

TAR:REG 30003

ASIAN DEVELOPMENT BANK

TECHNICAL ASSISTANCE

FOR THE

SE KONG-SE SAN AND NAM THEUN RIVER BASINS

HYDRO POWER DEVELOPMENT STUDY

July 1996

CURRENCY EQUIVALENTS
(as of May 1996)

Cambodia

Currency Unit	-	Riel (R)
R 1.00	=	\$0.0004
\$ 1.00	=	R 2,500

Lao PDR

Currency Unit	-	Kip (KN)
KN 1.00	=	\$0.001
\$ 1.00	=	KN 925

Viet Nam

Currency Unit	-	Dong (D)
D 1.00	=	\$0.00009
\$ 1.00	=	D 11,100

In this Report, rates of \$1.00 = R 2,500 = KN 925 = D 11,100 have been used.

ABBREVIATIONS

EPF	-	Electric Power Forum
GMS	-	Greater Mekong Subregion
Lao PDR	-	Lao People's Democratic Republic
MRC	-	Mekong River Commission
PRC	-	People's Republic of China
TA	-	Technical Assistance

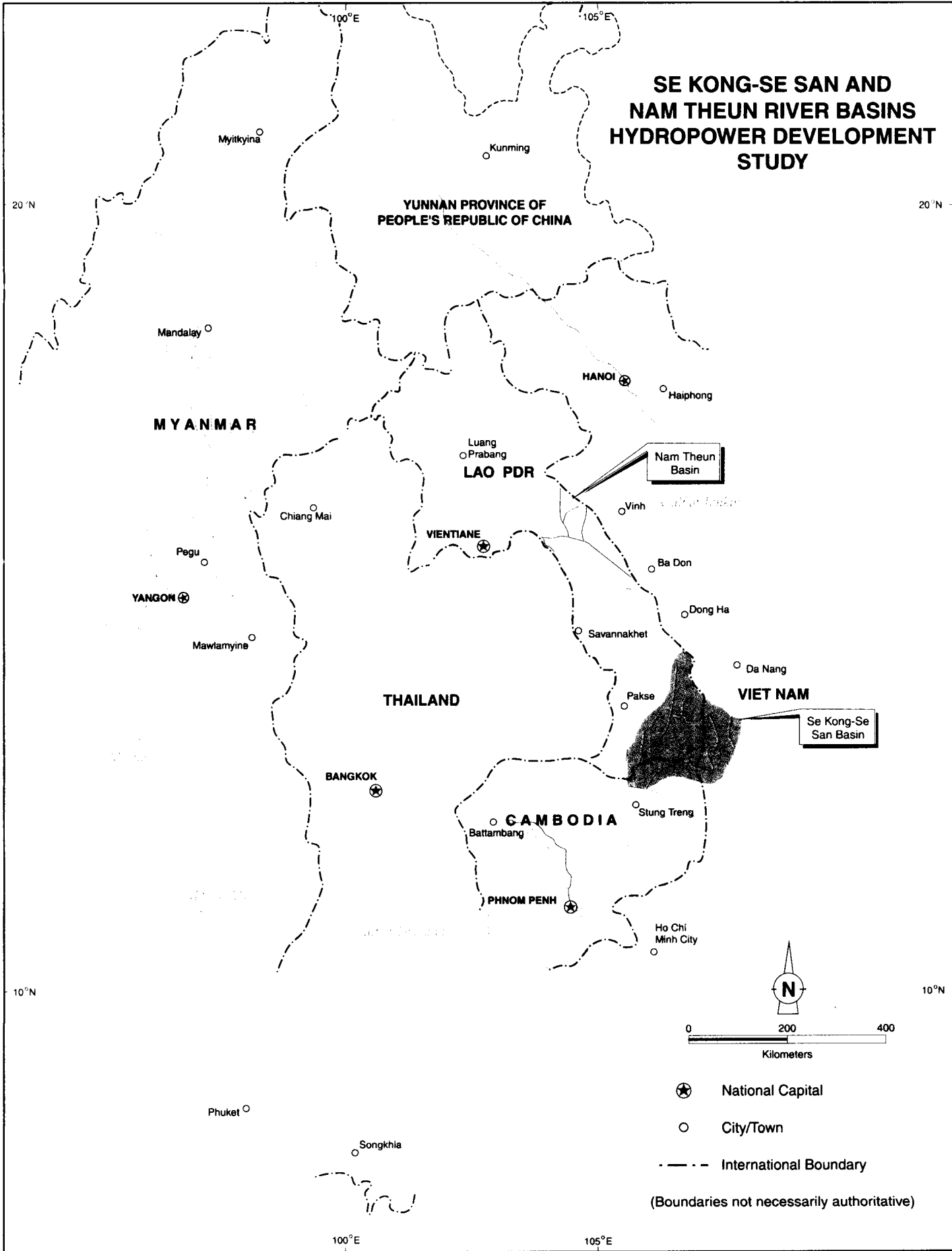
WEIGHTS AND MEASURES

Wh	(watt hour)	-	unit of energy
GWh	(gigawatt-hour)	-	1,000,000,000 Wh

NOTES

In this Report, "\$" refers to US dollars.

SE KONG-SE SAN AND NAM THEUN RIVER BASINS HYDROPOWER DEVELOPMENT STUDY



I. INTRODUCTION

1. Since 1992, the Bank has been actively promoting economic cooperation in the Greater Mekong Subregion (GMS), which consists of Cambodia, the People's Republic of China (the PRC), Lao People's Democratic Republic (Lao PDR), Myanmar, Thailand, and Viet Nam. The key activities included technical assistance programs to conduct sector studies to identify subregional programs and projects, high-level conferences and workshops to reinforce the subregional consultative process, and international forums to promote interest among international aid agencies and private investors.¹

2. In the energy sector, a Subregional Energy Sector Study was completed in November 1994.² At the Ministerial Conference on Subregional Economic Cooperation, held in Yangon, Myanmar on 24-25 April 1995, the Electric Power Forum (EPF) was established to be an advisory body to the ministerial conference and also to provide an institutional framework for power sector coordination. The core group of the EPF consists of two persons nominated by each government, a senior official from the government organization responsible for policy and planning in the power sector and the other, a senior official of a key power utility. One of the main objectives of the EPF is to coordinate and provide guidance in carrying out priority power sector projects identified in the Energy Sector Study.

3. During the first meeting of the EPF, three river basin studies were selected as priority projects and were endorsed for further study. Two of these relate to Se Kong-Se San and Nam Theun basins. At the second meeting, held in Vientiane, Lao PDR on 12-13 December 1995, the EPF reviewed the scope of work for the study prepared by the Bank and requested a regional technical assistance (TA) from the Bank to fund the study.³

II. BACKGROUND AND RATIONALE

4. The aggregate demand for electricity in the GMS is estimated to increase from 108,850 gigawatt-hours (GWh) in 1995 to about 600,000 GWh in 2020. However, the geographical distribution of this demand is uneven as shown in Table 1, with Thailand representing the largest share at 69 per cent and Lao PDR the smallest at 0.3 per cent. This geographical distribution is expected to remain substantially the same during 1995-2020.

5. Although the exploitable hydropower potential of the subregion as a whole, estimated at 1,090,000 GWh, is more than adequate to meet the estimated demand in the subregion by the year 2020, this potential does not match the demand on a geographical basis. The countries endowed with substantial hydropower resources are not large consumers of electricity, while the large consumers do not have adequate resources except Yunnan Province, in the PRC. As shown in Table 1, for example, Thailand has only 49,000 GWh of hydropower potential to meet a demand of 411,250 GWh in the year 2020, while Lao PDR has a potential of 102,000 GWh to meet a demand of 1,800 GWh in 2020.

¹ TA No. 5535-REG: *Promoting Subregional Cooperation Among Cambodia, the Lao People's Democratic Republic, Myanmar, Thailand, Viet Nam, and Yunnan Province of the People's Republic of China*, for \$4,000,000, approved on 10 June 1993.

² Asian Development Bank: *Subregional Energy Sector Study for the Greater Mekong Subregion*.

³ The proposed TA was first listed in *ADB Business Opportunities* in December 1995.

Table 1: Geographical Distribution of Electricity Demand and Exploitable Hydropower Potential

Country	Demand in Year 2020 (GWh)	Hydropower Potential (in GWh per year)
Cambodia	4,480	41,000
Yunnan Province, PRC	72,330	450,000
Lao PDR	1,800	102,000
Myanmar	14,450	366,000
Thailand	411,250	49,000
Viet Nam	92,980	82,000
Total	597,290	1,090,000

Source: Subregional Energy Sector Study

6. Some of the geographical imbalance in demand and supply has been addressed through bilateral arrangements in which one country develops its hydro resources to export power to another country in the region. Typical examples are Nam Ngum, Xeset, and Theun Hinboun power projects in Lao PDR that are already exporting power to Thailand or will be once the ongoing construction work is completed. In the absence of an institutional framework such as the EPF to promote regional cooperation in the power sector, most projects have been studied in isolation or on a national basis. Any economic benefits that would accrue from optimizing their design and operating parameters on a region-wide basis are thus being lost. Recent economic and political developments within and outside the region have helped strengthen economic cooperation among GMS countries thereby creating an environment conducive to a regional approach in hydropower planning. The Bank's intervention in carrying out the proposed TA is therefore considered timely and appropriate.

7. Considering the vast hydropower potential of the subregion and the rapidly increasing demand for electricity, it is reasonable to assume that a substantial proportion of this potential will be exploited eventually, leading to development of entire river basins. Therefore, it is important to assess the total cumulative environmental and social impacts that could result from staged development of a river basin, early in the development stage, so that such cumulative impacts are clearly understood and development plans optimized from an environmental and social point of view. Such an approach will ensure that environmental and social impacts from one project now will not adversely affect a better project in the future. Assessment of cumulative impacts require study of an entire basin, often located in more than one country, thus requiring a regional approach in the study.

8. It has been recognized by the GMS countries that cross-border power transmission would be required to meet the future subregional demand in the most efficient manner, using the available resource potential. Establishing a least-cost hydropower development program, optimized from a regional perspective, is required if maximum benefits from cross-border power exchange are to be realized. It eventually will lead to the establishment of a regional power transmission grid that could (i) reduce the generation capacity requirements of individual countries to meet their peak-time power demand because of the time diversity of such demand and (ii) reduce the generation reserve capacity requirements of individual power systems by sharing the capacity of other systems, both of which would reduce capital investments needed for new power plants. It has been estimated

that about \$1.8 billion of capital investment costs can be avoided during the period 1995-2020 by reducing the regional peak load alone, through transmission interconnections.¹ A regional grid would also facilitate economic exchange of power and thereby reduce operating costs.

9. Most of the external assistance to the power sector in the region has been for individual countries. A number of studies has been carried out on hydropower development by bilateral donors such as Australia, Japan, Norway and Sweden as well as multilateral aid agencies including the Bank and the World Bank. However, these studies have been undertaken for individual projects or for basin development in an individual country. The first initiative towards development of the power sector on a regional basis was taken by the Bank in 1994 through the Subregional Energy Sector Study. This was followed by setting up of the EPF under the guidance and financial assistance from the Bank.² The Government of Japan is presently assisting the Mekong River Commission (MRC) in carrying out a subregional power transmission study.

10. As a first step towards realizing the benefits from subregional cooperation in the power sector, hydropower development study of Se Kong-Se San and Nam Theun river basins encompassing Cambodia, Lao PDR, and Viet Nam was selected by the EPF, based on recommendations of the Energy Sector Study. The scope of the proposed study conforms to the Bank's strategy for the subregion of promoting economic cooperation among the GMS countries. The endorsement of the study at the ministerial conferences and at EPF meetings reflects the concerned governments' commitment to promote cooperation in the electric power sector. Such cooperation will improve sector efficiency and lead to further reforms needed to sustain the cooperation.

III. THE TECHNICAL ASSISTANCE

A. Objective

11. The long-term objective underlying the proposed TA is to facilitate economic cooperation among Cambodia, Lao PDR, Thailand, and Viet Nam by establishing cross-border trade in electricity to promote optimum utilization of the region's hydropower potential. The immediate objective is to prepare a regionally optimized, sustainable, and environmentally acceptable hydropower development plan for Se Kong-Se San, and Nam Theun river basins located in Cambodia, Lao PDR, and Viet Nam. The plan is intended to guide the decision makers in the GMS countries in developing their water resources. The proposed TA will also indirectly strengthen the skills of staff in the countries in hydropower planning and environmental and socioeconomic analysis, by associating them with the study.

B. Scope

12. The scope of the TA consists of carrying out a two-phase study of the Se Kong-Se San, and Nam Theun river basins to develop a least-cost hydropower expansion plan to meet the regional electricity demand. During the first phase, the findings of the previous and ongoing studies related to utilizing water resources of Se Kong-Se San and Nam Theun basins will be reviewed. At the same time, subregional electricity demand forecasts and generation and transmission expansion plans will also be reviewed and updated. Alternative hydropower development plans of the two river basins will then be developed to meet the subregional electricity demand to the extent possible. These alternative plans will take into account,

¹ *Subregional Energy Sector Study for the Greater Mekong Subregion.*

² The Bank is the co-chair of the EPF.

cumulative environmental and socioeconomic impacts of the projects as well as multipurpose use of the river basins.

13. The alternative development plans will be discussed at a meeting of representatives of the concerned countries to select the best option. The economic viability, environmental sustainability, social acceptance, national interests of concerned countries and availability of financial resources will be the key factors in selecting the option.

14. The preferred option will then be studied in detail. Engineering designs and cost estimates will be refined and technical and economic viability of individual projects and of the entire plan will be confirmed. Environmental and socioeconomic impacts will be studied in more detail and incorporated into the technical and economic analysis. The terms of reference for prefeasibility or feasibility studies of about six most promising hydropower projects will also be developed during the second phase.

15. During the course of the study, a number of workshops will be held to discuss key issues of the study and also to strengthen skills of counterpart staff of concerned countries, in hydropower planning and related aspects. Some of the workshops will be devoted to discussions with nongovernment organizations and vulnerable groups regarding issues such as project locations, resettlement alternatives, and consultative mechanisms.

C. Cost Estimates and Financing Plan

16. The total cost of the proposed TA is estimated at \$2.5 million. The details of the cost estimate are in Appendix 1. The Government of France will finance \$2.0 million of the cost of the TA under the Channel Financing Agreement between the Government of France and the Bank, while the Bank will finance the balance \$0.5 million, on a grant basis. The Bank's approval of the proposed TA will not commit it to finance any ensuing project.

D. Implementation Arrangements

17. The Executing Agency for the proposed TA will be the Bank, while MRC will be the Coordinating Agency for the TA. The following organizations will serve as Cooperating Agencies at national level in assisting the smooth implementation of the TA: (i) in Cambodia, the Department of Energy under the Ministry of Industry, Mines and Energy; (ii) in Lao PDR, the Department of Electricity under the Ministry of Industry and Handicrafts; and (iii) in Viet Nam, Electricity of Viet Nam under the Ministry of Industry.

18. MRC will assign a suitably qualified and experienced senior engineer, acceptable to the Bank, to act as the Project Coordinator, who will act as the counterpart to the consultants' team leader and will be responsible for coordination between the team leader, Cooperating Agencies and other relevant government agencies in the three countries and the Bank. In particular, MRC will assist the consultants, through the Project Coordinator, in establishing Project Offices and in obtaining required engineering and other data and maps from the participating government agencies, as well as providing relevant data available with MRC. It will also take care of travel arrangements for the consultants between the three countries involved, provide liaison and information services to the governments concerned. Provision has been made in the cost estimates to cover the incremental administrative costs to MRC in providing the services of the Project Coordinator as well as other administrative services.

19. The Cooperating Agency identified for each country will assign a Project Director experienced in hydro resources planning to act as the counterpart, assisted whenever necessary, by other Cooperating Agency staff. The Project Director will ensure that all available project related information including topographical and aerial maps, existing study reports and other relevant data are provided to the consultant in a timely manner. The Project Director will also liaize with other government agencies to obtain any additional information necessary and assist in obtaining custom clearances, work permits for field work and other government formalities.

20. A Steering Committee will be established, consisting of representatives from MRC and the Bank and the two EPF members from each country. The Committee, to be chaired by the Bank, will be responsible for providing overall direction and guidance in the conduct of the study. It will hold meetings at least three times during the study period or more often as necessary. The MRC will act as the Secretariat of the Steering Committee and will arrange Committee meetings, including distribution of papers and reports to the members.

21. The proposed TA will require about 70.5 person-months of international consulting services and 15 person-months of domestic consulting services. It will be implemented over a period of 20 months starting October 1996. A team of experts from a firm, with expertise in hydrology, hydropower engineering, watershed management, power systems engineering and economics, regional development planning, social and environmental aspects of hydropower development will be required for the international consulting services. The consultant will be selected in accordance with the Bank's *Guidelines on the Use of Consultants*. The broad terms of reference for the consulting services are in Appendix 2. Domestic consultants to carry out socioeconomic surveys and to liaize with local affected groups will be recruited by the international consultant, subject to the Bank's approval during the course of the study. The consultant will base the main project team in Savannakhet, Lao PDR and will maintain suboffices in Cambodia and Viet Nam as and when necessary. An inception report will be prepared within 3 months of commencement of the study and an interim report within 12 months. Initial environmental examination as a subreport to the interim report will also be prepared at the same time. The draft final report is expected within 18 months of commencement of the study. The equipment to be provided under the TA will be procured by the consultant in accordance with procedures of the Bank's *Guidelines on Procurement*.

IV. THE PRESIDENT'S RECOMMENDATION AND DECISION

22. The President recommends that the Board approve the Bank administering a portion of technical assistance for the purpose of the Se Kong-Se San and Nam Theun River Basins Hydropower Development Study, to be financed by the Government of France on a grant basis in an amount not exceeding the equivalent of \$2,000,000.

23. If the Board approves the Bank administering the portion of the technical assistance to be financed by the Government of France, the President, acting under the authority delegated by the Board, shall approve the provision of the balance of the technical assistance to be financed by the Bank on a grant basis in an amount not exceeding the equivalent of \$500,000, and hereby reports such action to the Board.

COST ESTIMATE

Item	Amount (\$'000)
1. Consultants	
a. Remuneration	
i. International Consultants	1,339.5
ii. Domestic Consultants	60.0
b. Per Diem	
i. International Consultants	136.2
ii. Domestic Consultants	31.5
c. Travel	
i. International	250.0
ii. Regional/Domestic	25.0
2. Equipment	
a. Computer Hardware, Software and Office Equipment	30.0
b. River Gauging Equipment	30.0
3. Communications	10.0
4. Studies, Surveys, Reports	
a. Aerial Mapping	100.0
b. Topographical and other surveys	100.0
c. Reports	20.0
d. Workshops/Meetings	60.0
e. Laboratory Services	10.0
5. Miscellaneous Services	
a. Vehicle Rental	25.0
b. Incremental Administrative Cost of MRC ¹	25.0
c. Other Incremental Administrative Costs	10.0
d. Contract Negotiations	8.0
6. Contingencies	229.8
TOTAL	2,500.0

— = magnitude zero
Source: Staff estimates

¹ Mekong River Commission

BROAD TERMS OF REFERENCE FOR CONSULTING SERVICES

1. The terms of reference will include, but not necessarily limited to, the following. The activities listed are not given in a particular sequence of events. The consultant will undertake the activities based on the workplan, staff deployment, and site conditions.

2. The consultant will take into consideration ongoing planning and construction activities carried out by others, including private investors and national and international agencies. The consultant will strive to maintain close coordination with other parties conducting hydropower and transmission studies in the same area to avoid any overlap and will make proposals on how to coordinate these activities.

A. Review of Previous Studies and Updating of Data

1. Collect, review and analyze all available data on existing and potential hydropower sites and other water related projects in the basins studied so far. The data will include, inter alia, hydrology, geodetic data and maps, geological and geotechnical data, environmental data, socioeconomic data, power market forecasts, as well as engineering studies of hydropower projects, transmission lines and other projects related to water resource development.
2. Identify and analyze gaps in the data and recommend actions to be taken to supplement them. The consultant will carry out field investigations such as preliminary geological inspection and topographical mapping to fill the gaps.
3. Prepare a preliminary analysis of the hydropower projects currently under consideration in Se Kong-Se San, Nam Theun, and other basins, in order to determine how they would fit into the overall optimum hydropower development plan for each river basin. Propose modifications, if any, to be introduced to make the projects compatible with the overall optimal plan.

B. Hydrology

1. Collect information on river discharges, sediment loads and other hydro-meteorological data related to hydropower development.
2. Propose and establish a hydrological and meteorological data collection network taking into account, existing facilities.
3. Install and calibrate the additional discharge and meteorological stations.
4. Undertake analysis of hydrological data including assessment of design floods, establish a record of flow and carry out hydrological studies necessary for energy production simulation.

5. Carry out a preliminary analysis of sediment transport and reservoir silting and suggest a program for further measurement.

C. Geology and Geotechnics

1. Collect and evaluate geological information and identify shortcomings. Based on field visits, maps and aerial photographs, complete the database required for the studies. The geotechnical investigations will be of a preliminary nature, adequate to identify preferred forms of development and allow the preparation of conceptual designs and cost estimates.
2. Carry out a geological field investigation to confirm, to the extent possible, the geological conditions at each site. The investigation will include, as necessary, test pits, auger borings and rock and soil sampling.
3. Prepare geological maps and reports for the various power projects based on aerial photographs, site inspection and field and laboratory investigations taking into account, work done by others, previously. Special attention will be given to the occurrence of karstic formations at the location of potential dam sites and reservoirs. The geological report for each of the sites will include assessment of stability of foundations and tunnels, assessment of permeability of reservoir areas, preliminary evaluation of seismic hazards and identifying and estimating availability of construction material.

D. Mapping

For areas not covered under previous and ongoing studies:

1. Carry out aerial photographs and prepare maps for selected areas such as reservoirs, dam sites, powerhouse sites and alignments of waterways of the most promising projects. The area to be mapped is estimated at 400-600 km².
2. Carry out topographic mapping and profiling of selected areas such as dam sites, power house sites, penstock alignments, which are not covered by maps prepared from aerial photographs. The data so collected will be used to prepare maps suitable for the study. Verify the water head to be developed by ground survey and/or by global positioning system (GPS) as may be necessary for preparation of conceptual designs.

E. Engineering Water Resource Planning, Design and Cost Estimating

1. Establish criteria to be used for identifying potential hydropower sites, assessing alternative project arrangements and ranking between individual sites and combinations of site developments. The criteria will include, inter alia, economic viability, environmental sustainability, social acceptance, national interests of the

concerned countries and availability of financial resources. Environmental and social impacts will be valued and incorporated in the economic analysis.

2. Based on the choice of the most suitable sites, the consultant will prepare basic site layouts and cost estimates of the various individual projects. On this basis the consultant will evaluate and compare the cost of developing combinations of projects in the basin. Hydropower development plans for basin-wide systems shall be formulated and a comparison and ranking of the various projects and plans will be carried out. The consultant will include in the analysis, all site related construction costs, costs of access roads and any costs associated with problems resulting from the site's geological conditions etc. The analysis will also include associated transmission system extension costs for interconnection with the transmission systems of Cambodia, Lao PDR, Thailand and Vietnam. Resettlement issues will be identified and fully costed into the analysis as will any adverse ecological aspects and related mitigation costs.
3. Carry out simulations to identify the optimum development plan for the whole basin. The consultant will consider and advise on the influence of specific site developments on the potential of other sites. Operation of reservoir systems will be simulated to identify the optimum characteristics of each project and the preferred sequence of construction.
4. Identify the least-cost feasible combination of projects to meet regional power and energy requirements with a 25-year horizon and suggest a development priority among the sites from an economic, environmental and social point of view, taking into account opportunities for integrated development of adjacent river systems and power exchange within integrated national systems as well as with neighboring countries.
5. Based on the review of the interim report, the consultant will refine the engineering study of each individual project and of the selected plan. Layouts for all main project components such as dams, waterways and powerhouse will be indicated. A reservoir operation study for the recommended plan will be carried out and installed capacity, number and size of units, etc. for each project will be determined.
6. Identify areas of interaction between hydropower and other water resources-related plans, propose solutions to conflicts and integrate them into the plan.
7. Identify and comment on implication that diversion schemes may have on the Se Kong-Se San and Nam Theun basins and the adjacent river basins. Cost of mitigating measures related to the impact on adjacent river basins will also be taken into account in the evaluation.
8. Identify and comment on the impact that the implementation of the Se Kong-Se San and Nam Theun hydropower development plan will have on the Mekong River.

F. Multipurpose Benefits

Identify any multipurpose benefits that may be derived from each project, such as irrigation, fishery, water supply, etc. and propose how these activities may be incorporated in subsequent project planning.

G. Environment

1. Identify characteristics of the natural environment, social and cultural linkages and sensitivities and assess the regional environmental implications of hydropower development of the river valleys selected.
2. Assess the cumulative environmental and social impacts that may result from the proposed hydropower development plan and to the extent possible, quantify the environmental and social costs and benefits of alternative development plans and for each individual project. This assessment will include possible deforestation, impact on up-and-down-stream ecology and socioeconomic impacts on the people concerned, particularly the rural poor. The principal positive and negative impacts, mitigation options and recommendations for site selection that minimize environmental problems will also be included.
3. Carry out an environmental screening process of proposed projects based on the concept of integrated regional economic-cum-environmental development planning.¹
4. Address the resettlement issue for each individual project as well as accumulated effects of the plan at the reconnaissance level. Carry out an evaluation of land use in the proposed reservoir areas, identify resettlement sites, assess the feasibility of relocating residents to those sites and examine the resettlement impacts on population currently established in the proposed resettlement areas.
5. Delineate options available for giving the indigenous population a share in the projects, such as a development fund derived from profits, or other measures.
6. Prepare a sustainable plan for watershed management taking into account work currently undertaken for Nam Theun and Nam Hinboun.
7. Review the relevant environmental policies and regulations of the concerned countries with a view to ensure policy cohesion and harmonization. Also review

¹ The Bank's Guidelines for *Integrated Regional Economic-cum-Environmental Development Planning: A Review of Regional Environmental Development Planning Studies in Asia*, Vols. I and II shall be followed.

the existing institutional capability of the countries to address the environmental concerns related to regional hydropower development.¹

H. Power Market

1. Update data on the power market by reviewing information about electricity forecasts, load variations, generation expansion plans, and transmission system development plans in Cambodia, Lao PDR, Thailand and Vietnam.
2. Each of the projects will be studied about its ability to cover peak load, shoulder load and base load at competitive costs compared with other generation options for Thailand and Viet Nam.

I. Transmission System Studies

1. Review the regional transmission interconnection studies currently undertaken by various national and international agencies for the Mekong basin. Integrate the results of these studies with interconnection requirements for the individual power projects and determine interconnection options.
2. Select the most likely routes from the projects to a central grid (to be identified under ongoing studies) and estimate the cost of the transmission system extensions. The criteria for route selection will include environmental considerations.

J. Economic and Financial Analysis

1. Carry out economic and financial evaluation of each alternative development plan and of each individual project as per the Bank's *Guidelines for Economic Analysis of Projects*. Such an evaluation will examine not only the viability of individual development plan, but will also address all important sector level issues including macroeconomic affordability.
2. Address the investment requirements, including costs associated with possible sources of financing and modality of implementing the plan.
3. Assess and comment on the absorptive capacity of the countries in the subregion and their ability to mobilize domestic resources for the implementation of larger schemes and the proposed development plan.

¹ The consultant shall liaise closely with the two teams of experts implementing TA No. 5622: *Subregional Environmental Monitoring and Information System* and TA No. 5684: *Subregional Environmental Training and Institutional Strengthening* so as to avoid duplication of work and to share information.

K. Further Studies

1. In the context of the power demand forecast and based on technical and economic criteria, identify at least six projects suitable for early implementation within the basins. Prepare terms of reference for prefeasibility and/or feasibility studies of these projects.
2. Prepare a program of further studies, investigations and measures necessary to implement the hydropower development plan and to preserve the hydropower potential of the basins.

L. Workshops

Organize workshops/meetings as and when necessary to present and discuss the inception report, interim report and draft final report and also to discuss major issues identified. Also organize workshops/meetings with concerned nongovernment organizations and vulnerable groups to discuss issues affecting them such as environmental impacts, resettlement alternatives and distribution of project benefits with a view to obtain their cooperation and enhance the consultative process.