1.4 Present Situation of the Observation Stations

1. Document: Memorandum, February 12, 1994

2. Photographs: Meteorological/Hydrological Stations

M E M O

Attention ; Mr. Somsack
From ; k. Inoue (Hydrologist of JICA Study Team)
Date ; February 12, 1994
Ref. ; Trip Report of Hydrologist

Mr. Inoue, Hydrologist of JICA Study Team for Se Kong Hydropower Master Plan, visited the sites from January 24 to February 5, 1994. The purpose of the site visit is ;

i) to check observer's activity at newly installed cable ways for the discharge measurement
ii) to check rain gauges and evaporation pans
iii) to measure the discharge of the Xe Namnoy River at the Xe Katam Powerhouse site
iv) to survey cross section of the river at the WL staff gauge stations
v) to collect latest data.

The river discharge measurement of the above iii) was carried out to investigate the river flow condition between the upstream scheme (at B.Latsasin) and the downstream scheme of the Xe Namnoy River.

The river cross sections of the item No. iv) will be used in order to estimate the stage relationship in the high flow period at the WL staff gauge station because no discharge measurement has been executed in rainy season.

The survey results are presented hereinafter.

1. Actual Schedule

Jan.24 (Mon)	VTE - PKS
	Preparation work at MIH Pakse
	Data collection at DHM Pakse
Jan.25 (Tue)	PKS - HKG - B.Latsasin - HKG
	Check rain gauge and evaporation pan at B.Latsasin
	Check rain gauge at B.Huaykong
	Check WL gauge at B.Nonghin
Jan.26 (Wed)	HKG - B.Latsasin - HKG

		Discharge measurement of Xe Namnoy at B.Latsasin
		River water sampling of Xe Namnoy
Jan.27 (Thu)	HKG - B.Nongtuan - Xe Katam P/H site - HKG	
		Discharge measurement of Xe Namnoy at Xe Katam P/H site
		River water sampling of Xe Namnoy
Jan.28 (Fri)	HKG - SKN	
		Check rain gauge and evaporation pan
Jan.29 (Sat)	Se Kong Town (SKN)	
		Discharge measurement of Se Kong at Se Kong Town
		River cross section survey
		River water sampling of Se Kong
		Data Collection
Jan.30 (Sun)	SKN - ATP	
		Check cable way at B.Hatsaykhao
		Cross section survey at B.Fangden
		River water sampling of Xe Kaman
Jan.31 (Mon)	ATP	
		Check rain gauge and evaporation pan at Meteo. station in Attapu
		Meeting with local authorities
Feb. 1 (Tue)	ATP - Xe Set	
		Check cable way at B.Fangden with DHM
Feb. 2 (Wed)	Xe Set - B.Latsasin - PKS	
		Discharge measurement of Xe Namnoy at B.Latsasin
Feb. 3 (Thu)	PKS - B.Thakno - Khorn water fall - PKS	
Feb. 4 (Fri)	PKS - Selabam P/S - PKS	
Feb. 5 (Sat)	PKS - VTE	

2. Situation of Gauging Station

(1) B.Latsasin (see Phot-1,2)

i) Evaporation Pan

It seems to be necessary to clean up the pan bottom and to change the water though no problem was found.

ii) Recording Rain Gauge

The observer informed us of time delay again though no delay had been observed in last our site visit on November 10,1993. Because batteries are new and paper position is correct, the dust spread from traffic on the access road which was constructed last year end is deemed to be one of causes.

Time check and adjustment in everyday should be continued.

(2) B. Huaykong (see Phot-3)

i) Rain Gauge

Because time gap between the recording paper and the watch, and unstable wooden foundation were found, we left our message to the observer in the village as below :

i) check batteries

ii) replace wooden parts to fix the gauge and keep level

iii) adjust paper position correctly

Periodical time check and adjustment will be required.

(3) B. Tongvay (see Phot- 4)

i) Rain gauge

A mass of insects in the battery box and the inner corner of the gauge were found. Clean up whenever the observer open the steel cover.

The gauge seems to be unstable because of deep concrete crack occurred at a big bolt fixing the wooden foundation on the concrete column. Repair work is necessary so as to fix the gauge and keep it level.

Batteries and a pen were changed by MIH counterpart.

(4) Se Kong Town (see Phot- 5,6,7)

i) Evaporation Pan

No problem was found.

ii) Rain gauge

The gauge is working well, however, it seems to be unstable because of the thin wooden base plate. The plate should be reinforced or replaced to thick one.

Tall trees around the meteorology station will affect rainfall observation. As we stated in last visit, some trees should be cut before next rainy season.

(5) Attapu (see Phot- 8,9)

i) Evaporation pan

The pan should be sat on timbers, like in Se Kong Town.

ii) Rain gauge

The recording paper had been finished when we visited the meteorological station in monday afternoon. Continuous observation should be kept any time.

The wooden base plate should be reinforced or replaced to thick one.

(6) B. Nonghin (Phot-10,11)

i) Water Level gauge

The automatic water level gauge which was installed in Xe Katam Project was functioning well.

3. Discharge Measurement

Discharge measurement of the Xe Namnoy River and the Se Kong River was carried out. Measurement at the Xe Kaman River could not be done because it was found that the cable way did not work as we had expected.

(1) Xe Namnoy River at B.Latsasin (Phot-12,13,14)

It was found that the river discharge was too small to measure the flow velocity at the cable way line in dry season.

The river discharge on Feb.2,1994 was 1.3 m3/s at the temporary access bridge of the Huay Ho Project. Suppose that the river width and depth at the cable way are 100 m and 1.3 m, the mean velocity would be 0.01 m/s. This velocity is too slow to measure.

When we measure the velocity from the gondola at the cable way in the same day, the dezital meter indicated some velocity, for example 0.6 m/s, though no rotation of the propeller was observed from the above. This is obviousely error that might be caused by small velocity.

In order to avoid such error, discharge measurement in dry season should be carried out at narrower stream such as at the temporary bridge.

The temporary bridge does not affect water level at the WL gauging station in present. In rainy season, however, the back water will easily reach the gauging station.

(2) Xe Namnoy River at Xe Katam P/H site (Phot-15,16)

Discharge measurement of Xe Namnoy River at Xe Katam Powerhouse site, which is located 400 m upstream from the bifurcation of the Xe Katam River, was carried out in cooperation with the observers in B.Latsasin and B.Nonghin. The results are shown as below with other measurement.

Date	River	Place	Q m3/s	Specific Q m3/s/100km2	CA km2
Jan 25	Xe Katam	B.Nonghin	1.0	0.58	171
Jan 26	Xe Namnoy	B.Latsasin	(2.0)	(0.37)	537
Jan 27	Xe Namnoy	Xe Katam P/S	7.4	0.94	784
Feb 2	Xe Namnoy	B.Latsasin	1.3	0.24	537

Although measurement on Jan26 was failed, discharge of more or less 2 m3/s could be assumed by visual observation at the site.

(3) Se Kong River at Se Kong Town (Phot-17,18)

There had been problem on the electric cable before, however the observer already solved this problem by fixing the cable to the steel wire with vinyl strings every one meter.

Despite of their good effort, it takes 3 or 4 hours to complete their measurement. A small hut to prevent from strong sun light and rain will be necessary.

A steady step on the steep slop is also required in order to keep safety and easy access to the cable way.

(4) Xe Kaman River at B.Hatsaykhao

It was found that the small steel cable which had been installed to control the horizontal movement of the current meter would not move by man power because of heavy load when a current meter and a weight were hung.

Discharge measurement is now carried out by boat.

In order to keep safety measurement in wet season, the present cable way should be improved and used again.

4. Cross section survey (Phot-19,20)

River cross section was surveyed at the water level gauging staions of Se Kong Town and B.Fungden.
The stage relationship at the WL gauging station will be developed by the cross section.

5. Water sampling

Four (4) bottle of river water were taken during our site reconnaissance. The sample water are to be analyzd by the Laboratory of Water Quality Analysis of the Department of Irrigation & Micro Hydropower under the Ministry of Agriculture and Forestry.
The results will be sent to Japan.

6. Data Collection

Following data were collected during the site reconnaissance,

Daily Precipitation	Se Kong Town	to Jan. 7,1994
	B.Pakeyon	to Dec.31,1993
	Nikhon 34	Jan.-Dec.,1993
	Paksong	Jan.-Dec.,1993
	KM 42	Jan.-Dec.,1993
	Nong Hing	Jan.-Dec.,1993
	Pakse	Jan.-Dec.,1993
Daily Water Level	Se Kong Town	Nov. and Dec.,1993
Daily Humidity & Temperature	Nikhon 34	Jul.-Dec.,1993
	Paksong	Jul.-Dec.,1993
	KM 42	Jul.-Dec.,1993
	Nong Hing	Jul.-Dec.,1993
	Pakse	Jul.-Dec.,1993

The following discharge measurement record are brought from the site.

Location	Date
Se Kong at Se Kong Town	Nov.11,1993
	19,1993
	26,1993
	Dec. 1,1993
	16,1993
	18,1993
	31,1993

The following data list to be collected by DHM Attapu was left because Mr.Punsuck who is the parson in charge was absent when we visited Pakse.

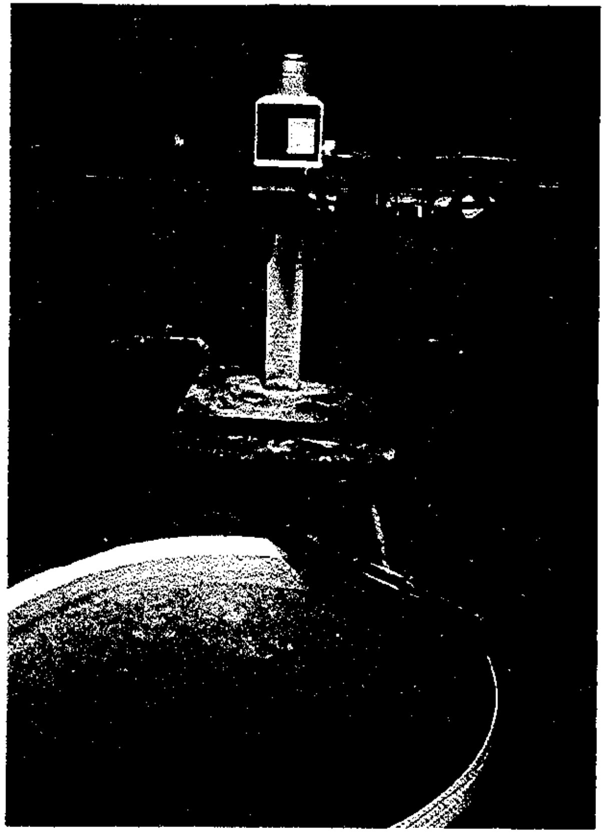
Data in B.Hatsaykhao
- All discharge record from the bigining
- All water level record from the begining

Data in Attapu
- Water level record at old gauging station at B.Fungden
  - data before April,1992 and
  - data after April,1993
- All discharge measurement record at B.Fungden if they have
- Water level record of the Se Kong River from May,1993
- Rainfall record from May,1993
- Daily temperature, humidity, and atmospheric pressure

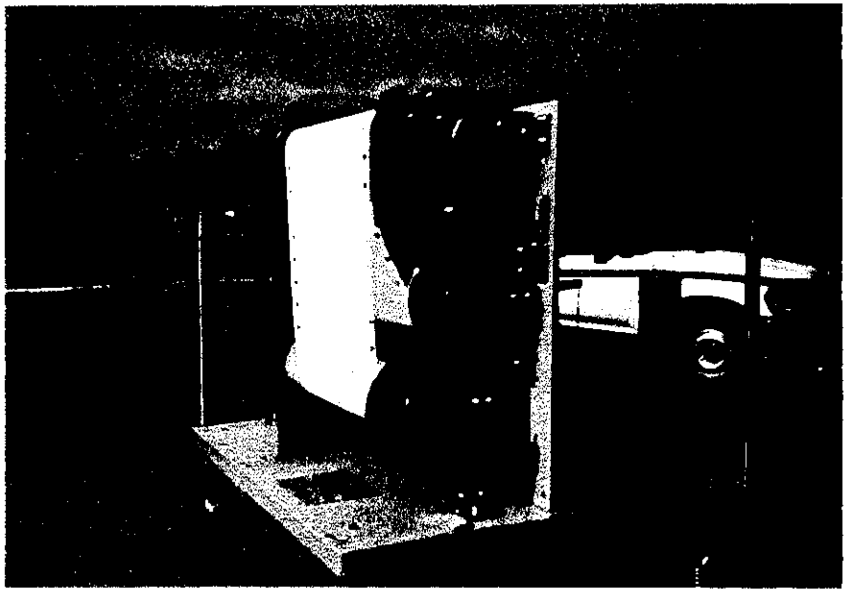
The above data will be sent to Japan through MIH Vientiane.

c.c. Mr.Tezuka ; JICA Study Team leader

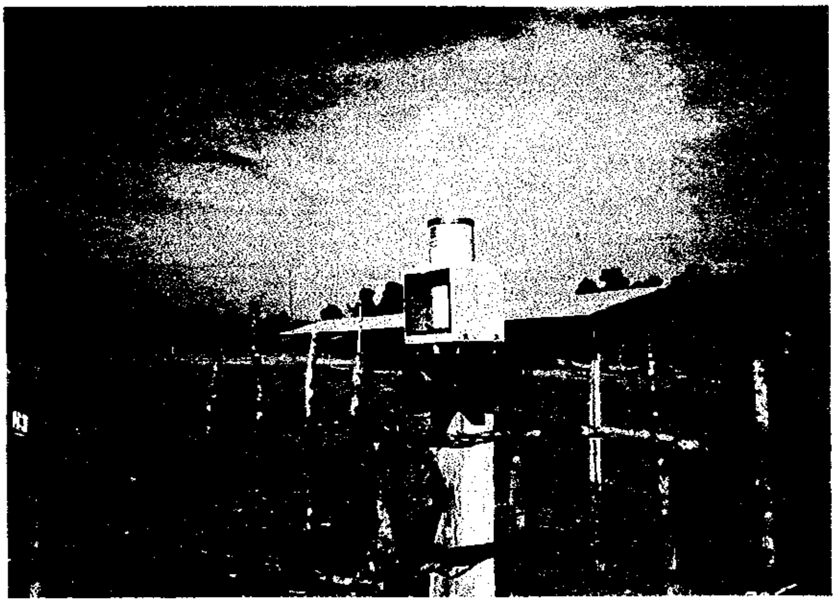
Meteorological Station in B.Latsasin



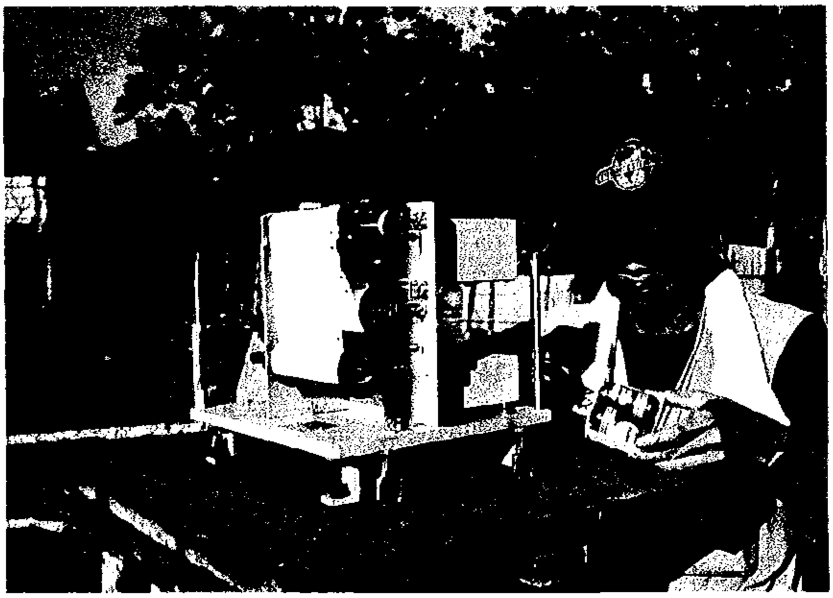
Phot - 1 : Recording Rain Gauge and Evaporation Pan



Phot - 2 : Recording Rain Gauge beside the DEWU Base Camp



Phot - 3 : Recording Rain Gauge at B.Huaykong



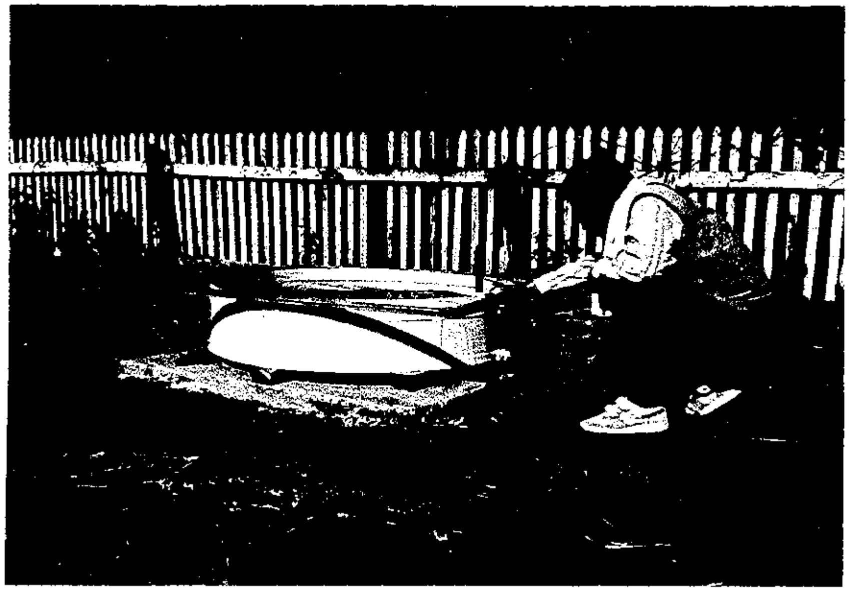
Phot - 4 : Recording Rain Gauge at B.Tongvay

Meteorological Station in Se Kong Town

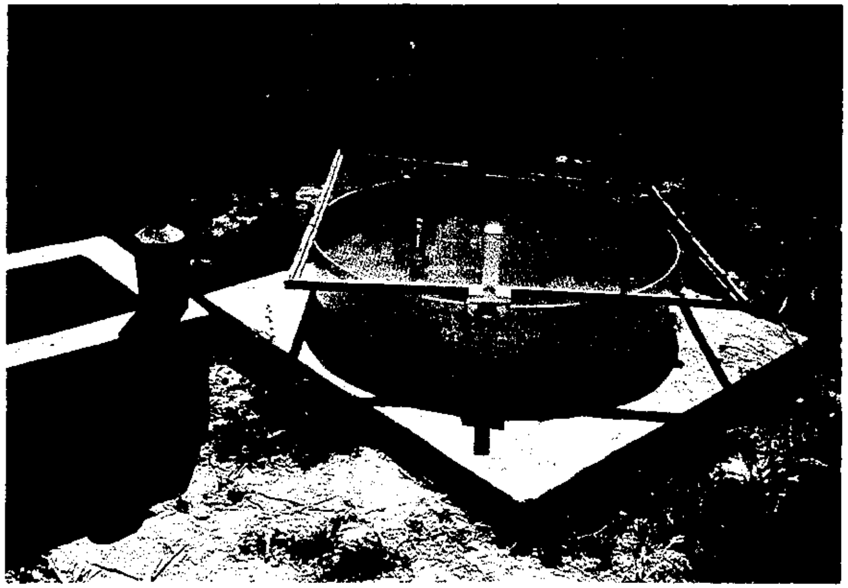
Phot - 7 : Tall Trees around
the Meteo.Station

phot - 6 : Recording Rain Gauge
see the wooden base plate

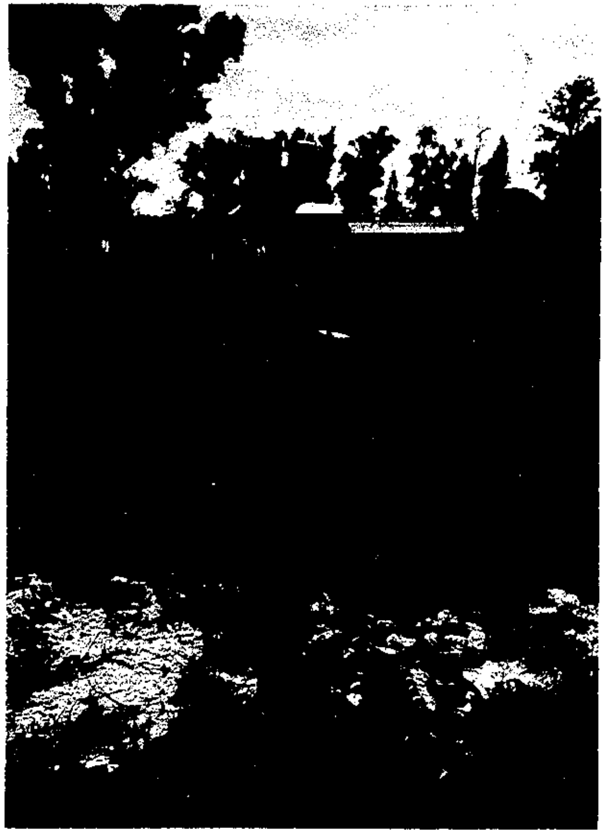
Phot - 5 : Evaporation pan



Meteorological Station in Attapu



Phot - 8 : Evaporation pan



Phot - 9 : Recording Rain Gauge

Water Leval Gauging Station of the Xe Katam River at B.Nonghin

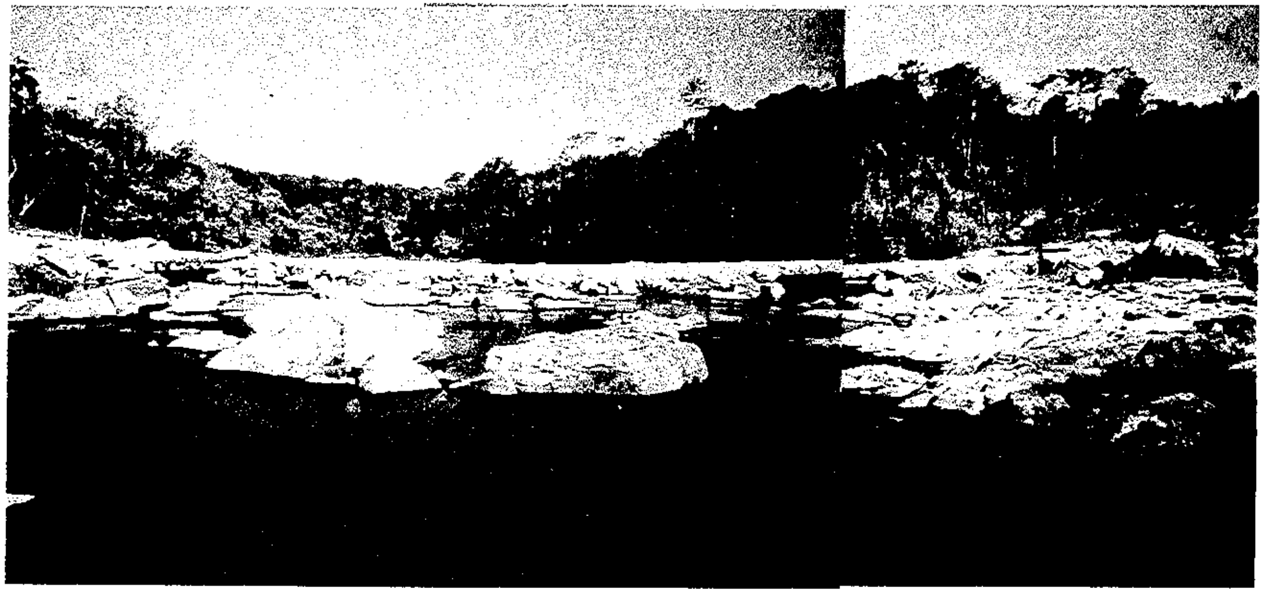
Phot -10 : Recording WL Gauge box
and Staff Gauge

Phot -11 : Upstream View

Discharge Measurement

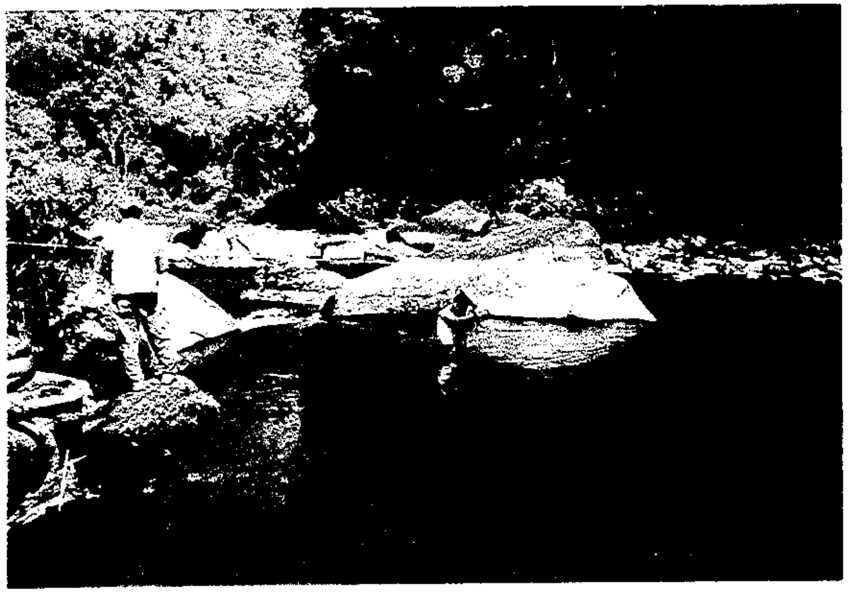
Phot -12 : Discharge Measurement of the Xe Namnoy River at B.Latsasin

Phot -13 : Discharge Measurement of the Xe Namnoy River at the Temporary Bridge in B.Latsasin

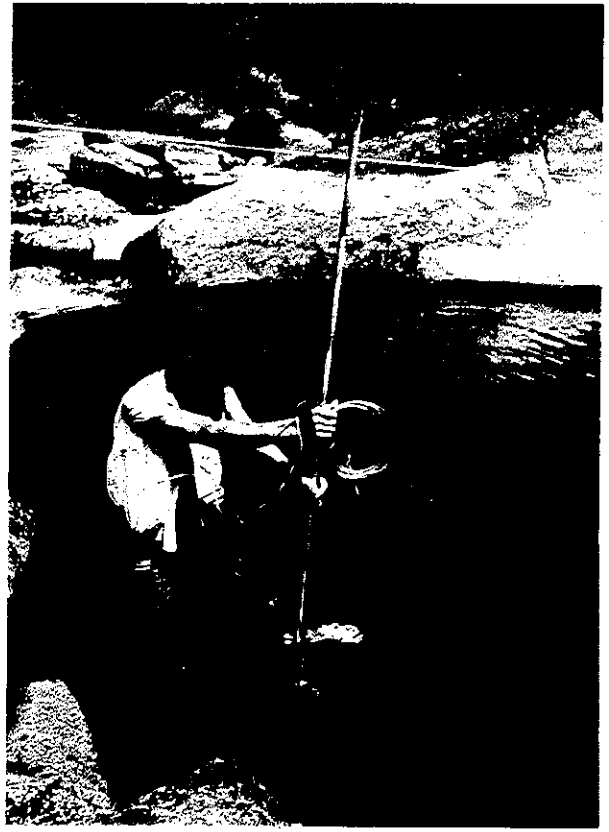


Phot - 14 : Temporary Bridge of the Huay Ho Project at B.Latsasin

Discharge Measurement of the Xe Namnoy River



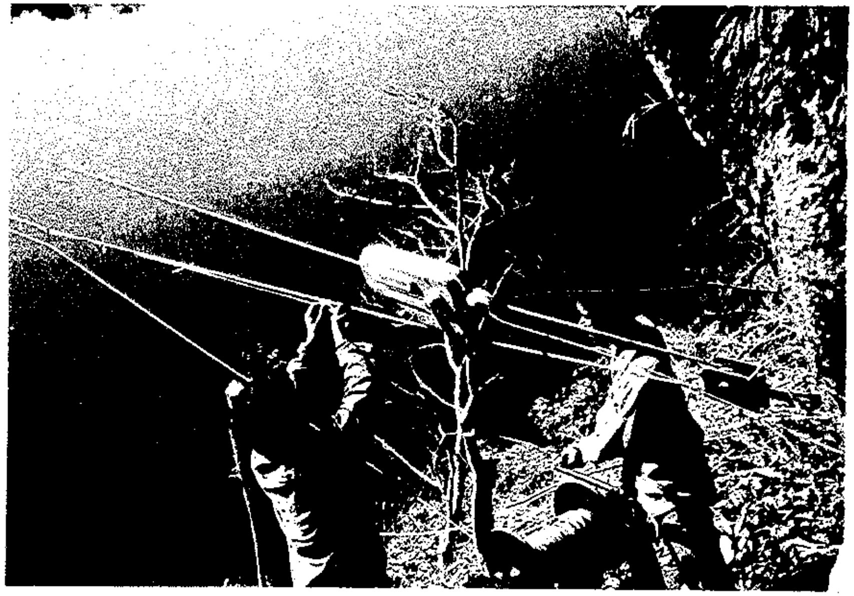
Phot - 15 : Measurement at Xe Katam Pj. P/H Site



Phot - 16 : Measurement by Current Meter

Discharge Measurement of the Se Kong River

Phot -17 : Cable Way at Se Kong Town



Phot -18 : Observer cutting vinyl String fixing electric cable and steel wire

River Cross Section Survey

Phot -19 : Survey at Se Kong Town

Phot -20 : Survey at B.Fangden

Appendix 2

Data of Hydropower Potential Study

Appendix 2

Data of Hydropower Potential Study

2.1 Data of Hydropower Potential Study

Documents:

Table AP2.1-1 Construction Quantity of Access Roads for Each Project

Description	Specification	Unit	Se Kong No.3	Se Kong No.4	Se Kong No.5	Xe Kaman No.1	Xe Kaman No.2	Xe Kaman No.3	Xe Kaman No.4	Xe Namnoy	Xe Pian	H. Katak Tak	Nam Kong No.1	Nam Kong No.2	Nam Kong No.3	Xe Xou	Dak E Meule	H. Lamphan Gnai
New Road Construction	In Plain Area	km	97	18	18	50	50	50	50	18	15	0	32	32	32	44	18	0
	In Mountain Area	km	0	0	92	0	72	81	129	7	0	18	0	10	24	0	112	38
Improvement of Existing Road		km	0	0	0	0	0	0	0	16	12	0	0	0	0	0	0	0
Bridge Construction	L=10m class	m	30	35	260	0	240	290	450	20	0	0	20	20	40	30	465	80
	L=20m class	m	160	80	22	40	320	320	360	0	40	0	80	80	140	40	240	60
	L=40m class	m	80	0	200	160	280	320	440	0	40	40	120	120	120	0	80	0
	L=100m class	m	100	0	0	100	100	100	200	1	0	0	60	60	60	100	200	0
	L=200m class	m	200	0	0	0	0	0	0	0	0	0	0	0	0	0	200	0

Table AP2.1-2 Costs of Access Road for Candidate Projects

Table of Construction Cost of Access Road in Each Project

Description	Specification	Unit	Unit Price	Se Kong No.4 Project		Xe Kaman No.1 Project		Xe Kaman No.3 Project		Xe Namnoy Midstream & Downstream Project		H. Katak Tok Project	
			(US$)	Q'ty	Amount (T.US$)	Q'ty	Amount (T.US$)	Q'ty	Amount (T.US$)	Q'ty	Amount (T.US$)	Q'ty	Amount (T.US$)
New Road Construction	In Plain Area	km	50,000	18	900	50	2,500	50	2,500	26	1,300	0	0
	In Mountain Area	km	70,000	0	0	0	0	81	5,670	15	1,050	18	1,260
Improvement of Existing Road		km	30,000	0	0	0	0	0	0	16	480	0	0
Bridge Construction	L=10m class	m	5,000	35	175	0	0	290	1,450	30	150	0	0
	L=20m class	m	5,000	80	400	40	200	320	1,600	20	100	0	0
	L=40m class	m	8,000	0	0	160	1,280	320	2,560	0	0	40	320
	L=100m class	m	11,000	0	0	100	1,100	100	1,100	100	1,100	0	0
	L=200m class	m	11,000	0	0	0	0	0	0	0	0	0	0
Total					1,475		5,080		14,880		4,180		1,580

Table Ap.2.1-3 Transmission Line Plan for Each Project

Site	Section	Line Length (km)
Se Kong No. 3	~ Roi Et S/S	371
Se Kong No. 4	~ Roi Et S/S	382
Se Kong No. 5	~ Roi Et S/S	428
Xe Kaman No. 1	~ Roi Et S/S	419
Xe Kaman No. 2	~ Bangyo S/S	210
Xe Kaman No. 3	~ Bangyo S/S	230
Xe Kaman No. 4	~ Sirindhorn P/S	274
Xe Namnoy (Midstream)	~ Sirindhorn P/S	148
Xe Namnoy (Midstream)	~ Roi Et S/S	351
Xe Namnoy (Downstream)	~ Bangyo S/S	91
Xe Pian	~ Bangyo S/S	86
H. Katak Tok	~ Sirindhorn P/S	179
Nam Kong No. 1	~ Sirindhorn P/S	230
Nam Kong No. 2	~ Xe Set P/S	161
Nam Kong No. 3	~ Xe Set P/S	146
Xe Xou	~ Xe Set P/S	145
Dak E Meule (Upstream)	~ Sirindhorn P/S	197
Dak E Meule (Midstream)	~ Xe Set P/S	92
H. Lamphan Gnai	~ Bangyo S/S	126

Table AP2.1-4 Transmission Line Plan for Candidate Projects

Site	Installed Capacity (MW)	Section	Line Length (km)	Transmission Voltage (kV)	Circuit	Kind of Conductor and Conductor Size	Construction Cost		Extension of Substation (10^6US$)	Remarks
							10^3US$/km	10^6US$		
Se Kong No.4	346	~ Roi Et S/S	382	230	1	ACSR 795MCM x 2	105.9	40.5	1.4	
Xe Kaman No.1	255	~ Roi Et S/S	419	230	1	ACSR 795MCM x 2	105.9	44.4	1.4	
Xe Kaman No.3	79	~ Bangyo S/S	230	115	1	ACSR 610m^2	85.5	19.7	0.5	Pakse Load
Xe Namnoy (Midstream)	192	~ Roi Et S/S	351	230	1	ACSR 795MCM x 2	105.9	37.2	1.4	
Xe Namnoy (Downstream)	63	~ Xe Namnoy (Midstream) P/S	4	230	1	ACSR 477MCM	63.2	0.3	1.4	
H. Katak Tok	105	~ Sirindhorn P/S	179	115	1	ACSR 477MCM x 2	75.9	13.6	0.5	

Note: Construction Cost is Direct cost only.

Fig. AP2.1-1 Unselected Alternative Development Plan of Xe Pian

(An independent development plan of Xe Pian)

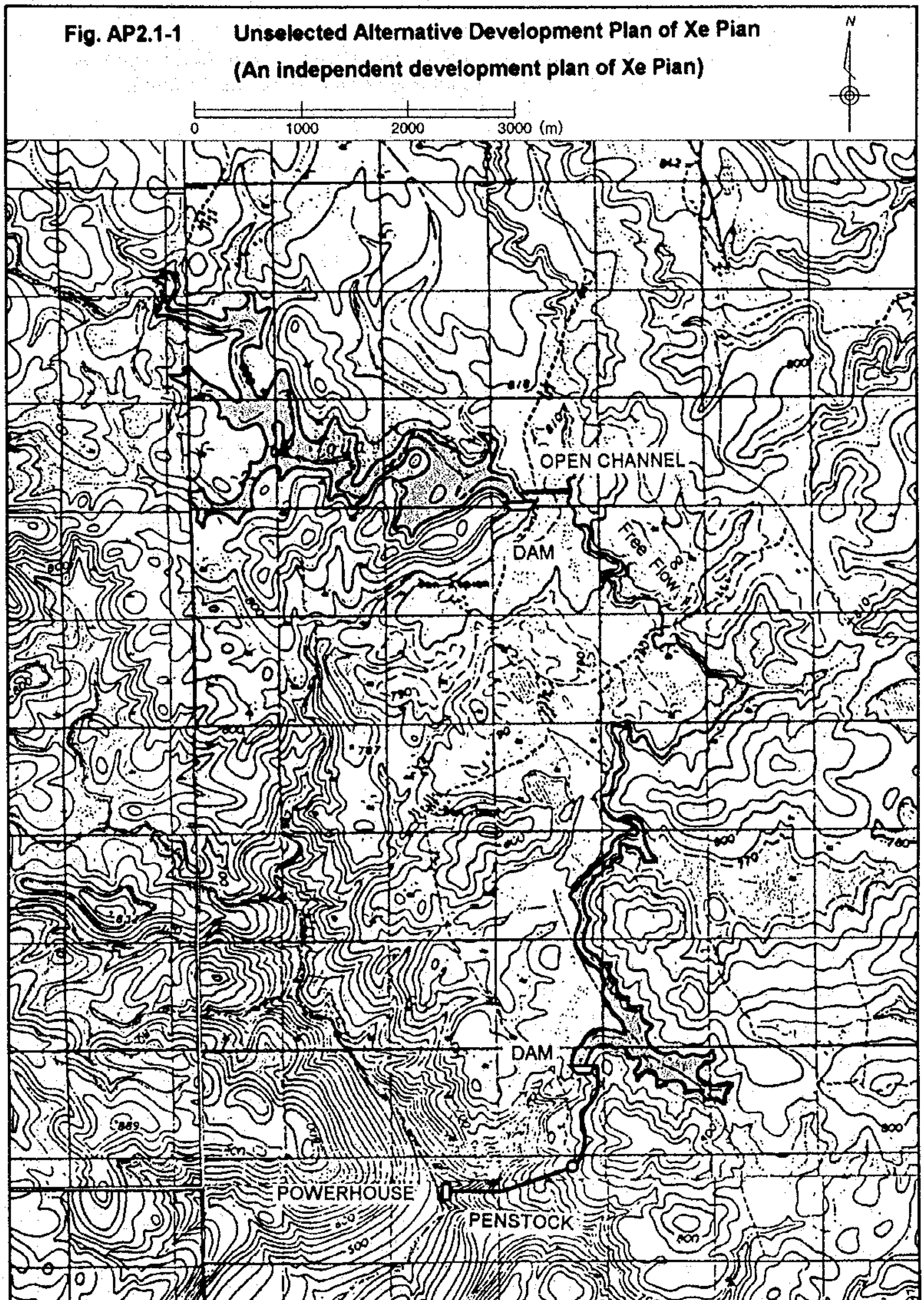


Table AP2.1-5 Unselected Alternative Development Plan of Xe Pian
(An independent development plan of Xe Pian)

Project	Unit	Xe Pian	
Hydrology			
Catchment Area	km^2	220	
Annual Inflow Volume	10^6m^3	438	
Average Inflow	m^3/s	14	
Project Structure			
Dam Height x Crest Length	m	25x190	
Tunnel Length	m	--	
Open Channel Length	m	1,400	
Penstock Length	m	1,150	
Reservoir			
High Water Level	m	760	
Low Water Level	m	758	
Gross Storage Capacity	10^6m^3	7	
Effective Storage Capacity	10^6m^3	1.0	
Regulation Ratio	%	--	
Regulated Firm Flow	m^3/s	3.0	
Power Generation Plan			
Tai Water Level	m	460	
Maximum Gross Head	m	300	
Net Head	m	295	
Maximum Discharge	m^3/s	15	
Installed Capacity	MW	38	
Firm Capacity	MW	(6hours) 30	
Annual Energy	GWh	203	
Plant Factor	%	61	
Project Economy			
Construction Cost[1)]	10^6\$	64.7	
Net Benefit (B-C)	10^6\$	5.9	
Benefit Cost Ratio (B/C)	--	1.82	
Energy Cost	¢/kWh	3.51	
Construction Cost per kW	$/kW	1,700	

1) Including transmission line cost and excluding interest during construction.

Doc. AP2.1-1 Questionnaire on Hydropower Potential Study raised by MIH on August 21, 1994

Ministry of Industry and Handicraft
Hydropower Project Office Date: 21/8/94.

Dear Mr. TEZUKA and all JICA Team,

I do hope that all of you are well and are busy with our project. We are all very well.

Taking the opportunity of the visit of Mr. Somsavanh to Japan, we send some more report received from HEC concerning:

- Drilling work : photographs of drilling samples
- Environmental work : some information related to the dauphin, population etc.
- The official letter from the Lao National Committee to the Mekong secretariat and the reply letter back for your contact with them.

This time I have some comments concerning the Sekong 4 and 5 as I have checked your hydropower potential study report. The questions and may be my proposal to you for your consideration are as follow:

The HWL of Sekong 4 is 320m, 300m and 280m in your case study

	case1	case2	case3	
HWL	280	300	320	
Net storage capacity	1,287	1,287	1,287	(*)
Firm discharge	144	144	144	(*)
Max. discharge	288	288	288	(*)
Installed capacity	273	346	397	

I observed that when increasing the HWL why the (*) not changed with. The same things repeat on the Sekong 5, Xekaman 1 and Xenamnoy downstream without Sepian and H Kataktok.

In case of Sekong 4 and 5 if taking in consideration of total development by combination for more efficiency of both projects, from the view of topographic condition of the Sekong 5 dam site I personally not so agree with its location. If you shift it a little bit downstream by reducing the HWL of the Sekong 4 to about 280m to 290m, there may not be any effect on its main feature with the same installed capacity of 346 MW. But doing like that what you will gain for the Sekong 5 :

- the dam site will be shifted down
- the tail water level could be about 285-290m
- the project could have more wider reservoir behind the dam before laying as narrow along the valley which could be good enough for regulating of flow for power generation, for sediment settlement and of course getting more reservoir capacity.
- the access road to the dam site will be less, etc.

What I have proposed here are just for your consideration and it would be very appreciated if you could provide your comments back with Mr.Somsavanh because I am preparing the report to the government about our project.

Tank you for kind consideration and good cooperation on the matters.

Yours sincerely,

Somsack PHRASONTHI
National Project Director

Doc. AP2.1-2 Comments of JICA Study Team prepared in September 1994 in reference to the MIH's Questionnaire

September, 1994

To : Mr.Somsack, MIH
From : JICA Study Team

RE: Comments to the Questionnaire on the Hydropower Potential Study

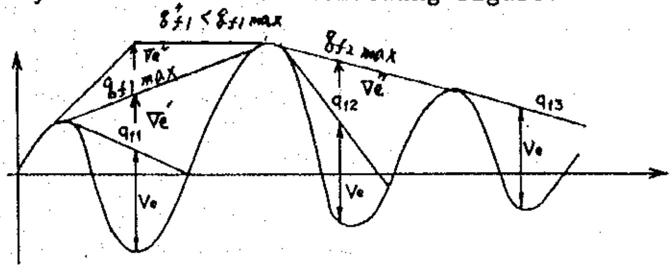
1. Project parameters hired in the Case study

As you said in your letter, we hired a constant value of active reservoir storage volume for a series of case study on the projects except the projects which has relatively small gross reservoir capacity available. There are some reasons on this manner as follows;

Reason 1

As you pointed out, we could set larger active (effective) reservoir storage volume ("Ve") for the projects which have sufficient gross storage volume comparing annual inflow volume ("Qin"). However, the following facts were found through the calculation of available firm discharge ("Qf") by the masscurve method;

1) The value of available firm discharge has a limitation when we consider annual regulation reservoir operation which we adapted to the study as shown in the following figure.



** Carry over reservoir operation, which regulates the reservoir inflow over some years, gives different manner. However, longer series of discharge data is required to apply this manner.

At the potential study stage, only a series of discharge data for five years was available for the study.

2) "Ve" values of 20 % of annual inflow volume could regulate approximately 90 % of annual inflow volume in the cases of many projects, so that the volume of discharge through turbine is not increased so much by increase of "Ve".

Example: Se Kong No.4 Project

Ve/Annual Qin	10%	15%	20%	25%	30%	40%
Available Qf	105	121	144	151	154	154

** Above figures were calculated based on the discharge data for five years at the potential study stage.

Reason 2

We focused much on energy generation but not on installed capacity, because the study was conducted as a potential study. When we focus on the energy production, it is not necessary to set larger reservoir capacity, when the volume of spilled water is already small.

The larger "Ve" requires the larger draw down of reservoir water level, and this draw down sometimes causes decrease of total energy generation especially in case of the dam type development scheme in which effect of draw down is large against available head. In general, for the dam type project, effect of head decrease is larger than increase of spill volume.

** When we focus on not only energy generation but also installed capacity of the project in further study including Pre-feasibility Study, we must make a comparative study on optimum active reservoir volume.

2. Development Scheme of Se Kong No.4 and Se Kong No.5 Project

In the potential study stage, we gave priority to the Se Kong No.4 project rather than Se Kong No.5 project, because the No.4 project is located downstream and the larger inflow volume is available for power generation, so that the larger energy become available by giving higher head (HWL) to the No.4 project.

Also, typographically, there is a rapid (keng), which has about 40 m difference in height within the section of 1 km in river length, at just downstream of the damsite of Se Kong No.5 project. If we select the damsite at the downstream of this rapid, it is necessary to construct about 40 m higher dam than our plan in order to have the same elevation of the proposed HWL of Se Kong No.5 project.

In addition, there is no big tributary in the section of Se Kong River from the proposed damsite to downstream by about MSL 250 m of river bed elevation, and river valley is too narrow along this section to get an incremental active reservoir volume so much.

** The result of optimization study on the Se Kong No.4 project gave us HWL of 290 m in contrast with 300 m, the result of potential study.

Therefore, we will make adjustment on the result of potential study. In the course of the adjustment study, we will review our result taking your comment into consideration.

END of comments

Thank you for your careful consideration.

2.2 Data of Previous Studies

Fig. AP2.2-1 Development Plan of Xe Namnoy proposed by Mekong Committee in 1970

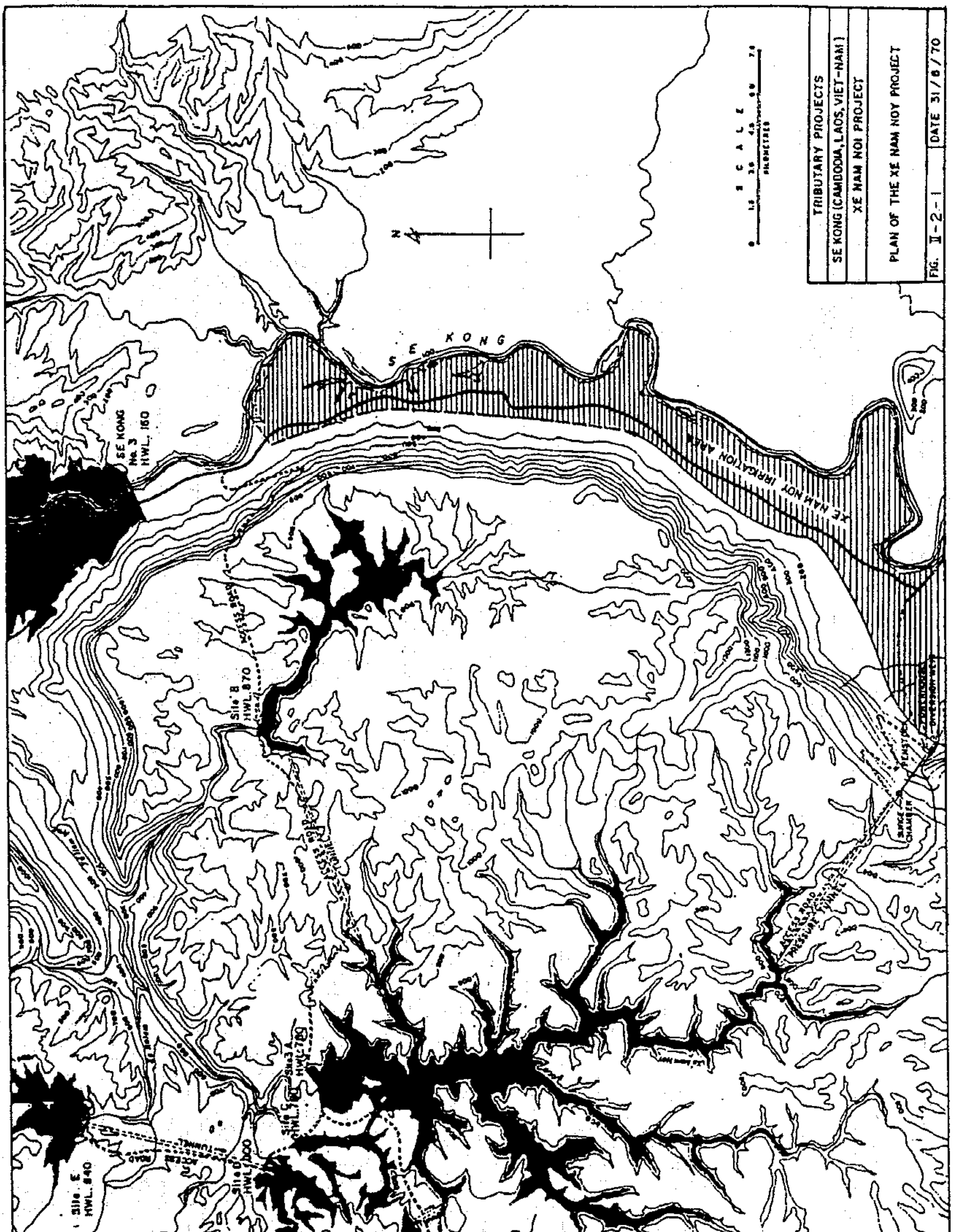


Table AP2.2-1 Development Plans of Xe Namnoy studied by JICA in 1992 (1/4)

(Alternative 1)

PLAN	UNIT	A: XE NAMNOY UPSTREAM		B: HOUAY KATAK-TOK	C: XE NAMNOY DOWNSTREAM	TOTAL
1.PROJECT FEATURE						
CATCHEMNT AREA	km^2	280.0	82.0	199.0	890.0	
DAM						
HEIGHT	m	95.0	53.0	68.0	28.0	
CREST LENGTH	m	500.0	300.0	300.0	200.0	
TUNNEL						
LENGTH	m	5,700.0	2,600.0	3,200.0	3,500.0	15,000.0
DIAMETER	m	4.0	2.2	3.2	4.8	
PENSTOCK						
LENGTH	m	2,340.0		2,960.0	220.0	5,520.0
DIAMETER	m	3.0		2.4	3.6	
MEAN INFLOW	m^3/s	11.5		6.3	28.2	
RESERVOIR						
HIGH WATER LEVEL	m	800.0		880.0	280.0	
LOW WATER LEVEL	m	790.0		870.0	278.0	
GROSS STORAGE CAPACITY	10^6 m^3	627.0		318.0	6.1	
EFFECTIVE STORAGE CAPACITY	10^6 m^3	277.0		168.0	1.2	
REGURATION RATIO	%	62.8		91.8		
POWER PLAN						
GROSS HEAD	m	676.0		776.0	79.0	1,531.0
NET HEAD	m	650.0		749.5	73.0	1,472.5
MAXIMUM DISCHARGE	m^3/s	36.0		19.4	60.0	115.4
INSTALLEC CAPACITY	MW	190.0		118.0	36.0	344.0
FIRM PEAK POWER	MW	185.4		115.5	7.6	308.6
ANNUAL ENERGY	10^6 kWh	524.6		331.4	139.3	995.3
FIRM ENREGY	10^6 kWh	406.1		252.8	16.7	675.6
SECONDARY ENERGY	10^6 kWh	118.5		78.6	122.6	319.7
PLANT FACTOR	%	31.5		32.1	44.2	33.0
2.PROJECT ECONOMY						
CONSTRUCTION COST	1,000US$	187,823.0		103,963.0	61,176.0	352,962.0
ANNUAL COST	1,000US$	18,943.7		10,485.6	6,170.2	35,599.5
ANNUAL BENEFIT	1,000US$	37,306.1		23,478.8	7,679.2	68,464.1
CONSTRUCTION COST / KWh	US$/KWh	0.36		0.31	0.44	0.35
CONSTRUCTIN COST / KW	US$/KW	988.54		881.04	1,699.33	1,026.05
B - C	1,000US$	18,362.4		12,993.2	1,509.0	32,864.6
B/C		1.97		2.24	1.24	1.92

Fig. AP2.2-2 Development Plans of Xe Namnoy studied by JICA in 1992 (1/4) (Alternative 1)

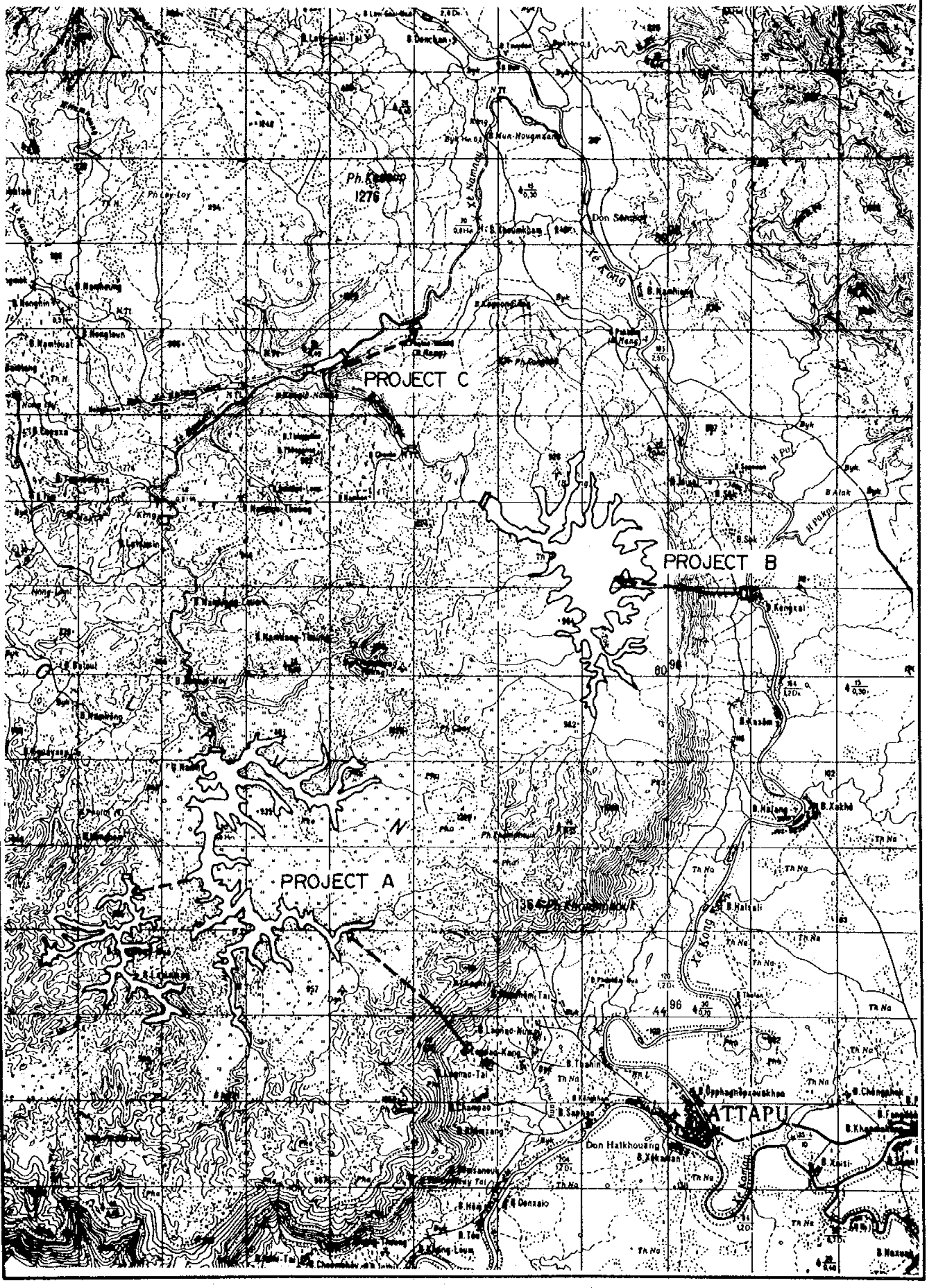


Table AP2.2-1 Development Plans of Xe Namnoy studied by JICA in 1992 (2/4)

(Alternative 2)

PLAN	UNIT	A XE NAMNOY UPSTREAM	D XE NAMNOY MIDSTREAM	B HOUAY KATAK-TOK	C XE NAMNOY DOWNSTREAM	TOTAL
1.PROJECT FEATURE						
CATCHEMNT AREA	km^2	280.0	257.0	199.0	972.0	
DAM						
HEIGHT	m	95.0	15.0	68.0	28.0	
CREST LENGTH	m	500.0	90.0	300.0	200.0	
TUNNEL						
LENGTH	m	5,700.0	9,350.0	3,200.0	3,500.0	21,750.0
DIAMETER	m	3.6	3.6	3.2	4.8	
PENSTOCK						
LENGTH	m	2,340.0	1,370.0	2,960.0	220.0	6,890.0
DIAMETER	m	2.7	2.8	2.4	3.6	
MEAN INFLOW	m^3/s	8.9	8.2	6.3	30.8	54.2
RESERVOIR						
HIGH WATER LEVEL	m	800.0	730.0	880.0	280.0	
LOW WATER LEVEL	m	790.0		870.0	278.0	
GROSS STORAGE CAPACITY	10^6 m^3	552.0		318.0	6.1	
EFFECTIVE STORAGE CAPACITY	10^6 m^3	191.0		168.0	1.2	
REGURATION RATIO	%	66.3		91.8		
POWER PLAN						
GROSS HEAD	m	676.0	450.0	776.0	79.0	1,981.0
NET HEAD	m	650.0	424.5	749.5	73.0	1,897.0
MAXIMUM DISCHARGE	m^3/s	28.0	26.0	19.4	60.0	133.4
INSTALLEC CAPACITY	MW	148.0	90.0	118.0	36.0	392.0
FIRM PEAK POWER	MW	144.2	8.7	115.5	8.3	276.7
ANNUAL ENERGY	10^6 kWh	404.3	240.8	331.4	148.0	1,124.5
FIRM ENERGY	10^6 kWh	315.9	19.0	252.8	18.2	605.9
SECONDARY ENERGY	10^6 kWh	88.4	221.8	78.6	129.8	518.6
PLANT FACTOR	%	31.2	30.5	32.1	46.9	32.7
CONSTRUCTION COST	1,000US$	146,877.0	80,115.4	103,963.0	61,176.0	392,131.4
ANNUAL COST	1,000US$	14,813.9	8,080.4	10,485.6	6,170.2	39,550.0
ANNUAL BENEFIT	1,000US$	28,819.9	13,035.2	23,478.8	8,169.7	73,503.7
CONSTRUCTION COST / KWh	US$/KWh	0.36	0.33	0.31	0.41	0.35
CONSTRUCTIN COST / KW	US$/KW	992.41	890.17	881.04	1,699.33	1,000.34
B - C	1,000US$	14,006.04	4,954.85	12,993.21	1,999.54	33,953.65
B/C		1.95	1.61	2.24	1.32	1.86

Fig. AP2.2-2 Development Plans of Xe Namnoy studied by JICA in 1992 (2/4) (Alternative 2)

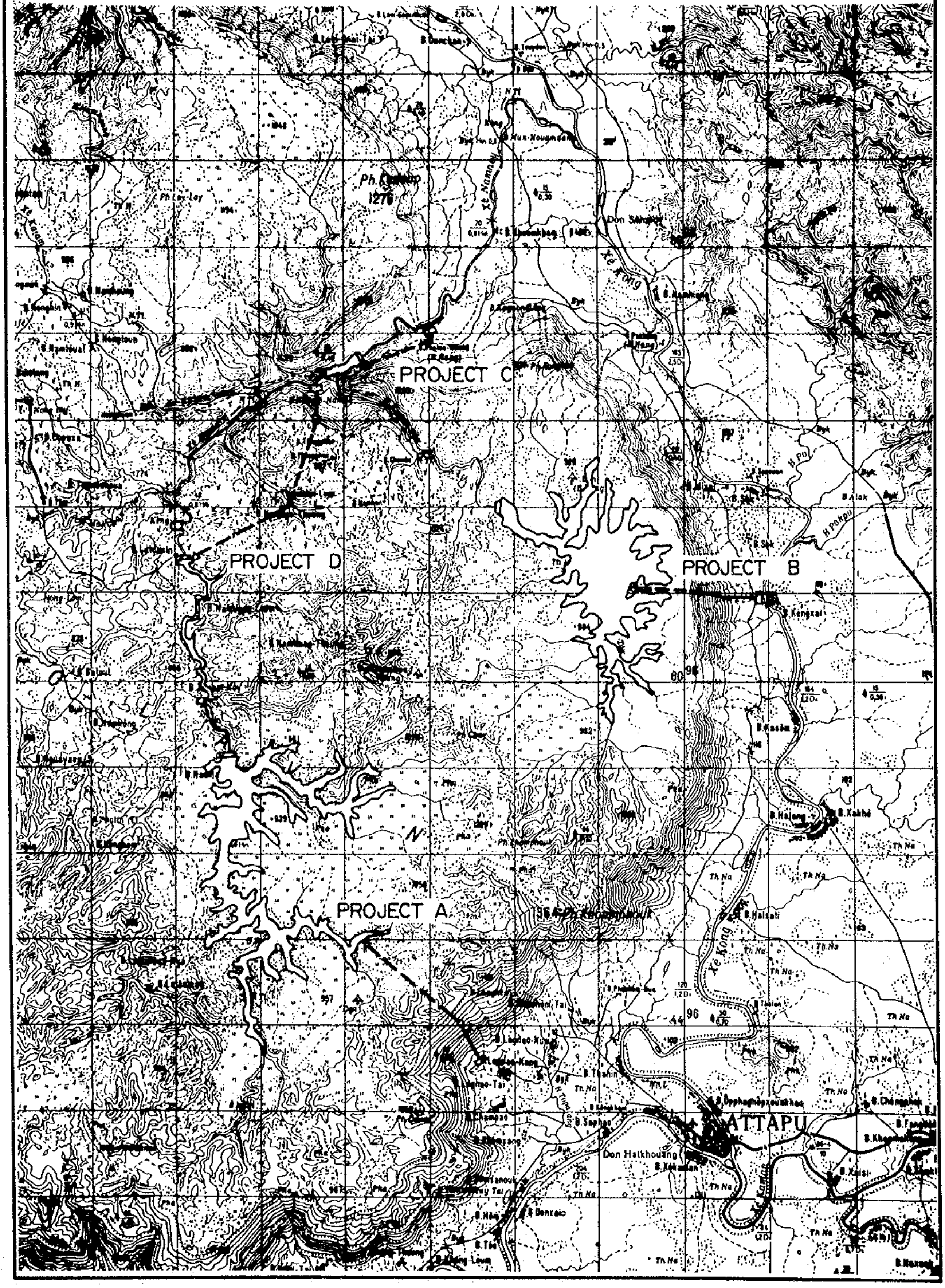


Table AP2.2-1 Development Plans of Xe Namnoy studied by JICA in 1992 (3/4)

(Alternative 3 : Optimum alternative plan proposed in 1992)

PLAN	UNIT	D XE NAMNOY MIDSTREAM	B HOUAY KATAK-TOK	C XE NAMNOY DOWNSTREAM	TOTAL
1.PROJECT FEATURE					
CATCHEMNT AREA	km^2	537.0	199.0	1,252.0	
DAM					
HEIGHT	m	38.0	68.0	28.0	
CREST LENGTH	m	400.0	300.0	200.0	
TUNNEL					
LENGTH	m	9,350.0	3,200.0	3,500.0	16,050.0
DIAMETER	m	4.7	3.2	4.8	
PENSTOCK					
LENGTH	m	1,390.0	2,960.0	220.0	4,570.0
DIAMETER	m	3.5	2.4	3.6	
MEAN INFLOW	m^3/s	17.0	6.3	39.7	
RESERVOIR					
HIGH WATER LEVEL	m	750.0	880.0	280.0	
LOW WATER LEVEL	m	740.0	870.0	278.0	
GROSS STORAGE CAPACITY	10^6 m^3	170.0	318.0	6.1	
EFFECTIVE STORAGE CAPACITY	10^6 m^3	107.0	168.0	1.2	
REGURATION RATIO	%	19.9	91.8		
POWER PLAN					
GROSS HEAD	m	466.0	776.0	79.0	1,321.0
NET HEAD	m	440.0	749.5	73.0	1,262.5
MAXIMUM DISCHARGE	m^3/s	56.0	19.4	60.0	135.4
INSTALLED CAPACITY	MW	200.0	118.0	36.0	354.0
FIRM PEAK POWER	MW	73.7	115.5	28.9	218.1
ANNUAL ENERGY	10^6 kWh	529.1	331.4	181.9	1,042.4
FIRM ENERGY	10^6 kWh	161.3	252.8	63.3	477.4
SECONDARY ENERGY	10^6 kWh	367.8	78.6	118.6	565.0
PLANT FACTOR	%	30.2	32.1	57.7	33.6
2.PROJECT ECONOMY					
CONSTRUCTION COST	1,000US$	158,360.0	103,963.0	61,176.0	323,499.0
ANNUAL COST	1,000US$	15,972.1	10,485.6	6,170.2	32,627.8
ANNUAL BENEFIT	1,000US$	31,562.3	23,478.8	11,041.5	66,082.6
CONSTRUCTION COST / KWh	US$/KWh	0.30	0.31	0.34	0.31
CONSTRUCTIN COST / KW	US$/KW	791.80	881.04	1,699.33	913.84
B - C	1,000US$	15,590.2	12,993.2	4,871.3	33,454.8
B/C		1.98	2.24	1.79	2.03

Fig. AP2.2-2 Development Plans of Xe Namnoy studied by JICA in 1992 (3/4)

(Alternative 3 : Optimum alternative plan proposed in 1992)

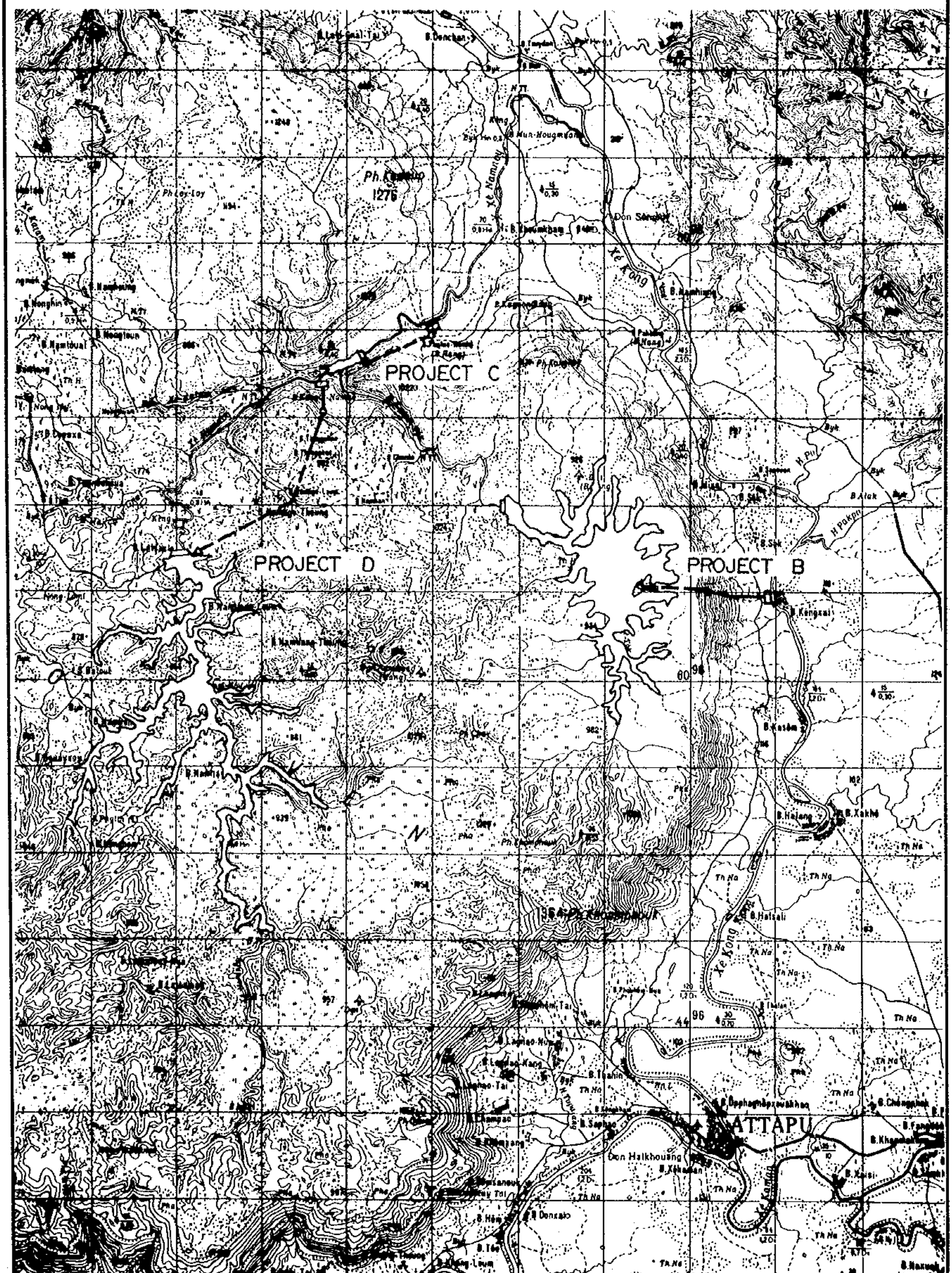


Table AP2.2-1 Development Plans of Xe Namnoy studied by JICA in 1992 (4/4)

(Alternative 4)

PLAN	UNIT	D-1 XE NAMNOY MIDSTREAM UP PLAN	D-2 XE NAMNOY MIDSTREAM DOWN PLAN	B HOUAY KATAK-TOK	C XE NAMNOY DOWNSTREAM	TOTAL
1.PROJECT FEATURE						
CATCHEMNT AREA	km^2	537.0	537.0	199.0	1,252.0	
DAM						
HEIGHT	m	38.0		68.0	28.0	
CREST LENGTH	m	400.0		300.0	200.0	
TUNNEL						
LENGTH	m	5,440.0	5,150.0	3,200.0	3,500.0	17,290.0
DIAMETER	m	4.7	4.7	3.2	4.8	
PENSTOCK						
LENGTH	m	640.0	580.0	2,960.0	220.0	4,400.0
DIAMETER	m	3.5	3.5	2.4	3.6	
MEAN INFLOW	m^3/s	17.0	17.0	6.3	39.7	
RESERVOIR						
HIGH WATER LEVEL	m	750.0		880.0	280.0	
LOW WATER LEVEL	m	740.0		870.0	278.0	
GROSS STORAGE CAPACITY	10^6 m^3	170.0		318.0	6.1	
EFFECTIVE STORAGE CAPACITY	10^6 m^3	107.0		168.0	1.2	
REGURATION RATIO	%	19.9		84.4		
POWER PLAN						
GROSS HEAD	m	306.0	160.0	776.0	79.0	1,321.0
NET HEAD	m	291.0	150.0	749.5	73.0	1,263.5
MAXIMUM DISCHARGE	m^3/s	56.0	56.0	19.4	60.0	191.4
INSTALLED CAPACITY	MW	133.0	68.0	118.0	36.0	355.0
FIRM PEAK POWER	MW	49.0	24.9	115.5	28.9	218.3
ANNUAL ENERGY	10^6 kWh	350.4	179.8	331.4	181.9	1,043.5
FIRM ENERGY	10^6 kWh	107.2	54.5	252.8	63.3	477.8
SECONDARY ENERGY	10^6 kWh	243.2	125.3	78.6	118.6	565.7
PLANT FACTOR	%	30.1	30.2	32.1	57.7	33.6
2.PROJECT ECONOMY						
CONSTRUCTION COST	1,000US$	102,518.0	56,974.0	103,963.0	61,176.0	324,631.0
ANNUAL COST	1,000US$	10,339.9	5,746.4	10,485.6	6,170.2	32,742.0
ANNUAL BENEFIT	1,000US$	20,912.6	10,717.8	23,478.8	11,041.5	66,150.7
CONSTRUCTION COST / KWh	US$/KWh	0.29	0.32	0.31	0.34	0.31
CONSTRUCTIN COST / KW	US$/KW	770.81	837.85	881.04	1,699.33	914.45
B - C	1,000US$	10,572.7	4,971.5	12,993.2	4,871.3	33,408.7
B/C		2.02	1.87	2.24	1.79	2.02

Fig. AP2.2-2 Development Plans of Xe Namnoy studied by JICA in 1992 (4/4)
(Alternative 4)