with elevations between 50 ML and 110 ML.

i) Tectonic Structure

Suban Jeriji Utara coal deposit is situated in the eastern foothills of the Bukit Barisan mountain range. The area is well drained by cross-strike tributaries leading into along-strike feeder streams. In general, the length of the obsequent tributaries is to some extent inversely proportional to the dip of the strata. The main rivers, such as, the Air Liling, Air Lengi, and Air Sudung flow to the north.

ii) Coal reserves

Five additional boreholes (total length 867m) were drilled in Suban Jeriji Utara.

The strata of the upper muara Enim Formation (Ma) in the Suban Jeriji Utara area occur predominantly in sandy (silty) clayey facios.

No large displacement faults have been found in the explored area.

Geological vertical in situ reserves in Suban Jeriji Utara area were calculated by computer. The geological reserves in the "indicated category amount to approximately 502 Mt (vertical in situ)", with a geological waste to coal ratio of 2.43:1 (m:m) and a maximum overburden thickness of 100m above the uppermost seam. Seam thicknesses range between 4.7m and 13.1m.

Geological coal reserves by coal seam are as follows:

Coal seam	Coal reserves
Niru	26.10 Mt
Jelawatan	117.83
Enim 1A	181.38
Enim 1B	70.44
Enim 2	106.48
Total	502.23

(Note) Specific gravity was estimated at 1.23 t/m^3.

iii) Coal Quality

The average values for expected in situ coal were determined to be:

total moisture	:	41 - 44%
ash	:	3.9 - 4.3%
sulphur	:	0.12%
CV net	:	3,153 - 3,344 kcal/kg

The lower ranking coal of the Jelawatan and Enim seams (Muara Enim Formation M4) were found to lose moisture more quickly than the higher ranking coals of M2 coal seams.

iv) Hydrology and Hydrogeology

The mining and dump area is easy to drain with the expection of the west and east branch of the Air Liling, which have catchment areas of 7.5 km^2 and 9.0 km^2, respectively, where they enter the southern rim of the outside dump.

The 100-year 4-hour downpour will generate a peak flood of approximately 160 m^3/s. North of the mining area, the Air Pelemai Kecil (1.3 km^2, 30 m^3/s) will have to be rerouted into the Air Pelemai Besar.

The coal/steriles sequence forms a multi-layered water-saturated system of low permeability. Coal is expected to have the highest permeability strong horizontal and vertical anisotropies will prevail. Groundwater is unconfined between coal seam outcrop lines and semi-unconfined to confined at greater depths with pressure heads of up to 1.3 MPa below the Enim 2 seam at the deepest point of the mine.

v) Geotechnics

The steriles are similar to very soft rock. Large failures are mostly defect-controlled. Stability was assessed to be 55-60° for individual sterile slopes of up to 20m vertical height for the sequence 100m above the Enim seams, 30° for the sequence of Enim Seams (35m) and 70° for the coal.

Prior to excavation, the steriles may be loosened in wide areas only, whilst coal may be loosened in all areas. Hard streaks must be investigated. Dumping of waste is possible at an overall slope inclination of 4:1 (H:V), if supported by an external layer and base drainage.

vi) Outline of the production plan

The area selected for Suban Jeriji Utara open cast mine is situated approximately 5 km north-east of the town of Tanjung Enim, traversed in the east by the Air Lengi and in the south-east by the Air Lling. A mining reserve of approximately 100Mt of coal was selected from geological in situ reserves ('indicated' category) of 502 Mt and allows for a coal production rate of 3.65 Mt/year. Including build-up and phase-out years, the mine has a life of 30 years. The average waste to coal ratio will be 1.6:1 (m^3/t).

A combined BWE/conveyor/spreader and S/T operation proved to be the optimum mining system from the viewpoint of economic viability and operational flexibility. Belt conveyors are to be used for coal haulage out of the pit to the permanent coal transfer point between the mine and its surface facilities.

A maximum of two BWEs, one spreader, two hydraulic shovels with 11 m^3 bucket and thirteen 50-ton trucks are required for waste and coal operation. An effective operation time of between 3,360 hrs/year and 3,460 hrs/year was determined for the shovel equipment in waste/coal operation and 3,793 hrs/year for the BWE/conveyor/spreader system. This includes an allowance for the adverse conditions to be expected during the wet season. Determination of the loading capacity of the excavators and the haulage capacity of the trucks also takes into account the specific operating conditions at Suban Jeriji Utara.

S/T operation commences one or two years before BWE operation, to prepare the mine for the introduction of BWE/conveyor/spreader system and to guarantee a smooth operation.

All waste is transported to an outside dump situated to the south and south-east of the mine. Inside dumping is not possible without sterilizing the remaining coal in the northern part of the mine. The outside dump will reach a final height of 140 ML.

Personnel requirement for the mine operation vary from year to year according to the annual coal and waste production and to the annual equipment requirement. A peak year requires 1,982 workers and 281 staff employees, including mine maintenance personnel.

The report prepared by Kinhill Otto-Gold Joint Venture "South Sumatra Coal Exploration Project - Suban Jeriji Utara Pre-feasibility Study" was consulted and quoted mostly to compose this section.

6-1-3 Investigation Activity under the Study

(1) The Purpose of the Project

The survey work in the field (Banko area of South Sumatra coalfield) in the second stage had been carried out by the work team dispatched by Pusat Pengembangan Teknologi Mineral which is an Indonesian governmental organizations under the control of Ministry of Mines and Energy (hereinafter, referred to as PPTM), spending the funds provided by Badan Pengkajian dan Penerapan Teknologi (hereinafter, referred to as BPPT), following the plan which was prepared by the survey team dispatched by Japan International Cooperation Agency and obtained consent of the parties concerned, and by united efforts of the JICA survey team, extending over three years from FY1985/86 to FY1987/88.
The main purpose of the above-mentioned field work was to obtain needed numbers and volumes of coal samples through the whole area of Banko for the coal gasification test at Serpong.

(2) Work Allotment between the Japanese Side and the Indonesian Side

The following works related to the coal sampling were performed by the Indonesian counterparts including funding, however coal spontaneous combustion test in FY1987/88 was carried out under initiative of the JICA survey team, by using apparatuses prepared by JICA.

1) Large diameter drilling work to obtain coal samples from each coal seam for the regular coal gasification test.

2) Pitting work to take bulk coal samples for the test run of the coal gasification facilities (coal sampling at remote places from existing roads was done by means of pitting).

3) Shallow hole drilling to check the thickness of overburden at planned places.

4) Surveying to locate the position of drilled holes and excavated pits.

5) Proximate, ultimate and ash component analyses of the coal samples.

Geological surveys were also carried out by the jointed survey team of PPTM and JICA to select proper coal sampling places, one year earlier than coal sampling work in each area.

JICA dispatched several engineers and prepared some apparatuses and tools to cooperate with the Indonesian counterparts and to fulfil the scheduled works within the specified time limit overcoming the heavy rainy season.

(3) Summary of Investigation Activity under the Study

All planned works were performed, although the commencement of the field work was forced to be delayed considerably, in the first year (FY1985/86) and second year (FY1986/87). Especially in the first year the delay was caused by the delay of administration works on the Indonesian side.

The field work in the third year (FY1987/88) was progressed quite well, promoted by good weather in spite of the rainy season.

The brief outline of the field works during the recent three years (from FY1985/86 to FY1987/88) is as follows:

1) Geological Survey

Geological survey was carried out in the North West Banko area in FY1985/86, and in the Central Banko and in the North Suban Jeriji area in FY1986/87 to select proper coal sampling places and to confirm outcrops/sub-outcrops lines estimated by Shell, respectively.

In FY1987/88, Arahan and Banjarsari area were also reconnoitered partially to obtain coal samples for coal gasification tests at Serpong, according to the advice of Drs Johannas, the director of Directorate of Coal, Directorate General of Mines, Ministry of Mines and Energy.

A) North West Banko

The JICA survey team integrated topographic, geological and outcrop/sub-outcrop maps prepared by Shell into one combined map after

combining with their own survey (see Fig. 6-1-1), after reconnoitering the said area. (see from Fig. 14 to Fig. 26 of Attachment 6-1)
Twenty of estimated coal seam sections were also drown up, based on the above mentioned map and core drilling results, driven by Directorate of Coal (hereinafter, referred to as D.O.C.) and Shell. (see from Fig. 27 to Fig. 31 of Attachment 6-1)
Geological survey was also carried out in FY1986/87 and then coal sampling places and method were selected, taking the following circumstance and factors into consideration.

i) relative difficultly of drilling machine from the existing road to coal sampling sites and obtainability of water near the drilling site.

ii) the total amount of budget prepared by BPPT for the field work.

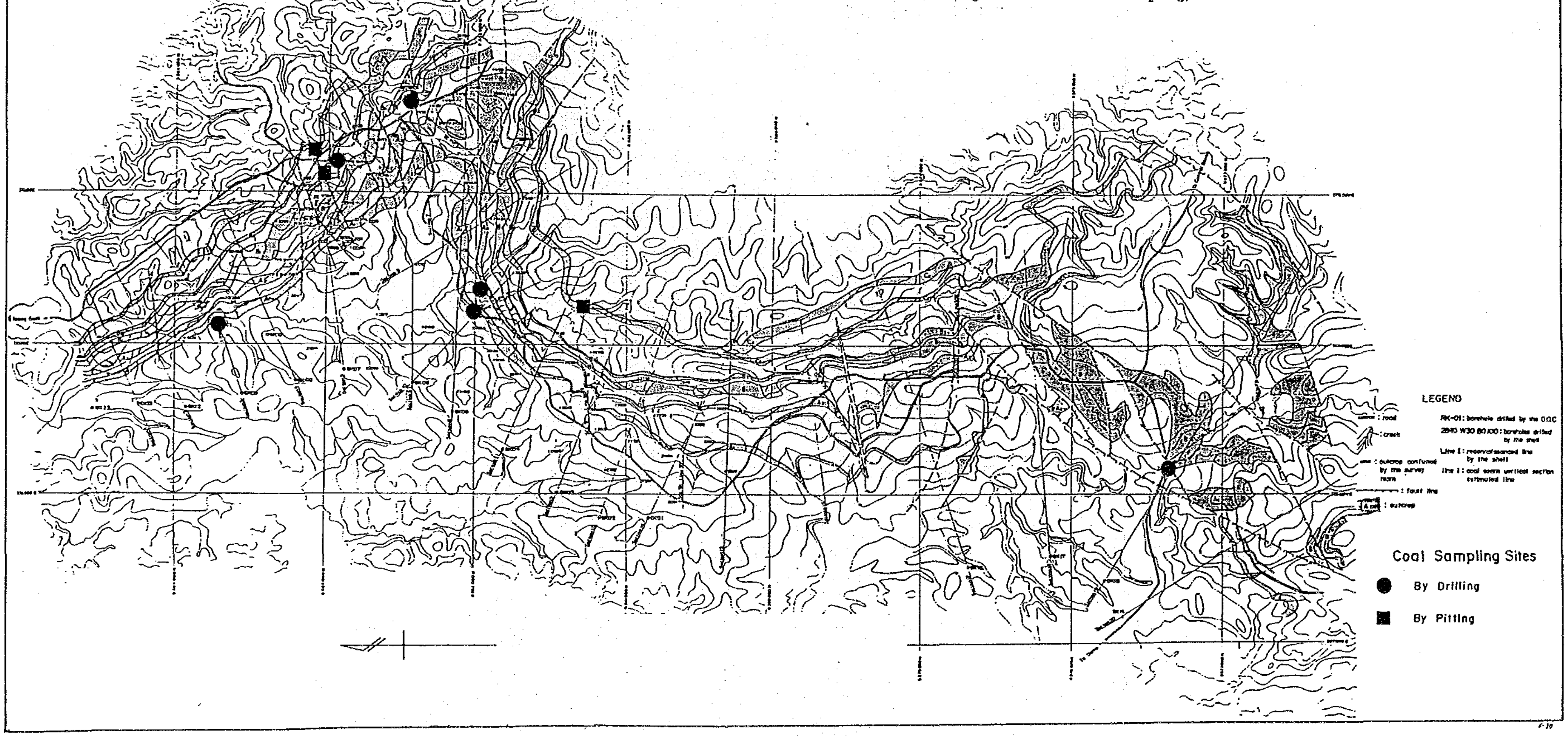
iii) period alloted for the field work.

iv) weather conditions.

v) execution of effective and practical sampling work.

vi) needed numbers and volume of coal samples.

Fig. 6-1-1 Combined Map (Topographical, Geological and Outcrop/Sub-outcrop Map) showing Location of Coal Sampling, North West Banko



B) Central Banko

Geological survey on the Central Banko area was also carried out in FY1986/87 for coal sampling works on the said area, which was planned in FY1987/88 based on the same key idea of FY1985/86. (see from Fig. 32 to Fig. 37 of Attachment 6-1)

Although an effort to draw up a map combined topographic maps with geological maps prepared by Shell separately and proffered by D.O.C. through their courtesy, the combined map was not completed in FY1986/87 and the work team could not catch C Coal Seam at the planned place near the existing road until the end of working period in FY1986/87, regrettably because of lack of outcrop/sub-outcrop map, covered eastern part of the Central Banko drawn up by Shell.

The attached combined map of the Central Banko (see Fig. 6-1-2) was brought to perfection in FY1987/88, after the work team was given the above-mentioned map of shell by the courtesy of Perum Tambang Batubara and reconnoitered the eastern part of Central Banko. (see Fig. 38 and 39 of Attachment 6-1)

Five coal sampling places (for Mangus 1 (A_1), Mangus 2 (A_2), Suban (B_1), Suban (B_2) and Petai (C)) were selected as shown on Fig. 6-1-2, based on the above-mentioned survey.

C) North Suban Jeriji

DOC kindly provided columnar sections of the boreholes driven by them in the area and geological map of the area in a scale of 1 : 10,000. (see Fig. 40 of Attachment 6-1)

The geological survey was achieved by the jointed survey team for a short period of time in FY1986/87.

Seven cross sections of coal seams on the North Suban Jeriji were drawn up (see Fig. 41 and 42 of Attachment 6-1) and three coal sampling places (for Jelawatan, Enim 1 and Enim 2 coal seam) were selected in FY1986/87. (see Fig. 6-1-3)

Furthermore, shallow drill holes were driven in the North West Banko in FY1985/86, in the Central Banko in FY1986/87 and FY1987/88, and in the North Suban Jeriji in FY1987/88, at proposed coal sampling places respectively, to check the thickness of overburden, one year before coal sampling work or prior to it in the same year, as a part of geological survey.

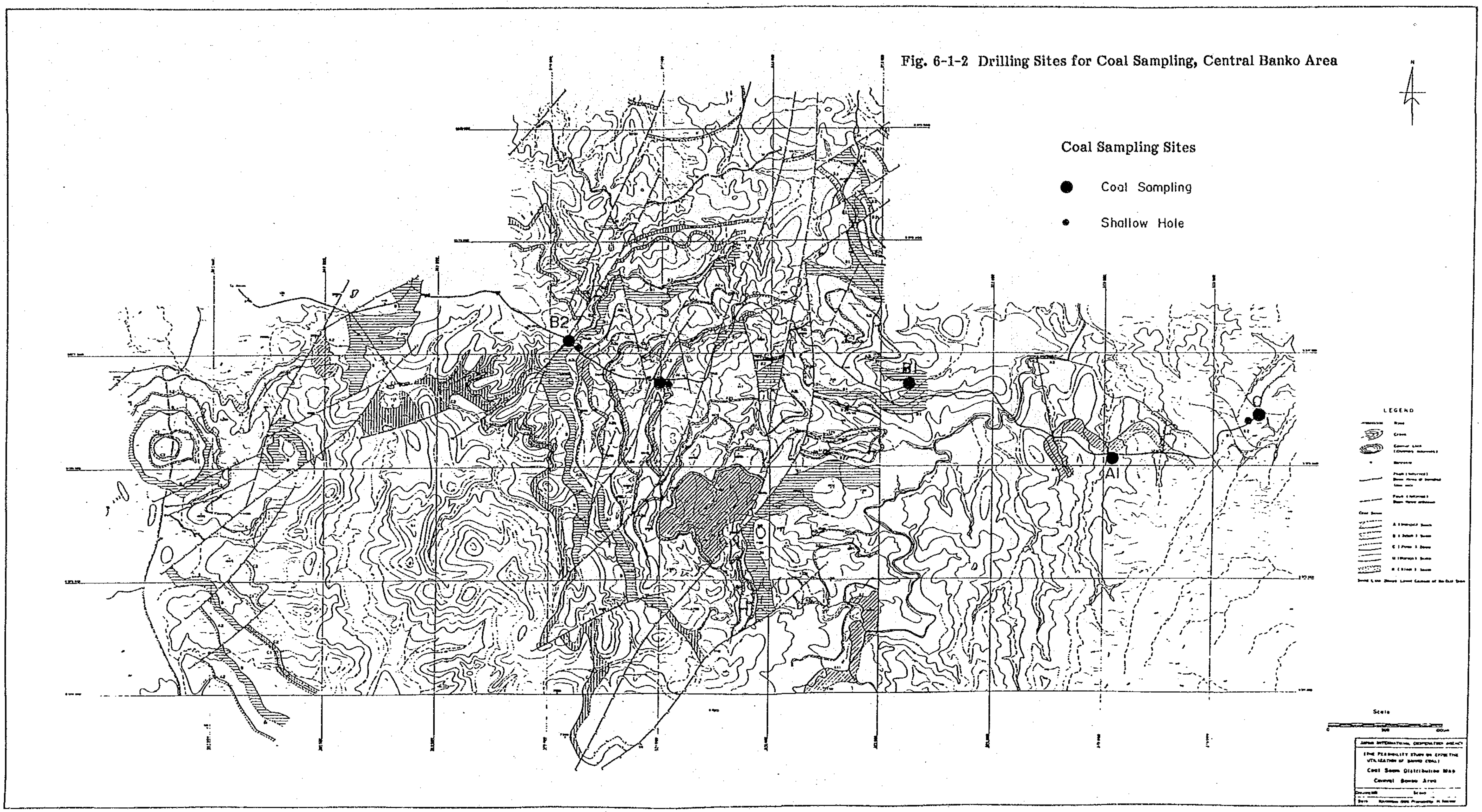


Fig. 6-1-2 Drilling Sites for Coal Sampling, Central Banko Area
Coal Sampling Sites
Coal Sampling
Shallow Hole
B2
B1
A1
C
LEGEND

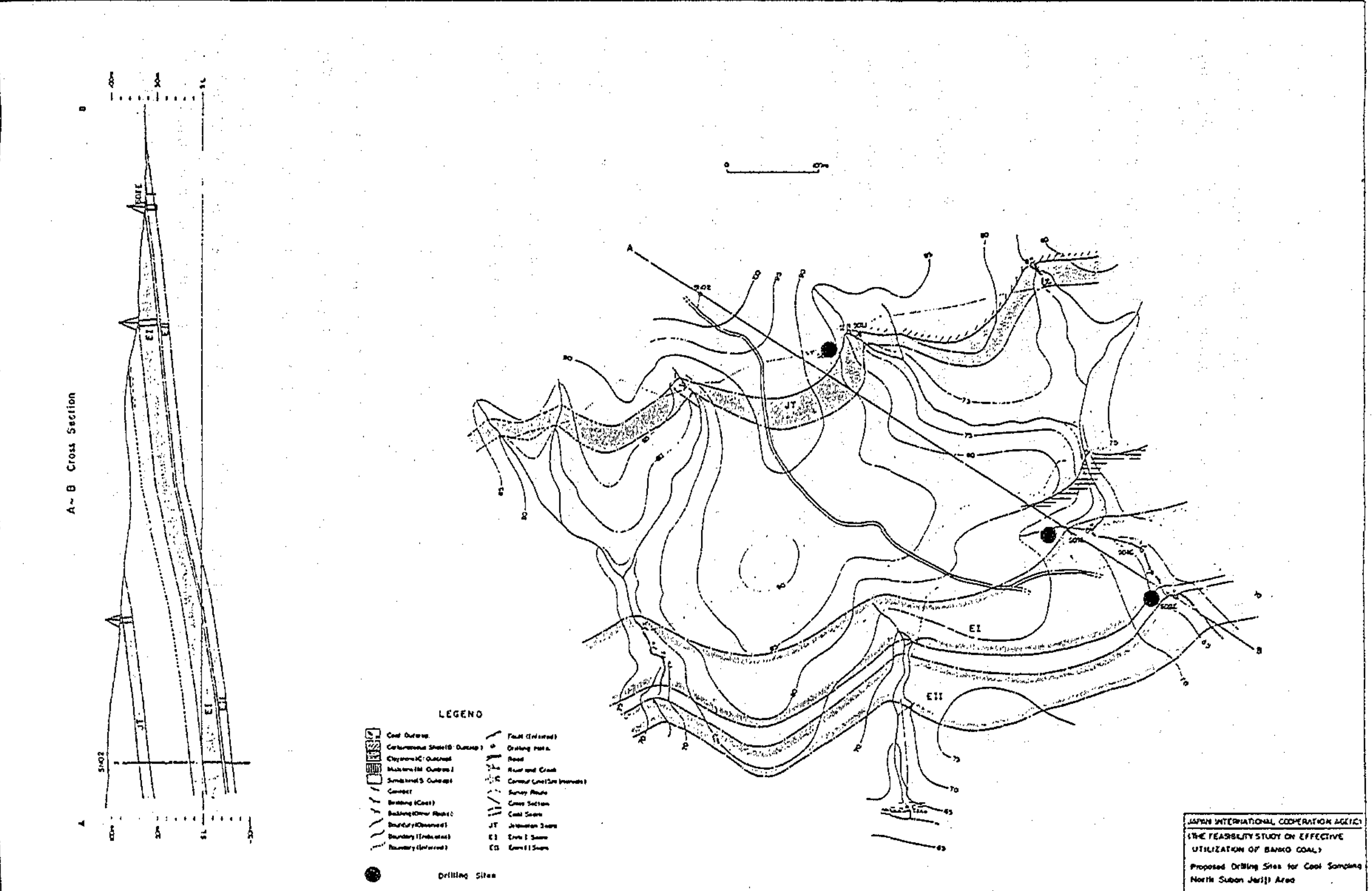


Fig. 6-1-3 Drilling Site for Coal Sampling, North Suban Jeriji

2) Coal Sampling

Coal gasification facilities prepared by JICA had been installed at Serpong in FY1986/87. Mechanical and process test run using bulk coal samples were planned in the last quarter of FY1986/87.

Then regular coal gasification tests were expected to carry out in FY1987/88 dividing into two phases (the first phase would be carried out at the beginning of the fiscal year). (see Fig. 6-1-4)

Therefore coal sampling schedule during the second stage of the project was decided as follows:

i) Bulk coal samples for mechanical and process test run, and coal samples for the first phase coal gasification test should be obtained in FY1986/87 immediately after the governmental budget excution which was expected at the end of May, before the rainy season in Sumatra Island which would be at the peak in the second half of the fiscal year.

ii) Coal samples for the second phase should be obtained in FY1987/88 in the same season of the year as the first phase coal sampling by the same reason.

Coal sampling in the first phase was decided to be carried out in the North West Banko area in FY1986/87, because the area had been investigated in detaild among the area to be studied.

The West Banko, the East Suban Jeriji and the West Suban Jeriji were omitted from coal sampling area, considering geological survey results and reconnaisance results carried out until the present.

The West Central Banko area also was given up trying to obtain bulk coal samples because of lack of access road.

Coal samples obtained from the North West Banko area in FY1986/87, then, from the Central Banko area and the North Suban Jeriji area in FY1987/88 are shown in Table 6-1-4 and Table 6-1-5. (see Fig. 6-1-1, Fig. 6-1-2 and Fig. 6-1-3)

Moreover, coal samples were obtained in the Arahan area (A_1 coal seam) and in the Banjarsari area (Enim 2 coal seam) by pitting, and collected in the stockyard of Bukit Asam Coal Mine (Air Laya Pit, A_2 coal seam) to compare gasifiability with those of coal in Banko area.

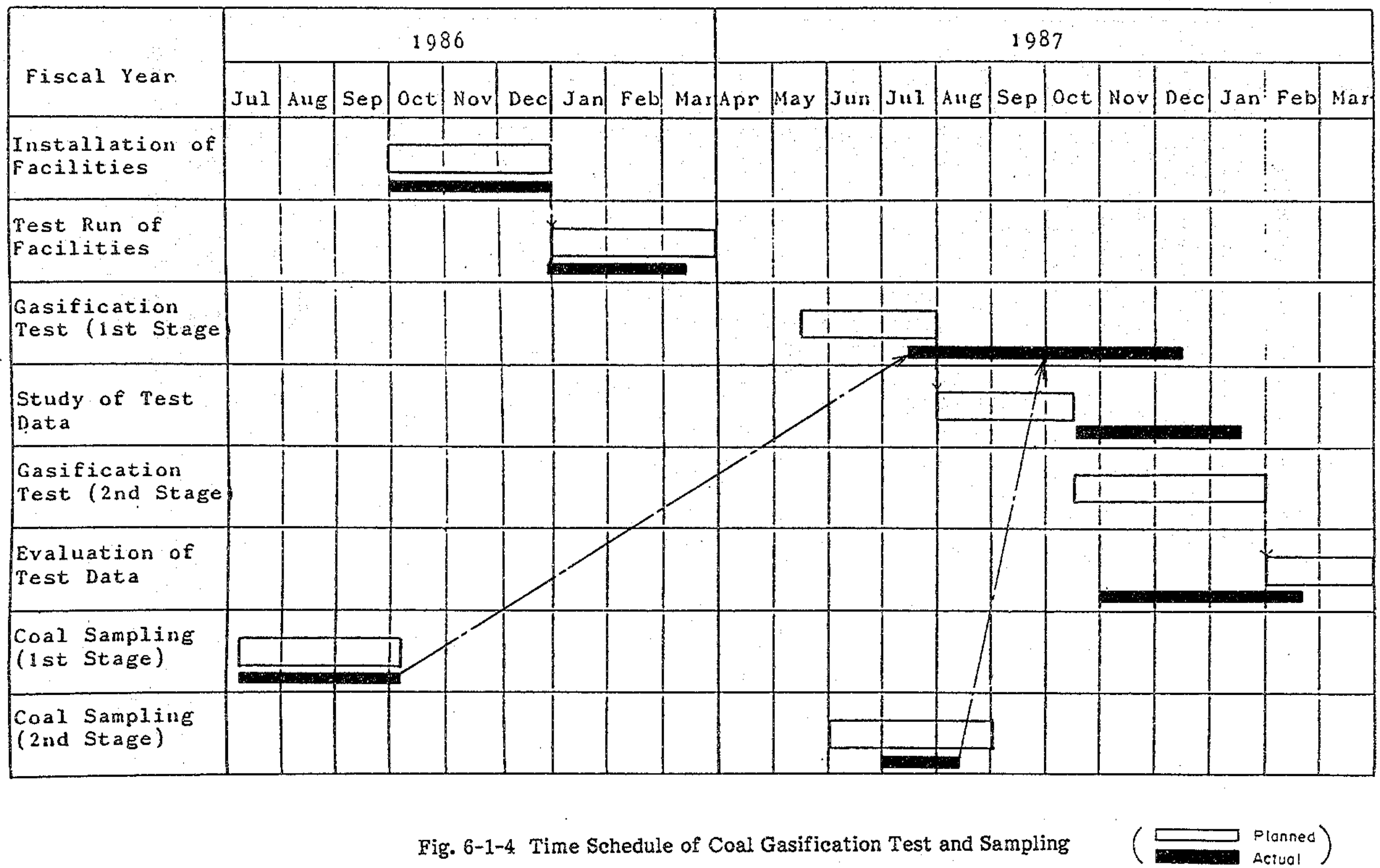


Fig. 6-1-4 Time Schedule of Coal Gasification Test and Sampling

Table 6-1-4 Summary of Coal Sampling Data (1)

Year	Area		Coal seam	Hole No.	Drilled or dug length (M) Overburden rock	Coal	Total	Coal recovered (M)	Core recovery (%)	Weight of coal sample (kg)	Sampling method
FY 1986/87	North West Banko	Northern part	A_1	1	4.14	6.26	10.40	4.79	76.5	40.20	
				2	4.35	6.00	10.35	6.00	100.0	47.20	
				3	4.65	6.00	10.65	6.00	100.0	52.00	Coring
				4	4.60	6.10	10.70	6.10	100.0	54.00	
				5	4.70	6.00	10.70	6.00	100.0	48.30	
				Sub-total	22.44	30.36	52.80	28.89	95.2	241.70	
			A_2*1	1	10.40	11.55	21.95	11.55	100.0	95.00	
				2	9.75	11.60	21.35	9.90	85.3	94.70	Coring
				Sub-total	20.15	23.15	43.30	21.45	92.7	189.70	
			B_1	1	5.50	4.80	10.30	4.80	100.0	25.00	
				2	5.00	4.80	9.80	4.80	100.0	29.90	
				3	4.70	5.00	9.70	5.00	100.0	27.00	
				4	4.80	4.90	9.70	4.60	93.9	24.00	
				5	4.77	5.08	9.85	4.60	90.6	27.00	
				6	5.65	4.80	10.45	3.70	77.1	24.50	Coring
				7	5.40	4.80	10.20	3.70	77.1	24.90	
				8	5.20	4.80	10.00	3.60	75.0	22.50	
				Sub-total	41.02	38.98	80.00	34.80	89.3	204.80	
			B_2	1	6.00	-	6.00	-	-	-	
				2	2.85	3.35	6.25	1.80	53.8	14.00	Coring
				1'	-	2.00	2.00	2.00	-	120.00	Pitting
				2'	-	2.00	2.00	2.00	-	120.00	
				Sub-total	8.85	7.35	16.20	5.80	-	254.00	
			C	1	-	2.00	2.00	2.00	-	130.00	Pitting
				2	-	2.00	2.00	2.00	-	106.00	
				Sub-total	-	4.00	4.00	4.00	-	236.00	
		Total			92.40	103.84	196.30	94.94	90.7	1,126.20	
		Southern part	A_1	1	4.26	12.44	16.70	12.44	100.0	104.45	
				2	4.56	12.22	16.78	12.22	100.0	103.15	Coring
				Sub-total	8.82	24.66	33.48	24.66	100.0	207.60	
			A_2	1	4.79	9.87	14.66	7.70	78.0	52.30	
				2	4.45	10.60	15.05	8.25	77.8	53.30	Coring
				3	3.99	10.41	14.40	8.80	84.5	51.50	
				4	5.05	10.50	15.55	8.70	82.9	49.40	
				1'	14.00	-	14.00	-	-	-	
				2'	13.00	-	13.00	-	-	-	
				Sub-total	45.28	41.38	86.66	33.45	80.8	206.50	
			B_1 + B_2	1	6.15	13.35	19.50	11.88	89.0	113.00	
				2	4.15	13.35	17.50	13.35	100.0	127.00	Coring
				3	3.95	13.35	17.30	12.75	95.5	123.00	
				4	3.80	12.95	16.75	12.95	100.0	118.50	
				Sub-total	18.05	53.00	71.05	50.93	96.1	481.50	
			C	1	-	2.00	2.00	2.00	-	79.00	Pitting
				2	-	2.00	2.00	2.00	-	78.00	
				3	-	2.00	2.00	2.00	-	57.00	
				Sub-total		6.00	6.00	6.00	-	214.00	
	Total				72.15	125.04	197.19	115.04	91.6	1,109.60	
	Ground total				164.61	228.88	393.49	209.98	91.2	2,235.80	

(Note 1) Samples of A_2 coal seam were obtained by boreholes for A_1 coal seam after extending and penetrating into A_2 coal seam.

Table 6-1-5 Summary of Coal Sampling Data (2)

Year	Area	Coal seam	Hole No.	Drilled length (m)			Coal recovered (m)	Core recovery (%)	Weight of coal sample (kg)	Sampling method
				Overburden rock	Coal	Total				
FY 1987/88	North Suban Jeriji	Jelawatan	1	4.65	8.40	13.05	8.40	100.0	61.50	Coring
			2	4.65	8.10	12.75	8.10	100.0	62.50	
			Sub-total	9.30	16.50	25.80	16.50	100.0	124.00	
		Enim 1	1	6.25	20.00	26.25	19.90	100.0	137.30	Coring
			Sub-total	6.25	20.00	26.25	19.90	100.0	137.30	
		Enim 2	1	4.10	8.05	12.15	7.10	88.2	60.00	Coring
			2	4.10	8.05	12.15	6.35	78.9	60.00	
			Sub-total	8.20	16.10	24.30	13.45	83.5	120.00	
			Total	23.75	52.60	76.35	49.85	94.8	381.30	
	Central Banko	A_1	1	3.45	12.85	16.30	11.35	88.3	112.50	Coring
			Sub-total	3.45	12.85	16.30	11.35	88.3	112.50	
		A_2	1	0.75	5.40	6.15	3.80	70.4	31.50	Coring
			2	1.80	6.30	8.10	5.00	79.4	42.00	
			3	1.66	5.74	7.40	4.40	76.3	33.50	
			Sub-total	4.21	17.44	21.65	13.20	75.7	107.00	
		B_1	1	3.40	13.70	17.10	14.70	100.0	124.50	Coring
			Sub-total	3.40	13.70	17.10	14.70	100.0	124.50	
		B_2	1	4.30	5.30	9.60	5.30	100.0	40.00	Coring
			2	4.30	5.40	9.70	5.30	98.1	43.00	
			3	4.80	4.90	9.70	4.80	98.1	41.00	
			Sub-total	13.40	15.60	29.00	15.40	98.8	124.00	
		C	1	17.10	8.60	25.70	8.60	100.0	68.50	Coring
			2	17.10	8.60	25.70	6.90	80.4	59.00	
			Sub-total	34.20	17.20	51.40	15.50	90.1	127.50	
			Total	58.66	76.79	135.45	70.15	91.4	595.50	
	Arahan (A_2 coal seam)								130.00	Pitting
	Banjarsari (Enim 2 coal seam)								130.00	Pitting
	Air Laya (A_2 coal seam)								130.00	Stockyard
	Grand total			82.41	129.39	211.80	-	-	1,366.80	

3) Coal Analysis

All the works related with coal analysis (proximate, ultimate and ash component analysis) were in the Indonesian portion and carried out by staffs of PPTM at the laboratory of PPTM or LSDE at Serpong using LECO apparatuses prepared by JICA (see Table 6-1-6)

Table 6-1-6 Summary of Coal Analysis

Grouping	Year	Analyzed at	Coal samples obtained by
Proximate analysis	FY1985/86	laboratory of PPTM	coring (shallow hole) (1)
	FY1986/87	LSDF at Serpong and laboratory of PPTM	coring (large diameter) (2) and pitting (3)
	FY1987/88	LSDF at Serpong	(2) and (3)
Ultimate analysis	FY1985/86	laboratory of PPTM	(1)
	FY1986/87	LSDE at Serpong and laboratory of PPTM	(2) and (3)
	FY1987/88	LSDE at Serpong	- do -
Ash component analysis	FY1985/86	laboratory of PPTM	(1)
	FY1987/88	- do -	(2) and (3)
	FY1987/88	- do -	- do -

There was a difference in opinion on the drying procedure of coal sample in the air between the Japanese survey team and the chemists of PPTM, which has an influence on ultimate analysis results.

The both parties discussed the matter mutually, based on

i) Standard Method of Laboratory Sampling and Analysis of Coal and Coke (American National Standard K18.1)

ii) Method for Proximate Analysis of Coal and Coke (JIS M8812) and Method of Ultimate Analysis of Coal and Coke (JIS M8813)

iii) Method for the Analysis and Testing of Coal and Coke, part 6-Ultimate Analysis of Coal, (Australian Standard)

Prepared by the JICA survey team, and then, decided to do coal analyses again in FY1987/88 on coal samples to be gasified, by chemists sent by PPTM in Bandung, or at Serpong, following Australian Standard.

Coal analysis results carried out in FY1987/88 are shown in Table 6-1-7, Table 6-1-8, and Table 6-1-9.

Pulverized and dried coal sample were analysed again three days before being blown into the furnace.

Table 6-1-7 Coal Re-analysis Results of Coal Samples Obtained in FY1986/87

Sample No.	Remarks	Proximate Analysis (%)					Calorific Value (Cal./gr)	Total S (%)	Ultimate Analysis (%)				Sampling place
		Total moisture	Moisture	Ash	V.M.	F.C.			C	H	N	O	
BU1 A_1 and BU2 A_1	a.m.	23.18	21.85	5.52	35.10	37.53	(4670) average of BU A_1	0.43	55.73	6.77	0.93	30.62	North West Banko Northern Part A_1 seam
	d.b.			7.06	44.92	48.02		0.55	71.31	5.55	1.19	14.34	
	d.a.f.				48.33	51.67		0.59	76.73	5.97	1.28	15.43	
BU1 A_2 and BU2 A_2	a.m.	28.05	23.85	2.51	35.09	38.55	(4906) average of BU A_2	0.18	55.90	7.09	0.79	33.53	- do - A_2 seam
	d.b.			3.29	46.08	50.63		0.24	73.41	5.83	1.04	16.19	
	d.a.f.				47.64	52.36		0.25	75.91	6.03	1.08	16.73	
BU2 B_1 BU4 B_1 and BU5 B_1	a.m.	31.60	23.32	31.3	35.21	38.34	(4445) average of BU B_1	0.70	53.84	6.78	0.88	34.67	- do - B_1 seam
	d.b.			4.08	45.92	50.00		0.91	70.21	5.46	1.15	18.19	
	d.a.f.				47.87	52.13		0.95	73.19	5.69	1.20	18.97	
BU3 B_2	a.m.	26.64	25.45	1.71	35.47	37.37	(4407) BU2 B_2	1.24	53.25	7.06	0.91	35.83	- do - B_2 seam
	d.b.			2.29	47.58	50.13		1.66	71.43	5.67	1.22	17.73	
	d.a.f.				48.70	51.30		1.70	73.10	5.80	1.25	18.15	
BU2 C	a.m.	25.84	20.85	1.50	36.44	41.24	(5019)	0.35	57.84	6.54	10.5	32.72	- do - C seam
	d.b.			1.90	46.04	52.06	average	0.44	73.08	5.33	1.33	17.92	
	d.a.f.				45.93	53.07	of BU C	0.45	74.50	5.43	1.36	18.26	
BS1 A_1 and BS2 A_1	a.m.	28.25	22.00	3.35	36.37	38.28	(4729) average of BS1 and BS2	0.53	54.60	6.71	0.85	33.96	North West Banko Southern Part A_1 seam
	d.b.			4.29	46.63	49.08		0.68	69.99	5.47	1.09	18.48	
	d.a.f.				48.72	51.28		0.71	73.13	5.72	1.14	19.30	
BS2 A_2	a.m.	29.73	24.18	3.41	34.59	37.82	(4909)	0.15	54.83	6.94	0.84	33.83	- do - A_2 seam
	d.b.			4.50	45.62	49.88	average	0.20	72.32	5.61	1.11	16.26	
	d.a.f.				47.77	52.23	of B5 A_2	0.21	75.73	5.87	1.16	17.03	
BS4 B	a.m.	28.11	22.32	3.49	36.70	37.49	(4168)	0.20	54.25	6.74	0.84	34.48	- do - combined B seam
	a.b.			4.49	47.25	48.26	average	0.26	69.84	5.48	1.08	18.85	
	d.a.f.				49.47	50.53	of B5 B	0.27	73.12	5.74	1.13	19.74	
BS1 C	a.m.	23.30	22.25	2.07	36.50	39.18	(5082)	0.45	57.84	6.89	1.06	33.53	- do - C seam
	d.b.			2.65	46.95	50.40	average	0.58	74.39	5.68	1.36	16.19	
	d.a.f.				48.23	51.77	of BS C	0.60	76.41	5.83	1.40	16.73	

(Note 1) Moisture shows moisture as received.

(Note 2) a.m., d.b. and d.a.f. are abbreviation for as mined, dry-basis and dry-ash-free, respectively.

(Note 3) Calorific values are analyses results in FY1986/87.

(Note 4) BU (or S) 1, A_1 of BU1 A_1 means Banko, Northern (or Southern) Part, Hole No. and name of coal seam.

Table 6-1-8 Coal Analysis Results of Coal Samples Obtained in FY1987/88

Sample No.	Remarks	Proximate Analysis (%)					Calorific Value (Cal./gr)	Total S (%)	Ultimate Analysis (%)				Sampling place
		Total moisture	Moisture	Ash	V.M.	F.C.			C	H	N	O	
CB A_1	a.m.	33.44	24.71	12.82	32.17	30.30	3754	1.07	43.48	6.35	0.70	35.58	Central
	d.b.			17.03	42.73	40.24		1.42	57.75	4.78	0.93	18.09	Banko
	d.a.f.				51.50	48.50		1.71	69.60	5.76	1.12	21.81	
CB A_2	a.m.	34.39	22.69	8.46	34.80	34.05	4273	0.24	49.27	6.46	0.80	34.77	- do -
	d.b.			10.91	45.01	44.05		0.31	63.73	5.10	1.03	18.89	
	d.a.f.				50.54	49.46		0.35	71.56	5.73	1.16	21.20	
CB B_1	a.m.	35.78	28.19	4.16	33.84	33.31	4219	0.24	48.59	7.07	0.86	39.08	
	d.b.			5.79	47.12	47.09		0.33	67.66	5.49	1.20	19.53	- do -
	d.a.f.				54.02	49.98		0.35	71.82	5.83	1.27	20.73	
CB B_2	a.m.	35.52	27.34	4.33	33.53	34.80	4307	0.25	49.93	6.96	0.85	37.68	
	d.b.			5.96	46.15	47.89		0.34	68.72	5.39	1.17	18.42	- do -
	d.a.f.				49.07	50.93		0.36	73.08	5.73	1.24	19.59	
CB C	a.m.	37.52	31.10	4.24	32.44	32.22	4018	0.24	46.70	726	0.96	40.60	
	d.b.			6.15	47.08	46.77		0.35	67.78	5.52	1.39	18.81	- do -
	d.a.f.				50.17	49.83		0.37	72.22	5.88	1.48	20.05	
SJ J	a.m.	42.33	29.80	8.39	33.19	28.62	3553	0.16	41.92	6.81	0.65	42.07	North Suban
	d.b.			11.95	47.28	40.77		0.23	59.72	4.99	0.93	22.18	Jeriji Jelawatan
	d.a.f.				53.70	46.30		0.26	67.83	5.67	1.06	25.18	coal seam
SJ E_1	d.a.b.	41.88	24.00	5.69	38.76	31.55	4289	0.17	49.44	6.82	0.72	37.16	North Suban
	d.b.			7.49	51.00	41.51		0.22	65.05	5.46	0.95	20.83	Jeriji Enim 1
	d.a.f.				55.13	44.87		0.24	70.32	5.90	1.03	22.51	coal seam
SJ E_2	d.a.b.	43.12	28.30	1.92	35.96	33.82	4187	0.12	49.13	6.96	0.77	41.10	North Suban
	d.b.			2.68	50.15	47.17		0.17	68.52	5.33	1.07	22.23	Jeriji Enim 2
	d.a.f.				51.53	48.47		0.17	70.41	5.48	1.10	22.84	coal seam
BJS E_2	d.a.b.	43.96	36.28	2.70	31.84	29.18	3502	0.32	41.81	7.50	0.70	46.97	Banjarsari
	d.b.			4.24	49.97	45.79		0.50	65.62	5.44	1.10	23.10	E_2 coal seam
	d.a.f.				52.18	47.82		0.52	68.52	5.68	1.15	24.13	
AR A_2	d.a.b.	36.13	29.76	1.58	33.71	34.95	4211	1.54	48.84	7.14	0.70	40.20	Arahan
	d.b.			2.25	47.99	49.76		2.19	69.53	5.45	0.99	19.59	A_2 coal seam
	d.a.f.				49.09	50.91		2.24	71.13	5.58	1.01	20.04	
AL A_2	d.a.b.	21.47	18.20	12.37	34.28	35.15	4697	1.58	50.80	6.27	0.84	28.14	Bkit Asam Coal Mine
	d.b.			15.12	41.91	42.97		1.93	62.10	5.19	1.03	14.63	Air Laya Pit
	d.a.f.				49.38	50.62		2.27	73.16	6.11	1.21	17.25	A_2 coal seam

Table 6-1-9 Ash Component Analysis Results of Coal Samples

Sample No.	%									
	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	K_2O	Na_2O	SO_3	P_2O_5
BU1 A_1 and BU2 A_2	67.00	18.45	7.40	0.56	1.08	0.15	0.39	0.10	1.52	0.02
BU1 A_2 and BU2 A_2	48.40	20.27	6.47	1.16	7.04	2.71	0.34	0.78	7.44	0.71
BU2 B_1 BU4 B_1 and BU5 B_1	59.90	18.90	4.42	0.56	5.30	1.75	0.20	0.30	4.86	0.16
BU3 B_2	41.50	36.99	7.07	3.06	1.76	0.58	0.47	0.23	0.44	0.03
BU2 C	49.70	36.24	7.21	1.65	1.14	0.30	0.11	0.19	0.92	0.16
BS1 A_1 and BS2 A_1	57.30	23.89	8.64	0.74	2.44	1.02	0.64	0.13	2.42	0.06
BS2 A_2	64.60	8.58	5.92	0.48	6.64	1.93	0.18	1.78	5.98	0.44
BS4 B	38.60	28.54	3.94	1.06	12.73	4.28	0.26	1.84	5.96	0.04
BS1 C	61.10	7.41	6.41	0.36	7.33	2.95	0.07	0.24	8.33	0.09
CB A_1	52.00	24.21	6.12	0.95	3.61	1.63	2.37	0.74	4.31	0.03
CB A_2	73.70	13.65	2.89	0.55	2.79	0.66	0.64	0.43	2.99	0.02
CB B_1	53.52	24.21	4.22	0.97	5.19	1.76	0.25	0.30	5.99	0.39
CB B_2	69.60	13.47	4.41	0.54	3.02	1.22	0.14	0.06	3.88	0.13
CB C	41.80	24.80	6.53	0.95	9.84	4.19	0.23	0.17	6.75	0.44
SJ J	56.70	23.62	5.27	1.38	3.57	0.92	0.37	0.08	3.38	0.05
SJ E_1	59.20	28.64	2.86	1.31	2.11	0.50	0.19	0.07	0.05	1.31
SJ E_2	62.60	22.24	5.22	1.07	1.49	0.42	0.25	0.04	1.66	0.03
BJS E_2	17.10	11.90	28.67	0.94	14.89	2.51	0.35	0.41	17.59	0.02
AR A_2	9.90	13.82	14.02	0.72	35.64	13.51	0.08	0.10	10.31	0.01
AL A_2	55.20	27.56	6.82	0.90	1.64	1.39	1.28	1.81	1.52	0.02

(4) Spontaneous Combustion Test

The tests were carried out in the old test mining pit (B_1 coal seam) excavated by Shell in Central Banko, building two coal heaps (the height : 2 meters, the base area : 6.70 m^2) (see Fig. 6-1-5)

Dug fresh coal, after taking away 1.5 meters thickness of coal from the surface was used to make two coal heaps.

The change of temperature within the coal heaps was observed, covering about one month.

The observation results were shown in Fig. 44 and 45 (No. 1 coal heap) and Fig. 46 (No. 2 coal heap) of Attachment 6-1. Fig. 47, 48 and 49 of Attachment 6-1 show isothermal line of the inside of the coal heap every 5 meters at the beginning and in the middle of temperature observation.

Spontaneous combustion in strict sense was not brought about, however, phenomena of sudden temperature rising with the highest temperature of 100°C, fuming and stinking were observed.

115°C of the maximum temperature was observed at the stockyard of Bukit Asam Coal Mine on the test which was entrusted to the safety department of PTBA.

According to the resident manager of Bukit Asam Coal Mine, it seems to him that heating, fuming and stinking at the coal heap within the stockyard come to happen frequently in the rainy season.

Water contents in coal heap may perform an important role on spontaneous combustion and it may be affected by the direction and velocity of the wind.

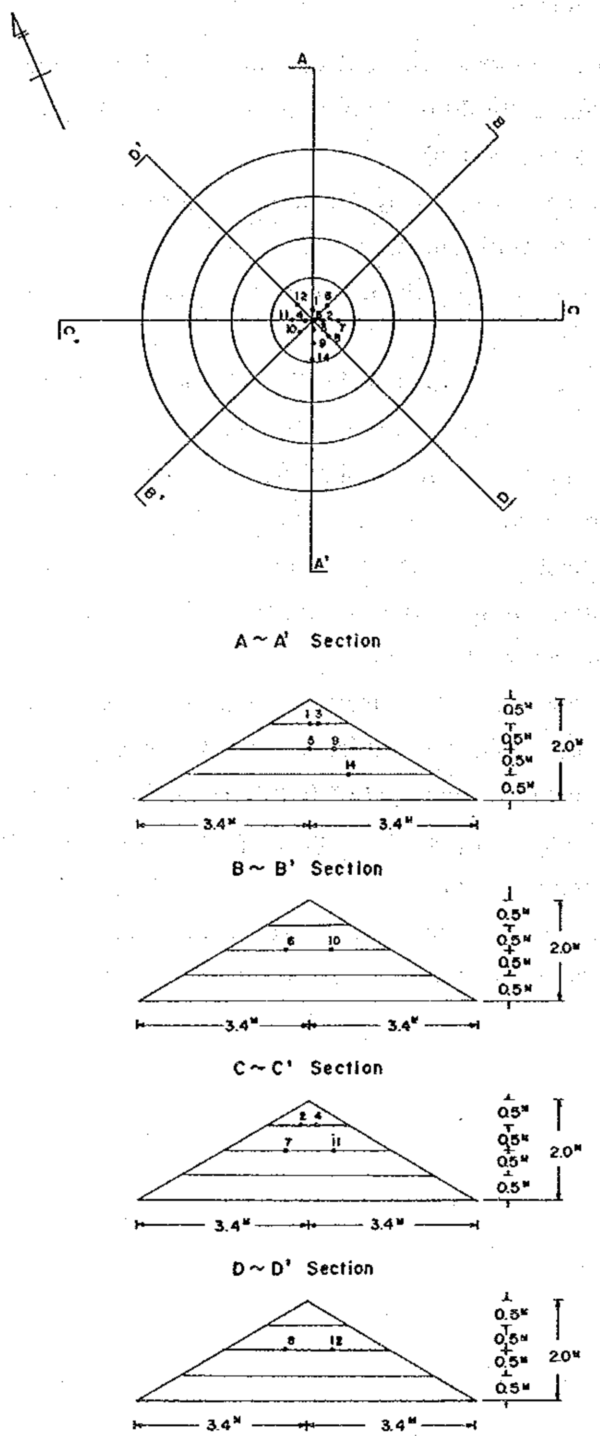


Fig. 6-1-5 Horizontal and Vertical Section of No. 1 Coal Heap for Spontaneous Combustion Test showing Thermometers Installed Position.

6-2 CONCEPTUAL STUDY OF COAL DELIVERY COST TO THE PLANT

6-2-1 Preface

A detailed study of coal mine planning (cost estimation should be included in the said study) is beyond the scope of the present report. However, because coal is the sole material in this case coal delivery cost to the plant is an inescapable and indispensable subject so as to examine feasibility of the Project throughly.

Therefore, coal delivery cost of two selected areas (North West Banko, and North Suban Jeriji) will be studied conceptually, based on the survey result under the present project and existing survey report furnished to us through the kindness of the Directorate of Coal, the Directrate General of Mine, the Ministry of Mine and Energy (hereinafter, reffered to as DOC) and the state-owned Coal Corporation (hereinafter referred to as PTB).

6-2-2 North West Banko Area

(1) Related Main Parameter to Study Coal Delivery Cost

1) Coal Reserve

Systematic exploration had been carried out by Shell Mijonbow N.V., and then, by Kinhill-Otto Gold Joint Venture (hereinafter referred to as Shell and K-OG, respectively) at the request of the Government of Indonesia.

Each party had estimated coal reserves at 145 and 445 million tons respectively (see 6-1-1 (3) and 6-1-2 (2)), however, their precondition to estimated coal reserve was not explained explicitly.

Coal reserve can be reviewed in detail, consulting existing exploration results and it is a quite important subject for such a study. However the said study is quite painful and time consuming, thus, beyond the scope of the present study.

Therefore, the following study was performed on the assumption based on the existing data and information, and required amount of coal during the project life - about 120 million tons - can be obtained from the following precondition.

Assumption	Precondition
Minable coal tonnage will be 125.2 million tons	Coal reserve calculation area: see Fig. 6-2-2 - Fig. 6-2-6 The deepest bench level: -25 ML (under sea level) Ultimate pit slope: 15° Specific gravity of coal: 1.26
Waste volume to be removed will be 287.6 million m^3	Dilution factor: 7% Mining loss: 5% Transportation loss: 0.3%

(Note 1) Safety factor on coal reserves was not considered so as to avoid far-reaching influence upon mining cost, caused by the said factor chosen arbitrarily.
The matter under consideration will be investigated later in the form of sensitivity analysis which will check influence of increase waste stripping ratio upon mining cost, resulted from unforeseeable discontinuity of coal seams between two faults.

(Note 2) Waste volume to be removed was increased at the rate of 5%, considering waste which would be removed for road construction. The final stripping ratio will be 2.38 bank m^3/ton.

(Note 3) Deterioration of coal caused by weathering (that is the so-called weathering loss) was neglected, judging from the survey results under the present project.

2) Hydrology and Hydrogeology

K-OG explained weather conditions, hydrology and hydrogeology in North West Banko area, in their report as follows:

i) Average annual rainfall is about 3,200 mm of which 1,400 mm is evaporated.

ii) Annual mean temperature is 28°C.

iii) Air Kiahan Besar/Air Bintan system which outer catchment area is 10.4 km^2, will yield approximately Qmax = 140 m^3/sec, after 100 years result as a rough estimate, 3-hours downpour at the point where creeks enter the mining area.

iv) About 70 m^3/sec of maximum runoff rate was observed with six stream gauge in Air Kiahan Besar.

v) All strata are water-saturated.

vi) Overburden/coal seam sequence forms a multi-aquiferous system of low to very low permeability and coal has the highest permeability among them.

vii) About 1.4 Mpa of pressure heads will be prevailing in the B and C seam interburden at the deepest point of the pit.

viii) It is almost certain that large quantity of groundwater will not percolate into the pit, however, a carefully thought-out measure is needed.

Waste-dump-heap area, pit dewatering facilities, diverted water conduits, dams and diverted waterway were considered, consulting the above-mentioned valuable information.

3) Geotechtonics

K-OG states in their report regarding slope of response as follows:

The steriles behave like materials between hard soil and soft rock. Large failures are defect-controlled. Drainage-supported long-term slope angles in all sterile sections are 21^o - 22^o at H = 100 m and 14^o at H = 100 m in A_1 overburden.

Coal slopes are 60^o - 70^o. Overall slope of 25^o - 30^o between A_1 and B_2 coal seam are probably stable with effective drainage.

Prior to excavation, the steriles and coal may be loosened in part or in general.

Dumping of waste is possible at an overall slope inclination of 5:1 (H:V), if supported by an external layer and base drainage.

K-OG also recommended the following specification for hauling road on materials at North West Banko which California Bearing Ratio is very low.

Material	In case of wheel loading	
	40,000 lbs	100,000 lbs
(surface) fine crushed rock (CBR 80%)	150 mm (thickness)	150 mm
(base) cause crushed rock (CBR 80%)	170 mm	270 mm
(sub-base) laminated bed oxide coal (CBR 20%)	730 mm	1,100 mm

Haulage roads were investigated with reference to the above valuable survey results and "Design of Surface Mine Haulage Roads - a Manual" published by United States Bureau of Mines.

(2) Mine Layout

1) Basic Idea

North West Banko block lies in the south-eastern direction of the town of Tanjung Enim of South Sumatra. Coal seams consist of Mangus, Suban and Petai coal seam, and, Mangus coal seam divides into two parts; upper Mangus (A_1) and lower Mangus (A_2) coal seam, throughout whole the area.

Suban coal seam also divides into two parts B_1 and B_2 coal seam except southern area of the said block, and Petai coal seam divides into two parts only at the southern area. (see Fig. 6-2-1)

Thickness of coal seam is 6 m - 15 m, the seam general strike is north to south, and dip varies from 5^o to 15^o towards the west.

Outcrops of coal seam lie scattered in creeks and suboutcrops also were checked by drilling or pitting at places, along the western flank of two sets of anticline structure.

Broken Hill Proprietary Co., Ltd., operates a coal mine in Hunter Valley of New South Wales, Australia, by a unique multi-bench excavation method, using shovel and trucks, front end loaders and dozers with ripper.

A similar mining method is applied on a small scale in Indonesia. For example: private coal mine on Mahakam River in Kalimantan, developing small coal mine in West Java and one-time Ombiline coal mine in Central Sumatra.

The said excavating method was considered for the study.

Continuous mining method combined bucket wheel excavators with shiftable belt conveyors can be introduced. However, movability of mining machines must be first considered with coal mines which dig rather thin plural coal seams by multi-bench excavation method, in order to keep a well balanced exposed length on faces between coal and waste corresponding to planned annual production rate and maintaining definite production level.

Furthermore, such a coal mine will always excavate coal and waste on the same bench at the same time, and then, both materials cannot be dug at the same time, if two belt conveyor lines (one line for coal, the other line for waste) are not installed, or, time differential transportation with single belt conveyor line is not applied or different haulage systems are not applied to coal and waste (for example, belt conveyor transportation method for waste, truck haulage for coal).

If the above mentioned three are followed, increase of initial investment cost or lowering of utilization of mining machines is not unavoidable.

Scrapers are also not advantageous because of long hauling road.

Therefore, loading and haulage system combined electric shovels or front end loaders with trucks was chosen taking serious view of manoeuverability of machines, and rather small capacity of machines were selected.

However rather bigger capacity of machines, and belt conveyor system for waste shall be investigated, so as to absorve increase of transportation cost, as much as practicable, when working faces sink down into lower level or approach to the northern or southern boundary of the deposit, then, hauling roads get longer and longer.

Coal will be loaded into truck by wheel loaders on the bench floor level, after ripping and pushing of dozers. Partial blasting will be needed to make ripping action easier.

Waste will be dug and loaded into trucks by shovels, except waste wedges which will be loaded with shovels or loaders after ripping and pushing with dozers. (see Fig. 6-2-1)

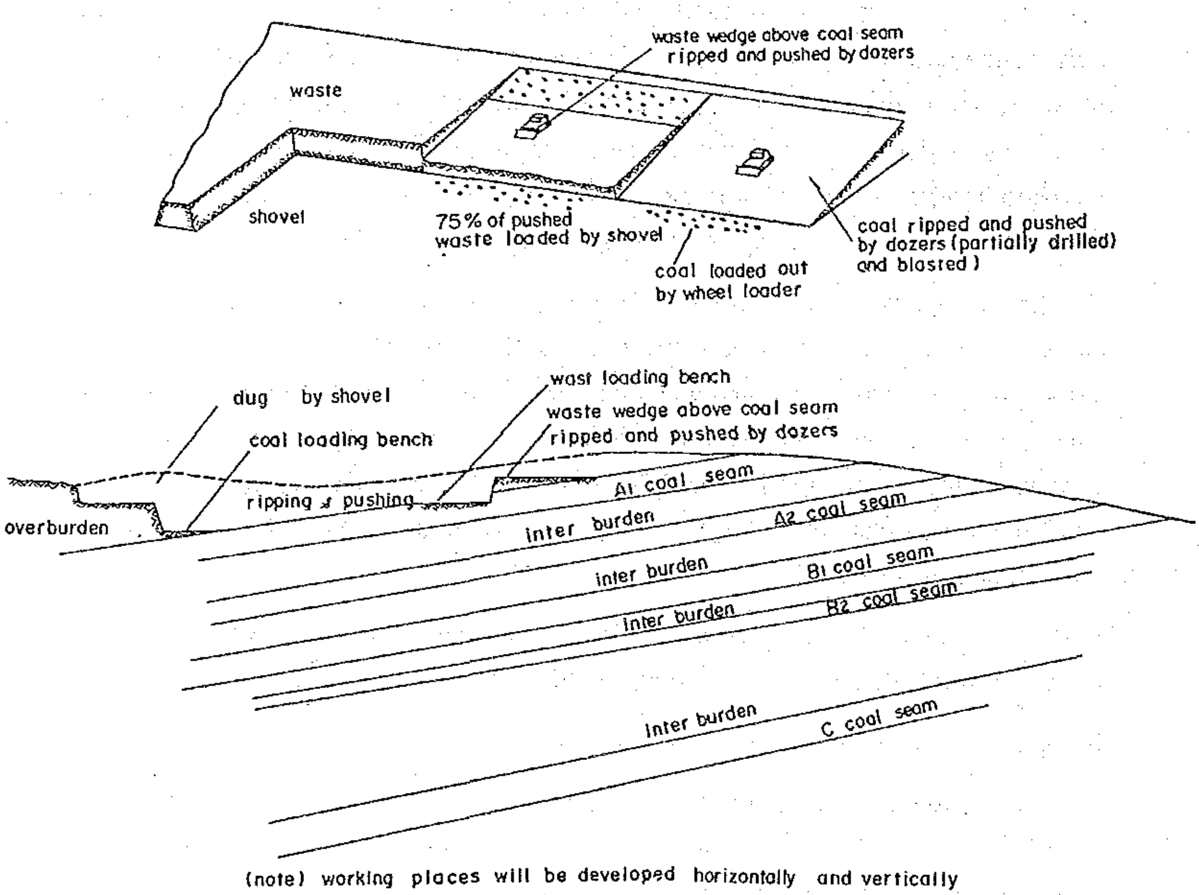


Fig. 6-2-1 Idealized Mining System in Three Dimensions

Some core drilling shall be carried out every year, covering the expected mining area, a few years before digging, for the future detailed mining plan.

Fig. 6-2-2, Fig. 6-2-3, Fig. 6-2-4, Fig. 6-2-5 and Fig. 6-2-6 show ultimate shape of expected mining area and its shape at the starting of production. Fig. 6-2-2 shows horizontally projected section and other drawings show vertical sections.

The drawings were prepared under the following idea.

i) Ultimate pit slope is 15^{o} (inclination of each bench wall: 60^{o} finally, 70^{o} during operation, temporary length of berms on each bench: 30 meters at least)

ii) Road slope: 8% max.

iii) The deepest bench level: -25ML

iv) All benches, facing the east or north direction, catch coal seam on each toe.

2) Production Schedule

Annual needed tonnage of run-of-mine coal for methanol production was estimated as follows, based on 27.6% moisture content on the belt conveyor at the mine, and considering 0.3% of transportation loss.

Therefore, annual production schedule is estimated as follows, considering stock of coal at the mine-site stock yard. Besides, moisture content at the mine is estimated at 30%, roughly so as to estimate mining cost rather conservatively, because it is impossible to measure exact moisture contents at the mine.

(x 1000 tons)

		1999	2000	2001	2002	2003	2004	2005
treated tonnage at the plant		-	866	1114	2103	2351	3340	3588
mined tonnage at the pit		59	840	1120	2100	2380	3325	3605
stock of coal	at the beginning of FY	-	59	33	39	36	65	50
	increase or decrease during FY	59	-) 26	6	-) 3	29	-) 15	17
	at the end of FY	59	33	39	36	65	50	67

		2006	2007 -2019	2020	2021 -2033	2034	total
treated tonnage at the plant		3712	3712	3712	3712	3712	121010
mined tonnage at the pit		3745	3710	3745	3710	3631	121010
stock of coal	at the beginning of FY	67	100	74	107	81	0
	increase or decrease during FY	33	-) 26*1	33	-) 26*1	81	
	at the end of FY	100	74*2	107	81*2	0	

(note)*1 total decrease in the stock of coal for 13 years' period
(note)*2 totaled tonnage at the end of the said period.

3) Annual Waste Removal Schedule

The matter was estimated that total waste removal volume was 287.6 million bank m^3 and stripping ratio was 2.30 bank m^3/ton in situ, consulting existing data and information. A detailed review was not carried out under the present project, as aforementioned, because such a task was beyond the scope of the present report. The total waste removal volume during pre-production period is estimated at 15.5 million bank m^3, based on Fig. 6-2-2. The balanced 272.1 million bank m^3 shall be removed during production period and annual waste removal schedule is fixed as follows.

	Pre-Production Period				Production Period					
annual digging volume (10^3m^3)	FY1997	98	99	sub-total	2000	1	2	3	4	5
waste	1824	6382	7294	15500	6627	7952	9542	10496	9746	9524
coal	-	-	47	47	667	889	1667	1889	2639	2861
total	1824	6382	7341	15547	7294	8841	11209	12385	12385	12385
daily digging *2 volume (10^3m^3/day)	10.42*1	18.23	20.84		20.84	25.26	32.03	35.39	35.39	35.39
Stripping ratio	-	-	-	-	7.89	7.10	4.54	4.41	2.93	2.64

(note)*1 the second half of the fiscal year only
(note)*2 as assuming that the annual working days are 365 days.

annual digging volume (10^3m^3)	2006	2007 -9	2010 -19	2020	2021 -25	2026 -33	34	sub-total	total
waste	9413	9441	7420	7392	7420	6865	6865	272100	287600
coal	2972	2944	2944	2972	2944	2944	2882	95982	96029
total	12385	12385	10364	10364	10364	9809	9747	368082	383629
daily digging *2 volume (10^3m^3/day)	35.39	35.39	29.61	29.61	29.61	28.03	27.85	31.31	
Stripping ratio	2.51	2.54	2.00	1.97	2.00	1.85	1.89	2.25	

Average daily digging volume and final stripping ratio during production period are 31.31 thousand m^3/day and 2.25 m^3/ton, respectively, as shown in the above table.

(3) Mining Facilities

Numbers of main and subsidiary mining machines, to be procured newly every year for setting-up in production or replacement, were estimated considering the following preconditions, shown as in the Table 6-2-1.

i) annual warking days: 350 days

ii) working system: 3 shifts of 8 hours (actual working hours/shift: 6 hrs) a day (4 crews shall be organized and one of 4 crews will take leave in turn every day)

iii) ordinary pit utilization factor: 0.90

iv) pit utilization factor during rainy season (from September to March): 0.70 considering unfavorable influence on working efficiency, caused by heavy rain during the rainy season

v) machine availability: 85%, in principle

(4) Support Facilities

1) Coal Stockyard Facilities

Mined coal will be hauled from the pit to the stockyard by trucks, and then coal will be transported to the plant by the belt conveyor.

The stocked capacity of coal will be 200,000 tons (pit production equivalent to half a month's operation) and inside belt conveyor and hoppers to feed the above mentioned transportation belt conveyor will be constructed.

Some dozers and front-end-loaders will be posted in order to handle coming and outgoing coal.

2) Buildings and Other Structures

The following buildings and other structures were considered in the conceptual investigation.

i) mine office: fully air-conditioned, furnished with needed furnitures and utensils

ii) engineering room: fully air-conditioned, furnished with needed office furniture, utensiles and facilities

iii) training center: partially air-conditioned, furnished with needed facilities

iv) machine shops, including heavy vehicle service shop (with pits), light vehicle workshop (with pits), tyre repair shop and storage, blacksmith's shop, engine reconditioning service and painting shop - furnished with needed facilities to service and repair all machines by mine staffs

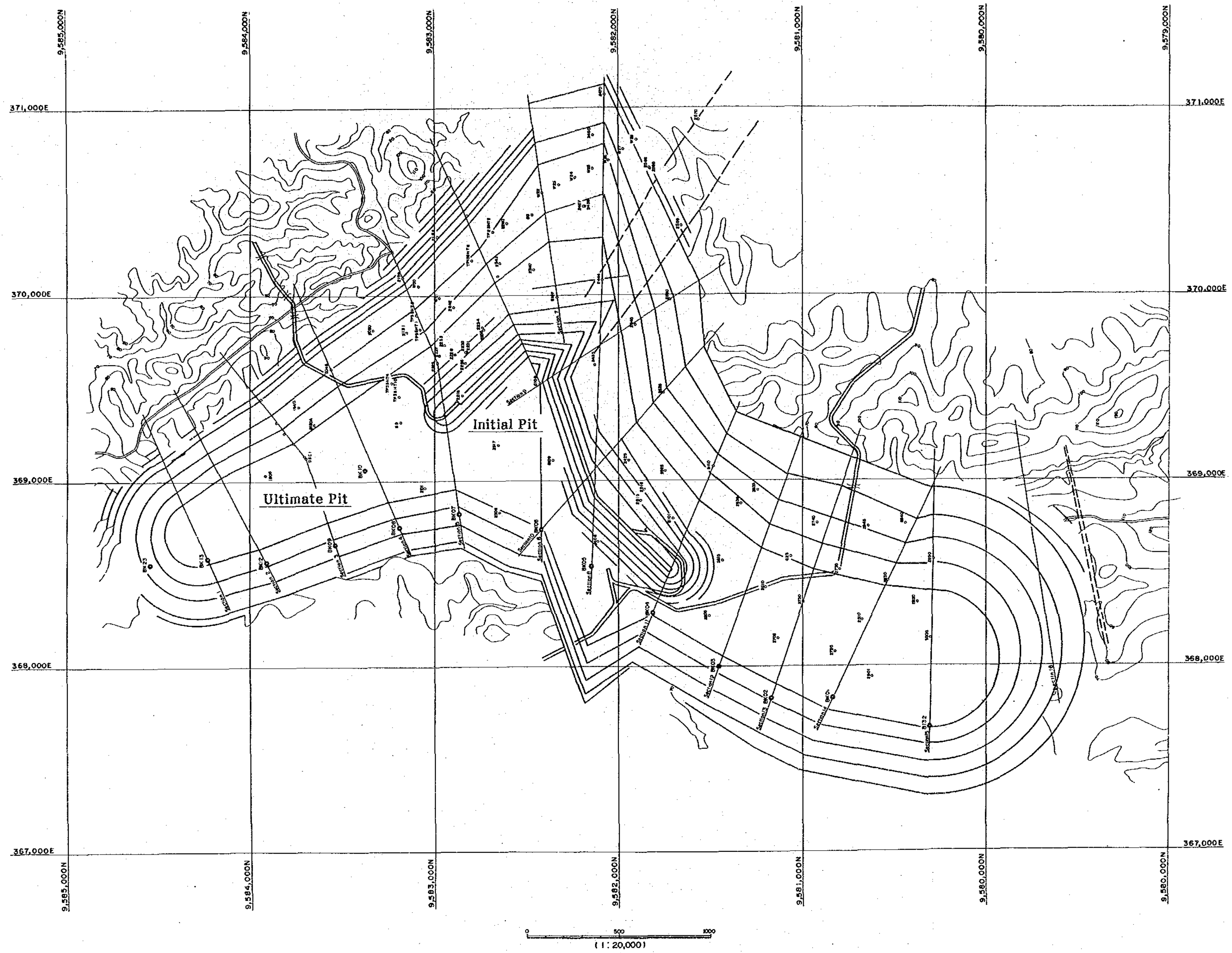


Fig. 6-2-2 Holizontally Projected Ultimate Shape of Expected Mining Area and its Shape at the Starting of Production

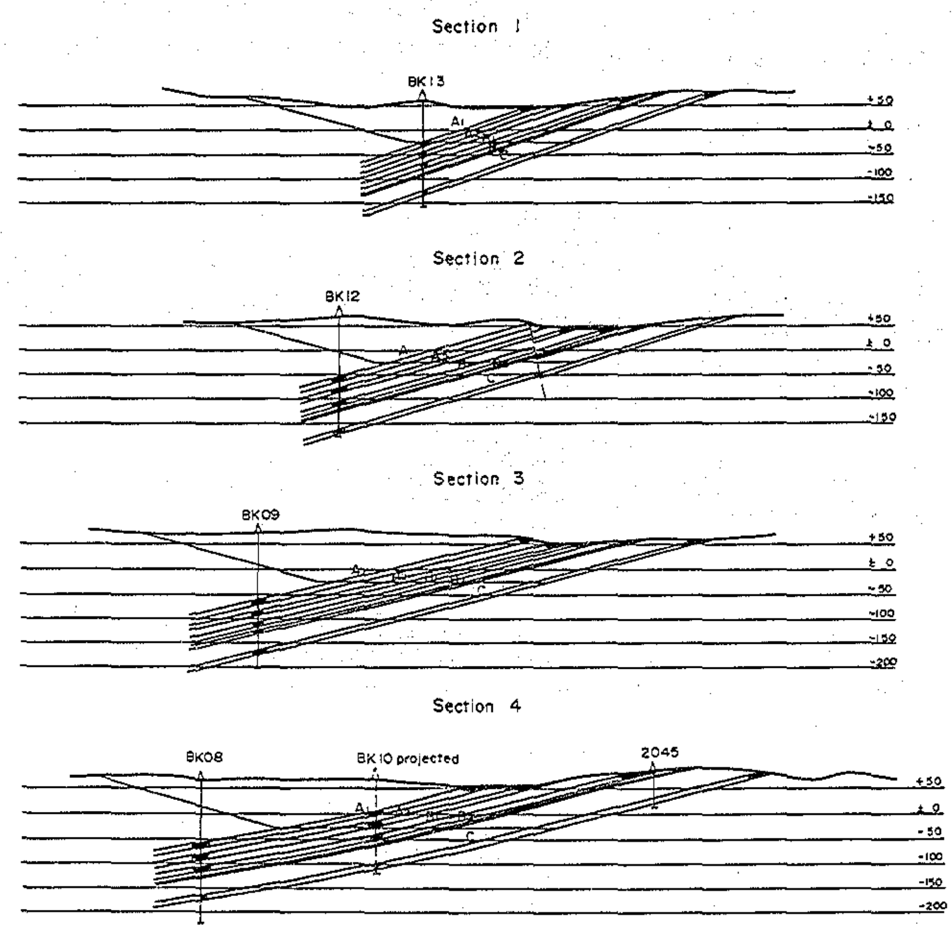


Fig. 6-2-3 Ultimate Shape of Expected Mining Area and its Shape at the Starting of Production (Vertical Section - 1)

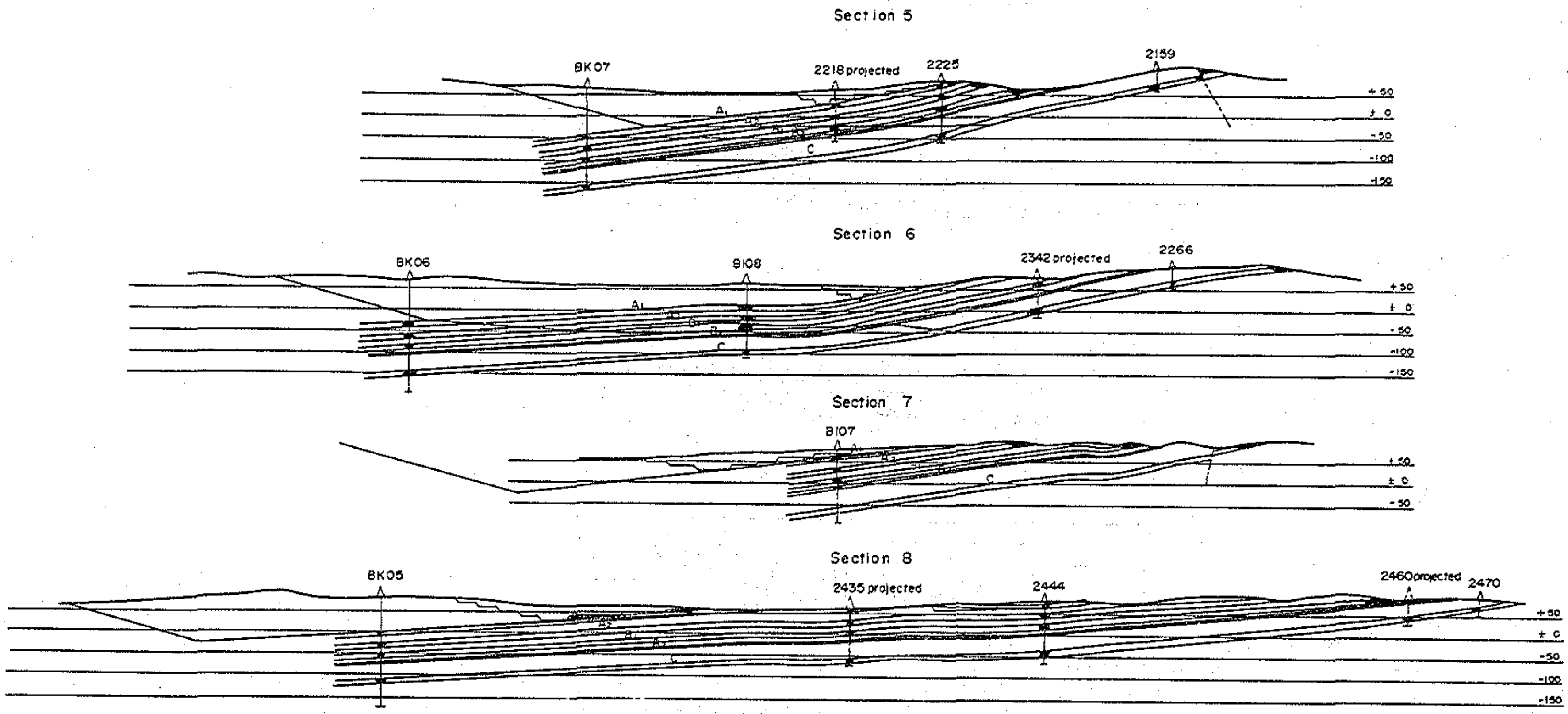


Fig. 6-2-4 Ultimate Shape of Expected Mining Area and its Shape at the Starting of Production (Vertical Section - 2)

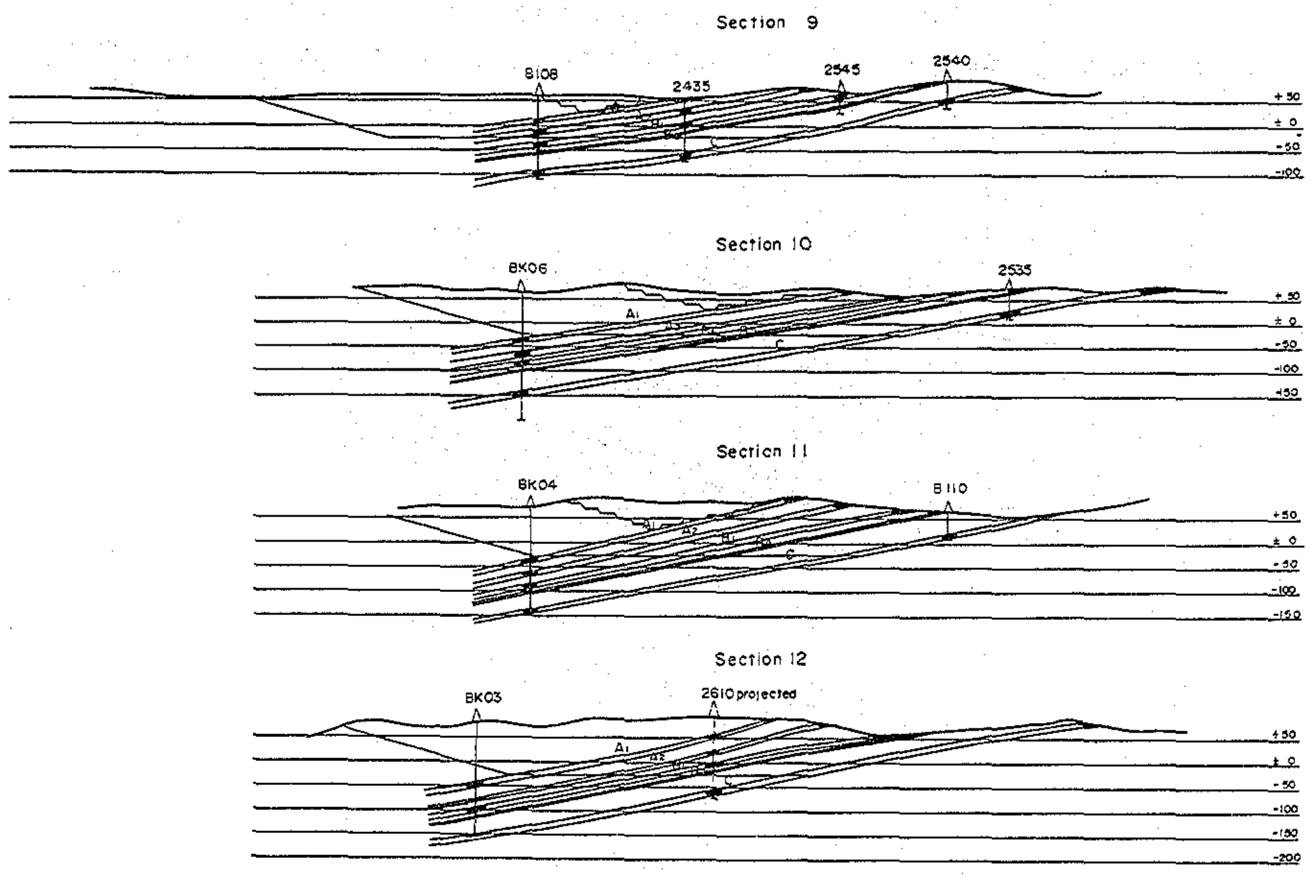


Fig. 6-2-5 Ultimate Shape of Expected Mining Area and its Shape at the Starting of Production (Vertical Section - 3)

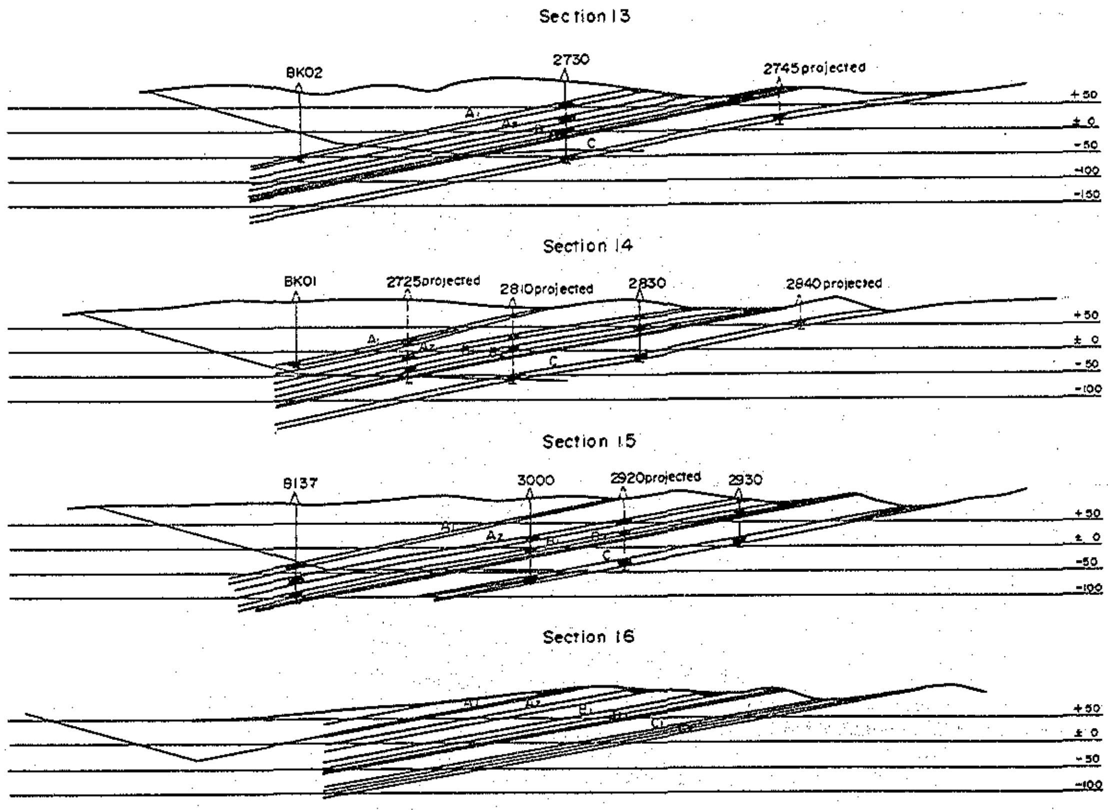


Fig. 6-2-6 Ultimate Shape of Expected Mining Area and its Shape at the Starting of Production (Vertical Section - 4)

v) electric service station - ditto -

vi) warehouse - furnished with needed utensiles and facilities

vii) fuel oil storage tanks

viii) powder magazine

ix) outdoors fenced storage yard

x) garage

Furthermore, the following items and facilities were also considered in the conceptual study.

i) reconstruction of the approach road from Tanjung Enim to the mine site

ii) power distribution line from the main substation to each facilities within the mine

iii) water storage facilities and supply system

iv) temporary facilities and construction at the beginning of the pre-production period

v) some kind of needed vehicles and special mobiles (see Table 6-2-1)

It was promised in estimating the initial investment cost that electric power is supplied from Bukit Asam power plant by PLN at the main substation of the mine.

The said substation construction cost was included in the initial investment cost. However, the transmission line from the power plant to the mine site was not included in the investment cost borne by the coal mine, on the assumption that it is territory of PLN, even if the construction cost shall be paid back in the form of power rate.

The expenses to acquire the ownership of land (compensation money) were also considered in the conceptual study, consulting with advice done by the person of Muara Enim Sub-Province Office, in charge.

3) Townsite

Construction cost of a primary school, a junior high school, a dispensary, a mosque, canteens and some recreational facilities (such as tennis court, basket court and a swimming pool which also serves as water reservoir in the case of fire) were considered in the study, besides construction cost of housing facilities for staffs, workers and foreign consultants.

The numbers of houses, prepared under the present Project, were decided as shown in Table 6-2-3, under the condition that

i) Houses will be prepared for employees above V category as needed.

ii) The company will accommodate employees who need funds to buy or to build their own houses with a loan as needed.

iii) All employees who do not live in the houses prepared under the project will be given housing allowance.

iv) Foreign consultants also will be prepared houses by the company.

(5) Mine Organization Chart and Needed Number of Employees

It is estimated that a joint venture with majority owned by Republic of Indonesia will be established newly in order to manage and operate the Banko coal gasification project, and then, the coal mine will be operated by one department of the said company. Mine organization chart is shown in Fig. 6-2-7, and needed numbers of employee, by categories are shown in Table 6-2-2.

(6) Technical Assistance and Training

The mine shall be constructed by a joint venture and personnel required for mine operation will be trained by the said company during pre-production period.

Machines procured and facilities constructed will be transferred from the contractor to the joint venture at the end of pre-production period.

Operation assistance carried out by the foreign partner of joint venture also will be necessary at least 10 years, after starting operation.

After making a decision to drive the project, the following work shall be done by the said foreign partner, before starting construction work.

(i) preparing detailed design for mine and support facilities for mine construction.

(ii) preparing tender specifications evaluation of tender document presented by suppliers and/or contractors, and selection of suppliers and contractors.

All the above mentioned expenses were appropriated in the cost estimation.

(7) Investment Cost Estimation

Needed investment cost (initial investment cost and replacement cost) was estimated, taking into the above mentioned consideration. Procurement program of main machines and equipment is shown in Table 6-2-1.

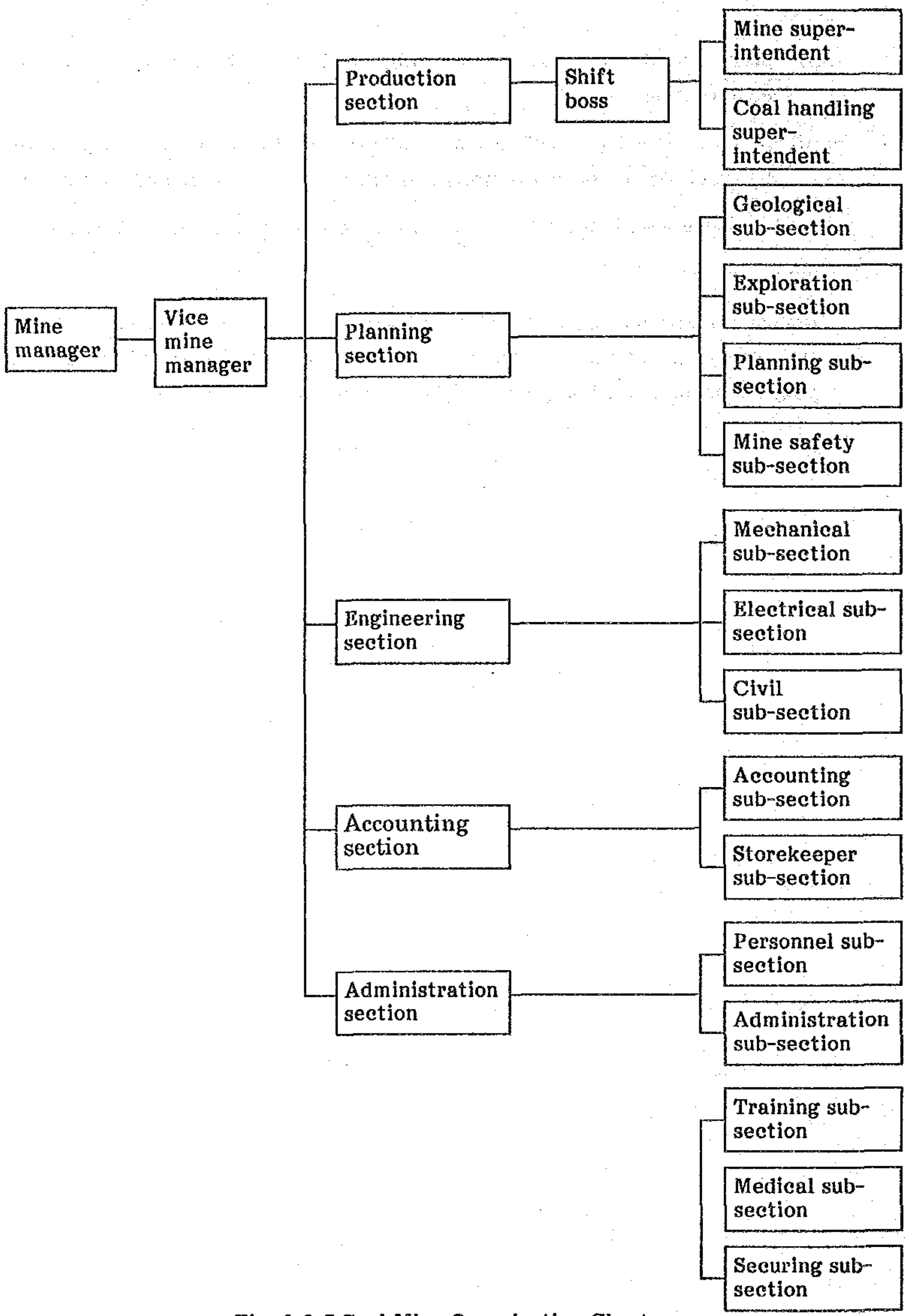


Fig. 6-2-7 Coal Mine Organization Chart

Table 6-2-1 (1) Procurement Program of Main Machines and Equipment (1)

Items	Specification	Pre-production period				Production period																																					Remarks
	F.Y.	1997	1998	1999	Sub-total	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	Sub-total	Total	
Electric shovel	Working weight 232 tons, installed power 1091 KW bucket capacity 10.7 m³, cutting height: max. 14.6 m cutting radius max. 17.4 m dumping height max. 10.3 m marion 151-M class.	2	1		3			1										1 (1)	1 (1)				1 (1)										1 (1)	1 (1)							6 (5)	9 (5)	(note) enclosed figures in parentheses are shown number of machines to be replaced.
Wheel loader	Working weight 48 tons with high lift spade edge rock with teeth (9.1 m³), flywheel power 690 HP, Caterpillar 992 C class			1	1	1				1							2 (2)			1 (1)								2 (2)		1 (1)											8 (6)	9 (6)	
Off-highway truck	Flywheel power 650HP, operating weight (empty) 3,866 kg, capacity (2:1) 34.1 m³, Caterpillar 773 B class	8	5	3	16	1	2	6	2	2	14 (13)	2 (2)	2 (1)	3 (3)	6 (6)	3 (2)	4 (4)	8 (8)	5 (2)	2 (2)	2 (2)	6 (5)	5 (5)	3 (3)	2 (1)	13 (12)	3 (2)	3 (3)	5 (4)	9 (7)	1 (1)	3 (3)	10 (9)	6 (6)	6 (5)	5 (5)	9 (8)	3 (2)			156 (126)	172 (126)	
Dozer	Flywheel power 520HP, operating weight 56 tons with single shank ripper, Caterpillar D10N class			1	1	1		2		2	1				2 (2)		2 (2)	2 (2)	1 (1)						2 (2)		2 (2)		2 (2)	1 (1)				2 (2)			2 (2)				24 (18)	25 (18)	
Dozer	Flywheel 165HP, operating weight 17 tons with semi-universal blade, Caterpillar D6H class	4	3	1	8	1		1		3 (2)	1 (1)	1 (1)	1 (1)		1 (1)		3 (3)	1 (1)	1 (1)	3 (3)	2 (2)	1 (1)		1 (1)	3 (3)		4 (4)	2 (2)	1 (1)		1 (1)	3 (3)		4 (4)	2 (2)	1 (1)					42 (39)	50 (39)	
Dozer	Flywheel power 120HP, operating weight 12 tons with angle blade, Caterpillar D5H class	1	1		2					1	1 (1)					1 (1)	1 (1)			1 (1)		1 (1)	1 (1)					1 (1)	1 (1)		1 (1)			1 (1)	1 (1)						12 (11)	14 (11)	
Track loader	Flywheel power 210HP, operating weight 25 tons with 26 m³ multipurpose bucket. Caterpillar 973 class		1		1					1	1 (1)					1 (1)	1 (1)					1 (1)	1 (1)					1 (1)	1 (1)					1 (1)	1 (1)						10 (9)	11 (9)	
Motor grader	Flywheel power 200HP, operating weight 18 tons blade length 4.27 m Caterpiller, LG class	1			1																			1 (1)																	1 (1)	2 (1)	
Backhoe	Flywheel lpower 75HP, operating weight 7 tons with 2.5 yd³ bucket (SAE heaped), Caterpillar 436 class	1			1																1 (1)																				1 (1)	2 (1)	
Blasthole drill	Crawler – mounted track-type, compressed – air operated			1	1	1				2													1 (1)	1 (1)				2 (2)													7 (4)	8 (4)	
Air compressor	Portable-type, operating weight 4 tons flywheel power 235HP, 25.5 m³/min.			1	1	1				2													1 (1)	1 (1)				2 (2)													7 (4)	8 (4)	
Track crane	Max. lifting capacity 25 tons, height 431 m		1		1																																					1	
Water sprinkler	600 ℓ	2	2	1	5										2 (2)	2 (2)	1 (1)										2 (2)	2 (2)	1 (1)												10 (10)	15 (10)	

Table 6-2-1 (2) Procurement Program of Main Machines and Equipment (2)

Items	Specification F.Y.	Pre-production period				Production period																																					Remarks
		1997	1998	1999	Sub-total	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	Sub-total	Total	
Fuel oil carrier	600ℓ	2	2	2	6										2 (2)	2 (2)	2 (2)											2 (2)	2 (2)	2 (2)											12 (12)	18 (12)	
4 whell drive car		17			17			17 (17)					17 (17)					17 (17)						17 (17)				17 (17)					17 (17)					17 (17)			119 (119)	136 (119)	
Dump truck	7 tons	3			3						3 (3)								3 (3)								3 (3)								3 (3)						12 (12)	15 (12)	
Flatbed truck	For labour transportation 7tons	3	3	2	8					3 (3)	3 (3)	2 (2)					3 (3)	3 (3)	2 (2)					3 (3)	3 (3)	2 (2)					3 (3)	3 (3)	2 (2)					3 (3)			35 (35)	43 (35)	
-do-	For micellaneous affairs 7 tons	3			3					3 (3)							3 (3)							3 (3)							3 (3)							3 (3)			15 (15)	18 (15)	
-do-	For micellaneous affairs 4 tons	5			5					5 (5)							5 (5)							5 (5)							5 (5)							5 (5)			25 (25)	30 (25)	
Mobile crane	40 tons	1			1																	1 (1)																			1 (1)	2 (1)	
Passenger car		1			1			1 (1)					1 (1)					1 (1)					1 (1)					1 (1)					1 (1)					1 (1)			7 (7)	8 (7)	
Fire truck		1			1											1 (1)												1 (1)													2 (2)	3 (2)	
Ambulance		1			1																1 (1)																				1 (1)	2 (1)	
Minibus		5			5				5 (5)						5 (5)						5 (5)						5 (5)							5 (5)							25 (25)	30 (25)	
Forklift	6 ton	2			2										2 (2)													2 (2)													4 (4)	6 (4)	
Food container truck		1			1										1 (1)													1 (1)													2 (2)	3 (2)	
Dewatering pump			3		3	1		1			1		4 (3)		1 (1)		2 (1)			2 (1)		4 (4)	1	1 (1)		4 (2)			4 (2)		4 (4)	3 (1)	1 (1)		6 (4)			6 (4)			46 (29)	49 (29)	
Core drilling machine	40 ~ 50 m operating weight 1.0 tons 11 KW	2			2																2 (2)																				2 (2)	4 (2)	
Dewatering pipe	150 mmφ unit: set		0.75		0.75	0.10		0.10			0.10		0.20		0.10 (0.10)	0.75 (0.75)	0.20 (0.10)	0.10 (0.10)		0.20 (0.10)		0.30 (0.10)	0.10		0.20 (0.20)	0.20 (0.20)	0.10 (0.10)	0.75 (0.75)	0.60 (0.30)	0.10 (0.10)	0.40 (0.40)	0.30 (0.30)	0.30 (0.30)		0.10 (0.10)						5.30 (4.00)	6.05 (4.00)	
Ballast plant				1	1															1 (1)		1 (1)																			2 (2)	3 (2)	
Stockyard belt conveyor				1	1																																					1	

Table 6-2-2 Numbers of Employee for Each Category

	I	II	III	IV	V	VI	VII	VIII	Total
Mine manager	1								1
Vice mine manager	1								1
Production section	4		5		15	337	287	600	1248
Planning section	5	4	10	10		30		50	109
Engineering section	7	3	10	10		20	20	50	120
Accounting section	1	2	10	20		5	5	10	53
Administration section	1	5	15	30		65	115	300	531
Total	20	14	50	70	15	457	427	1010	2063

(Note 1) I : Mine manager, vice mine manager, engineer and section chief; mainly university graduates
II : Sub-section chief; university or academy graduates
III : Senior professional; academy graduates
IV : Junior professional; academy or senior high school graduates
V : Superintendent; high school graduates or same level
VI : Skilled worker
VII : Semi skilled worker
VIII : Unskilled worker

(Note 2) *The above figures show the maximum annual numbers of employee.*

Table 6-2-3 Construction Plan of Houses

	1997	1998	1999	Sub-total	2000	2001	Sub-total	Total
Foreigner	50			50				50
Category I	5	3	2	10				10
II	3	2	2	7				7
III	15	10	10	35	6	6	12	47
IV	20	15	15	50	10	10	20	70
V	5	5	5	15				15
Total	98	35	34	167	16	16	32	199
Dormitory	2	1		3				3

(Note) 20 of 50 houses prepared for foreigners will be available for the company after starting production.

(8) Operating Cost Estimation

Operating cost during the life of the project is estimated as follows, taking the above mentioned consideration and the following premise into account.

i) All of the required funds for the coal mine development and operation will be raised by long-term and short-term debt.
Loaning conditions are as follows:

	Annual interest rate	Remarks
Long-term debt		
for coal mine development	8.18%	Repayment is started after the start of production
for infrastructure construction	5.00%	
Short-term debt		
for working fund	13.00%	The longest loan term is one year
for deficit covering	13.00%	

ii) Depreciation allowance will be calculated following the procedure provided in the statute.

		Annual depreciation rate and method
Category 1	Lifetime not more than four years	50%, declining balance method
Category 2	Lifetime not more than eight years	25%, declining balance method
Category 3	Lifetime not more than eight years	10%, declining balance method
Category for buildings, including their expansions, repairs, and modifications		5%, fixed installment method

(Note) Expenses incurred in obtaining mining rights except those for oil and gas have to be amortized following the unit of production method with a maximum of 20% p.a.

iii) Import duties were not considered on the assumption that they would be exempted since the coal mine would be operated by an organization of the government.
However, value added tax on payment and land tax were appropriated in the operating cost estimation.

Table 6-2-4 Estimated Mining Cost Except Interest

Unit: 10^3 = US$

	Production period												
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Mining cost													
Labour cost	3,296	3,296	3,448	3,523	3,874	3,895	3,895	3,914	3,914	3,914	3,911	3,991	3,991
Material expences	5,478	6,379	8,247	9,029	10,132	10,410	10,589	10,657	10,740	10,833	9,933	10,016	10,095
Power cost	787	787	912	912	912	1,037	1,037	1,162	1,287	1,412	1,537	1,537	1,787
Preparatory work	449	449	449	599	599	599	449	449	449	599	599	599	449
Sub-total	10,010	10,911	13,056	14,063	15,517	15,941	15,970	16,182	16,390	16,758	15,980	16,143	16,322
Other than mining cost													
Labour cost	4,946	4,946	4,946	4,946	4,946	4,946	4,946	4,946	4,946	4,946	4,946	4,946	4,946
Material cost	637	637	637	637	637	637	637	637	637	637	637	637	637
Power cost	328	351	351	351	351	433	433	433	433	433	592	592	592
Tax and public dues	20	20	20	20	20	20	20	20	20	20	20	20	20
Amount paid to outside contractors	511	511	511	511	511	511	511	511	511	511	511	511	511
General expenses	224	224	224	224	224	224	224	224	224	224	224	224	224
Sub-total	6,666	6,689	6,689	6,689	6,689	6,771	6,771	6,771	6,771	6,771	6,930	6,930	6,930
Project management & training fee	5,314	5314	5,314	5,314	5,314	3075	3,075	3,075	3,075	3,075	—	—	—
Depreciation & amortization	11,757	10,791	10,607	10,456	10,169	10,975	10,996	10,068	9,399	9,386	9,466	9,719	10,683
Contingency	5,062	5,056	5,350	5,478	5,653	5,514	5,522	5,414	5,345	5,399	4,856	4,919	5,090
Total	38,809	38,761	41,016	42,000	43,342	42,276	42,334	41,510	40,980	41,389	37,232	37,711	39,025
$/ton	44.81	34.79	19.50	17.86	12.98	11.78	11.40	11.18	11.04	11.15	10.03	10.16	10.51

	Production period												Sub-total	
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024		
Mining cost														
Labour cost	3,967	3,967	3,967	3,986	3,986	4,007	4,026	4,047	4,063	4,063	4,082	4,121	97,144	1.16
Material expences	10,219	10,264	10,348	10,442	10,537	10,620	10,723	10,850	10,925	11,025	11,144	11,249	250,884	2.99
Power cost	1,787	2,038	2,038	2,488	2,488	2,538	2,788	2,788	2,788	2,788	2,788	2,788	45,211	0.54
Preparatory work	449	449	599	599	599	449	449	449	599	599	599	449	13,025	0.16
Sub-total	16,422	16,718	16,952	17,515	17,610	17,614	17,986	18,134	18,375	18,475	18,613	18,607	406,264	4.85
Other than mining cost														
Labour cost	4,946	4,946	4,946	4,946	4,946	4,946	4,946	4,946	4,946	4,946	4,946	4,946	123,650	1.47
Material cost	637	637	637	637	637	637	637	637	637	637	637	637	15,925	0.19
Power cost	592	592	592	592	592	592	592	592	592	592	592	592	12,777	0.15
Tax and public dues	20	20	20	20	20	20	20	20	20	20	20	20	500	0.01
Amount paid to outside contractors	511	511	511	511	511	511	511	511	511	511	511	511	12,775	0.15
General expenses	224	224	224	224	224	224	224	224	224	224	224	224	5,600	0.07
Sub-total	6,930	6,930	6,930	6,930	6,930	6,930	6,930	6,930	6,930	6,930	6,930	6,930	171,227	2.04
Project management & training fee	—	—	—	—	—	—	—	—	—	—	—	—	41,945	0.50
Depreciation & amortization	11,247	10,959	10,226	9,895	9,834	9,765	9,604	4,296	4,662	4,834	5,063	5,287	230,144	2.74
Contingency	5,190	5,191	5,116	5,151	5,156	5,146	5,178	4,404	4,495	4,536	4,591	4,624	127,436	1.52
Total	39,789	39,798	39,224	39,491	39,530	39,455	39,698	33,764	34,462	34,775	35,197	35,448	977,016	11.65
$/ton	10.72	10.72	10.57	10.64	10.65	10.63	10.69	9.10	9.28	9.37	9.48	9.55	11.65	

	Production period											$/ton
	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	Total	
Mining cost												
Labour cost	4,121	4,121	4,121	4,082	4,098	4,118	4,137	4,158	4,158	4,158	138,416	1.14
Material expences	11,357	11,115	11,231	11,340	11,461	11,579	11,696	11,826	11,863	11,799	366,151	3.03
Power cost	2,788	2,788	2,788	2,788	2,788	2,788	2,788	2,788	2,788	2,788	73,091	0.60
Preparatory work	449	449	599	599	699	63	63	63	213	213	16,335	0.14
Sub-total	18,715	18,473	18,739	18,809	18,946	18,548	18,684	18,835	19,022	18,958	593,993	4.91
Other than mining cost												
Labour cost	4,946	4,946	4,946	4,946	4,946	4,946	4,946	4,946	4,946	4,946	173,110	1.43
Material cost	637	637	637	637	637	637	637	637	637	637	22,295	0.18
Power cost	592	592	592	592	592	592	592	592	592	592	18,697	0.15
Tax and public dues	20	20	20	20	20	20	20	20	20	20	700	0.01
Amount paid to outside contractors	511	511	511	511	511	511	511	511	511	511	17,885	0.15
General expenses	224	224	224	224	224	224	224	224	224	224	7,840	0.07
Sub-total	6,930	6,730	6,930	6,930	6,930	6,930	6,930	6,930	6,930	6,930	240,527	1.99
Project management & training fee	—	—	—	—	—	—	—	—	—	—	41,945	0.35
Depreciation & amortization	4,966	4,207	4,441	5,336	5,601	5,136	5,026	4,871	3,952	12,111	285,790	2.36
Contingency	4,592	4,442	4,517	4,661	4,722	4,592	4,596	4,595	4,486	5,700	174,339	1.44
Total	35,203	34,052	34,627	35,736	36,199	35,205	35,236	35,231	34,390	43,699	1,336,594	11.05
$/ton	9.48	9.17	9.33	9.63	9.75	9.48	9.49	9.49	9.26	11.77	11.05	

iv) Both investment cost and operating cost were estimated, based on 1988 U.S. Dollar value and commodity price levels.

The study was carried forward on condition that the coal mine would be operated together with the plant, in the hands of the same joint venture as described above therefore mined coal would be delivered at actual cost basis general principles profits of coal mine operation (which are usually liable for taxation) should not be carried out.

It is predestined for a opencast mine operation that haulage distance is getting longer and longer and transportation cost rises as the pit sinks down, moreover the stripping ratio fluctuates the cost year in and year out.

It is also quite knotly problem on the study that declining balance method of depreciation is advisable.

Coal unit delivery cost to the plant under investigation should be divided into several yearly segments, because the cost in the early years is quite high compared with that in the latter years, and profit will not be realized until after the five year's deficit carrying foreward period. (see Table 6-2-4)

To simplify the following discussion, a 14 $/ton of uniform unit coal cost to the plant, including the interest, was applied.

The matter should be investigated in the future.

(9) Influence of Lack of Uniformity of Coal Seam on the Coal Delivery Cost to the Plant

A small but quite important difference was found on thickness between survey results carried out by Shell and BPPT-PPTM/JICA team.

Differences in specific gravity estimated by Shell and Kunhill-Otto Gold also was observed.

The subject for investigation under this heading is change in stripping ratio and its influence on the coal delivery cost to the plant. The lack of coal seam at the expected places is caused by the following reasons.

i) Misunderstanding about thickness of coal seam penetrated by Boreholes

ii) Discontinuity of coal seam cutting by faults

iii) Local shrinkage of coal seam

Furthermore, low estimation of specific gravity is also one of reasons to raise the stripping ratio.

It is still premature to draw the final and definite conclusion now and it is also beyond the scope of this project.

The following will only be an outline at this stage. If the stripping ratio went up ten persent the mining cost will rise by about 2%.

6-2-3 North Suban Jeriji

The survey work under this project had been carried out only to reconfirm outcrops and find suitable core drilling places in the 1987/88 and 1988/89 fiscal year. Therefore, there is not enough data and information on the said area available, and only breaf discussion has been held based on the pre-feasibility report prepared by Kinhill-Otto Gold J.V., which was given to us through the kindness of the director of Directorate of Coal, Directorate General of Mine, Ministry of Mines and Energy.

The summary of the above mentioned report is as follows.

Coal reserve : 502 million tons
Selected mining coal reserve : 100 million tons
Annual production rate : 3.65 million tons/year
Mine life : 30 years (including build-up and phase-out years)
Stripping ratio : 1.6 bank m^3/ton
The height of the lowest bench : 140 ML (depth: 125 m)
Mining method : Shovel/truck method at the first stage, then switch over to Bucket-Wheel-Excavator/Conveyor/Spreader method
Coal quality : Total moisture: 41 ~ 44%
Ash: 3.9 ~ 4.3%
Sulphur: 0.12%
CV net: 13.2 ~ 14.0 MJ/kg
Total number of employee : 3118 (in peak year)

Cost summary :

(US$ '000s)

	Capital cost		Operating cost	
	Initial	Replace-ment	Total amount	$/ton
Mine	145,937	117,574	478,767	4.84
Surface facilities	41,111	26,023	226,514	2.29
Land aquisition and environmental	1,696	-	-	-
Project management	25,549	-	-	-
Training	-	-	9,400	0.09
Operational assistance	-	-	17,200	0.17
Total	214,293	143,595	731,881	7.40
US$ / ton	2.17	1.45	7.40	

(Note 1) Based on 1986 price level and U.S.$ value

(Note 2) Import duty is exempted only from initial investment cost.

(Note 3) Contingency is included in the estimation. ($0.34/ton)

Kinhill-Otto Gold JV also estimated the capital cost and operating cost at almost same level with N.W. Banko (initial capital cost: $1.79/ton, replacement capital cost: $1.91/ton and operating cost: $7.36/ton) regardless of differences in stripping ratio.

The above mentioned suggestion will be followed in this study, because it will be impossible to offset the increase of coal consumption tonnage resulting from it's rather inferior quality compared with North West Banko (that means increase of stripping ratio) by decrease of unit mining cost.

6-2-4 Evaluation of Coal Basins as Energy Resources

The government of Indonesia carried forward the exploration programme on South Sumatra coal field after being granted a loan by the World Bank and after inheriting the task from Shell.

The government appointed Kinhill-Otto Gold JV to be consulting company to assist in carrying out the above mentioned programme.