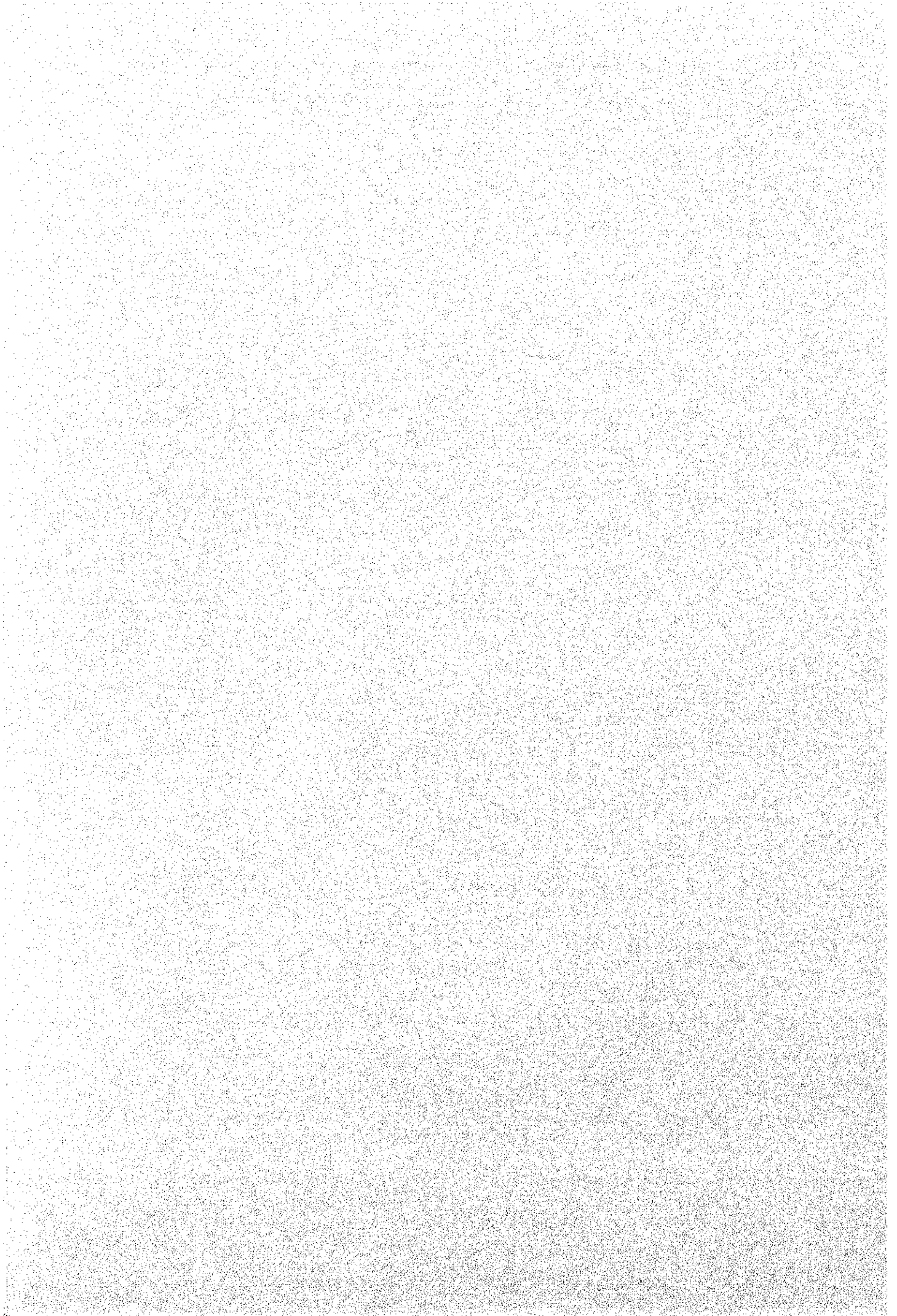


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要請書

THE KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

FEASIBILITY STUDY
ON
THE INTEGRATED AGRICULTURE AND WATER RESOURCES DEVELOPMENT PROJECT
OF
THE HUAI MONG-HUAI LUANG RIVER BASIN

TECHNICAL ASSISTANCE
FOR
FEASIBILITY STUDY

PREPARED BY ROYAL IRRIGATION DEPARTMENT
BANGKOK
THE KINGDOM OF THAILAND
MARCH, 1993
TECHNICAL ASSISTANCE FOR FEASIBILITY STUDY

PROJECT TITLE : The Feasibility Study on the Integrated
Agriculture and Water Resources Development
Project of the Huai Mong-Huai Luang River Basin

LOCATION OF PROJECT

SITE : Udon Thani and Nong Khai Provinces

REQUESTING AGENCY : Royal Irrigation Department,
Ministry of Agriculture and Cooperatives

PROPOSED SOURCE OF
ASSISTANCE : Government of Japan

CONTENTS

	<u>Page</u>
I. BACKGROUND	74
1.1. Present Conditions.....	74
1.1.1. Huai Mong Basin.....	74
1.1.2. Nam Suai Basin.....	76
1.1.3. Huai Luang Basin.....	77
1.2. Problem and Constraint.....	79
1.3. Inevitability on Water Resources Development.....	80
1.3.1. Water Balance/Operation Analysis.....	80
1.3.2. Flood Analysis.....	80
1.3.3. Requirement of Technical Assistance.....	80
II. OBJECTIVES OF THE STUDY	81
2.1. Objectives of the Study	81
2.2. The Study Area	82

III. PROPOSED INTEGRATED AGRICULTURE AND WATER RESOURCES DEVELOPMENT PROJECT	83
3.1. Phase-I Study (Master Plan Study)	83
3.1.1. Comprehensive Water Balance in Basins	83
3.1.2. Irrigation and Drainage Development.....	84
3.1.3. Agricultural Development.....	85
3.2. Phase-II Study (Feasibility Study on Priority Project(s)).....	86
3.3. Expected Project Benefit.....	86
3.4. Preliminary Project Cost Estimate.....	86
3.5. Preliminary Economic Evaluation.....	86
 IV. SCOPE OF WORK FOR THE STUDY	 87
(1) Review of Developing Progress Work in the Basins.....	87
(2) Water Resource Availability in the Basin.....	87
(3) Development of Irrigation and Drainage	87
(4) Improvement of Agricultural Farming	87
(5) Plan of Facilities	88
(6) Construction Plan and Cost Estimation	88
(7) Plan of Operation & Maintenance Services	88
(8) Implementation Programme	88
(9) Environmental Assessment	88
(10) Project Evaluation	88
 V. ASSISTANCE PERIOD AND ASSIGNMENT OF EXPERTS	 89
5.1 Assistance Period.....	89
5.2 Assignment of Experts.....	89
 ATTACHED MAPS AND FIGURES	
Location Map of the Study Area	90
Figure-1 Work Schedule of Feasibility Study	91
Figure-2 Manning Schedule	92

I. BACKGROUND

The Study area of 8,660 km², which consists of three (3) river basins as called Huai Mong, Nam Suai and Huai Luang as tributaries of the Mekong river, is located at the northern most of the northeastern region, which faces to Vientiane, the capital of Democratic Peoples Republic (DPR) of Laos, and at the opposite bank of the Mekong river. The bridge across the Mekong river to connect Thailand to Laos, is now under construction. The outline of three river basins is as follows;

<u>Description</u>	<u>Unit</u>	<u>Huai Mong</u>	<u>Nam Suai</u>	<u>Huai Luang</u>	<u>Total</u>
-Watershed in Basin	km ²	3,310	1,250	4,100	8,660
-Estimated Annual Runoff	MCM	761	287	940	1,988
-Completed Project					
Large Scale	No.	0	1	1	2
Middle Scale	No.	1	0	2	3
Small Scale	No.	15	30	45	90

Note: excluding SSIP by ARD, DDP, etc.

1.1. Present Conditions

1.1.1. Huai Mong Basin

The Huai Mong river is one of tributaries of the Mekong river which in this area forms the border between of Kingdom of Thailand and the Laos DPR. The Huai Mong river basin with a drainage area of 3,310 km² consists of three (3) sub-basins, such as upper, middle and lower sub-basins.

(1) Upper Sub-basin Area

This river basin is surrounded by mountainous ranges with an elevation of about 600 to 700m in west and 300 to 500m in east and north. An drainage area of 1,307 km² in the upper basin is mainly divided into three (3) basins, that is, the Huai Nam Bon river basin in the southern part, the Huai Mong river basin in western and the Huai Khang river basin in northern. In each basin, the river system consists of the several tributaries which runoff water from the mountain range into the main river course of Huai Mong through a valley located in vicinity of Ban Na Ang.

Along the profile in several tributaries, a few diversion works are operated for water supply and irrigation in dry season. From topographic point of view, river basins except the Huai Nam Bon basin, have much potentialities on water resources development due to introduce a reservoir. Most of cultivated lands, which are located along the river course, are not irrigated during the dry season due to no irrigation facility. The Huai Nam Bon river basin area has no suitable site for construction of large and middle scale water storage facility, because the area is already well developed and many villages is located and many peoples are lived in.

(2) Middle Sub-Basin Area

This area is located at between Ban Na Ang and Ban Klang Yai in Changwat Udon Thani with a length of about 35 km and a width of about 23 km, and is surrounded by a very narrow and steep sloped mountain ranges with an elevation of 300 to 500m in west and by rolling lower hill with an elevation of about 200 to 250m in other directions. The water on the Huai Mong river is flowing in the north-eastern part of the area. The paddy fields are extending along the river and its tributaries only due to no water during the dry season. At Ban Ngao, the village peoples want to introduce a reservoir to solve water shortage problem for their life during the dry season. In the western mountainous area, the suitable reservoir site is not founded because of steep and narrow topographic constraint.

(3) Lower Sub-Basin Area

The area is divided into two (2) parts, that is low lying areas surrounded by lower hilly area which extends along the Mekong river, and the mountainous area in north-eastern part of the sub-basin area with the Phu Ya U mountain with an elevation of 588m.

In the low lying area, there is an existing project to make an effort, at eliminating the present conditions of flood and drought in the region and to improve the living standard of rural people in Amphoes Sri Chiangmai and Tha Bo in the Changwat Nong Khai.

The project has an beneficial area of 8,700 ha, which was constructed by the former National Energy Administration from 1982 to 1988 to increase agricultural production in the lower area by

introducing irrigation and drainage facilities and by protecting the area from seasonal flooding of the main river and tributaries.

The Tha Bo regulator at the Huai Mong river mouth under the NEA project, equipped with sluice gates and a two-way pump station, which will prevent the Mekong flood water from entire the basin area and, to drain standing water on the area into the Mekong river when the water level of the Mekong river is higher for gravity drainage.

In the dry season, it will retain two (2) regulating reservoirs which will store water for small scaled irrigation pumping station and will replenish it by pumping from the Mekong river. However, up to present, the pumping station was not operated to lift irrigation water from the Mekong river.

A total area of about 8,700 ha has been well irrigated by 10 small pumping stations with irrigation canals. The area supports a rural population of 30,000 living in 42 villages. On the other hand, an on-farm development scheme is under the implementation now since 1989.

While, in the mountainous area, namely the Huai Thon river basin, a reservoir plan is under the study by the RID. Out of the plan, there are many potential sites to introduce a reservoir in this area.

(4) Findings

When, in the upper and middle sub-basin areas, water resource development is implemented in the future, the proposed reservoir(s) will influence the water resource of the existing project due to store water at the reservoir(s) under the limited water resources conditions. The basin wise water balance study shall be executed based on the water resources in the basin which consist of an inner basin of the project and outer basin of proper project own basin water and utilization of the Mekong river if necessary, before construction of the reservoir(s) in the upper basin area.

1.1.2. Nam Suai Basin

The Nam Suai river drains runoff from an area of about 1,250 km² into the Mekong river. The depressed area along the Nam Suai river is

generally formed with shallow swamps. Many natural shallow lakes and ponds with intermitted water are widely observed along the water course. Elevations usually range from 160 to 170m above the mean sea level(MSL) at low lands and raising to more than 180m at highland. The flat land scarp normally exists along the Nam Suai river and its tributaries where paddy are mostly cultivated. The area is exposed to a water shortage problem due to no larger watershed with wide and dense forest.

The low land with elevations below 162m MSL covers an area of about 100 km². This land frequently subject to flooding from the high water stage of the Mekong river to a depth of 1 to 3m for a long duration. The area at higher land elevation in the low land is also occasionally flooded.

There are a number of former NEA's electrical small pumping irrigation project located along the Mekong river. Some of these projects are under construction by former NEA. On the other hand, the RID has also constructed the reservoir on the Huai So tributary on the right bank of the Nam Suai river. There are number of lakes, ponds and small reservoirs constructed by the Governmental agencies and local farmers.

Farmers occasionally constructed dikes along the tributaries to store water in their artificial ponds for their uses in dry season. These dikes are normally damaged during flood season. However, those ponds are of little use as most of them have no water during the dry season. In the basin, the major constraint on crop production are damages in the cause of floods which occur annually in the flood plain area of the basin and to a certain extent by drought conditions during the dry season.

1.1.3. Huai Luang Basin

The Huai Luang basin is located in the eastern part of the Study area. An drainage area of about 4,100 km² forms about 35 to 45km width and 150 km long along the river profile. While a section of the basin forms as low level in center and level up to both summits in neighboring basins as formed like a ship bottom formation. As for the topographical conditions the basin area is divided into following three (3) sub-basins.

(1) Upper Sub-Basin Area

The area located in upper portion from Changwat Udon Thani forms a mountain range located in the southwest part at 591 m to unglulate 545m in the southeast. The Luang reservoir located at center in the sub-basin. The project is classified into the large scale project under the RID programme, and its constructions were completed in 1952 for the first stage and in 1984 for the second stage, respectively. The water supply operation for crop production is under the obtaining benefit since 1952. The reservoir also is supplying domestic water for the Muang Udon Thani town peoples. The project scale is shown by dimensions:

- Storage Capacity : 113.3 MCM
- Catchment Area : 666.4 km²
- Dam Height : 12.5 m
- Dam Length : 4,900 m
- Storage Water Level : 201 m
- Irrigation Area : 12,800 ha
- Beneficial Area in Wet: 12,800 ha of Paddy Field at EL 170 to 180m
- Beneficial Area in Dry: 1,920 ha of Paddy and 3,840 ha of Vegetables
 - Crop Yield : 4.2 ton/ha of paddy
 - Crop Intensity : about 140%
- Irrigation canals : 57.0 km

The project is well operational now, and has no serious problem within the project area. However, the farm lands and farmers out of the project area are still warring about water shortage during the dry season. The RID has a program to supply water, especially domestic water, for the area by introducing the river dike embankment and a diversion weir at the downstream of the Luang reservoir.

(2) Middle Sub-Basin Area

The middle sub-basin area topographically forms about 40 km width with an elevation of 190 to 200 m at a boundary of the neighboring watershed and 170 m in center of the Luang river. One of major tributaries, the Huai Dan river, joins the main Luang river in this area. Along the Luang river profile in middle part, few numbers of the diversion weir were constructed for domestic water supply and/or irrigation purposes. Most of the undulated water-

shed area is trouble with water shortage during the dry season. There area many small water storage ponds for domestic water use in the hilly area to keep water. Since the area is developed, the suitable sites for construction of large and medium scale reservoirs are not found.

The area is not affected by the Mekong water during the wet season due to the higher elevation land than the high water stage of the Mekong water. Therefore, many paddy fields are observed at the flat plain on the both banks of the main river course and its tributaries.

(3) Lower Sub-Basin Area

As for the lower basin related to the Mekong river, the particular river system is meandering formation along the Luang profile caused by gentle slope and flat plains on the both banks. The topographical elevation of 160 m or less is widely extended along the river profile about 50 km long from estuary to upper direction, and also developing 5 to 10 km cross sectional width. Consequently, many inundation areas, which are uncultivated and/or remained as swampy areas, are located in the flat plain due to the lack of flood protection facilities from the Mekong river and of a drain system to the Mekong river. The water shed with an highest elevation of about 190m is already developed and very shallow.

The area has a fertile soils at the low flat plain with an elevation of less than 170m MSL. However, water shortage problems are also usually attacked this area. The water resources shall be created based on the water resources in the basin which consist of an inner basin of the project and outer basin of proper project own basin in the Study area and utilization of the Mekong river water.

1.2. Problem and Constraint

The upper and middle portions of the Study area are suffering water shortage for not only agriculture but also domestic water supply due to poor facilities to keep water within the area during the dry season. The lower portion of the Study area is troubled with both water shortage and flooding by runoff from the upper catchment area and by back water from the Mekong river.

1.3. Inevitability on Water Resources Development

1.3.1. Water Balance/Operation Analysis

Under such conditions on limited water resource and on much excess water on the flat plains as mentioned before, the water resource shall be effectively utilized for various purposes. The following water balance simulations shall be done in order to make optimum scale, design and alignment of various irrigation and drainage facilities to perform systematic water operation.

The basin wise water resources development analysis aims to explore water resources by saving, better distribution and/or developing/ creating water to solve existing problems and constraint. Especially, between lower portion and middle and upper portions, water balance/operation simulation model shall be established for proper/optimum water distribution system based on the water resources in the basin which consist of an inner basin of the project and outer basin of proper project own basin in the Study area and utilization of the Mekong river water based on available amount of water sources and present and future water demand. By the plan, more irrigation area will be expanded and, stable agricultural productions will be expected.

The various water resources to be developed will be prioritized based on the analysis.

1.3.2. Flood Analysis

A flood simulation analysis in the lower flat plains, which are influenced by high water stages of the Mekong river, shall be executed to clear the present flood conditions. The simulation will present the improvement countermeasures to convert from flooding plains to cultivated lands. On the other hand, the Mekong water with high water table will be considered as one of the water resources to irrigated the flat plains along the Huai Luang river and its tributaries.

1.3.3. Requirement of Technical Assistance

Under the brief study on the present water use state in the Study area, the Feasibility Study aims to promote the available water utilization efficiency to be raised up, so that rotational land use, reclamation in a swampy area in lower basin area and water development

in upper basin may be possible. For this purpose, a plan of approach to study on water balance in three basins should be carried out by a total simulation analysis for long terms about 20 years as much as possible under the computer aided large simulation program which composed of several sub-routines.

One of the sub-routines in the Huai Mong Basin which is composed of a reservoir operation (in upper and left bank basin areas), inter basin of it, and lake operation in lower area may involve operations on pumping, a regulator related with the Mekong water fluctuation. These sub-routines will be composed of several present and future parameters, involving rainfall, infiltration, runoff, evaporation and water requirement from the agricultural field and domestic and rural industrial water demand, etc.

Under these component sub-routine, the water balance study on each basin will be carried out by the simulation on the daily or weekly basis depend upon available basic local data for long terms. One of recommendable water development plan will be obtained from as a result of the simulation analysis of various alternative approaches.

In connection with the plan of approach to simulation analysis with many parameters involved in the large scale of a basin, the technical assistance is required to help the water balance study in the basins due to much complicate studies. This is one of required assistance task for the water balance study involved own river basin and the Mekong water as new water development of tributaries as major significant assistance requirement. Likewise, as per the water balance study, the project formulation and evaluation will be also required by the technical and economical assistant.

II. OBJECTIVES OF STUDY

2.1. Objectives of the Study

The objectives of the integrated agricultural and water resources development study shall be carried out by quantity, quality and time variation basis. The study is to increase available water resources in the river basins, to establish an effective utilization plan on irrigation water, and to reduce flooding areas in lower basin area related with flood water levels of the Mekong river as well as to

reclaim a new area for irrigated agriculture. Major constraints to increase crop yields are damages by floods which annually occur in the flood plain area, by drought conditions, and by lack of facilities during the rainy and dry seasons. To solve such problems, the integrated water resources development plan shall be established based on the water resources in the basin which consist of an inner basin of the project and outer basin of proper project own basin in the Study area and utilization of the Mekong river water if necessary.

2.2. The Study Area

The Study area is located at the northeastern region of Thailand, which covers part of both Changwats of Udon Thani and Nong Khai. The area covers about 86.6 km² and its population is 1.23 million in 1990. The study area mainly covers two (2) Changwat areas, namely Udon Thani and Nong Khai which have an area of 6,830 and 1,830 km² with in the Study area, respectively. Major features of both areas are summarized as follows;

Item	Udon Thani	Nong Khai	Total
Population	861,980	368,490	1,230,470
- Male	425,990	183,280	609,270
- Female	436,000	185,210	621,210
- Household	111,420	64,740	176,160
Total Area (ha)	682,320	183,300	865,620
Agricultural Land (ha)	249,800	67,110	316,910 (100%)
- Paddy field (ha)	158,040	42,460	200,500 (63)
- Upland field (ha)	81,970	22,020	103,990 (33)
- Tree area (ha)	6,320	1,700	8,020 (3)
- Flower area (ha)	3,440	920	4,360 (1)
- Others (ha)	40	10	50 (0)
Others (ha)	432,520	183,300	615,820

The family size of both Changwat are 7.7 persons per household in Udon Thani and 5.7 persons per household in Nong Khai.

III. PROPOSED INTEGRATED AGRICULTURE AND WATER RESOURCES DEVELOPMENT PROJECT

The Study will be divided into two (2) Phases, namely, Phase-I and Phase-II Studies. During the Phase-I study, the master plan on the Integrated Irrigation Water Operation Plan will be proposed, and during the Phase-II study, the feasibility study on the selected priority project(s) will be carried out.

3.1. Phase-I Study (Master Plan Study)

3.1.1. Comprehensive Water Balance in Basins

The Study area of about 8,660 km² is mainly divided into three (3) river basins, such as Huai Mong with a drainage area of 3,310 km², Nam Suai with 1,250 km² and Huai Luang with 4,100 km². Based on the mean annual rainfall of 1,481 mm and runoff coefficient of 15.5% at KH 18 on the Huai Mong river, these river basins annually produce huge surface runoff of 1,987 million m³ from three (3) river basins. However, most part of this water resources of 1,799 billion m³ (about 90%) is flowed out in wet season. During dry season that lands want water for irrigation, the small amount of 188 billion m³ is available.

In those basin areas, many water utilization facilities are individually planned and constructed without any optimum water utilization plan at present. The RID has three (3) medium scale reservoir projects in the Study area, and each project has no relation of water resources within a river basin. The RID has five (5) proposed projects in Changwat Udon Thani and two (2) in Changwat Nong Khai. Before implementing those projects, the comprehensive irrigation water balance study shall be made by considering optimum water uses for various development ideas of the area in order to solve and avoid such problems and/or constraint. Because the uncontrolled development of water resources and lands in the river basin areas will invite unrecoverable environmental destruction.

The Study consists of four (4) major analysis, such as (1) the potential water resources by basin, (2) estimating the present water demand to clear the existing water condition and problems/constraint, (3) forecasting future water demand in agricultural field, and (4) carrying out the water balance based on the above various conditions. From point of view water operation, watershed area management and

agricultural land use in the river basin will also be studied during the Study period. The Study should be carefully carried out from economic points of view, especially water cost to be developed and maintained

3.1.2. Irrigation and Drainage Development

The Study area has many potentialities on irrigation development. From the point of view no rain and more advantages on agricultural productivity in dry season, irrigation water shall be kept for irrigation in the certain places. The irrigation facilities also can supply domestic water for the rural peoples during the dry season from October to May. The following development projects on irrigation development will be expected under the said comprehensive water operation plan.

(1) Huai Mong River Basin Development

Since the Huai Mong river basin consists of mountainous and plain areas, there are various suitable sites for reservoirs to store the necessary water for dry season. The proposed four (4) reservoirs can irrigate about 58,100 rai (about 9,300 ha) in wet season and about 26,750 rai (about 4,280 ha) in dry season with a crop intensity of about 146%. The proposed crops are paddy in wet season and cash crops like vegetables, beans, vegetables, etc. The project also can supply domestic water for about 13,100 rural peoples who are living in and around the benefit areas. Dam heights are less than 33 m and length less than 3,900 m in maximum. A reservoir capacity is 38.7 MCM in maximum. The total irrigation canal length of 46.5 km will be needed to irrigate above acreage.

(2) Nam Suai River Basin Development

In the Nam Suai river basin, the Nam Suai project is proposed to take irrigation water from the Mekong river. The project covers the total beneficial areas during wet and dry seasons are about 100,400 rai (about 16,070 ha) and 78,200 rai (about 12,510 ha), respectively. Therefore, crop intensity of about 160% will be expected. The project component consists of a regulator, a feeder canal, a pump station, a reservoir, dikes, 34 small scale irrigation pump stations located around the reservoir and 63km of irrigation canals.

(3) Lower Huai Luang River Basin Development

Another irrigation development scheme, which takes irrigation water from the Mekong river during the flood period and supply water to fields by small scale pump and/or portable pump during the dry season, covers about 50,000 rai (about 8,000 ha) of farm lands in the lower Huai Luang area, which elevation of lands are less than 170 m. The crops to be introduced the irrigated area are as the same as the above mentioned irrigation area. A regulator will be considered to keep water in the river course for irrigation. The farmers shall prepare small scale pump and/or portable pump equipment. The total irrigation canal of 32 km will be proposed.

(4) Middle Reach of Huai Luang River Basin Development

At the middle reaches of the Huai Luang river, several diversion weirs will be proposed to keep water for wet season irrigation for farm lands around the rivers. The total irrigation area of about 100,000 rai (about 16,000 ha) will be irrigated by small scale pump and/or portable pump due to topographic constraint in this area. The irrigation area is located at lands with an elevation of below 180 m along the river. The project components consist of diversion weirs, river dike treatments, irrigation canals and small pump stations along the river. The 35 small pump stations and the total irrigation canal length of 39 km will be needed to supply irrigation water to fields.

(5) Selection of Priority Project(s)

During the Phase-I Study period, the priority project(s) shall be selected among the various projects under the Master Plan Study based on assessment on various fields.

3.1.3. Agricultural Development

On introducing the various irrigation facilities in the Study area, the agricultural development as a soft-wear field, such as new farming technique on not only paddy cultivation and also other crops, post harvest, research and extension service, agricultural credit, etc., shall be studied to product the maximum farm benefits with minimizing the investment cost.

A part of the Study area, which is located along the Mekong river, has big potentiality for dry season vegetables like baby corn, tomatoes, tobacco, because of fertile soils in those areas. Those crops not only will bring big benefit to the farmers in the area, but also will create much employ opportunity.

3.2. Phase-II Study (Feasibility Study on Priority Project(s))

During the Phase-II study period, the feasibility study on the selected project(s) shall be carried out toward to implementation. The feasibility study consists of the necessary fields. (refer to attached Figures)

3.3. Expected Project Benefit

The incremental agricultural production is estimated at 64,200 ton of paddy during the wet season (present paddy production of 74,100 tons from the beneficial area of 49,370 ha and proposed 167,900 tons from the same area). The yields at present and proposed are 1.5 ton/ha (237 kg/rai), 3.4 ton/ha (550 kg/rai), respectively. The net beneficial areas of wet and dry seasons are estimated at 49,370 ha and 16,790 ha, respectively.

The net benefit from paddy and representative vegetables of groundnut are preliminarily calculated at 394.0 million baht and 307 million baht, respectively. The total annual benefit preliminarily amounts at 701.9 million baht.

3.4. Preliminary Project Cost Estimate

The necessary costs to develop those project areas are preliminarily estimated at about 5,600 million Baht.

3.5. Preliminary Economic Evaluation

The benefit from the project is calculated at based on the aforesaid figures. The EIRR of 13.5% is preliminarily calculated.

IV. SCOPE OF WORK FOR THE STUDY

The scope of work for the study is as follow:

(1) Review of Developing Progress Work in the Basins

Reviewing all existing study reports, data and informations at present states for the developing progress work in the basins :

- Water Sources in the River Basin
- Land Use and Crop Production
- Flood and Drought Damages

(2) Water Resource Availability in the Basin

To conduct available water source finding in the basins, study and /or analysis based on the hydrological data from existing records for long period as much as possible.

- Hydrological Analysis in the Basin
- Reservoir Operation Study
- Inundation Study by the Mekong River and its Tributaries in the Basin
- Simulation Analysis for Water Balance in the Basin, Inter Basin and the Mekong Water Utilization

(3) Development of Irrigation and Drainage

To conduct survey and study on the existing irrigation canals, drainage system, pumping functions, regulation reservoir related to water requirement and present rainfed system.

- Irrigation Water Requirement
- Irrigation and Drainage Canal System
- Pumping Irrigation System and Regulation Reservoir
- Improvement of Traditional Rainfed Area

(4) Improvement of Agricultural Farming

To conduct survey and study on the summer crops, new crops in second crops and cash crops in green house related to marketing availability and land use as well as soil texture.

- Land Classification and Soil Survey
- Cropping Pattern in Wet and Dry Seasons
- Introduction of Farm Modernization
- Marketing Research

(5) Plan of Facilities

To conduct survey and study on the facility plan, including dam, diversion work, regulator, reservoir and irrigation & drainage canal system.

- Dam and Reservoir
- Irrigation and Drainage Canal System
- Regulator and Reservoir

(6) Construction Plan and Cost Estimation

To conduct survey and cost estimation for project implementation of facilities, including civil work, procurement of equipment and construction management as well as financial proposal.

- Dam and its Reservoir Construction Work
- Irrigation & Drainage Construction Work
- Regulator and its Reservoir Construction Work
- Project Cost

(7) Plan of Operation & Maintenance Services

To conduct survey and study on water operation at each basin, subject on water operation, management and control through reservoir and regulator operation related to rainfall, runoff and water level fluctuation on the Mekong river

- Huai Mong Basin
- Nam Suai Basin
- Huai Luang Basin

(8) Implementation Programme

(9) Environmental Assessment

(10) Project Evaluation

The time schedule for the study refers to Figure-1.

V. ASSISTANCE PERIOD AND ASSIGNMENT OF EXPERTS

5.1 Assistance Period

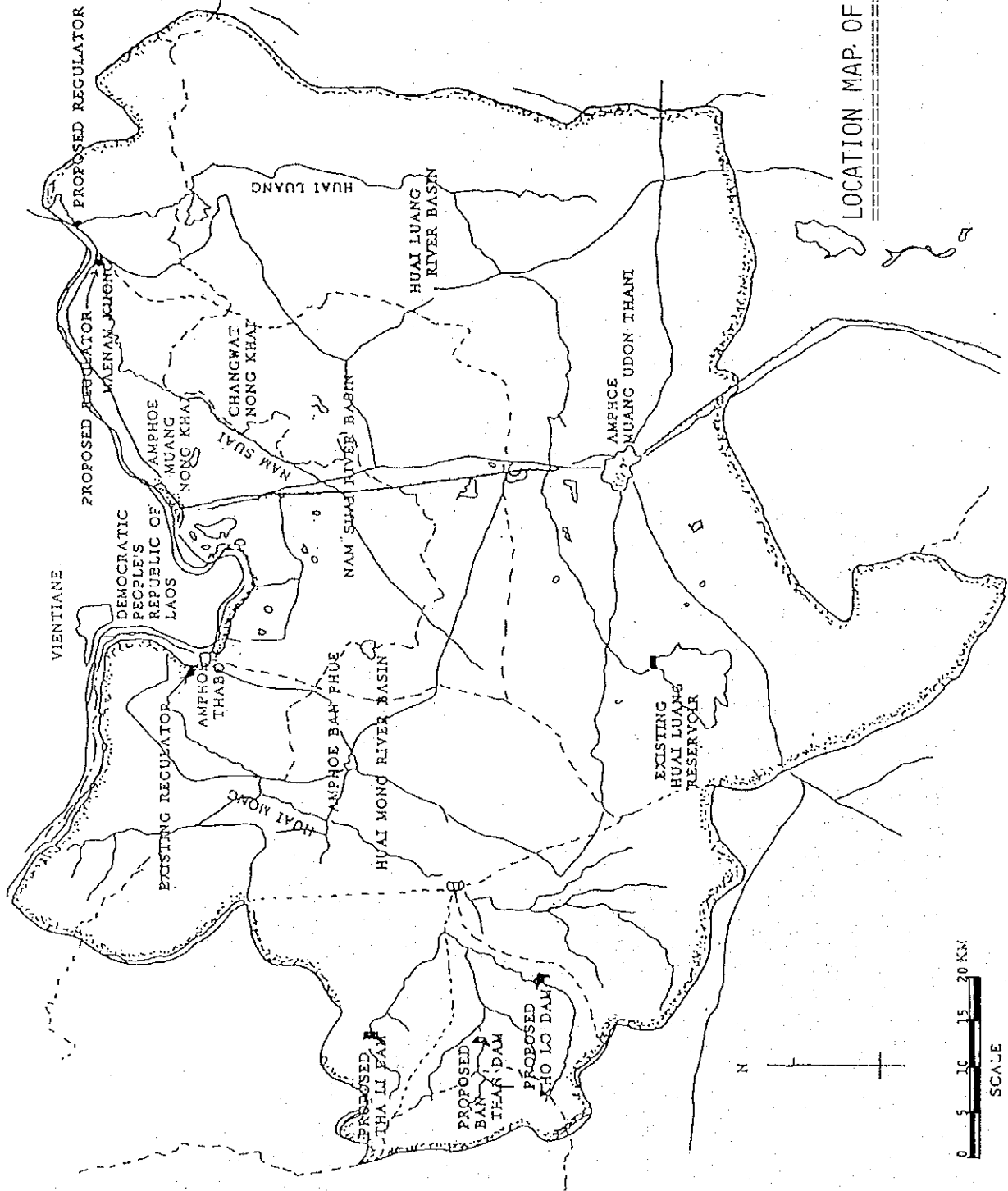
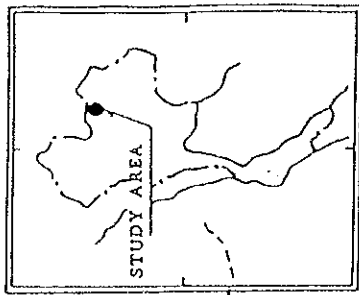
The assistance period is tentatively proposed about eighteen months in fiscal two years which is divided into two phases studies. The Phase-I work covers nine months for prefeasibility study including preparation of basic concept. Consequently the Phase-II work also covers nine months for feasibility study on the project formulation. While preparation of the topographical maps and geological survey work will be executed by the RID at time being six months between end of the Phase-I to Phase-II. Detailed work schedule is shown in the attached paper of Figure-1.

5.2 Assignment of Experts

Under the assistance period, the following experts are proposed to assign for the work schedule in the Figure-1. The manning schedule is prepared in the attached paper Figure-2.

Assignment of Experts	1st year			2nd year			Total
	Phase - I			phase - II			Sum
	Site	Home	Sum	Site	Home	Sum	
1. Team Leader/Planning	6	3	9	5	4	9	18
2. Irrigation/Drainage	6	3	9	4	2	6	15
3. Hydrology	6	3	9	2	2	4	13
4. Water Management	6	3	9	1	2	3	12
5. Plan of Facility - A	3	1	4	4	4	8	12
6. Plan of Facility - B	3	1	4	3	5	8	12
7. Basin Conservation	3	-	3	2	2	4	7
8. Construction Plan/Cost Estimation	2	1	3	3	5	8	11
9. Agriculture/Soil	6	3	9	3	3	6	15
10. Agro-Economy	3	-	3	2	3	5	8
11. Environmental Assessment	2	1	3	2	3	5	8
<u>Total</u>	<u>46</u>	<u>19</u>	<u>65</u>	<u>31</u>	<u>35</u>	<u>66</u>	<u>131</u>

Notes : Every experts who will perform technical transfer at site work within two weeks in Phase - I stage and within four weeks in Phase - II stage.



LOCATION MAP OF THE STUDY AREA

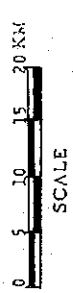
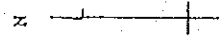


Figure - 1 WORK SCHEDULE OF FEASIBILITY STUDY

DESCRIPTORS	M O N T H S																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Phase - I Study (Feasibility Study)																		
2. Survey Work (Topography and Geology)																		
3. Phase - II Study (Feasibility Study)																		
1. Review of Developing Program Work in the Basin																		
- Water Sources in the River System																		
- Land Use and Crop Production																		
- Flood and Drought Damages																		
2. Water Sources Availability and Balance																		
- Hydrological Analysis in the Basin																		
- Reservoir Operation Studies																		
- Foundation Study by Mekong River and Tributaries in the Basin																		
- Simulation Analysis for Water Balance in the Basin																		
3. Development of Irrigation and Drainage																		
- Irrigation Water Requirement																		
- Irrigation and Drainage Canal System																		
- Pump Irrigation System and Regulation Reservoir																		
- Improvement of Traditional Refined Area																		
4. Improvement of Agricultural Farms																		
- Land Classification and Soil Survey																		
- Cropping Pattern in Summer Crops																		
- Introduction of New Crops in Winter																		
- Cash Crops in Green House																		
- Marketing Research																		
5. Plan of Facilities																		
- Dam and Reservoir																		
- Irrigation and Drainage Canal System																		
- Pumping Station and Regulation Reservoir																		
6. Construction Plan and Cost Estimation																		
- Dam and Reservoir Work																		
- Irrigation and Drainage Work																		
- Pumping Station and Reservoir Work																		
- Project Cost																		
7. Plan of Operation & Maintenance Services																		
- Hual Mong Basin																		
- Nam Sual Basin																		
- Hual Luang Basin																		
8. Implementation Programme																		
9. Environmental Assessment																		
10. Project Evaluation																		

Figure - 2 MANNING SCHEDULE

ASSIGNMENT OF EXPERTS	PHASE - I											PHASE - II							SITE HOME WORK	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
1. Team Leader/Planning	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	11	7
2. Irrigation/Drainage	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	10	5
3. Hydrology	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	8	5
4. Water Management	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	7	5
5. Plan of Facility - A	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	7	5
6. Plan of Facility - B	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	6	6
7. Basin Conservation	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	5	2
8. Construction Plan/Cost Estimation	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	5	6
9. Agriculture/Soil	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	9	6
10. Agro - Economy	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	5	3
11. Environmental Assessment	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	4	4
TOTAL																			77	54

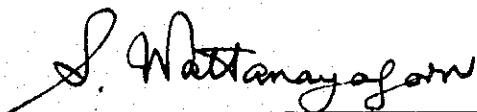
Notes : (1) : Site Work
 (2) : Home Work
 (3) : Technical Transfer Period.

実施細則 (S/W)

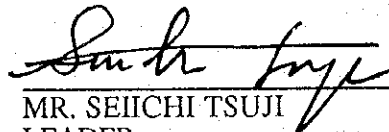
SCOPE OF WORK
FOR
THE MASTER PLAN STUDY
ON
THE INTEGRATED AGRICULTURE AND WATER RESOURCES DEVELOPMENT
PROJECT
OF HUAI MONG, NAM SUAI AND HUAI LUANG RIVER BASIN
IN
THE KINGDOM OF THAILAND
AGREED UPON BETWEEN
ROYAL IRRIGATION DEPARTMENT
AND
JAPAN INTERNATIONAL COOPERATION AGENCY

BANGKOK

DECEMBER 20, 1994



MR. SAWAD WATTANAYAGORN
DIRECTOR GENERAL
ROYAL IRRIGATION DEPARTMENT
MINISTRY OF AGRICULTURE
AND COOPERATIVES



MR. SEIICHI TSUJI
LEADER
PREPARATORY STUDY TEAM
JAPAN INTERNATIONAL
COOPERATION AGENCY

I. INTRODUCTION

In response to the request of the Government of the Kingdom of Thailand, the Government of Japan has decided to conduct a Master Plan Study on the Integrated Agriculture and Water Resources Development Project of Huai Mong, Nam Suai and Huai Luang River Basin (hereinafter referred to as "the Study"), within the general framework of technical cooperation between Japan and Thailand, which is set forth in the Agreement on Technical Cooperation between the Government of Japan and the Government of the Kingdom of Thailand signed on November 5, 1981.

Accordingly, the Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of the technical cooperation programs of the Government of Japan, will undertake the Study in close cooperation with the authorities concerned of the Government of the Kingdom of Thailand.

The present document sets forth the Scope of Work with regard to the Study.

II. OBJECTIVES OF THE STUDY

The objectives of the Study are:

1. To conduct a Master Plan Study on the Integrated Agriculture and Water Resources Development Project of Huai Mong, Nam Suai and Huai Luang River Basin, and
2. To carry out technology transfer to the Thai counterpart personnel in the course of the Study.

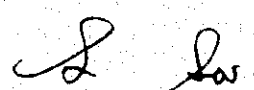
III. STUDY AREA

The Study Area covers approximately 8,660km² along the Huai Mong, Nam Suai and Huai Luang River Basin, in Northeastern Region.

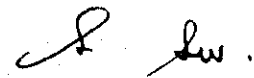
IV. SCOPE OF THE STUDY

In order to achieve above objectives, the Study will cover the following items;

1. To collect and review relevant existing data and information
 - 1) Natural condition
 - 2) Social and Economic condition
 - 3) Water resource development
 - 4) Irrigation and drainage
 - 5) Inundation
 - 6) Agriculture
 - 7) Agroecconomy
 - 8) Environment
 - 9) Others



2. To review the existing projects and plans by RID in the study area
3. To review the related projects and plans by other organization in the study area
4. To carry out the initial field survey for understanding the present condition
 - 1) Agricultural water resource development in upper basin of three rivers
 - 2) Inundation in lower basin of three rivers
 - 3) Others
5. To analyze collected initial data
6. To identify potentials, problems and constraints against development of the study area
7. To make basic concept for development
 - 1) Overall agricultural development plan
 - 2) Selection of priority area(s) and project(s)
8. To carry out the detail field survey on the priority area
9. To analyze collected detail data
10. To prepare master plan
 - 1) Agricultural water resource development
 - 2) Improvement of inundation
 - 3) Irrigation and drainage
 - 4) Water management
 - 5) Land use planning
 - 6) Farming system and cropping pattern
 - 7) Rural infrastructure development
 - 8) Agricultural organization and supporting services
 - 9) Outline design of main facilities
 - 10) Operation and maintenance plan for major structure
 - 11) Environment impact
 - 12) Project implementation schedule
 - 13) Estimation of project costs and benefits
11. Recommendation



V. STUDY SCHEDULE

The study will be carried out in accordance with the attached tentative work schedule.

VI. REPORTS

JICA shall prepare and submit the following reports in English to the Government of the Kingdom of Thailand.

1. Inception Report

Twenty (20) copies at the commencement of the Study.

2. Progress Report

Twenty (20) copies during the field work in the Kingdom of Thailand.

3. Interim Report

Twenty (20) copies at the end of field work in the Kingdom of Thailand

4. Draft Final Report

Twenty (20) copies work in Japan. The Government of the Kingdom of Thailand will provide JICA with its comments on the Draft Final Report within one (1) month after receipt of the Draft Final Report.

5. Final Report

Fifty (50) copies within two (2) months after the receipt of the comments of the Government of the Kingdom of Thailand on the Draft Final Report.

VII. UNDERTAKING OF THE GOVERNMENT OF THE KINGDOM OF THAILAND

1. To facilitate smooth conduct of the study, the Government of the Kingdom of Thailand shall take necessary measures ;

1-1. to secure the safety of the Japanese study team,

1-2. to permit the members of the Japanese study team to enter, leave and stay in the Kingdom of Thailand for the duration of their assignment therein, and exempt them from foreign registration requirements and consular fees,

1-3. to exempt the members of the Japanese study team from taxes, duties, fees and any other charges on equipment, machinery and other materials brought into the Kingdom of Thailand for the conduct of the study,

1-4. to exempt the members of the Japanese study team from income tax and charges of any kind imposed on or in connection with any emoluments or allowances paid to the members of the Japanese study team for their services in connection with the implementation of the Study,

1-5. to provide necessary facilities to the Japanese study team for the remittance as well



as utilization of the funds introduced into the Kingdom of Thailand from Japan in connection with the implementation of the Study,

- 1-6. to secure permission for entry into private properties or restricted areas for the implementation of the Study,
 - 1-7. to secure permission for the Japanese study team to take all data and documents (including maps and photographs) related to the Study out of the Kingdom of Thailand to Japan,
 - 1-8. to provide medical services as needed. Its expense will be chargeable on the members of the Japanese study team.
2. The Government of the Kingdom of Thailand shall bear claims, if any arises, against the members of the Japanese study team resulting from, occurring in the course of, or otherwise connected with, the discharge of their duties in the implementation of the Study, except when such claims arise from gross negligence or willful misconduct on the part of the members of the Japanese study team.
 3. Royal Irrigation Department, Ministry of Agriculture and Cooperatives (hereinafter referred to as "RID") shall act as counterpart agency to the Japanese study team and also as coordinating body in relation with other governmental and non-governmental organizations concerned for the smooth implementation of the Study.
 4. RID shall, at its own expense, provide the Japanese study team with the following, in cooperation with other organizations concerned :
 - 4-1. available data and information related to the Study,
 - 4-2. counterpart personnel,
 - 4-3. suitable office space with necessary equipment in Bangkok and project site(s),
 - 4-4. credentials or identification cards, and
 - 4-5. necessary number of vehicles with drivers for field trip.

VIII. UNDERTAKING OF JICA

For the implementation of the Study, JICA shall take the following measures ;

1. To dispatch, at its own expense, study teams to the Kingdom of Thailand, and
2. To pursue technology transfer to the Thai counterpart personnel in the course of the Study.

IX. OTHERS

JICA and RID shall consult with each other in respect of any matter that may arise from or in connection with the Study.



TENTATIVE WORK SCHEDULE

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Work in Thailand		█								█											
Work in Japan							▬	▬	▬	▬	▬	▬									
Submission of Reports	▲			▲			▲			▲		▲	F/R								
				P/R			IT/R			DF/R											

(Note) IC/R : Inception Report
P/R : Progress Report
IT/R : Interim Report
DF/R : Draft Final Report
F/R : Final Report

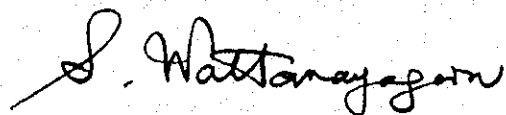
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MINUTES OF MEETING
ON
THE SCOPE OF WORK
FOR
THE MASTER PLAN STUDY
ON
THE INTEGRATED AGRICULTURE AND WATER RESOURCES DEVELOPMENT
PROJECT
OF HUAI MONG, NAM SUAI AND HUAI LUANG RIVER BASIN
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MR. SEICHI TSUJI
LEADER
PREPARATORY STUDY TEAM
JAPAN INTERNATIONAL
COOPERATION AGENCY


The Preparatory Study Team (hereinafter referred to as "the Team") organized by the Japan International Cooperation Agency (hereinafter referred to as "JICA"), headed by Mr. Seiichi TSUJI, visited the Kingdom of Thailand from December 11 to 22, 1994 for the purpose of discussing and confirming the Scope of Work for the Master Plan Study on the Integrated Agriculture and Water Resources Development Project of Huai Mong, Nam Suai and Huai Luang River Basin (hereinafter referred to as "the Study").

The Team had a series of discussions with the officials concerned of Royal Irrigation Department, Ministry of Agriculture and Cooperatives (hereinafter referred to as "RID") on the Scope of Work for the Study. The list of participants in a series of meetings is attached in the Annex.


As a result of the discussions, RID and the Team agreed on the Scope of Work for the Study.

The following are the main issues discussed and agreed upon by both sides in relation to Scope of Work for the Study.

1. RID fully understood the explanation by the Team that the Study shall be the master plan study in the requested area.
2. According to the result of the Study, RID shall request the feasibility study to the Government of Japan.
3. The Study should be sufficiently investigated all potential water resources in order to identify development potentials considering economic, social and environmental aspects.
4. RID shall coordinate with other organization and agency including Mekong Secretariat.
5. The Study shall be considered about the utilization of the Mekong River water, if necessary.
6. RID shall assist to collect data and information regarding the other projects conducting under other organization and agency.
7. RID shall provide the data of the existing projects and plans in the study area, including topographic map (scale : 1/50,000) of the study area.



8. After completion of the study, all maps and data shall be returned to RID.
9. RID shall provide the Japanese study team with suitable offices, each in Bangkok and project sites, equipped with electricity, water supply, telephones, desks, chairs and so on.
10. RID requested that the following equipment necessary for the Study be procured by JICA and be donated to RID after the termination of the Study.
 - Office equipment such as personal computer and note type computer, etc.
 - GPS
11. RID shall provide necessary numbers of counterpart personnel, at its own expenses, who are qualified governmental officials, during the whole Study period.
12. RID requested the counterpart training in Japan and to assist the seminar holding in Thailand.

 Sw.

LIST OF PARTICIPANTS

RID

Mr. Sawad Wattanayagorn	Director General
Mr. Roongrueng Chulajata	Deputy Director General for Engineering
Mr. Kitcha Polparasi	Deputy Director General for Operation & Maintenance
Mr. Charoon Kamolratana	Director of Project Planning Division
Mr. Suwit Thanopanuwat	Water Resources Expert, Project Planning Division
Mr. Vudhichai Chullakesa	Chief of Planning Section 3, Project Planning Division

JICA Study Team

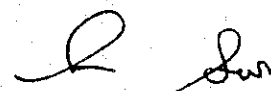
Mr. Seiichi Tsuji	Leader
Mr. Toshimitsu Miyamori	Member
Mr. Hisao Tsukamoto	Member
Mr. Hideo Osawa	Member
Mr. Masayuki Honjou	Member

JICA Expert

Mr. Koichi Yamazaki	RID
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JICA Thailand Office

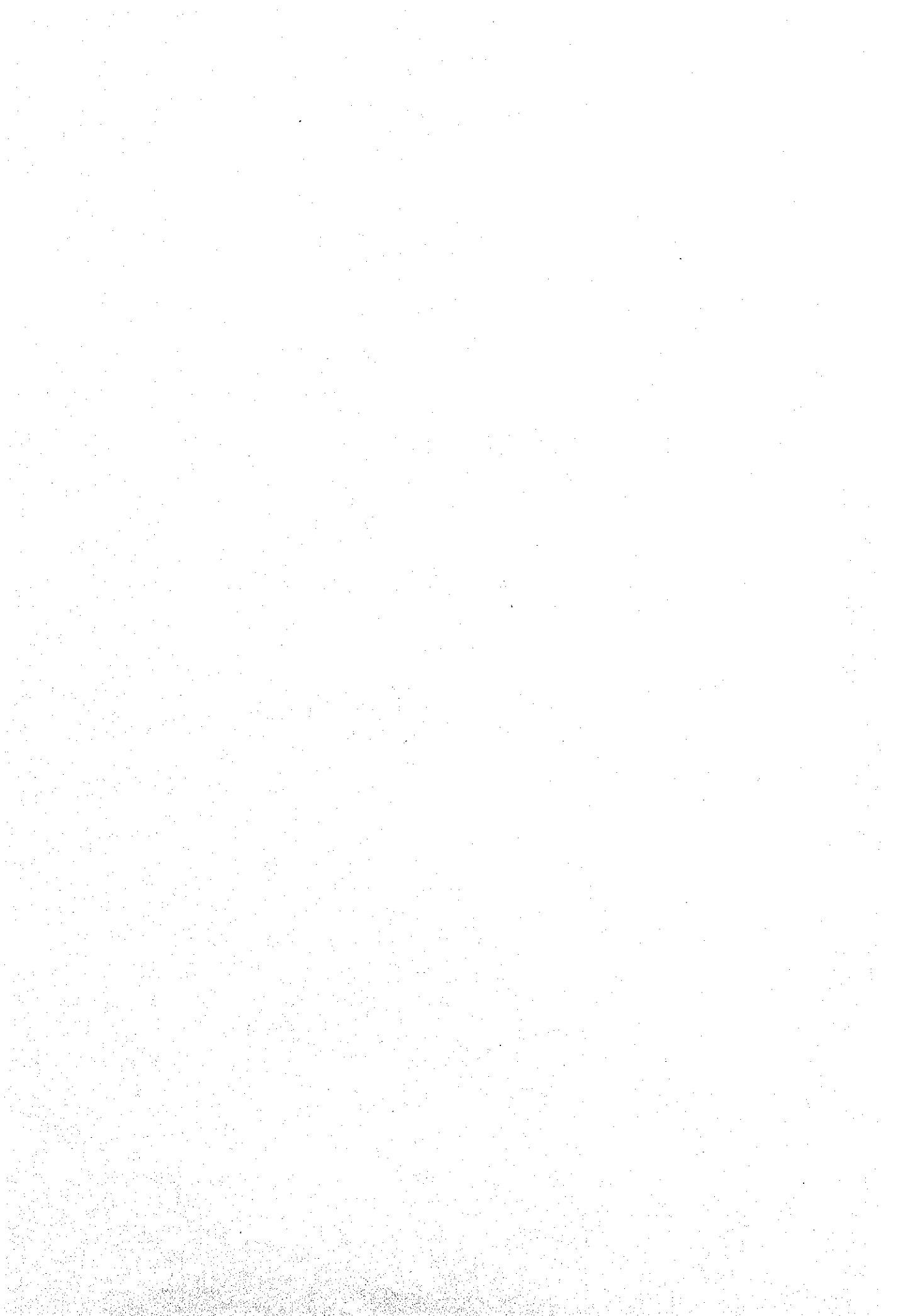
Mr. Naoto Hattori	Assistant Resident Representative
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17. Mean Annual Runoff Yield and Drainage Area of River Basin in Thailand
18. Climatological Data of Thailand 30 Years Period (1961～90)
19. かんがいプロジェクトリスト(1993年)
20. Water Resources Development in Thailand - Small Scale Irrigation Project, 1988
21. Water resources Development Project - Large/Medium Scale Project, 1988
22. Water Resources Development Project, Nong Bua Lampoo Provincial Office, Up to 1994
23. Water resources Development Project, Udon Tani Provincial Office
24. Description of Udon Tani RID Provincial Office
25. Upper Huai Luang Dam Project, Udon Tani, 1981
26. Upper Huai mong Irrigation Development Pre-feasibility Study, 1990
27. Environmental Impact Assessment in Thailand, 1992
28. タイかんがい技術センター計画 (フェーズII)
29. History of IEC Project
30. Agricultural Statistic of Thailand, Crop Year 1992/93
31. Pocket Thailand Figures, 1994

32. Feasibility Study of Nam Suai Basin
 - Main Report
 - Annex A: Soil Survey and Land Classification
 - Annex B: Hydrology and Water Resources
 - Annex C: Engineering Plan and Estimates
 - Annex D: Topographic Survey and Geotecnic Investigation
 - Annex E: Agriculture and Institutions
 - Annex F: Environmental Impact Assessment
33. Summary of Irrigation for Rice Cropping Year 1993 - Huai Luag Irrigation Project
34. Summary of Huai Luang Dam Project
35. Description of Huai Luang Project
36. Huai Luang Irrigation Project
37. Huai Luang Irrigation Scheme Map
38. Huai Mong Project
39. Huai Mong Project, Irrigation Scheme Map
40. The National Energy Administration Regulation for the Requisition of Pumping Service from Electrical Pumping Station of NEA
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42. Nong Kai Province, 93年度農產物生產量
43. Kong-Chi-Mun Project
44. Maps : Scale 1/50,000
45. Udon Tani RID Provincial Office Map, 1/250,000



JICA