JAPAN INTERNATIONAL COOPERATION AGENCY

MINISTRY OF INDUSTRY AND HANDICRAFTS OF
THE GOVERNMENT OF LAO P.D.R.

FEASIBILITY STUDY
ON
THE NAM NGIEP-I HYDROELECTRIC POWER PROJECT
IN
THE LAO PEOPLE'S DEMOCRATIC REPUBLIC

FINAL REPORT : VOLUME 2

EXECUTIVE SUMMARY

FEBRUARY 2000

NIPPON KOEI CO., LTD.

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PREFACE

In response to a request from the Government of the Lao People's Democratic Republic, the Government of Japan decided to conduct the Feasibility Study on the Nam Ngiep-1 Hydroelectric Power Project in the Lao People's Democratic Republic and entrusted the Study to Japan International Cooperation Agency (JICA).

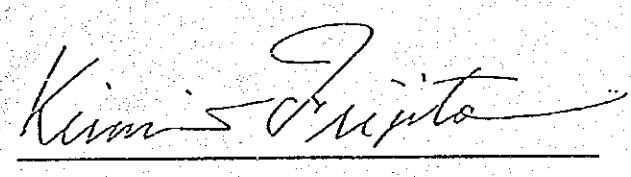
JICA dispatched a study team consisting of personnel of NIPPON KOEI Co., Ltd. led by Mr. Ichiro ARAKI to the Lao People's Democratic Republic, six times during the Study period between July 1998 and February 2000.

The Team held discussions with the officials concerned of the Government of the Lao People's Democratic Republic, and conducted related field surveys. After returning to Japan, the Team conducted further studies and compiled the final results in this report.

I hope this report will contribute to the promotion of the Project and to enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Lao People's Democratic Republic for their close cooperation throughout the study.

February 2000



Kimio FUJITA
President
Japan International Cooperation Agency

NIPPON KOEI CO.,LTD.
Consulting Engineers

February 2000

To. Mr. Kimio FUJITA
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Sir,

Letter of Transmittal

We are pleased to submit herewith the Final Report of Feasibility Study on the Nam Ngiep-I Hydroelectric Power Project in the Lao People's Democratic Republic.

Our Nippon Koei had studied it for about 19 months from July 1998 to February 2000 under contract with JICA.

This Final Report deals with the detailed procedure for the development scale justification of the Nam Ngiep-I Hydroelectric Power Project as the first stage of the Feasibility Study. This Project aims to serve the best interests of the Lao P.D.R. by selling power to the neighboring countries through a private enterprise based on the national power policy. Accordingly, during the Study, the environmental impact assessment had been carried out beyond usual view points of the Study in line with JICA's own principles. Preciously, in consideration of the recent worldwide criticism on dam construction, we had tried to find a smooth way to proceed a hydropower project by focussing on environmental issues, especially on social matters of resettlement and opening all studied results and information to public at workshops. We believe that it will take the first step forward a new sense of values from a former out-and-out economic believer of project formation.

We hope this Final Report would help not only to shift smoothly to the next stage for the Feasibility Study on the Nam Ngiep-I Hydroelectric Power Project but also to provide further similar projects with useful information.

The Final Report consists of seven (7) volumes, Main Report, Executive Summary and five (5) volumes of Supporting Report. Main Report covers all the study results including the hydropower planning procedure and the summary of natural and social environmental issues. Executive Summary presents main outputs of the Study. Supporting Reports give the detailed information, data and analysis to Main Report, such as (i) First Environmental Impact Assessment Report, (ii) Preliminary Environmental Management/Monitoring Plan, (iii) Preliminary Resettlement Plan, (iv) Sub-Contractor's Field Investigation Report, and (v) Records during Field Investigations.

We wish to take this opportunity to express sincere gratitude to your Agency and the Environmental Assessment Committee for the Study. We also wish to express our deep gratitude to the Government of Lao P.D.R., the Embassy of Japan in Vientiane, the JICA Laos Office for close cooperation and assistance extended to our Study Team during field investigations and studies in Lao P.D.R.

Sincerely yours,

Ichiro ARAKI, Team Leader

Feasibility Study on the Nam Ngiep-I
Hydroelectric Power Project
Nippon Koei Co., Ltd.

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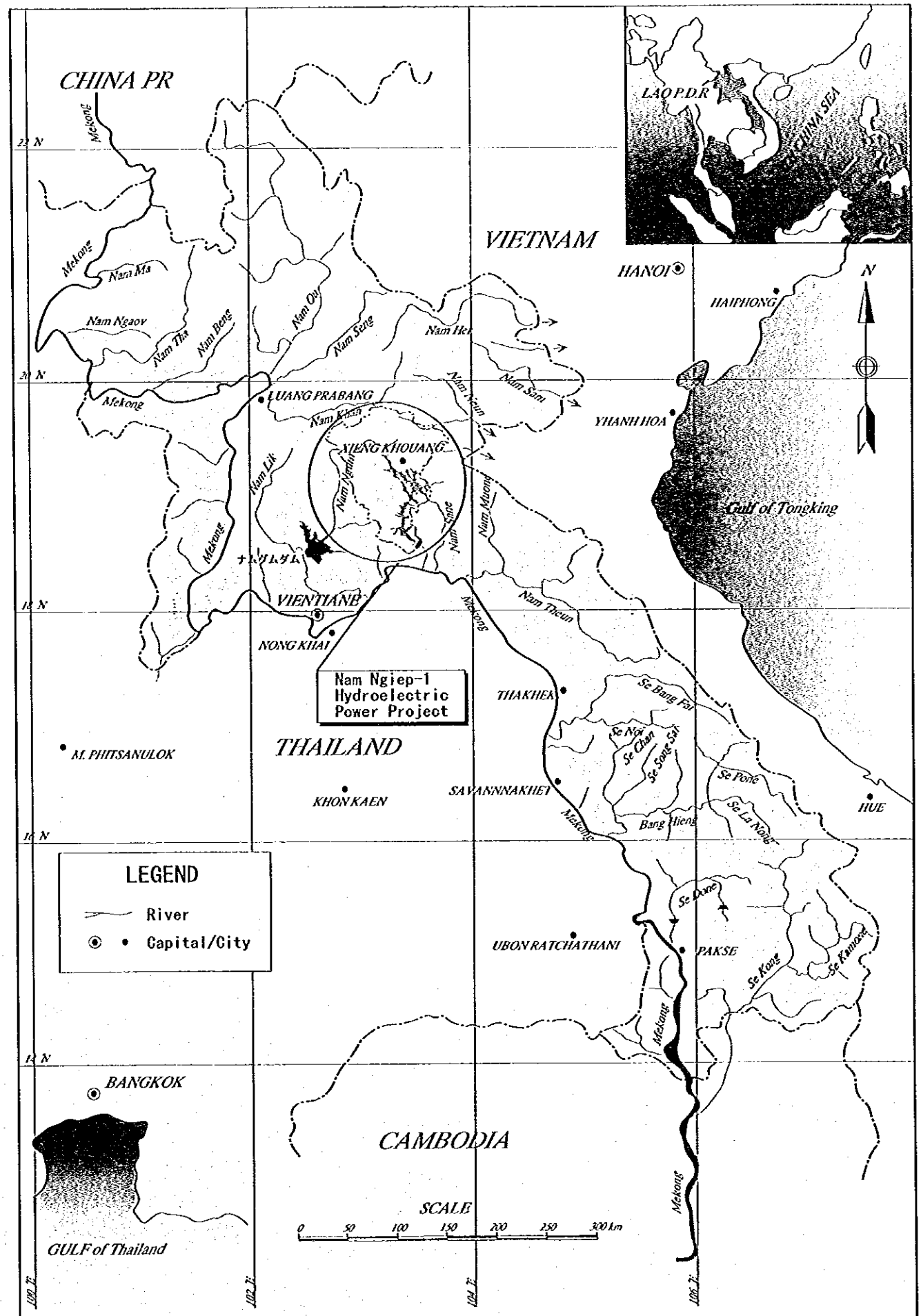
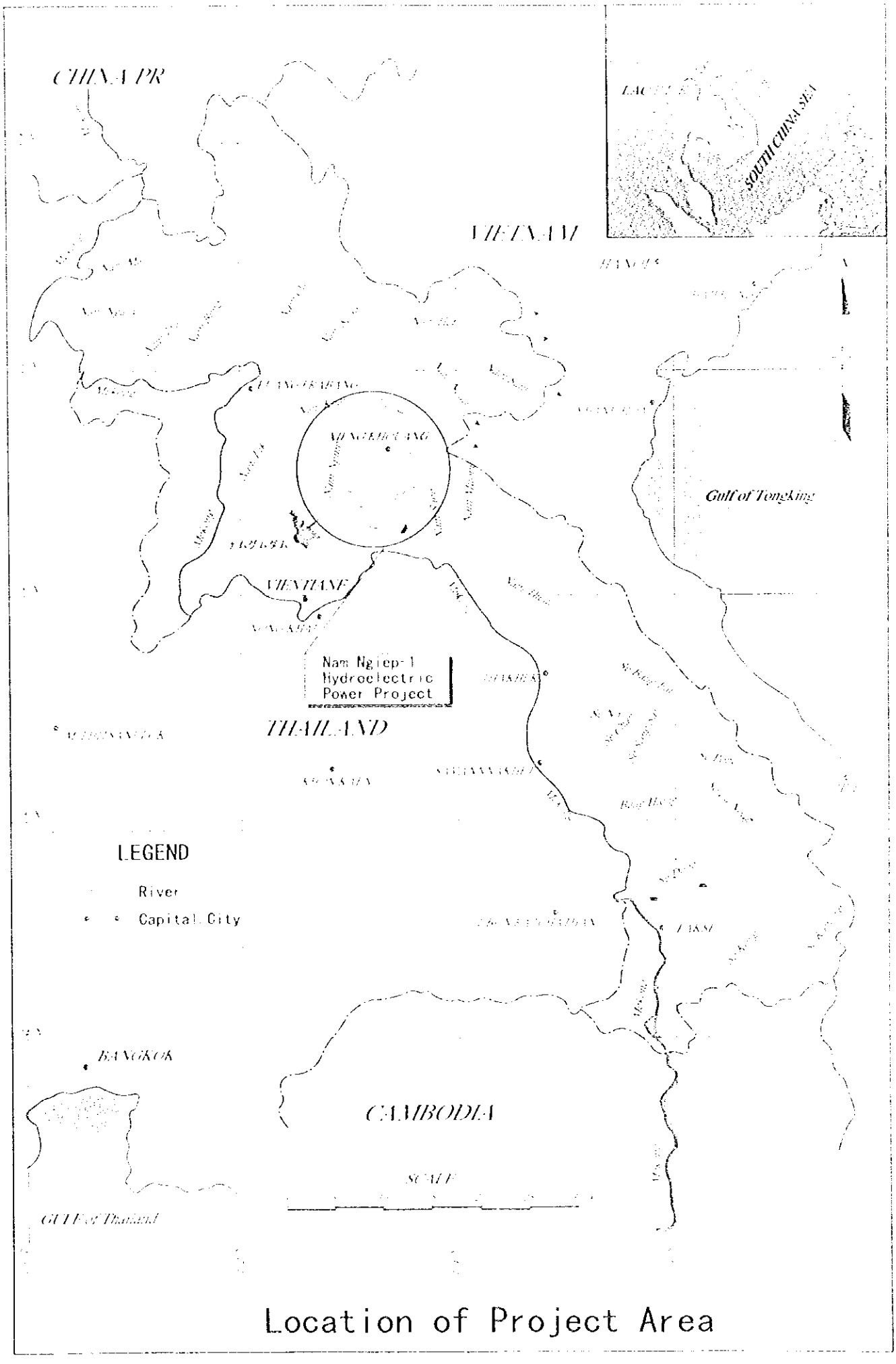


Location of Project Area



Location of Project Area

OUTLINE OF THE STUDY

CONCLUSIONS AND RECOMMENDATIONS

1. MILLENNIUM DAM

On one hand, some advanced countries lost significance in the dam development, and on the other hand it is a fact that some developing countries need it as a tool for their national development. Accordingly, we had provided them not only financial aid but also the intellectual assistance to judge the priority of development from the environmental standpoint. The judgements were on the basis of understandable national development policy on national interests from the other countries by an effective utilization of rich water resources under the best geopolitical advantages.

As a conclusion of the above, the Study Team proposes to construct "the Millennium Dam" at the end of the Study. We named a dam of the Nam Ngiep-I HEPP as "the Millennium Dam" on ground of our oath to recover "the silent rivers" in the next century, not by the reason of our memorial to propose it at the end of this century.

Therefore, in order to that the proposal of "the Millennium Dam" may be worthy for coming ages, the detailed procedures to reach the conclusion were shown in the report hereinafter.

The conclusion reached both to minimization of environmental impacts at the extent, and realization of an economic-viable and financially attractive development, is the universal truth for the coming hydropower development. Consequently, the alternative with FSL at EL.320m is proposed to select the most promising development scheme for the Project.

This conclusion was made on the recent worldwide circumstance and with understanding that the development should be made on the international rule even in the developing countries. However, on the other hand, there is a different recognition that it is still permissible greatly for the developing countries to give national developments the highest priority in order to maximize their own benefits.

The Study has not been carried out in line with the theme of choice between "Environmental Conservation" and "Promotion of National Development". But, the same will probably come to the main theme by shaping up of the Project. The scale of the Project, which constructs the permanent structure, is determined based on the sense of value at that time. Especially, for the Project likely to be implemented by IPP, the minimization of risks is a key factor for determination of the development scale.

Therefore, the extent and scopes for further investigation and study should not be limited only for the medium scale development of FSL.320m.

2. PROJECT EVALUATION

Today's world has been continuously trying to cope with them. The modern civilization, which applied to natural science, was developed with the technology to control nature. However, in the society of high technological principles, which is ruled by this civilization, nature philosophy contrary to human is only resulted. Therefore, as an environmental destruction of present society is led by this nature philosophy, a doubt and a regret against to this nature philosophy have led an effort to create a symbiotic relationship between human and nature. These recent tendencies require us to show various evaluation criteria for a dam project implementation.

Under the viewpoint mentioned above, the general evaluation to be carried out by all persons at any positions under various evaluation criteria is indispensable for the dam development alternatives with priority on the environmental study. Therefore, the Study Team recommended the most attractive alternative as a conclusion of evaluation results by proposing seven (7) items of design criteria as shown below, which are expected to raise various discussions among GOL, JICA, village people and NGOs.

No.	Evaluation Category	Evaluation Criteria	Evaluation Results
1.	Natural Environment Evaluation	E.C. on the assumption that the existing natural, developed-natural and artificial environments should be preserved or improved.	Impacts on Natural Environment will become large as increasing dam scale, until a failure of the environmental preservation
2.	Social Environment Evaluation	E.C. on the assumption that people and social system surround them should be preserved and improved.	Impacts on Social Environment will become large as increasing dam scale, but, Social system can be kept safety by changing slowly.
3.	Economic Evaluation	E.C. on the assumption that the economic feasibility shall be judged by avoid cost of thermal generation.	Mathematical evaluation can be done with economical index: B/C, B-C, and EIRR; however, only a validity of hydropower can be evaluated.
4.	Financial Evaluation	E.C. on the assumption that the benefit by electricity sales shall cover all investment, under a good enterprise as IPP.	Same as Item No.3, however, evaluation is based on several assumptions such as BOOT composition, fund procure, electricity sale cost, and commencement day of commercial operation.
5.	Technical Evaluation (Dam Construction)	Technical evaluation criteria for a high dam construction.	A Large-scale dam is technically restricted to construct. The highest record of dam construction is 180m, that of project design is 220m.
6.	Evaluation on EAC & Workshops	E.C. judged from opinion, suggestion and questionnaire results at EAC/Workshop.	Evaluation is based on individual extent of interest and understanding on participants, and on their positions.
7.	Evaluation on Japan's Mekong River Develop.Plan	E.C. judged from the viewpoint of stance in official development aid of Japan	Aid policy in peace, development, environment preservation is essential for evaluation.

Note: E.C means Environmental Criteria.

The Study Team recommended the most attractive alternative, the medium-scale dam development with FSL.320m, as a conclusion of evaluation results by proposing seven (7) items of design criteria as shown below:

No.	Evaluation Category	General Evaluation Results	
		Medium-Scale (FSL.320m)	Large-Scale (FSL.360m)
1.	Natural Environment Evaluation	O	Δ
2.	Social Environment Evaluation	O	Δ
3.	Economic Evaluation	Δ	O
4.	Financial Evaluation	Δ	O
5.	Technical Evaluation(Dam Construction)	O	O
6.	Evaluation on EAC & Workshops	O	Δ
7.	Evaluation on Japan's Mekong River Basin Development Plan	O	O
8.	General Evaluation Results	O	Δ

Note: O : Recommended alternative to develop.
Δ : Recommended alternative not to develop compared with other one.

The various reasons that the medium-scale dam alternative have been selected as the most recommendable one by the Study Team were epitomized by the following four (4) reasons:

(i) Evaluation results of the social environmental aspects: This alternative will save the Thaviang Sub-District, where is expected of the future development due to not only a geographic advantage but also the recent regional development projects for extension of both a national highway and a rural electrification.

(ii) Evaluation results of the preliminary resettlement plan: This alternative will save the population being resettled forcibly as less as possible due to avoiding inundation of the Thaviang Sub-District.

(iii) Evaluation results of economic and financial analysis: This alternative will clear the critical economic index for IPP projects, even the Study Team's evaluation criteria thinks a great deal of evaluation results both on the social and natural environmental aspects.

(iv) Evaluation results of General and Site Workshops: This alternative was selected under deep consideration of the evaluation results by local peoples and local governments through both General and Site Workshops during the field investigations.

Accordingly, at the following two points, the Nam Ngiep-I HEPP is expected to set as a high valuation on dam developments in the world not only by peoples in Lao PDR but also by both local and international NGOs, as well as international financing agencies being willing to invest in positively based on the comprehensive development intention:

(i) The project might become a pathfinder of the advanced development procedure selecting a project scheme based on the EIA results at the preliminary F/S stage of hydroelectric power project, and

(ii) The Project will save the reservoir area of 74km^2, the dam height of 40m, the construction cost of US$118mil., and resettlement population of 3,000, instead of lost values at the install capacity of 94MW, the annual energy of 556GWh, and B-C(current value) of US$80mil.

HYDROPOWER PLAN

3. OBJECTIVES OF THE PROJECT

In line with the Lao National Policy for increasing in earning from sales of electricity to abroad by the development of abundant domestic hydroelectric resources, The Nam Ngiep-1 HEPP is recommended to develop for export of clean, stable and economic electricity to Thailand to meet the growing demand.

The Project will not only attain conventional hydropower benefits, but also contribute to (i) expansion of irrigable area around the proposed reservoir, (ii) rural electrification, (iii) improvement of downstream river-navigation condition, and (iv) accessibility among Bolikhamxay Province, Xaysonmoun Special Zone and Xieng Khouang Province with a transporting system in the reservoir.

4. DEVELOPMENT TYPE AND SCALE OF THE PROJECT

The project development scale was optimized not only taking into consideration economic and financial attractiveness but also making comprehensive assessment of environmental impacts in and around the Project area. Negative impacts and indirect benefits, which are difficult to quantify, were relatively evaluated through value judgement based on the specific evaluation criteria. Collateral solutions or set-off effects to the negative impacts as well as the value or point judgements for the indirect benefits are summarized in the attached tables below:

Quantified Environmental Impacts

No.	Natural-Social Environmental Impacts	Collateral Solution
1.	Inundation of villages	Supply of equal-scaled resettlement facilities
2.	Peoples' mental burden for resettlement (*1)	Monetary support such as outfit allowance for resettlement and guarantee fund for villager's living after movement at a decent-life level for several years.
3.	Water level fluctuation at downstream due to discharge from power station	Provision of re-regulation pond for stabilization of water level
4.	Decreasing fishes at downstream reach	Promotion and construction of facilities for fishery
5.	River shore erosion at downstream reach	River protective works
6.	Tentative water pollution by hydrogen sulfide from the submerged forest	Provision of public wells for downstream villages
7.	Destruction (damage) of peoples' production due to construction	Compensation and relocation
8.	Sedimentation at upstream end of reservoir (*2)	Heightening river bank when actually required
Note (*1)	As the result of EIA, it was revealed that the present infrastructures in the Project area are not satisfactory to the villagers and local market is much stagnant. Judging from the above, even the scale of resettlement become large, the consensus of the people will be positive against the resettlement, if a meticulous welfare is provided to them with well-supply of local electrification, medical facilities, schools, public wells, etc., supply of equal-sized farmland, technical guidance for agriculture and stockbreeding, provision of industrial promotion center in the resettlement land, etc.	
Note (*2)	Judging from the state of sedimentation measured for the existing Nam Ngum reservoir, prospective sedimentation at the upstream end of the Nam Ngiep-1 HEPP reservoir is deemed to be negligible small.	

Interpretation for Impacts not Quantified

No.	Evaluation
1.	Mental-burden of the highland people in the form of changing living circumstances due to resettlement is considered to be set off by the contribution to the nation with the decreasing shifting cultivation and guarantee of their lives with well-supplied resettlement facilities and support.
2.	Declined CO_2 purification effect in the river basin due to vanishing forest is considered to set off by the amount of CO_2 emission, which is expected to decrease by hydropower development instead of thermal plant construction.
3.	Noise, dust, water pollution, etc during construction will be restricted and minimized by applying careful construction control in conformity with the local environmental rules and regulations in Lao PDR.
4.	In the tropical country, influence of the discharge for power generation, which will negatively affect on an adequate water temperature for irrigation, will be negligible small.

The conclusion reached that the minimization of the environmental impacts at the extent of an economic-viable and financially attractive development is the universal truth for the coming hydropower development. Consequently, the alternative with FSL at EL.320m was selected as the most promising development scheme for the Project. The principal project features are as shown in the table below:

Proposed Principal Project Features

Structure	Parameter	Unit	FSL.320m
Reservoir	Catchment area at dam site	km^2	3,700
	Annual basin rainfall	mm	2,470
	Annual mean runoff	m^3/s	162.3
	Annual mean runoff	mill. m^3	5,118
	Average run-off coefficient	-	0.56
	Probable max. flood, PMF	m^3/s	15,900
	Mean annual sediment flow	$t/km^2/yr$	413.4
	Reservoir area at FSL	km^2	73.9
	Gross & effective storage volume	10^6m^3	2,279, 1,779
	Min. operation level (MOL)	EL.m	284
	Draw-down	m	36
Dam	Dam type	-	CFRD
	Dam height & crest length	m	157, 524
	Dam volume	10^6m^3	6.9
	Dam crest level	EL.m	325
Spillway	Spillway crest level	EL.m	306.5
	Design flood capacity	m^3/s	8,730 (Q=10,000yr)
Waterway	Design discharge	m^3/s	221
	Headrace tunnel diameter & length	m	9.0, 420
Power Plant	Powerhouse type & size	Surface type	L58mxW31mxH58m
	Design flood discharge	m^3/s	4,519 (Q=100yr)
	Rated head	m	131.8
	Type of turbine	-	Vertical Francis
	Plant capacity & nos. of unit	MW	240=2nos@120
	Annual energy	GWh	1,349
Re-regulation Structure	Max. pond level	EL.m	173
	Required storage capacity	mill. m^3	4.7
	Design flood discharge	m^3/s	4,519 (Q=100yr)

5. FARMLANDS AND VILLAGES IN RESERVOIR AREA

The area of cultivating lands and number of villages as shown below will be inundated by the proposed reservoir of FSL320m. However, most of the villages and paddy fields of Thaviang

Sub-District except B.Pou in the upper reservoir area will be released from inundation. Name of the affected villages are as listed below:

Inundating Lands & Number of Villages

No.	Affected Item	Extent
1	Paddy Field	361 ha
2	Dry Field	114 ha
3	Village	5 nos.

Name of Affected Villages

No.	Name of Village	Area	EL. (m)
1	B. Pou	Upper Reservoir	319
2	B. Houaypamon	Lower Reservoir	275
3	B. Namyouk	Lower Reservoir	271
4	B. Sopphouh	Lower Reservoir	261
5	B. Sopyouk	Lower Reservoir	245

Meanwhile, B.Pou will be relocated in the near future by a national plan irrespective to the Project to the area along National Route-4 where will not be affected by inundation.

6. POWER PEAK TIME DURATION

Since EGAT is hoping for the time being to purchase from the most IPP Projects in Lao PDR the intermediate peaking power, the similar peak time duration of 16-hour is applied in this moment for the study of the Nam Ngiep-1 HEPP. However, as the daily peak demand in Thailand is trending sharp year by year, it is expected that EGAT will require in the near future power purchase from Lao PDR for peak demand. If EGAT accepts 8-hour or less peaking operation, the Project becomes drastically attractive.

7. RE-REGULATION FOR DOWNSTREAM FLOW

The maximum discharge to be released from the power plant will be about 220m^3/s. According to the operation rule proposed by EGAT, a power generation will be interrupted daily for several hours and entirely on Sunday and Thai national holidays, thus, the water level at downstream of the dam will be fluctuated largely with dangerous ranges to the riparian peoples. To minimize the influence by plant discharge to the downstream river corridor, a discharge regulation facility will be constructed at 5km downstream of the proposed main damsite.

8. CAPITAL COST OF THE PROJECT

The total capital cost of the Nam Ngiep-1 HEPP was estimated at US$345.9 million, expressed at mid-1999 price level. The total capital cost makes a unit cost of 1,440US$/kW with installed capacity of 240MW. The total cost for the intentional environmental impact mitigation measures was estimated at US$21.1 million, which is equivalent to 6.0% of the total capital cost of the Project. Preliminary cost breakdown of the Project is shown in the tables below:

No.	Particular		Unit	EL.320m
1.	Direct Const. Cost (Civil)	-	mill.US$	161.8
2.	Direct Const. Cost (M & E)	-	mill.US$	120.4
3.	Direct Const. Cost (Preparatory works)	-	mill.US$	11.2
4.	Total Direct Construction Cost	(1+2+3)	mill.US$	293.4
5.	Environmental Impact Mitigation Cost	-	mill.US$	21.1
6.	Engineering Service Cost	-	5%	15.7

No.	Particular		Unit	EL.320m
7.	Administration Cost	-	5%	15.7
8.	Total Capital Cost for EIRR	(4+5+6+7)	mill.US$	345.9
9.	Price Escalation	(4)x7.5%	0%	22.0
10.	Physical Contingency	(1+3)x10%		17.3
11.	Tax and Duties	-		0.0
12.	Land Acquisition	-		0.0
13.	Total Project cost (for FIRR)	-	mill.US$	385.2

9. PROJECT BENEFITS

Project benefits other than income from electricity sales are summarized in the table below:

No.	New Economic Opportunities	Economic Effect
1.	Creation of reservoir	Flood regulation effect to downstream reach by reservoir storage function and prospective enlargement of irrigable area around reservoir
2.	Navigation in reservoir	Economical interconnection of Xieng Khouang Province and Bolikhamxay Province (*1) and prospective tourism development (*2)
3.	Fishery in reservoir (*3)	Stabilization of catch of fish and prospective development of rural socio-economy
4.	Increasing job opportunity by Project	Increasing people's living standard with more labor income
5.	Resettlement of highland people	Decreasing the are of shifting cultivation
6.	Technical guidance for agriculture and stockbreeding (*3)	Modernization of rural agriculture and stockbreeding
7.	Rural electrification by power supply from Project	Notable improvement in living circumstances and prospective rural industrial development
8.	Macro economic impact derived from Project	Decreasing poverty and regional economic activation
(*1)	Economic interconnection of both provinces, Xieng Khouang and Bolikhamxay will give impacts to the economic activities in the remote Xieng Khouang Province, which were not briskly due to poor transportation condition and security problem of National Road Nos. 4 and 7.	
(*2)	Assuming from the trend of national economic expansion to the Southern region, as well as the recent inroads of tourism into the areas near the existing Nam Ngum reservoir, it is also presumed that development of tourism will be expected for the areas around the reservoir soon after the completion of the Project. Especially the Thaviang Sub-District, from its topographic advantage with widely developed flat land along the reservoir, has a high possibility of tourism development as resort area.	
(*3)	By the construction of a rural industrial promotion center in the main resettlement area, technical guidance will be provided to the resettlement people dispatching several foreign experts for the respective sector.	

10. FINANCIAL VIABILITY

An independent BOT power development company is assumed in the model and the debt-equity ratio of 65-35 is used, assuming a joint venture between GOL and a consortium of private sectors. The GOL would be responsible for 25% of equity investment, and the GOL equity is assumed to come from an international soft loan. An initial tariff of 6.6 cents/kWh in 2011, the date of commissioning, is assumed as levelised tariff and will increase with an annual escalation of 2.5 %. The expected loan terms are given below. The financial IRR obtained for FSL.320m Alternative is 12.8% as FIRR on Project and annual net benefit (NPV) is assumed to be US$79.8million (NPV).

Source	Interest (%)	Grace Period (years)	Maturity (years)	Commitment Fee (%)	Front-end Fee (%)
1. OECF	3.3	5	20	0.0	0.0
2. JCB	8.5	3	8	0.5	1.0
3. ADB	8.5	3	15	1.0	1.0
4. IFC	0.0	0	0	0.0	0.0
5. TCB	10.0	3	8	1.0	1.0

Note: OECF : Overseas Economic Corporation Fund
JCB : Japanese commercial banks
ADB : Asian Development Bank
IFC : International Finance Corporation
TCB : Thai Commercial Bank

Financial steadiness against prospective risks involved in the project is favorable as shown in the table below, except the return on project is somewhat sensitive to the decrease in total energy sales:

No.	Risk Analysis	FSL.320m	FSL.360m
1.	Base Case	12.8%	13.7%
2.	10% Increase in Investment Cost	11.6%	12.5%
3.	10% Decrease in Total Energy Sales	11.4%	12.3%

ENVIRONMENTAL IMPACT ASSESSMENT

11. IMPACTS IN THE DOWNSTREAM AREA

Both the proposed FSL alternatives EL.360m and EL.320m have the same dam site. Consequently, the environmental impacts in the downstream area are very similar and do not provide a significant basis for differentiating the two (2) alternatives from the environmental point of view.

12. RESERVOIR AREA AND FOREST

The large-scale dam alternative (FSL.360m) will inundate exactly not only twice more land (14,820ha) than the medium-scale alternative (FSL.320m, 7,390ha), but also three (3) times more cultivated land (950ha compared to 310ha). Almost 10,000ha of forest, representing a potential timber volume of 290,000m^3 are also flooded by FSL.360m, against only half of these values for FSL.320m.

13. WATERQUALITY IN THE RESERVOIR

The clearing of reservoir is efficient to reduce the duration of low water quality. However, the clearing of the forest in the vast Nam Ngiep reservoir of 74km^2 may require an immeasurable long time and huge cost. Therefore, it seems not economical and realistic.

The improvement of the low-water quality at the downstream river stretch will have to be

planned with some re-aeration facilities.

14. SEQUESTERING LOSS OF CARBON

With the flooding of the forest, Laos will lost a potential for sequestering the carbon, resulting eventually in a higher contribution to global warming. It represents a loss for a potential selling of carbon credits to any industrialized nations. Based on a forest growth of 2 to 3 m^3/ha/year, the loss may be estimated at US$180,000-270,000/year for FSL.360m and at US$88,000-130,000/year for FSL.320m.

15. DRAW-DOWN AREA CULTIVATION

During operation, the water level of the reservoir will fluctuate, exposing draw-down areas which may be developed for agriculture or grazing. For rice production, the land must be exposed around 5 months. FSL.320m offers almost twice more areas for rice cultivation than FSL.360m: almost 2,000ha against 1,000ha. Only a part of this area is suitable for rice culture when considering soil quality and local topography.

16. WATER QUALITY IN MEDIUM AND LONG TERM

The residence time of water into the reservoir is about 13 months for FSL.360m and only 3.6 months for FSL.320m. This short residence time combined with a limited inflow of Phosphorus from the watershed leads to the conclusion that there should be no problem of water quality in the medium and long term. After the impoundment, as the intense decay of organic matter in the water consume all the dissolved oxygen, it is anticipated that the water will recover a reasonable level of oxygen after only 5 to 6 years for FSL.360m and after only 2 years for FSL.320m.

17. WATER QUALITY IN SHORT TERM

Because of its depth, the reservoir will probably be stratified, with a 15-20m depth layer of well aerated water over a deeper water body of colder and anoxic water. Turn over may occur during the cold season as observed in the Nam Ngum reservoir, but its magnitude has still to be assessed. As the water intake is located most of the year below 20m from the surface, it is anticipated a release of low quality water in the downstream river, with impacts on aquatic life and population. To mitigate this impact, appropriate facilities as multi level intake or downstream re-aeration structure may be studied in a further investigation.

18. RE-REGULATION FOR DOWNSTREAM

A re-regulation facility will be constructed below the tailrace channel to regulate the flow over

24 hours, to avoid daily changes in river flow which could have resulted in hazards for the population and excessive erosion of the riverbed.

The average monthly flow will be significantly changed at the downstream area: the dry season flow will be increased 3 times and the wet season flow reduced by 50% from present situation.

19. IMPACTS OF ACCESS ROAD AND TRANSMISSION LINE

Impacts on land at downstream will be limited to land acquisition for only 10km of access road and 110km of transmission line. Compensation for the loss of land will be provided to the concerned population. Impact is the same for both alternatives.

20. ENVIRONMENTAL MANAGEMENT PLAN

To mitigate the impacts during construction, filling stage of the reservoir and operation stages, a program of activity has been prepared in the Environmental Management Plan (EMP). The constitution of an Environmental Management Unit (EMU) is also proposed.

PRELIMINARY RESETTLEMENT PLAN

21. POSSIBLE INVOLUNTARY RESETTLEMENT

According to the sociocconomic surveys of the Project area conducted December 1998 through March 1999, overall, including both Upstream and Downstream areas of the proposed dam site, nearly 2,000 households and 12,000 persons may be affected to one degree or another by the Project. About 660 households and 5,000 persons in 14 villages are in the Upper Reservoir and another 200 households and 1,200 persons in 4 villages the Lower Reservoir could potentially be affected by involuntary resettlement. For Downstream area about 1,300 households and 6,800 people in 15 villages would be affected through changes in the Nam Ngiep River flow and water.

22. FSL.360M ALTERNATIVE

While not all villages within the proposed reservoir area would be submerged even by FSL.360m, their rice lands are all situated along the Nam Ngiep River and its territories at low levels. So it can be assumed that virtually all the villages would require resettlement, if FSL.360m is chosen for implementation. Generally speaking, mitigation includes minimizing resettlement to the extent possible, carrying out an international standard of resettlement planning and implementation if unavoidable, and fair compensation for the displaced population.

23. FSL.320M ALTERNATIVE

The recommended design mitigation at this time is to consider the medium-scale dam alternative. The initial thinking was that lowering the FSL to EL 320m would reduce the number of affected villages down to 5 villages. There is not enough information at this time, however, to determine what the amount of backwater effect would be, i.e., how much higher the water at the back of the reservoir will be than at the front end. Two (2) meters would be assumed, including a safety margin. Therefore, consideration of the backwater effect indicates that EL.318m might be necessary to protect the majority of irrigated paddy land belonging to the Upper Reservoir villages, nearly 300ha of the total reservoir paddy land. This FSL.318m dam would more surely reduce the affected population down to 260 households and about 1,600 people.

24. PREPARATION OF FULL RESETTLEMENT ACTION PLAN

The Preliminary Resettlement Plan (PRP) is prepared without the final design of the Project having been decided. Once the alternative is selected, a full Environmental Impact Assessment (EIA) and Social Impact Assessment (SIA) will be required by internationally accepted guidelines, as well as preparation of a full Resettlement Action Plan (RAP) and a Social Action Plan (SAP) for mitigating other social impacts. During preparation of a draft RAP, the following studies will take place:

(i) Socio-Cultural Assessment of Resettlement and Host Communities (Part of SIA),

(ii) Preparation of a Public Consultation Framework,

(iii) Capacity Assessment of Resettlement Sites,

(iv) Backwater and Sedimentation Modeling,

(v) Archeological Review and Field Survey, and

(vi) Technical Resources explored and detailed TOR for development of Livelihood Packages prepared.

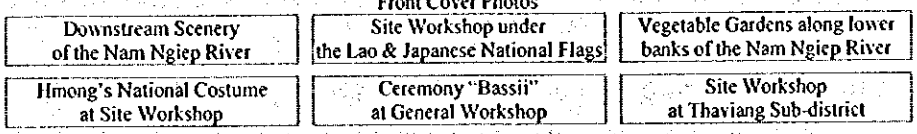
FEASIBILITY STUDY
ON
THE NAM NGIEP-I HYDROELECTRIC POWER PROJECT
IN
THE LAO PEOPLE'S DEMOCRATIC REPUBLIC

FINAL REPORT

COMPOSITION OF REPORTS

Volume 1	Main Report		
Volume 2	Executive Summary		
Volume 3	Supporting Report (I)	:	First Environmental Impact Assessment Report
Volume 4	Supporting Report (II)	:	Preliminary Environmental Management Plan
Volume 5	Supporting Report (III)	:	Preliminary Resettlement Plan
Volume 6	Supporting Report (IV)	:	Sub-Contractor's Field Investigation Report
Volume 7	Supporting Report (V)	:	Records during Field Investigations

Front Cover Photos



VOLUME 2 : EXECUTIVE SUMMARY

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ABBREVIATIONS

Lao PDR agencies

EDL	Electricite du Laos
GOL	Government of Lao PDR
HPO	Hydropower Office (Department of Electricity, MIH)
LWU	Lao Women's Union
MAF	Ministry of Agriculture and Forestry
MIH	Ministry of Industry and Handicrafts
MOH	Ministry of Health
STEA (former STENO)	Science, Technology and Environ. Agencies (Organization)

Foreign organizations

ADB	Asian Development Bank
GOJ	Government of Japan
IUCN	World Conservation Union (Switzerland)
JICA	Japan International Cooperation Agency (Japan)
NTEC	Nam Theun 2 Electricity Company
OECF	Overseas Economic and Cooperation Fund (Japan)
UNDP	United Nations Development Program
WCS	The Wildlife Conservation Society (New-York)
WHO	World Health Organization

Others

B.	"Ban" Village in Laotian language
BOT	Built-Operate-Transfer
BOOT	Built-Own-Operate-Transfer
CFRD	Concrete Faced Rockfill Dam
EAC	Environmental Assessment Committee
EIA	Environmental Impact Assessment
EMMP	Environmental Management & Monitoring Plan
F/S	Feasibility Study
GPS	Global Positioning System
HEPP	Hydroelectric Power Project
ICB	International Compctitive Bidding
IEE	Initial Environmental Examination
IPP	Independent Power Producer
LCB	Local Competitive Bidding
MOU	Minutes of Understanding
NBCA	National Biodiversity Conservation Area
NGOs	Non Governmental Organizations
NK-NBCA	Nam Khading Protected Area
PKK-NBCA	Phou Khao Khouai Protected Area
PPA	Power Purchase Agreement
SPP	Small Power Producer
RAP	Resettlement Action Plan
S/W	Scope of Works
TOR	Terms of Reference

Unit

EL.( )m	Meters above Sea level
US$	US Dollar
K.	Kip in Lao PDR
Bht.	Baht in Thailand
MW	Mega Watt (one million watt)
GWh	Giga Watt Hour (one billion watt hour)
B-C, B/C	B: Benefit and C: Cost
EIRR, FIRR	Economic/Financial Internal Rate of Return

1. CONCLUSIONS & RECOMMENDATIONS

1.1 MILLENNIUM DAM

On one hand, some advanced countries lost significance in the dam development, and on the other hand it is a fact that some developing countries need it as a tool for their national development. Accordingly, we had provided them not only financial aid but also the intellectual assistance to judge the priority of development from the environmental standpoint. The judgements were on the basis of understandable national development policy on national interests from the other countries by an effective utilization of rich water resources under the best geopolitical advantages.

As a conclusion of the above, the Study Team proposes to construct "the Millennium Dam" at the end of the Study. We named a dam of the Nam Ngiep-I HEPP as "the Millennium Dam" on ground of our oath to recover "the silent rivers" in the next century, not by the reason of our memorial to propose it at the end of this century.

Therefore, in order to that the proposal of "the Millennium Dam" may be worthy for coming ages, the detailed procedures to reach the conclusion were shown in the report hereinafter.

The conclusion reached both to minimization of environmental impacts at the extent, and realization of an economic-viable and financially attractive development, is the universal truth for the coming hydropower development. Consequently, the alternative with FSL at EL.320m is proposed to select the most promising development scheme for the Project.

This conclusion was made on the recent worldwide circumstance and with understanding that the development should be made on the international rule even in the developing countries. However, on the other hand, there is a different recognition that it is still permissible greatly for the developing countries to give national developments the highest priority in order to maximize their own benefits.

The Study has not been carried out in line with the theme of choice between "Environmental Conservation" and "Promotion of National Development". But, the same will probably come to the main theme by shaping up of the Project. The scale of the Project, which constructs the permanent structure, is determined based on the sense of value at that time. Especially, for the Project likely to be implemented by IPP, the minimization of risks is a key factor for determination of the development scale.

Therefore, the extent and scopes for further investigation and study should not be limited only for the medium scale development of FSL.320m.

The principal project features are as shown in the table below:

Proposed Principal Project Features

Structure	Parameter	Unit	Features
Reservoir	Catchment area at dam site	km^2	3,700
	Annual basin rainfall	mm	2,470
	Annual mean runoff	m^3/s	162.3
	Annual mean runoff	mill. m^3	5,118
	Average run-off coefficient	-	0.56
	Probable max. flood, PMF	m^3/s	15,900
	Mean annual sediment flow	$t/km^2/yr$	413.4
	Reservoir area at FSL	km^2	73.9
	Gross storage volume	10^6m^3	2,279
	Effective storage volume	10^6m^3	1,779
	Full supply level (FSL)	EL.m	320
	Minimum operation level (MOL)	EL.m	284
	Draw-down	m	36
Dam	Dam type	-	CFRD
	Dam height length	m	157
	Dam crest length	m	524
	Dam volume	10^6m^3	6.9
	Dam crest level	EL.m	325
Spillway	Spillway crest level	EL.m	306.5
	Design flood capacity	m^3/s	8,730 (Q=10,000yr)
Waterway	Design discharge	m^3/s	221
	Headrace tunnel diameter & length	m	9.0, 420
Power Plant	Powerhouse type	-	Surface type
	Powerhouse size	m	L58mxW31mxH58m
	Design flood discharge	m^3/s	4,519 (Q=100yr)
	Rated head	m	131.8
	Type of turbine	-	Vertical Francis
	Plant capacity & nos. of unit	MW	240=2nos@120
	Annual energy	GWh	1,349
Re-regulation Structure	Max. pond level	EL.m	173
	Required storage capacity	mill. m^3	4.7
	Design flood discharge	m^3/s	4,519 (Q=100yr)

1.2 PROJECT EVALUATION

Today's world has been continuously trying to cope with them. The modern civilization, which applied to natural science, was developed with the technology to control nature. However, in the society of high technological principles, which is ruled by this civilization, nature philosophy contrary to human is only resulted. Therefore, as an environmental destruction of present society is led by this nature philosophy, a doubt and a regret against to this nature philosophy have led an effort to create a symbiotic relationship between human and nature. These recent tendencies require us to show various evaluation criteria for a dam project implementation.

Under the viewpoint mentioned above, the general evaluation to be carried out by all persons at any positions under various evaluation criteria is indispensable for the dam development alternatives with priority on the environmental study. Therefore, the Study Team recommended the most attractive alternative as a conclusion of evaluation results by proposing seven (7) items

of design criteria as shown below, which are expected to raise various discussions among GOL, JICA, village people and NGOs.

No.	Evaluation Category	Evaluation Criteria	Evaluation Results
1.	Natural Environment Evaluation	E.C. on the assumption that the existing natural, developed-natural and artificial environments should be preserved or improved.	Impacts on Natural Environment will become large as increasing dam scale, until a failure of the environmental preservation
2.	Social Environment Evaluation	E.C. on the assumption that people and social system surround them should be preserved and improved.	Impacts on Social Environment will become large as increasing dam scale, but, Social system can be kept safety by changing slowly.
3.	Economic Evaluation	E.C. on the assumption that the economic feasibility shall be judged by avoid cost of thermal generation.	Mathematical evaluation can be done with economical index: B/C, B-C, and EIRR; however, only a validity of hydropower can be evaluated.
4.	Financial Evaluation	E.C. on the assumption that the benefit by electricity sales shall cover all investment, under a good enterprise as IPP.	Same as Item No.3, however, evaluation is based on several assumptions such as BOOT composition, fund procure, electricity sale cost, and commencement day of commercial operation.
5.	Technical Evaluation (Dam Construction)	Technical evaluation criteria for a high dam construction.	A Large-scale dam is technically restricted to construct. The highest record of dam construction is 180m, that of project design is 220m.
6.	Evaluation on EAC & Workshops	E.C. judged from opinion, suggestion and questionnaire results at EAC/Workshop.	Evaluation is based on individual extent of interest and understanding on participants, and on their positions.
7.	Evaluation on Japan's Mekong River Develop.Plan	E.C. judged from the viewpoint of stance in official development aid of Japan	Aid policy in peace, development, environment preservation is essential for evaluation.

Note: E.C means Environmental Criteria.

The Study Team recommended the most attractive alternative, the medium-scale dam development with FSL.320m, as a conclusion of evaluation results by proposing seven (7) items of design criteria as shown below:

No.	Evaluation Category	General Evaluation Results	
		Medium-Scale (FSL.320m)	Large-Scale (FSL.360m)
1.	Natural Environment Evaluation	O	Δ
2.	Social Environment Evaluation	O	Δ
3.	Economic Evaluation	Δ	O
4.	Financial Evaluation	Δ	O
5.	Technical Evaluation(Dam Construction)	O	O
6.	Evaluation on EAC & Workshops	O	Δ
7.	Evaluation on Japan's Mekong River Basin Development Plan	O	O
8.	General Evaluation Results	O	Δ

Note: O : Recommended alternative to develop.
Δ : Recommended alternative not to develop compared with other one.

The various reasons that the medium-scale dam alternative has been selected as the most recommendable one by the Study Team were epitomized by the following four (4) reasons:

(i) Evaluation results of the social environmental aspects: This alternative will save the Thaviang Sub-District, where is expected of the future development due to not only a geographic advantage but also the recent regional development projects for extension of both a national highway and a rural electrification.

(ii) Evaluation results of the preliminary resettlement plan: This alternative will save the population being resettled forcibly as less as possible due to avoiding inundation of the Thaviang Sub-District.

(iii) Evaluation results of economic and financial analysis: This alternative will clear the critical economic index for IPP projects, even the Study Team's evaluation criteria thinks a great deal of evaluation results both on the social and natural environmental aspects.

(iv) Evaluation results of General and Site Workshops: This alternative was selected under deep consideration of the evaluation results by local peoples and local governments through both General and Site Workshops during the field investigations.

Accordingly, at the following two points, the Nam Ngiep-I HEPP is expected to set as a high valuation on dam developments in the world not only by peoples in Lao PDR but also by both local and international NGOs, as well as international financing agencies being willing to invest in positively based on the comprehensive development intention:

(i) The project might become a pathfinder of the advanced development procedure selecting a project scheme based on the EIA results at the preliminary F/S stage of hydroelectric power project, and

(ii) The Project will save the reservoir area of 74km^2, the dam height of 40m, the construction cost of US$118mil., and resettlement population of 3,000, instead of lost values at the install capacity of 94MW, the annual energy of 556GWh, and B-C(current value) of US$80mil.

2. HYDROPOWER PLAN

2.1 BASIC PARAMETERS

DAM SITE

In the Pre-F/S Report submitted to Lao PDR in 1991 and revised in 1995 by French government, the most downstream gorge of the Nam Ngiep River just downstream of the confluence of the Nam Katha River has been identified as a promising dam site of the Project.

In this JICA Study being carried out since August 1998, the above location was confirmed to be the most appropriate dam site in comparison with the other two conceivable sites at 20km and 40km upstream of the proposed dam site. River flow is affluent there and the dam site topography and geology are suitable for the construction of a high dam.

RESERVOIR CAPACITY

There were notably differences without any regularity between the existing map and the elevations measured in this Study by GPS survey.

The topographic map revised during this Study was compared to the existing map of 1:50,000. As a result, it was revealed that the upper reservoir area is about 5% narrower than that measured by the existing map. Therefore, the upper reservoir area and capacity were reduced and the Area-Capacity Curve was updated.

FINAL SEDIMENT LEVEL IN RESERVOIR

The final sedimentation level in the Nam Ngiep Reservoir, which gives a basic condition for determination of Minimum Operation Level (MOL), was roughly assumed at EL.200m on an assumption that most sediment will be trapped at the flat and wide upstream reach of the reservoir.

The adopted sediment yield is 413.4 t/km^2/year, which was estimated for the Nam Ngiep River basin in the "Study of Alternatives" of the Nam Theun-2 Project. Because, the said value is conservative compared with the figures assumed in the other reports as well as the yield actually observed in the watershed of the Nam Ngum-1 Project.

DISCHARGE FOR POWER GENERATION

A river run-off series, which has been computed for the Nam Ngiep River basin in the "Study of

Alternatives" of the Nam Theun 2 Project, was applied for the project power output calculation. This run-off series consists of the long-term monthly mean discharges for 30 years. The average discharge is 162.3m^3/s, which is 77% of 210.8m^3/s adopted in the Pre-F/S Report.

PEAK TIME DURATION

Since EGAT is hoping for the time being to purchase from the most IPPs in Lao PDR the intermediate peaking power, the similar peak time duration (16-hour) is applied in this moment for the study of the Nam Ngiep-1 HEPP. However, the daily peak demand in Thailand is trending sharp year by year, therefore, it is expected that EGAT will require in the near future power purchase from Lao PDR for peak demand. If EGAT accepts 8-hour peaking operation, the Project becomes drastically attractive.

2.2 ALTERNATIVE SCHEMES AND LAYOUT

FIRST PHASE ALTERNATIVES

Alternative development scales of dam type scheme were studied by changing operational range of reservoir to evaluate economic and financial viability and the different impacts at the upstream and downstream areas of proposed reservoir area and downstream reach of the damsite. The alternative study for dam type schemes was executed with two (2) phases: first phase and second phase.

At the first phase, three (3) dam scales: large, medium and small were selected changing Full Supply Level (FSL) of the reservoir with definitions as shown in the table below.

No.	Alternative Plans	Description
1.	Large-scale dam scheme	The scheme aiming to a large power output by a high dam. Reservoir of the scheme will inundate all villages. Possible FSL is ranging from EL.360m to EL.400m.
2.	Medium-scale dam scheme	The scheme with a medium-scale dam considering the minimization of impacts by the development. Possible FSL is ranging from EL.240m to EL.360m.
3.	Small-scale dam scheme	The scheme to be developed with a small-scale dam taking no inundation of villages into consideration. Possible FSL is at EL.240m.

The results of the first phase study manifested the followings:

(i) The small-scale dam scheme is not justified from the economic viewpoint.

(ii) Even in the medium-scale scheme, FSLs lower than EL.300m seem to be not economical: B/C<1 and EIRR<0.1.

(iii) Project viability of the large-scale scheme is superior to the medium-scale scheme.

Besides, the following two conclusions were derived from the above:

Conclusions at First Phase Study are as follows:

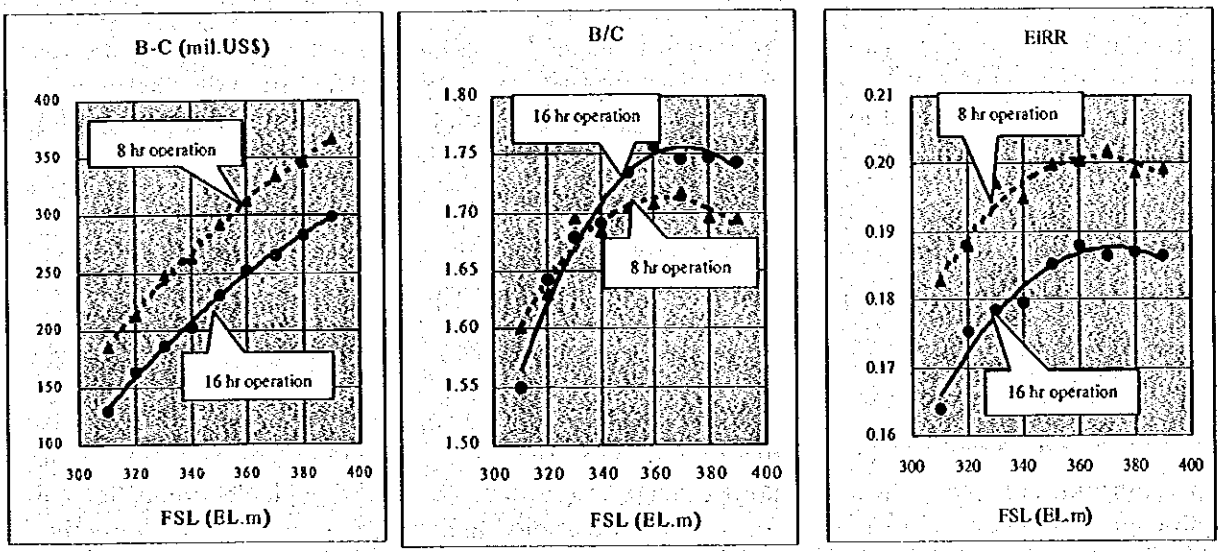
(i) The large-scale dam is economically optimum scale with the condition that the peoples at Thaviang Sub-District agree to be resettled.

(ii) The medium-scale dam is economic-viable and environment-optimum scale. Its most impact-less FSL may be located at around EL.320m.

RESULT OF SECOND PHASE ECONOMIC COMPARISON

At the second phase, economic comparison was carried out for the medium-scale and large-scale dam schemes for FSLs between EL.310m and EL.390m at 10m intervals. The summary of the comparative economic aspects of the respective scale is as shown below:

No.	FSLs	Inst. Capacity (MW)	Total Energy (GWh)	Const. Cost (Mil.US$)	B/C	B-C (Mil.US$)	EIRR (%)
1.	EL.310m	214	1,192	316.3	1.55	129.83	16.39%
2.	EL.320m	240	1,349	339.6	1.64	163.21	17.52%
3.	EL.330m	263	1,508	367.5	1.68	186.44	17.85%
4.	EL.340m	280	1,626	392.1	1.69	202.60	17.97%
5.	EL.350m	314	1,777	420.4	1.73	230.85	18.52%
6.	EL.360m	334	1,905	445.6	1.76	252.46	18.81%
7.	EL.370m	356	2,030	476.1	1.75	265.83	18.65%
8.	EL.380m	377	2,148	505.0	1.75	282.37	18.69%
9.	EL.390m	401	2,282	538.4	1.74	299.29	18.65%



From the above study, it is clear that economic-optimum development scale is FSL.360m and environment-optimum scale is around FSL.320m.

Therefore, further study will be concentrated for these two dam development scales to investigate the most recommendable financing method for each development scale. And, the final recommendable development scheme of the Project will be determined as the result of the overall assessment of the three (3) main parameters for judgement, namely (i) natural & social environmental issues, (ii) economic issues, and (iii) financial issues (financing plan).

3RD ECONOMIC COMPARISON RESULTS

The results of 3rd economic comparison is shown below:

No.	Particular	Unit	Medium-Scale FSL EL.310m	Large-Scale FSL EL.360m
1.	Installed capacity	MW	240	334
2.	Total energy production	GWh	1,349	1,905
3.	Project construction cost	Mil.US$	346.0	464.0
4.	B	Mil.US$	417.1	585.7
5.	C	Mil.US$	258.7	347.0
6.	B/C	-	1.61	1.69
7.	B-C	Mil.US$	158.4	238.7
8.	EIRR	%	17.2	18.0

RUN-OF-RIVER TYPE SCHEMES

Viability of run-of-river type scheme was firstly studied for a supplemental function to the medium and small-scale dam schemes, selecting the site at the upstream rapid of the Nam Ngiep River (as Main stream run-of-river type scheme) and at a rapid on the Nam Phouan River the right bank branch of the main stream, which is located at 24km upstream of the dam site (as Branch run-of-river type scheme). But, finally run-of-river type was deleted from the alternatives, because the relative basin inflow is quite small comparing with the required waterway length for both schemes, by which economical development is not expected.

2.3 VALUATION OF COST AND BENEFIT

PROJECT COSTS

The critical path of the Project construction will be on the series of the works for river diversion, dam embankment, reservoir impoundment and wet testing for hydro and electromechanical equipment. Construction period was provisionally assumed to be five (5) years for all alternative schemes. Construction costs were tentatively estimated on the basis of international competitive bidding (ICB).

Economic lifetime and frequency for replacement of generating equipment were assumed to be 50 years long and once per 30 years. And, the discount rate is applied for 10%.

Various natural-social environmental impacts are listed below, respectively for the impacts, which can be quantitatively evaluated and other impacts, which are difficult to be quantified with its interpretation.

(Quantified Impacts)

No.	Natural-Social Environmental Impacts	Collateral Solution
1.	Inundation of villages	Supply of equal-scaled resettlement facilities
2.	Peoples' mental burden for resettlement (*1)	Monetary support such as outfit allowance for resettlement and guarantee fund for villager's living after movement at a decent-life level for several years.
3.	Water level fluctuation at downstream due to discharge from power station	Provision of re-regulation pond for stabilization of water level.

No.	Natural-Social Environmental Impacts	Collateral Solution
4.	Decreasing fishes at downstream reach	Promotion and construction of facilities for fishery
5.	River shore erosion at downstream reach	River protective works
6.	Tentative water pollution by hydrogen sulfide from the submerged forest	Provision of public wells for downstream villages
7.	Destruction (damage) of peoples' production due to construction	Compensation and relocation
8.	Sedimentation at upstream end of reservoir (*2)	Heightening river bank when actually required
Note (*1)	As the result of EIA, it was revealed that the present infrastructures in the Project area are not satisfactory to the villagers and local market is much stagnant. Judging from the above, even the scale of resettlement become large, the consensus of the people will be positive against the resettlement, if a meticulous welfare is provided to them with well-supply of local electrification, medical facilities, schools, public wells, etc., supply of equal-sized farmland, technical guidance for agriculture and stockbreeding, provision of industrial promotion center in the resettlement land, etc.	
Note (*2)	Judging from the state of sedimentation measured for the existing Nam Ngum-1 reservoir, prospective sedimentation at the upstream end of the Nam Ngiep-1 HEPP reservoir is deemed to be negligible small.	

(Not Quantified Impacts)

No.	Interpretation
1.	Mental-burden of the highland people in the form of changing living circumstances due to resettlement is considered to be set off by the contribution to the nation with the decreasing shifting cultivation and guarantee of their lives with well-supplied resettlement facilities and support.
2.	Declined CO_2 purification effect in the river basin due to vanishing forest is considered to set off by the amount of CO_2 emission, which is expected to decrease by hydropower development instead of thermal plant construction.
3.	Noise, dust, water pollution, etc during construction will be restricted and minimized by applying careful construction control in conformity with the local environmental rules and regulations in Lao PDR.
4.	In the tropical country, influence of the discharge for power generation, which will negatively affect on an adequate water temperature for irrigation, will be negligible small.
Note	Preparation of the impartial criteria for quantitative evaluations is quite difficult at this stage against the negative impacts on aquatic bio-diversity due to basin inundation, and for the species, which migrate seasonally from and to the Mekong River. These impacts are therefore not considered in the economic and financial analysis, but at the final stage, these will be relatively evaluated giving weighted points or through value judgement based on the evaluation criteria prepared by several senses of values.

INDIRECT OR SECONDARY BENEFITS

The Project specific benefits other than earnings from export of electricity are shown in table below. These benefits are also difficult to quantify at this stage and therefore not considered in the economic and financial analysis. At the final stage, these will be relatively evaluated giving weighted points or through value judgement based on the evaluation criteria prepared by several senses of values.

No.	New Economic Opportunities	Economic Effect
1.	Creation of reservoir	Flood regulation effect to downstream reach by reservoir storage function and prospective enlargement of irrigable area around reservoir
2.	Navigation in reservoir	Economical interconnection of Xieng Khouang Province and Bolikhamxay Province (*1) and prospective tourism development (*2)
3.	Fishery in reservoir (*3)	Stabilization of catch of fish and prospective development of rural socio-economy
4.	Increasing job opportunity by Project	Increasing people's living standard with more labor income
5.	Resettlement of highland people	Decreasing the are of shifting cultivation
6.	Technical guidance for agriculture and stockbreeding (*3)	Modernization of rural agriculture and stockbreeding
7.	Rural electrification by power supply from Project	Notable improvement in living circumstances and prospective rural industrial development
8.	Macro economic impact derived from Project	Decreasing poverty and regional economic activation

Note (*1)	Economic interconnection of both provinces, Xieng Khouang and Bolikhamxay will give impacts to the economic activities in the remote Xieng Khouang Province, which were not briskly due to poor transportation condition and security problem of National Road Nos. 4 and 7.
Note (*2)	Assuming from the trend of national economic expansion to the Southern region, as well as the recent inroads of tourism into the areas near the existing Nam Ngum-1 reservoir, it is also presumed that development of tourism will be expected for the areas around the Nam Ngiep-1 reservoir soon after the completion of the Project. Especially the Thaviang Sub-District, from its topographic advantage with widely developed flat land along the reservoir, has a high possibility of tourism development as resort area.
Note (*3)	By the construction of a rural industrial promotion center in the main resettlement area, technical guidance will be provided to the resettlement people dispatching several foreign experts for the respective sector. For the above plan, the annual cost required for a practical three years service period was appropriated as the cost for industrial promotion guidance.

2.4 ECONOMIC ANALYSIS USING AVOIDED COST

GENERAL

The economic analysis compared project cost to the cost that would have been incurred should thermal units be used, thus deriving the benefits of avoided cost. Avoided cost, in this case, could be used as a proxy to Least Cost Analysis, assuming that any project which is cheaper than the combination of gas turbine and combined cycle is fit into the Least Cost Expansion Plan.

PARAMETERS FOR ECONOMIC ANALYSIS

The basic assumptions for the 2nd stage economic analyses are summarized as follows:

No.	Parameters	Unit	Economic Parameters	
			FSL.320m	FSL.360m
1.	Total Capacity (FSL.320m Alternative)	MW	240	334
2.	Plant Utilization Factor	%	64.2	65.1
3.	Total Cost (exclude IDC)	Mil. US$	339.6	445.6
4.	Years of the Project Considered	Years	50	50
5.	SCF	-	Not used	Not used
6.	O&M	%	1.0	1.0
7.	Auxiliary use and Line Loss	%	1.3	1.3

RISK ANALYSIS

The result of the 2nd stage economic study for FSL.320m alternative is 17.5% in economic internal rate of return. The Project was then tested against probable risks associated with the project in following cases: (a) 10% up cost overrun, (b) alternative fuel price down by 20%, (c) project delay by one year, and (d) O&M cost increased by 20%.

No.	Risk Analysis	EIRR (%)
1.	Base Case	17.5%
2.	10% Increase in Investment Cost	15.7%
3.	Alternative Fuel Price Down by 20%	14.9%
4.	Project Delay by One Year	15.9%
5.	O&M Cost Increase by 20%	17.4%

2.5 FINANCIAL ANALYSIS

GENERAL CONCEPTS

As the current trend dictates and the GOL's policy encourages private sector participation in hydropower generation, financial analysis of the Project is becoming more and more important. Even if the GOL/EDL is going to undertake this Project by themselves, an independent commercial operation entity may be established to be responsible for its own profits and losses.

The focal point in the financial analysis is whether the overall project is profitable, and whether the potential investors, private or public, or joint efforts, will see the incentives attractive enough for them to forgo the investment opportunities elsewhere to invest in the Nam Ngiep-1 HEPP. Equally important, whether the Project could bring a reasonable level of income to the government, national and provincial, through dividends distribution, taxes, royalty, and other charges and duties while maintain an affordable tariff level, no higher than that of one of the six IPPs currently under consideration.

The financial analyses of the Project is based on the assumption that the scheme will be owned and operated by a commercial company that will supply to the Thai national grid all the energy generated. The tariff, as well as other relevant parameters for financial analyses, is determined based on two principles: (a) the project must be profitable, and (b) the tariff level should be no higher than that paid by EGAT to IPPs in Thailand.

A detailed analysis was carried out for the medium-scale dam alternative with FSL.320m and financing scheme of public-private joint investment (BOT) was tested. But the concession period is 25 years and after 25 years, the Project will be reverted to the GOL. The large-scale dam alternative with FSL.360m was evaluated for comparison to FSL.320m.

PARAMETERS FOR FINANCIAL ANALYSIS

The basic assumptions for financial analyses are summarized as follows:

No	Item	Amount		Remarks
1.	Construction Period	5	years	
2.	Project Life	30	years	
3.	Tariff	Peak Power	Off-Peak Power	
	(1) Initial tariff (c/kWh)	6.6	0	
	(2) Escalation rate	2.5%	0	
4.	O&M Costs			
	(1) Initial Cost (%)	1.0%	of Base cost	
	(2) Escalation rate	2.5%		
5.	Loyalty fee	5.0%		5% of revenue
6.	Depreciation	430.3	Mil.$ (FSL.320m)	Depreciable assets value
		577.1	Mil.$ (FSL.360m)	
	(1) Useful life	25	years	
	(2) Residual value	0%		
	(3) Method		Straight-line	
7.	Escrow account	50%		50% of annual debt service
8.	O&M reserve account	0%		
9.	Cash required	2%		2% of revenue
10.	Accounts receivable	12.5%		1.5 month of revenue
11.	Supplies and spares	0%		
12.	Accounts payable	8%		1 month of O&M Cost
13.	Deposit rate	2.5%	per annum	
14.	Income tax	15%	from 6th year of operation	
15.	Dividend rate	80%	of Net Profit from 5th year of operation	

COST ASSUMED FOR FINANCIAL ANALYSIS

Total investment cost, excluding IDC, is US$385.2 million at the mid-1999 price level; the cost of transmission equipment, escalation cost, physical contingencies are included in this total. Disbursement of the Project cost is as shown in the table below.

Year	2006	2007	2008	2009	2010	2011	Total
1. Disbursement of Base Cost							
(1) Ratio	10.0%	20.0%	35.0%	20.0%	15.0%	0.0%	100.0%
(2) Amount (Mil.$)	38.5	77.0	134.8	77.0	57.8	0.0	385.2
2. Equity							
(1) Ratio	28.6%	45.0%	26.4%	0.0%	0.0%	0.0%	100.0%
(2) Amount (Mil.$)	38.6	60.7	35.6	0.0	0.0	0.0	134.8
3. Loan (Mil.$)	0.0	16.4	99.2	77.0	57.8	0.0	250.4
(1) OECF	0.0%	18.0%	47.0%	35.0%	0.0%	0.0%	100.0%
-Disburse.	0.0	15.8	41.2	30.7	0.0	0.0	87.6
-Interest		0.0	0.5	1.9	3.0	3.1	8.5
-Total	0.0	15.8	41.7	32.6	3.0	3.1	96.1
(2) JCB	0.0%	0.0%	46.8%	28.5%	24.7%	0.0%	100.0%
-Disburse.	0.0	0.0	41.0	25.0	21.6	0.0	87.6
-Interest		0.0	0.0	3.5	5.9	8.2	17.6
-Total	0.0	0.0	41.0	28.5	27.6	8.2	105.3
(3) ADB	0.0%	0.0%	46.8%	28.6%	24.6%	0.0%	100.0%
-Disburse.	0.0	0.0	17.6	10.7	9.2	0.0	37.6
-Interest		0.0	0.0	1.5	2.5	3.5	7.6
-Total	0.0	0.0	17.6	12.2	11.8	3.5	45.1
(4) IFC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
-Disburse.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-Interest		0.0	0.0	0.0	0.0	0.0	0.0
-Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(5) TCB	0.0%	0.0%	0.0%	28.5%	71.5%	0.0%	100.0%
-Disburse.	0.0	0.0	0.0	10.7	26.9	0.0	37.6
-Interest		0.0	0.0	0.0	1.1	3.9	4.9
-Total	0.0	0.0	0.0	10.7	27.9	3.9	42.5
4. Loan Total							
-Disburse.	0.0	15.8	99.8	77.1	57.7	0.0	250.4
-Interest	0.0	0.0	0.5	6.9	12.5	18.7	38.6
-Total	0.0	15.8	100.3	84.0	70.2	18.7	289.0
5. Equity & Loan	38.6	76.4	135.9	84.0	70.2	18.7	423.8
6. Front-end Fee							
(1) OECF	0.0	-	-	-	-	-	0.0
(2) JCB	1.1	-	-	-	-	-	1.1
(3) ADB	0.5	-	-	-	-	-	0.5
(4) IFC	0.0	-	-	-	-	-	0.0
(5) TCB	0.4	-	-	-	-	-	0.4
Total	1.9	0.0	0.0	0.0	0.0	0.0	1.9
7. Comitm't Fee							
(1) OECF		0.0	0.0	0.0	0.0	0.0	0.0
(2) JCB		0.5	0.5	0.3	0.2	0.0	1.6
(3) ADB		0.5	0.5	0.3	0.2	0.0	1.4
(4) IFC		0.0	0.0	0.0	0.0	0.0	0.0
(5) TCB		0.4	0.4	0.4	0.3	0.0	1.6
Total	0.0	1.4	1.4	1.0	0.6	0.1	4.6
Grand Total	40.5	77.8	137.3	85.0	70.9	18.8	430.3

(Euity) / (Equity+Loan+Interest) Ratio =31%

BENEFITS ASSUMED FOR FINANCIAL ANALYSIS

The energy generated and supplied, net of line loss and auxiliary use, is assumed to be 766GWh for mid-peak energy (6 hr/day and 6 day/week) and 576GWh for off-peak energy on FSL.320m Alternative, while 1,082GWh for mid-peak energy and 813GWh for off-peak energy on FSL.360m Alternative. The weighted average price of peak and off-peak tariffs in the year 2011 is assumed to be US$0.066/kWh, the date of commissioning.

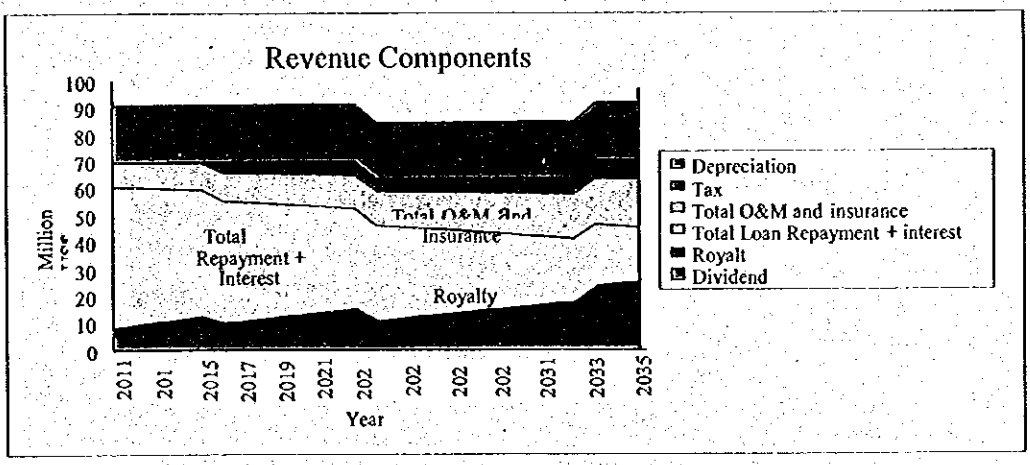
Based on the rules setup by the government policy, the following three- step tariff structure has been assumed:

Step	Years	Period	Tariff in 1999	Tariff in 2011
1st	1-12	12	4.7	6.6
2nd	13-22	10	4.3	6.3
3rd	23-25	3	4.7	6.6

FSL.320M ALTERNATIVE MODEL

FSL.320m Alternative of which project cost is US$385.2 million excluding IDC, FSL is EL.320m, plant capacity is 240MW, annual energy is 1,342GWh at a grid-end, assumes a joint venture between GOL and a consortium of private sectors. An independent BOT power development company is assumed in this model and the debt-equity ratio of 65%:35% is used. The GOL would be responsible for 25% of equity investment, and the GOL equity is assumed to come from an international soft loan.

The financial IRR obtained for FSL.320m Alternative is 12.8% as FIRR on Project and annual net benefit (NPV) is assumed to be US$79.8million (NPV).



FSL.360M ALTERNATIVE MODEL

The annual power generation of FSL.360m Alternative is 1,895GWh at a grid-end. The cost of FSL.360m Alternative is assumed at US$516.6million, excluding IDC. The financial IRR obtained for FSL.360m Alternative is 13.7% as FIRR on Project and annual net benefit is assumed to be US$143.7million (NPV).

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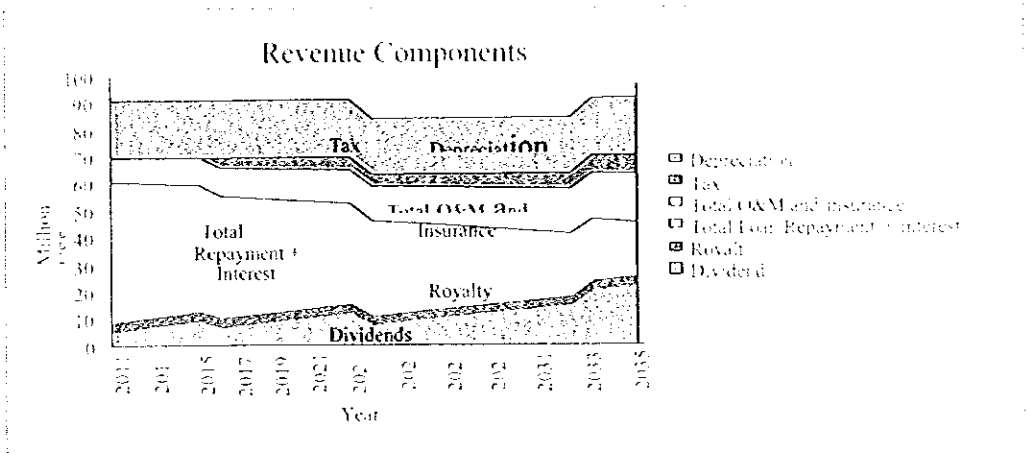

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SENSITIVITY ANALYSIS

A sensitivity analysis of FIRR was carried out for both FSL.320m and FSL.360m Alternatives to test the risks involved in the project for the following two cases.

- 10% increase of Base Cost
- 10% decrease of Annual Energy Generation

Delay of the project completion was not considered, because enough 5-year period was taken for construction.

The results are favorable as shown in Table below.

No.	Risk Analysis	FSL.320m	FSL.360m
1.	Base Case	12.8%	13.7%
2.	10% Increase in Investment Cost	11.6%	12.5%
3.	10% Decrease in Total Energy Sales	11.4%	12.3%

2.6 CONCLUSIONS

Both FSL.320m and FSL.360m Alternatives are financially viable under the conservative conditions following the current actual economic conditions, since their FIRRs are over 12%. However, FSL.360m Alternative of a larger output is more competitive than FSL.320m one with the different FIRR of about one (1) point only. Consequently, as a conclusion, the basic data for the economic evaluation, such as a topography, geology and hydrology are not enough to determine the final selection of the dam height.