3. Scope of Work の協議経過

Scope of Work(S/W)は，事前に日本国内の関係各省会議において了承されたDraft S/W に基づき，7月2日及び3日の事務レベル協議（RID, Chief of Policy Branch（PPD) Mr. Suthi 他）並びに7月4日の会議（RID, Chief Civil Engineer Mr. Chari, Director of Project Planning Division Dr. Boonyok 及び Chief of Policy Branch Mr. Suthi）において協議され，7月6日に事前調査団長　中道宏とRID, Chief Civil Engineer Mr. Chariとの間で，Minutes of Meetings とともに署名された。

フィージビリティ・スタディ（F/S）の実施方針については，全面的に調査団の案が了承されたが，主な協議内容と修正部分は次のとおりである。

（Outline of the Study）

(1) タイ側より F/S をPart-Cと名づけたいとの提案があり，プレ・フィージビリティ・スタディとの関係から，これを了承した（S/WのP.3，以下同じ）。

(2) Work Plan(Part-A）において，水資源評価の対象を具体的にしたいとの提案があり，"Water resources"を "Water resources(surface water and groundwater)"と修正し，また "and other water uses"を追加した（P.3)。

(3) Part-Aについてのみ記載されている環境調査については，この段階における十分な調査を実施してもらいたいとの提案があり，"to reffer the environmental consideration" を "to study the environmental impact" に修正し，"if necessary" を削除した（P.3)。

(4) Part-Bの調査項目のうち，地下水についてのデータ収集を追加したいとの提案があり，地域の水資源有効利用を考慮して，(1)-dに "and Hydrogeology" を追加した(P.4)。

(5) Part-Cの内容のうち，(9) Recommendation に，F/S 以後必要となる設計段階における作業内容についての勧告を明記するよう提案があり，調査団は左記のことは当然Recommendation に含まれるものと説明したが，本件実施に対するタイ側の積極的な姿勢と理解し，タイ側発言として会議議事録に記載した（P.6）。

（Reports）

(1) レポートの提出部数については，インテリム・レポートとドラフト・ファイナル・レポートは関係各機関に説明，協議する必要があるとの提案を受けて増部（30→50）し，プログレス・レポートは必要最小限の部数（30→20）とした（P.7）。

(2) ファイナル・レポートの一部として，マイクロ・フィルムを1セット作成するよう提案があり，報告書の有効活用に資することから，タイ側発言として会議議事録に記載した（P.7)。

(Undertaking of the Government of the Kingdom of Thailand)

(1) ＲＩＤが便宜供与する内容として，ＲＩＤの権限外のものが多数含まれているとの指摘があったが，内容的には両国がとりかわしている技術協力協定にのっとっているものであることを説明し，タイ側の了解を得た。ただし，今後Ｓ／Ｗには技術協力協定の内容は再掲しない方向で検討することが望ましいとの調査団見解を，外務省，大使館，ＪＩＣＡに報告した(P.8)。

(2) ＲＩＤが実施する調査として，resettlement の検討を円滑にするため，地形図を作成したいとの提案があり，これを追加した(P.8)。

(3) カウンターパートのメンバーについて，地下水担当を追加するとともに，Expert の表現は相当高度な専門家であり人選が難しいとの提案があり，Specialist に変更した(P.8)。

(4) 現地事務所の場所について，ナコンサワンよりも適当な所がみつかる可能性があるとの提案があり，〝Nakhon Sawan〟を〝Project site〟に修正した(P.10)。

(Tentative Working Schedule)

(1) 調査の項目として，タイ国内では現地調査のみではなく，室内作業もするということから，〝Field Work〟を〝Field and Office work in TH.〟に，〝Home Office Work〟を〝Office Work in Japan〟に修正するよう提案があり，これを了承した(P.11)。

4. Request for Technical Assistance Project

Project Title : Feasibility Study for the Sakae Krang River Basin Irrigation Project

Executing Agency : Royal Irrigation Department (RID)
Ministry of Agriculture and Cooperatives

Proposed Source of Assistance : Government of Japan

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1. Background Information

Project History

The water resources development in the Sakae Krang basin has been strongly requested by the rural people in the basin, throughout the period of the Third and Fourth National Development Plan, in order to improve the agricultural structures and to maintain the social security in and around the river basin. To substantially initiate the basin development, the RID commenced the surveys and studies on irrigation and agricultural developments in the Thap Salao sub-basins in 1971. Immediately after the completion of the surveys and studies, the Thap Salao Irrigation Project with a net area of 88,000 rai (14,080 ha) was implemented and completed in 1980. The riverflow in the Thap Salao, however, is not so dependable as to irrigate the project area of 88,000 rai and moreover reckless land reclamation from wide forest has been ruining the function of the runoff yield. Exploitation of supplemental water resources was essential for the Thap Salao Irrigation Project.

In recent years, the RID has envisaged construction of storage dams to eliminate the constraints of shortage of irrigation water all over the Sakae Krang river basin. Four dam sites have been reconnoitered by the RID in the upper reach of the four tributaries of the Sakae Krang river. Among them, the Thap Salao storage dam has been given high priority of implementation since the storage dam would supplement irrigation water for the existing Thap Salao Irrigation Project. Implementation of the Thap Salao dam construction has been recently launched by the RID, in response to the strong request of the beneficiary farmers.

Following the substantial implementation of the study of the Thap Salao Dam Project, the exploitation of water resources in the Mae Wong, Khok Khwai and Khlong Pho sub-basins has been given high priority in view of their endowed water resources, topographic and geological conditions much favourable for dam construction, and serious shortage of irrigation water in their lower basins.

Accordingly, evaluation of the agricultural land and water resources, appropriate means of the conservation of natural resources and study on the direction for the Sakae Krang overall river basin development are urgently required.

Study Area and the Project

The Sakae Krang river basin lies in the north-western part of the Central Plain, the Sakae Krang river flows south easterly to its confluence with the Chao Phya river, about 50 kilometres south of Nakhon Sawan. The Sakae Krang river basin with a gross area of 7,000 Km^2 can be divided into four sub-basins; the Mae Wong, the Klong Pho, Thap Salao and Khok Khwai. The project area of

the Thap Salao sub-basin covers about 110,000 rai (17,600 ha) of net irrigable land extended along the both sides of Thap Salao river. The Royal Irrigation Department plans to construct a dam at about 35 km upstream from the existing headwork on the Thap Salao river in order to provide stable irrigation water to the existing Thap Salao irrigation system with 88,000 rai (14,080 ha) and also to newly develop about 22,000 rai of irrigation system.

The Mae Wong Irrigation Project area is located in northern part of the Sakae Krang river basin and almost founded by the Mae Wong and Khlong Pho rivers. The area is almost covered with paddy fields of about 600,000 rai. Most of these paddy field still remain rainfed; only 25,000 rai out of them are irrigated by three existing irrigation system. The area has been habitually subject to the serious shortage of irrigation water and flood damages. To exploit irrigation water and mitigate floodings, the RID contemplate construction of a storage dam in the upper reach of the Mae Wong river, major tributary of the Sakae Krang river.

Apart from Mae Wong and Thap Salao river, there remains two major tributaries, Khlong Pho and Khok Khwai river, which area frequently facing with the flood and drought phenomenon. In order to cope the problems, RID proposed the construction of storage dams in the upper reach and diversion dams in the downstream where gravitationel irrigation could be implemented. The study area should cover the potential agricultural land of the Sakae Krang basin which is approximately 800,000 rai.

2. Details of the Project

2.1 Project Objectives

1) To review the overall Sakae Krang riverbasin water resources development plan.

2) To identify the possible projects, setting their priorities and recommend the Stage of development.

3) To conduct the pre-feasibility study on the potential project.

4) To conduct the feasibility study on the first priority project(s).

2.2 Program Goal

1) To prepare a pre-feasibility report of Sakae Krang riverbasin water resources development plan.

2) To prepare a feasibility report to support its request for overseas financial assistance for the project implementation.

2.3 Duration of the Project

18 months

2.4 Project Site

Study area of the Sakae Krang river basin is located at the north west of the Chao Phya Plain. The basin covers about 7,000 Km^2 and is lying administratively on the Uthaithani, Nakornsawan, Chainat, and Kamphaengphet Provinces.

3. Work Plan

The general scope of work for the study would cover:

Part A

To conduct the overall river basin development study on the Sakae Krang river basin of about 7,000 Km^2. The study will include the following items;

1) Review and evaluation of all existing and proposed irrigation project in the basin.

2) Evaluate the agricultural land and water resources and identify the possible reservoirs and examine the ground water potential.

3) Study the basic concept for the plan of agricultural development and formulate possible irrigation projects.

4) Identification of the projects, their priorities, and recommend the stage of basin development. Selection of the projec(s), new and/on rehabilitation, to be study at pre-feasibility and feasibility level.

5) Refer the environmental consideration and recommend water and/or soil conservation if necessary.

6) Determine the hydropower development potential in the basin. Detail study should be carried out by others.

Part B

To conduct the pre-feasibility study of the project(s) selected in Part A. The study include the following items;

1) General conditions prevailing in the project areas including those belong to natural and socio-economics in order to identify the natural and social constraints which limit the areas from early development.

2) Collection and identification of the validity of basic project information as well as technical studies required for subsequent project feasibility study.

3) Studies and analyses to the pre-feasibility level, the hydrological, engineering and economical components which shall be composed of in plan formulation.

4) Formulation of the plans of development together with estimation of all project requirements to the pre-feasibility level which shall be capable for identification of the priority involved in each of the projects.

5) Identification of the project priority taking into account the plan formulation itself, the economic feasibility as well as the social elements involved in each of the projects.

6) Recommendations/suggestions for further study or on measures to be under taken based on the results obtained from pre-feasibility study.

Part C

To carry out the feasibility study of the project(s) selected in Part A. The study will include the following items;

A. General

1) Studies on overall natural, social and economic conditions prevailing in the project area so as to identify the necessity of project development from national and regional economic development point-of-view.

2) Formulation of the alternative plans of development and selection of the most adequate plan for project proposal, and identification of the project priority taking into account the plan formulation, the economic feasibility as well as the social elements involved in each project.

B. Terms of Reference

Necessary field surveys and studies on the feasibility study as described below will be undertaken by the SURVEY TEAM.

1) Field Survey Data Collection, etc.

i) Review all previous surveys results and studies on topography, geology, hydrology, irrigation, agriculture, economy, etc.

ii) Additional field survey and data collection.

2) Storage Dam and Irrigation/Drainage Facilities

i) Comparison study on the proposed dam site and determination of dam site.

ii) Hydrology analysis on the storage dam.

iii) To determine optimal development scheme.

iv) To estimate irrigation water requirement for the project area, considering consumptive use and irrigation efficiency and etc.

v) To determine hydropower development potential and other potential water uses.

vi) To determine scale of irrigation and drainage system and design of the related structures.

vii) To prepare the design of storage dams irrigation system and related facilities, and to estimate quantities of works and materials for the dam.

3) Agricultural Study

i) To prepare the soil map and land capability map.

ii) To study existing agricultural support services and to propose measures to strengthen the support services, considering extension, institution, credit, input supply, farm machinery services, marketing, etc.

iii) To examine and assess present land use, farming practices, use of farm inputs and agricultural production.

iv) To propose appropriate future cropping pattern, considering current agricultural characteristics including land and water resources and socio-economy.

4) Socio-Economy Study

i) To estimate impact of the projects based on the land tenure, farm size distribution, demographic characteristics, employment, income levels and its distribution, etc.

ii) To assess the seasonal farm labour requirement and labour supply under with/without project conditions.

iii) To evaluate income profits of typical farmer households under with/without project condition.

iv) To propose social infrastructural facilities as needed for inhabitant in the project area.

5) Project Implementation

i) To prepare the project implementation schedule, taking into account of the optimal construction arrangements and capacity of the project executing agency for construction supervision of the project.

6) Operation and Maintenance

i) To estimate the operation and maintenance cost including administration budget, equipment and material cost for the project.

7) Project Costs

i) To estimate the total project cost which consists of direct construction cost, engineering and administration cost, preparation work cost, physical contigency and price contigency.

ii) To prepare distribution of the project cost in accordance with the project implementation schedule.

8) Economic and Financial Evaluation

i) To estimate the project economic cost and its distribution schedule and to estimate the anticipated economic benefit.

ii) To evaluate economic and financial feasibilities by calculating the internal rate of return (IRR).

iii) Sensitivity analysis on the economic and financial feasibilities.

9) Environmental Consideration

To conduct a study on the environmental impact of the proposed project according to the NEB's Guideline.

4. Assistance Requested

4.1 Expert

A team of experts is requested for working in Thailand and Japan as follows :-

	Expert	Man-months Thailand	Japan	(Total)
1.	Team Leader	5	3	8
2.	Hydrologist	2.5	1.5	4.0
3.	Engineering Geologist	2.5	2	4.5
4.	Soil Mechanical Engineer	2.5	2	4.5
5.	Dam Engineer	5	3	8
6.	Irrigation/Drainage Engineer	5	3	8
7.	Survey/Design Engineer (A)	4	3	7
8.	Survey/Design Engineer (B)	4	2.5	6.5
9.	Agronomist	4	2	6
10.	Soil Scientist	3	2	5
11.	Agro-Economist	3	2	5
12.	Environmental Expert	2	1.5	3.5
13.	Electrical Engineer	2.5	1.5	4.0
	(Total)	45	29	74

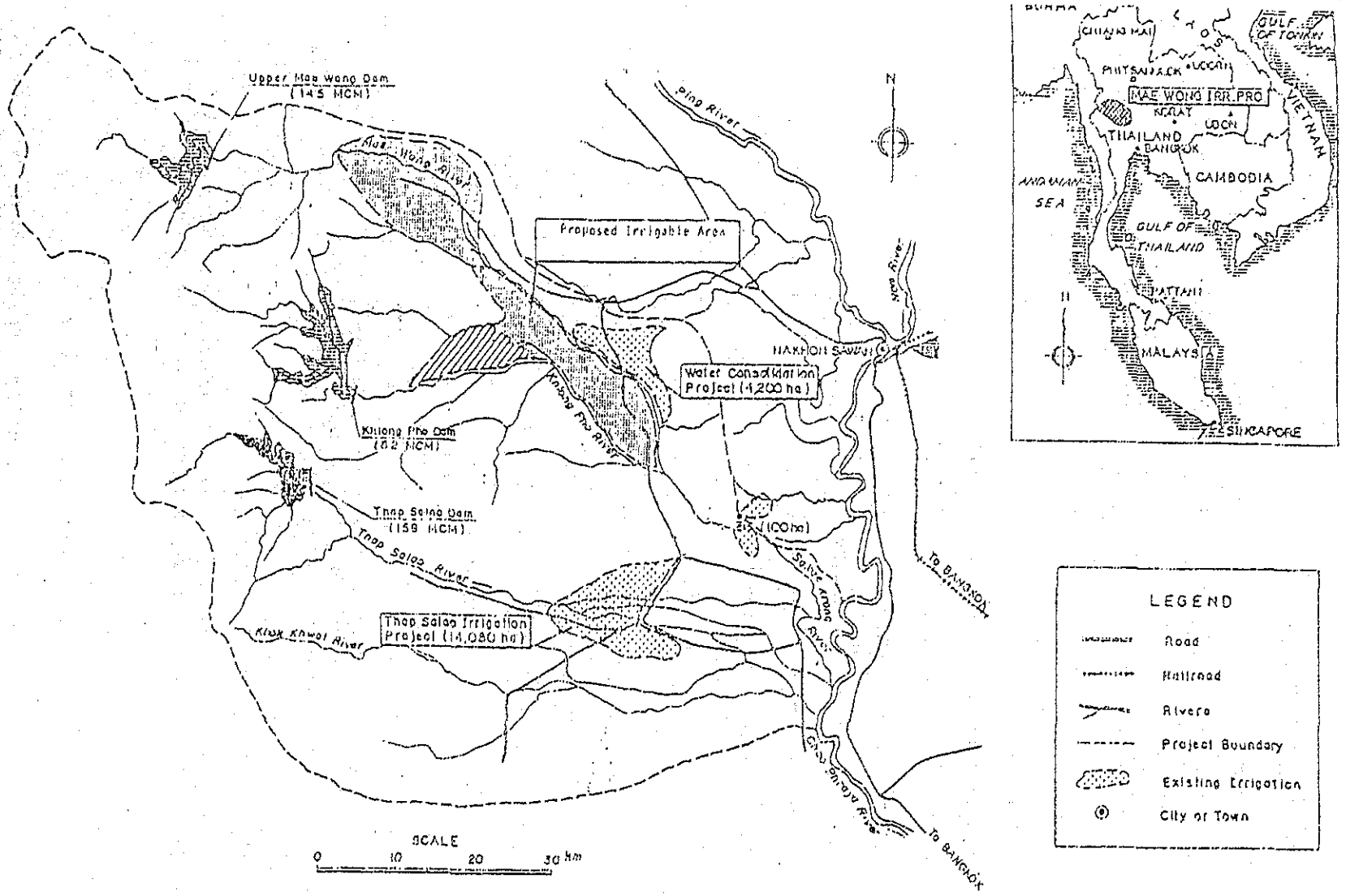
4.2 Fellowship

It is proposed that JICA shall receive RID personnel connected with the study for technical traning in Japan in accrodance with the normal procedure under the Colombo Plan Technical Cooperation Scheme.

5. Counterpart Contribution

RID will provide the necessary and qualified engineering staff as it is available to the experts during the period of work undertaken.

Prepared by: Project Planning Division
Royal Irrigation Department
Tel. 241-3354
June, 1982


Upper Mae Wong Dam
(14.5 MCM)
Mae Wong River
Ping River
Proposed Irrigable Area
Water Conservation
Project (4,200 ha)
Khlong Phe Dam
(8.2 MCM)
Khlong Phe River
Thap Salao Dam
(15.9 MCM)
Thap Salao River
Thap Salao Irrigation
Project (14,080 ha)
Klok Khwai River
Sakae Krang River
Chao Phraya River
To BANGKOK
NAKHON SAWAN
N
SCALE
0 10 20 30 km
BURMA
CHIANG MAI
GULF OF TONKIN
PHITSANULOK
UDON
MAE WONG IRR. PRO
KORAT
LOEI
THAILAND
BANGKOK
VIETNAM
CAMBODIA
ANDAMAN SEA
GULF OF THAILAND
PATTANI
MALAYSIA
SINGAPORE
LEGEND
Road
Railroad
Rivers
Project Boundary
Existing Irrigation
City or Town

5. MANUAL OF NEB GUIDELINES FOR PREPARATION OF ENVIRONMENTAL IMPACT EVALUATIONS

（抜　粋）

PREFACE

The attached NEB Manual of Environmental Impact Evaluation Guidelines has been prepared by NEB for issuance to all agencies or individuals, in both the public and private sectors, who propose to undertake (i) construction of any new project in Thailand which significantly alters the existing natural and man-made environment in the area effected by the project, or (ii) construction of major alterations or changes in existing projects which will significantly alter the existing environment.

An initial step, to be taken in the first or preliminary stages of project planning, is to carry out an Initial Environmental Examination (IEE) for submittal for review by NEB. This is a preliminary examination for determining whether or not the project is likely to involve significance environmental effects. If this determination is negative, then the IEE itself will usually be the only environmental analysis which is needed.

If the IEE indicates a follow-up study is needed, then an appropriate EIS (Environmental Impact Statement) report is to be prepared by the agency or individual who proposes the project. This is to be prepared in sufficient scope and detail to enable the NEB to evaluate the overall worth of the project in terms of economic benefits versus possible impairments to precious environmental resources or values

Based on this evaluation NEB can make its recommendations to the RTG on whether the project is meritorious in the overall balance and thus should be allowed to proceed, and (a) if so to delineate the properly applicable environmental constraints, and (b) if not to enumerate the reasons for this decision and where feasible to indicate what additional environmental protection measures need be included in order for the project to be reconsidered.

The agencies of the RTG concerned with project development include those Ministries and other branches of the RTG with operational responsibilities in the areas of jurisdiction affected by the proposed project. It is NEB's desire to work in close cooperation with all Ministries and other agencies concerned, especially those with leading role responsibilities, in order to expedite planning of and concurrence on all projects needed for the continuing development of the country.

It is recognized that the state of the art in preparing EIS reports is still in the evolutionary stage, even in the USA where an intensive effort has been underway in developing an appropriate technology and methodology for almost 10 years. Hence procedures for preparation of EIS reports have not been standardized and considerable latitude may be in order to preparing the EIS report for any particular project. The main requirement is to present enough information on all sensitive environmental questions to permit NEB to arrive at a fair and objective judgment.

Experience in the USA and other countries where good progress has been made in environmental protection has shown that the EIS report represents the most valuable tool yet developed which can be used by government for assessing the worth of projects in a manner that (a) protects the proper interests of all agencies and people concerned, and (b) will permit continuing economic growth in the country while at the same time protecting and preserving essential environmental values, so these will be perpetually available for meeting both standard of living and quality of life purposes. Careful attention has been given to utilize concepts and criteria on environmental values which are appropriate for Thailand, so that realistic environmental protection can be achieved within realistic economic and other constraints.

The intention of these guidelines is to initiate an appropriate system of environmental protection in Thailand. The Manual includes guidelines for preparing Initial Environmental Examinations, for preparing Environmental Impact Statements, and for preparing Terms of Reference for inviting proposals from consulting firms or other agencies interested in carrying out EIS studies for particular projects. It is planned to update reissue the Manual periodically as experience is gained in this field of work in Thailand.

Kasem Snidvongs

(Kasem Snidvongs)
Secretary General
National Environment Board

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PART I

INTRODUCTION

MANUAL OF NEB GUIDELINES

FOR PREPARATION OF ENVIRONMENTAL IMPACT EVALUATIONS

PART I: INTRODUCTION

1. The National Environment Board (NEB), in cooperation with the implementing agencies of the RTG, has initiated a program by which an Environmental Impact Statement ("EIS") is to be prepared for every proposed project which significantly affects importing environmental resources or values. For every proposed project an Initial Environmental Examination (IEE) should be prepared, in order to ascertain whether or not a full-scale EIS is needed for that particular project. Responsibility for preparing the IEE and the EIS if needed, is with the implementing agency. That is, the agency of the RTG which has the leading role for planning and implementing the project must arrange for preparation of the IEE, and the EIS if needed, for submittal to NEB for appropriate review and action.

2. To assist the RTG agencies in preparing such documents, NEB has prepared a series of guidelines, each dealing with a particular aspect of the subject of environmental analysis. These guidelines are as follows:

(a) General Guidelines for Preparation of Environmental Impact Statements: These guidelines are applicable for all types of project.

(b) Supplemental EIS Guidelines for Specific Project Categories: Additional guidelines, to be taken into account in preparing the EIS for a particular category of project, have been prepared for the following categories:

Agro-Industries
Coastal Zone Development
Dams and Reservoirs
Dredging and Filling
Highways
Housing Projects
Human Settlements
Industrial Estates
Industries
Institutions
Mining
Nuclear Power
Offshore Mining
Oil Pipelines
Ports and Harbours
Rapid Transit
Thermal Power

Additional Supplemental Guidelines will be prepared from time to time for additional categories of projects.

(c) Guidelines for Preparation of Initial Environmental Examination: These are applicable to all proposed projects. As noted above, the objective of the IEE is to determine whether a follow-up EIS will be needed.

(d) Guidelines for Preparation of Terms of Reference for Preparation of Environmental Impact Statements: Assuming an EIS must be prepared for a proposed project, then it is necessary to prepare Terms of Reference for such preparation, to be used by the Implementing Agency for issuing to any group or firm interested in preparing a proposal for carrying out the desired EIS study including preparation of the EIS report. These Terms of Reference incorporate both the General Guidelines (A above) and the appropriate Supplemental Guidelines (B above) for the category in which the project lies, and in addition should present pertinent additional information and requirements which are unique for the particular project.

3. This manual includes the four sets of guidelines noted above, as follows:

Part II : General EIS Guidelines
Part III : Supplemental EIS Guidelines
Part IV : IEE Guidelines
Part V : EIS Terms of Reference Guidelines

4. Examples of EIS, IEE, and Terms of Reference documents prepared for particular projects may be inspected at and/or borrowed from NEB.

5. As experience is gained in Thailand in the practice of environmental analysis, this various parts of this manual will be periodically revised as needed.

MANUAL OF NEB GUIDELINES FOR PREPARATION OF ENVIRONMENTAL IMPACT EVALUATIONS

PART II

GENERAL EIS GUIDELINES

GENERAL GUIDELINES FOR PREPARATION OF ENVIRONMENTAL IMPACT STATEMENTS FOR REVIEW BY NEB

OUTLINE

GENERAL GUIDELINES FOR PREPARATION OF ENVIRONMENTAL IMPACT STATEMENTS FOR REVIEW BY NEB

1. Introduction

The guidelines presented in this report are general guidelines applicable to all types of development projects regardless of their type or nature. In addition, NEB has prepared "Supplementary Guidelines for Specific Project Categories", which are generally applicable for projects of a particular category. Thus it is NEB's intent that, for any particular project, the applicable guidelines will be both the "General Guidelines" and the "Supplementary Guidelines" for the appropriate project category. In addition, given the location and size of a specific project and other information on its salient aspects, it is possible to prepare a third set of "Specific Project Guidelines" applicable only to the specific project. The policy of NEB will be to issue the General Guidelines and Supplemental Guidelines for general use, and to prepare Specific Project Guidelines only when this is considered necessary.

All of the guidelines issued by NEB are tentative because the technology and practice of preparing, EIS reports is still in evolution. There is no concensus on the best procedure or methods use is conducting an EIS study. The objective of NEB has been to develop these guidelines so they will suit the current conditions of development in Thailand, and so they can be implemented by Project Proposers within budget and time limitations appropriate for Thailand at this time. For projects in the USA and other industrialized nations, the EIS report requirements involved much higher levels of expenditures; however, it is believed the EIS reports to be produced here pursuant to these guidelines will serve to meet minimum essential environmental protection needs in Thailand.

The guidelines described here are intended for use mainly in preparing complete EIS reports. They may also be used for preparing an "IEE" or "Initial Environmental Examination" report, which represents a preliminary type of EIS evaluation to determine whether a full-scale EIS report is really needed. NEB's guidelines for IEE reports are being prepared for distribution in a separate document.

It is intended to update these guidelines, based on experience, every year.

2. Objectives of Environmental Impact Statement (EIS)

The objectives of the EIS (Environmental Impact Statement), to be submitted to NEB for proposed project by the Project Developer, are the following:

(a) To identify and describe (in as quantified a manner as possible) the environmental resources/values (ER/V) which will be affected by the proposed project, under existing or "without project" conditions.

(b) To describe the effects the proposed project would have on the ER/V (again, in as quantified a manner as possible), including positive effects which enhance ER/V as well as negative effects which impair them, whatever direct or indirect effects, both short-term and long-term effects, including description of the specific ways by which the project plan or design will minimize adverse effects and maximize positive effects.

(c) To describe alternatives to the proposed project which could accomplish the same results desired by the Project Developer but with a different set of environmental effects, including description of the effects associated with each alternative.

With the above information in hand, NEB will be in a position to determine that the Project Developer did seriously consider all feasible alternatives and their environmental effects, and did select the alternative which can best protect ER/V as well as achieve the desired project objectives, and did or will plan the project to incorporate provisions for minimizing adverse effects on environment and provisions for enhancing ER/V especially where such enhancement is needed to offset possible losses in precious natural resources/values.

The basic premise of the EIS is that the Project Developer does not have the right to use up precious ER/V resulting in greater loss than gain to the public welfare. The main purpose of the EIS is to seek ways by which the project can proceed without any irreparable losses to environment, and with minimize losses of any and all environmental resources/values within a context whereby the net effect on the public welfare will be a desirable or essential gain.

3. EIS Methodology

(a) General Methodology

Although numerous efforts have been made to formulate systematic approaches for making environmental assessments, with efforts to quantify the effects and relate them to each other, thus far there is no concensus on any particular procedure (Ref. 1 to 14). This is because of the difficulty in attempting to quantify effects because of their often intangible nature or scientific complexity--for most of the effects meaningful parameters which can be used as inputs for quantified analysis, for example in modelling, have yet to be developed. Even in the traditional field of waste treatment and disposal, now about 100 years old, it is still difficult to correlate different levels of waste treatment with different levels of effects on water quality in the water bodies to which the waste effluents are discharged. For these reasons all attempts to develop quantified approaches to environmental assessment, including use of checklists, matrices, networks (flow chart relationships), and map overlays (Ref. 17) including using of mathematical models, have been essentially subjective with the quantification depending greatly on the background and bias of the observer.

It is concluded, at present, that the best general approach for use by NEB is a review, item by item, of effects on individual environmental resources or values, including both identification of the resource or value and description and quantification of the effect to the extent possible. Within this context, of evaluation environmental effects one by one, it is possible to group these effects in a systematic manner.

For the purpose of evaluating project impacts on environmental values in developing countries such as Thailand, it is believed the most practicable approach now available is that developed by the U.S. Corps of Engineers (Ref. 1). This distinguishes between natural environmental resources and human use resources stemming from utilization or development of the natural resources. The methods classifies all environmental resources or values into four tiers or levels beginning with the natural physical resources of the area (See Figure 1). The second tier represents the natural ecological or biological resources (other than man) which derive from the physical resources. Next are the human use values which result from man's utilization of the natural resources (for example, agricultural cropping which replaces the natural forest, and urbanization which replaces agriculture). It is this tier which corresponds to the concepts of economic development and standard of living. The final tier represents human quality of life values, which depend on maintenance of a satisfactory balance between protection and preservation of the natural resources and utilization of these for human economic gain.

The guidelines described in this document have been patterned after the U.S. Corps of Engineer methodology. They may be modified to suit the needs of any particular case, but generally they represent a suitable approach which may be used in preparing EIS reports for NEB review.

(b) Mathematical Modeling

While it is has not yet proven possible to employ mathematical modeling to express the relationships between all ER/V data, methods have been and are being developed for use of modeling for quantifying relationships involved between a limited number of these parameters. For example, the ecology of a lake or reservoir may be modeled to show effects of waste discharges on production of algae and other aquatic organisms (Ref. 16). Also models have been developed for use in Northeast Thailand which show the impact on agricultural productivity as related to farm size, farming methods, soil productivity, mechanization, and crops types and cropping patterns, for both rainfed and irrigated agriculture (Ref. 7). Another example in Thailand is the model of thermal diffusion as related to ecology development by EGAT in connection with studies of nuclear power potentials at Ao Phai.

4. Environmental Resources/Values (ER/V)

The ER/V to be taken into account by the Project Developer in preparing the EIS are listed in Table 1. Note that these have been arranged, for purpose of convenience in making the evaluation, in four groups interrelated in the manner shown in Figure 1. Those four groups include (a) physical

resources, (b) ecological (or biological) resources, (c) human use values, and (d) human quality of life values. Alteration in Group (a) will affect Group (b), and both Groups (c) and (d) will be effected by alterations in (a) and (b). Actually, any change in any ER/V will to some degree effect all other ER/V, in that they are all interrelated as shown in Figure 2. However, for purposes of discussion and analysis each ER/V can be evaluated on its own, with suitable references to other ER/V evaluations.

While the majority of projects will tend to affect most of the ER/V listed in Table 1, for particular projects some of the ER/V will be of key importance and others of minor importance or insignificant, depending upon the nature of the project and upon the region in which it is located. For purposes of guidance, Table 2 has been prepared to show which ER/V will generally be of primary importance according to the type of project. Table 3 similarly indicate primary ER/V according to various regions of Thailand, including the coastal region, urban sectors, rural/agricultural sectors, river valley areas, and forest/hilly areas.

5. Organization of EIS Report

A suggested format for organization and presentation of the EIS is given in Annex 3. This format has been found useful and applicable for most project situations. The EIS report should contain essentially the information noted in Annex 3 in general and in particular the information noted in the applicable Supplemental Guidelines.

The extent of detail to be included in the EIS study and report will depend mainly upon the size and nature of the project and on its location, which together will determine the extent of the environmental impacts to be caused by the project. Generally, based on experience in the USA, the cost of preparing a competent EIS is in the range of 10 to 30 percent of the total cost for preliminary project planning to the feasibility level (i.e., planning of the project up to the point necessary to permit a decision on whether to proceed with detailed final plans and construction).

Preparation of a competent EIS report usually involves considerable expertise in a number of specialized fields of engineering and the physical and social scientists. Because these various aspects are related to each other, EIS technology is interdisciplinary in nature. It may be desirable to obtain expert consultants from the public and private sectors to assist in preparing the report.

6. Environmental Protection Planning Related to Project Development

A typical project involves successive stages of development, usually (a) reconnaissance or pre-feasibility studies, (b) feasibility studies to set the basis for a decision to proceed or not, (c) detailed planning or final design (preparation of plans and specifications), (d) construction, (e) start-up operations, (f) normal operations, and (g) in some cases, project termination or abandonment. Activities for protection of ER/V are part of each of these stages. Figure 3 illustrate such a sequence of events for a typical water resource development project such as a dam

and reservoir. Similarly, for any type of proposed project there will be an appropriate sequence of environmental protection activities to be carried out by the Project Developer at various stages in the development of the project.

Because the EIS is a part of the planning stage of project development (usually a part of, or supplement to, the feasibility study), the EIS report will not of course have available the detailed information to be developed in later stages. However, the EIS report must describe or explain the plan by which the proposed project will give continuing adequate attention to ER/V as the project evolves including any needs for continuing monitoring after the project has been built and has entered the operations phase.

It should be emphasized that environmental planning is an aspect of all stages of project planning. It is especially important that environmental protection be a part of the earliest project planning activity, in order that every advantage is taken in the overall planning process to obtain the minimum essential environmental protection at least cost. Also certain aspects of environmental planning, such as resettlement planning, by their very nature need to be considered at the earliest planning stages because of the extensive time required to prepare and implement adequate solutions.

7. References

There are many references dealing with the subject of preparation of EIS, and a listing of some of these is given the list of references in Annex 2. Additional references applicable to particular types of projects are given in the Supplemental Guidelines.

SUPPLEMENTAL EIS GUIDELINES

DAMS AND RESERVOIRS

OUTLINE

SUPPLEMENTAL EIS GUIDELINES

DAMS AND RESERVOIRS

1. Introduction

Dam and reservoir projects are among the most sensitive of all development projects in terms of pervasiveness of their influence in altering environmental resources. Because they usually cause a major alteration in the hydrologic regime of the watershed involved, they usually result in a drastic alteration of the physical and ecological setting in the immediate vicinity of the project and also these effects may continue far downstream to the area of final discharge of the stream and beyond. Also, dam and reservoir projects usually result in establishment of new access routes to upstream areas in the watershed, resulting in impacts on forests, wildlife, mineral development, and agricultural practices throughout the watershed.

Review of the history of major dam/reservoir projects from the environmental point of view, brought about by the advent of environmentalism over the past decade, has shown, (a) while such projects have generally realized their anticipated benefits in increased water supply, power production, and flood control, (b) the planning of the projects has often not taken into account the project effects on many other environmental resources including effects on aquatic and terrestrial wildlife and on forests, and effects on people including problems of resettlement and of alterations in socio-economic patterns. Thus dam and reservoir projects have, in the past, tended to result in a number of significant adverse effects mostly because these potentials were not considered essential to project planning. However, the studies of past projects also show, if planning of dam and reservoir projects is expanded to be truly comprehensive, the projects will achieve their essential gains in power and food production, flood control, water supply, etc., with minimum environmental losses and moreover in many cases it is possible to incorporate into the project plan provisions for offsetting any such losses and even for enhancement of certain environmental values.

2. Project Description

The project description should include essentially the salient information about the project at a degree of detail comparable to that obtained for feasibility level reports. Among other things, the project description should include (a) a base map of the region affected by the project (the watershed tributary to the dam and downstream zones affected), (b) maps of the reservoir and of downstream affected areas, (c) preliminary engineering description of each project component (dams, dikes, powerhouses, by-pass channels, irrigation canals, etc.), and (d) projected project benefits including the pertinent economic analyses.

It is important that the EIS report make every effort to obtain use the latest available maps of the affected areas, especially with respect to topography and land uses.

3. Tabulation of Environmental Effects of Dam/Reservoir Projects

The effects of dam/reservoir projects in general on selected environmental resources/values are illustrated in Table 1, which includes consideration of power generation and irrigation sub-projects as well as the main dam/reservoir itself. This tabulation is, of course, intended only to indicate the general nature of those relationships, which may vary widely from project to project.

4. Environmental Effects Common to Dam/Reservoir Projects

Some of the typical effects of the core dam/reservoir system, common to all reservoir projects, are illustrated in the following discussion (these are to be considered to the extent applicable):

(a) Physical Resources

(i) Surface Water Quantities (Hydrology): The hydrologic regime of the river system will be considerably altered by the project, hence a comparison should be made of the typical hydrographs representing both before and after conditions, including evaluation of adequacy of available meteorological/stream gaging data, for typical normal, flood, and drought year conditions. Also, describe the overall effect in the mass water balance by months and annually, including use of stored water for beneficial purposes which would otherwise be lost, and including losses of water over non-project conditions (e.g., from evaporation), so that a water balance is obtained for both before and after conditions.

(ii) Surface Water Quality: Describe water quality for before and after conditions including both the reservoir and the river downstream, for average and seasonal conditions, including effects of storage on physical parameters (temperature, dissolved oxygen, suspended solids/turbidity), on dissolved mineral constituents (TDS, Ca, Mg, Na, K, HCO_3, CO_3, SO_4, Cl, NO_3, Mn, Fe), on biological parameters (plankton, benthos), and on applicable pollution parameters (BOD, COD, heavy metals, chlorinated hydrocarbons, etc.).

(iii) Ground Water: Describe anticipated effects of project on ground water quantity/quality both in reservoir vicinity and downstream, including alterations in ground water table, water logging of wells, leakage from reservoir, alterations in infiltration rates in the watershed, and control measures included in the plan.

(iv) Soils: This includes consideration of effects of the project on soil erosion in the watershed (Items a/vi and b/iv) as well as the irrigation aspects as discussed in Section 5.

(v) Geology/Seismology: Adequacy of foundation conditions for structural stability of dam, dikes, and other appurtenant structures, and earthquake hazards in the region.

(vi) Sediments and Erosion: Describe estimated amounts of sediments (silt) expected to accumulate in reservoir from watershed runoff,

plans for minimizing this effect, and effects of the accumulation on beneficial reservoir uses, including review of basic data on sediments carried by the stream and the stream bed and the adequacy of these data. Describe estimated future extent of downstream erosion due to scour of clear water released by dam, including expected vertical and horizontal erosion and new stream water surface levels, and planned protective or corrective measures.

(vii) Climate: Possible changes in microclimate in the project vicinity (especially in local humidity which may affect insect pest densities).

(b) Ecological Resources

(i) Fisheries: Describe expected losses in pre-project (existing) riverine fisheries due to (1) inundation, (2) to reduction in the downstream inundation fishery (due to reductions in inundation due to storage), (3) to reduction in the downstream fishery in the river zone below the dam where changes in the hydrologic regime will be large, (4) to reduction in downstream (and estuarine and marine) fisheries due to trapping of nutrients in reservoir, and (5) to effects of the dam in interfering with migratory species. Describe expected new fisheries situation in the reservoir (See Item b/v) and in the altered river (and in any affected downstream estuarine and marine) zones, compare the new situation with the old, and describe plans for making up for anticipated losses (so nobody will be "worse off" with the project than without it) including proposed fish hatchery and artificial propogation operations, proposed fish farming, etc.

(ii) Aquatic Biology: Describe (a) expected new ecology in the reservoir (See Item b/v), (b) expected new ecology on the affected downstream riverine zone (including effects of nutrient trapping in the reservoir), (c) effects on estuarine/marine zones which may be affected, including salinity changes. Include probable effects on primary productivity and on fish food chains, considering biological life both in the water column and benthos. Describe monitoring programs for assessing before and after conditions for establishing base data to use in planning any necessary corrective measures, including details on sampling and analyses to be used for assessing physical, chemical, and biological characteristics of the affected aquatic zones, and frequency of sampling to provide statistically reliable information for all seasons of the year, and methods of analysis for interpreting the significance of the data. The continuing monitoring program, to be a part of the project operation, should be designed so that continuing assessments may be made over the years of the effects of the project in modifying the aquatic ecosystem. Describe feasible corrective measures if required.

(iii) Wildlife (Terrestrial Fauna): Describe (a) impact of project on wildlife in watershed area above dam and also in downstream zones affected by changes in hydrologic regime and by changes in access to the watershed including both the reservoir waterway and roads to be built,

(b) impact on fauna to be inundated and plans for salvaging and rehabilitation, (c) new wildlife resource to be created by the reservoir and plans for its management (especially water-fowl suitable for hunting), and (d) any need and plans for establishing wildlife reserves in the watershed as an integral part of project planning (to compensate for wildlife losses from encroachment).

(iv) Forests: Describe (a) impact of project in inundating forest reserves (including estimates of loss of forest productivity), (b) in accelerating depreciation of forests through increased access both by the new lake waterway and by the new roads to be built, (c) present and future status of forests on watershed, and their role in soil and water conservation, and (d) proposed measures for preserving this role.

(v) Reservoir Ecology: Describe anticipated environment in the new reservoir including (a) the new fishery to be created and plans for its management including management of fishing communities and provisions for regulation to prevent overfishing, and for storage, processing, and marketing of fish, (b) use of reservoir for wildlife propogation, (c) anticipated physical, chemical, and biological properties of the new water body, including both the water column and benthos, and thermal stratification phenomena, (d) problems of stability of reservoir banks including protection against erosion from wave action, (e) control of sanitation along reservoir periphery, (f) uses of drawdown zone for agricultural and other purposes, (g) problems due to surface water level fluctuation (e.g., effects on shoreline facilities), (h) extent to which inundated trees will be removed and salvaged, or retained, (i) problems of controlling growth of water weeds in the reservoir, and (j) other problems relating to the reservoir not adequately discussed in other sections of the EIS report.

(c) Human Use Values

(i) Water Supply: Describe impact of the project in improving availability of water supply for downstream communities (including consideration of the effects of low flow augmentation), including consideration of both water quantity and quality, and including assurance that the altered hydrologic regime will not result in low flows less than would occur under without project conditions.

(ii) Aquaculture: Describe potentials for improved downstream aquaculture resulting from low flow augmentation (including needs for aquaculture to offset downstream fishery losses).

(iii) Navigation: Describe effects of project on navigation both above and below project (before and after conditions) including beneficial effects due to low flow augmentation downstream. Describe any proposed navigation improvements including transhipment facilities, removal of obstacles, and landing facilities.

(iv) Flood Control: Even if not designed for flood control, the project, if it involves significant storage, will achieve significant flood control. Hence it is necessary to describe the anticipated altered (before and after) hydrologic regime under flood conditions, the anticipated benefits in reduction in flood damages, including reclamation of lands for agricultural use (and comparable reductions in inundation fisheries).

(v) Mineral Development: Describe potentails for mineral development due to improved access to watershed areas and (for a hydropower project) for mineral processing due to ready availability of power.

(vi) Highways/Railways: Describe plans for alterations in highway and railroad routes and their effects on ER/V values.

(vii) Land Uses: Describe changes in land use patterns expected to result from the project.

(d) Quality of Life Values

(i) Socio-Economics: Describe program of socio-economic surveys for assessing the social/economic situation of the rural population in the region affected by the project, including areas above, around, and below the dam, to gain background data to be used in planning the project so that the affected population can share in the project benefits. Describe plans for improving the welfare of the affected rural population, including effects of new roads to be provided, new communities to be located in the vicinity of the reservoir, new industries which could stem from the project, rural electrification, etc.

(ii) Resettlement: Detailed discussion of plans for managing resettlement of the population to be inundated including (a) provisions for rehabilitation of these families in their new living/working situations, (b) socio-economic surveys for establishing baseline data on the status of the families to be resettled, (c) alternative choices for resettlement (including both rural and urban alternatives), (d) extent to which the affected families have been consulted in developing the alternatives, and (e) other information as needed to assure NEB that the resettlers will share in the benefits of the project and be at least as well off as for without project conditions. If resettlement involves changes methods of agriculture (e.g., growing upland crops instead of paddy, use of irrigated agriculture in addition to rainfed crops, etc.), describe provisions for assisting the resettlers to make this adjustment including agricultural extension and other institutional measures (such as assistance in obtaining credit from farmers cooperatives or otherwise).

(iii) Public Health: Describe (a) expected impact of the project in altering hazards of water-oriented diseases in the region including malaria, dengue fever, liver flukes, etc., and proposed corrective measures, including hazards expected to occur during the period of dam construction and during the normal operations period following construction, (b) plans for provision of adequate minimum community sanitation facilities in new villages to be located around project, both to enhance village living and to minimize pollution of the reservoir, and (c) other anticipated public health/sanitation problems.

(iv) Nutrition: Describe probable effects on nutrition pattern due to the altered fishery production (and, for an irrigation project, due to increase crop production).

(v) Recreation and Aesthetics: Describe recreation and aesthetic values of the new reservoir system and plans for effective development of its recreational potentials including provision for conservation of natural beauty spots during project operation. Describe measures needed during construction for conserving natural aesthetic values including proper replanting of borrow areas and other cut or disturbed areas so as not to create obvious scars and blemishes to the landscape.

(vi) Archaeology and Historical Treasures: Describe measures for assessing archaeological values or historical or cultural treasures to be inundated, and any necessary corrective program for salvaging or preserving these values.

5. Irrigation Projects

Should the project include a significant irrigation component, then these irrigation facilities will need to be evaluated in terms of the following:

(a) Crop and Food Production: Estimated impact on types and amounts of crops to be produced, and the resulting increase in food production and effects on diet and nutrition.

(b) Institutional Requirements: Plans for reorientation and training of the farmers to make the adjustment to irrigated farming including plans for extension services, farmers cooperatives, and service centers for furnishing training, credit, ready purchase of farm inputs (fertilizers, insecticides, etc.), ready marketing of surplus products, etc., including necessary socio-economic basic data surveys.

(c) Irrigation Distribution: Plans for distribution and use of the irrigation water to assure it will in fact be made available to the farmer's plot in an economical and reliable manner (within his means, and available when needed), use of farmers' cooperatives for maintenance and operation of the facility, and needs for land leveling and land consolidation.

(d) Drainage and Salinity Buildup: Provision of adequate drainage to prevent soil water-logging, to prevent salinity buildup, and in saline soil areas to prevent bringing of ground salt to the surface.

(e) Soil Fertility: Review of water/soil quality parameters to assure continuing irrigation will not result in loss of soil fertility.

(f) Return Flows: Effects of return flows (irrigation drainage) on river water salinity, and plans for reuse of return flows.

(g) Water Supply: Use of the Irrigation system as a water supply for community development, for industrial development, and for year-around fish farming (aquaculture).

(h) Agro-Industries: Potentials for agro-industrial development in the irrigation areas and plans for assisting in implementing such projects, especially to take advantage of the ready availability of power and of local agricultural products.

(i) Agricultural Chemicals: Effects of runoff from farming areas containing residues of fertilizers and toxic chemicals on stream ecology, and effects of toxic chemicals on terrestrial wildlife.

6. Hydropower Projects

If the project includes provision for power generation, the EIS should include consideration of the followings:

(a) Market for Power: Availability of assured market for planned power generation.

(b) Alternative of Thermal Power: Cost of generating and delivering power to places of use compared with alternative power sources (thermal plants)

(c) Rural Electrification: Potentials for furnishing power to rural villages in vicinity of project.

(d) Transmission Lines: Precautions in design of transmission lines to assure protection of ER/V as noted in Item b/ii (wildlife) and d/v (aesthetics).

7. Review of Overall Project Size and Purposes

(a) Optimum Dam Height: Describe feasible alternative dam heights (range of alternative maximum high pool levels), and explain process of analysis leading to selected reservoir high pool level including summary of environmental impacts associated with each alternative pool level.

(b) Alternative Uses of Storage: Describe feasible alternative uses of the storage to be made available by the project, and the process of analysis leading to the selected balance between use of the project for its various purposes (power, irrigation, flood control, etc.), and explain the rationale basic to the final selection of the best balance of uses. Describe the operating rule curve for reservoir management to be used for achieving these purposes.

(c) Alternative Project Locations: Describe feasible alternative locations for the dam/reservoir project, and the reasons for selection of the recommended project including consideration of environmental effects

8. Surveillance and Monitoring

An appropriate plan should be developed and described for monitoring to ascertain the continuing impact of the project on those applicable ER/V which are especially sensitive to dam/reservoir projects such as:

(a) Hydrology (surface and ground water)(gauging program);

(b) Water quality (surface water)(reservoir and downstream);

(c) Fisheries (reservoir and downstream).

(d) Applicable public health hazards;

(e) Applicable socio-economic surveys.

9. Reference Reports

EIS reports or studies, which have been made for projects in Thailand and which may serve as valuable references, include the following:

(a) "Pa Mong Optimization and Downstream Effects Study". Mekong Committee, August 1976. (A detailed discussion of the anticipated environmental effects of the proposed major Pa Mong project on the Mekong River.)

(b) "Environmental Study of Nam Pong Dam and Reservoir Project". NEA, 1978 (A detailed analysis of the environmental effects of the Nam Pong multipurpose project in Northeast Thailand since completion of the project in 1968.)

(c) Environmental Impact Studies for EGAT Dam/Reservoir Projects:

(i) "Ecology Reconnaissance of the Quai Yai Hydroelectric Scheme". EGAT, 1 November 1972.

(ii) "Environmental and Ecological Investigation of Pattani Multipurpose Project". EGAT, 12 October 1976.

(iii) "Lang Suan Multi-purpose Project Preliminary and Environmental and Ecological Investigatio ". EGAT, October 1977.

(iv) "Preliminary Environmental Study of Upper Khwae Noi Basin". EGAT, 1976.

(v) "Environmental and Ecological Investigation of Lower Quae Yai Project". EGAT, August 1978.

(d) "Phitsanulok Irrigation Project, Preliminary Environmental Impact Assessment", RID, 31 August 1976.

10. References on Environmental Impact Methodologies Applicable to Dam and Reservoir Projects

(1) "Environmental Assessment Manual". Prepared for U.S. Army Corps of Engineers, North Pacific Division by Battelle Pacific Northwest Laboratories, 1974.

(2) "Hydropower Projects and Their Associated Planning Impacts". C. Grant Ash and E.O. Gangstad, U.S. Corps of Engineers, Washington, D.C., 1976.

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(8) "Environmental Evaluation System for Water Quality Management Planning". Report to Environmental Protection Agency by N. Dee et al, Battelle-Columbus Laboratories, Columbus, Ohio, 1973.

(9) "Preparation and Coordination of Environmental Statements, EP 1105-2-507". Chief of Engineers, Washington, D.C., 1974.

(10) "Procedure for Evaluation of Impacts Arising from Alternatives for Managing Wastewater, Contract No. DACW 23-72-C-0034". R.S. Gremmell et al, Northwestern University and Northwest Consortium for USAE District, Chicago, Ill, 1972.

(11) "Criteria Used by Federal Agencies in Identifying Actions which Require an Environmental Impact Statement, MTR-6533". I. Golden and R. Pagano, Interstate Commerce Commission, 1973.

(12) "Environmental Impact Study for Army Military Programs, Report No. CERL-IR-D-13". USAE Construction Engineering Research Laboratory, Champaign, Ill., 1973.

(13) "Handbook for Environmental Impact Analysis, Technical Report E-59". USAE Construction Engineering Research Laboratory, Champaign, Ill., 1974.

(14) "A Philosophy of Environmental Impact Assessment: Some Considerations for Implementation". J.J. Jordan, Journal Soil and Water Conservation, 1973.

(15) "Environmental Impact Computer System, Technical Report E-37". E.Y. Lee et al, USAE Construction Engineering Research Laboratory, Champaign, Ill., 1974.

(16) "A Procedure for Evaluating Environmental Impact". L.B. Leopold et al, Circular 645, U.S. Geological Survey, Washington, D.C., 1971.

(17) "Analyzing the Environmental Impacts of Water Projects". Prepared for the U.S. Army Engineer Institute for Water Resources, Alexandria, VA., by Stanford University, National Technical Information Service, Springfield, VA., 1973.

(18) "An Analysis of Environmental Statements for Corps of Engineers". Water Projects, IWR Report 72-3. L. Ortolano and W.W. Hill, National Technical Information Service, Springfield, VA., 1972.

(19) "Environmental Impact Evaluation System (Proceedings of International Conference on Pumped Storage Development and Its Environmental Effects). E.A. Seaman, Journal American Water Resources Association, 1971.

(20) "Environmental Impact Assessment: A Procedure". L.V. Stover, Sanders and Thomas, Inc., 1972.

(21) "Matrix Analysis of Alternatives for Water Resources Development, Technical Paper". USAE District, Tulsa, Ok., 1972.

(22) "Aesthetics in Environmental Planning, EPA-600/5-73-009". EPA, 1973.

(23) "A Review of Environmental Impact Assessment Methodologies". Prepared for U.S. Environmental Protection Agency by Battelle's Columbus Laboratories, Columbus, Ohio, 1974.

(24) "Design of an Environmental Evaluation System, Contract No. 14-06-D-7005". I.L. Whitman, Battelle Columbus Laboratories for Bureau of Reclamation, 1971.

(25) "Optimum Pathway Matrix Analysis Approach to Environmental Decision Making Process". J.C. Zieman et al, Institute of Ecology, University of Georgia, Athens, 1971.

TABLE 1: ENVIRONMENTAL PARAMETERS FOR ANALYSIS OF DAM AND RESERVOIR PROJECTS

(INCLUDING IRRIGATION AND HYDROELECTRIC SUB-PROJECTS)

Environmental Resource / Project Component		Physical Resources								Ecological Resources				Human Use Values														Quality of Life Values							
		Surface Water Hydrology	Surface Water Quality	Ground Water Hydrology	Ground Water Quality	Soils	Geology/Seismology	Erosion/Sedimentation	Climate	Fisheries	Aquatic Biology	Terrestrial Wildlife	Forests	Agriculture/Irrigation (if applicable	Aquaculture	Water Supply	Navigation	Recreation	Power (if applicable)	Flood Control	Dedicated Area Uses	Industry	Agro-Industry	Mineral Development	Highways/Railways	Land Use	Socio-Economic	Resettlement	Cultural/Historical	Aesthetic	Archaeological	Public Health	Nutrition
Dam and Reservoir	A	3	2	2	1	-	-	3	1	((3))	((3))	((3))	2	(3)	(3)	(3)	(2)	(3)	(3)	(3)	3	-	-	(2)	((2))	3	(3)	3	1	((3))	1	((2))	(3)
	B	3	-	3	-	2	3	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	3	-	-	-	1	-
Irrigation System	A	1	3	2	-	3	-	2	-	(3)	(3)	1	-	(3)	(3)	(3)	-	(1)	-	-	-	(2)	(2)	-	1	3	(3)	-	-	-	-	(2)	(3)
	B	2	3	3	1	3	3	3	1	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Hydroelectric Power and Transmission	A	-	-	-	-	-	-	1	-	-	-	1	3	1	-	-	-	-	3	-	-	3	2	-	-	3	(3)	-	-	2	-	-	-
	B	1	-	1	1	2	2	1	-	-	1	1	3	-	-	-	-	-	-	-	1	1	1	1	-	-	-	-	-	-	-	-	-

NOTES: (a) (A) means significant impact of project on environmental resources, whereas (B) means impact of the environment on the project.

(b) Numerical value of 3 means probable major impact, 2 means intermediate, and 1 means significant but relatively minor.

(c) Numbers in parentheses indicate effects are mostly enhancement of environmental.
Numbers in double parentheses represent combination of adverse and beneficial effects.
Numbers without parentheses represent either adverse or beneficial effects.

6. 収集資料リスト

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(農業・協同組合省)

(2) 1978 Agricultural Census Report Thailand
① Whole Kingdom
② Changwat Uthai Thani
③ Nakhon Sawan
(National Statistical Office, Office of the Prime Minister)

(3) 1980 Population & Housing Census
① Whole Kingdom
② Northern Region
③ Chanqwat Uthai Thani
④ Chanqwat Nakhon Sawan
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(4) Statistical Handbook of Thailand 1982
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(5) National Income of Thailand 1983 Edition
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