PART II

DETAILED EXPOSITION

CHAPTER 1

INTRODUCTION

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INTRODUCTION

1.1 PURPOSE OF SURVEY

This feasibility study is made at the request of the Philippine Government to determine the feasibility of tailings disposal program thru TLP System in order to prevent the environmental pollution by affluent slurry of the farms downstream of the Baguio mining area, in Luzon Island, thereby contributing towards establishing permanent measures against environmental pollution with tailings.

1.2 BACKGROUND

In 1971, the President of the Republic of the Philippines issued Executive Order No. 309 to organize a special committee to consider the countermeasures against environmental pollution in the Pangasinan farming region and to start a full-scale investigation of the problem. This environmental pollution is generally considered due to the siltation by tailings from six (6) metal mines around Baguio City, four (4) are located upstream of Agno River and two (2) upstream of Bued River.

The following year, the Committee surveyed the contamination in the eastern sea area of Lingayen Gulf where the above two (2) rivers empty. The committee also surveyed Tañon Strait in Cebu Island where tailings disposal to the sea has newly begun.

Topography of these mining areas surrounding Baguio City is very rugged. These areas are located where localized torrential downpours are in excess of 1,000 mm/day during typhoon seasons. The two (2) major mines at the basin of the Agno River have adopted a dam system for disposal of their tailings, while the other four (4) minor mines are still relying upon
where in the tailings are flushed out every year. In the Philex Mine, the largest in the area which has a current capacity of 28,000 tons/day, tailings flowed out twice from their dam through damaged parts.

Having examined several pipe line methods, the Special Committee proposed in 1975 a TLP System which measures about 29 kms. and consists of a

tunnel about 15 km. long penetrating the mountain area, and the launder or pipe line or a combination of both laid up to the sea coast.

The Government requested domestic and foreign organizations to study the feasibility of the proposed TLP system, and asked in 1977 the Japanese Government for cooperation in the matter thru the Japanese Embassy in the Philippines.

The Japanese Government acted on the PPP principle (Polluters Pay Principle) for environmental pollution problems and sent a preliminary investigation mission (3 persons) to the Philippines at the end of the year to review the basic problems such as original TLPS plan, the mining companies' capacity to bear the investigation costs, etc.

In view of this tailings disposal problem in the Philippines, they decided to dispatch the main mission for the feasibility study of TLPS.

1.3 SURVEY ITEMS

The survey items are generally divided as follows:

a. Investigation of mines at Baguio District.
b. Survey and selection of the routes of TLPS.
c. Geological Survey around TLPS route.
d. Survey of the sea area where tailings are disposed.
e. Collection and research of other related data.

1.4 ORGANIZATION OF THE SURVEY MISSION

The Mission had the honor to appoint Mr. Ken Saito, Director of the Metal Mining Agency, to act as the leader of the Mission. The Mission also asked the persons below for their special participation in the survey.

Ken Saito	Leader of the Mission
Mutsumi Motegi	Adviser
Shozo Sawaya	Coordination of the Mission's local activities.

The staffs of technical sections are:

Hiroo Washimi	Subleader Hydraulic transportation	(Dowa Engineering Co.)

Ikuo Morita	Mining	(Dowa Engineering Co.)
Nobuyoshi Asami	Civil Eng'g.	(")
Takao Matsumoto	Piping	(")
Noriyuki Fukubayashi	Sea area	(")
Kenichi Watanabe	Geology	(")
Futaki Hikage	Civil Eng'g.	(")
Tsutomu Kodama	Geology	(")
Taizo Matsumoto	Geology	(")
Setsuo Takemoto	Coordination of the total activities	(Japan International Cooperation Agency)

1.5 SURVEY SCHEDULE

The Mission left Japan on January 30 and returned on February 28, 1978. During this period of 23 or 30 days, it conducted investigation activities on various fields. The group, headed by the Mission leader, took 10 days to study the whole situation including the conditions of agriculture and fishing. The group in charge of the sea area survey also spent 10 days. The geological survey group took 16 days for the field survey, survey by aerial photos, and a partial and simplified levelling of the tailing transportation route on the plain. The other group spent 18 days for the System Planning as well as the mine survey, general investigation along the route and of the tunnel entrances. In the meantime, all the members except for the geological survey group inspected the tailings disposal of the Marcopper Mine (27,000 tons/day tailings) and the C.M.I. Mine (System under construction for transporting 10,000 ton/day tailings) in the Marinduque Island, and the Atlas Mine (100,000 ton/day tailings) in Cebu Island.

CHAPTER 2

RESULTS OF MINE SURVEY

CHAPTER 2

RESULTS OF MINE SURVEY

2.1 PRODUCTION

2.1.1 Annual Report

According to the Annual Report, the past production records of the mines are:

Table 2-1 Actual Results of Production

MINE	Philex	B.M.I.	B.C.I.	Itogon	Atok	B.X.
Year	1976	1976	1976	1975/10~ 1976/9	1975~ 1976(1)	1976
Tons Milled DMT/Year	8,620,510	1,124,724	933,000	115,771	30,020	52,488
Tons Milled DMT/Day	26,435	3,124	2,592	300-330		150
Grade Au g /DMT	0.678		4.48	4.39	2.64	8.47
Grade Ag g /DMT						63.98
Grade Cu %	0.402	0.38				0.49
Grade Zn %						10.86
Metal Au Kg./Year	5,397	119	3,468	422	71	372
Metal Ag Kg./Year	6,453	587		171	66	2,097
Metal Cu MT/Year	30,640	3,448				47
Metal Zn MT/Year						5,133

Note) (1) Atok has stopped operations since June 1976.

2.1.2 Present Production

The present production of each mine are shown below.

Table 2-2 Present Production

Mine / Period	Philex	B.M.I.	B.C.I.	Itogon	Atok	B.X.	Total
1978 Plan (Projection) DMT/Year	9,000,000	1,296,000	1,000,000	140,000	-	52,500	(1) 11,488,500
1978 (Projection) DMT/Day	27,000 ~ 28,000	3,600	2,857	400	150	150	(2) 34,657
1977 Actual record DMT/Year	9,954,000		955,800		-		
1977 DMT/Day	30,000		2,730		-	151	
Jan. 1978 DMT/Day	30,000	3,387	2,900	145	-		

Note) (1) Atok is not included.

(2) 27,500 DMT/D is assumed for Philex Mine.

2.2 EARNINGS AND EXPENSES

Table 2-3 shows the earnings and expenses of each mine according to the Annual Report. Philix Mine is keeping the balance in the black while B.C.I., ITOGON and ATOK have substantially run into red figures. As shown there is a large difference of revenue and expenditure among the 6 mining companies.

Table 2-3 Earnings and Expenses

(Unit: x Peso 1,000)

A/C Title \ Mine	Philex	B.M.I.	B.C.I.	Itogon	(1) Atok	B.X.
Year	1976	1976	1976	1975/10~ 1976/9	1975~ 1976	1976
Total Operating Income	451,313	35,361	133,744	12,752		24,932
Total Operating Cost	202,148	29,964	136,680	10,901		20,783
Operating Earnings	249,165	5,397	△ 2,936	1,851		4,149
Other Income (Charges)	-	(829)	15,376	(782)		781
Depreciation, etc.	26,096	2,930	11,652	1,643		3,929
Earning before Tax	223,069	1,638	788	△ 574		1,001
Income Tax, payable	72,430	-	4,965	-		341
Income Tax, Deferred	-	-	5,751	-		-
Net Earnings	150,639	1,638	1,574	△ 574		660

Note) (1) Atok retaining their product because of a low Au price. Further, they have suspended their operation since July 1976.

2.3 PRODUCTION PLAN FOR THE NEXT 5 YEARS

In order to obtain the basic data for TLPS Project, the feasibility study mission interviewed the staff of the six (6) mining companies concerning their future production program and their mine development plans.

The results are shown in Table 2-4. All of them have neither new mine development programs, nor long-term production programs for the next 5 years. The feasibility study mission, therefore, decided to use their production forecasts 5 years hence the basic data for TLPS Project.

The data below show the estimated output of each mine 5 years hence, but not the quantity of the tailings disposed by TLP system, which will be described in the next Chapter.

Table 2-4 Output Forecasts After 5 Years From 1978

Unit: Ton

Plan/Mine	Philex	B.M.I.	B.C.I.	Itogon	Atok	B. X.	Total
5 years Plan up to 1983 DMT/Year	9,000,000	1,296,000	1,000,000	140,000	151,200	52,500	11,639,700
5 years Plan up to 1983 DMT/ Day	28,000	3,600	2,900	400	450	150	35,450

2.4 MILL TAILINGS

2.4.1 Milling Process and Tailings

(1) Philex Mine

a. Milling Process

The milling process is by copper flotation at a capacity of 31,000 DMT/D. The grinding mill is provided with:

5 mø ball mill (with capacity of 8,000 DMT/D)	1 unit
3.5 mø ball mill (with capacity of 4,000 DMT/D)	4 units
Ball mill (with capacity of 2,300 - 2,500 DMT/D)	3 unis

The flotation unit has a group of slime flotation cells and 3 groups of sand flotation cells.

b. Flow of tailings slurry (See the Flow Sheet)

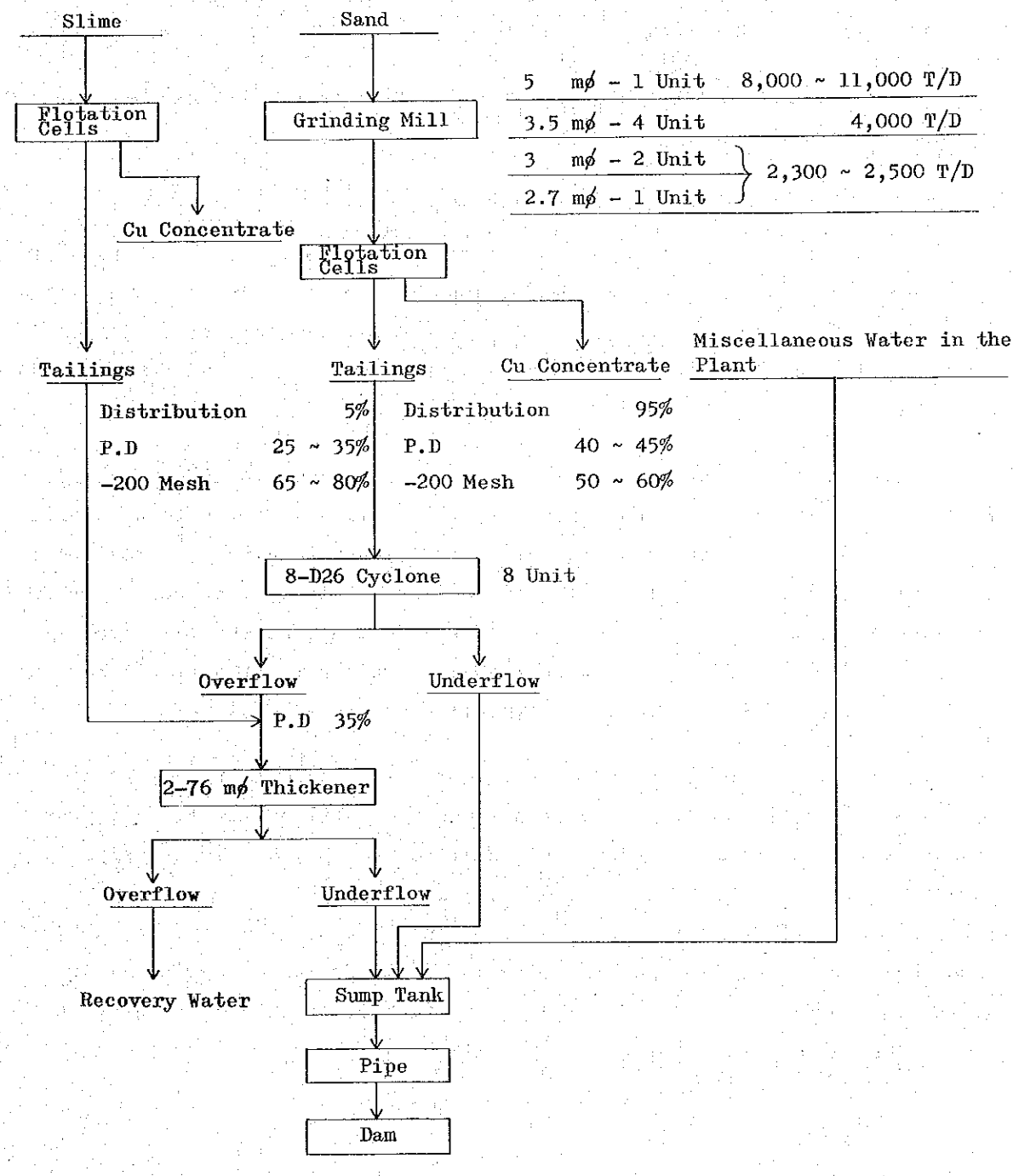
The sand flotation tailings is fed to the cyclones. The underflow of the cyclone is directed to the sump tank while the overflow is mixed with a slime flotation tailings and then fed to the two 76 mø thickeners (PD 35%). The underflow in the thickener flows into the sump tank (PD 50-60%) and the overflow is used as mill water.

While the miscellaneous water, that is water used for floor washing, drain water from equipment and machines, water spilled on the floor within the mill site, etc. flow into the sump tank through launders. A small-sized classifier is provided at the inlet of the launder to prevent coarse grained ores and foreign matters mixed in the flow from clogging the pipe leading to the dam (described later). When it rains, rain water may enter the site from the outside and flow into its miscellaneous water.

The tailings slurry which flows into the sump tank is fed by gravity to the dam through two (2) lines of 300 mmø polyethylene pipes. The pipe has an average gradient of -2.5% and the flow velocity within the pipe is more than 4.4 m/s. The wear rate of the pipe is 3 - 4 mm/10 million DMT tailings. At the dam site, about half of the tailings slurry is classified into coarse sand and fine sand or slime by cyclones installed on the dam bank. The former is used for building up the bank of the dam. The tailings fed to the dam is about 28,000 DMT/D.

During dry season, the slurry density of tailings to the dam is 40 - 45% solid. During rainy season, the rain water mixes with the tailings slurry. The required volume of tailings thickener overflow is reduced, because abundant mill water is available. Consequently, the feed rate of tailings slurry to thickener can be reduced. Thus, in the rainy season, the slurry density of tailings to dam is reduced to 35 - 40% solid.

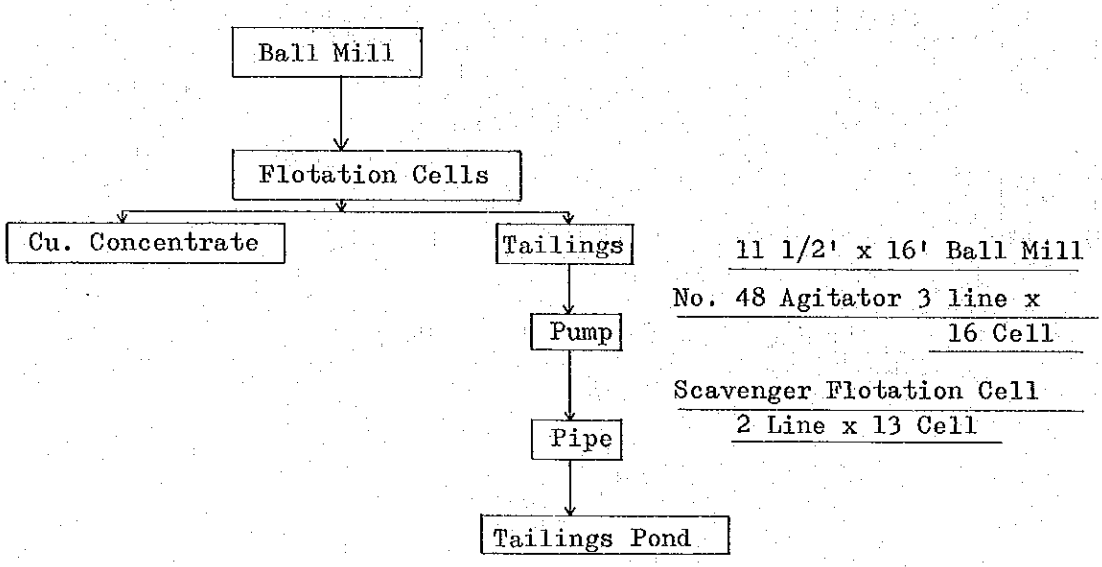
Flow Sheet of Philex



(2) B.M.I.

(a) Mill tailings process

Flow Sheet of B.M.I



(b) Milling process

Milling is by copper flotation at a capacity of 4,000 DMT/D.

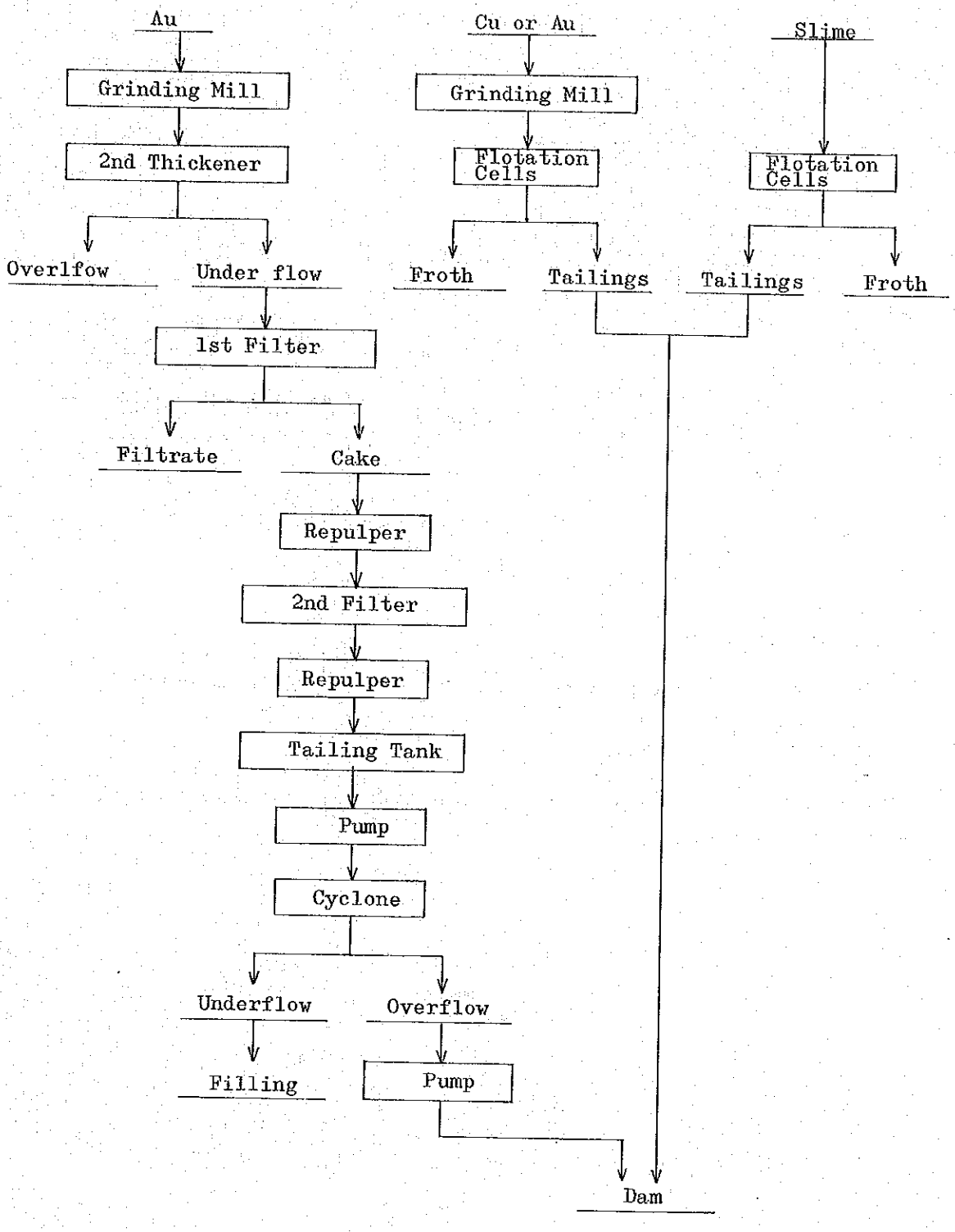
(c) Flow of tailings slurry

The system is simple. The tailings from the flotation machines is sent to the dam by pump.

(3) B.C.I.

(a) Mill tailing process

Flow Sheet of B.C.I



(b) Milling process

The mill produces gold and silver by cyanidation process.

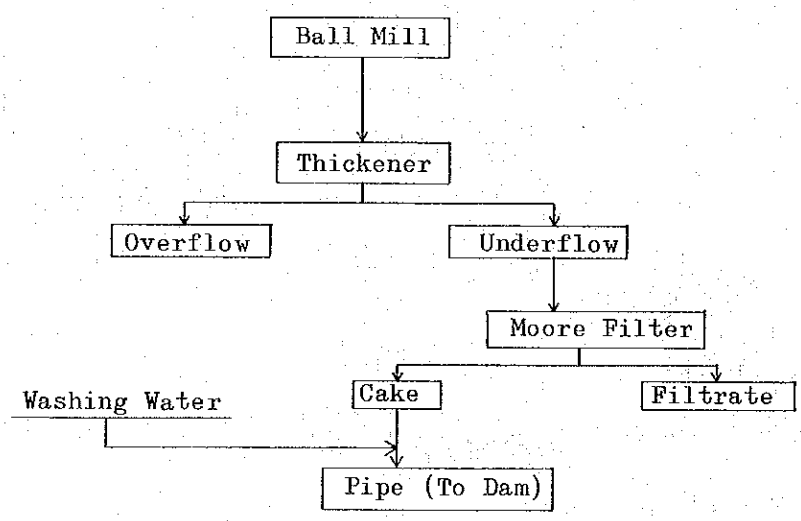
(c) Flow of tailings slurry (See the Flow Sheet)

In this mill, the copper dressing equipment is not in operation while the gold dressing equipment is at work. The tailings of the gold dressing equipment is filtered by the secondary filter, and then stirred in the repulper tank and fed to the cyclone by pump. The underflow is used for back filling in underground workings and the overflow is sent to the dam through wooden launder, pump and steel pipes. The life of the steel pipes is more than 7 - 8 years.

(4) Atok Mine

(a) Mill tailings process

Flow Sheet of Atok



(b) Milling process

The mill produces gold by cyanidation process.

The plant is now out of operation.

(c) Flow of tailings slurry

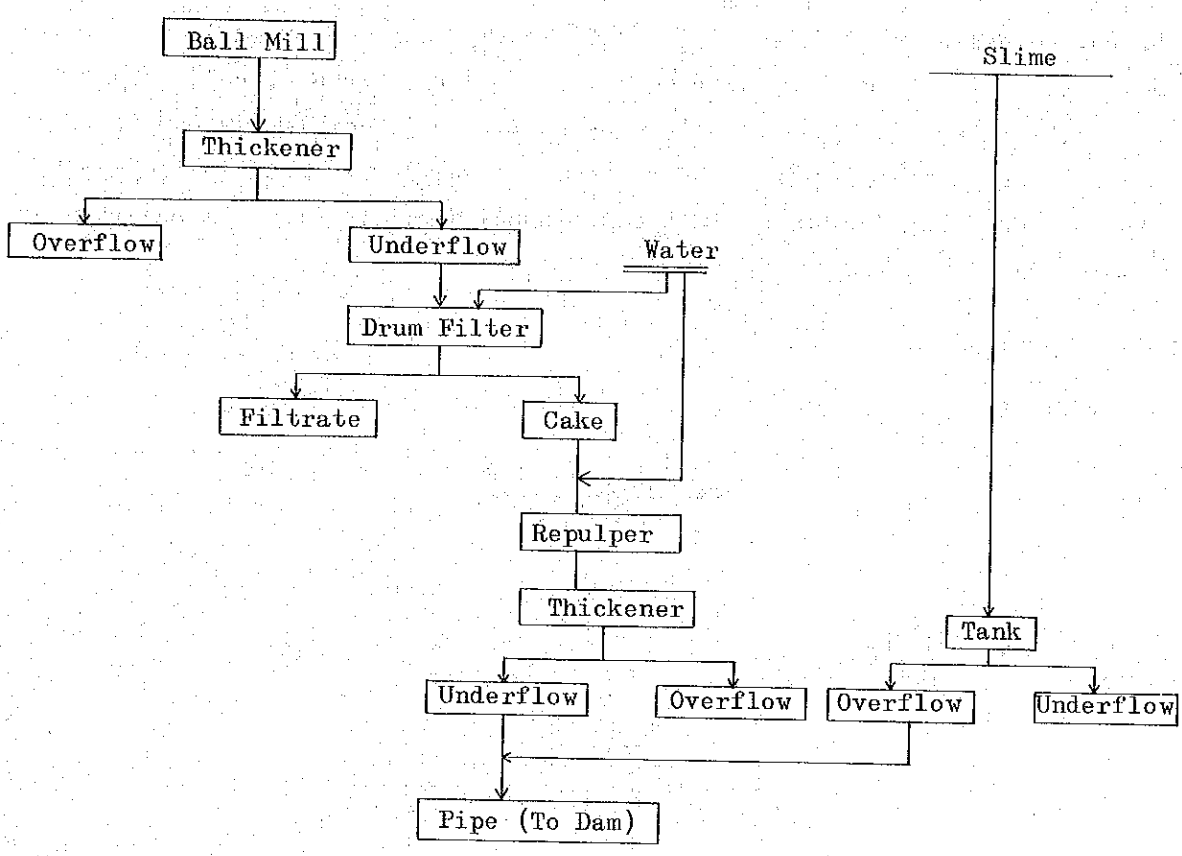
The tailings of the milling process is filtered by a Moore filter, mixed with washing water, and sent by gravity to the dam through launder.

The launder has a gradient of -10%.

(5) Itogon Mine

(a) Mill tailings process

Flow Sheet of Itogon



(b) Milling process

The mill produces gold by cyanidation process.

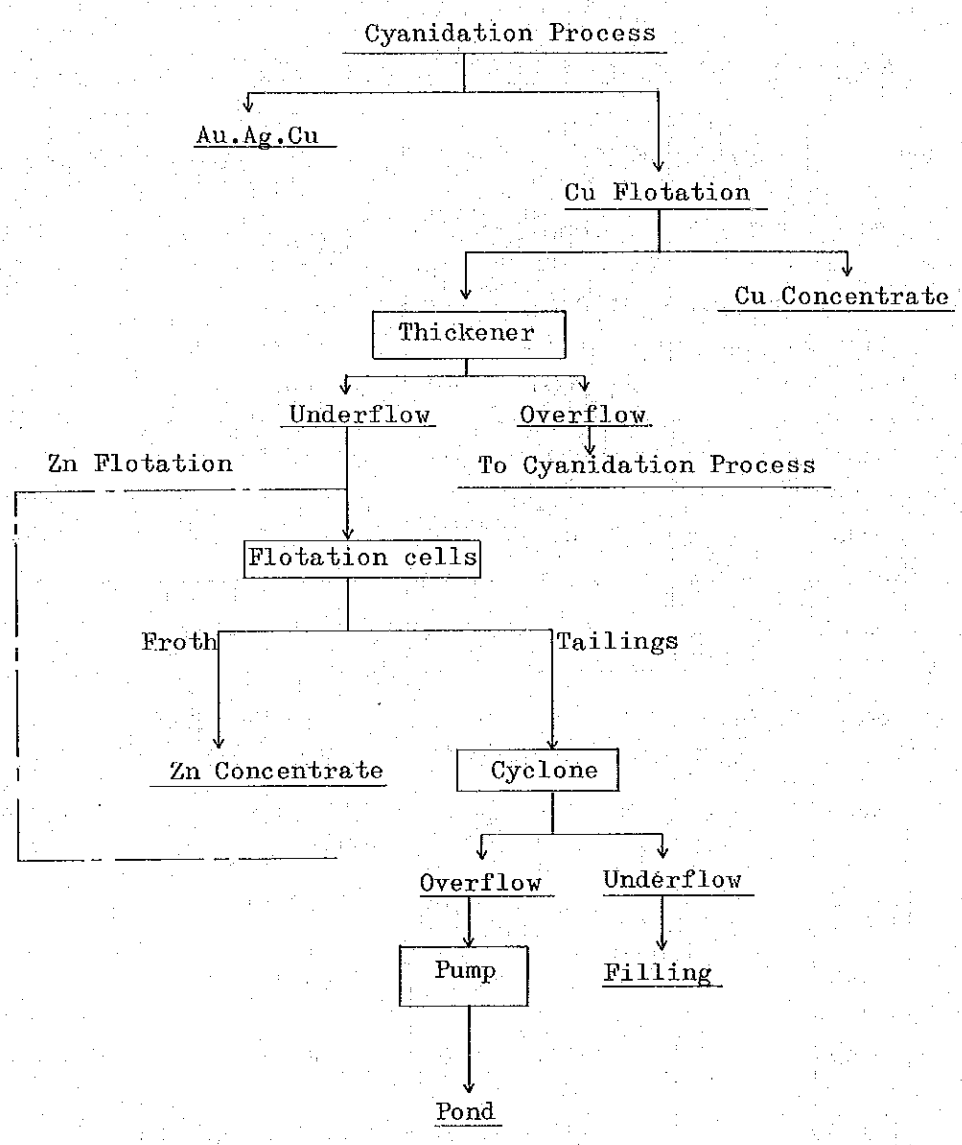
(c) Flow of tailings slurry

The tailings of the milling process is filtered by drum filter, stirred by repulper and fed to the tailings thickener. The underflow is mixed with the overflow of the slime tank and fed by gravity to the dam through 6"ϕ plastic pipes. Corrosion occurs little in the pipes.

(6) B.X.

(a) Mill Tailings process

Flow Sheet of B.X.



(b) Milling process

The mill is using cyanidation process, copper flotation process, with the final tailings coming from the zinc flotation process. About 25% of the final tailings is used as back fill for underground openings. The remainder is sent to the tailings pond by pump.

2.4.2 Specifications of Mill Tailings

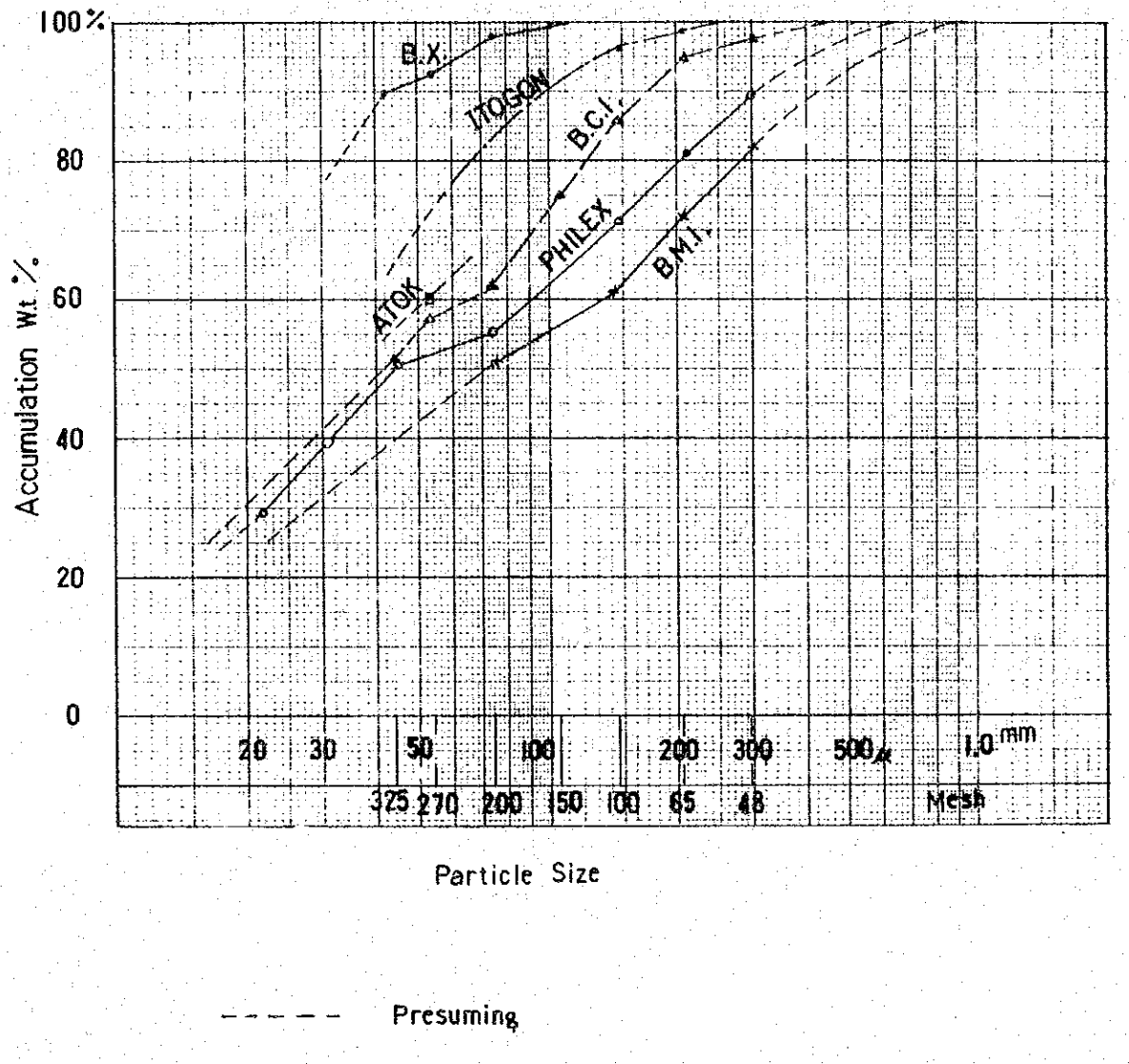
Table 2-5 shows the current volume and properties of tailings (excluding sand for back filling) produced in the six(6) mines.

Table 2-5 Volume and Properties of Tailings from 6 Mines

Item		Unit	Philex	B.M.I.	B.C.I.	Atok	Itogon	B.X.
Tonnage	Mean	DMT/D	28,000	3,600	2,150	150	400	150
	Max.	DMT/D	31,000	3,600	2,200			
	Min.	DMT/D	27,000	3,500	2,100			
Specific Gravity			2.6-2.8	2.6	2.7	2.5	2.7	2.9
Concentration	Mean	% Solid (wt)	40	30	41	37.5	29	25
	Max.	% Solid (wt)	45	38	46	42.5	31	
	Min.	% Solid (wt)	35	28	39	32.5	24	
Size Distribution	Mesh	% wt			No sand filling			
	+ 28			2.50	0.20			
	+ 48		10.73	15.50	0.90			
	+ 65		7.92	9.70	3.40		1.00	
	+100		9.83	10.70	8.60	40.00	2.16	
	+150		8.20		11.60		5.22	0.23
	+200		8.05	11.10	11.70		11.16	1.43
	+270				6.10			4.90
	+325		55.27	50.50	4.50	60.00	80.46	3.40
	-325				52.70			90.04

Fig. 2-1 shows the size distribution of tailings from the 6 mines.

Fig. 2-1 Accumulation Curve of Size Distribution



2.5 PRESENT CONDITIONS OF THE TAILINGS DISPOSAL SYSTEMS

2.5.1 Philex Mine

The mill head of Philex Mine is about 30,000 DMT/D (Cu 0.4%), and the tailings, which is substantially equal to mill head, is being accumulated in the dam.

Dam No. 1 currently in use (the construction work started in 1968 and completed in 1971) was partially destroyed twice by typhoons in 1974 (rainfall:1,160 mm/day) and 1976 (rainfall: 2,419 mm/3 days), and the tailings of about 5 million tons was flushed out to the Agno River. The dam has been repaired and is planned to be used till the middle of 1980's.

Dam No. 2 is under construction and will be completed in 1980 at a cost of 30 million pesos. It has a capacity of 50 million DMT and may be used until 1985.

Further, the construction of dam No. 3 is planned. Its construction work must start in 1980 if the completion in 1985 is supposed. The construction of this dam will be examined by Philex in connection with TLP system project.

The clarified water of the tailings accumulated in the dam is discharged into the river. The chemical analyses of this clarified water and the pit water are shown in Table 2-6 (All chemical analyses used in the Chapter were done by N.P.C.C.).

The expenses of tailings disposal consisting of construction depreciation cost (not including the interest) and running cost are about ₱1.2/DMT.

Table 2-6 Philex, Results of Chemical Analysis

NO.	Station Identification	Hg ppb	Cu mg/l	Zn mg/l	Cd mg/l
w - 1	Underground Water	0.00	0.81	Nil	Nil
w - 2	Dam Over Water	0.00	0.07	0.04	Nil
w - 3	River Flow (Upstream of Dam)	0.00	0.01	Nil	Nil

2.5.2 B.M.I. Mine

The mill head of B.M.I. Mine is about 3,400 DMT/D (Cu 0.4%), and the tailings, which is equal to mill head, is being impounded in the ponds constructed with tailings sand along the Bued River bed and the dam at the Emerald Creek.

No. 3 and No. 6 ponds at the river bed have already been filled up with tailings. At present, No. 1 pond and No. 2 dam at the Emerald Creek are being used. B.M.I. has two (2) dam construction programs with a total capacity of 1,227,000 DMT but it is undecided when to start the construction.

The B.M.I. Mine discharges the clarified water from the tailiings dam and pond into the river. Table 2-7 shows the chemical analyses of the clarified water, the pit water and the river water.

The tailings disposal system of this Mine is by accumulating the tailings during dry season and flushing out during rainy season. The actual tailings disposal cost was ₱0.63/DMT in 1977.

Table 2-7 B.M.I., Results of Chemical Analysis

No.	Station Identification	Hg. ppb	Cu mg/l	Zn mg/l	Cd mg/l	Cn mg/l
w-33	Bued River Flow (Upstream of B.X.)	0.00	Nil	Nil	Nil	
w-28 w-29	Tailings (B.M.I.)	0.00	51.70 ~ 75.10	6.96 ~ 9.05	0.08 ~ 0.18	125.00
w-26 w-27	Dam Over Water	0.20	0.17 ~ 0.20	0.04	Nil 0.02	1.00
w-32	Underground Water	0.00	0.61	0.98	0.02	
w-30 w-31	Bued River Flow (Downstream of B.M.I.)	0.00 0.20	0.33 ~ 0.52	0.34 ~ 0.38	0.03 ~ 0.07	2.00
w-34	Bued River Flow (Camp - 4)	0.00	0.21	0.13	0.01	
w-35	Bued River Flow (Dongon Bridge)	0.00	0.26	0.07	Nil	

2.5.3 B.C.I. Mine

The mill head of B.C.I. Mine is about 2,900 DMT/D (Au 4.5 gm/DMT). About 26% (750 DMT/D) of tailings which is equal to mill head, is being filled back into the underground and the remaining 2,150 DMT/D of tailings is being impounded in the tailings dam.

Construction of the No. 1 dam started in 1960 and completed in 1969.

It had been used for about 8 years and accumulated 6,121,000 DMT tailings in it.

The No. 2 dam is under construction and its construction began in 1974 and will be completed in April 1978. Its capacity is 7,247,000 DMT, and can be used for about 10 years up to 1987. At present, the tailings is accumulated in temporary ponds provided inside the No. 2 dam area.

The clarified water of the accumulated tailings in the dam is discharged into the river.

Table 2-8 shows the chemical results of several water samples collected in this survey.

Table 2-8 B.C.I., Results of Chemical Analysis

No.	Station Identification	Hg ppb	Cu mg/l	Zn mg/l	Cd mg/l
w - 4	Underground Water (Acupan Mine)	0.10	0.11	0.24	Nil
w - 5	Dam Over Water	0.15	9.87	1.79	0.01
w - 6	River Flow (Downstream of Dam)	0.20	1.48	0.66	0.01
w -12	River Flow (Downstream of Junction With Itogon)	0.50	1.37	0.98	0.01

With regards to the No. 1 dam, the average total cost (including depreciation of the construction cost and the operation cost, not including any interest) is ₱0.94/DMT throughout 8 years of use. The total construction cost of No. 2 dam is estimated about ₱15,655,000 and the unit cost is ₱2.16/DMT as far as the construction cost is concerned.

2.5.4 Itogon Mine

The mill head of Itogon Mine is 230 DMT/D (Au 4.4 gm/DMT) and plans a production increase to 400 DMT/D by the end of 1978. The tailings which is equal to mill head is accumulated in the ponds at the riverbed of the Tolbing River.

The Mine is constructing a tailings dam at the area surrounding the tailings ponds currently used, and will be completed in 1981.

When this dam is completed, it will prevent the tailings accumulated during the dry season to be flushed out during rainy season.

With the final capacity of about 1,573,000 DMT, the dam will be available for about 11 years. The estimated unit cost of construction is ₱1.53/DMT.

This Mine discharges the clarified water in the tailings pond into the Tolbing River. Table 2-9 shows the chemical analysis of slurry and water sampled in this survey.

Table 2-9 Itogon, Results of Chemical Analysis

No.	Station Identification	Hg ppb	Cu mg/l	Zn mg/l	Cd mg/l	CN mg/l
w-7	Slurry (Slime Thickener Overflow)	350.00	20.60	27.95	0.61	
w-8	Tailings (To Pond)	40.00	58.00	181.17	0.90	125.00
w-9	Underground Water	0.00	Nil	Nil	Nil	
w-10	Pond Over Water	1.30	3.62	5.71	0.01	17.50
w-11	River Flow (Downstream of Pond)	0.80	2.40	4.02	0.01	2.50

2.5.5 Atok Mine

Atok Mine has suspended its operation since July 1976, but plans to resume it at a rate of 150 DMT/D from the middle of 1978, and at 450 DMT/D (Au 3.7 gm/DMT) in 5 years from then, Accordingly, the tailings which is equal to mill head has to be disposed.

Atok is planning to accumulate the tailings within a rubble-made retaining bank which is under construction along the Ambalanga River. Its capacity will only correspond to the volume of tailings disposed in 4 - 5 months. They have further two (2) dam construction programs, of which either construction time or capacity has not yet been decided.

Table 2-10 shows the chemical analyses of the pit water and the river water sampled in this survey.

Table 2-10 Atok, Results of Chemical Analysis

No.	Station Identification	Hg ppb	Cu mg/l	Zn mg/l	Cd mg/l
w - 15	Underground Water	0.00	Nil	0.01	Nil
w - 16	River Flow (Upstream of Mine)	0.00	0.18	0.02	Nil
w - 17	River Flow (Downstream of Mine)	0.00	0.06	0.01	Nil

The construction cost of the existing dam of this Mine is ₱1.53/DMT.

2.5.6 B.X. Mine

The mill head of B.X. Mine is 150 DMT/D (Au 8.5 gm/DMT, Ag 62.5 gm/DMT, Cu 0.5%, Zn 10.86%). About 125 DMT/D remained after the concentrates have been collected is the tailings. About 25% of which is filled back into the pit, and the remaining 90 DMT/D is accumulated in tailings ponds constructed at the riverbed of the Bued River. They are planning to change the bank of this pond at the riverbed side into a rubble type but is execution time is not yet decided. Under the present conditions, the tailings pond will be flushed out during rainy season.

This Mine discharges the clarified water of the tailings pond into the Bued River. Table 2-11 shows the chemical analyses of slurry and water sampled in this survey.

Since this Mine is located at immediate upstream of the B.M.I. along the Bued River, the chemical analytical samples of this river water were collected at two points of upstream and downstream in these 2 mines. The results are shown in the Paragraph of B.M.I. (Table 2-7).

Table 2-11 B.X., Results of Chemical Analysis

No.	Station Identification	Hg ppb	Cu mg/l	Zn mg/l	Cd mg/l	CN mg/l
w - 18	Underground Water	0.00	0.58	4.78	0.02	
w - 19	Pond Over Water	0.00	55.00	1.18	0.01	8.60
w - 20	Tailings (To Pond)	0.00	446.90	2,472.00	7.76	4.00
w - 21	Slurry (Cyclon Feed)	0.00	369.71	2,404.60	5.90	

2.5.7 Evaluation of Chemical Analysis

In this survey, samples of the clarified water of tailings dams and ponds of each mine, etc. were collected and analyzed. However, these chemical analyses are results from a single sampling and therefore cannot be used for asking the general judgement on properties of the waste water from the mine.

Further, since the Philippines have no standards for properties of waste water, it is at present impossible to determine the adequacy of waste water discharged from mines.

Accordingly, the chemical analysis mentioned above will only be useful as refernce data on the present conditions of tailings disposition in each mine, and we like to leave the judgement on the chemical analyses results to the Philippine Government.

Location map of sampling and tabulated analysis results are included in Appendix A-2-1.

CHAPTER 3

BACKGROUND OF TLP SYSTEM PLANNING AND MAIN POINTS OF FEASIBILITY STUDY

CHAPTER 3

BACKGROUND OF TLP SYSTEM PLANNING AND MAIN POINTS OF FEASIBILITY STUDY

3.1 BACKGROUND OF THE TLP SYSTEM PLANNING

(Quoted from Appendix C.1.1)

3.1.1 Promulgation of Executive Order No. 309

The contamination of the Pangasinan farming region downstream of the Agno River and the Bued River, Baguio district became an issue from the beginning of the 1960's and the Government and the mines (6 companies) began to make efforts to prevent the siltation which was regarded responsible for the pollution. The two (2) major mines constructed dams, B.C.I. succeeded in reducing the volume of effluent slurry in 1969 and Philex in 1971. The remaining four (4) mines which were still relying upon the ponds have been repeating the same method of accumulating the tailings in the ponds during dry season and flushing it out during rainy season.

In April 1971, Executive Order No. 309 was issued by the President to appoint a special executive committee to consider counter-measures (Ad Hoc Committee), and the same time to seek cooperation from officials and private fields.

The special committee was organized with the Director of Mines, as Chairman and representatives from N.P.C.C. and the mining companies in Baguio district as members. The subordinate organization is the government agency for environmental pollution presentation.

This measure concerns an overall feasibility study to transport the tailings to Lingayen Gulf for its disposal thru a pipe line or other method, and calls for prompt preparation of the feasibility study by sonsulting the opinions of experts in the country and abroad.

3.1.2 Development Prior to Planning the Pipe Line System

(1) N.S.D.B. Special Committee

In Octover 1972, an invertigation group was organized by N.S.D.B. under Special Order No. 121 to study the effect of tailings on the sea life.

The group consisted of specialists selected from N.S.D.B., P.F.C., N.P.C.C., B.P.W., N.I.A. and B.O.M.

The subjects of study were the methods of dumping the tailings from the Beguio mining district to the Lingayen Gulf and the present conditions of the Tañon Strait in Cebu Island where the tailings from the Altas C.M.D.C. are dumped.

It was concluded that if the tailings is dumped at the eastern inlet coast (near Barrio Rabon) of the Lingayen Gulf after the area has been enclosed by bank or partition, there will be no adverse effects on the sea life.

(2) RAD-13 (Rehabilitation and Development - 13)

During the floods from July - August, 1972, the tailings within the dams flushed out and gave serious damage downstream to the farming regions.

The Government decided to request the United Nations for their cooperation in the rehabilitation of program from the flood disaster as well as the development of the area. It was confirmed by N.S.D.B. that the plan for disposing the tailings from the Baguio mining district would be included in this rehabilitation program, and execution of this plan was entrusted to the Ad Hoc Committee (Modification Program of RAD-13).

(3) Pipe line project

By 1970, a plan to transport the tailings to the Lingayen Gulf by means of pipe line had already been proposed by N.P.C.C. The outline of the Plan is as follows.

Twentyfour-inch diameter pipe line with a total length of 29.0 km. will be laid along the Kennon Road from Camp 4 to the neighborhood of Barrio Rabon.

Design conditions of the common line area:
Transport volume: 10 million DMT/year
Concentration of slurry: 40% by weight
Flow speed in pipe about 7 ft/sec.
Pipe: 24" dia. spiral pipe
Construction cost: 22 million pesos (estimated on the basis of prices in 1971).

Further, it was estimated that the total capacity of the ore dressing site was 27,600 DMT/day and 29,900 DMT/day (future) and -200 mesh of the particle size distributions of tailings was 70.5% by weight.

The required construction cost was to be paid in five (5) years at the interest rate of 6% or 0.6 pesos/ton.

3.1.3 Dam-pond and/or Flushing System

(1) Recommendation by Dr. Sheid

In May 1973, Dr. Scheid, consultant from the U.N., visited the Philippines at the request of the Philippine Government to investigate the tailings disposal system (pipe lines at that time) of the ATLAS Mine in Cebu Island as well as in the Baguio district. He recommended to the special committee that the above-mentioned pipeline plan should not be adopted because of many economic and technical difficulties.

Having studied many opinions and data, a flushing system was proposed instead of the pipeline system for disposal of the tailings.

(2) Tailings Disposal Regulation Committee

In October 1973, the Tailings Disposal Regulation Committee was organized by N. S. D. B. to utilize the results of the U. N. investigation team. The committee disignated the Director of B.O.M. as Chairman, and the representative of N.P.C.C., N.S.D.B., B.S., N.I.A., B.P.W., B.F., B.P.I. and the mines as members.

(3) Oil crisis and water-power generation program

In November 1973, the oil crisis came, and the N.P.C. planned to construct two (2) water-power generation plants downstream of the Agno River. They proposed this plan to the special executive committee and stated that the dam-pond flushing system recommended by the U.N. is undesirable for the construction of the power-generation plant.

N.P.C.C. accepted this opinion and published their view that the U. N. method will not solve the problem of silt accumulation in the farms and therefore cannot be a permanent solution to the tailings disposal problem.

3.1.4 Planning of TLP System and its Outline

The N.P.C.C. continued the investigations and in May 1975, they summarized in a position paper, a permanent method to settle the tailings disposal problem in the Baguio District and submitted it to the Committee. Below is the outline of the method.

This system transports the tailings over the 15 km route from Camp 4 at the Kennon Road to Camp 1 by menas of a tunnel and over the 10 km route from Camp 1 to the seashore by means of pipeline or launder line or combination of both. The sea bottom has almost no gradient and there is little tidal flow so that the taillngs dumped into the sea will tend to accumulate. N.P.C.C. reported that this tendency was ideal for the reclamation of the area.

The six (6) mines in operation in the Baguio area will conduct their respective tunnels, pipe line, launder lines or ditches to Camp 4. No tailings will therefore be discharged into the rivers.

It was recommended that the construction of the line from Camp 4 to the sea be undertaken by the Government. The Government will determine and receive the toll charges from the mining companies which uses the line. These charges will be known as the tailings fund as in the case of the pipe line system.

a. Tunnel

The cost for driving a tunnel 15' x 15' was estimated at 1,000 pesos/m or 15 million pesos for the entire length as of 1972, and 45 million pesos as of 1975.

b. Tailings transportation to the sea

Concrete launder supported by concrete saddles, piers and towers will be provided. Tunnels will be constructed when the line has to cross mountains. Similarly, when towers or piers for launders go beyond 60 ft. high, pipe lines will be used instead.

The construction cost was estimated to be about 1,000 pesos/m or 10 million pesos for the straight line as of 1975.

c. Disposal at the sea area

The sea bottom around Rabon at the eastern part of the Lingayen Gulf is almost flat within 5 km from the coast so that it is necessary to enclose the area with bulkhead or causeway. The reclamation area is about 50 square km. and the bulk construction cost amounts to about 50 million pesos.

d. Repayment of the cost

The tailings produced by the four (4) mines at the Agno River amounts to 24,100 t/d at present, and more than 36,000 t/d or 8,796,500 t/year after expansion of the facilities of the mines. In addition, 1,013,000 t/year is produced by mines at the Bued River area. The total tailings produced is 9,209,500 t/year. It will be 15 - 20 million tons/year in the future when each mine has expanded its facilities.

The toll charges for the line in this Project is proposed to be 1 peso/ton and amounts to 10 million pesos at present and will amount to 16 - 20 million pesos in the future. The cost for constructing the bulkhead or causeway, i.e. 100 million pesos, will be fully paid in 5 to 10 years.

e. Assessment of the reclaimed land

If an area of about 50 km^2 is reclaimed, the assessment amounts to 1,000 million pesos. On the eastern side is a low rolling hill which is not suitable for agriculture although wide enough for location of an industry. The land preparation and other costs are 20 pesos/m^2.

3.1.5 Feasibility Study Plan for TLP System

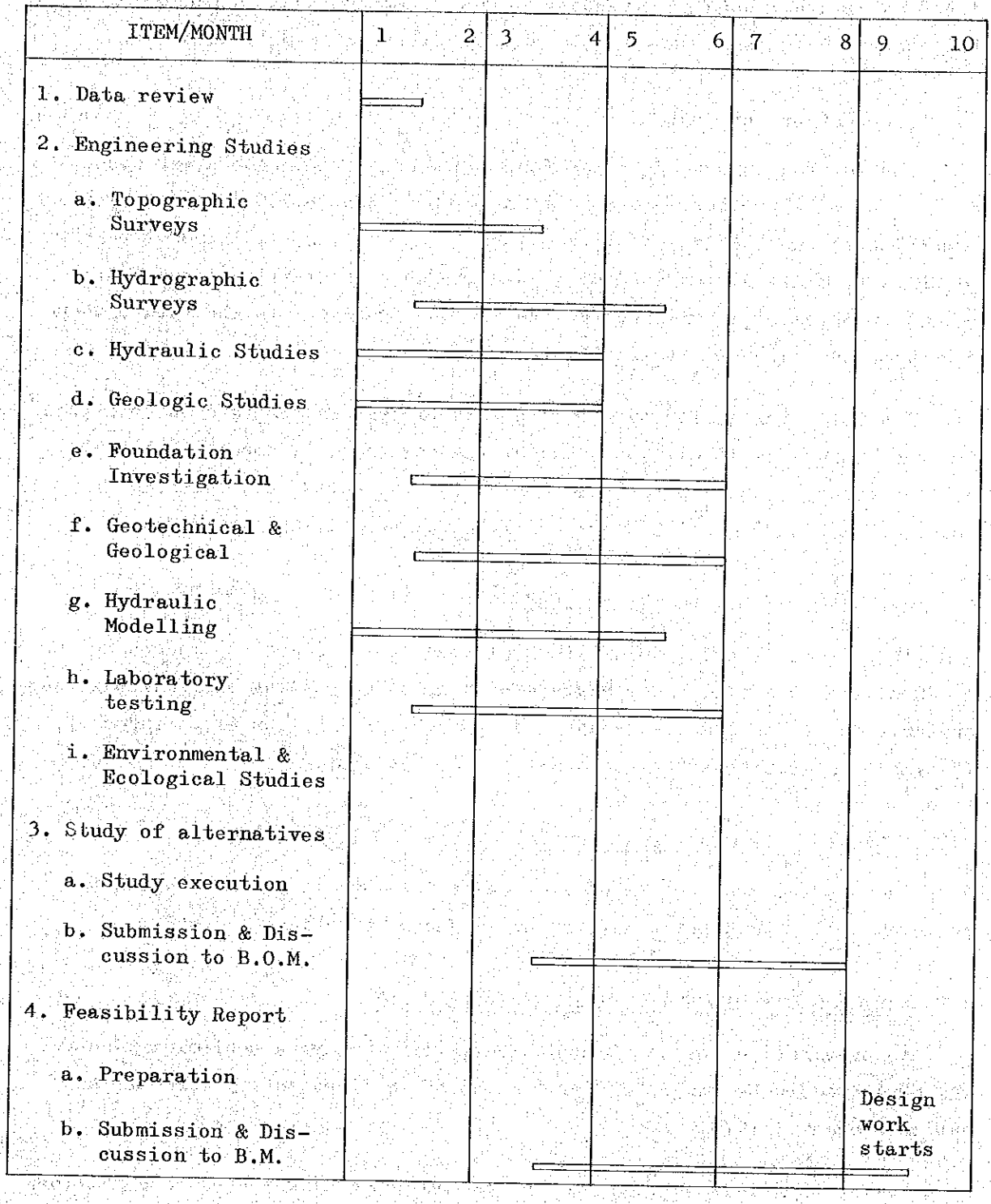
The outline and program of the Feasibility Studies planned but not followed by the Philippine Government is shown in Table 3-1.

3.2 BASIC CONDITIONS FOR THIS FEASIBILITY STUDY

In preparation for the present Feasibility Study, a preliminary survey was conducted in December, 1977 and a one month filed survey was carried out in February, 1978.

During the field survey, the Memorandum concerning the basic conditions for this feasibility study was exchanged between the Philippine and the Japanese Governments. The memorandum is shown in Appendix A-3-1.

Table 3-1 Work Items and Study Program



Below are the basic conditions reached in the agreement between Philippine and Japan concerning the present feasibility study.

(1) The feasibility study covers the design of the TLP system, which has previously been proposed by the Philippine Goverrnment, and other proposals to the final tailings disposal in the Lingayen Gulf.

(2) This Project of TLP system will be established on condition of the participation and cooperation of the related six (6) mines in the Baguio mining district.

(3) The TLP system consists of the following three (3) portions.

Feeder line from each mine to Camp 4.
Common line from Cap 4 to the Lingayen Gulf.
Final disposal at the Lingayen Gulf.

a. Feeder line is under the control of each mine. Therefore, the independent program of each mine is respected. However, the feeder line should be located upstream of and close to the common line. The technical recommendations concerning the feeder line are to be supplied to the mines in view of its importance.

b. The route and specifications of the common line will be determined based on the results of the field survey. Moreover, the consideration on the special consideration in the special conditions of this Project is included in the studies of construction of tunnels and line facilities, the programs of operation and maintenance, and the costs.

c. The final treatment in the Lingayen Gulf shall take the form of reclamation. Several systems are conceived for location and method of reclamation. Each differs from the others in its effect on the sea and in the construction cost. The system to be adopted is left to the judgment of the Philippine Government. In this feasibility study, some plans are proposed.

(4) With regard to the effect of tailings on the sea environment after the tailings has been disposed into the sea area, while the problem of the overflow from the dam and spread thru the river will be eliminated, the problem of the overflow from the reclaimed land and direct spread into the sea will arise.

As the tailing samples taken during the field survey are limited in nature, it is difficult to judge their total effect on the sea area. Furhtermore, the sea environment needs long-term observations. We can, at the present stage, show only the sampling data on hand.

(5) The term of the common line construction works will be planned as short as possible in view of the urgency of this Project.

3.3 EXAMPLES OF TAILINGS DISPOSAL SYSTEMS

The tailing disposal systems now employed in the world are classified as below.

a. Dams are constructed around a mine and the slurry is transported from the ore dressing site to dams over a relatively short distance and accumulated in them. The overflow of the clarified liquid is discharged into rivers through a certain part of the dam.

b. Ponds are built around a mine and the tailings are temporarily stored in them. The overflow is discharged from a certain part of the pond. It is used for relatively small scale mines.

c. Volume of the tailings from ore dressing process is reduced partially or by half by charging it in the pits. The remainder is disposed in the dam.

d. The tailings is utilized as aggregate.

e. The tailings is transported to a sea shore and disposed if no suitable location of dam is available around the mine. In this method, the transporation methods are divided as below.

i) Pipe line, launder line or a combination of both are used as the transport line from the thickener at ore dressing site.
Example: Atlas, Marcopper, etc. in Philippines

ii) A long-distance tailings transport is made as in the item i) thru dams around the mine.
Example: Akita Pre. in Japan.

iii) Slurry flow passage is formed on the surface ground and allow the slurry to flow by gravity utilizing the landform and weather conditions.
Example: El Salvador in Chile.

Tailings disposal systems at the sea area are classified as follows:

i) The tailings is discharged into the sea according to depth, topography of the sea bottom and tidal flow conditions.

o The transport line is extended to a certain point in the sea to discharge the tailings from the end. The discharged slurry is carried away by the ocean current.
Example: Atlas in Philippines.
(See Appendix A-3-2)

o A causeway is constructed from the seashore toward offing and slurry is discharged from end of the transport line laid on the causeway. The slurry is used as foundation of the causeway. By free settlement, the slurry is partially disposed by tide.
Example: Marcopper in Philippines
(See the Appendix A-3-2)

o Pipe line is laid on the sea bottom to a certain point, and the slurry is discharged from end of the line. Solid particles in the slurry are carried away by the sea bottom current.
Example: Pechiney in France

ii) Dam or pond is constructed on the sand area of the sea coast and the tailings is impounded within it in the same pattern as in the item a). The overflow of clarified liquid is discharged from a certain part, or neutralized before discharge into the sea depending upon the requirements of the area. Settlings after the neutralization treatment are disposed in the dam or pond.

The dam or pond filled with the tailings is covered with soil brought from other places and then planted with trees for a long range stabilization of the structure.