3. FIRST ENVIRONMENTAL IMPACT ASSESSMENT

3.1. CONTEXT OF EIA STUDY

Environmental field investigations were carried out from November 1998 to September 1999 in order to establish the information base line by reference to which potential impacts may be estimated. An Initial Environmental Examination (IEE) was produced in October 1998. Preliminary impact assessment and conclusions were presented in an Interim Report in March 1999. Both documents were subject to public presentation and extensive discussions with the Environmental Assessment Committee (EAC) and the Hydropower Office (HPO) of the Ministry of Industry and Handicraft.

The first EIA report has been prepared in accordance with the recommendations of the major international agencies as JICA, ADB and World Bank. The following chapters have been developed in the main First EIA report:

(i) The institutional and legal framework for environmental management in Lao PDR,

(ii) A summary description of the Project components,

(iii) The baseline information on present environmental and social conditions,

(iv) The analysis of impacts and the presentation of mitigation measures,

(v) A summary of the Environmental Management plan,

(vi) A summary of the Preliminary Resettlement plan, and

(vii) A summary of the Public Consultation and Participation activities carried out.

3.2. BASELINE INFORMATION ON PROJECT AREA

CLIMATE AND METEOROLOGY

The proposed dam site is located about 54km upstream the confluence of the Nam Ngiep River with the Mekong River. The controlled catchment at dam site is 3,700km², or 82% of the total river catchment (4,510km²).

Rainfall is close to 2,500mm/year in average in the catchment area, as against less than 2,000mm/year everywhere else in the region. More than 90% of the rainfall is concentrated into the wet season from May to October.

Mean annual discharge at dam site is estimated at 161m³/s, based on a run-off coefficient of 0.56. For the purpose of the study, series of flow at dam site have been generated over a 30 years period. Average for 30 years and typical values for mean, wet and dry years are summarized below:

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
30 years	47	40	35	33	65	182	345	472	384	180	95	58	161
Mean year	59	50	43	40	68	185	236	581	358	168	106	65	163
Wet year	37	33	36	40	91	339	442	850	564	223	122	64	237
Dry year	46	35	30	24	28	71	219	251	173	92	50	40	88

WATER QUALITY

Water quality of the river was investigated in 4 sampling stations during 4 sampling campaigns in January, March, June and late August 1999. The water quality of the Nam Ngiep River is good. Close to neutral pH, nutrients content and dissolved solids in the low to medium range during the dry season. During the rainy season, nutrient content is slightly higher because of the run-off collecting organic matter and dust deposited on the ground surface. However, these values remain on the low side, thus reducing the long term risk of eutrophication in the reservoir. Some coliform pollution from fecal origin is observed downstream, resulting from the presence of villages and the slow flow of the river.

AQUATIC ECOLOGY AND FISHERIES

Fish samples were collected, observed and identified from 21 stations along Nam Ngiep River and its tributaries, including 9 stations of the Upper Reservoir, 5 stations in the Lower Reservoir area and 7 stations in the downstream area. Two surveys were carried out during dry season in January 1999 and wet season in July 1999.

During the first survey, 115 species were collected and identified. During the second survey, 19 additional species were collected, raising the biodiversity of the basin to 134 species. This total of 134 fish species compares well with other nearby river basins as the Nam Leuk basin (122 species) and the Nam Theun/Xe Bang Fay basin (165 species). Most of the species found are widely distributed in the region. However, some species not identified at species (only genus) level may have more restricted distribution. Additional investigation on that matter is recommended for the next stage of the study. Some species observed in the Upper or Lower reservoir have been already reported from other rivers in the Mekong basin to be migratory. During the field surveys, fish migration for spawning was reported by the villagers, but the exact timing of the migrations, location and distance of the migrations is still not known.

In coordination with the socio-economic survey, a specific questionnaire was developed in order to get a clear picture of the subsistence fisheries as an economic activity of the local communities.

Fishing activities are present in all of the 31 surveyed villages with an average of more than one person fishing in each household. Most of the villagers fish about 2-3 days a week and reported that in the Nam Ngiep River, fish catches are at peak in November-December. Less than 33% of the investigated households have a boat. Gillnet with hook and lines represent the most popular fishing gears.

The quantity of fish catches is in average of 0.7kg/fishing time/hh. The average fish consumption per household and per year has been established at 137kg/hh/year in the downstream area. No consistent information was gathered from the upstream area, but where it should not be much different than from the downstream area. This figure is particularly close to the result of a 3-year fishery monitoring for the Nam Leuk Project, which comes to an average of 133kg/hh/year (or 50-60 grs/capita/day). There is limited fish culture practices in the Project area.

VEGETATION AND WILDLIFE

The field work related to the terrestrial ecology was designed i) to provide a preliminary information on the present condition of wildlife and habitats in the project area and ii) to provide a preliminary information on the vegetation biomass and commercial timber volumes available in the reservoir area. A first field work campaign was carried out from January 22 to February 20, 1999 by a team of 7 persons followed by a second field work campaign from April 1 to 12, 1999.

The identification of the trees observed indicate that the areas of catchment surveyed have low species diversity in comparison to other woodlands in Lao PDR (Xaignabouli, Vientiane Province, Attapu). The level of diversity is comparable to the degraded woodlands of the Nam Leuk catchment. More than 160 plant species belonging to 40 families have been identified. The forest area visited within the limits of the future reservoir consists mostly of secondary degraded forest, with sometimes a dense bamboo cover.

All the catchment areas experience or have experienced in the past hunter-gatherer degradation pressures, which can be significant. The potential for development in the catchment is variable according to the system considered, taking into consideration the local vegetation, geology, soils and topography, as presented in the attached figure.

The results from preliminary estimate of commercial timber in the reservoir area suggest that there could be approximately 30cm^3/ha to be removed. However, there may be less potential considering that areas in the upper reservoir have already been extensively logged.

The overall fresh above ground biomass density of 278.5t/ha is comparable to findings of the Nam Leuk biomass survey (289.8 undried above ground biomass density). Of critical importance in terms of water quality is the rapidly degradable biomass which will play an important role in the early oxygen demand in the new reservoir water body.

The areas traversed outside the inundation zone appeared reasonably rich in terms of animal species diversity and high in terms of density and could be described as a "rich community". Two areas of interest have been identified: North of B.Sopphoun up to B.Nakang is one area. The second area is directly south of B.Sopyouk and east of the Nam Ngiep River, outside the reservoir area. The later appeared particularly rich, with evidence of at least two separate herds of Asiatic Elephant of approximately 12 and 6 individuals respectively.

During the surveys, 100 bird species, 48 mammal species and 9 reptile species have been reported from the visited parts of the catchment area. From these, 16 mammal species and 3 reptile species have already special conservation significance (International or National).

3.3. IMPACT SCREENING

Anticipated impacts are summarized in Tables 3.1 and 3.2.

3.4. IMPACTS DURING THE CONSTRUCTION PHASE

The project construction sites are all located around the dam site, with the exception of some quarry sites not yet identified. It is anticipated a total requirement of 250 to 500ha, mainly in a non agricultural and non populated area. No resettlement or significant compensation for land is expected for construction sites.

Both alternatives require only 10km of new access road (or about 20ha of land including disposal and borrow areas) and the construction of a 110km long transmission line. The cost of land acquisition for road and TL towers has been estimated at about US$110,000.

In case of inappropriate handling or storage of chemicals or petroleum products on the construction site, accidental release in the river water may affect more than 5,000 persons living in the downstream area, and which use river for drinking and cooking. The same may happen with inappropriate sanitation system in the workers camps with release of pathogens.

Preventive measures will include strict enforcement of safe handling and storage procedures by the Contractor(s), and the implementation of alternative water supply systems for the downstream villages. Based on one hand pump for 20 households, the estimated cost is US$250,000. For remaining impacts on fish and fisheries, a penalty system may be implemented, making the contractor(s) responsible for accidental spill and in charge of paying a compensation for fishery loss to downstream villagers.

Transport of equipment and materials will increase truck traffic on the roads with higher accident hazard for population. Traffic signs, speed limit, maintenance of trucks and roads will be required from contractor. Increased dust emission will be controlled by regular watering of construction sites and roads inside the villages. Grass cover on spoil areas may limit dust emission by wind.

3.5. IMPACTS DURING THE FILLING PHASE

The filling event is probably the most important and impacting stage of a hydropower project. Indeed, this is the short time during which i) the hydrology of the downstream system is abruptly modified, ii) the water quality of the system is strongly altered and iii) the wildlife in the reservoir must migrate out.

As soon as the dam is closed, the downstream area faces significant change in flow, even with a 20m^3/s riparian flow released at dam site, as shown in table below:

(Mean year situation)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Muangmai	Before	69	58	50	46	80	217	276	680	419	196	124	76
	After	30	28	27	27	32	52	60	119	81	48	38	31
Mekong Conf.	Before	72	61	53	49	84	228	290	714	440	206	130	80
	After	33	31	30	29	36	63	74	154	102	59	44	35

Simulation of reservoir filling shows that with a 20m^3/s riparian release, the FSL.360m reservoir fills in 13 to 25 months according to the year (wet or dry) and in 16 months for a mean year. The FSL.320m reservoir fills similarly in 3 to 12 months, with only 3 months for a mean year. Increasing the riparian release to 50m^3/s will result only in minor increase of filling time: +2 months for FSL.360m, +1 to +2 months for FSL.320m. The difference is not so large to give the opportunity to adapt at best the riparian release for the benefit of population and project. It is recommended that a study is carried out during next stage of the Project development in order to optimize the riparian release during the filling period.

IMPACTS ON LAND

Land cover in the reservoir area is presented below for both alternatives.

Land cover	Area (ha)	
	FSL.360m	FSL.320m
Evergreen forest	830	450
Deciduous forest	8,950	4,480
Forest regrowth	1,200	380
Shrubland	2,890	1,770
Cultivated land	950	310
Total area	14,820	7,390

The alternative FSL.360m affects almost twice more land than the alternative FSL.320m, and 3 times more cultivated land. All compensation costs related to this area are detailed in the Preliminary Resettlement Plan.

The flooding of the forest represents an economic loss for all the flooded forest products: timber, non timber forest products (medicinal plants, fruits, material, value for animals and conservation) and more globally, the forest as a carbon storage participating in the greenhouse effect reduction. At FSL.360m, 9,780ha of forest representing a timber volume of 290,000m^3 will be flooded against only 148,000m^3 for FSL.320m (4,930ha forest).

As the water level will raise fast during the first few months of the filling (about 140m in 3 months, 2.3m/day the first month), it is probable that animals become trapped on temporary islands or stranded. It is recommended to implement a rescue program for animals during filling.

IMPACTS ON WATER QUALITY

This is a key impact of this stage, unfortunately not limited to the filling period. The alteration of water quality will probably last for few years during the operation phase.

The main cause of water alteration is the decay of the organic matter contained in the flooded vegetation and the upper layer of the soil. It is estimated that the degradable carbon content of above ground vegetation together with the first 5 cm of topsoil is about 2.4 million tons Carbon

for FSL.360m alternative and 1.2 million tons Carbon for FSL.320m alternative.

About 21% of this biomass is soft and is rapidly degraded in about 2 to 3 years. The remaining part of the biomass consists in wood parts (timber, large branches, large roots) which decay slowly over 15 to 20 years or even more.

The critical period is the decay of soft biomass, as large quantities of methane gas released from anaerobic degradation will consume all the dissolved oxygen in water, affecting the aquatic life. There is no effective solution to avoid this temporary alteration of water, but only to limit its intensity and its duration. One possibility is a pre-impoundment clearing, combined with a commercial logging. Based on the recent clearing experience of the Nam Leuk reservoir, clearing and burning may reduce the soft above ground vegetation biomass by about 70% to 80%. For hard biomass, the clearing and logging operations can hardly remove more than 50% of the original volume. No practical solution exists to reduce the biomass from the soil. A mitigation measure may be to implement a water re-aeration device at the level of the tailrace channel. These options have to be investigated during next stage of Feasibility.

The Nam Leuk reservoir (1,300ha) was totally cleared by hand by the local population (400 persons) in 5 months, at an average cost of US$420/ha. On this basis, a clearing cost of about US$5-6 millions for the FSL.360m and about US$3 millions for FSL.320m may be expected. This cost is largely balanced by the reduction of the Global Warming Potential (GWP) of the greenhouse gas emission, and by benefits for future uses of the reservoir (fisheries, tourism).

Because the release of low oxygen water downstream will affect fisheries, it is recommended to prepare a fishery intensification program which will provide to the population a fish production system independent from the river.

If the situation of water quality will be unsurprisingly acute at short term, various computations show that the improvement of water quality will be fast and that the situation in the reservoir will be reasonably good in the long term, at least for the active superficial layer of the reservoir.

3.6. IMPACTS DURING THE OPERATION PHASE

THE DRAW DOWN AREAS

The reservoir will be a highly dynamic system with regular changes of level and area according to season and to the inflow conditions. The draw down areas, seasonally exposed to the air, may be suitable for land development: agriculture, grazing, wet land. The maximum draw down area expected for each alternative is about the same, around 4,000ha. However, only a part of this area is exposed at least 5 months, a suitable duration for paddy production: about 1,000ha for FSL.360m and 1,500-1,800ha for FSL.320m. The lowest option is the most promising on this subject.

THE RESERVOIR

As other deep reservoir, the Nam Ngiep will probably stratify. This means that a superficial layer of water, about 15-20m thick will become quickly well oxygenated. This is the layer

where plankton and fish development occurs. Below this layer, the remaining part of the water body will receive no oxygen and will be the place where no fish or other aquatic life develop, except anaerobic bacteria releasing methane gas and sulfur hydrogen. This water shows also a lower temperature and a lower pH, which may create corrosion problems for the equipment.

It is possible that, as observed in the Nam Ngum reservoir, this stratification turns over once a year, when colder flow and colder air temperature affect the water body. There is a mixing, detrimental for the upper layer but positive for the bottom layer which liberates part of its dissolved gas and receives some oxygen, thus reducing the corrosiveness of the water. Further studies are required during next stage.

The risk of eutrophication of the upper layer in the long term is low because the residence time of water in the reservoir is short (13.2 months for FSL.360m and only 3.6 months for FSL.320m) and natural Phosphorus loading rate is low (0.45gP/m²/year for FSL.360m and 0.90gP/m²/year for FSL.320m).

The water intake will be situated a large part of the year more than 15-20m below the reservoir level, thus releasing downstream anoxic water. If no multilevel intake is considered, because of high cost, re-aeration device and fishery intensification program downstream become priorities.

Using some models based on empirical observation of existing reservoirs in Asia, the forecast of sustainable open fish production gives about 11kg/ha/year for FSL.360m (or a production of about 160t/year) and 13kg/ha/year for FSL.320m (or a production of 96t/year). Much higher production may be expected if additional fish culture using floating cages is developed.

THE DOWNSTREAM AREA

A major impact will be the change of river flow. Turbine operation is anticipated for 16 hours per day, and the flow will be regulated over 24 hours by a re-regulation facility. However, the future situation will be significantly different from the present one: In Muangmai in a mean year, the future flow with the Project at FSL.360m will be about 3 times higher during the dry season and only half of the initial flow during the wet season. This change of flow will have effects on the river use by the population. More regularized flow is beneficial for the development of pumped irrigation and for river transportation. However, a higher level year long will slightly reduce the area of vegetable gardens generally developed by the villagers along the lower banks of the river. n evaluation of the loss and a compensation is recommended.

The change in water quality downstream will reflect the evolution of water quality in the reservoir as previously presented. Fisheries will probably be affected.

COMPARISON OF ALTERNATIVES

Tables 3.3 and 3.4 presents, for each project alternative the quantified indicators discussed in this report, in order to facilitate the comparison in the environmental field.

The environmental efficiency of a hydropower project may also be measured by the number of ha of land affected and the number of displaced person for each MW of installed capacity. The position of both alternatives is compared with several other projects in the world and presented in Figure 3.1.

3.7. ENVIRONMENTAL MANAGEMENT PLAN

The objectives of the Environmental Management and Monitoring Plan (EMP) is i) to provide the framework for undertaking all the Environmental Protection Measures (EPMs) recommended and related to direct impacts of the Project, and ii) to establish a monitoring of these measures throughout the life of the project, but with a special focus during the construction and filling phases. The Plan also provides a possible institutional organization framework for its implementation, defining briefly the roles and responsibilities of each party.

The Environmental Measures proposed as a result of the First EIA study are presented in Tables 3.5 and 3.6.

Table 3.1 IMPACTS IN DOWNSTREAM AREA AND CONSTRUCTION ZONES

DEVELOPMENT PHASE	IMPACTED FIELD	TYPE OF IMPACT	CAUSES	CONSEQUENCES	CRITERIA CONSIDERED FOR ASSESSMENT	PROPOSED MITIGATION
CONSTRUCTION PHASE	AQUATIC SYSTEM	Water pollution by accidental release of chemical	Storage and handling of chemicals on construction site (mainly oil products)	Temporary effect on aquatic ecology and fisheries	Type of pollutant Dilution of pollutant at various distance from release	Appropriate storage & handling of chemicals Compensation
					Occurrence of event and severity Local fish consumption	Compensation
		Water pollution by release of pathogens in river	Inappropriate sanitation system of workers camps	Hazardous use of river as source of domestic waterbh	Type of pathogens (survival time) Flow velocity Population at risk Water use	Design of sanitation system Contract obligation for contractor Compensation
		Excessive sediment load	Inappropriate prevention measures during earthworks	Temporary effect on aquatic ecology and fisheries	Load SS Period (DS more affected) Occurence	Construction methods Compensation
		Permanent pollution by chemicals	No treatment of effluents from batching plant before release in the river	Effect on aquatic ecology and fisheries	SS and pH of river water Distance from release	Sedimentation and buffering ponds
	LAND SYSTEM	Impact on land use at construction sites	Implementation of project sites: construction sites, camps, quarries, disposal areas	Loss of natural resources Loss of grazing land Loss of agricultural land	Areas required & location Land use	Design to minimize needs Land acquisition & compensation
			Construction of access roads and Transmission lines	Loss of natural resources Loss of grazing land Loss of agricultural land Disturbance to wildlife	Areas required & location Land use Areas of interest for wildlife	Adjust route to minimize effects on valuable land Land aquisition
	SOCIAL	Local employment and income	Opportunities for unskilled workforce: earthworks, clearing	Improved income for local population	Workforce availability in the villages according to season Priority to local villagers Recruitment procedure	Give priority to local villagers for employment on project sites
		Public safety	Transport of equipment and materials, intense truck traffic	Noise Dust emission Accidents and injuries risk for villages crossed by road	Measures required to minimize the risk	Design Traffic regulations and signs Watering of roads during DS Reduce traffic at night
			Concentration of in-migrants in the construction area	Risk of epidemic diseases Dissemination of HIV and water related diseases	Prevention program and monitoring	Public Information and awareness program
					Design and organization of camps facilities	Hygiene in the camps Medical control, equipment, monitoring
RESERVOIR FILLING	AQUATIC SYSTEM	Reduction of river flow	Impounding of the reservoir	If no riparian release (RR), 100% of aquatic habitat and fisheries destroyed for 3-5 years If riparian release, part of fisheries and habitats preserved	Appropriate RR Duration of filling and period Expected reduction of fish catches	Compensation
				Water shortage downstream	Alternative water supply	Compensation
				Irrigation impaired	% of affected rainfed and irrigated production	Compensation for loss
		Alteration of water quality	Flooding of vegetation and soils in the reservoir	Water anoxic after few months of filling	Duration of filling Organic matter available in reservoir and decay kinetic	Partial only Reservoir clearing
				Unsuitable for domestic use Unsuitable for livestock use	Alternative water supply Village/HH numbers	Compensation
	SOCIAL	Resettlement of reservoir population	Impounding of the reservoir	Potential impacts on land use and on host population	Location and availability of land, Development planning of host or nearby villages	Mitigation measures to be addressed in RAP
		Employment and regional economy	End of construction works	Reduction of workers population and related local economic activities	Number of workers Average contribution to local economy	Public information
		Impaired river transport	Reduction of flow during filling	River transport impossible because of low flow, even with riparian release of 20 cumecs	Number of boats on the river Contribution to the local economy	Compensation
RESERVOIR OPERATION	AQUATIC SYSTEM	Irregular daily flows	Production of intermediate & peak energy (16 hrs/day)	Destruction of aquatic habitats and fisheries Erosion of river channel	100% loss of fisheries 100% loss river transport	Re-regulation pond or compensation
				Danger for people and livestock	High risk of accident	Warning system Re-regulation pond
		Regular seasonal flows	Energy production is stable year long	Improve dry season flow of Mekong	NNG flow as % of MKG flow	Not required
				Improve river transport in dry season	Number boats Increased level of river	Not required
				Provides high potential for dry season irrigation during both wet & dry season	Average discharge Land suitability Location for pumping station(s)	Not required
		No significant increase of flow in wet season	Run off is stored in the reservoir	No attraction of migrating fishes in early wet season Loss for fisheries	Nb of migrating species observed Importance in catches	Compensation for loss
		Low to very low sediment load in the water	Sediment is deposited in the reservoir	Water flow more erosive, mainly during dry season Risk of river bed erosion	Role of backwater effects from Mekong Risk possibly minimized by slow velocity of flow	River protection structures if required
		Short term anoxic water release	Decomposition of flooded vegetation & soil organic matter	Short term release of anoxic water, unsuitable for domestic & livestock	Expected duration of problem is 4 to 7 years according to FSL alternative	Pre-impoundment reservoir clearing Res. Management
				Destruction of D/S fisheries as function of DO level	Re-aeration rate of water DO concentration at distance from dam	Alternative fisheries development Financial compensation
		Long term seasonal release of anoxic water	Stratification of reservoir Reservoir management	Unsuitable water for domestic and livestock use Effect river fisheries	Period of event: probably October to January, when reservoir level highest	Multi level water intake
		Long term accidental or permanent pollution of water	Development of population and industries around reservoir and in catchment	Unsuitable water for domestic use or for other uses.	Level of risk Type of pollution	Strategic plan for watershed control
	LAND SYSTEM	Loss of river bank gardens	Increase of river level by about 1 m in dry season with potentially more erosive waters	Loss of lower part of the river bank gardens (flooding or erosion)	Initial area of gardens potentially impacted Average crop production	Compensation

Table 3.2 IMPACTS IN INUNDATION ZONE AND CATCHMENT AREA

DEVELOPMENT PHASE	IMPACTED FIELD	TYPE OF IMPACT	CAUSES	CONSEQUENCES	CRITERIA CONSIDERED FOR ASSESSMENT	PROPOSED MITIGATION
CONSTRUCTION PHASE	AQUATIC SYSTEM	No significant impact anticipated				
	LAND SYSTEM	Impact on land use	Implementation inside the future reservoir of quarries, camps and disposal sites	Localized loss of natural resources, grazing land	Limited impact; areas required for construction purposes	Early compensation and land acquisition procedures
	SOCIAL	Local employment and income	Clearing of reservoir Collection of forest products	Improved income for local population	Workforce availability in the villages according to season Priority to local villagers Recruitment procedure	
		Resettlement of affected population	Flooding of the reservoir area	Development of new sites for resettlement to be completed before reservoir impoundment	Population, ethnic groups, needs for livelihood re-development	Resettlement Plan & Compensation for transitory period
RESERVOIR FILLING	AQUATIC SYSTEM	Loss of river habitats as permanent stream and rapids	Creation of reservoir	Loss of fast water habitats Disruption of river integrity	Presence of migratory species	Compensation by contribution to conservation trust fund
		Alteration of water quality	Flooding of areas rich in organic matter	Anoxic conditions of water resulting in fish kills Fish population taking refuge in upper tributaries	Carrying capacity of initial river area	Compensation by contribution to conservation trust fund
				Possible loss of rare fish species	Presence of rare species	Conservation of areas of similar biological value
				Water inadequate for domestic supply purpose (drinking/bathing)	Existing/resettled population around reservoir	Alternative water supply
				Water inadequate for livestock supply	Population around reservoir & estimated number livestock heads	Alternative water supply if required
	LAND SYSTEM	Loss of terrestrial habitats with associated flora and fauna	Inundation of the reservoir area	Loss of rare plant species	List of plants observed in the area	Conservation of substitute habitats
				Loss riverine habitats rich in bird diversity	Length of river flooded Areas of interest for biodiversity	Conservation of substitute habitats
				Loss of rare terrestrial fauna	List of animal species with conservation status	Conservation of substitute habitats
				Drowning of animals during inundation phase	Large mammals possibly at risk Velocity of flooding Pre-impoundment clearing Presence of islands	Pre impoundment program (clearing) Animal rescue program during reservoir filling
		Loss of forest products	Inundation of the reservoir area	Loss of existing forest timber	Type & location of forested areas Commercial timber density	Pre-impoundment logging
				Loss of existing non-timber forest products	Type & location of forested areas Importance in population income	Collection program associated with pre-impoundment vegetation clearing
		Loss of production systems and dwellings	Inundation of the reservoir area	Loss of houses, built-up private & community structures & infrastructures, of cultivated areas and grazing land	(See details in operation stage)	Planned resettlement and compensation
		Loss of mineral production	Inundation of the reservoir area	Loss of sand and gravel production; Possibly gold (not reported)?	Population affected Areas of interest	Provide households with substitute income
		Floating debris	Inundation of cleared area; Only part of wood biomass totally burnt	Threat for water intake and later for boat transport and fishing	Volume of trunks/branches Areas for landing and transforming	Preparation and implementation of a removal program
	SOCIAL	Population livelihood not yet re-established	Displacement of population to new sites just before flooding	New production systems to be implemented	Resettlement Action Plan	Assistance and compensation
RESERVOIR OPERATION	AQUATIC SYSTEM	River system permanently flooded	Creation of the reservoir	Loss of river aquatic products	Area of flooded river system	No mitigation
		Low water quality after filling (short term)	Decay of vegetation biomass and soil organic matter	Problem expected to last 4 (FSL 320) to 7 (FSL 360) years	Evaluation of vegetation biomass Pre-impoundment clearing plan	Vegetation biomass clearing may reduce duration of problem
				No reservoir fisheries until the end of water quality problem	Possible duration of problem Time required in other reservoirs to reach stable reservoir fisheries conditions	Net protein compensation to affected population
		Seasonal long term low water quality	Turn over of stratified reservoir	May limit intensification of fish production using floating cages	Risk of seasonal turn over due to the physiognomy of reservoir	Adjust production schedule in accordance with turn over occurence
		Gain of aquatic resources	Creation of the reservoir; Improvement of epilimnion quality	Increased productivity and potential for fisheries	Potential yield after stabilization of reservoir conditions	Development of a reservoir fisheries program
				Gain from fisheries intensification	Fish cages, fish species production according to management	Preparation of a reservoir fisheries intensification plan
		Increased sediment load in the water	Uncontrolled development in the catchment area resulting in increased erosion	Reduction of reservoir storage and related project life	Dead volume of the reservoir Erosion rate per km²	Strategic plan for watershed control
				Increased sedimentation at the tail of the reservoir May result in higher backwater effects with flooding of fields and built up assets	Hydraulic engineering of river levels Resettlement levels	Decrease FSL or increase resettlement level
		Presence of a long water body	Reservoir creation	Potential for transport of goods and persons	Lakeshore population	Not justified
		Reservoir access restricted by seasonal draw down of 30 m.	Reservoir management for energy production	Loss of potential benefit from transport part of the year (dry season)	Distance from lake shore in wet and dry season	Appropriate berthing facilities adapted to 30 m draw down
		Creation of temporary draw down areas	Reservoir management for energy production	Impaired landscape, possible sites for water related diseases	Draw down area is 54 km² (FSL 360) or 44 km² (FSL 320)	Management Plan for draw down areas
		Reservoir safety	Safety of public transport boats and on reservoir shores	Risk of drowning	Magnitude of transport on the reservoir	Installation of signs Inspection of boats for public transport
		Creation of new wetlands	Reservoir management for energy production	Potential for increased production of aquatic products and improvement of aquatic biodiversity	Location of potential wetlands Draw down area & topography	Management of wetland production Conservation status for key areas
		Creation of new spawning areas	Reservoir management for energy production	Increased fish production and biodiversity	Location of potential areas	Conservation status for key areas
		Improvement of reservoir water quality	Stabilization of reservoir water quality after 10 years	Economic gain of clean domestic water supply	Lakeshore population after 10 years estimated 12 per km of perimeter.	Not justified
				Economic gain of water supply for livestock	Livestock population based on human population;	Not justified
				Economic gain for reservoir side gardens irrigation	75% lakeshore household have garden (or 1.5 garden/km of reservoir bank)	Not justified
				Economic gain for irrigation along reservoir side	1 ha irrigation/km of reservoir shore	
		Long term eutrophication of reservoir	Nutrient inflow from a developed catchment	Development of aquatic weeds and floating vegetation which affects turbines, evaporation and reservoir productivity	Expected Phosphorus loading Magnitude of draw down Residence time for water	Watershed control Removal of vegetation if required
	LAND SYSTEM	Economic loss of future land resource harvest	Reservoir creation	Economic loss of timber resource	Area flooded, type of forest Annual average production	No mitigation
				Economic loss of non timber resource	Area flooded, type of forest Average annual value	No mitigation
				Economic loss for bamboo	Area flooded Density of bamboo	No mitigation
				Economic loss of future rainfed crop production	Area flooded Average production	No mitigation
				Economic loss of future dry season irrigated production	Area flooded Average production	No mitigation
				Economic loss of riverbank gardens	Household affected Average annual production	No mitigation
				Economic loss of grazing area	Number of livestock & cattle to move reflects grazing area	No mitigation
		Financial loss of developed land by displaced people	Reservoir creation	Loss of rainfed paddy fields	Area	Compensation for unmovable asset and 3 years production
				Loss of irrigated paddy fields	Area	Compensation for the unmovable assets plus 3 years
				Loss of gardens (fruits and vegetables gardens)	Area or unit	Compensation for unmovable assets plus

Table 3.3 Comparison of Alternatives (1/2)

No.	Components & Indicators	Unit	Alternative	
			FSL.EL.360m	FSL.EL.320m
I.	**RESERVOIR**			
1.	FSL Area	km²	148.2	73.8
2.	FSL Volume	Mill.m³	6,780	2,280
3.	MOL Level	m	335	284
4.	MOL Area	km²	104	32.7
5.	MOL Volume (Dead storage)	Mill.m³	3,689	627
6.	Mean Level	m	342	306
7.	Mean Area	km²	133	54
8.	Mean Volume	Mill.m³	5471	1548
9.	Mean Depth	m	41.4	28.7
10.	Reservoir shoreline at FSL	km	565	350
11.	Draw down (DD) magnitude	m	25	36
12.	DD area (maximum)	ha	4,420	4,110
13.	DD area exposed >120 days	ha	1,200	2,300
14.	Length of river flooded	km	90	70
15.	Average river width in reservoir area	m	80	80
16.	River area flooded	ha	720	560
17.	River area above reservoir	ha	228	388
18.	Length of tributary system dammed	km	372	372
19.	Area of tributary system dammed	ha	2,100	2,100
20.	Average river bank width in reservoir	m	50	50
21.	Area of river bank flooded	ha	450	350
22.	Controlled catchment area	km²	3,700	3,700
II.	**RESERVOIR FORECASTS**			
1.	Hydraulic Residence Time (months)	month	13.2	3.6
2.	Areal Hydraulic Loading (m/year)	m/yr	34.5	68.1
3.	Catchment to Reservoir area ratio	-	25.0	49.3
4.	Duration of water quality problems	year	6	2
5.	Filling Period (no riparian release)	month	15	3
6.	Filling Period with RR of 20 m3/s	month	16	3
7.	Filling Period with RR of 50 m3/s	month	18	4
8.	Mean annual evaporation	Mill.m³	204	83
9.	Reservoir shoreline development	-	13.1	11.4
10.	Maximum temperature	°c	29	29.7
11.	Minimum temperature	°c	21	21.4
12.	Phosphorus loading rate (gP/m²/y)	-	0.449	0.902
13.	Electrical conductivity in future lake	µS/cm	46	62
14.	Morpho-edaphic index (MEI)	-	0.65	0.93
15.	Reservoir potential fish catch	tons/y	160	96
16.	Reservoir potential fish yields	kg/ha/y	11.3	13.6
III.	**TERRESTRIAL RESOURCES**			
1.	Forest area flooded	ha	9,780	4,930
2.	Timber standing volume (30 m³/ha)	m³	293,000	148,000
3.	Timber annual production (1.5 m³/ha/y)	m³/y	16,500	8,000
4.	Open woodland	ha	2,890	1,770
5.	Distance to nearest (NBCA)	km	14	14
6.	Area with important wildlife species	ha	100	100
7.	Flooded biomass rapid decay	'000 t	568	284
8.	Flooded biomass slow decay	tons	2,140	1,071

Table 3.4 Comparison of Alternatives (2/2)

No.	Components & Indicators	Unit	Alternative	
			FSL.EL.360m	FSL.EL.320m
IV.	**DOWNSTREAM AREA AND CONSTRUCTION SITES**			
1.	Length of river downstream	km	54	54
2.	Area of river downstream	ha	880	880
3.	Area of river banks	ha	400	400
4.	flow change driest month (dam)	initial	355%	333%
5.	flow change wettest month (dam)	initial	34%	49%
6.	Villages along river	nos.	14	14
7.	Households	nos.	1,132	1,132
8.	Population	nos.	6,473	6,473
9.	Grazing land	ha	19,716	19,716
10.	Buffalo	nos.	864	864
11.	Cattle	nos.	986	986
12.	Average flow velocity	m/s	0.2	0.2
13.	Population km 0-10 (from dam site)	nos.	785	785
14.	Population km 10-20 & 20-30	nos.	0	0
15.	Population km 30-40	nos.	3,307	3,307
16.	Population km 40-54	nos.	3,166	3,166
17.	Area for re-regulation pond	ha	240	240
18.	Area for dam construction site & camps	ha	150	150
19.	Area for quarries and borrow areas	ha	150	100?
20.	Length of new access road	km	10	10
21.	Area for new access road	ha	20	20
22.	Length of transmission line	km	110	110
23.	Area for transmission line (ROW)	ha	550	550
24.	Area for TL (land acquisition)	ha	2.0	2.0

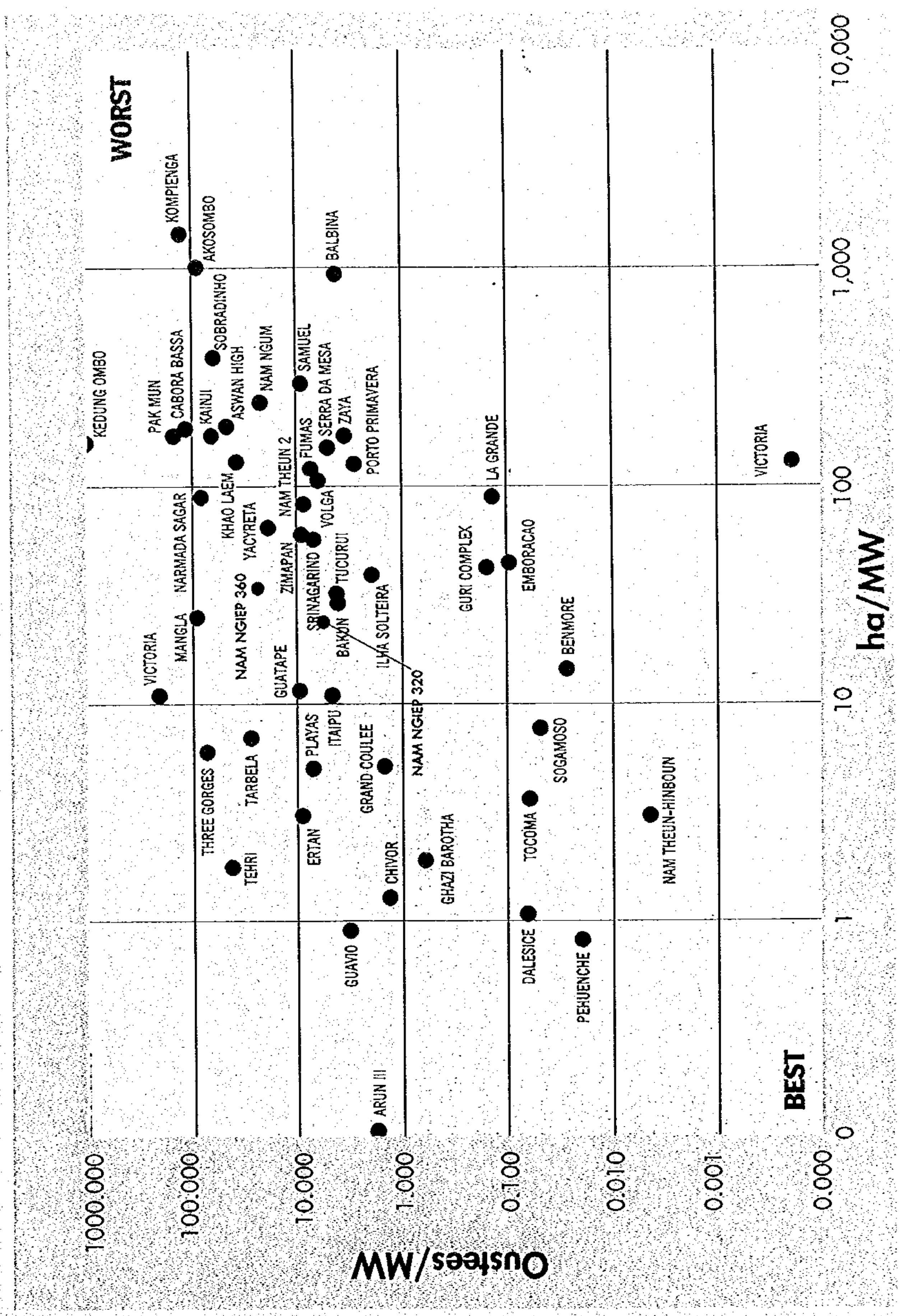
Table 3.5 Recommended Environmental Mitigation Studies and Measures (1/2) (Unit : US$)

No	Environmental Measures	Responsible Organism	Executing Organism	Duration (years)	Unit Cost Estimate	Total Cost FSL360	Total Cost FSL320
A	**Completion of EIA Study to International Standards**	**JICA/GOL**	**HPO/Consul.**	**2**			
A1	Monitoring of fisheries	JICA/HPO	Dept. Fishery	2	15,000	30,000	30,000
A2	Aquatic Ecology surveys	JICA/HPO	Consulting	2	60,000	60,000	60,000
A3	Study on intensification of fisheries in reservoir area and in downstream villages	JICA/HPO	Consulting	1	60,000	60,000	60,000
A4	Water quality monitoring	JICA/HPO	Consulting	2	25,000	50,000	50,000
A5	Water quality forecast study (reservoir modeling)	JICA/HPO	Consulting	1	60,000	60,000	60,000
A6	Study of sedimentation and backwater effects	JICA/HPO	Consulting	1	100,000	50,000	100,000
A7	Study and design of water re-aeration structures	JICA/HPO	Consulting	1	50,000	50,000	50,000
A8	Study for optimization of riparian release	JICA/HPO	Consulting	1	20,000	20,000	20,000
A9	Study for Downstream villages water supply	JICA/HPO	Consulting	1	50,000	50,000	50,000
A10	Land use study based on new aerial photos for reservoir, access road and TL	JICA/HPO	Consulting	1	60,000	60,000	50,000
A11	Land use study of village gardens along river banks in downstream area	JICA/HPO	Consulting	1	20,000	20,000	20,000
A12	Study on wildlife and biodiversity with preparation of a rescue plan	JICA/HPO	Consulting	1	80,000	80,000	80,000
A13	Survey of reservoir timber and vegetation biomass	JICA/HPO	NOFIP, Consulting	2	150,000	150,000	110,000
A14	Preparation of a logging and clearing plan	JICA/HPO	Consulting	1	50,000	50,000	46,000
A15	Strategic study for biodiversity compensation and support (participation to trust fund?)	JICA/HPO	CPAWM, Consulting	1	20,000	20,000	20,000
A16	Preliminary watershed management plan	JICA/HPO	Consulting	1	10,000	10,000	10,000
A17	EIA for resettlement sites (Provisional budget)	JICA/HPO	JICA/HPO	1	100,000	100,000	70,000
A18	Preparation of detailed Environmental Management and Monitoring Plan	JICA/HPO	Consulting	-	60,000	60,000	60,000
A19	Coordination, reporting, presentation	JICA/HPO	Consulting	-	60,000	60,000	60,000
	SUB TOTAL A					1,040,000	1,006,000
B	**Organization of the Environmental Management Unit (EMU) and Committee**	**GOL/DEV**	**STENO**				
B1	Constitution of EMU	GOL/DEV	STENO/ HPO/EDL	0.5	80,000	80,000	80,000
B2	Capacity building of EMU (1 year Technical Assistance) and Creation of Committee	STENO/DEV	EMU/ Consulting	1	300,000	300,000	300,000
B3	Preparation of detailed working program for EMU	GOL/DEV	STENO / Consulting	0.5	Included in previous	-	-
B4	Appointment of Independent Panel of Experts (2)	GOL/DEV	STENO	-	-	-	-
B5	Preparation of detailed envir. spec. for Contractors	JICA/HPO	Consulting	-	30,000	30,000	30,000
	SUB TOTAL B					410,000	410,000
C	**Measures during Construction Phase**	**GOL/DEV**	**EMU**	**5**			
C1	Provide operating budget for EMU	GOL/DEV	STENO	5	180,000	900,000	900,000
C2	Appointment of Independent Panel of Experts (2)	GOL/DEV	EMU	-	60,000/yr	300,000	300,000
C3	Monitoring of contractor's construction sites and camps	GOL/DEV	EMU	5	EMU operation	-	-
C4	Provision for compensation for accidental spill or downstream pollution	STENO	EMU	When justified	(reimb.by contractor)	*100,000*	*100,000*
C5	Provision for independent investigation audit and arbitration of impact event if required	EMU	Consulting	When justified	(reimb.by contractor)	*20,000*	*20,000*
C6	Monitoring of fisheries in reservoir & D/S villages	EMU	Fishery Dept.	5	15,000	75,000	75,000
C7	Construction of water supply facilities for downstream villages last 1-2 years of Construction	EMU	Contractor	1-2	250,000	250,000	250,000
C8	Water quality monitoring (incl. tech. assistance)	EMU	Vientiane Laboratory	5	25,000	125,000	125,000
C9	Study for detailed rehabilitation of quarries, borrow and spoil banks	EMU	Consulting	1	30,000	30,000	30,000
C10	Preparation of specifications for logging and clearing tender documents, evaluation of tenders	STENO Forest.Dept.	EMU Consulting	0.5	20,000	20,000	20,000
C11	Technical Assistance to EMU for supervision and monitoring of logging and clearing	EMU	Consulting D. Forestry	2	200,000	200,000	150,000
C12	Clearing of reservoir	EMU	Contractor	2	5800,000	5,800,000	3,000,000
C13	Preparation of a detailed watershed development and management plan	STENO CPAWM	Consulting	1	100,000	100,000	100,000
C14	Study for creation of wildlife reserve	STENO	EMU, Consulting	1	50,000	50,000	50,000
C15	Budget for land acqui.&compens. along A/road & T/L	STENO/DEV	EMU	1	110,000	110,000	110,000
	SUB TOTAL C					8,080,000	5,230,000

Table 3.6 Recommended Environmental Mitigation Studies and Measures (2/2) (Unit : US$)

D	Measures during filling phase	STENO	EMU	1			
D1	Provide operation budget for EMU			1	180,000	180,000	180,000
D2	Water quality monitoring	EMU	Vientiane Laboratory	1	12,000	12,000	12,000
D3	Specific monitoring of released water quality	STENO	EMU, Consulting	1	12,000	12,000	12,000
D4	Monitoring of downstream fisheries	EMU	Fishery Dept.	1	15,000	15,000	15,000
D5	Implementation of the animal rescue plan and management of the filling event (2 years)	EMU	Consulting, Contractor	1st year	180,000	180,000	130,000
D6	Removal of floating trunks and branches and release on ground landings	EMU	Contractor	1	200,000	200,000	150,000
D7	Implementation of the fisheries intensification program in downstream villages	MOAF	Fish.Dept. Contractor	-	Not project	-	-
	SUB TOTAL D					599,000	499,000
E	Measures during operation phase (year 1-5)	STENO	EMU	1-5 Years			
E1	Provide operation budget for EMU	GOL/DEV		1	180,000	180,000	180,000
E2	Water quality monitoring	EMU	Vientiane Laboratory	5	18,000	90,000	90,000
E3	Specific monitoring of released water quality	STENO	EMU Consulting	2	12,000	24,000	24,000
E4	Management of the filling event (2 years)	EMU	Consulting Contractor	2nd year	70,000	70,000	40,000
E5	Evaluation of Compensation for loss of river bank gardens and existing irrigation facilities	STENO	EMU	1	EMU budget	-	-
E6	Provision for Compensation for loss of river bank gardens and existing irrigation facilities	STENO	EMU	1	50,000 (provision)	50,000	50,000
E7	Monitoring of downstream fisheries	EMU	Fish. Dept.	5	15,000	75,000	75,000
E8	Development of irrigation in the downstream area	MOAF	Irrig. Dept. Contractor	-	Not project	-	-
E9	Compensate for lost biodiversity by annual contribution to environmental trust fund ?	GOL	EDL or DEV	5	?	?	?
E10	Implementation of watershed management plan (for aspects related to Project)	GOL	EDL or DEV	5	?	?	?
	SUB TOTAL E					489,000	459,000
F	Measures during operation phase (year 6-50)	STENO	EMU	Years 6-50			
F1	Water quality monitoring	EMU	Vientiane Laboratory	5	12,000	60,000	60,000
F2	Compensate for lost biodiversity by annual contribution to environmental trust fund ?	GOL	EDL or DEV	45?	?	?	?
F3	Implementation of watershed management plan	GOL	MOAF	20	?	?	?
F4	Implementation of commercial fisheries program in the reservoir	GOL/DEV	MOAF	5	Not project	-	-
F5	Implementation of fish culture in the reservoir	GOL/DEV	MOAF, Private Sect.	5	Not project	-	-
	SUB TOTAL F					60,000	60,000
	GRAND TOTAL (A to F)					10,678,000	7,664,000

Note: DEV= Developer, EMU= Environmental management Unit, GOL= Government of Laos



FEASIBILITY STUDY ON THE NAM NGIEP-1 HYDROELECTRIC POWER PROJECT IN THE LAO PEOPLE'S DEMOCRATIC REPUBLIC	FIRST ENVIRONMENTAL IMPACT ASSESSMENT	Figure 3.1
JAPAN INTERNATIONAL COOPERATION AGENCY	**HYDROPOWER EFFICIENCY RATIOS**	

4. PRELIMINARY RESETTLEMENT PLAN (PRP)

4.1. PROPOSED RESERVOIR AREA

The entire NNHP Reservoir Area will be within the *Khetpiset* (Special Zone) Xaysomboon as shown in Figure 4.1. Formerly part of Vientiane and Xieng Khouang Provinces, Xaysomboon was set up on July 23, 1994 to give the area special preference for community development. *Lao Soung* represent the majority of the population in the area (45%) followed by *Lao Theung* (35%) and *Lao Loum* (20%).

The *Upper Reservoir Area* of the proposed NNHP is within Thathom District, in Thaviang Sub-District. With a population of approximately 7,500 people living in 33 villages, Thathom District has the second lowest population in Xaysomboon. The present National Route 4 (NR4) to be upgraded to National Road 1 passes through the proposed Upper Reservoir Area. The Government plans to extend the national network with a center spine NR1. This road is strategically important for the social economic development of the country and will run from the northern-most point of Lao's border with China to Cambodia in the south, adding another 1,000km to the network.

The Upper Reservoir Area will also benefit from the transmission line route for the ADB-financed Power Transmission and Distribution Project, since the line is along NR4. The district will have an even more strategic location when NR5 is completed, linking Thailand through Vientiane to Vietnam. The junction of NR5 and NR1 will be in the Thaviang Sub-District of Thathom, the Upper Reservoir Area of the NNHP.

It is possible that with better transportation facilities in the Upper Reservoir Area, and with the high population density relative to cultivable land area in China and Vietnam, there could be an excellent potential in *niche* market items grown at high tropical elevations, in addition to more common products such as horticulture, dairy and beef cattle or reservoir fisheries.

The *Lower Reservoir Area* of the proposed NNPP is within Hom District, Xaysomboon. The District's population is approximately 6,600 people living in 31 villages, making it the least populated district in Xaysomboon. Hom District is 90% *Lao Soung* with some *Lao Theung* and *Lao Loum* making up balance.

4.2. RESETTLEMENT IMPACTS OF RESERVOIR INUNDATION

A reconnaissance field visit August 25-28, 1998 for the IEE found the population within the planned Reservoir Area to be more built up than anticipated. Instead of around an expected

2,000 people, it found the overall reservoir area population to be more than double this figure, at somewhat less than 5,500 persons. The reconnaissance team also found considerable government-supported irrigation development in the proposed Reservoir Area.

The extent of this was confirmed by a socioeconomic survey carried out December 1998 to January 1999. This survey found about 650ha of irrigated rice paddy, with 150ha more planned by GOL, instead of, as was originally assumed, only dry evergreen tropical forest, temporary or permanent agricultural areas, degraded forest, old re-growth and fallow resulting from shifting cultivation in the proposed Reservoir Area. In addition, the *Upper Reservoir Area* is a national Focal Area for Rural Development (FARD), making it a resettlement receiving area for highland populations; and the *Lower Reservoir Area* has been under a UNDP development project for a couple of decades. At FSL.360m, the proposed reservoir will flood 17 villages consisting of some 853 households, with a population of 5,204. More than 800ha of irrigated paddy land built through GOL or UNDP aid schemes would be inundated. Distribution of all villages in the proposed reservoir area is shown in Figure 4.2.

The socioeconomic survey was extended to the downstream area in March 1999. According to the socioeconomic survey of the Project Area, overall, including both Upstream and Downstream Areas, nearly 2,000 households and 12,000 persons may be affected to one degree or another by the NNHP. 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 Villages as shown in Figure 4.3, about 1,300 households and 6,800 people in 15 villages would be affected through changes in the Nam Ngiep River flow and water. The villages affected both upstream and downstream of the proposed Dam are shown in table below:

Reservoir Are				
Upper Reservoir:		Households	Population	EL.(m)
1.	B. Phonehom	67	375	368
2.	B. Namlong	17	107	364
3.	B. Xiangkhong	39	247	362
4.	B. Nakang	25	132	355
5.	B. Nahong	75	446	342
6.	B. Viengthong	46	273	339
7.	B. Naxay	22	125	332
8.	B. Naxong	81	522	330
9.	B. Phonyeng	63	349	328
10.	B. Dong	82	509	327
11.	B. Hatsamkhone	27	174	326
12.	B. Phiangta	49	322	323
13.	B. Pou	66	416	319
Upper Reservoir Sub-Total:		*659*	3,997	-
Lower Reservoir:				-
1.	B. Houaypamon	18	127	275
2.	B. Namyouk	86	540	271
3.	B. Sopphouh	23	132	261
4.	B. Sopyouk	67	408	245
Lower Reservoir Sub-Total:		*194*	*1,207*	-
Total of Reservoir:		853	5,204	-

Downstream of Dam				
Bolikhan District		Households	Population	EL.(m)
1.	Hat Kham	88	533	-
2.	Tahua	55	252	-
3.	Somseum	185	1,136	-
4.	Nam Pa	71	427	-
5.	Houay Koun	281	1,632	-
Bolikhan District Sub Total :		*680*	*3,980*	-
Pakxan District				-
1.	Nong – Deng	19	112	-
2.	Thong –Noi	50	329	-
3.	Thong – Gnai	62	340	-
4.	Song Khon	42	239	-
5.	Phonsi	48	276	-
6.	Thakokkhen	58	349	-
7.	Nam Tek	39	203	-
8.	Nam Ngiep	67	331	-
9.	Sen – Oudom	67	314	-
10.	Komsipchet (Military Village)	147	363	-
Pakxan District Sub Total :		*599*	*2,856*	-
Total of Dam D/S		1,279	6,836	-

The table also illustrates which villages will be affected at FSL.360m and FSL.320m. While not all villages would be submerged even by FSL.360m alternative, their rice lands are all situated along the Nam Ngiep River and its territories at low levels. So we can assume that virtually all the villages would require resettlement, if FSL.360m dam 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.

The recommended design mitigation at this time is to consider the lower 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 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. We would assume about 2m, 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 300 ha 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.

Besides the backwater effect, *population increase* will also need to be taken into account. Since the *Upper Reservoir Area* is a FARD, located within a river valley and along a national highway, 10 years from now the current population will have grown by natural increase (nationally at 2.6% and in Xaysomboon at 3%) and by in-migration. Although this Preliminary Resettlement Plan (PRP) will use the above population figures, for planning sake all quantities and financial evaluations will increase by 30% to account for the natural population increase and for in-migration over a 10 year period ending in 2010.

According to the socioeconomic survey, some 53% of households in the Reservoir Area have been there for less than 5 years. For the Upper Reservoir this figure is nearly 60% and for the Lower Reservoir almost 40%. Similarly, some 42% of households reported that they had been 'officially resettled' in the Reservoir Area, 43% in the Upper Reservoir and 41% in the Lower Reservoir. The Reservoir Area households surveyed have come from 23 different districts in the 7 northern Provinces of (i)Xieng Khouang, (ii)Xaysomboon, (iii)Houaphanh, (iv)Bolikhamsay,

(v)Vientiane, (Vi)Luang Namtha, and (vii)Luang Prahbangh.

Most village households in the Upper Reservoir surveyed came from Kham District, Xieng Khouang Province. Thathom District itself, which is the district where the Upper Reservoir is located, accounts for the second largest number of households after Kham District. In contrast to the Upper Reservoir, most of the Lower Reservoir households surveyed, virtually all *Lao Soung*, came from Hom District of Xaysomboon, the district in which they now live.

4.3. DEVELOPMENT OF DRAFT RAP & FINAL RAP

This document, the Preliminary Resettlement Plan (PRP) is prepared without the final design of the NNHP having been decided. Once the dam height is arrived at, 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

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

Upon completion of the draft RAP, the F/S should also come to an end, and Project Preparation, including Detailed Project Engineering Design and a final RAP, should coincide with the process of securing finance and international guarantees for the Project.

During the Project's Detailed Engineering Design Phase, following the F/S, a number of studies and program design activities should be carried out to finalize the RAP. These will include, but not necessarily be limited to:

(i) Detailed Design of Livelihood Packages

(ii) Detailed Census of Population and Inundation Loss of Assets and Natural Resources, including detailed Land Tenure Survey

(iii) New Village Design, including access roads, electricity, water, infrastructure, housing and community layout of resettlers' choice, and other features determined through community consultation

(iv) Unexploded Ordinance (UXO) Reconnaissance and, as Necessary, Clearance of Resettlement Sites

(v) Livestock Transport And Health Program Design

(vi) Pre Resettlement Health Program Design, with focus on maternal and child health, elderly, handicapped and otherwise vulnerable persons

(vii) AIDS/HIV Awareness And Prevention Program, with focus on construction sites and surrounding areas

(viii) Estimate of land and population affected by Transmission Line(s) and Access Roads and formulation of compensation plan for affected persons.

(ix) Environmental Impact Assessment (EIA) of RAP

Other studies and program design activities, with TORs and costs will be determined during preparation of a Social Action Plan (SAP) and Watershed Management *cum* Regional Development Plan.

Some very rough figures for the preparatory RAP studies might be approximately US$1,100,000 for FSL.360m alternative and about US$600,000 for FSL.320m alternative, not including costs for studies included under the EIA.

4.4. RESETTLEMENT ACTION PLAN (RAP)

RESETTLEMENT OBJECTIVES AND PRINCIPLES

The resettlement objectives of the NNHP RAP, as it is developed, will be in accordance with the *Draft National Resettlement Policy for Major Projects in the Lao PDR*, as developed through preparation of the Nam Theun 2 (NT2) resettlement policy. This policy has been reviewed by the World Bank and found in accordance with international best practice.

Accordingly, the main objectives of the NNHP RAP will ensure that (a) the population to be resettled materially improves its standard of living after resettlement and that (b) those compensated under the policy are compensated adequately.

IDENTIFICATION OF POTENTIAL RESETTLEMENT SITES

The Study Team and the counterparts carried out a preliminary inventory of 16 potential resettlement sites from mid July to mid October 1999 as shown in Figure 4.4. Most of the sites were recommended through interviews with officials of Xieng Khouang and Bolikhamsay Provinces, of Borikhan District within Bolikhamsay Province, and of the Xaysomboon Special Zone. An assessment of the sites was also made through use of aerial photos (1:30,000 taken in 1998) for identifying land use at each site. The photo interpretation was backed up with topographic maps at a 1:100,000, 1:50,000 and 1:25,000 scale, depending on availability, to study the topographic conditions.

A prioritizing of resettlement areas was carried out, based on the cultural preference of rural Laotians for rice cultivation. Resettled households are assumed to need 1.0ha of paddy field and 0.5ha for housing, gardens and other facilities. This is about 15% higher for land holding than that currently prevailing in the Reservoir Area, at 0.83ha/household for irrigated and rainfed paddy (0.18ha/household for wet season irrigated paddy alone). The Study Team generally assumed that about 50% of relatively flat land classified as 'unstocked' forest would be suitable for paddy development. On October 2, 1999, a helicopter reconnaissance was also carried out for the proposed resettlement sites to the South of the proposed reservoir.

The preliminary inventory of potential Resettlement Sites for the NNHP has indicated that out of 16 sites proposed by Local Government officials, resettlement might be possible in 14 sites. Three (3) of the sites were judged to be most attractive: Sites D1 and D2 in the Bolikhan District, Bolikhamsay Province and XK3 in Kham District, Xieng Khouang Province. Because they: have greater potential for paddy development; are located close to the administration center and near populated areas that could provide other earning opportunities; are within the FARD of either the concerned District or Province; and have been suggested by local authorities. Although all of the sites will be studied, these 3 sites alone, it is thought, could accommodate 3,250 households.

The Resettlement Site Inventory is a desk study, and its conclusions are preliminary and indicative. The scope of study for future investigations will include, *inter alia*, technical investigation of soil suitability and water availability for agricultural development, particularly of irrigation development; the prevailing socioeconomic, tenure and cultural conditions of the proposed sites; and other feasibility of additional livelihood packages at the sites.

INCOME RESTORATION

Reassembling lost production systems is a complex and difficult task that requires specialists from a diverse set of backgrounds and, in order to work, will require the full participation of the resettlers themselves, not only in implementing the schemes but in planning them as well.

The NNPP will explore a range of livelihood options, each described in more detail in the main text of the PRP. The option of irrigated rice paddy appears to be one that most resettlers from the Reservoir Area are familiar with, given the amount, thanks to Government development programs, of irrigated land that already exists in the affected communities. Forestry management seems to be a concept that is also familiar, at least to those communities in the Lower Reservoir, though more needs to be known about this. Other livelihood options are floating net aquaculture, dairy and/or livestock cattle using grass on some 45km^2 of the reservoir draw-down area, fruit orchards, eco-tourism, and technical skills training. The project will explore using the services of NGOs specializing in rural development to assist in preparing these livelihood packages, through an extensive public consultation program to on the one hand understand villagers' desires and requirements and on the other to inform them about the proposed livelihood packages. This is so that the resettler's desires will be fully incorporated into the RAP at all levels.

REHABILITATION OF INDIGENOUS AND VULNERABLE PEOPLE

The Project will follow WB and ADB policies on indigenous peoples, which require in the cases of impacted vulnerable minorities, preparation of an Indigenous Peoples Development Plan (IPDP). During the Reservoir Area census carried out as part of the final RAP preparation, identification of other vulnerable groups (elderly, poor, handicapped, etc.) will be made and plans put together accordingly to assist them in making a successful transition to the new Resettlement Sites.

INSTITUTIONAL ORGANIZATION

In response to the NT2, the largest and most complex development project involving significant resettlement with which GOL has had to deal, GOL has established a comprehensive

resettlement organizational structure that may be expected to function as well for the NNHP.

This comprises a Resettlement Committee (RC), a Resettlement Management Unit (RMU), District Resettlement Working Groups (DRWG), and Village Resettlement Committees (VRC). Collectively, these organizations will be given the responsibility for implementing the NNHP's RAP. Other Implementing Organizations will include the Provincial Authorities, the Lao Women's Union (LWU), Village Organizations, the Ownership Company, and Consultants, Contractors and NGOs.

During the resettlement implementation, the RMU and district working groups will play important roles. In order to strengthen their institutional capacity, a training program will be needed for their resettlement staff to have a clear understanding of resettlement policy objectives, the detailed resettlement program, and resettlement entitlements. In addition, workshops and on-the-job training will introduce a wide range of new skills for implementing livelihood and community development programs.

PARTICIPATION AND CONSULTATION

To obtain WB or other international donor funding requires that high social, environmental and economic standards be met in Project design and implementation. One such requirement is that the Project development process should involve the stakeholders – those people and institutions who have an interest in the Project, who will be directly or indirectly affected by it – and that their involvement should be integrated into the decision-making for the Project.

At the RAP preparation phase, the Study Team has carried out environmental and social studies prior to a decision on the project design, so that these factors are incorporated at the earliest possible stage into the project design itself. As part of the feasibility process for the Project, public consultations in the Project Area will be conducted separately during the Scoping, carrying out of EIA and SIA Studies, and Finalization of the EIA and SIA Reports. The Study Team will engage an NGO or subcontract to a local consultant to design and facilitate the implementation of the Public Consultation Process.

To ensure the basic rights and interests of resettlers are protected, concerns are adequately addressed and entitlements delivered, a Grievance and Appeals Procedure will be designed for the Project during preparation of the RAP. At present, an established procedure has been developed by the NT2 and will be the starting point for the NNPP, as described in detail in the main text of the PRP.

Monitoring will be carried out to ensure that the resettlement implementation is successful and that the villagers materially improve their livelihood after resettlement. Monitoring will be both internal and external. Internal monitoring will focus on the physical progress of resettlement implementation against the schedule in the approved RAP. Independent external monitoring will be on the change of livelihood and standard of living among the relocated people.

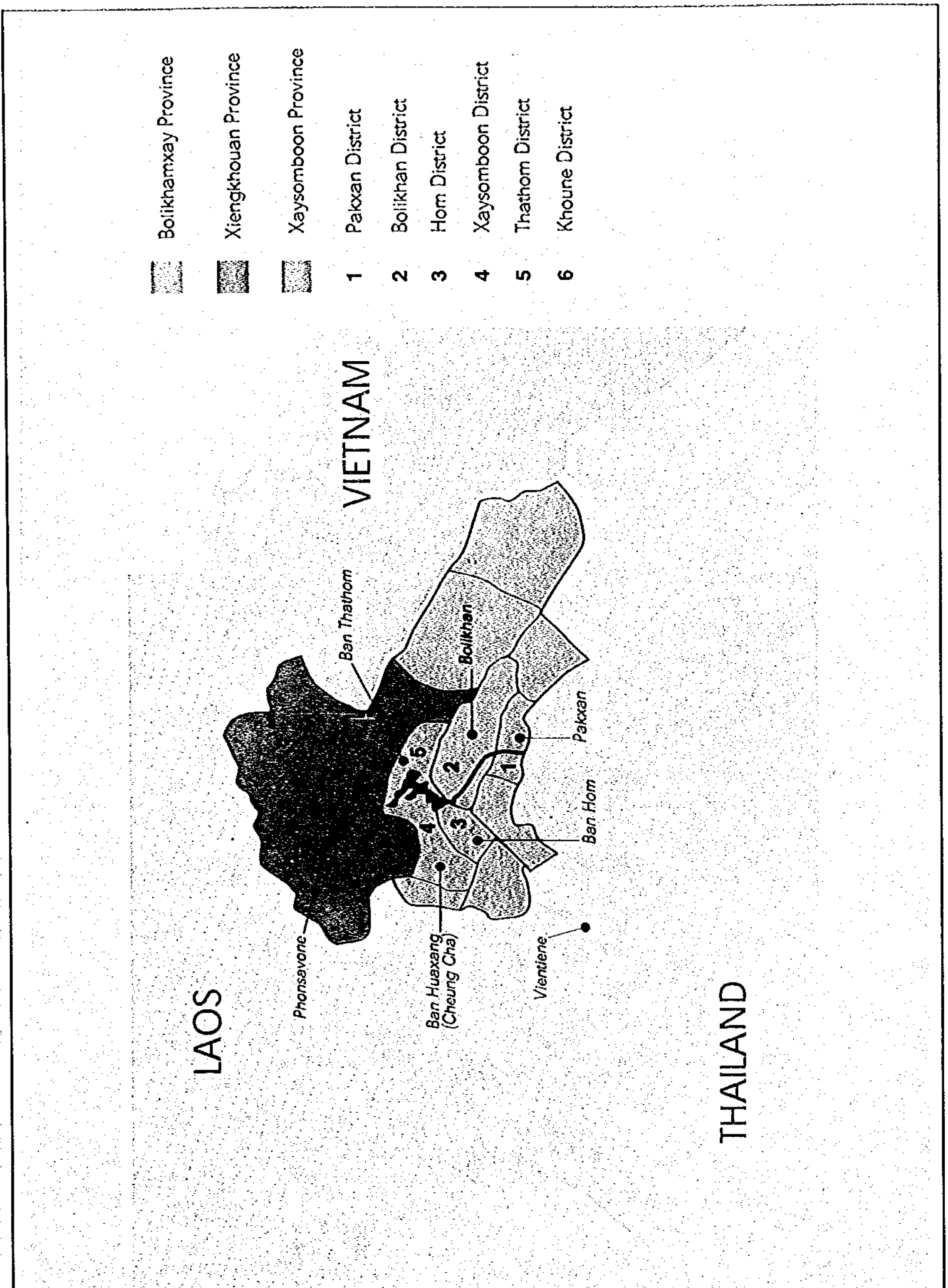
BUDGET AND INUNDATION COSTS

Actual costs will be determined in the RAP preparation phase, based on a more comprehensive inventory of inundated assets. The current estimate is for FSL.320m dam RAP to cost just over US$5 million and FSL.360m dam RAP to cost in the vicinity of US$ 18 million including 15% of contingency. This compares well with international standards for resettlement budgeting, at

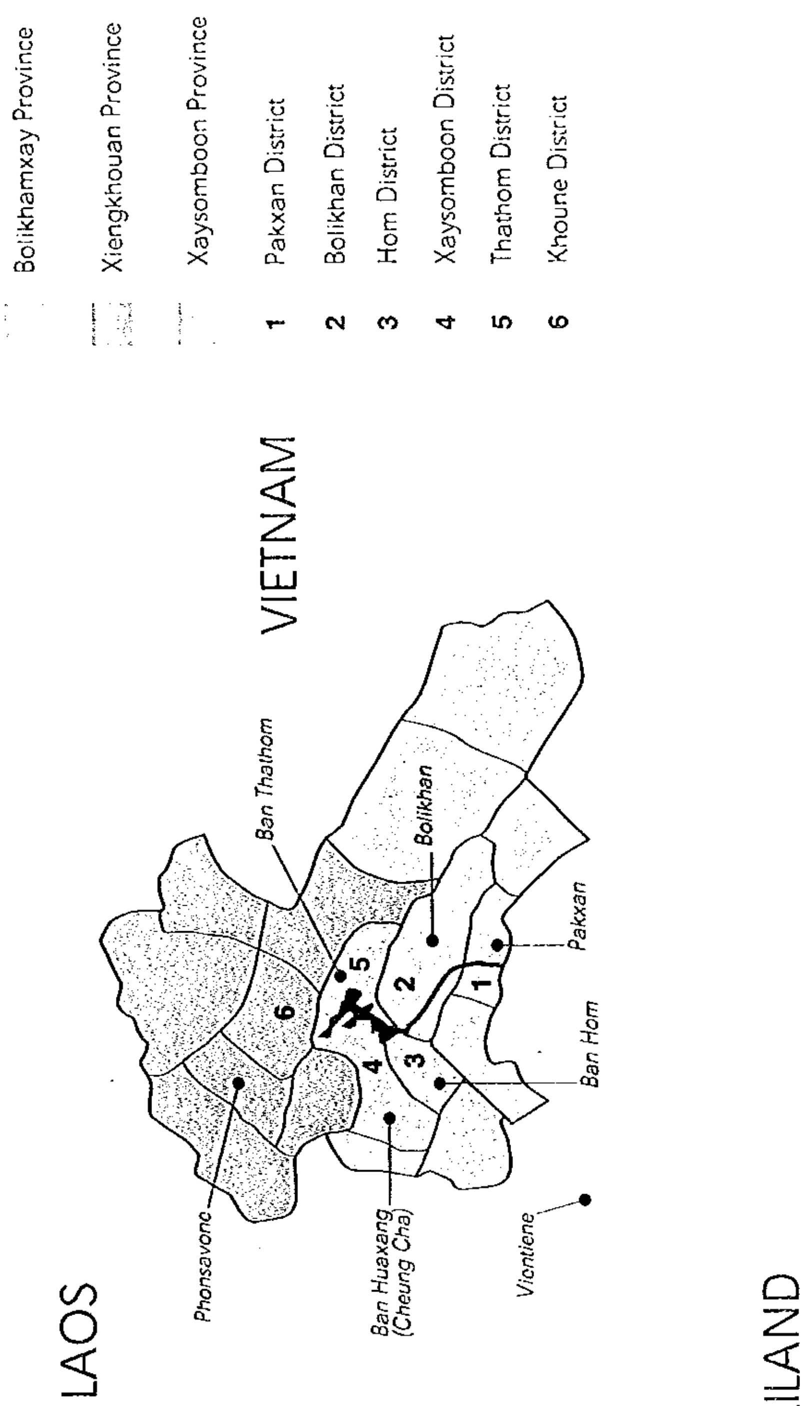
about $3,600 per person, or about ten times the per capita GDP of about US$350. Including 30% added for population growth over ten years, these estimated total RAP figures will be around US$7 and US$23 million respectively.

ENVIRONMENTAL IMPACTS AND RESTORATION

In addition to a Population Carrying Capacity Survey of the identified Resettlement Sites, the Project will carry out EIA studies of the sites. The EIA will identify the beneficial and adverse impacts arising from the Project's resettlement activities, in terms of both the natural and human environment, and will propose mitigative measures to minimize adverse impacts while maximizing the beneficial impacts. An important aspect of the EIA in northern Laos will also be a reconnaissance survey of UXO and defoliants contamination at the Resettlement *Sites*.



FEASIBILITY STUDY ON THE NAM NGIEP-1 HYDROELECTRIC POWER PROJECT IN THE LAO PEOPLE'S DEMOCRATIC REPUBLIC	First Environmental Impact Assessment	Figure 4.1
JAPAN INTERNATIONAL COOPERATION AGENCY	Boundary Orientation Map	



FEASIBILITY STUDY ON THE NAM NGIEP-1 HYDROELECTRIC POWER PROJECT IN THE LAO PEOPLE'S DEMOCRATIC REPUBLIC	First Environmental Impact Assessment	Figure 4.1
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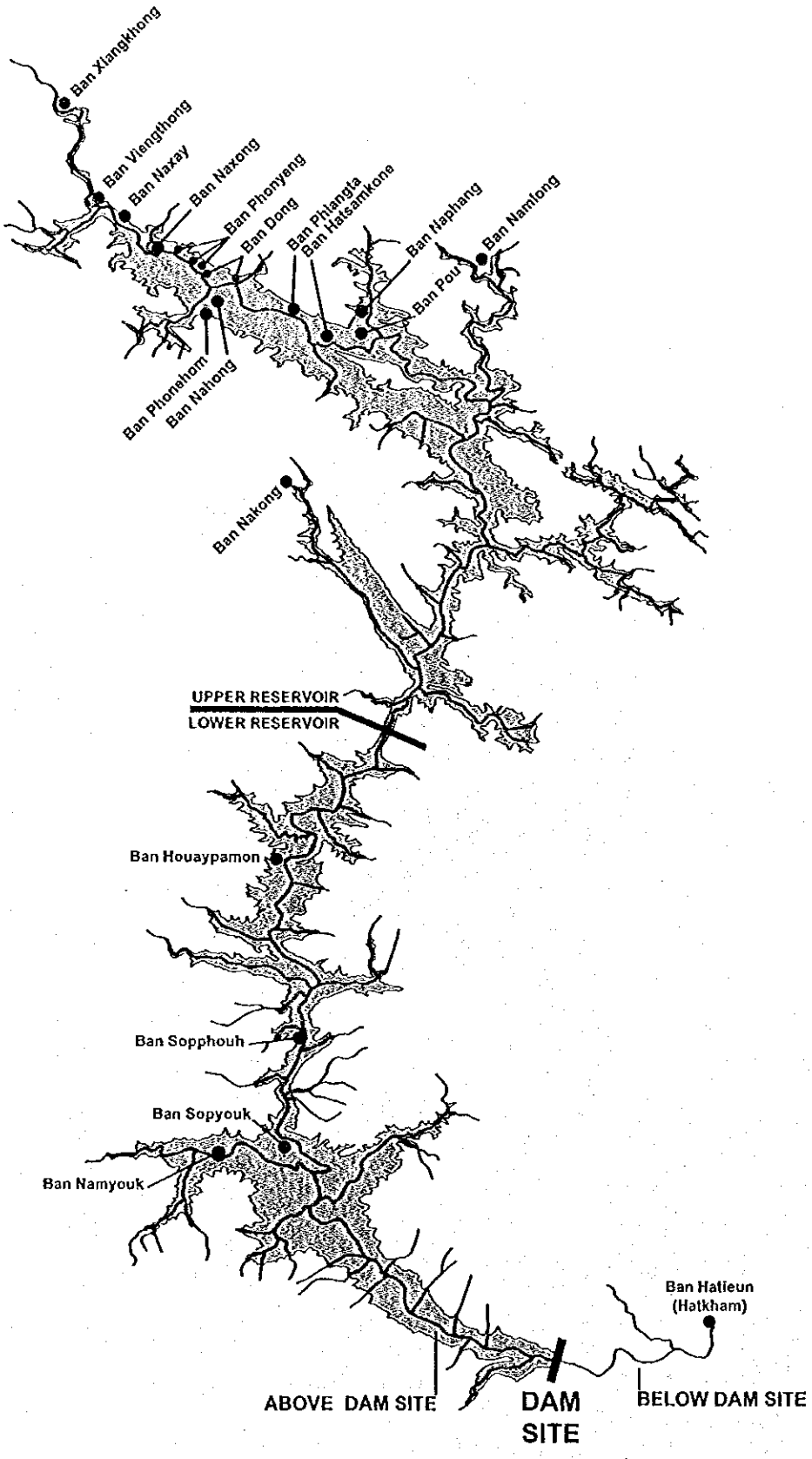
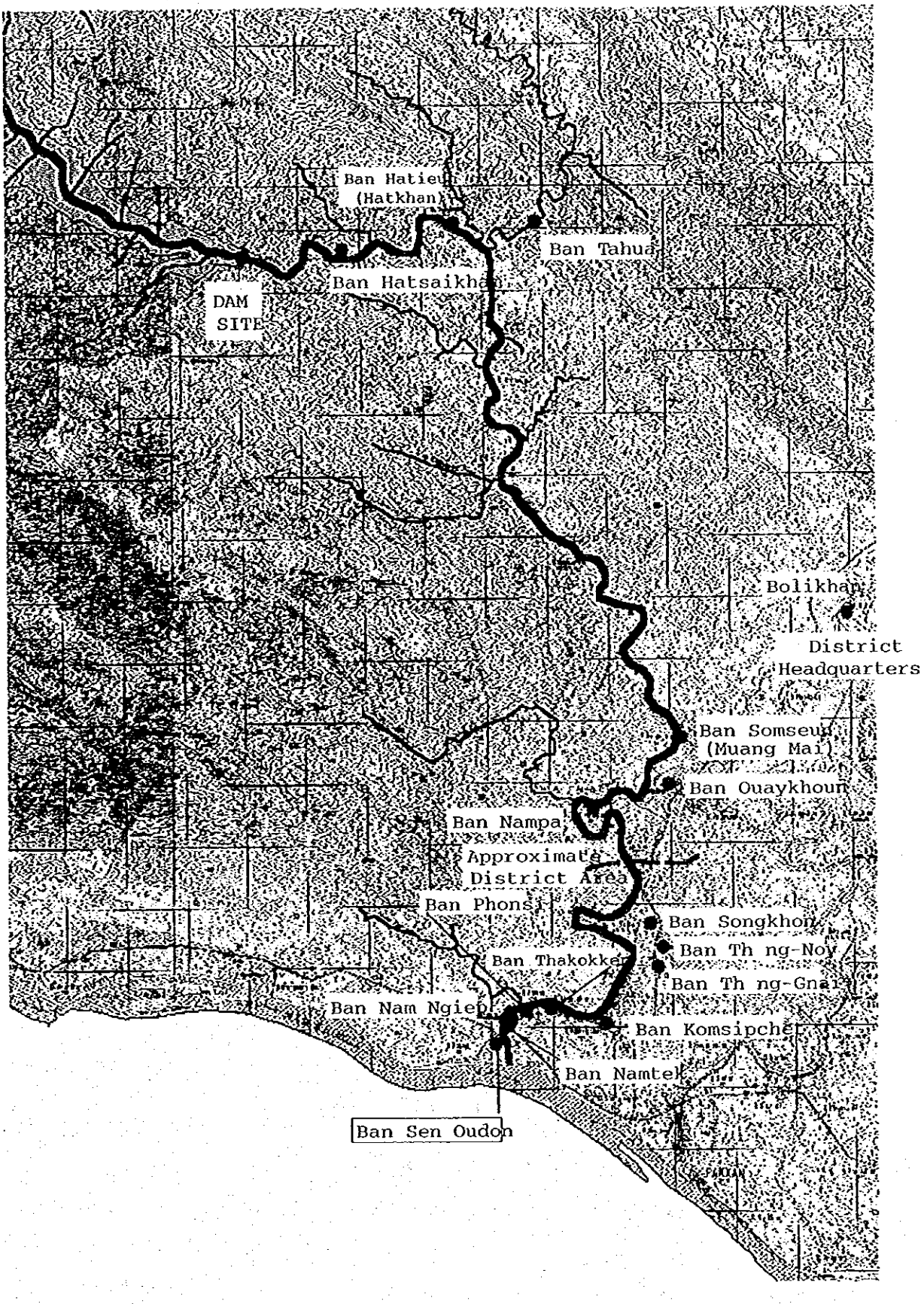
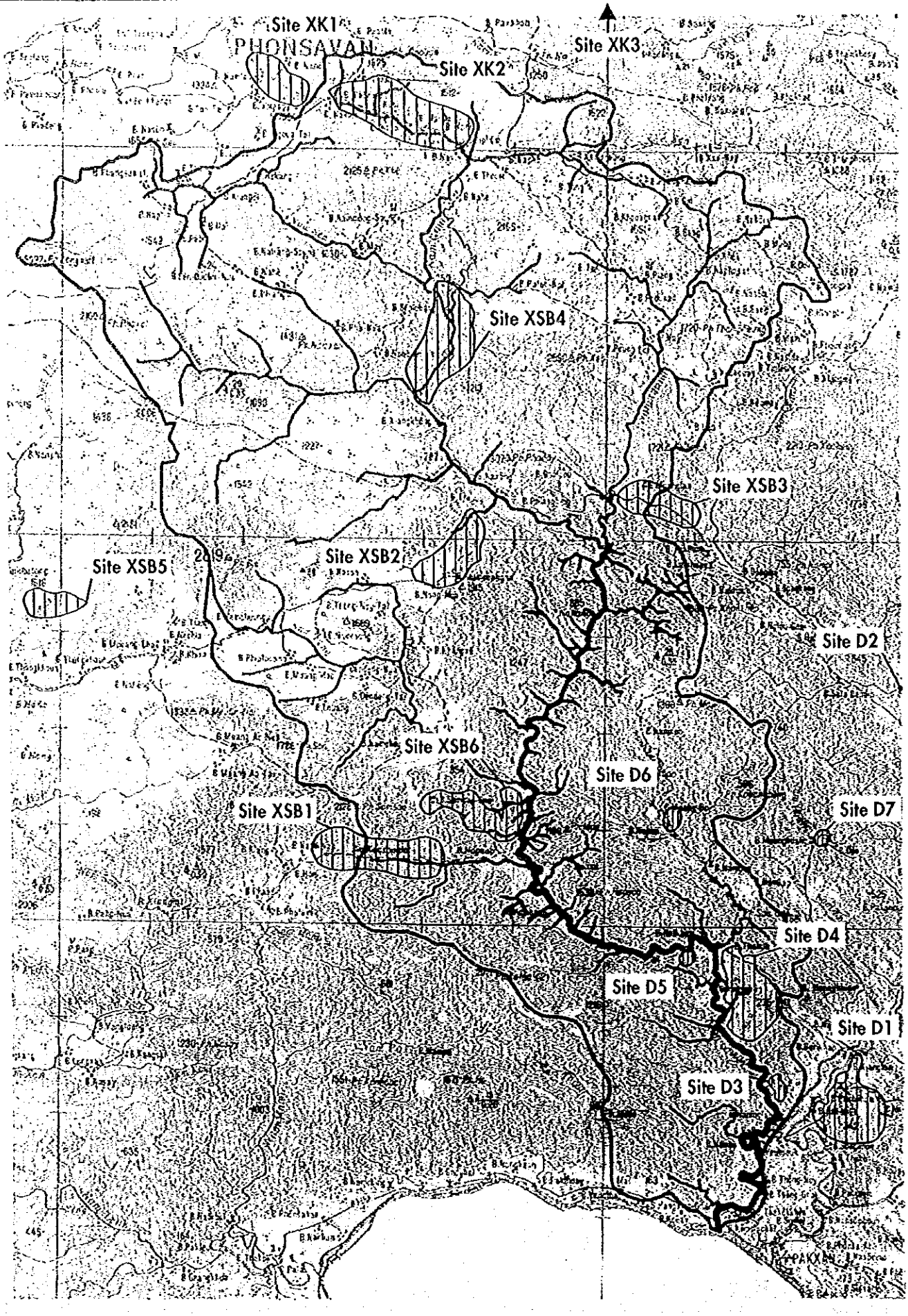


FEASIBILITY STUDY ON THE NAM NGIEP-1 HYDROELECTRIC POWER PROJECT IN THE LAO PEOPLE'S DEMOCRATIC REPUBLIC JAPAN INTERNATIONAL COOPERATION AGENCY	First Environmental Impact Assessment	Figure 4.2
	Reservoir Area Overview	



FEASIBILITY STUDY ON THE NAM NGIEP-1 HYDROELECTRIC POWER PROJECT IN THE LAO PEOPLE'S DEMOCRATIC REPUBLIC JAPAN INTERNATIONAL COOPERATION AGENCY	FIRST ENVIRONMENTAL IMPACT ASSESSMENT	Figure 4.3
	VILLAGES OF THE DOWNSTREAM AREA	



FEASIBILITY STUDY ON THE NAM NGIEP-1 HYDROELECTRIC POWER PROJECT IN THE LAO PEOPLE'S DEMOCRATIC REPUBLIC JAPAN INTERNATIONAL COOPERATION AGENCY	FIRST ENVIRONMENTAL ASSESSMENT	Figure 4.4
	POTENTIAL RESETTLEMENT SITES