No.

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR THE REHABILITATION
OF
THE KANDAL STUNG IRRIGATION SYSTEM
IN
THE KINGDOM OF CAMBODIA

DECEMBER 2004

JAPAN INTERNATIONAL COOPERATION AGENCY

NIPPON KOEI CO., LTD.

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PREFACE

In response to a request from the Government of Cambodia, the Government of Japan decided to conduct a basic design study on the Project for the Rehabilitation of the Kandal Stung Irrigation System in the Kingdom of Cambodia and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Cambodia a study team from November 10, 2002 to October 8, 2004.

The team held discussions with the officials concerned of the Government of Cambodia, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Cambodia in order to discuss a draft basic design, and as this result, the present report was finalized.

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

I wish to express my sincere appreciation to the officials concerned of the Government of Cambodia for their close cooperation extended to the teams.

December, 2004

Seiji Kojima

President
Japan International Cooperation Agency

December, 2004

Letter of Transmittal

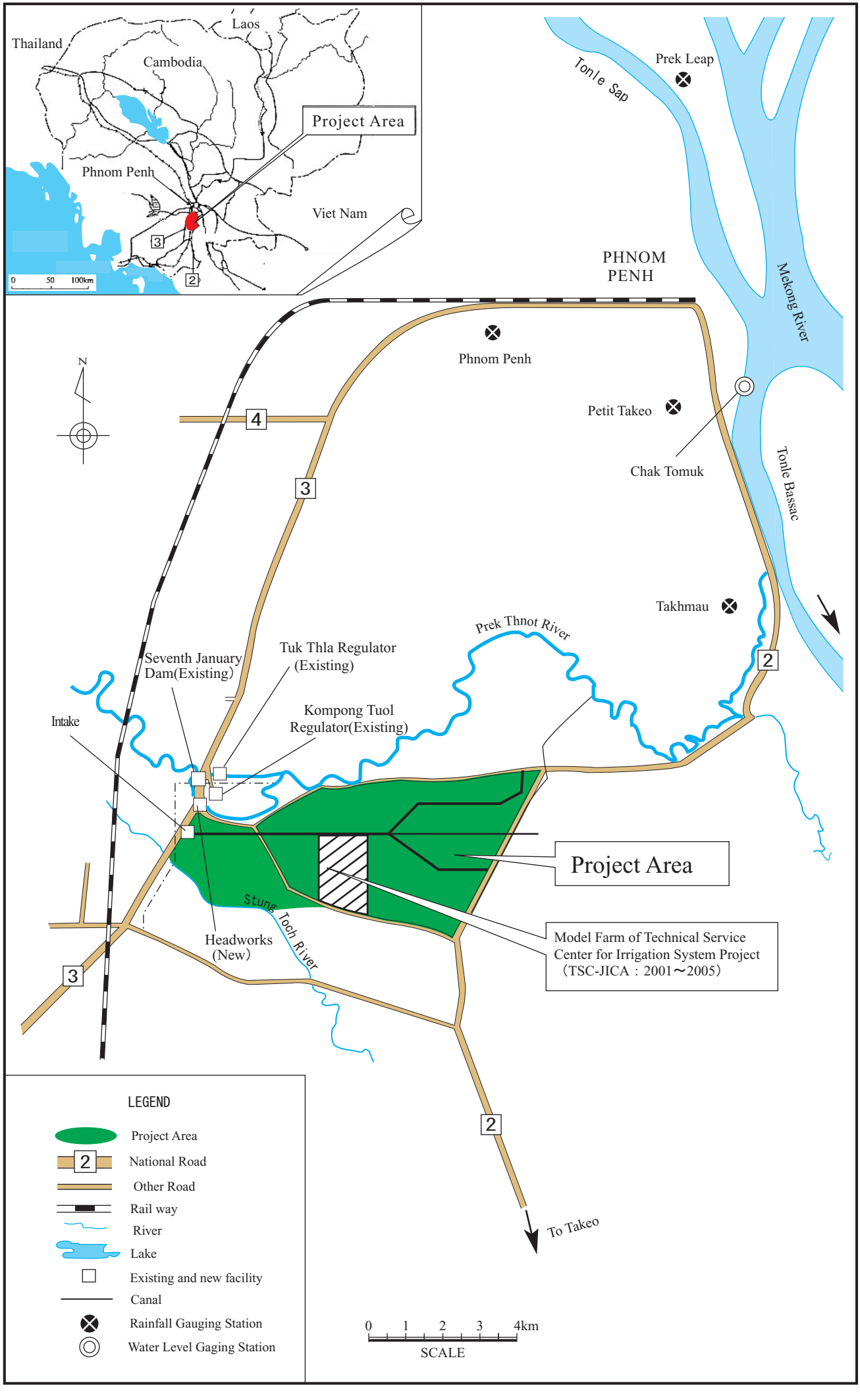
We are pleased to submit to you the basic design study report on the Project for the Rehabilitation of the Kandal Stung Irrigation System in the Kingdom of Cambodia.

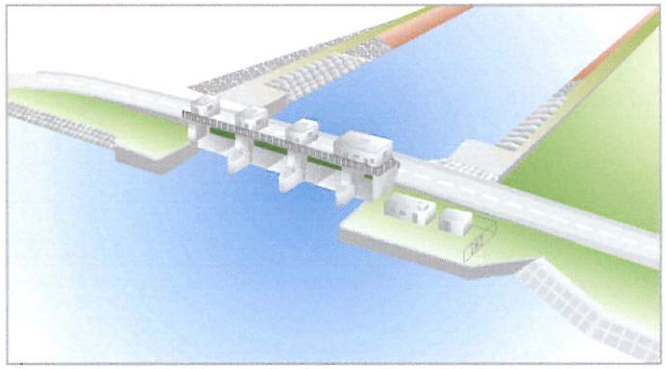
This study was conducted by Nippon Koei Co., Ltd., under a contract to JICA, during the period from November, 2002 to December, 2004. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Cambodia and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Toshikazu Kambara
Chief Consultant,
Basic design study team on
The Project for the Rehabilitation of the Kandal Stung Irrigation System in the Kingdom of Cambodia
Nippon Koei Co., Ltd.


Thailand
Laos
Cambodia
Project Area
Phnom Penh
Viet Nam
0 50 100km
Tonle Sap
Prek Leap
PHNOM PENH
Mekong River
Phnom Penh
Petit Takeo
Chak Tomuk
Tonle Bassac
Takhmau
Prek Thnot River
Seventh January Dam(Existing)
Tuk Thla Regulator (Existing)
Kompong Tuol Regulator(Existing)
Intake
Project Area
Stung Toch River
Headworks (New)
Model Farm of Technical Service Center for Irrigation System Project (TSC-JICA : 2001～2005)
To Takeo
LEGEND
Project Area
National Road
Other Road
Rail way
River
Lake
Existing and new facility
Canal
Rainfall Gauging Station
Water Level Gaging Station
0 1 2 3 4km
SCALE



HEADWORKS

PERSPECTIVE

Abbreviations

ADB	Asian Development Bank
APS	Associazion per la Participazione allo Sviluppo
AQIP	Agriculture Quality Improvement Project
AusAid	Australia Agency for International Development
BPSWRM	Battambang Provincial Service for Water Resource and Meteorology
BHN	Basic Human Needs
CAAEP	Cambodia Australia Agricultural Extension Project
CARDI	Cambodia Agricultural Research and Development Institute
CI	Contour Interval
CMAC	Cambodia Mine Action Centre
CSF	Cambodia Social Fund
DAP	Dai-Ammonium Phosphate
EIA	Environmental Impact Assessment
E/N	Exchange of Notes
EU	European Union
FAO	Food Agriculture Organization
FFS	Farmers Field School
FWUC	Farmer Water User Community
FWUG	Farmer Water User Group）
IRRI	International Rice Research Institute
JICA	Japan International Cooperation Agency
LBKS	Local Benchmark of Kandal Stung
LLDC	Least Less Developing Countries
LWS	Lutheran World Service
MAFF	Ministry of Agriculture, Forestry and Fisheries
MOEF	Ministry of Economic and Finance
MOWRAM	Ministry of Water Resources and Meteorology
NGOs	Non Governmental Organizations
NWRS	National Water Resource Strategy
OJT	On the Job Training
O&M	Operation and Maintenance
PIMD	Participatory Irrigation Management Development
SEDP	Socio-economic Development Plan

SMEC	Snowy Mountains Engineering Cooperation Limited
TSC	Technical Service Center for Irrigation System Project
UXO	Unexploded Ordnance
WFP	World Food Program

Summary

BACKGROUND OF THE PROJECT

1. The agriculture sector in Cambodia contributes 36% of the GDP, employing 70% of the working population. In the second 5-year Socio-economic Development Plan (2001 – 2005), poverty reduction and sustainable self-sufficiency of food security through agriculture and rural development are planed as the major goals to be accomplished. Cambodia identifies the importance to promote the shift from rainfed farming to irrigation farming to achieve the goal. 79 % (665 sites) of the existing irrigation systems are severely damaged due to civil war, flood etc, and rehabilitation of those existing irrigation systems is considered urgent and given high priority.

2. The Kandal Stung area (Project Area), which extends over along the right riparian area of the Prek Thnot river, is blessed with fertile land and is expected to play a role as the food supply base for Phnom Penh because of its suitable location along National Roads No.2 and 3 linking with Phnom Penh. However, the Project Area can not adequately play this role because of the unsatisfactory condition of the existing irrigation facilities. In the Project Area, the existing irrigation facilities, which had been constructed under the "Pol Pot Regime", are severely deteriorated. The main canal is silted and its side slopes are seriously eroded. Furthermore, due to improper design, distributed water does not reach the fields.

3. Under such a situation, the Government of Cambodia (GOC) requested that the Government of Japan (GOJ) provide technical assistance for a study on integrated agricultural development in the suburbs of Phnom Penh including the Project Area and focusing on the rehabilitation of the existing irrigation facilities. In reply to this request, the GOJ undertook "the Master Plan Study on the Integrated Agricultural and Rural Development Project in the Suburbs of Phnom Penh" from 1994 to 1995. As a result, a Project Area of 1,950 ha was selected as the first priority area for development.

4. The GOC has requested grant aid assistance from the GOJ for the rehabilitation of the regulators and the main canals aiming at steady supply of irrigation water.

5. The GOJ, through the Japan International Cooperation Agency (JICA), dispatched the Basic Design Study Team to Cambodia 5 times from 10 November 2002 to 8 October 2004. The Study Team discussed project size and the components with the Ministry of Water Resources and Meteorology (MOWRAM) based on the data collected in the field survey. The following table lists the major items requested by the GOC.

Requested Items

Component	Quantities
1) Construction of new headworks	1 no.
2) Rehabilitation of regulators and the 7th January dam	3 nos.
3) Demolish of regulator	1 no.
4) Construction of new intake	1 no.
5) Rehabilitation of main canal and related structures	5.3km
6) Rehabilitation of O&M road	9.3km

6. The Study Team examined design flood discharge and design low water discharge on the Prek Thnot River based on collected existing flood discharge and low water discharge data. The Study Team selected 70 households in the Project Area and collected baseline data on the social and agricultural activities. The Study Team also collected inventory data on the existing agricultural infrastructure as well as the records of the operation and maintenance activities for the infrastructure to analyze the existing problems and the difficulties faced in rehabilitation. The Study Team studied the other similar projects and the Technical Service Center for Irrigation Systems under JICA Project-type Technical Cooperation and incorporated those lessons into the field survey results and designed the basic concept of the Project.

7. The Study Team compiled the study results in the basic design report and submitted it to JICA. The JICA Cambodia office explained the contents of the design report to MOWRAM and the contents of the report were accepted by MOWRAM.

CONCEPT FOR BASIC DESIGN

8. The concept for the basic design is as follows :

(1) Size of Major Irrigation Facilities for Rehabilitation

An area of 1,950 ha was chosen for the Project in consideration of the contribution to poverty reduction, which is the ultimate goal of the Project, the GOC's opinion of the Project, income balance between the beneficiaries and non-beneficiaries and the project cost for rehabilitation.

(2) Cropping Plan

The Project Area is topographically flat with Cambisol soil suitable for rice cultivation. The proposed cropping plan is comprised of double cropping of the IR varieties (early maturing varieties) and single cropping of the local varieties.

(3) Facilities Improvement and Rehabilitation Plan

(a)The Project shall be compatible with the development plan of the model site for the JICA Project-type Technical Cooperation, Technical Service Center (TSC) for Irrigation Systems launched in January 2001.

(b)Two existing regulators (Tul Thla and Duem Russ) shall be used in their present condition except for raising the height of the gates, because the flood control function of both regulators have been recovered through the rehabilitation work done by ADB funds.

(c)The Kompong Tuol regulator shall be demolished as requested by the GOC in April 2003.

(d)As the river flow from late April to early May during the early rainy season is small and unstable, the puddling proposed in the cropping calendar may not be possible. In order to rectify the water deficit for puddling, river water during the dry season shall be stored upstream of National road No.3 by raising the crest of the existing 7th January dam and the gate height of the regulators.

(e)New headworks shall be constructed to secure the present capacity of flood discharge, because the capacity will be decreased after demolition of the Kompong Tuol regulator and the raising of the crest height of the 7th January dam and the gate height of the Tukutula and Duem Russ regulators.

(f)The rehabilitation of the secondary and tertiary canals and related facilities shall be designed taking into consideration the easy execution of O&M works to be done through farmers' participation after completion of the Project works.

(4) Operation and Maintenance Plan

As the Project covers an irrigable area of 1,950 ha, MOWRAM should take responsibility for O&M works for the main irrigation facilities following the concept in the National Water Resource Strategy Paper. On the other hand, the O&M works for the minor facilities, like tertiary canals and related structures, should be undertaken by the Farmer Water User Community (FWUC) with technical assistance of the Project O&M Office established by MOWRAM.

CONTENTS OF THE PROJECT

9. The proposed contents of the Project are as follows:

(1) Project Area	:1,950 ha
(2) Crops	:The early maturing IR rice varieties, the local rice varieties, maize, soy beans, and vegetables
(3) Headworks	:1 no., Movable weir (all gates), Width 50m, Height 4.8 m, Floodway gate 3 nos., Sluiceway gate 1no., River maintenance flow gate 1 no.
(4) 7th January Dam	:1 no., Heightening 0.55m, Total length of overflow 212m, Construction of sheet piles (l = 4.0m)
(5) Tuk Thla Regulator	:1 no., Heightening of gate crest 0.40m, Total width 36.75 m, Construction of sheet piles (l = 4.0m)
(6) Deum Russ Regulator	:1 no., Heightening of gate crest 0.20m, Total width 5.87 m
(7) Kompong Tuol Regulator	:To be demolished
(8) Rehabilitation of Main Canal and Related Facilities	
(a) Main Canal	:Design discharge 2.73 ~1.03 m^3/s, 5.3 km long, Concrete block lining for both slopes
(b) Intake	:1 no., Design intake discharge 2.73m^3/s, Gate with rubber seal on four sides (B x H = 1.8m x 2.1m, 3sets)
(c) Turnout	:26 nos.
(d) Check Structure	:2 nos.
(e) Crossing Structure	:8 nos.
(f) Maintenance Flow Gate	:6 nos.
(g) O&M Road	:For main canal 5.3 km, for secondary canal 9.3 km

IMPLEMENTAION PLAN FOR THE PROJECT

10. The implementation for the Project would require about 32 months including the detailed design study.

11. MOWRAM is the executing agency, and the Engineering Department in MOWRAM is responsible for design and construction. The Project O&M Office established by MOWRAM is responsible for the O&M works for the main irrigation facilities. In accordance with the policy of the GOC, O&M works for the minor facilities like

tertiary canals and related structures should be undertaken by FWUC with technical assistance from the Project O&M Office established by MOWRAM.

12. The O&M budget, including the running cost for the Project O&M Office, should be arranged by MOWRAM. The O&M cost for irrigation facilities, including the running cost for the Project O&M Office, is estimated as USD 8,080 per year. Since MOWRAM at present provides O&M budget of USD 4,790 per year for Rolaing Chrey headworks, USD 5,690 per year for Tuk Thla regulators and USD 2,350 per year for Kompong Tuol Regulator, the above required budget is considered affordable for MOWRAM.

13. Since there are no FWUC in the Project Area, it is important to establish the Project O&M Office to organize FWUC and give technical guidance to them. This Project O&M Office and FWUC will be supported by the following organs:

    (a) Training and participation of the field day presenting the rice double cropping plot and farming practice information organized by TSC team at TSC Model Site

    (b) The agricultural information about integrated farming systems from the TSC and the District Agriculture Office

    (c) The agricultural information about crop diversification from the District Agriculture Office

    (d) Support from the District Office for implementation of the irrigation project

14. At present, the existing water management organization in the Project Area plays a role to settle the water disputes among the communes. The concept for the organizing FWUC in the area should be based on the existing rural structure. Hence, organizing 7 FWUCs along the main irrigation canal, and an apex-organization like FWUC - Board to supervise the 7 FWUCs should be formed. Each FWUC undertakes to organize FWUG based on the tertiary canals.

15. Most of the beneficiaries in the Project Area are not familiar with the formation of large farmer's organizations and appeared to require much time to establish FWUC. Hence, training of the beneficiaries should be commenced from the time when the FWUG is established. The training program consists of classroom work and practical training. The Project O&M Office plays a major role to conduct the farmer's training in collaboration with the technical affairs of MOWRAM and the District Agriculture Office.

16. Irrigation Service Fee (ISF) is calculated by the Project O&M Office on behalf of FWUC based on the actual irrigable area until FWUC is able to manage it by itself. The Project O&M Office provides guidance to enable FWUC to collect ISF in accordance with calculations of water usage. The annual ISF to cover O&M costs that will be borne by FWUC is estimated at US$ 2.0 per farmer. This amount is considered affordable for the beneficiaries based on the baseline survey results, and is equivalent to 0.7% of the expected increase in revenue (US$ 281)

CONCLUSION AND RECOMMENDATIONS

17. The following direct and indirect effects are expected through the implementation of the Project as long as MOWRAM receives the necessary support from the related organizations, especially the Ministry of Agriculture, Forestry and Fisheries, local government and JICA Project-type Technical Cooperation.

(1) Direct effects

The existing irrigation system (maximum irrigable area 1,950 ha, about 2,800 households with 13,400 population) will be improved and secure necessary irrigation water to introduce a double cropping system in the Project Area with the rehabilitation of headworks, main irrigation canals, and O&M of roads and related structures through Japan's Grant Aid System.

(2) Indirect effects

- Realization of irrigated agriculture in the Project Area of 1,950 ha
- Increase of crop intensity (108% to 174%)
- Increase of productivity and quality (Local variety 1.8 to 3.0 ton/ha, IR variety 2.5 to 4.0 ton/ha)
- Increase of Farm Income (USD138 to USD418)
- Contribution to rural poverty reduction, which is one of the goals of the National Socio Economic Development Plan

18. After the rehabilitation of the main facilities to be implemented by Japan's Grant Aid System and after completion of the secondary/tertiary canals, the GOC should endeavor to popularize the double cropping of rice.

(1) Agricultural Extension

As 60 to 90% of the beneficiaries are not familiar with farming practice of the early maturing IR rice varieties in the Project Area, it is essential for the project to develop farmer's capacity on farming technology, including water management, for the new rice double cropping system. Thus, the Project O&M Office will be required to conduct a training program by establishing demonstration plots within the Project Area in conjunction with the district agriculture office and the preceding projects (TSC, Agricultural Quality Improved Project(AQIP), NGOs).

(2) Strengthening of Farmer's Credit and Publicity of Market Information

(a) Many farmers in the area complain about the existing credit availability due to small size of loans and high interest rates, thus administrative guidance for correction should be necessary.

(b) As there are a lots of requests from the beneficiaries for credit to purchase improved seeds and fertilizers, strengthening of the financing system is essential in conjunction with the preceding NGO and donor's projects such as AQIP.

(c) Strengthening of the market-oriented farming system is necessary for the beneficiaries by informing them of market price information, profitable second crops, monthly rice market prices etc.

Basic Design Study Report
On
Rehabilitation
Of
The Kandal Stung Irrigation System
In
The Lower Prek Thnot Basin
In
The Royal Government of Cambodia

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Units and Measures

Length

mm	milimeter
cm	centimeter
m	meter
km	kilometer

Area

cm^2	square centimeter
m^2	square meter
km^2	square kilometer
ha	hectare

Volume

cm^3	cubic centimeter
m^3	cubic meter
MCM	million cubic meter

Weight

g	gram
kg	kilogram
t	ton
MT	metric ton

Time

s	second
m	minute
hr	hour
d	day
mon	month

Power and Energy

A	ampere
V	volt
W	watt
kW	kilowatt
kWh	kilowatt hour
HP	horse power

Others

ppm	parts per million
℃	degree centigrade
%	percent

Currency

$	USA Currency (Dollar)
¥	Japanese Currency (Yen)
R, Riel	Cambodian Currency

Exchange Rate

As of September, 2004
$ 1.00 = ¥ 110.08

Chapter 1 BACKGROUND OF THE PROJECT

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Agriculture is the main economic sector in Cambodia, contributing 36%[1] of GDP and employing 70%[2] of the working population. GDP per capita in 2002 was estimated at US$ 297, and Cambodia was listed as one of the least of the least developed countries (LLDC). The population was 14.1 million[3] in 2003, and 84% of people dwell in the rural areas. Out of 2.25 million ha of cultivated land, only 18% or 0.4 million ha is provided with an irrigation system. The main staple food crop is rice, and its crop yield is low, say 1.7 ton/ha on average in the country

The suburbs of Phnom Penh have less fertile land and low river discharge in the dry season, however many people live there. Infrastructure is not sufficiently developed and the socio-economic condition is poor. In the suburbs of Phnom Penh, the Kandal Stung area (Project Area) which extends along the right riparian area of the Prek Thnot river, is blessed with fertile land and is expected to play a role as a food supply base for Phnom Penh because of its suitable location along National Roads No.2 and 3 linking with Phnom Penh. However, the Kandal Stung area can not adequately play this role because of the unsatisfactory functioning of existing irrigation facilities.

Under such a situation, the Government of Cambodia (GOC) requested that the Government of Japan (GOJ) provide technical assistance for the study on the integrated agricultural development in the suburbs of Phnom Penh including the Project Area and focusing on the rehabilitation of the existing irrigation facilities. In reply to this request, the GOJ undertook "the Master Plan Study on the Integrated Agricultural and Rural Development Project in the Suburbs of Phnom Penh" from 1994 to 1995. As a result, the Project Area (1,950 ha) was selected as the first priority area for development. In the Project Area, the existing irrigation facilities, which had been constructed under the "Pol Pot Regime", are severely deteriorated. The main canal is silted and its side slopes are seriously eroded. Furthermore, due to the improper design, the distributed water does not reach the fields.

The GOC has requested from the GOJ for the rehabilitation of the regulators and main canals aiming at a steady supply of irrigation water. The major items requested by the GOC are as follows:

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[1] *ADB Key Indicators 2003*
[2] *The State of Food and Agriculture 2002*
[3] *Estimated by the United Nation in 2003*

Requested Items

Component	Quantities
1) Construction of new headworks	1 no.
2) Rehabilitation of regulators and the 7th January dam	3 nos.
3) Demolish regulator	1 no.
4) Construction of new intake	1 no.
5) Rehabilitation of main canal and related structures	5.3 km
6) Rehabilitation of O&M road	9.3 km

In the Project Area, the Technical Service Center (TSC) for irrigation systems under the JICA Project-type Technical Cooperation was launched in January 2001 to develop the capacity of the staff of the Ministry of Water Resources and Meteorology (MOWRAM). A part of the Project Area has been selected as a model site (260 ha), and rehabilitation work for the tertiary canals has been conducted through On-the-Job-Training. It is expected that irrigation water will be steadily supplied and distributed to the Project Area, including the model site, as a result of Japan's Grant Aid project, the Rehabilitation of the Kandal Stung Irrigation System.

Chapter 2 CONTENTS OF THE PROJECT

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2.1 Basic Concept of the Project

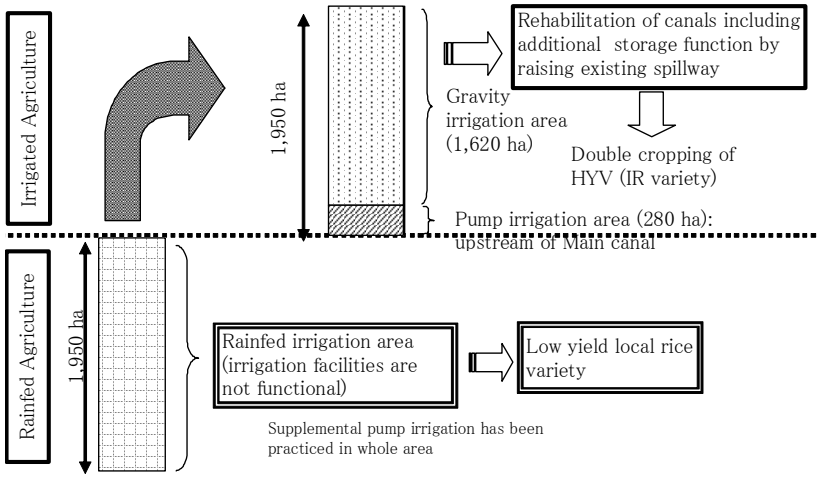
(1) Ultimate Goals and Project Purpose

(a) Irrigation Conditions and Problems in the Project Area

The main problem for irrigation farming in the Project Area is the inability to maintain a stable supply of irrigation water through the existing irrigation facilities due to improper design/construction and severe deterioration resulting from poor O&M. The irrigable area during the dry season is very small and even in the rainy season supplemental irrigation by pump is required. The existing farming practice in the Study Area is mostly similar to that under the rain-fed condition, so that the cultivation pattern in the area is confined to only single cropping of the local varieties which are tolerant to erratic water supply. Thus, the average yield of paddy is low, only around 1.8 t/ha/season.

(b) Project Purposes

As mentioned above, 84% of the total population in the country lives in the rural areas, of which 42% are below the poverty level. In order to improve this living situation, the GOC decided on the growth of national economy and the poverty reduction as main goals in the 2nd 5-year Socio-economic Development Plan (2001-2005). To attain these goals, the GOC set forth the need for development of agriculture and rural areas, and promoted the rapid conversion from rainfed agriculture to irrigated agriculture as a strategy for improving farm income and living standards. The short term strategy targets the rehabilitation of existing irrigation facilities and improvement of O&M works, while the medium and long term targets are the expansion of the irrigation area by development of medium and large-scale irrigation projects. In consideration of such ultimate goals,



the Project aims to contribute to reduction of rural poverty by improving agricultural productivity through introduction of a new cropping system combining a single cropping of the local rice variety with double cropping of an early maturing rice variety under a stable irrigation water supply based on rehabilitation of the existing irrigation facilities (refer to (2) Proposed Cropping Plan). The following are the proposed goals at each level:

Project Purpose:

The rain-fed agriculture over the whole irrigation system (1,950 ha) is to be replaced by irrigation agriculture under a stable water supply condition through rehabilitation of the existing irrigation facilities followed by proper O&M works.

Overall Goal

Rice production in the Study Area is improved by introducing a double cropping system.

Super Goal:

The Project contributes to reduction of rural poverty by improvement of agricultural productivity.

The following cropping pattern is proposed under the stable water supply after rehabilitation of the irrigation facilities. Cropping in 800ha (40% of total Project Area) can be obtained in the 4th year, and 1,950 ha (the whole of the Project Area) can be obtained after the 8th year from completion of the rehabilitation.

Projected Acreage for Popularization of the Proposed Cropping Pattern

Year after completion of the construction	Scheduled Progress of 2nd and 3rd canals (ha)	Irrigation Able (ha)	Projected acreage for introduction of proposed cropping system (including rice double cropping) in ha <refer to *1, *2, and *3>				
Assumption: Realization of the proposed cropping system in five (5) years			Block 1	Block 2	Block 3	Block 4	Total
0 year	500						
1 year	1,000	500	100				100
2 year	1,500	1,000	150	50			200
3 year	1,950	1,500	200	150	50		400
4 year		1,950	400	200	150	50	**800**
5 year			500	400	200	150	1,250
6 year			500	500	400	200	1,600
7 year			500	500	500	400	1,900
8 year			500	500	500	450	1,950

**1: Each block is comprised of 500 ha which is rehabilitated every year.*

**2: Annual increasing acreage:*
The factors involved in spread of rice double cropping system is based on a) seed availability, b) present cultivated area of rice double cropping system, c) farmer's supporting system. Considering of these factors with multi-effects by TSC's demonstration plot, the first year is assumed to be 100 ha. Leading farmers (10 % of the beneficiar in each block will cultivate but the most of the beneficiaries confirm water distribution to their paddy field only. That is, the block 1 is assumed to 50 ha more because of demonstration effect by TSC Model Site. An increment during the 2nd to 3rd years is sluggish but increase twice at 4th year, and in the 5th year, the whole area is projected to be expanded with the proposed cropping system.

**3: The diffusion of proposed cropping system over the whole area is projected 8 to 10 years after completion of the construction work by the Japan's Grant Aid.*

The above mentioned implementation of the rice double cropping system is based on the following considerations.

1) Currently, 100 ha to 200 ha of rice paddies, depending on annual precipitation, are being planted under the double cropping system with the IR variety combined with the local variety. The initial participating farmers (about 10 % of the whole area) are expected to promote the rice double cropping system to other areas.

2) The Agricultural Quality Improvement Project (AQIP), financed by AusAid, has operated a contract farming enterprise for improved rice seed production resulting in wide availability of improved seeds. In addition, the local farmers are highly interested in the IR varieties having high yield of 22 tons in 2002.

3) Most of the local farmers have intentions to introduce rice double cropping system if a steady supply of irrigation water is available. This was confirmed through the baseline survey.

In addition to the above, accomplishment of the proposed cropping plan as planned will also be assisted by the following:

1) The demonstration plot of rice double cropping with water management practice

in the TSC Model Site might be scheduled by TSC team and its application to the surrounding area is widely expected.

2) Proper water management for the proposed cropping system is expected by assigning the irrigation engineers trained through TSC activity to the Project O&M Office.

3) The rehabilitation works for the lateral/tertiary canals are almost completed.

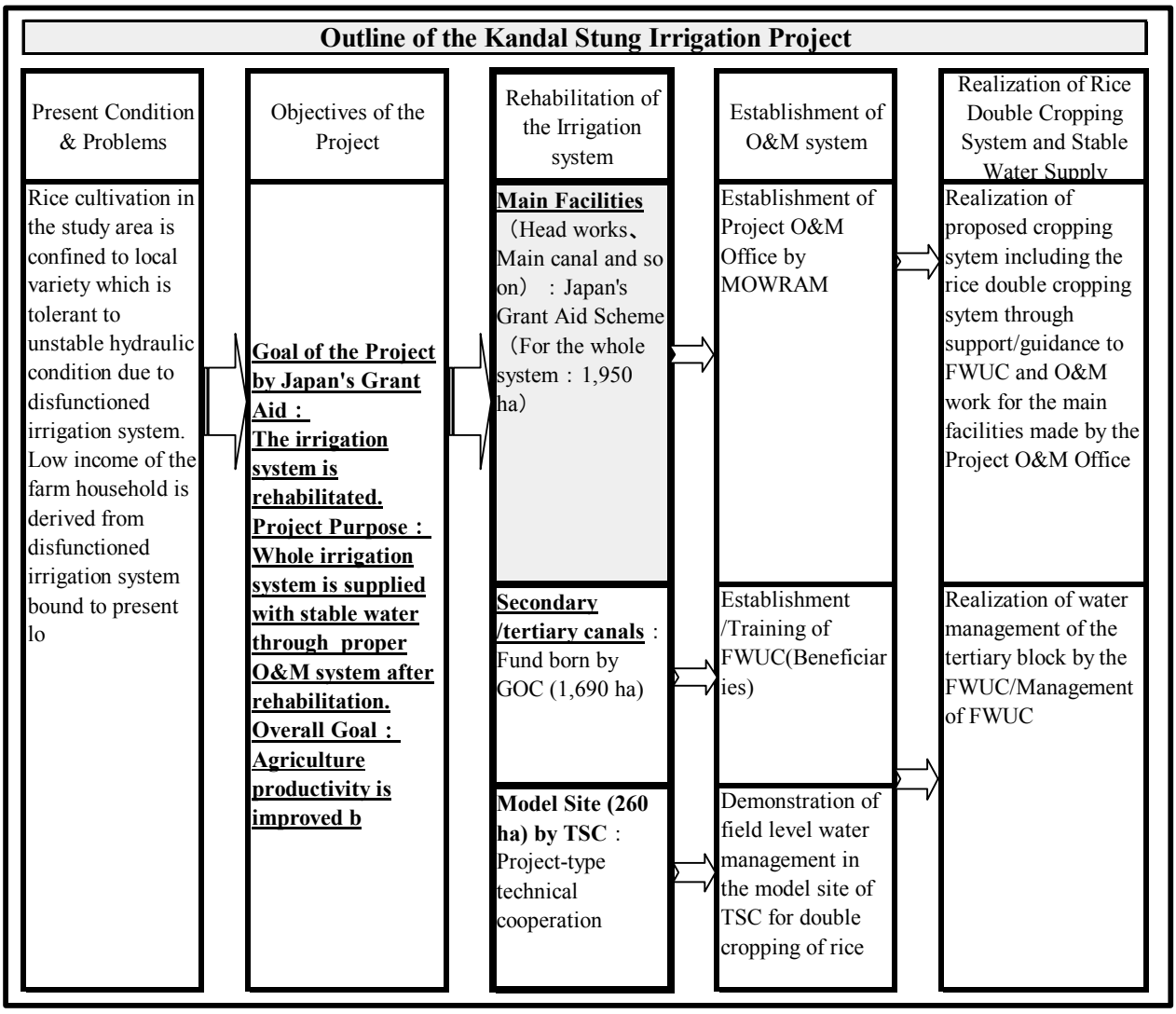
Furthermore, if an additional input such as technical cooperation to focus on technical guidance of water management as core subject is provided, the achievement of the proposed plan is further facilitated.

(2) Scope of Work for the Project

To achieve the said goals, improvement of the major irrigation facilities, such as headworks, regulators, intakes, main canals, and O&M roads will be covered by Japan's Grant Aid, while rehabilitation of the lateral and tertiary canals with O&M works will be undertaken by MOWRAM and the Farmer Water User Community (FWUC). After rehabilitation of irrigation facilities, irrigation water supply will be stable and the rice double cropping system is expected to become feasible for 800ha. The major facilities to be constructed/rehabilitated under Japan's Grant Aid are listed below:

- Construction of new headworks : 1 no.
- Rehabilitation of regulators and 7th January dam : 2 nos.
- Demolish regulator : 1 no.
- Construction of new intake : 1 no.
- Rehabilitation of main canal and related structures : 5.3km
- Rehabilitation of O&M road : 9.3km

The figure given below shows the outline of the Project



2.2 Basic Design of the Requested Japanese Assistance

2.2.1 Design Policy

(1) Basic Concept

(a) Size of Major Irrigation Facilities for Rehabilitation

The Project Area for rehabilitation is 1,950 ha considering natural and social conditions and the implementing capacity of the GOC as described below (see the Conceptual Figure).

1) Availability of Water Resources

The irrigable area was chosen based on available water resources. Summary of the water balance study on the Prek Thnot River is tabulated below. The calculation is based on the 5 year probability drought discharge of the Prek Thnot

River. Considering the river maintenance flow, the irrigable area is around 1,950 ha.

Summary of Water Balance Study on Prek Thnot River

(Unit: m^3/sec)

	Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
A	5 years Probability of Drought Discharge（at Rolaing Chery Diversion）	2.8	1.4	1.0	3.2	11.9	30.2	51.3	56.4	78.4	105.7	44.9	18.4
B	Irrigation Intake Discharge at Upstream of the Project Area（1,700 ha、Rainfall Pattern at 1969）	0.8	0.0	0.0	0.7	1.9	0.8	1.8	0.9	1.8	0.6	1.2	1.9
C	Available water resources at Project Area (A-B)	2.0	1.4	1.0	2.5	10.0	29.4	**49.5**	55.5	76.7	105.2	43.7	16.4
D	Irrigation Water Requirement（1,950 ha、Rainfall Pattern at 1969）	0.8	0.7	0.0	0.1	0.8	1.3	**2.33** Peak Requirement	1.0	0.3	0.6	1.3	1.5
E	Water Balance（Proposed Intake Site）[C-D]	1.2	0.7	1.0	2.5	9.1	28.0	**47.1**	54.5	76.4	104.5	42.4	15.0
F	River Maintenance Flow at Tuk Thla Regulator	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
G	Water Balance（Downstream of Project Area）[E-F]	0.6	**0.1**	0.4	1.9	8.6	27.5	**46.6**	54.0	75.8	103.9	41.8	14.4

2) Topographic Condition

Since the Project Area is topography flat, there is no restriction on irrigation.

3) Social Aspect

The whole of 1,950 ha is currently functioning on one irrigation system and the farmers under the existing scheme have a sense of belonging to the scheme. Therefore the Project should be designed so as not to increase the income gap in the Project Area. If the Project is targeting only a part of the existing scheme of 1,950 ha, a disturbance between beneficiary and non-beneficiary can be created due to the income gap of USD418 and USD138 per hectare. Therefore the Project Area should be 1,950 ha and incorporate all of the farmers in the existing scheme.

4) Technical Capacity on Rehabilitation of Lateral and Tertiary Canals

Considering the past experience of MOWRAM to plan, design and construct irrigation projects alone, it is believed that their technical capacity is enough to carry out rehabilitation of lateral and tertiary canals. Moreover, MOWRAM can obtain advanced irrigation technologies from the model area under Technical

Service Center for Irrigation Systems under JICA Project-type Technical Cooperation located in the Project Area.

5) Operation and maintenance organization

The O&M budget, including the running cost for the Project O&M Office, should be arranged by MOWRAM. The O&M cost for irrigation facilities, including the running cost for the Project O&M Office, is estimated to be USD 8,080 per year. Since MOWRAM at present provides an O&M budget of USD 4,790 per year for Rolaing Chrey headworks, USD 5,690 per year for Tukutula regulators and USD 2,350 per year for Kompong Tuol Regulator, the above required budget is considered affordable for MOWRAM.

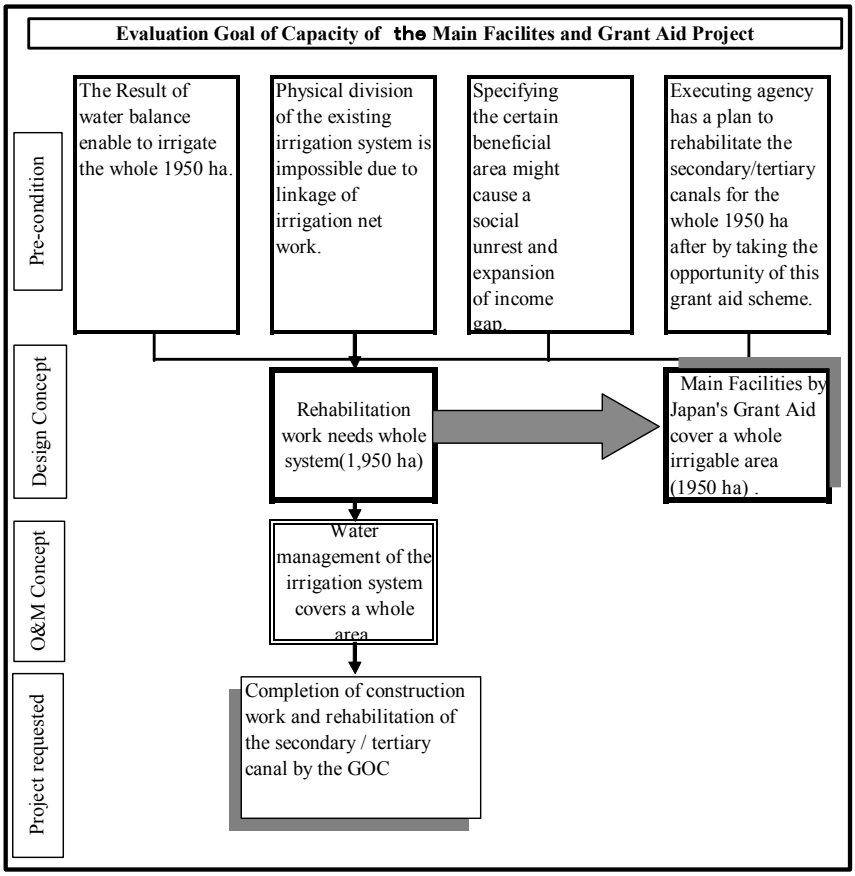
In addition to the above, the following are also considered in the choice of the Project Area of 1,950 ha.

1) The GOC aims at expansion of a farming system including irrigated rice double cropping for the whole 1,950 ha and plans to rehabilitate the lateral and tertiary canals of the same area with the O&M Plan including establishment and training of FWUC. MOWRAM has already commenced an official procedure to rapidly secure budget for the Project, to complete rehabilitation work for the lateral and tertiary canals covering 1,950 ha 4 years later and to materialize the proposed cropping plan on the basis of realization of proper water management 8 to 10 years later.

2) As mentioned above, the GOC targets 1,950 ha development and the benefiting farmers expect the same development target.

3) The existing main canal system covers the whole area (1,950 ha), therefore it would be physically difficult to identify a beneficial area for rehabilitation work for the existing irrigation facilities if the target area is less than 1,000ha. In case of a beneficial area less than 1,000 ha to permit easy water management, the channel section enlarged due to erosion should be repaired, which would lead to an increase of construction cost. In addition, the reduced beneficial area would be incompatible with the future expansion plan of the GOC.

4) The Project is expected to be a model project aiming at improvement of farm income by increase in agricultural production through introduction of a rice double cropping system. This will contribute to poverty reduction which is a goal mentioned above. The reduction of beneficial area would bring about less contribution to this goal.



(b) Design Concept for Rehabilitation of Facilities

The basic concept for design of the facilities is as follows;

1) The plan for irrigation development and rehabilitation of the irrigation facilities basically follows the result of the development study carried out by JICA during 1994-95 (in the case of without Prek Thnot dam).

2) Two existing regulators (Tuk Thla and Duem Russ) shall be used in their present condition except for raising the height of the gates, because the flood control function of both regulators were recovered through the rehabilitation work done with ADB funds.

3) Kompong Tuol regulator shall be demolished at the request of the GOC of April 2003.

4) As the river flow from late April to early May during the early rainy season is small and unstable, the paddling in a proposed cropping calendar could not be made. In order to overcome the water deficit for paddling, river water would be stored during the dry season on the upstream side of National road No.3 by raising the crest of the existing 7th January dam and the gate height of regulators.

5) New headworks shall be constructed to secure the present capacity of flood discharge, because otherwise the capacity would be decreased after demolition of Kompong Tuol regulator and raising the crest height of 7th January dam and gate heights of Tukutula and Duem Russ regulators.

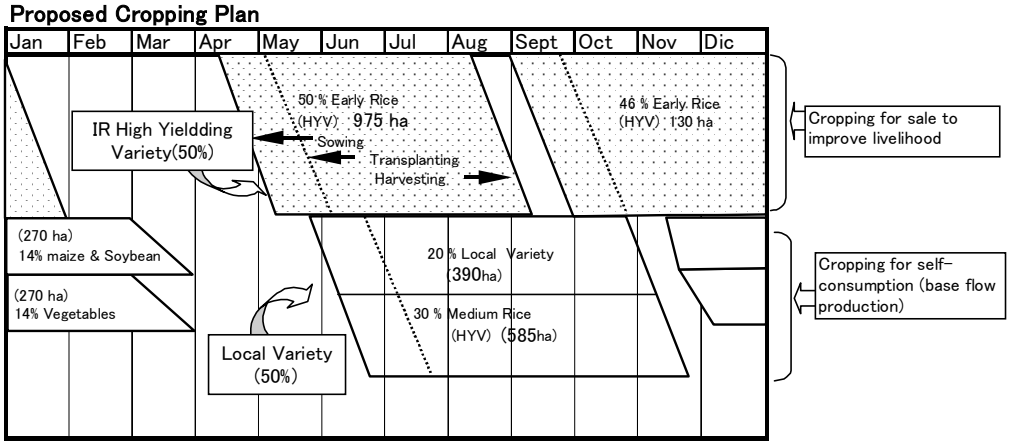
6) The Project works shall be compatible with the development plan of the model site for the JICA Project-type Technical Cooperation, Technical Service Center for Irrigation system launched in January 2001.

7) The rehabilitation of lateral and tertiary canals and related facilities shall be designed taking into consideration easy execution of O&M with farmers' participation after completion of the Project works.

(2) Cropping Plan

As described below, the proposed cropping plan is comprised of double cropping (50% of the whole area) of the IR varieties (early maturing varieties) and single cropping of the local varieties (second 50% of the whole area) with a 4 to 6 month growth period. Cultivation of vegetables and leguminous crops are considered after harvesting local rice varieties.

Proposed Cropping Plan



The proposed cropping plan is designed mainly with rice which is the main crop in Cambodia. In the rainy season, the local rice variety with a growing period of 4 to 6 months is planed for 50% of the total land for self consumption and the IR rice variety with a growing period of 3 to 4 months is planted in the other 50% as a cash crop. After harvesting of the local variety, upland crops such as vegetables, beans and maize are planed as a cash crop in the dry season.

This proposed cropping plan is the same as proposed by the feasibility study of JICA in

1995, and its justification was confirmed based on the following examination:

1) The Project Area is topographically a flat flood plain and is covered with Cambisol soil suitable for rice cultivation.

2) The Project Area has been cultivated with paddy rice as a stable food supply for a long period. Thus the beneficiaries have ample experience in rice cultivation. The cultivated local rice varieties are tolerant of flood and erratic rainfall conditions (Flood risk has already been mitigated through the Flood Emergency Rehabilitation Project for Prek Thnot River during 2001-2002)

3) The local rice production is still needed for self consumption. The baseline survey showed that the average household size was 5.9 persons holding 1.15 ha/household of farmland. Annual rice consumption per household is estimated at 890 kg (white rice) based on the requirements of 151 kg/head/year. Assuming that 50% of the paddy field is planted with the local variety and its yield is 3 t/ha, 1,070 kg of white rice is produced (3,000 kg paddy rice x 1.15 ha x 62%) on the average holding. This amount is equivalent to the annual family consumption and for seed requirements for the next cropping season.

4) As a countermeasure for poverty reduction, it is essential to introduce high yielding varieties with shorter growth periods. Because of the short maturity, double cropping in the rainy season is possible if suitable irrigated condition is available. The net profit (sale price – production cost) increases from 138 US$/ha to 418 US$/ha, around three times as much as at present, as shown below.

Difference of Agricultural Income between With and Without Project in an Averaged Farm Household

Crpping System		Planting Area (ha)	Yield (/ha)	Cropping Time	Harvest (t)	Gross Profit (Riel)	Production Cost (Riel)	Net Profit (Riel)	Net Profit (USD)
Present	Single crop of local CV	1	1.8	1	1.8	1044000	494000	550000	138
With Project	Local CV 50 %	0.5	3	1	1.5	870000	603800	568100	418
	ER-CV 50 % (2 times	0.5	4	2	4	1716000	610250	1105750	
Difference									280

Remark: * ER-CV refers to earl rice cultivar.

5) Effective use of production resources (land, labor, animal draft power) and the adjustment thereof; for the proposed cropping system, adjustment of the production sources such as labor and animal draft-power is necessary for introducing the rice double cropping system.

This proposed cropping plan has been verified as feasible making use of a five year probability of irrigation water resource and water balance based on water requirements for irrigation, but the field operation appears to be extremely tight. Any delay of 1st

cropping following the paddling operation in late April might affect the 2nd cropping. If the 2nd rice planting is delayed to January there is a probability of continuous dry spells which will affect the growth stage. Therefore, start of the paddling operation from late April is essential for this proposed cropping pattern.

(3) Required Water Resource Facilities

(a) Main Constraints of Rice Farming in the Early Rainy Season

Although some farmers start the preparation of rice seedlings in April in the present farming practice, transplanting of seedlings is generally conducted in June to July due to a delay in the preparation of paddy fields. The land preparation for paddy fields depends completely on the amount of rainfall and river flow (no reliable supplemental irrigation water supply is expected in the season at present). Due to such a hydrological and irrigation situation, farmers have selected the local rice variety (medium and long growing period variety), which can stand in the nursery for a long period of 45-60 days. The transplanting of overgrowth seedlings are usually made after cutting the top leaves. Under these situations, farmers have not been able to introduce the IR-variety (non-photosensitive) which grows with a period of 110 - 120 days, because a considerable reduction of paddy yield is caused by the insufficient growing period in the paddy field.

(b) Flow Condition of Prek Thnot River

The irrigation water resource for the Project Area is the balanced flow after diverting water at the Rolaing Chrey headworks which are located 40 km upstream of the Tuk Thla regulator. The estimated drought water discharge with a five year probability at the headwork (refer to Table 2.1) shows that the river discharge at the site is less than 3 m^3/sec from the end of January to the beginning of May except for occasional runoff greater than 3 m^3/sec (total irrigation requirements of the Rolaing Chrey and the Kandal Stung areas in May are estimated at 2.7 m^3/sec). During a drought period, especially April to May, the available river discharge for the Study Area is smaller than the calculated one due to excess diversion at the Rolaing Chrey headwork. This river flow situation is one of the reasons why the land preparation in the area is often delayed considerably. On the other hand, the river flow at the end of May to mid-December becomes more than 10 m^3/sec even in the 5-year-drout condition. This is much greater than the 2.7m^3/sec of design demand in this period, therefore no problem occurs.

(c) Need of Stable Irrigation Water Supply in Early Rainy Season

In addition to the above condition, consideration shall be given to the following:

1) Currently, no discharge measuring device is provided for the intake structure at

Rolaing Chrey headworks, therefore actual intake discharge could not be determined; and.

2) The "Integrated Development Project in the Western Side Phnom Penh Municipality" was launched in August 2002, aiming to provide supplemental irrigation water for the agricultural land of 24,000 ha extending on both banks of the Prek Thnot River. The main water resource of this project is the Prek Thnot River.

To realize the double cropping of paddy rice during the rainy season under the conditions mentioned above, it is necessary to provide stable irrigation water supply for the early paddy, especially in April and May. As a recommended measure, it is proposed to increase the storage capacity by raising the crest elevation of the existing spillway. After raising of the spillway crest, every farmer could enjoy the availability of water necessary for land preparation in the upstream areas of the National Road No. 3.

(d) Water Storage (degree of crest raising for the 7th January Dam)

Raising the crest height of the existing 7th January Dam and the gate height is planned to eliminate the shortage of irrigation water, especially for land preparation, that occurs in April and May when the conditions of the river flow and rainfall are limited and unstable. The average crest elevation of the 7th January Dam is EL.11.26m. On the other hand, the surface elevation of paddy fields upstream of the Tuk Thla regulator is EL. 12.20m. Since the raising of the crest over EL. 11.80m would cause the inundation in this upstream paddy field due to a backwater effect, especially at the time of the beginning of flood, the crest elevation is planned at EL. 11.80m. As the design flood water level is set at EL. 13.0 m based on the surface elevation of the existing National Road No.3, no modification of the design flood water level is planned. Taking this into consideration, construction of new headworks is needed to compensate for the reduced capacity of the 7th January Dam.

(4) Design Consideration for Natural Conditions

(a) Flow Characteristics of Prek Thnot River

The flow discharge of the Prek Thnot River varies drastically from the rainy to the dry seasons. The river discharges exceed 100 m^3/sec in the rainy season (June to November), but are less than 10 m^3/sec in the dry season (December to May). In particular, the river flow becomes only 1 to 2 m^3/sec in January to February. The construction for the structures on the river should thus be planned taking into account such river flow pattern and scheduled for the dry season as much as possible.

(b) Dispersive Soils

Excavated soils from the canal banks and slopes have special are highly dispersive when wet. The dispersive soils which were used for the canal embankments are severely eroded and holed by dissolution caused by rains and flows in and around the area. From this phenomenon, it is apparent that those soils are not suitable for the embankment material. To ensure a stable embankment, it is necessary to apply suitable soils for embankment and/or slope protection by lining and sod facing.

A suitable source of embankment materials (borrow material) containing lateritic soils is located on the right bank of the Prek Thnot river some 30 km upstream of the construction site. Those soils were actually used for a rehabilitation project for provincial roads financed by ADB in 2001 to 2002. From this situation, those soils will also be used for work in the Project.

(c) Existing Canals and Related Structures

Sections of the existing canals have been excessively widened by erosion and lack of maintenance. Application of hydraulically favorable designs would incur high construction cost due to the need for a large volume of borrowed material. It is therefore planned to retain the present section as it is and rehabilitate it using a lining. The existing structures are severely deteriorated at present. Also their design does not interface with a new gravity irrigation system. From these findings, it is judged that those should be totally replaced by new structures. The foundation of the intake structure has an N-value of more than 30, so the direct foundation method is to be employed.

(5) Design Consideration for Social Conditions

The rehabilitation of irrigation facilities will raise the sense of ownership of beneficiary farmers, ensure rainy season paddy, and create employment opportunity. Prior to the commencement of rehabilitation work, the contents of the rehabilitation work should be explained to beneficiaries concerned, to promote smooth execution of construction and project operation. Explanations should cover a) execution of rehabilitation work during the dry season (December to May), b) return of the public land which is used for agricultural activities by farmers without any request for compensation, and c) need of collection of Irrigation Service Fee (ISF) for O&M of lateral and tertiary canals to be rehabilitated by beneficial farmers. Those explanations to and communication with the farmers will be carried out under the responsibility of MOWRAM.

(6) Design Consideration for Local Contractors and Materials

Construction materials such as cement, aggregates, forms and small concrete piles which are available in the local market and also local civil contractors should be used to the extent technical factors and quality considerations allow. According to the experience of civil work done in and around the Study Area, the major materials such as embankment soil materials, lateritic soils for pavement and aggregates for concrete, would be supplied by the local suppliers. As mentioned above, the excavated materials at the site are not technically suitable for the embankment materials. Thus, the borrowed materials will be procured from borrow pits located 30 km upstream of the Prek Thnot river. Because general construction machinery and equipment from Japan and USSR is available in the local market, it is planned to use this machinery and equipment under lease conditions, except for special machinery. Construction materials from abroad will be landed at Sihanoukvlle port, and transported to the work site.

(7) Design Consideration for O&M Capabilities of Executing Agency and Beneficiaries

(a) Execution Agency

MOWRAM, the executing agency of the Project, was established in June 1999. Although no MOWRAM district office has been established, three staff have been assigned to the Kandal Stung agriculture office for operation, inspection of the main facilities and observation of hydrological data at the site. For rehabilitation of existing irrigation facilities, it is possible that the required O&M staff will be arranged from the TSC and capacity building programs financed by ADB.

Actual expenditure of the Kandal Provincial MOWRAM Office was US$ 13,700 in 2000 and US$ 15,500 in 2001, which is a 13% increase in two years. Except for emergencies like flood damage, the O&M cost includes the personnel expenses only. The O&M budget for the Project O&M Office should be arranged by MOWRAM as part of the O&M budget for national irrigation system.

Taking into account that the O&M for the major facilities will be carried out by the Project O&M Office, the basic design for rehabilitation for major facilities shall be made in the following manner:

1) Use of procurable construction materials around the work site or in the country to permit easy O&M.

2) Application of structural mechanism with simple operation

3) Participation of engineers and technicians for O&M work, to the rehabilitation work, to deepen their knowledge on the structural mechanisms

(b) Beneficiaries

There are presently no Farmer Water User Community (FWUC) in the Study Area. Thus, it is necessary to establish the FWUCs, to carry out O&M for lateral and tertiary canal systems. If farmers recognize the benefit of an organization for O&M works by observing the efforts of the Project O&M Office of MOWRAM, FWUC and groups (FWUG) could smoothly be organized. According to the baseline survey on ISF, which was conducted by the Basic Design Study Team, all the interviewees answered positively regarding paying. Possible amount would be in the range US$1–25/year/family on the condition that the irrigation water would be satisfactorily provided through rehabilitated facilities. Smooth collection of ISF should be possible once the system achieves the satisfaction of each water user. In this sense, the Project O&M Office, which is in charge of major facilities, has high responsibility for timely and equitable water distribution to the lateral canal system.

(8) Design Consideration for Setting a Standard for Facilities and Materials

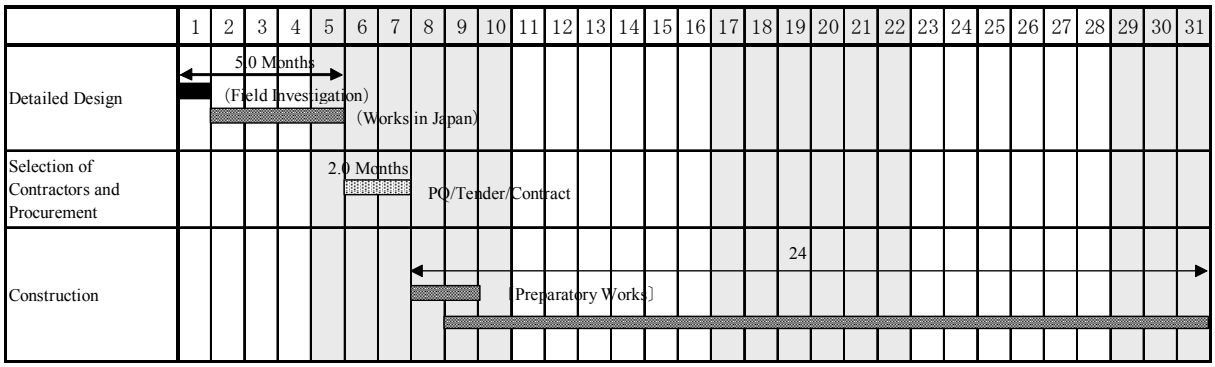
Considering the budget for O&M works by MOWRAM, the rehabilitated structures should be solid, requiring minimal maintenance and easy to operate. The main canal is planned to be lined by concrete blocks to protect the erosion of canal slopes and allow easy maintenance. The lining is limited to slopes only, not the bottom, considering the uplift pressures and saving on lining cost. The O&M roads along irrigation canals are paved by laterite soils to ensure accessibility in the rainy seasons.

(9) Design Consideration for Method and Schedule of Construction

In consideration of the number of workable days for rehabilitation works on the river, earthworks for the main canal and concrete lining (assuming two dry seasons), the work sites, the work quantities, , and the Japanese grant aid system, the construction period is set for 24 months.

In general, it is technically and economically favorable that the rehabilitation work, especially earthwork and lining work for main canal is carried out with no irrigation water in the canal. Hence, MOWRAM explained to the farmers through commune chiefs that a) rehabilitation for the main canal will be executed in the dry season, b) water will not be supplied in the dry season, and c) raising of a sense of ownership of the farmers and creation of job opportunities will be achieved through their participatory approach to rehabilitation work. This explanation was accepted by the farmers. Raising of the crest of the 7th January Dam and construction of new headworks will be executed in the dry season, however new headworks will be constructed in not only the dry season, but also in the rainy season due to the large work volume. The construction of facilities crossing National Road No.3 will be made by providing a detour so as not to interfere with the traffic.

Implementation Schedule



(10) Design consideration for environmental conservation

According to the Sub-decree on the Environmental Impact Assessment (EIA) Process under the Law on Environmental Protection and Natural Resources Management (1996), an EIA should be carried out for any irrigation project which has a commanding area of larger than 5,000 ha. The Ministry of Environment has been informed by official letter that the Kandal Stung Irrigation Project is not subject to an EIA because it has only 1,950 ha of Area (refer to Appendix-3). However, the Ministry commented the following in the letter regarding things to be considered (translated by MOWRAM):

(a) Keep water flow conditions for the Project and people living in the downstream area

(b) Assure no flooding in the village, road, camps and paddy field of people,

(c) Increase possibility of migration for fish, bird and other animal in the case of seeing that it is necessary,

(d) Conduct the appropriated measure to reduce the damage of irrigation system by flood

The following countermeasures will be taken to conserve the environmental conditions:

For item a): No change to flow condition is proposed by the Project except for the dry season when the rehabilitation work is carried. Prior consent of related farmers about the stoppage of the water supply is to be planned and executed by the implementation agency.

For item b): Due to the raising of the existing spillway, the normal water level in the upstream area will be raised up by 50 -60 cm, but no change of flood water level of EL. 13.0 m is expected. The storage area has

been surrounded by flood protection dikes and there are no roads or houses in the storage area. The reduced discharge of the existing spillway from raising the overflow crest is planned to be compensated for by construction of a new spillway.

For item c): No river crossing structure is planned. So, no countermeasures for any animals are required.

For item d): The Flood protection dike for the Project Area was raised and strengthened by MOWRAM in 2001 and 2001. No additional measures would be required by the Project.

2.2.2 Basic Plan

2.2.2.1 Project Features

(1) In order to solve the unstable agricultural production in the Study Area (1,950 ha) in the suburb of Phnom Penh, due to the deteriorating of the existing irrigation facilities, this grant aid cooperation is to supply a budget for rehabilitation. At first, the works requested by the GOC were a) rehabilitation of the existing spillway and regulator (2 nos.), b) construction of a new headworks (1 no.), c) construction of a new intake structure (1 no.), d) Rehabilitation of the main canal (5.4km), e) rehabilitation of drainage canal (18km), f) rehabilitation of O&M road (28km) and rehabilitation of farm roads (8km). However, taking into account a) stable water supply to the Study Area, b) demolition of Kompong Tuol regulator due to much leakage, c) present conditions of drainage canals, O&M road and farm roads, these requests were modified for the following reasons:

(2) For poverty alleviation in this area, the improvement of agricultural productivity is essential therefore the introduction of high yielding varieties with shorter growth period is planned. For this to be possible it is planned to supply an appropriate water amount to fields (1.40 lit/sec/ha for main canal and 1.72 lit/sec/ha for lateral canals and others). However, as the river discharge is occasionally insufficient and/or unstable to provide water for puddling for a half month from the end of April to the beginning of May, it is rather difficult to adopt the above-mentioned variety under the present condition. This problem will be overcome by raising of the crest of the existing spillway of the 7th January Dam (which controls the water level) from EL.11.26m to EL.11.80m as well as increasing the gate crest height at the existing regulators (Tuk Thla and Deum Russ), then the upstream area shall have a storage capacity in order to supply stable water to the area.

(3) Out of the existing regulators (Tuk Thla, Kompong Tuol and Deum Russ), the

Kompong Tuol regulator will be demolished as requested by the GOC because the site survey indicated serious leakage and a structurally unstable condition.

(4) In the Project, as the present flow should be guaranteed, a new structure is required for compensation due to the raising of the crest and the gate crests and the demolition of the Kompong Tuol regulator. Under the condition that the design elevation of the dike and the design flood water level are set at EL.14.00m EL.13.00m respectively. A comparison study was made for a movable gate structure (flood-way gates and a sand-flush gate) or a fixed weir structure (a fixed weir and a sand-flush gate). As a result, the movable gate structure was slightly higher than the fixed weir structure in construction cost, however the movable gate structure has an advantage from the view point of technology such as sand flushing and river surface control in normal condition and at the early stage of flood. The O&M cost for movable gate structure was estimated at US$ 6,000/year. It was confirmed that this amount could be paid by MOWRAM. In addition, the movable gate structure could be smoothly connected with National Road No.3 due to smaller area occupied by the structure.

(5) As the original soil along the main canal is very weak against flowing water and rain, and may have a high dispersive characteristic in water. It is therefore recommended to cover the original soil with clay soil including laterite to a certain extent and execute lining works for both slopes but not the bottom to avoid uplift pressure and save the construction costs.

(6) The existing drainage canals have dual functions for both irrigation and drainage purposes. For irrigation purposes, farmers in the area have constructed many earth dams and checks using bamboo sticks to raise the water level and divert the water in the canals to their farms. There is no severe complaint about inundation damages caused by these structures and the narrowed portion of the culverts. It should be considered that the improvement of canals for drainage purposes would only fail without provision of lateral and tertiary canals. The farmers in the area would immediately start the construction of dams and checks for diverting water to their farms and register strong complaints with the government. Flow capacity of the drainage canals would therefore be reduced. Under the Project, therefore no improvement work of drainage canals is planned.

(7) As for the O&M road, rehabilitation of about 28 km was requested by the GOC, two O&M roads along drainage canals were cancelled because a) cost benefit ratio would be very low due to use of borrow materials for construction of roads, b) roads running east to west have been developed and maintained well, and c) no rehabilitation will be made for drainage canals. Finally, the length of O&M road to be rehabilitated became 14.6 km along the main canal and lateral canal.

(8) Farm road rehabilitation, the requested length was 8 km, was finally cancelled with consent of MOWRAM because communes have improved and maintained them by themselves.

In conclusion, the modified components as the most appropriate plan for the Project are as follows:

Final Plan and Reasons for Modification

Planning Major Item		Originally Requested Item	Final Plan and Reasons for Modification
1)	Construction of a new headworks	No request	1 no. (As the raising of the crest of the existing spillway and regulators are planned in order to increase the water storage capacity in the upstream area, in order to maintain the existing flow capacity under the new facilities, a new headworks is planned.
2)	Rehabilitation of the regulators	2 sites	3 nos. (The rehabilitation of the Tuk Thla and Kompong Tuol regulators was originally requested. Through the study, the heightening works for the existing spillway and regulators and demolition of the Kompong Tuol regulator were planned. In addition, the rehabilitation of the Deum Russ regulator (heightening work) was also planned through the site survey. As a result, the number of the structures to be rehabilitated became 3 sites.
3)	Construction of a new intake	1 site	1 no. (no change)
4)	Rehabilitation of the main canal and related structures	5.4 km	5.3km (As a result of the topographic survey, it was found that the total length of the main canal was 5.3km.)
5)	Demolition of the regulator	No request	1 no. (In April 2003, the GOC requested the demolition of the Kompong Tuol regulator. After checking the condition of the structure, serious leakage and unstable conditions were found and its demolition was planned in conclusion.)
6)	Rehabilitation of the drainage canals	18 km	0 km (Through the site survey, no serious damage was reported so that no work was planned.
7)	Rehabilitation of O&M roads	28 km	9.3km (For efficient investment performance, the distance of the road length was reduced to 14.6km. Out of this distance, 5.3km was included into the construction works for the main canal
8)	Rehabilitation of the farm roads	8 km	0 km (The existing farm roads are kept in good condition by farmers without serious problem at present. Hence, no work is planned.

2.2.2.2 Headworks

(1) Design Parameter

In the design parameter for headworks, the design top elevation of the dike and the design flood level were decided at EL. 14.0m and EL.13.0m respectively judging from the surface elevation of the road and the flood mark on the 7th January Dam. From

this, the design parameters for rehabilitation and construction of irrigation facilities were proposed in the Steering Committee Meeting on September 10, 2004. After thorough discussion among MOWARAM, JICA and Basic Design Study Team, the following design parameters were confirmed:

Flood Level of 7th January Dam

Design Parameter for Headworks

Design Parameter	Elevation (m)
1)Design Flood Water Level	EL.13.00
2) Design Top Elevation of Dike	EL.14.00
3) Design Intake Water Level	EL.11.80
4) Design Upstream River Bed Level	EL.7.00
5) Design Downstream River Bed Level	EL.5.00
6) Design Top Elevation of Gate	EL.11.80
7) Design Bottom Elevation of Gate	EL.7.00

(2) Examination of Weir Type and Location

Two weir types, fixed and movable, were compared in the following 5 plans:

Comparison of Weir Type

Weir Type	Weir Mechanism
1-1 Movable weir (all gates)	Steel slide gate
1-2 Movable weir (all gates)	Rubber dam
2-1 Fixed weir (fixed weir+ Floodway/sluiceway gate)	Fixed weir
2-2 Fixed weir (fixed weir + Floodway/sluiceway gate)	Floodway/sluiceway gate are installed in Fixed weir
2-3 Fixed weir (fixed weir + Floodway/sluiceway gate)	Floodway/sluiceway gate are installed near Fixed weir

The dimensions of gates employed in this comparison, are as follows:

Dimensions of Gates

Plans of Weir Type	Specification of Gates
1) Movable weir	Floodway gate：B12.5m×H4.8m×3nos. Sluiceway gate：B5.0m×H4.8×1no. （Gate sill　：EL.7.00m, Gate top：EL.11.80m） River maintenance Flow Gate　：B1.5m×H1.5m×1no. （Gate sill　：EL.11.4m,Gate top：EL.11.90m）
2) Fixed weir	Crest length of bathtub type weir：L＝175m Floodway/sluiceway gate　：B5.0m×H4.8×2nos. （Gate sill：EL.7.00m, Gate top：EL.11.80m） River maintenance flow Gate　：B1.5m×H1.5m×1no. （Gate sill：EL.11.4m, Gate top：EL.11.90m）

In addition, four alternatives are examined for four locations corresponding to both weir types. The four alternatives are as follows:

(a) Alternative- 1

Kompong Tuol regulator is to be demolished and a new headworks is to be constructed at the same site.

(b) Alternative - 2

A new headworks is to be constructed in the middle of Kompong Tuol regulator and the 7th January Dam.

(c) Alternative- 3

A new headworks is to be constructed in the middle of the 7th January Dam and the old river.

(d) Alternative 4

A new headworks is to be constructed at the intersection of the old river and national road No.3

The examination of alternatives is shown in Table 2.2 - 2.4. The result of the comparison study is as follows:

(a) From the O&M aspects, the movable weir will be more expensive than the fixed weir (however, it is confirmed that MOWRAM will be able to allocate the budget for O&M of movable weir (US$ 6,000/year)).

(b) From the technical aspect (sand flushing, water level controlling, taking measurements of flood in the initial phase), the movable weir will be favorable over the fixed weir. The required area for construction of the movable weir will be smaller than the fixed weir. The movable weir will also be smoothly joined with National Road No.3.

(c) From the construction cost aspect, the movable and fixed weirs are almost equal. However, an adoption of a fixed weir will require the excavation of a new river channel because the fixed weir will block the existing river channel to the intake.

(d) MOWRAM focuses on the importance of O&M of water level and taking measurements of flood in the initial phase. MOWRAM has organized a taskforce, with the minister as a chair person, to improve O&M of the gate facilities.

Judging from above results, the movable weir has advantages over fixed weir. In this

plan, the movable weir type is therefore selected as the suitable weir type.

(3) Spanning of Movable Portion

In the case of design flood water level (EL.13.00m), the total existing capacity of all the facilities is estimated as 830 m^3/s. In this case, discharge capacity of the 7th January Dam is 270 m^3/s and the Tuk Thla regulator is 320 m^3/s. Thus, the required discharge capacity of the new headworks shall be 240m^3/s in order to keep the existing capacity. The dimension of the new headworks to secure the required discharge capacity is shown as below.

Floodway Gate : B 12.5m × H 4.8m × 3 sets

Sluice Gate : B 5.0m × H 4.8m × 1 set

The sluice gate is planed on the right bank near the intake structure. The following gate will be constructed in order to discharge a small quantity of water.

River Maintenance Flow Gate : B 1.5m × H 1.5m × 1 set

(Gate sill : EL. 11.40m, Gate top : EL. 11.90m)

(4) Determination of Dimension of Headworks

Referring to the design water level, river bed level and elevation of dike which was confirmed in the Steering Committee Meeting, the dimension of headworks is determined as shown in the following table.

Elevation of Major Portion in Headworks

Dimension	Elevation
1) Design dike elevation	EL.14.00m
2) Design elevation of bridge surface	EL.15.30m
3) Design elevation of upstream of apron	EL.7.00m
4) Design elevation of downstream of apron	EL.4.00m
5) Design top elevation of floodway gate/sluice gate	EL.11.80m
6) Design sill elevation of floodway gate/sluice gate	EL.7.00m
7) Design elevation of major bed	EL.10.00m

(5) Specification of Gates

Specification of Gates

Facility Name	Headworks		
1) Gate Name	Floodway Gate	Scoring Sluice Gate	River Maintenance Flow Gate
2) Quantity (sets)	3	1	1
3) Gate Type	Plate girder, Fixed wheel gate	Plate girder, Fixed wheel gate	Steel Slide gate
4) Clear Span (m)	12.5	5.0	1.5
5) Gate Height (m)	4.8	4.8	1.5
6) Design Head (m)			
Upstream	5.8	5.8	2.4
Downstream	0.0	0.0	0.0
7) Operation Head (m)			
Upstream	5.8	5.8	2.4
Downstream	0.0	0.0	0.0
8) Water Tightness	Three edges sealed at upstream side	Three edges sealed at upstream side	Four edges sealed at downstream side
9) Hoisting Type	Motor driven wire rope winch type 1 motor 2 drum	Motor driven wire rope winch type 1 motor 2 drum	Rack type (Manual)
10) Hoisting Speed	0.3m/min	0.3m/min	-
11) Gate Operation System	Local and remote control	Local and remote control	Operation Deck (Concrete type)
12) Hoisting Height (m)	7.0	7.0	1.5
13) Sediment Height (m)	0.5	0.5	0.0

(6) Design of Pier of Weir

(a) Gate and Hoist House

1) Operation Deck

The width and length of the operation deck are determined taking into account the dimension of the under frame, hoist house control panel, passage (more than 80cm), and pier.

Dimension of Operation Deck

Name of Operation Deck	B × L
1) Left Bank deck	4.50m×6.50m
2) Center deck	6.50m×6.50m
3) Right bank deck	12.00m×6.50m

2) Hoist Houses

According to the experience of similar headworks, the maximum height of hoist is 2.00m, and the height of the control panel is 2.20m. In consideration of the above mentioned parameters, the ceiling height of the reinforced concrete hoist house and the clearance for hoisting of machineries, the height of the hoist house is

determined at 3.00m. A gateway of 3.0m x 3.0m, is designed in the ceiling in order to carry machineries to/from the hoist house.

(b) Gate Pier

1) Height of gate pier

Floodway and sluice gates are designed to be one-overflow type gate. In general, the height of a gatepost is 1.0 m above the height of a rectifier. Therefore the height of the gatepost is determined at 7.5 m.

2) Cross section of gate pier

Stairways are planned for the pier of the weir on the right bank, and an operation bridge which passes to an operation bridge is installed upstream of the gatepost. In the downstream, a box culvert will be established for National Road No.3 to cross the river. Construction of the box culvert will be implemented for spare gate which will be removed to prevent obstruction. The gate has two piers, and the inspection gallery is 1.0 m wide.

(c) Pier of Weir

1) Width of pier of weir

Taking into consideration the empirical equation from the Ministry of Agriculture, Forestry and Fishery and the block-out for gates, the width of pier for a weir is determined at 2.5 m.

2) Length of pier of weir

The length of the pier is calculated considering the operation deck in front of the pier, the operation room, stoplog, ladder from pier to road bridge, and location of road bridge. The calculated length is 22.0m.

3) Top elevation of pier of weir

The bottom elevation of the girder should be equal or higher than design dike elevation. Therefore, the top elevation of the pier of weir is determined to be equal to the design elevation of dike EL.14.00m.

(7) Design of Pier Footing and Apron

(a) Sheet piling work

Sheet piling work is studied from vertical and horizontal directions.

1) Sheet pile works for vertical direction

The thickness of the upper weir body is 5.0 m, and the thickness of the lower part is 20.0 m. The thickness of the upper apron is 1.0 m and the thickness of the lower apron is 2.00m. From those values, the creep length is calculated. Using the creep length calculated and Lane's creep coefficient, a length of sheet pile (SP-II) ℓ＝3.0m is determined to ensure the required creep length. For the upstream side of the weir a length of (SP-II) ℓ＝4.0m is adopted for the sheet piles considering the reduction of uplift. In addition, sheet piles of (SP-II) ℓ＝2.0m length are to be driven at edge of upstream apron to avoid the scouring.

2) Sheet piling work for horizontal direction

Sheet pile for horizontal direction shall be set in front of the weir and the middle part of the weir body. In front of the weir, sheet piles (SP-II, L=4.0m) shall be driven (on left bank: 35 m, on right bank: 44 m). In the middle part of the weir body, sheet piles (SP-II, L=9.0 m, 14 m) shall be driven for 20 m in length on the right and left sides.

(b) Design of Concrete Slab Part of Pier and Downstream Apron

Thickness of the downstream apron and concrete slab part of the pier are designed based on uplift caused by the difference in upstream and downstream water level and creep length. The designed thickness of the downstream apron and concrete slab part of the pier are 1.5 m and 2.0 to 5.0 m, respectively.

(8) Type of Gate Facilities

The dimensions of the floodway gate, sluiceway gate and river maintenance flow gate are shown in the following table.

dimensions of floodway gate, sluiceway gate and river maintenance flow gate

	H	L	L/H
1) Floodway gate	4.8m	12.5m	2.60
2) Sluiceway gate	4.8m	5.0m	1.04
3) River maintenance flow gate	1.5m	1.5m	1.00

A plate girder roller gate shall be adopted for the floodway gate because L/H is 2.60. The most important role of the sluiceway gate is to flush sand in the sluiceway smoothly. Therefore, the type of gate should be selected from the view point of sand flushing. If a roller gate is adopted, it is possible to start sand flushing immediately after opening the gate and avoid damage from the sand because it has been pulled upward. Roller gates are adopted for most sluiceway gates these days. A roller gate shall

therefore be employed in the Project.

(9) Hydraulic Design of Apron and River Bed Protection Work

The design flood water level for the downstream apron and river bed protection was studied considering adequate dissipation against small and medium magnitude floods. As a result, USBR-III was adopted as the energy dissipater type and the dimensions of the apron and river protection work were determined.

(10) Operation Bridge and Stairway

Hoist houses are planed to be set at the top of each pier in order to operate the gates, and the control house and generator house are to be placed on the right bank which is near the town. A stairway is to be set on the right bank for security. An operation bridge is necessary to connect the hoist houses and stairway.

(11) Design of Road Bridge

As the headworks are planed to be constructed on National Road No.3, a road bridge is also to be constructed. The total road width of the bridge is determined to be 11.80m after the confirmation of the Ministry of Public Works and Transport through MOWRAM. The bridge types considered are generally categorized into concrete bridge type and steel bridge type. According to the construction schedule of the Project, the bridge will be erected in the rainy season. Thus, a steel bridge is selected, because it can be set without supporting works.

(12) Generator

Floodway gates and the sluiceway gate can be operated both from the hoist houses and the control house. The electric facilities in the headworks are a) gates except for the river maintenance flow gate, b) a control panel and room lightning for the hoist houses and control house, and c) street lightning for the road bridge. There is no electricity near the site, therefore, an additional 50 KVA generator is planned for standby.

(13) Foundation

According to the geological investigation, the bearing stratum is from EL.-8.00m. The foundation surface of each structure is shown in the table below.

Height of Pier and Retaining Wall

structure	1) Foundation surface	2) Bearing stratum	3) = 1) - 2)
1) Pier	EL.2.00m	EL.-8.00m	10.00m
2) Retaining wall (Upstream)	EL.6.00m	EL.-8.00m	14.00m
3) Retaining wall (Downstream)	EL.2.50m	EL.-8.00m	10.50m

As the bearing stratum is not adjacent to the foundation surface, a spread foundation could not be adopted in this case. Thus, a pile foundation shall be adopted. PC piles are selected for pile type because they are common in Cambodia. The dimensions of the piles for each structure which were determined from the pile calculation based on a stability analysis are presented in the table below.

Dimensions of RC Pile

Structure	Pile dimension	Pile Type
1) Pier	□400mm x 400mm, ℓ = 11.00m, 1.40m x 1.91m interval	RC
2) Retaining wall (Upstream)	□400mm x 400mm, ℓ = 15.00m, 1.35m x 1.50m interval	RC
3) Retaining wall (Downstream)	□400mm x 400mm, ℓ = 12.00m, 1.60m x 1.125minterval	RC

2.2.2.3 Rehabilitation of Existing 7th January Dam and Regulators

(1) Design Condition

(a) Design

In the area, there are several river structures, namely the 7th January Dam, the Tuk Thla Regulator, the Kompong Tuol Regulator and the Deum Russ Regulator. The design concept for those facilities is as follows:

1) The Kompong Tuol regulator shall be demolished.

2) The maximum intake water level shall be raised to EL.11.80m from EL. 11.26m.

3) The crest elevation of the 7th January Dam shall be raised to EL.11.80m from EL. 11.26m.

4) At the Tuk Thla Regulator, the gate crest elevation shall be raised to EL.11.80m from EL. 11.26m by the expansion of the existing gate leaves.

5) At the Deum Russ regulator, the gate crest elevation shall be raised to EL.11.80m from EL. 11.26m by the expansion of the existing gate leaves.

This above design concept was confirmed in the Steering Committee Meeting on September 11, 2004.

(2) Scope of Work

(a) 7th January Dam (spillway)

1) Height raising : New construction of over-flow weirs outside the existing structure.

: Height 0.55m（Crest level：EL. 11.80m）

: Total length of overflow 212m

2) Protection against leakage：Continuous sheet piles（ℓ= 4.0m）

(b) Tuk Thla Regulator

1) Height raising：Rasising the gate crest by expansion of gate leaves

：Height 0.40m（Crest level：EL. 11.80m）

2) Protection against leakage：Continuous sheet piles（ℓ= 4.0m）

(c) Deum Russ Regulator

1) Height raising：Raising the gate crest by expansion of gate leaves

：Height 0.20m（Crest level：EL. 11.80m）

(d) Kompong Tuol Regulator：To be demolished.

(3) 7th January Dam

(a) Present Condition

The 7th January Dam, with a bathtub-type spillway, was constructed in 1996-1997 on the upstream side of the portion collapsed by flood on the National Road No.3 funded by MOWRAM fund. MOWRAM was the executing agency for the construction works. The length of the weir crest is 230m and a bridge of 80m long and 8m wide is constructed. Presently, the 7th January Dam is functioning.

7th January Dam

(b) Crest Heightening Work

In order not to harm the existing structure, a new retaining wall shall be set outside the existing one. The new retaining wall shall be provided in contact with the existing wall. The elevation of the upper surface of the bottom slab should be set at EL.7.00m which is coincidental with the gate sill of the newly designed headworks, at EL.7.00m.

According to the survey result during the F/S, sufficient bearing capacity for the foundation is expected because the N value = around 10. However, as the geological survey did not investigate as many individual points within the subject area as would be required for adequate design of a foundation, PC piles (□20cm x 20cm, ℓ= 4.0m) will be used at an interval of 2m just beneath the wall to be conservative.

(c) Sheet Piling Work

The intake water level is to be raised to EL.11.80m from 11.26m so that the seepage length shall become longer and some countermeasure shall be required accordingly. For this, sheet pile (SP-II) shall be adopted as protection against uplift. The length of the sheet pile is calculated from Lane's creep coefficient and the difference between the upstream and downstream water levels. In consideration of this calculation and protection against scouring, sheet piles of ℓ= 4.0m are to be employed.

(4) Tuk Thla Regulator

(a) Present Condition

This regulator was constructed in the '70s under the "Pol Pot Regime" at a crossing point of National Road No.3 and a shortcut channel. The objective of the regulator is to maintain the water level in order to supply water to the Project Area. Twenty five manually operated gates were initially installed, and in 2001 all the gates were upgraded with motor-driven lifting devices by the funds of ADB. The gate dimensions are 0.9 – 1.1 m width and around 2.4m height. The regulator is presently functioning without any problem. The principal features are summarized below.

Tuk Thla regulator

Dimension of Tuk Thla Regulator

Item	Description
1) Gate number	25 gates
2) Type	Steel slide gate
3) Dimension	B0.9m～1.1m×H2.4m
4) Elevation of gate sill	Gate sill : EL.8.94m, Bottom of culvert : EL.8.56m
5) Elevation of gate top	Gate top : EL.11.44m

(b) Gate Heightening Work

The expansion of the gate leaves by 40cm is required for adjusting the gate crest to EL.11.80m because the elevation of the gate crest is now around EL.11.44m. Firstly, the existing gate leaves shall be taken, washed and cleaned so as to remove rust from them. After such works, a new steel plate shall be welded to the original one (Adjustment shall be made up to the gate crest elevation EL.11.80m.). Then, all

original rubber shall be replaced with new as well as a new outside guide rail. After checking them, all the gate leaves shall be set back into the original places. These heightening works will be carried out for all 25 gates.

(c) Sheet Piling Work

The intake water level is to be raised to EL.11.80m from 11.26m so that the seepage length shall become longer and some countermeasure shall be required accordingly. Sheet pile (SP-II) shall be adopted as protection against uplift. The length of the sheet pile is estimated from Lane's creep coefficient and the difference between the upstream and downstream water levels. In view of this estimation and for protection against scouring, sheet piles of ℓ = 4.0m are employed.

(5) Deum Russ Regulator

(a) Present Condition

The Deum Russ regulator was set at the boundary between the Stueng Touch River and Prek Thnot River. It has three gates and they are manually operated. This regulator, including gates is, in working condition. The following table shows the main dimensions of the regulator:

Dimension of Deum Russ Regulator

Contents	Dimension
1) Number of gates	3nos.
2) Type of gates	Steel slide gates
3) Gate dimension	B 1.76 ～ 1.82m、H 2.00m
4) Gate sill	EL. 9.61m
5) Gate crest	EL. 11.61m (average)

(b) Expansion of Gate

The expansion of gate leaves by 20cm is required for adjusting the gate crest to EL.11.80m because the elevation of the gate crest is around EL.11.61m. The height of the pier is only 1.5m so that it is physically impossible to take out the gate leaves (h=2.0m). Therefore, the present operation deck and piers shall be demolished and replaced with new ones (h=2.5m) considering the future O&M. The existing gate leaves shall be taken out, washed and cleaned so as to remove rust from them. After such work, a new steel plate (h=20cm) shall be welded to the original one (Adjustment shall be made for increasing the gate crest to elevation EL.11.80m.). Then, all rubber shall be replaced with new as well as a new outside guide rail. After checking them, all gate leaves shall be set back into the original places. These heightening works will

be carried out for all 3 gates.

(c) Sheet Piling Work

The height is to be raised only 20cm and no remarkable difference of water levels between the rivers is expected. Therefore no sheet piling works will be needed.

(6) Kompong Tuol Regulator

(a) Present condition

This regulator was constructed in the '70s under the Pol Pot regime on the old river route. In comparison with the Tuk Thla regulator, the size of gates is relatively small. Water leakage is observed due to poor construction work. Thus, MOWRAM desires to remove the regulator. In 2001, the gates were upgraded from manually operated to motor driven by ADB. Site observations and drawing checks indicated much leakage and an unstable structural condition. The principal features are summarized below.

Konpong Tuol Regulator

Dimension of Kompong Tuol Regulator

Item	Description
1) Gate number	6 gates
2) Type	Steel slide gate
3) Dimensions	B1.4m～1.5m×H3.3m
4) Elevation of gate sill	Gate sill：EL.8.03, bottom of culvert：EL.7.85
5) Elevation of gate top	Gate top：EL.11.33m

(b) Demolition work

As mentioned above, it was confirmed through the site observations that a) currently, water passes under the foundation due to much leakage, b) a structurally unstable condition exists due to severe scouring at the end of the downstream apron. It could be said that those problems were due to poor maintenance rather than deterioration. The review of design also showed the required creep length was not secured. With the above, it was decided that the Kompong Tuol Regulator was to be demolished. The demolition work shall be done as follows:

1) All of the structural parts shall be demolished and dismantled.

2) The structural parts shall be buried under compacted soil.

3) The embankment shall be raised to the elevation of National Road No.3 and asphalt pavement shall be laid.

4) At the upstream portion, a river protection work shall be set.

2.2.2.4 Rehabilitation of the Main Canal and Related Facilities

(1) Design Condition

(a) Design parameters

The main canal and related facilities are to be constructed in order to supply sufficient water to the Project Area. The following design parameters were confirmed between MOWRAM and the Basic Design Study Team in the Steering Committee Meeting held on September 10, 2004.

Design Parameters for Main Canal

Design Parameter	Design Value
1.Design water level before intake	EL.11.80m
2.Design water level after intake	EL.11.50m
3.Design water depth	1.50m
4.Design total width of right dike	5.50m
5.Design total width of left dike	3.00m
6.Design width of inspection road	4.50m

(b) Scope of the rehabilitation works

In the Steering Committee Meeting held on September 10, 2004, the following scope of the works were confirmed:

Irrigation System	Rehabilitation of the main canal for 5.3km
(a) Design discharge	2.73～1.03m^3/sec
(b) Type of canal	Concrete block lining for both slopes with earth lining on the bottom; canal side slope 1:1.5
(c) Construction of intake	1site
a) Design intake discharge	2.73m^3/sec
b) Design intake water level	E.L. 11.50m
c) Gate	Gate with rubber seal on four sides (B x H = 1.8m x 2.1m, 3sets)
(d) Turnout	26 sites
(e) Check structure	2 sites
(f) Crossing structure (culvert)	8 sites
(g) Maintenance flow gate	6 sites
(h) O&M roads	Rehabilitation of O&M roads for main canal of 5.3km, lateral canal of 9.3km

(2) Basic Design for Irrigation System

(a) Route plan

The existing main canal route is planned to be utilized without major changes. The diagram for the main irrigation canal is shown in the Figure 2.1.

(b) Canal section of the main canal

The existing main irrigation canal has severely deteriorated and malfunctioned due to severe erosion caused by soil characteristics, lack of maintenance work, poor-design, difficulty in obtaining adequate budget, and no co-operation from the beneficiaries. Since the canal was formed by excavation, no gravity irrigation has been realized. The O&M road along the canal is corrugated due to lack of maintenance and has also been narrowed due to agricultural activities. The overall rehabilitation of the canal and its O&M road is required.

The most important thing for the farmers in the area is that water should be conveyed to the downstream area smoothly even if the water level is still low. In the present situation, the sill of the existing intake is rather high and the bottom of the canal is undulated. Therefore, frequently no water conveyance occurrs when the river water surface is low. For fixing this problem, the design water depth should be the same in every part of the canal. After the overall examination of the canal profile, the design water depth was determined to be 1.5m. The rehabilitated cross section of the main canal should be designed in order to minimize the burden of land acquisition and embankment material from outside.

As the original soil along the main canal is very weak against flowing water and rain, and may have a high dispersive characteristic in water, it is recommended to cover the original soil with clay soil and eliminate the interface between the original soil and the water in the canal. Sod facing shall be placed on the other parts for protection. The canal side slopes shall be 1:1.5. The lining is planned for both slopes but not the bottom to avoid damage by uplift pressure and for saving on construction cost as proposed by the F/S.

(c) Design discharge

The irrigation area is 1,950 ha. The unit discharge is designed to be 1.40 lit./sec/ha, the same as the result of the F/S executed in 1996. This design value was confirmed by the Steering Committee Meeting.

The planned discharge is supplied to the field through 31 turnouts on the main canal (including 5 turnouts under control of TSC). The irrigation diagram is shown in Figure

2.1.

(d) Intake

1) Location

As National Road No.3 is crossing the beginning point of the main canal, the intake shall be constructed at 55m downstream from the beginning point of the main canal.

2) Type of gate

The design water level after the intake is set at EL.11.50m so that some adjustment should be made for the gap between the intake water levels before and after the intake. The intake should protect the main canal from flood. For those requirements, the steel gates of B 1.80m x H 2.00m with rubber seals on four sides are provided.

3) Steel sheet piling works

In order to protect the downstream part after the intake from scouring and to minimize leakage, steel sheet piles 3m in length shall be provided at the underneath and end parts of the regulator.

(e) Turnout

The Project covers 26 turnouts. An additional 5 turnouts are to be constructed under control of TSC. Out of the 26 turnouts, T.O.21 connects to the outside area. Continuous water supply from it is not necessary, but it is one of the water resources. A steel slide gate of B 1.00m x H 0.75m shall be adopted. As T.O.25 and T.O.26 shall be used for gates to the lateral/tertiary canals, steel gates of B 1.00m x H 1.00m are provided. For other turnouts, steel slide gates of B 0.70 m x H 0.70 m shall be provided. Locations, discharge sides and discharge quantities are given in the following table.

Location of Turnout, Side and Discharge

No.	Section No.	Side	Discharge (m3/s)	No.	Section No.	Side	Discharge (m3/s)
T.O.1	0+225	Right	0.330	T.O.14	2+670	Left	0.027
T.O.2	0+225	Left	0.021	T.O.15	2+950	Right	0.020
T.O.3	0+590	Right	0.011	T.O.16	2+950	Left	0.024
T.O.4	0+590	Left	0.011	T.O.17	3+175	Left	0.034
T.O.5	0+945	Right	0.006	T.O.18	3+475	Left	0.029
T.O.6	1+150	Right	0.020	T.O.19	3+825	Left	0.046
T.O.7	1+150	Left	0.004	T.O.20	4+175	Left	0.071
T.O.8	1+500	Right	0.022	T.O.21	4+687	Right	0.297
T.O.9	1+760	Right	0.035	T.O.22	4+675	Left	0.064
T.O.10	1+760	Left	0.004	T.O.23	5+165	Right	0.081
T.O.11	2+170	Right	0.014	T.O.24	5+165	Left	0.084
T.O.12	2+170	Left	0.034	T.O.25	5+315	Right	0.365
T.O.13	2+670	Right	0.043	T.O.26	5+315	Left	0.373

(f) Check gate

Two check structures shall be provided in order to adjust discharge and velocity, keep intake water levels at the respective turnouts, carry out O&M of the canal, and increase the safety by controlling water level in the canal. In those structures, as well as controlling water level with steel gates, duckbill weirs shall be provided at both upstream sides to avoid rapid water level raise.

The main feature of the check structures are shown in the following table.

Major Dimension of Check Gates

	Check Structure – 1	Check Structure – 2
1) Location	No.2 + 690 (2.690m)	No.4 + 191(4.191m)
2) Gate	B 1.60m x H 1.50m x 2 sets (Steel slide gate with three sides rubber sealing)	B 1.20m x H 1.50m x 2 sets (Steel slide gate with three sides rubber sealing)
3) Length of weir	8.0m(both sides)	6.0m(both sides)

(g) Crossing structures (culverts)

All existing bridges shall be demolished and be replaced by 8 new culverts.

(h) Maintenance flow gate

In the upstream area, there are several old river courses. Several farmers are now utilizing these for irrigation and other purposes. Allowing for such practice by the farmers, gate structures shall be set for water supply. Out of the required six sites, two upstream sites requires steel slide gates of B 0.75m x H 1.00m, and steel gates with 600mm Ø shall be provided at the other four sites.

(3) Hydraulic Calculation for the Main Canal

(a) Design condition

Design of the main canal is made applying the Manning's Formula with the following conditions.

Design water level before the intake: EL. 11.80m

Design water level after the intake: EL. 11.50m

Design sill elevation at beginning point (BP): EL. 10.00m

Design water depth: 1.50m (BP to end point (EP))

Canal length: 5.3km

Type of canal: Open canal (Concrete block lining with both canal slopes)

Canal side slopes : 1 : 1.5

Roughness coefficient : 0.017 (slope), 0.025(canal bed)

(b) Design for canal section

The results of the hydraulic calculations for the respective canal sections are given in Tables 2.5 and 2.6 and summarized as follows.

Canal Dimension

Section (m)	Distance (m)	Canal bed width (m)	Gradient
0 – 225	225	7.0	1/80,000
225 - 1,150	925	5.0	1/70,000
1,150 – 1,760	610	5.0	1/73,000
1,760 – 2,670	910	4.0	1/56,500
2,670 – 3,175	505	4.0	1/62,500
3,175 – 3,475	300	3.0	1/65,000
3,475 – 3,825	350	3.0	1/70,000
3,825 – 4,175	350	3.0	1/77,500
4,175 – 4,687	512	3.0	1/87,000
4,687 – 5,167	480	2.0	1/110,000
5,167 – 5,315	148	2.0	1/145,000

(4) O&M Roads

(a) Scope

O&M roads are provided for the main and lateral canals as shown below.

O&M Roads

Canal Name	Length
Main Canal	5.3km
Lateral Canal	9.3km

(b) Design for O&M roads

Present condition of the O&M roads is bumpy and narrowed due to: a) no repair of pot holes, b) no cutting of trees and grass, c) no proper pavement or maintenance, and d) damage to culverts on the road. The rehabilitation work is needed for widening the road width, construction and repair of crossing structures, and smoothing and pavement. The rehabilitation work would contribute to improve the access for agricultural activities and construction of lateral and tertiary canals. The road width is 5.5 m along the main canal (pavement width of 4.5 m) and 4.5 m along the lateral canals (pavement width of 4.5 m). Surfacing would be made of lateritic soils with 0.15 m thickness.

2.2.3 Basic Design Drawings

Drawings prepared in the basic design are attached to this report.

2.2.4 Implementation Plan

2.2.4.1 Implementation policy

The Project will be implemented on the following conditions in consideration of the application for Japan's Grant Aid System.

(1) MOWRAM will be the executing agency for the Project Implementation in the GOC.

(2) When the Exchange of Notes (E/N) between the GOJ and GOC regarding the stages of detailed design is signed, MOWRAM will take care of overall procedures necessary for the implementation of the Project.

(3) A Japanese consultant firm, recommended by the Japan International Cooperation Agency (JICA) and entrusted by MOWRAM will sign the contract with MOWRAM, and will prepare detailed design and tender documents.

(4) The GOC shall commence arrangements for land acquisition and house compensation in parallel with detailed design.

(5) Before signing of E/N between the GOJ and GOC regarding the Project implementation, MOWRAM shall make sure of the successful acquisition works by getting approval from the communes. The Japanese Consultant entrusted by MOWRAM will start the tendering work after signing of contract for project supervision.

(6) A Japanese contractor, after signing the contract for construction works with MOWRAM, will undertake the construction works and the consultant will execute construction supervision.

(7) Upon completion of the construction works, the responsibility of the operation and maintenance function of the rehabilitated main irrigation facilities will be transferred to the Project O&M office established by MOWRAM.

In Cambodia, several Japanese contractors have been engaged in the construction works of projects under Japan's Grant Aid System. These contractors have employed local contractors as subcontractors, mostly for the purpose of manpower supply and partial supply of construction equipment. Thus, in this Project, construction works are planned to be performed on the basis that the Japanese contractor will arrange construction equipment and materials by himself and also use the manpower supplied by the subcontractors, and construction work shall be carried out under the supervision of Japanese consultants.

The construction work generally consists of the following construction works.

－Construction of headworks: 1 no.

－Rehabilitation of existing regulators including 7th January dam: 3 nos.

－Demolition of existing regulator: 1 no.

－Rehabilitation of intake structure: 1 no.

－Rehabilitation of main canal: 5.3 km

－Rehabilitation of O&M roads: 9.3 km

Taking into account the quantities of the construction materials, construction period, and site condition (rainy and dry seasons), the above construction work is divided into i) construction of headworks, ii) rehabilitation of the existing regulators, and iii) rehabilitation of the intake, main canal and O&M roads, and construction supervisors shall be deployed for each construction work. In addition, at the beginning of the construction works, experts for quality control (concrete and soil mechanics) will be assigned. From these conditions, the following Japanese experts will be assigned by the contractor;

－Site manager

－Chief engineer (headworks/spillway/regulators)

－Office administrator

－Civil engineer (intake, main canal, O&M Road, earthworks, concrete works)

－Mechanical engineer (gate and mechanical works)

－Electric engineer (electrical works)

－Building engineer (building works)

2.2.4.2 Implementation Conditions

(1) Environment Impacts during Construction

The possible environmental impacts during the construction will be a) noises due to the construction, b) dust, mainly from the vehicles, c) vibration due to operations of heavy machines and d) traffic accidents. At the construction site, it is not likely that damage to buildings will occur due to noise or vibration. However, considering the inhabitants, night works should be strictly prohibited in principle. In order to avoid dust, mainly from the vehicles, spreading of water onto the construction road will be carried out properly. In addition, prevention of accidents caused by construction equipment should be encouraged by a) education to drivers on safe driving, b) regular safety meetings and c) deployment of traffic control officers.

(2) Construction in Existing Cultivated Land

The construction works will need sites for temporary deposit of excavation materials and access to the existing cultivated land and a full agreement with the beneficiaries and the executing agency about suspension of cultivation has been confirmed. The contractor, however, should explain to the beneficiaries concerned about construction schedules and sites with the assistance of the Project O&M Office beforehand in order to minimize the period for suspension of the farming and in keeping strictly to the construction schedule.

2.2.4.3 Scope of works

(1) Scope of Works to be executed by the Japanese Side

(a) Detailed design and preparation of tender documents

(b) Undertaking of the construction of the irrigation facilities as described in “Section 2.2 Basic Design”.

(2) Undertaking by the GOC

(a) Land provisions and arrangements required for implementation of the Project

(b) Undertaking of budgeting and settlement for customs, inland duty imposed on the

procured machinery and materials, and others

(c) Coordination with other relevant agencies and issue necessary consent(s) concerned for implementation of the Project

(d) Give guidance from MOWRAM to the FWUC about O&M of the facility

(e) Maintain the security of the periphery of the Project Area including land mines

(f) Construction and improvement of lateral and tertiary canals

(g) Establishment of O&M office

2.2.4.4 Construction Supervision

(1) Preparation of Detailed Design and Tender Documents

Immediately after signing E/N between the GOJ and GOC for the detailed design and construction works, the contract for the consulting services will be concluded between MOWRAM and the Japanese consultant, and then detailed design and tender documents will be prepared in collaboration with MOWRAM. The consultant should discuss the design and implementation schedule of the works with MOWRAM during the site investigation. At the detailed design stage, the following works will be done.

(a) Additional Investigation/Survey (additional investigation/survey based on Basic Design)

1) Investigation of construction site of the new headworks for topography

2) Investigation of construction site of the intake structure for topography and obstacles

3) Re-checking of location of quarry sites for earthworks

(b) Preparation of Detailed Design

1) Detailed design based on the basic design and additional investigation/survey results

2) Review of the Project cost through the detailed design

(c) Preparation of the tender documents

1) Preparation of the tender drawings

2) Preparation of the tender documents for the construction works

(2) Tendering and Construction Supervision

After the completion of the works on the detailed design and preparation of tender documents, the Japanese consultant will start tendering works in collaboration with MOWRAM at first. The scope of construction supervision is summarized as follows:

(a) Review/Check and approval of construction drawings

Review/check and approval of construction drawings, application for commencement of the works, sample of materials, specifications of the equipment, etc. submitted by the contractor.

(b) Progress and quality control

Check and guidance on the construction plan and time schedule, quality control and progress of the construction works and necessary inspection of the construction methods.

(c) Approval for payment to the contractor

Check and review of the performance of the works necessary for issuing payment certificates and the completion certificate to the contractor

2.2.4.5 Procurement Plan

Major construction materials for the construction works are cement, aggregates, crushed stones, pre-cast concrete products, forms, reinforcement bars, PVC pipes, etc. These materials are available in Cambodia and there is no problem about quality or availability. In case of "water-sealing gates", there is no availability in the domestic market for this product. Thus, they would be imported from Japan and/or the third countries. There are several rental companies for most kinds of construction equipment in Cambodia from whom construction equipment can be hired.

2.2.4.6 Quality Control Plan

Since there is no statutory standard for quality control in the country, quality control of the works will be made by the consultant based on the Japanese standards. Among the tests items, items for concrete and soil mechanics can be tested by the laboratory of MOWRAM and of the Ministry of Public Works.

For daily quality control, the contractor shall execute concrete and soil tests such as slump and compressive strength tests of concrete and density tests of embankment by the sand replacement method.

Test items and their standards and frequency are shown in following Table.

Items of Test, Method and Frequency

Description	Test Item	Standard	Frequency	Test Method
1. Concrete works				
Cement	Kind of cement	Ordinary Portland cement	Every delivery time	In presence of the Engineer
	Conform to specification	JIS R5210	300 ton/time	Factory certificates
Admixture	Conform to specification	JIS A6204	Before design mix	Factory certificates
Aggregates	Gradation	Technical specification	When quarry site is changed	In presence of the Engineer
	Bulk density	Coarse aggregate: 1.25kg/liter		
		Fine aggregate: 1.45kg/liter		
	Density and water absorption	Fine aggregate: Gravity: >2.5 Absorption: <3.5%		
		Coarse aggregate: Gravity: >2.5 Absorption: <3.0%		
	Resistance to abrasion by LAM	Less than 40%		By testing institute
	Material passing standard sieve 75μm in aggregate	Coarse aggr.: <1% Fine aggr. : < 5%		
	Clay lumps contained	Coarse aggr.: <0.25% Fine aggr. : < 1%		
	Organic impurities in fine aggregates	Lighter color less than standard		
	Soundness of aggregates by use of sodium sulfate	Coarse aggr.: <12% Fine aggr. : < 10%		
	Alkali reaction	ASTM C289-66		
Field mix	Surface moisture	JIS A 1111	1 time/day	Presence of the Engineer as required
	Slump	JIS A 1101	2 times/day (morning, afternoon)	
	Flexural strength of concrete	JIS A 1108	Less than 50 m3/day: 1 time More than 50 m3/day: 2 times	In presence of the Engineer
2. Embankment Works				
Material	Density of soil particles	JIA A 1202	All materials	In presence of the Engineer
	Particle size distribution of soils	JIA A 1204		
	PL, LL tests	JIS A 1205		
	Water contents of soils	JIS A 1203		
Construction	Test embankment	More than 95% of maximum dry density		
	Moisture contents	±5% of optimum moisture content	1 time/200 m, 3 sampling	Presence of the Engineer as required
	Field density	More than 95% of maximum dry density		
3. Procurement (Reinforcement steel bar, gates)				Site, shop, factory inspection, Review/evaluation of certificates issued by supplier/manufacturer

2.2.4.7 Implementation Schedule

As stated in Section 2-2, the Project will be implemented under the following phases.

(1) Detailed design stage

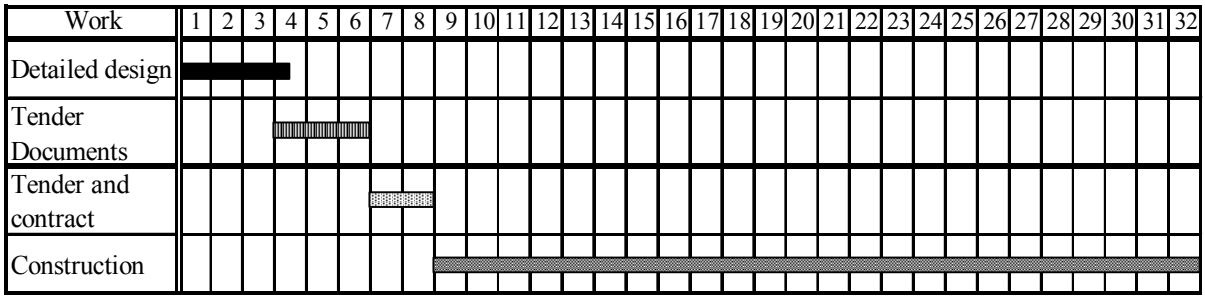
- Detailed design 3.5 months
- Preparation of tender documents 3.0 months

(2) Construction stage

- Tendering works 2.0 months
- Construction works 24.0 months

The construction schedule is shown below

Construction Schedule



2.3 Obligations of Recipient Country

2.3.1 Items to be Undertaken by Recipient Country

(1) Items to be undertaken by recipient country

In implementing the Project, MOWRAM, as an implementing agency in the GOC, should undertake the following activities:

(a) provide necessary documents and information for the Project.

(b) secure the land for expansion of canals and roads, and the land for construction of temporary site office, and storage / deposit for building materials.

(c) secure the budgeting measures and staff for the Project implementation by MOWRAM.

(d) open bank account in Japan, including bearing the banking costs and handling charges.

(e) arrange for tax exemption for machinery and materials procured in accordance with

the E/N and proceed with the necessary formalities for customs clearance.

(f) arrange for tax exemption from any taxes such as customs tax, inland duty and other financial surcharges imposed to the Japanese in accordance with the E/N.

(g) support Japanese Nationals' entry and stay for fulfillment of the contract in accordance with the E/N.

(h) authorize approval, permission, and authorization for the Project implementation

(i) establishment of the Project O&M Office and the budget allocation for implementing an effective O&M work for the rehabilitated irrigation facilities under the Project.

(j) implement rehabilitation works for the lateral/tertiary canals.

(k) establishment/organization of FWUC undertaking O&M works for the minor irrigation facilities.

(l) take speedy action for coordinating any claims against the Project implementation from a third party or concerned non-beneficiaries.

(m) secure the safety of the Japanese Nationals from any conflicts, riots, trouble, insurrections, mines, etc.

(2) Supplementary obligations for the recipient country

(a) Items related to construction of the main irrigation facilities

An arrangement for land acquisition covering the following items must be completed in time to conclude a contract with the selected civil contractor;

1) Land acquisition of the existing paddy field along to the main canal (maximum 2 m width from toe of slope for the canal),

2) Construction site for the temporary site office, and

3) Site for the storage and stock yards for materials

Also, according to recent information from the Cambodian Mine Action Center (CMAC), there is a possibility of UXO, unexploded bombs dropped by airforces 2-3 m underground in the Kandal Stung area, especially in the southern part of the existing main canal. Therefore, MOWRAM is required to take action for investigation/bomb disposal (including mines) in coordination with the CMAC immediately after signing of the E/N.

(b) Planning for the effective O&M for the rehabilitated facilities by Japan's Grant Aid

In order to maintain and properly and effectively use the facilities constructed and equipment provided under the Grant, the following services, to be carried out by MOWRAM, are essential.

1) Establishment and management of the Project O&M Office to undertake O&M works for the main irrigation facilities.

2) Establishment of the organization/system for securing the funds to rehabilitate the lateral/tertiary canals, and implementation of the rehabilitation work for the lateral/tertiary canals (design, construction and land acquisition should be carried out simultaneously with the Project under the Grant).

3) Establishment/organization of FWUC undertaking O&M works for the minor irrigation facilities.

4) Undertaking to minimize the effects of "the Integrated Development Project in the Western Side of Phnom Penh Municipality" as it impacts the Kandal Stung Irrigation Project (formulation of a rule for diversion at the Rolaing Chery, etc.).

2.3.2 Supplemental Notes on the GOC's Obligations

(1) Official procedures required for the Project implementation

MORAM has experience in implementation/management of "the Project for Improvement of Facilities of Colmatage Systems in Kandal Province along the Mekong River (1999.12- 2001.3)". Thus, MOWRAM has experience in the proceedings necessary for the official formalities for the Project.

(2) Land Acquisition

MOWRAM has experience in land acquisition issues through a) on-going projects for the construction of flood relief channels financed by ADB, and other projects, and b) the relevant commune heads in the area are helpful for that issue. In case difficulties in carrying out land acquisition are faced by MOWRAM and concerned commune heads, an alternative approach which is handled by the Inter-ministerial Resettlement Committee has already been established. The Minister of MOWRAM has issued a letter to commit to manage land acquisition under agreement with the beneficiaries concerned within three months after signing of the E/N (see Appendix-6).

(3) Investigation /Bomb Disposal (including land mines) of UXO

As investigation/bomb disposal of UXO is a risky issue associated with human lives, MOWRAM has stated its ability to manage the issue with full responsibility. Thus, the

management of this issue is assumed to be a responsibility of MOWRAM

(4) Establishment/Management of the Project O&M Office

The organization of the Project O&M Office of the main facilities by MOWRAM, comprised of the civil engineers trained by the TSC, should be done with the staffs for agriculture and institutional development. Thus TSC's technical guidance and assistance to the Project O&M Office is anticipated. The budget for organizing and training FWUC is already capitalized by MOWRAM as part of the budget for rehabilitation of lateral/tertiary canals.

(5) Rehabilitation of the Small Scale Canals

MOWRAM Battambang Provincial Office (BPSWRM) has achieved the rehabilitation of the tertiary canals of Komping Pouy Irrigation Scheme through the Grass-root Grant (US$ 362,000). The construction was carried out over 2 years from 2001 to 2002, focusing on the target area of 958 ha (first phase: 550 ha, second phase: 408 ha, averaged annual progress; 500 ha/year, averaged cost /ha: US$ 380). Design for the rehabilitation work was undertaken by BPSWRM, and construction was carried out by the local contractor hired by BPSWRM. The beneficiaries participated in the project by offering the farmland for canal rehabilitation. With respect to technical expertise for the Kandal Stung case, MOWRAM is considered to be capable of accomplishing the rehabilitation work based on the Battambang case.

Concerning the draft of the funds for rehabilitation work (Total: US$ 770,000), MOWRAM is forced to rely on donor assistance including Japan. Allocation of funding is not considered a problem as a) the budget scale is not unduly large (annually around US$ 190,000 over a 4 year construction schedule), and b) MOWRAM has already given first priority to the Project. Further MOWRAM has already submitted the budget application to the Ministry of Economics and Finance on January 2003 (See Appendix-4).

2.3.3 Necessary Project Items to Achieve the Overall Goal of the GOC

After completion of the rehabilitation work of the main facilities and the lateral/tertiary canals, the GOC should make the following self-efforts on the administrative service to popularize the rice double cropping system for the proposed cropping system.

(1) Agricultural Extension

As 60 to 90 % of the beneficiaries are not familiar with the proper farming practice for the early maturing IR rice varieties in the area, it is essential for the Project to strengthen the farmer's training on farming practice, including water management

practice, for the new rice double cropping system. Thus, the Project O&M Office is required to conduct a training program by establishing demonstration plots within the area in conjunction with the district agricultural office and the preceding projects (AQIP, NGOs).

(2) Strengthening of farmer's credit and publicity of market information

(a) Many farmers complain about the existing farmer's borrowing capacity in the area due to the small amounts available and the high interest rates charged, thus administrative guidance for correction should be necessary.

(b) As there are a lots of requests from the beneficiaries for the purchase of improved seeds and fertilizers on credit, strengthening of the financing system is essential in conjunction with the preceding NGO and donor's projects such as AQIP.

(c) Strengthening of the market-oriented farming system is necessary for the beneficiaries by informing them of market price information, good cash producing second crops, monthly rice market prices, etc.

(3) Rehabilitation of the farm roads

At present, plot to plot irrigation from the tertiary canals is widely prevalent, thus carrying paddy out of the field needs to pass the cultivated paddy fields where there are no farm roads when rice double cropping is introduced. Harvesting time between single cropping and double cropping is different. Therefore, there is some possibility that some farmers would abandon the rice double cropping; thus MOWRAM should consider rehabilitation of the farm roads in agreement with the beneficiaries during the rehabilitation work for the lateral/tertiary canals.

2.3.4 Required Cost to be provided by the GOC for the Project

The estimated cost to be provided by the GOC (MOWRAM) is estimated as below and its breakdown is shown in Tables 2.5 and 2.6.

Required Costs to be born by the Cambodian Side

Description	Unit Price (USD)	Quantity	Amount (USD)
1. Land acquisition m2	1	20,000	20,000
(1) Main canal: 15,000 m^2			
(2) O&M roads (4 nos): 5,000 m^2			
2. Investigation and removal of UXOs	LS		156,000
3. Banking cost	LS		2,700
4. Customs clearance cost	LS		1,000
4. Construction and improvement of lateral	LS		767,000
and tertiary canals			
5. Establishment of O&M office	LS		10,500
Total			957,200

2.4 Operation and Maintenance

2.4.1 Operation and Maintenance Plan

(1) Government policy for O&M plan of the irrigation project

The National Water Resource Strategy Paper stipulates that, in principle, operation and maintenance costs should be borne by the beneficiaries as much as possible due to the severe financial situation in Cambodia. Therefore, the GOC will support establishing and strengthening the independent FWUC in terms of technical and financial points as a key policy. The Paper also specifies that irrigation projects larger than 1,500 ha should be undertaken by MOWRAM in terms of O&M work of the main irrigation facility. As the Project covers an irrigable area of 1,950 ha, MOWRAM should take responsibility for O&M work for the main irrigation facility, while the minor facilities like tertiary canals and related structures should be undertaken by FWUC in principle. Even though the facility is nonfunctional and there is insufficient irrigation water supply, commune-basis water management is coordinated by the Kandal Provincial MOWRAM Office at present.

Therefore, it is essential for MOWRAM to undertake the O&M works for the main irrigation facilities and FWUC for the tertiary canals and related structures in order to operate and maintain the whole irrigation system, noting especially the following issues which are key factors for O&M works.

(a) The counterparts and technicians trained by the TSC-JICA Project-type Technical Cooperation are assigned to the O&M works for the main irrigation facilities. MOWRAM should improve capacity building by dispatching the counterparts to consulting firms or contractors during the construction period.

(b) MOWRAM should organize and train the commune based FWUCs followed by the signing of the E/N.

(c) MOWRAM should secure the necessary budget and staff for the above activity.

(d) TSC supports the above-mentioned activity.

(2) Lesson Learned from the Colmatage Project (Previous Grant Project)

"The Project for Improvement of Facilities of Colmatage System in Kandal Province along the Mekong River (completed in March, 2001)" located in Kien Svay District in Kandal Province, which was financed by a Japan's Grant Aid System, was implemented with construction of the main facilities for the traditional Colmatage farming and institutional support for establishment of FWUC as the soft component scheme. The Colmatage farming system is a traditional farming way to build up soil fertility by

taking muddy river water, including fertile elements, into the hinterland expanded to the flood plain in order to expand fertile farmland through a siltation process.

In this project, FWUCs have been organized around the 4 rehabilitated Colmatage canals under MOWRAM guidance. This institutional support to establish the FWUC was implemented in one year from August 2000 up to completion of registering FWUC via a soft component scheme by the Japan's Grant Aid System. The lessons learned from the Colmatage Project through analysis of the investigated results are summarized as below;

(a) Insufficient Confirmation Process to Grasp the Beneficiaries' Needs:

Rehabilitation work for the Colmatage canals appeared to be launched with insufficient processes to confirm the beneficiary's needs on rehabilitation of the Colmatage Project. For example, the beneficiaries belonging to the three Colmatage Canals continued their own farming without use of the water from the rehabilitated canals except for Koki Thom Colmatage.

(b) Inconvenience of institutional support system on FWUC formation:

The institutional and financial resources that would be required by MOWRAM, which undertook to organize and strengthen the Colmatage FWUC, were underestimated and support of the soft component in the Japan's Grant Aids System was applied for one year. However, monitoring was not conducted, and a follow-up analysis was discontinued as well.

Based on the above lessons, the O&M frame work in this irrigation project should be strengthened by paying adequate attention to the following points.

(a) Confirmation of the Project Needs for Rehabilitation

In the Project, the design and construction of the irrigation system must be brought into harmony with the beneficiaries' needs via confirmation of their intentions. The beneficiaries' needs were clearly confirmed through the result of the baseline survey to the beneficiaries and the seven commune heads.

(b) Establishment of the Project O&M Office and strengthening of FWUC by MOWRAM

From experiences with the Colmatage Project, it is apparent that the beneficiaries need a long time to become used to managing FWUC independently following the FWUC formation, and they are usually faced with difficulties in collecting ISF. Therefore, the implementing agency, MOWRAM needs to establish the Project O&M Office as a core of the project implementation with provision of annual budget for O&M cost and

necessary staff.

(3) Project Implementation Frame Work

The Project is implemented by the following organs (See Figure 2.2), and each organ's function with composition of the members is as follows;

Implementing Organs and its Role for the Kandal Stung Irrigation Project

	Implementing Organs	Function	Member
1	Steering Committee	The steering committee is scheduled to be set up followed by the E/N and shoulders the following role. ●Coordination work of inter-ministerial matters related to construction work of the Project ● Monitoring the construction work and progress of the Project implementation (including establishment of the O&M Office, management and FWUC) and administering/guiding the Project when it is necessary.	・Chairman ・Under Secretary of State of MOWRAM ・Concerned Directors/Deputy Director of MOWRAM and Director of Kandal Provincial MOWRAM Office ・CDC Representative ・MAFF Representative ・Res., Rep., of JICA Cambodia Office ・JICA Expert/MOWRAM ・JICA TSC Chief Advisor ・Project Manager of Construction of Lateral/Tertiary Canals ・Project Manager of the O&M Office In accordance with necessity, Representatives of Kandal Stung District Office and FWUC are convened.
2	MOWRAM	●Overall managerial work of the grant aid project and construction of the lateral/tertiary canals ●Land acquisition and compensation for construction work ● Arrangements for closing the water canal during the dry season for construction work ●Establish/Guide/Supervise the Project O&M Office and support to organize FWUCs ●Design/construction of the lateral/tertiary canals	・Irrigated Agriculture Dept., ・Engineering Dept., ・Project Manager of O & M Office ・Project Manager of Construction of Lateral/Tertiary Canals
3	Technical Service Center for Irrigation System (TSC)	●Give guidance/recommendations to the staff assigned to the Project O&M Office ●Supporting formation of the FWUC ●Establish a demonstration rice double cropping plot in the JICA TSC Model Site	・JICA Experts Team ・Counterparts
4	Farmers Water User Community (FWUC)	●Collection of ISF from FWUC members ●Implementation of regular O&M work for the lateral/tertiary canals ●Carry out the necessary support of technical advice/farm management to FWUC members ●Mediation of disagreement among the FWUGs	・FWUC Committee member ・Beneficiary
5	Project Operation & Maintenance Office	●Comprehensive O&M work for the main facility (water intake work, main canal) ●Give guidance on water management to FWUC ●Give guidance on farm management to FWUC ●Give guidance on O&M to FWUC	・Project Manager/Chief Irrigation Engineer ・Senior Agriculture Extension Officer ・Senior Irrigation Community Organizer ・Treasurer And technicians/assistants amounted to 10members

(4) Project O&M Office establish by MOWRAM

MOWRAM should establish the Project O&M Office at the Project site immediately after the signing of the E/N, and should immediately commence the action to organize FWUC. The Project O&M Office shall be established in the campus of the District Office by renting a vacant office. The Project O&M Office should have a role to undertake the O&M works of the main irrigation facilities and support FWUC about a) water management, b) farm management, and c) operation and maintenance. This Project O&M Office and FWUC will be supported by the following organs:

(a) Training and participation of the field day about the rice double cropping plot with farming practice information organized by TSC team at the TSC Model Site

(b) The agricultural information about integrated farming systems from the TSC and the District Agriculture Office

(c) The agricultural information about crop diversification from the District Agriculture Office

(d) Support from the District Office about implementation of the irrigation project

MOWRAM shall assign the following 10 staff for the Project O&M Office. The agricultural extension officer could be assigned from external organizations. The duties and responsibilities for 10 staff of 4 positions, and annual O&M cost for the Project O&M Office are shown in Table 2.7 and 2.8.

Assigned Staff	Staff Number	Remark
- Project Manager/Chief Irrigation Engineer	1	Transferred from MOWRAM
・Technician/Irrigation	1	
・Assistant/Irrigation	1	
- Senior Agricultural Extension Officer	1	Transferred form MAFF
・Technician/Agricultural Extension	1	
・Assistant/Agricultural Extension	1	
- Senior Irrigation Community Organizer(ICO)	1	Transferred from MOWRAM (From Irrigated Agriculture Dept.)
・Vice ICO	1	
・Assistant/ICO	1	
- Treasurer	1	Transferred from MOWRAM
Total	10	

(5) FWUC

(a) Basic Concept for establishment of FWUC

It is essential that the Project O&M Office establish the 7 commune-based FWUCs comprised of FWUGs as a base unit. At present, a water management organization in the Project Area plays a role to settle the water disputes among the communes during the early rainy season (there are currently no clear disputes observed within the communes). The concept for organizing FWUC in the area should be based on the existing rural structure. Hence, organizing 7 FWUCs along the main irrigation canal, an apex-organization like FWUC - Board to supervise 7 FWUCs is formed. Each FWUC undertakes to organize FWUG (commanding an area of 30 to 50 ha) based on the tertiary canals (See Figure 2.3).

(b) Process to organize FWUC

MOWRAM has adopted the PIMD (Participatory Irrigation Management Development) and issued the PIMD guideline comprised of 6 parts in June, 2000. The GOC has recommended that all donor-assisted irrigation development programs follow the same strategy of organizing FWUC following the PIMD. The PIMD stipulates the 8 steps of FWUC formation process, and the Project formation is requested to proceed in accordance with the following steps.

Step-1: A series of community or village level forums or public meetings are conducted to create community awareness.

Step-2: Setting the levels of the irrigation block (FWUG for the tertiary canals)

Step-3: Selection of each FWUG representative

Step-4: Formation of FWUC (For the Lateral canal)

Step-5: Formation of FWUC-Committee

Step-6: Formulation of the Draft FWUC Statutes

Step-7: Final ratification of the FWUC Statutes

Step-8: Registration of the Statutes and the Committee of FWUC into MOWRAM

(c) Training Plan for the FWUC

Most of the beneficiaries in the area are not familiar with a large farmer's organization and appeared to require much time to establish FWUC. Hence, training of the beneficiaries should be commenced from the time when FWUC is established. The training program consists of class work and practical training. The Project O&M Office plays a major role to conduct the farmer's training in collaboration with the technical affairs of MOWRAM and the District Agriculture Office. MOWRAM has proceeded with budgeting of the US$ 50,560 for farmer's training and formation of

FWUC.

1) Class work program

This course work shall be conducted over one year with the subjects shown below:

- Interpretation of the Pracas 306, a policy of O&M for the irrigation system promulgated by the GOC
- Interpretation of the statutes adopted by the Kandal Stung FUWC (tentative name)
- Responsibility of administrative management including office work and account management for the FWUC Office
- Methodology to build a system for collecting ISF
- Formulation of cropping plan associated with water management method
- Method to formulate annual O&M plan and water management
- Farming technology about rice, vegetables, and livestock
- Farmer's credit, marketing information

2) Practical training

Practical training about the above-mentioned course work could be carried out in the rehabilitated farmland via On-the-Job-Training in order to endow self-help in FWUC. To support FWUC, the TSC launched in January 2001, (a JICA technical cooperation project), is expected to contribute to capacity building for the beneficiaries. The TSC Project aims to enhance the technical knowledge and capacity of irrigation engineers of MOWRAM, especially in rehabilitation techniques of existing irrigation systems including surveys, planning, design, construction and water management. The model site of the TSC is located at the center of the Project Area and the OJT for rehabilitation of the lateral/tertiary canals is scheduled to run from January to April in 2003. The rice double cropping demonstration plot is planned in the TSC model site and its many advantages are anticipated to be sought after.

(6) Collection of Irrigation Service Fee (ISF)

ISF is calculated by the Project O&M Office every year based on the actual irrigable area until FWUC is able to manage by itself. The O&M office provides guidance to enable FWUC to collect ISF in accordance with calculations of water usage. The annual O&M cost necessary for FWUC is estimated at US$ 2.0 as shown in Table 2.9

(single cropping and double cropping in the rainy season are one unit). This ISF amount is considered affordable for the beneficiaries based on the baseline survey result, and is equivalent to 0.7 % of the expected increase in revenue (US$ 281).

(7) Demonstration of the rice double cropping in the model site of TSC

According to the discussions with the TSC team, which has a model site of 260 ha in the Project Area, the following support generated by the TSC is expected in the O&M of the irrigation:

(a) Rehabilitation of the Tertiary Canals within the Model Site:

The rehabilitation work could be completed by April 2005 as a series of the OJT program.

(b) Assistance for the realization of rice double cropping system of the early maturing rice variety:

After confirming the availability of the irrigation water in the model site, TSC will give technical advice to the required extension program by MORAM which will be executed on the site (its substance is not fixed).

(c) Support of organizing farmers group for water management

Organizing the farmer's group will be carried out by MOWRAM based on the experience and know-how obtained through TSC's participatory water management program at tertiary canal level.

(8) Demonstration of the rice double cropping in the model site of TSC

In implementing the Project, the following works are to be carried out under Japan's Grant Aid:

(a) Construction of new headworks

(b) Rehabilitation of Tuk Thla regulator

(c) Crest raising works of Deum Russ regulator

(d) Construction of intake facility

All structures are equipped with gate facilities as described above, and the gates are to be operated during floods and the dry season in accordance with the operation rules. Operation and maintenance manuals are essential and are to be prepared for the respective facilities. In preparing the operation and maintenance manuals, the operation rule of Rolaing Chery Regulator, which is located in the upstream area, should be

included and incorporated taking into account the elevation of paddy fields (EL. 12.30 m) that are located at the side of the river. The O&M Office should operate and maintain the facilities according to the manuals, and the manuals are to be updated through the actual operation and experiences, if necessary.

2.4.2 Operation and Maintenance Cost

The operation and maintenance costs are estimated as below and breakdown is shown in Table 2.8.

Operation and Maintenance Cost

Item	Amount (USD)
Personnel cost of O&M office	2,475
O&M cost for O&M office	1,460
O&M cost (average of 30 years)	4,145
Total	8,080

2.5 Other Relevant Issues

(1) To establish the project implementation organization in the MOWRAM and secure necessary budget for implementation of the project

The required cost to be provided by the GOC for the Project is USD 957,200. It is composed of a) land acquisition, b) investigation and removal of UXOs, c) bank and customs clearance costs, d) construction and improvement of the secondary and tertiary canals and e) operation and maintenance of the Project O&M Office. Only the construction and improvement of the secondary and tertiary canals in the above 5 items have been agreed between MOWRAM and the Ministry of Economics and Finance to allocate necessary budget so far. The GOC should secure the budget for implementation of remaining items which is more than USD166,500 for smooth execution of the Project.

(2) Proper O&M for the improved facilities

Soon after commencement of the construction, MOWRAM should establish the Project O&M Office and allocate necessary staff to organize FWUC.

(3) Collaboration with JICA Project-type Technical Cooperation

The engineer and technical officer trained in TSC under JICA Project-type Technical Cooperation planed to be assigned to the Project for O&M works for main irrigation facilities. MOWRAM is required to dispatch their staff member to the Project O&M Office to work with the Consultant and Contractor to develop their technical capacity.

Chapter 3 PROJECT EVALUATION AND RECOMMENDATIONS

Chapter 3 PROJECT EVALUATION AND RECOMMENDATIONS

3.1 Project Effects

(1) Direct effects

The Project will be implemented by Japan's Grant Aid System. The main canals and related facilities will be rehabilitated and maintained to provide a stable supply of water to the field. The following are the direct effects of the rehabilitation of the Project facilities.

Expected Direct Effects

Present Condition and Problems	Rehabilitation Plan	Effects and Improvement Level
Irrigation water could not be distributed to paddy fields physically due to damage and deterioration and improper plan/design of related structures. Cultivation of rice is limited to only one crop in the rainy season except near irrigation canals where the farmers are cultivating by pump irrigation using standing water. Due to unstable supply of irrigation water, crop yield limited to 1.8 ton/ha of local variety and 2.5 ton/ha of IR variety.	- Rehabilitation of regulators (3 places) - Rehabilitation of 7th January dam (crest heightening works) - Construction of new headworks (1 place) - Construction of intake structure (1 place) - Rehabilitation of existing main canal and related structures (5.3 km) - Rehabilitation of existing inspection road and related structures (5.3 km) - Rehabilitation of existing main canal (14.6 km) - Rehabilitation of drainage structures for main drainage canal (8 places) - Rehabilitation of existing main canal (5.3 km) - Rehabilitation of existing main canal (5.3 km)	Rehabilitation of the major irrigation system produces a stable irrigation water supply to the fields. By proper water management and maintenance, more than 40% of the existing area can be irrigated through the year from the existing rain fed paddy field. Irrigated paddy field after Project*: 800 ha (Present: 0 ha)

* Paddy field area with stable irrigation water supply and establishment of cropping pattern.

(2) Indirect effects

GOC should undertake i) to implement rehabilitation works for the lateral/tertiary canals and ii) to establish and organize FWUC to undertake O&M works for the minor irrigation facilities. Under the above premises, the following indirect effects are expected through the implementation of the Project.

Expected Indirect Effects

Expected Indirect Effects	Contents
Realization of Rice Double Cropping	Realization of rice double cropping through stable irrigation water supply during the rainy season (July to December) Crop intensity: Present :108%, With project (8-10s year after completion): 174%
Increase of Productivity	Increase of productivity (unit yield) through stable irrigation water supply 1) Local variety Present: 1.8 ton/ha, With project (after 4 years): 3.0 ton/ha 2) IR variety Present: 2.5 ton/ha, With project (after 4 years): 4.0 ton/ha
Introduction of Dry Season Crops and Increase of Farm Income	Through the introduction of dry season crops, the farm income of beneficiaries who are registered in FWUC is increased. Farm income: Present: 138US$/house, With project (after 4 years): 418US$/house
Contribution to National Socio Economic Development Plan	Contribution to the rural poverty reduction.

(3) Beneficiaries

Through the implementation of the Project, the number of beneficiaries is estimated at 2,800 households or 13,400 people (2002 year census).

(4) Accomplishment Index

The accomplishment index under the Japan's Grant Aid System is 800 ha of net irrigation area. A base line survey has been carried out to monitor and evaluate the project effects. The method of the baseline survey is presented in 2.2.4 (2) in this report. The evaluation of project effects will be investigated and monitored 4 years after the completion of the project. The index for the evaluation is to be based on the a) Project Completion Reports, b) Reports prepared by the MOWRAM and c) intake discharge

records.

3.2 Recommendations

After completion of the rehabilitation work of the main facilities that will be implemented by Japan's Grant Aid System, and the lateral/tertiary canals, the GOC should make the following self-efforts for the administrative services to popularize the rice double cropping system for the proposed cropping system.

(1) Agricultural Extension

As 60 to 90 % of the beneficiaries are not familiar with the farming practice for the early maturing IR rice varieties in the area, it is essential for the Project to strengthen the farmer's training on farming practice, including water management practice, for the new rice double cropping system. Thus, the Project O&M Office is required to conduct a training program by establishing demonstration plots within the area in conjunction with the district agriculture office and the preceding projects (TSC, AQIP, NGOs).

(2) Strengthening of Farmer's Credit and Publicity of Market Information

(a) Many farmers complain about the existing farmer's borrowing capacity in the area due to the small financing amount available and the high interest rates charged, thus administrative guidance for correction should be necessary.

(b) As there are many requests from the beneficiaries for purchase of improved seeds and fertilizers on credit, strengthening of the financing system is essential in conjunction with the preceding NGO and donor's projects such as AQIP.

(c) Strengthening of the market-oriented farming system is necessary for the beneficiaries by informing them of market price information, good cash producing second crops, monthly rice market prices, etc.

Tables

Table 2.1 80% Dependable Daily Discharge of the Prek Thnot River at Rolaing Chery for Diversion Weir

(probable drought with once in five years)

(Unit: m^3/sec)

DAY	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.0	1.7	1.3	1.9	1.7	17.4	14.7	81.1	13.9	37.9	107.3	34.3
2	3.7	1.7	1.1	1.4	1.5	10.2	11.4	164.0	29.3	30.6	84.4	70.9
3	3.6	1.6	1.0	1.0	1.6	28.3	35.9	156.0	48.1	31.6	68.8	57.3
4	3.5	1.6	1.0	1.0	2.7	19.2	31.5	108.8	77.3	53.4	55.2	26.2
5	3.5	1.6	0.9	0.6	3.4	30.1	39.7	123.0	85.4	56.6	38.3	14.5
6	3.5	1.5	1.3	1.0	1.6	16.4	28.4	133.7	110.1	117.8	32.2	12.6
7	3.5	1.4	1.7	1.6	1.3	19.5	26.1	102.5	52.4	156.4	27.8	11.7
8	3.4	1.6	1.6	1.2	2.2	13.4	51.1	109.7	34.5	173.5	24.9	10.6
9	3.1	2.0	1.2	1.0	8.0	8.2	44.3	95.4	26.6	217.6	22.6	11.7
10	3.0	2.0	1.0	0.8	15.0	6.3	31.1	69.5	31.2	265.2	21.0	17.0
11	2.9	1.7	0.9	0.6	16.9	7.5	38.6	65.1	36.2	196.0	20.2	19.7
12	2.8	1.5	0.8	0.4	13.0	6.3	34.9	48.0	31.8	125.0	19.4	15.6
13	2.8	1.4	0.7	0.3	11.2	4.6	61.0	41.9	29.6	71.5	18.6	11.9
14	2.7	1.3	0.6	0.4	7.7	5.4	78.1	40.1	52.8	61.6	83.9	9.3
15	2.6	1.2	0.6	0.3	9.6	4.6	83.0	34.1	111.9	52.0	58.1	13.7
16	2.6	1.2	0.5	0.4	8.4	5.0	68.2	27.5	107.5	46.6	72.9	40.3
17	2.5	1.1	0.5	0.4	8.0	10.8	41.1	25.3	132.3	45.5	72.4	37.8
18	2.4	1.1	0.5	1.3	6.2	57.1	49.7	19.3	152.7	40.1	55.2	23.8
19	2.4	1.0	0.5	2.1	4.6	117.6	50.4	18.1	175.0	40.1	67.4	15.2
20	2.3	0.9	0.5	2.6	6.1	101.7	63.7	16.0	178.5	49.1	52.6	12.2
21	2.3	0.9	0.5	8.4	5.7	91.1	66.4	13.5	144.8	39.0	46.8	9.8
22	2.2	0.9	0.4	21.8	4.1	49.7	54.0	14.4	155.4	37.9	50.8	8.3
23	2.2	0.9	0.4	15.7	3.6	38.4	38.6	20.1	125.2	46.6	62.7	7.5
24	2.1	0.9	0.3	9.0	5.3	24.6	33.4	39.8	63.9	107.9	22.4	7.0
25	2.1	1.9	0.4	5.7	15.4	33.5	45.0	21.2	49.9	171.7	19.2	9.3
26	2.1	1.0	0.5	4.4	16.9	56.4	82.1	18.6	47.1	209.5	17.2	11.4
27	2.0	0.9	0.4	2.7	11.9	39.1	85.8	21.8	41.7	259.8	15.3	9.8
28	2.0	1.4	1.1	2.1	27.9	26.3	65.1	29.7	55.2	130.4	15.8	7.8
29	1.9	-	1.1	1.9	54.2	20.0	54.7	20.7	47.1	103.4	32.8	7.3
30	1.9	-	3.3	1.6	61.8	16.1	74.0	14.2	51.0	125.0	29.6	6.7
31	1.9	-	2.7	-	22.6	-	71.8	15.1	-	102.5	-	6.1
Total (m^3/s)	83.5	38.0	29.2	93.8	360.1	884.5	1553.8	1708.3	2298.5	3201.8	1315.9	557.1
Max (m^3/s)	4.0	2.0	3.3	21.8	61.8	117.6	85.8	164.0	178.5	265.2	107.3	70.9
Min (m^3/s)	1.9	0.9	0.3	0.3	1.3	4.6	11.4	13.5	13.9	30.6	15.3	6.1
Ave. (m^3/s)	2.7	1.4	0.9	3.1	11.6	29.5	50.1	55.1	76.6	103.3	43.9	18.0
Total (MCM)	7.2	3.3	2.5	8.1	31.1	76.4	134.2	147.6	198.6	276.6	113.7	48.1

Table 2.2 Alternative Study for the Flood Discharge Facilities

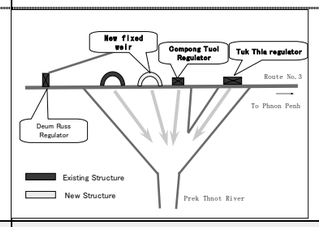
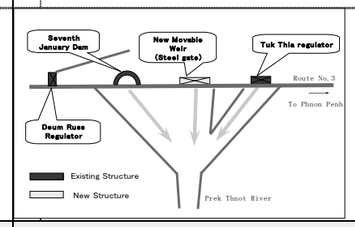
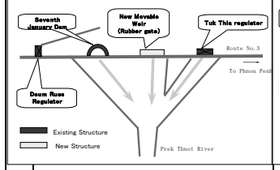
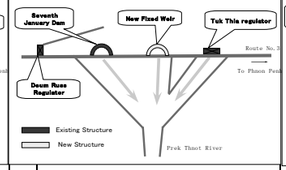
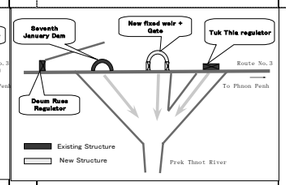
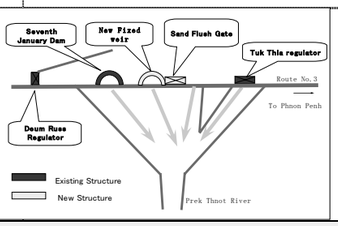
	Original Plan (New spillway + Improvement of existing gates)		**Alternative①-1** (New movable weir (steel gates) + Removal of Kompong Tuol Regulator)	**Alternative①-2** (New movable weir (ruber gate) + Removal of Kompong Tuol Regulator)	**Alternative②** (New fixed weir + Removal of Kompong Tuol Regulator)	**Alternative③** (New fixed weir + New gate + Removal of Kompong Tuol Regulator : spillway&gate combined type)	**Alternative④** (New fixed weir + New gate + Removal of Kompong Tuol Regulator)
Structures							
1. Seventh January Dam	Improvement (gate heightening and the works against hydraulic piping)		Improvement (gate heightening and the works against hydraulic piping)	Improve	Improve	Improve	Improve
2. Kompong Tuol Regulator	Improvement (gate heightening and the works against hydraulic piping)		Remove	Remove	Remove	Remove	Remove
3. Tuk Thla Regulator	Improvement (gate heightening and the works against hydraulic piping)		Improvement (gate heightening and the works against hydraulic piping)	Improve	Improve	Improve	Improve
4. Deum Russ Regulator	Improvement (gate heightening and the works against hydraulic piping)		Improvement (gate heightening and the works against hydraulic piping)	Improve	Improve	Improve	Improve
5. New spillway	New construction (bathtub-type spillway)		—	-	New construction (bathtub-type spillway)	New construction (bathtub-type spillway)	New construction (bathtub-type spillway)
6. Flood gate	—		New construction (steel gate)	New construction (rubber gate)	-	-	-
7. Sand flush gate	—		-	-	-	New construction	New construction
1st Evaluation							
Supply of maintenance flow and riverbed materials in dry season at right and left river flow	Available	○	Available	○ Available	× Not available	○ Available	○ Available
Sedimentation and water route in reservoir	Same as the present condition	○	Improved possibly	○ Improved	× Deteriorated	X Probably deteriorated in terms of sedimentation. River water route around spillway should be	○ Same as the present condition
Utilization of the existing facili	Highly utilized	△	Utilized at low level	△ Utilized at low level	△ Utilized at low level	△ Utilized at low level	△ Utilized at low level
Necessity of approval of ADB (This gate was replaced by ADB in 2001)	Not necessary	○	Necessary (already approved)	○ Necessary (already approved)	○ Necessary (already approved)	○ Necessary (already approved)	○ Necessary (already approved)
Flood regulation at earlier stage of flood	Not considered; The 2 fixed weir spillways (new spillway and Jan07spillway) can not contribute to lower the river water level at earlier stage of flood.	○	Considered; There is only one fixed weir spillway, Jan07spillway, which can not contribute to lower the river water level at earlier stage of flood.	○ Considered; There is only one fixed weir spillway. Jan07spillway, which can not contribute to lower the river water level at earlier stage of flood.	× Not considered; The 2 fixed weir spillways (new spillway and Jan07spillway) can not contribute to lower the river water level at earlier stage of flood.	X Not considered; The 2 fixed weir spillways (new spillway and Jan07spillway) can not contribute to lower the river water level at earlier stage of flood.	X Not considered; The 2 fixed weir spillways (new spillway and Jan07spillway) can not contribute to lower the river water level at earlier stage of flood.
Risk of mis-operation	Risk at low level: There are only 2 gate facilities, Tuk Thla, Kompong Tuol, and Deum Russ regulators, to be operated. In addition, the operators are familier with such existing gates.	X	Risk at high level: New steel sluce gate installed in new facility might lead to big damage in case of mis-operation in flood season.	○ Risk at low level: New rubber gate installed in new facility has less risk of flood damage in case of mis operation in comparison with the steel gate.	○ Risk at low level: New fixed weir installed in new spillway does not need any operation and no any mis-operation happen.	△ Risk at low level: New sand flush steel gate, one of newly installed facilities, might lead to a damage in case of mis-operation in flood season. New fixed weir	△ Risk at middle level: New sand flush steel gate, one of newly installed facilities, might lead to a damage in case of mis-operation in flood season. New fixed weir
Experience in Canbodia	—	○	There is some experiences, for example Roleng Chery Regulator.	X No experience of the rubber gate in Canbodia	○ There is some experiences, for example Seventh January Dam.	○ There is some experiences, for example Seventh January Dam.	○ There is some experiences, for example Seventh January Dam.
Result of 1st Evaluation	—	○	Good: High effectiveness against flood regulation in early stage of flood. If O & M can be done properly and the project cost is not too high, this case can be selected.	X Negative: There is no experience of the rubber dam in Cambodia.	× Negative: In this case, the environment of river will be deteriorated because supply of maintenance flow and riverber material will be hampered at right river stream.	X Negative: In comparison with case (4), the system is much complicated and it does not function well.	○ Good: Less effectiveness against flood regulation in early stage of flood. However its operation cost is less than that of the full movable gate system. If O&M cost is limeted, this case should be selected.
Schematic image							
2nd Evaluation							
Control of Upstream River Water Surface Elevation in Normal Condition		○	As the design water level is planned to be revised from WL.11.26m to WL.11.80m, the water depth between the design water level and the design flood water level (WL.1The 6.00m) will decrease. In order to protect the paddy fields (EL.12.30m), the control of the upstream river water surface shall be executed strictly. For it, the gate weir type has an advantage comparing with the fixed weir type.				△ As the design water level is planned to be revised from WL.11.26m to WL.11.80m, the water depth between the design water level and the design flood water level (WL.1The 6.00m) will decrease. In order to protect the paddy fields (EL.12.30m), the control of the upstream river water surface shall be executed strictly. For it, the fixed weir type has a disadvantage comparing with the gate weir type.
Control of Upstream River Water Surface Elevation at the Beginning of Flood		○	Better than the fixed weir type. (The gate weir may decrease the water pressure to the dike because it can lower the river water surface at the early stage of flood.				△ Worse than the fixed weir type. (The fixed weir could not decrease the water pressure to the dike because it cannot lower the river water surface at the early stage of flood.
Land Acquisition and Removal of Houses		○	As the area of the structure is comparatively small, the burden of land acquisition and removal of houses is small as well.				△ As the area of the structure is comparatively large the burden of land acquisition and removal of houses is large as well.
Necessity of River Dredging		○	As this structure does not block the river course, river dredging for a new river course is not required.				× As this structure block the river course, river dredging for a new river course is required.
Connection to the existing National Road No.3		○	As the area of the structure is comparatively small and the bridge part is short, the connection to the existing National Road No.3 can be made smoothly.				△ As the area of the structure is comparatively large and the bridge part is long, the connection to the existing National Road No.3 cannot be made smoothly.
Life of Structure		○	Up to 50 years if operation and maintenance is done properly. (In Southeast Asia, there are many gate structures with age of more than 50 years.				○ Up to 50 years if operation and maintenance is done properly. (In Southeast Asia, there are many gate structures with age of more than 50 years.
Maintenance and Operation for Gates		△	The dimensions of gates are given below: 1) Floodway gate : B12.5m x H4.8m x 3nos. 2) Sluiceway gate : B 5.0m x H4.8m x 1no. 3) Control gate : B 1.5m x H1.5m x 1no. The burden of the budget and staff deployment for operation and maintenance is rather heavy. However, after checking the present internal budget allocation and staff deployment, it was confirmed that the Cambodian side can afford them even in case of the gate weir.)				○ The dimensions of gates are given below: 1) Fixed weir : L=175m (Crest Elevation : EL.11.80m) 2) Sluiceway gate : B 5.0m x H4.8m x 2no. 3) Control gate : B 1.5m x H1.5m x 1no. The burden of the budget and staff deployment for operation and maintenance is rather small. However, after checking the present internal budget allocation and staff deployment, it was confirmed that the Cambodian side can afford them even in case of the gate weir. This means that there is no difficulty of budget for operation and maintenance.)
Construction Cost		○	The construction cost is almost the same as that of the fixed weir.				△ Ditto
Condition of Adoption		—	It is necessary to improve the budget system for daily maintenance and operation activities and communication/order system, and clarify the responsible persons as well as strengthen the education and training program to staff of operation and maintenance.				— It is necessary to improve the budget system for daily maintenance and operation activities and communication/order system, and clarify the responsible persons as well as strengthen the
Result of 2nd Evaluation		○	From the view point of maintenance and operation, the gate weir may be a burden to the Cambodian side. (However, after checking the present internal budget allocation and staff deployment, it was confirmed that the Cambodian side can afford them even in case of the gate weir.) From the technical view points (sand flushing and river water surface control in normal condition and at the early stage of flood), the gate weir has an advantage and its construction cost is almost the same as the fixed weir. Also, the area of the structure is small so that the smooth connection between the weir's bridge and the National Road is possible. In addition, MOWRAM makes much of water surface control in normal and flood condition in these days. In conclusion, the gate weir alternative has a vantage point				△ From the view point of maintenance and operation, the fixed weir may be a less burden to the Cambodian side. (However, after checking the present internal budget allocation and staff deployment, it was confirmed that the Cambodian side can afford them even in case of the gate weir.) From the technical view points (sand flushing and river water surface control in normal condition and at the early stage of flood), the fixed weir has a disadvantage. Also, it requires additional river dredging/ excavation so that its construction cost is slightly higher than that of the fixed weir.

Table 2.3 Comparison for Location Alternatives of Gate Weir

Item	1. Alternative-1		2. Alternative-2		3. Alternative-3		4. Alternative-4	
	Evaluation		Evaluation		Evaluation		Evaluation	
1. Dimension	—	Sluiceway gate : B5.0m × H4.8m × no. Control gate : B1.5m × H1.5m × 1no. Simple steel girder bridge : B11.8m × L50.0m × 1no.	—	ditto	—	ditto	—	ditto
2. Location	—	The structure shall be newly constructed on the location of the existing Kompong Toul Regulator to demolished.	—	The structure shall be constructed between the Kompong Toul Regulator and the 7th January Dam.	—	The structure shall be constructed between the 7th January Dam and the old river course.	—	The structure shall be constructed between the old river course and the National Road No.3.
3. Foundation	△	The foundation layer starts from EL.10.00m so that the length of piles are designed to be 13m to 14m. (The elevation of the bottom base of the structure is EL.2.0m)	△	The foundation layer starts from EL.10.00m so that the length of piles are designed to be 13m to 14m. (The elevation of the bottom base of the structure is EL.2.0m)	○	The foundation layer starts from EL.−7.00m so that the length of piles are designed to be 10m to 11m. (The elevation of the bottom base of the structure is EL.2.0m)	○	The foundation layer starts from EL.−7.00m so that the length of piles are designed to be 10m to 11m. (The elevation of the bottom base of the structure is EL.2.0m)
4. Function of sand flushing	×	As the structure is far from the existing river course, its function of flushing sand is the lowest among the alternatives.	△	Its function of sand flushing is lower than Alternative-3 and -4.	○	The structure is almost beside the river course, but its function of sand flushing is lower than Alternative-4.	◎	The structure is just beside the river course and its function of sand flushing is the best among the alternatives.
5. Interference by the 7th January Dam during the flow over the weir	◎	As the structure is separate from the 7th January Dam, no interference is expected for the flow over the weir.	×	Being close to the 7th January Dam, the fow over the weir may be affected by the dam and the design flow disharge could not be maintained at certain stages.	△	Being close to the 7th Janurary Dam, the flow over the weir may be affected by the dam and the design flow discharge could not be maintained at certain stages.	◎	As the structure is separate from the 7th January Dam, no interference is expected for the flow over the weir.
6. Road alignment (Safety driving of vehicles)	○	At the left side, there is no problem for the connection between the bridge and the road because straight line could be set between them. At the right side, a curve with the same radius as the existing one is required.	◎	No curve is required.	×	At each side, a gentle curve is required.	○	At the right side, there is no problem for the connection between the bridge and the road because straight line could be set. At the left side, a curve with the same radius as the existing one is required.
7. Removal of houses	◎	Removal of houses : 0	◎	Removal of houses : 0	△	Removal of houses : 0 (The removal of houses is not required in principle. Safety measure for transportation and sprinkle against dust caused by construction equipment are	×	Removal of houses : 9
8. Removal of small restaurants	◎	Removal of small restaurants : 0	×	Removal of small restaurants : 9	△	Removal of small restaurants : 2	◎	Removal of small restaurants : 0
9. Land acquisition	○	The area of the structure is belonging to the public land and no additional land acquisition is required	○	The area of the structure is belonging to the public land and no additional land acquisition is required.	△	A part of the driving channel is within the private land.	△	A part of the driving channel is within the private land.
10. River dredging/excavation	×	The river dredging/excavation is required in order to expand the existing artificial channel to the regulator diverted from the	△	In order to convey sufficient water to the weir, the upstream sand bank is to be removed.	◎	Not required.	○	Not required.
11. Excavation volume of the driving channel after the weir	○	As the channel after the Kampong Toul Regulator is used as a driving channel, the unit excavation volume is comparatively small. The volume, however, is larger than that of Alternative-4 because its length is long.	△	The excavation for the driving channel is required on the flat land between the 7th January Dam and Kompong Toul Regulator.	×	The excavation volume is rather huge because it is carried out at the hill side.	◎	Utilizing the existing old river course, the excavation volume is rather small.
12. Temporary flood release channel during the construction period	×	A temporary flood release structure is required.	◎	The existing Kompong Toul Regulator is used as a temporary flood structure during the construction period.	◎	The existing Kampong Tool Regulator is used as a temporary flood structure during the construction period.	◎	The existing Kampong Tool Regulator is used as a temporary flood structure during the construction period.
13. Construction Cost	×	The construction cost is the highest because of the cost increase such as a temporary flood release structure, expansion of the artificial channel, foundation treatment.	△	The construction cost is the higher than Alternative-3 and -4 because of the cost increase such as river dredging/excavation, expansion of the artificial channel, foundation treatment.	○	The construction cost is a little bit higher than Alternative-4 because the excavation volume of the driving channel is comparatively larger than that of Alternative-4.	◎	The construction cost is the lowest.
Conclusion	×	It cannot be recommended because of its highest construction cost and its low function.	△	It cannot be recommended because its high construction cost and function comparing with Alterantive-3 and -4.	○	This alternative is the second best, but it is close to the 7th January Dam and its hydraulic function is low. It, therefore, is not recommendable.	◎	There is a problem of removal of houses, but this alternative is the best one from the view point of cost and function.

Table 2.4 Comparison for Location Alternatives of Fixed Weir

Item	1. Alternative-1		2. Alternative-2		3. Alternative-3		4. Alternative-4	
	Evaluation		Evaluation		Evaluation		Evaluation	
1. Dimension	—	Fixed weir : L=175m Floodway gate : B12.5m × H4.8m × 2nos. Control gate : B1.5m × H1.5m × 1no. Simple steel girder bridge : B11.8m × L34.5m × 1no. B11.8m × L12.5m × 1no.	—	ditto	—	ditto	—	ditto
2. Location	—	The structure shall be newly constructed on the location of the existing Kompong Toul Regulator to demolished.	—	The structure shall be constructed between the Kompong Toul Regulator and the 7th January Dam.	—	The structure shall be constructed between the 7th January Dam and the old river course.	—	The structure shall be constructed between the old river course and the National Road No.3.
3. Foundation	△	The foundation layer starts from EL.10.00m so that the length of piles are designed to be 13m to 14m. (The elevation of the bottom base of the structure is EL.2.0m)	△	The foundation layer starts from EL.10.00mso that the length of piles are designed tobe 13m to 14m. (The elevation of the bottom base of the structure is EL.2.0m)	○	The foundation layer starts from EL. −7.00m so that the length of piles are designed to be 10m to 11m. (The elevation of the bottom base of the structure is EL.2.0m)	○	The foundation layer starts from EL.−7.00m so that the length of piles are designed to be 10m to 11m. (The elevation of the bottom base of the structure is EL.2.0m)
4. Function of sand flushing	×	As the structure is far from the existing river course, its function of flushing sand is the	△	Its function of sand flushing is lower than Alternative-3 and -4.	○	The structure is almost beside the river course, but its function of sand flushing is	◎	The structure is just beside the river course and its function of sand flushing is
5. Interference by the 7th January Dam during the flow over the weir	◎	As the structure is separate from the 7th January Dam, no interference is expected for the flow over the weir.	×	Being close to the 7th January Dam, the flow over the weir may be affected by the dam and the design flow discharge could not be expected at certain stages.	△	Being close to the 7th January Dam, the flow over the weir may be affected by the dam and the design flow discharge could not be maintained at certain stages.	◎	As the structure is separate from the 7th January Dam, no interference is expected for the flow over the weir.
6. Road alignment (Safety driving of vehicles)	○	At the left side, there is no problem for the connection between the bridge and the road because straight line could be set between them. At the right side, two sharp curve are required..	◎	At the right side, there is no problem for the connection between the bridge and the road because straight line could be set between them. At the right side, one sharp curve is required.	×	At each side, a curve is required. Especially at the left side, a sharp curve should be set. From the view point of safety driving, such a curve should be avoided.	○	At the right side, there is no problem for the connection between the bridge and the road because straight line could be set . At the left side, a curve with the same radius as the existing one is required.
7. Removal of houses	◎	Removal of houses : 0	◎	Removal of houses : 0	△	Removal of houses : 7 (The removal of houses is not required in principle. Safety measure for transportation and sprinkle against dust caused by construction equipment are necessary.)	×	Removal of houses : 9
8. Removal of small restaurants	◎	Removal of small restaurants : 0	×	Removal of small restaurants : 9	△	Removal of small restaurants : 2	◎	Removal of small restaurants : 0
9. Land acquisition	○	The area of the structure is belonging to the public land and no additional land acquisition is required.	○	The area of the structure is belonging to the public land and no additional land acquisition is required.	△	A part of the driving channel is within the private land.	△	A part of the driving channel is within the private land.
10. River dredging/excavation	×	The river dredging/excavation is required in order to expand the existing artificial channel to the regulator diverted from the river course.	△	In order to convey sufficient water to the weir, the upstream sand bank is to be removed.	◎	Not required.	○	Not required.
11. Excavation volume of the driving channel after the weir	○	As the channel after the Kampong Toul Regulator is used as a driving channel, the unit excavation volume is comparatively small. The volume, however, is larger than that of	△	The excavation for the driving channel is required on the flat land between the 7th January Dam and Kompong Toul Regulator.	×	The excavation volume is rather huge because it is carried out at the hill side.	◎	Utilizing the existing old river course, the excavation volume is rather small.
12. Temporary flood release channel during the construction period	×	A temporary flood release structure is required.	◎	The existing Kompong Toul Regulator is used as a temporary flood structure during the construction period.	◎	The existing Kampong Tool Regulator is used as a temporary flood structure during the construction period.	◎	The existing Kampong Tool Regulator is used as a temporary flood structure during the construction period.
13. Construction Cost	×	The construction cost is the highest because of the cost increase such as a temporary flood release structure, expansion of the artificial channel, foundation treatment.	△	The construction cost is the higher than Alternative-3 and -4 because of the cost increase such as river dredging/excavation, expansion of the artificial channel, foundation treatment.	○	The construction cost is a little bit higher than Alternative-4 because the excavation volume of the driving channel is comparatively larger than that of Alternative-4.	◎	The construction cost is the lowest.
Conclusion	×	There is no burden for removal of houses and land acquisition. It, however, cannot be recommended because of its highest construction cost and its low function.	△	It cannot be recommended because its high construction cost and smaller discharge comparing with the designed one due to hydraulic affection by the 7th January Dam close to the structure.	○	As the structure is close to the 7th January Dam as well as Alternative-2 and a sharp curve should be set, this alternative is not recommended.	◎	Among the alternatives, this alternative is recommendable.

Table 2.5 Construction Cost of Lateral and Tertiary Canals

Cost Items	Contents	Unit	Amount
Actual cost of project implementation	Lateral/tertiary canal & structures ①	USD	505,595
	Survey & detail design (①*15%	USD	75,840
	Farmer training & FWUC establishment (①*10%)	USD	50,560
	Site construction supervision (①*7%)	USD	35,400
	Sub total		667,395
Contingency	(②*15%)	USD	100,100
Grand Total			767,495

Source: Kandal Stung Rehabilitation Project/MOWRAM, Dec., 2002

Table 2.6 Establishment Cost of O&M Office for the Project

Item of Expense		Unit	Quantity		Unit Price		Total		Remark
			Number	M/M	(Riel)	(USD)	(Riel)	(USD)	
Project O&M Office	O&M Office (140m^2)	m^2			0	0.00	6,560,000	1,640.0	Renovation cost for the vacant office in the District Office site
and Office Items	Personal Computer	set	1		3,320,000	830.00	3,320,000	830.0	
	Printer	set	1		1,000,000	250.00	1,000,000	250.0	ditto
	Copy machine	set	1		6,080,000	1520.00	6,080,000	1,520.0	possible for A3 paper coping
	Desk & Chair for staff	set	10		1,128,000	282.00	11,280,000	2,820.0	
	Table for meeting	set	1		764,000	191.00	764,000	191.0	For 8 persons
	and chair	set	8		104,000	26.00	832,000	208.0	
	Cabinet	set	2		616,000	154.00	1,232,000	308.0	
	Table Telephone	set	1		1,400,000	350.00	1,400,000	350.0	Wireless type telephone
	White board	set	1		452,000	113.00	452,000	113.0	
	Office Stationary (One lot)	lot	1		0		0	0.0	
	Water supply system	lot	1		9,988,000	2497.00	9,988,000	2,497.0	Drilling up to 50 m depth + submergible pomp
	Diesel Generator	set	1		10,400,000	2600.00	10,400,000	2,600.0	Supplying electricity to the Office
Vehicle for O&M Work	Pick up truck(4WD)	set	1		80,000,000	20000.00	80,000,000	20,000.0	Used car for the Project Manager
	Motor cycle (50 cc)	set	8		2,000,000	500.00	16,000,000	4,000.0	Used car for AEO, ICO with technitians
									and assistant
Sub total							149,308,000	37,327.0	

Remark: AEO: Agriculture Extension Ofiicer, ICO: Irrigation Community Organizer

(Exchange rate: 4,000 Riel/USD)

Table 2.7 Duties and Responsibilities of O&M Staff of MOWRAM

	Position/Qualification	Terms of Reference
1	◆Project Manager／Chief Irrigation Engineer (CIE) ・ Engineer ・ 7-8 years experience ・ English communication Skill	■In charge of overall responsibility for the Project O &M and take the duty of water management and O & M work for the main irrigation facility ● Formulate an annual O & M Plan facilities, and supervise the routine inspection and O&M work ● Formulate water distribution plan based on the cropping area and water demand ● Carry out farmer's training to ensure irrigation practice efficiently in collaboration with the SAEW and SICO ● Monitor and evaluate the FWUC activity based on the formulated Monitoring & Evaluation System (M&E) in collaboration with SAEO and SICO, and direct necessary supervision to the FWUC ● Update and revise a manual of water management for the Project ● Establish a partnership with the concerned agricultural supporting organizations such as District Agriculture Office, AQIP, CARDI, etc.
	◆Technician	●Give guidance of O&M and water management to the beneficiaries in the field under instructed by the CIE
	◆Assistant ・Qualified staff	●Assist SIE and Technician
2	◆Senior Agricultural Extension Officer (SAEO) ・Engineer ・7-8 Years Experience ・English Communication Skill	■ Carry out agriculture extension work focusing on the Kandal Stung Irrigation Project as a command area, and formulate an annual extension plan with guidance for the beneficiaries in the proposed cropping plan. ● Grasp the agronomic environment (natural and socio-economic environment) of the command area ● Formulate a best-fit extension plan for the Kandal Stung command area ● Guide and train the beneficiaries about farming practice of IR cultivars ● Guide a second crop to the rice ● Formulate a crop guideline for the major crops ● Plan and conduct study tour for the beneficiaries in collaboration with the CIE and SICO ● Establish a partnership with the concerned agricultural supporting organs such as District Agriculture Office, AQIP, CARDI, etc.
	◆Technician	●Give guidance to the beneficiaries in the field under instruction made by the SAEO
	◆Assistant ・Qualified	●Assist SAEO and Technician
3	◆Senior Irrigation Community Organizer (SICO) ・Engineer ・7-8Years experience ・English communication Skill	■Organize the beneficiaries in the command area into the FWUC ●Grasp the village social-structure, farming system and water management in the command area ●Organize the FWUC based on the area-basis 7 communes involved in the command area in collaboration with CIE and SAEO ●Formulate a cadastral map and registered land for the FWUCs and the FWUC members ●Formulate a rational ISF (cash, rice and labor) to the FWUCs with collecting ISF system
	◆Vice ICO ・Technician	●Organize the FWUC under instruction made by SICO
	◆Assistant ・Qualified	●Assist SICO and Vice ICO
4	◆Treasurer(TR) ・Technician ・5 Years experience	■ Give a guidance to FWUC for collecting ISF from the beneficiaries and take a Responsibility of financial management of the Project O&M Office. ●Prepare the financial statement of the Project O& M Office to MOWRAM ●Proceed with a formality to apply subsidy for the Project O&M Office to MOWRAM ●Guidance for the treasures of the FWUCs

Table 2.8 Annual Cost of the Project O&M Office of MOWRAM

Item of Expense		Unit	Quantity		Unit Price		Total		Remark
			Total	M/M	(Riel)	(USD)	(Riel)	(USD)	
O&M Staff	・Project Manager/Irrigation Engineer	Person	1	12	150,000	37.50	1,800,000	450.0	allowance only(MOWRAM Staff)
	・Technician	Person	1	6	150,000	37.50	900,000	225.0	allowance only(MOWRAM Staff)
	・Assistant	Person	1	6	150,000	37.50	900,000	225.0	allowance only(MOWRAM Staff)
	・Senior Agriculture Extension Officer	Person	1	6	150,000	37.50	900,000	225.0	allowance only(MAFF Staff)
	・Technician	Person	1	6	150,000	37.50	900,000	225.0	allowance only(MAFF Staff)
	・Assistant	Person	1	6	150,000	37.50	900,000	225.0	allowance only(MAFF Staff)
	・Senior Irrigation Communitry Organizer	Person	1	6	150,000	37.50	900,000	225.0	allowance only(MOWRAM Staff)
	・Vice ICO	Person	1	6	150,000	37.50	900,000	225.0	allowance only(MOWRAM Staff)
	・ Assistant	Person	1	6	150,000	37.50	900,000	225.0	allowance only(MOWRAM Staff)
	・Treasurer	Person	1	6	150,000	37.50	900,000	225.0	allowance only(MOWRAM Staff)
Sub Total			10	66	1,500,000	375	9,900,000	2,475.0	①
O&M Expence for the Project O&M Office	Office Supply	lot/M	12		60,000	15.00	720,000	180.0	
	Consumable goods	lot/M	12		40,000	10.00	480,000	120.0	
	Communication(prepaied card for mob. ph	hour/Day	66		40,000	10.00	2,640,000	660.0	
	Fuel (Disel)	Lit／Day	1000		2,000	0.50	2,000,000	500.0	10lit/day x 100 days
Sub Total				0				1,460.0	②
Annual O&M cost	O&M cost for vehicles						0	0.0	fuel charge is including in allowance
	Periodical check	lot /30years					72,000,000	18,000.0	before 10years:US$360/year, after 10 years : US$720/year
	Parts replacement	lot /30years					12,800,000	3,200.0	Rubber should be replaced every 20 years
	Painting	lot /30years					160,000,000	40,000.0	Painting should be done every 12 years
	Diesel for operation	lot /30years	35100		2,000	0.50	70,200,000	17,550.0	1,170 lit /year
	Periodical maintenance	lot /30years						45,600.0	1st 10years:US$760/year, 2nd 10 years US$1,500/year,
									3rd 10 years:US$2,300/year
							sub total	124,350.0	
							÷30	4,145.0	
Sub total				0			315,000,000.0	4,145.0	③
					①＋②＋③			8,080.0	

Table 2.9 Annual O&M Cost of FWUC

Item of Expense		Unit	Quantity		Unit Price		Total		Remark
			Total	M/M	(Riel)	(USD)	(Riel)	(USD)	
FWUC Board Staff (Apex committee)	・Chairman	Person	1	9	40,000	10.00	360,000	90.0	Board member is elected on every 3 years.
	・1 st Chief	Person	1	9	20,000	5.00	180,000	45.0	
	・2nd Chief	Person	1	9	20,000	5.00	180,000	45.0	
	・3rd Chief	Person	1	9	20,000	5.00	180,000	45.0	
	・4th Chief	Person	1	9	20,000	5.00	180,000	45.0	
	・5th Chief	Person	1	9	20,000	5.00	180,000	45.0	
	・Board member	Person	1	9	20,000	5.00	180,000	45.0	
FWUC Staff	・Chairman	Person	7	9	40,000	10.00	360,000	90.0	Board member is elected on every 3 years.
	・1st Chief	Person	7	9	20,000	5.00	180,000	45.0	
	・2nd Chief	Person	7	9	20,000	5.00	180,000	45.0	
	・3rd Chief	Person	7	9	20,000	5.00	180,000	45.0	
	・4th Chief	Person	7	9	20,000	5.00	180,000	45.0	
	・5th Chief	Person	7	9	20,000	5.00	180,000	45.0	
Sub Total			49	117	300,000	75	2,700,000	675.0	①
FWUC Board Offic	Office								Commune office is used as FWUC Board Office
and Office Suupy	Office Supply	lot/M	12		60,000	15.00	720,000	180.0	
	Consumable goods	lot/M	12		40,000	10.00	480,000	120.0	
	Regular meeting with FWUC	Person	84		8,000	2.00	672,000	168.0	Monthly meeting with 7 FWUC
7 FWUCs Office &	Office								Commune office is used as FWUC Office
Office Supply	Office supply	lot/M	12		40,000	10.00	480,000	120.0	
	Consumable goods	lot/M	12		20,000	5.00	240,000	60.0	
	Regular meeting with FWUG	Person	480		4,000	1.00	1,920,000	480.0	Monthly meeting with 40 FWUG(Est.
									FWUG/50 ha)
Sub Total					172,000	43	4,512,000	1,128.0	②
Annual O&M cost	Removal of silt and repair of cracks	Time/Yr	1						Beneficiaries offer their labor force.
	Removal of canal debris	Time/Yr	2						
	Cutting of grasses on canal embankments	Time/Yr	2						
	Transition of structures	Time/Yr	2						
	- Labor	person	40		4000	1.00	160,000	40.0	
	- Materials	Lot/time	2		720000	180.00	1,440,000	360.0	Est. 18 USD/100 ha/year
	Protection works of structures	Time/Yr	2						
	- Materials	Lot/time	2		1060000	265.00	2,120,000	530.0	Est. 27 USD/100 ha/year
	- Labor	person	40		4000	1.00	160,000	40.0	
Sub total					1788000	447.00	3,880,000.0	970.0	③

①+②+③ 2773.0 USD (Exchange rate: 4,000 Riel/USD)

O&M expense/ha/year 2 USD

(ISF/ha = Total O&M cost * 1.45/1950 ha)

Figures

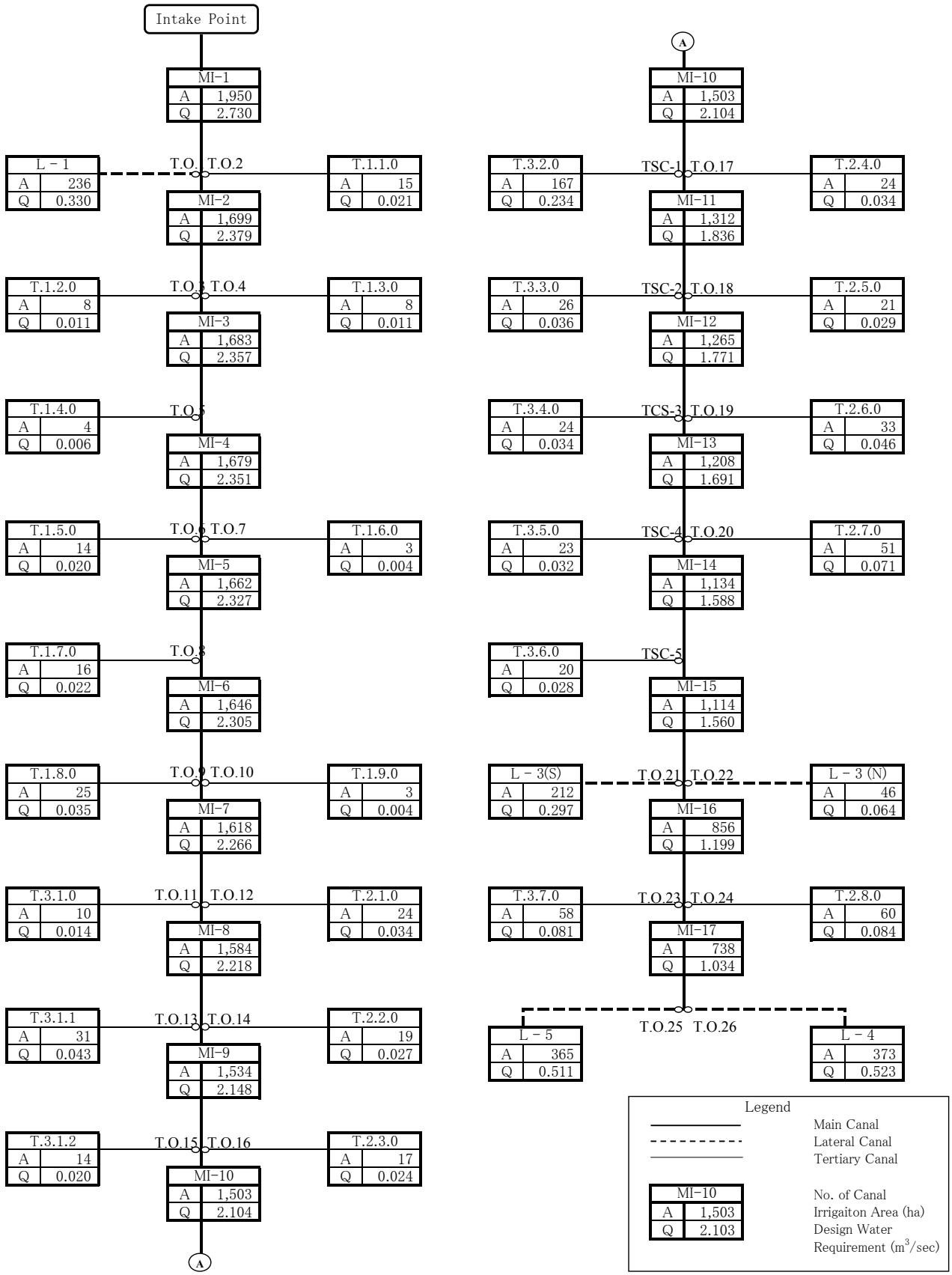


Figure 2.1 Irrigaton Diagram

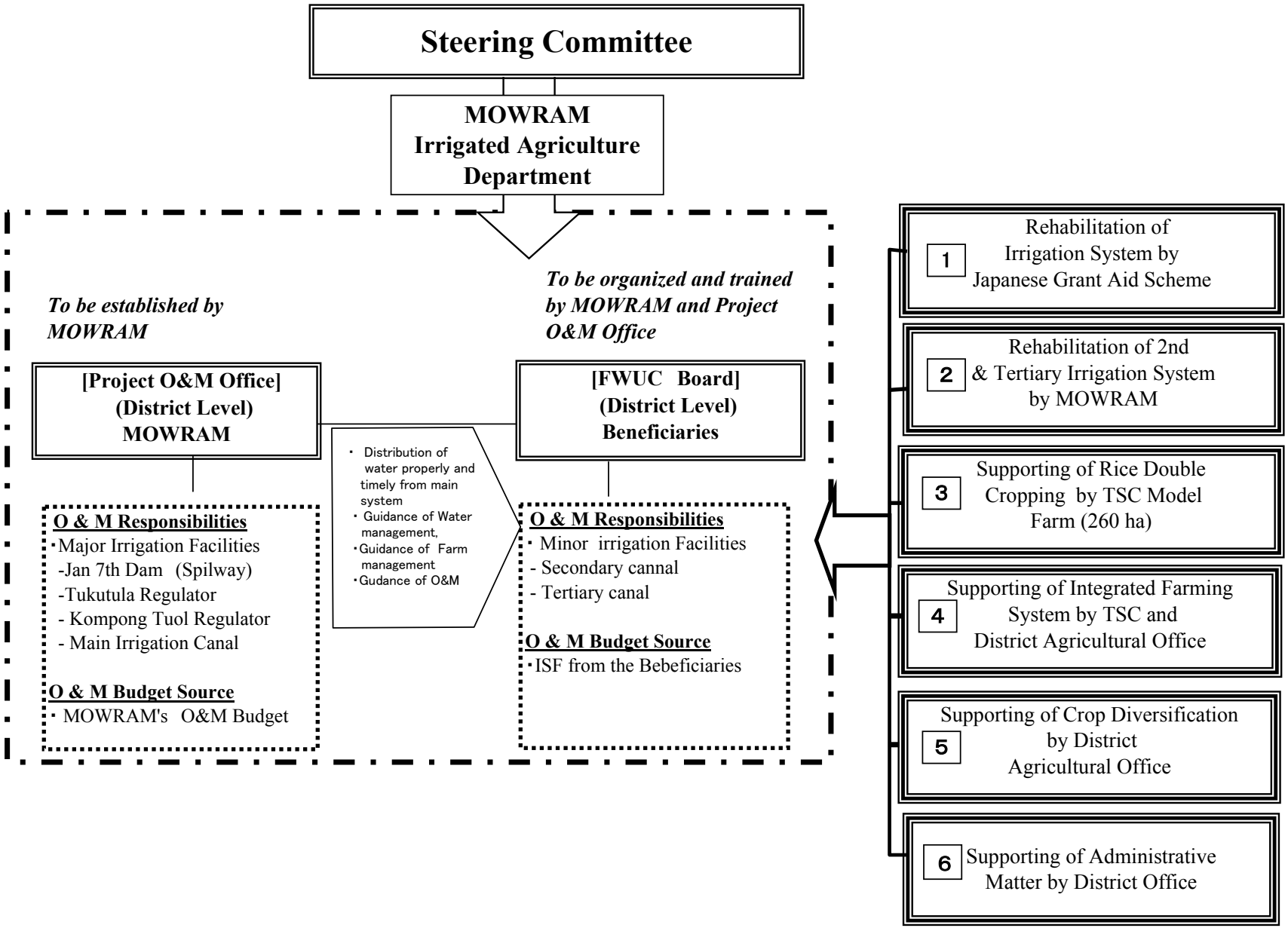
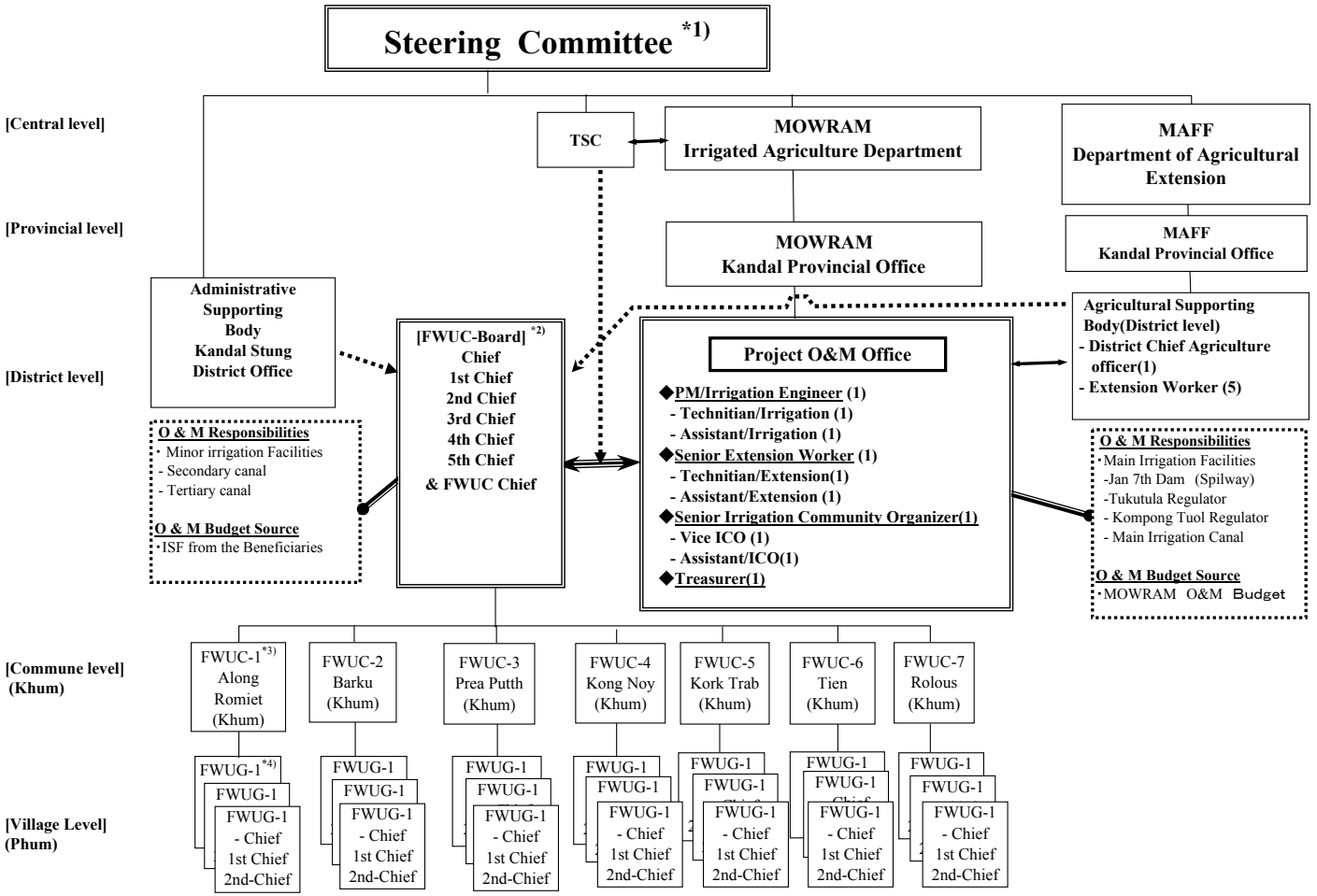


Figure 2.2 Proposed Organization of O&M Activities



Remark: A FWUG is proposed to be organized based on every 50 ha irrigation block in each commune..

*1) Remark
Chairperson of the S/C, Under Secretary of State of MOWRAM
Director General of Technical Affairs of MOWRAM
Director of Planning and International Cooperation Dept, MOWRA
Director of Irrigated Agriculture Dept, MOWRAM
Director of Water Resource Management and Conservation Dept.,
Deputy Director of Engineering Dept
Director of Kandal Provincial Bureau of MOWRAM
CDC Reprepresentative
MAFF Representative
Res Rep of the JICA Cambodia Office
JICA Expert of MOWRAM
Chief Advisor of TSC
Representative of Kandal Stung District Office
Representative of FWUC-Board
Project Manager of the Project O&M Office
Project Manager for Construction of Secondary & Tertiary Canals

*2) Remark
Chief Supervise overall matter
1st Chief Planning of Operation & Maintenance
2nd Chief Water Distribution
3rd Chief Farm management
4th Chief Treasurer
5th Chief Secretary
FWUC Head

*3) Remark
Chief Supervise overall matte
1st Chief Planning of Operation Maintenance
2nd Chief Water Distribution
3rd Chief Farm management
4th Chief Treasurer
5th Chief Secretary

*4) Remark
Chief Farmer's Group Leader
1st Chief Water Distribution and Maintenance
2nd Chief Treasurer

Figure 2.3 Proposed Organization of FWUA

Appendixes

1. Member List of Study Team

2. Survey Schedule

3. List of Parties Concerned in the Recipient Country

1. Member List of Study Team

Inception Report Explanation and 1st field Survey Team

（From 10th November, 2002 to 23rd December,2004）

(1)	Team Leader	Kazuo NAKAGAWA	Managing Director, Agricultural Development Cooperation Department, Japan International Cooperation Agency (JICA)
(2)	Technical Adviser	Susumu TANAKA	Chief, Overseas Land Improvement Cooperation Office, Design Division, Rural Infrastructure Department, Ministry of Agriculture, Forestry and Fishery
(3)	Project Coordinator	Motoharu WAKABAYASHI	Forth Project Management Division, Grant Aid Management Department,JICA
(4)	Chief Consultant / Irrigation Plan / Design	Koji OKADA	Nippon Koei Co., LTD.
(5)	River / Hydrology	Hidetoshi SAWADA	Nippon Koei Co., LTD.
(6)	Agriculture / Water Management / O&M	Zetsugaku KURITA	Nippon Koei Co., LTD.
(7)	Physical Condition Survey	Yutaka NIIKAWA	Nippon Koei Co., LTD.
(8)	Construction Plan / Cost Estimate	Hajime KAMO	Nippon Koei Co., LTD.

2nd field Survey Team

（From 10th February, 2003 to 19th February, 2003）

(1)	River / Hydrology	Hidetoshi SAWADA	Nippon Koei Co., LTD.
(2)	Agriculture / Water Management / O&M	Zetsugaku KURITA	Nippon Koei Co., LTD.
(3)	Physical Condition Survey	Yutaka NIIKAWA	Nippon Koei Co., LTD.

Draft Final Report Explanation Team

（From 12th March, 2003 to 18th March,2003）

(1)	Team Leader / Project Coordinator	Motoharu WAKABAYASHI	Forth Project Management Division, Grant Aid Management Department,JICA
(2)	Chief Consultant / Irrigation Plan / Design	Koji OKADA	Nippon Koei Co., LTD.
(3)	Agriculture / Water Management / O&M	Zetsugaku KURITA	Nippon Koei Co., LTD.

3rd Field Survey Team

(From 23rd June, 2003 to 18th July, 2003)

(1)	Team Leader	Juro CHIKARAISHI	Resident Representative, JICA Cambodia Office
(2)	Project Coordinator	Jiro TAKEICHI	Project Formulation Advisor, JICA Cambodia Office
(3)	Chief Consultant / Irrigation Plan / Design	Koji OKADA	Nippon Koei Co., LTD.
(4)	Gate and Mechanical Engineer	Arata YAMAGUCHI	Nippon Koei Co., LTD.
(5)	Physical Condition Survey	Yutaka NIIKAWA	Nippon Koei Co., LTD.
(6)	Construction Plan / Cost Estimate	Hajime KAMO	Nippon Koei Co., LTD.

4th Field Survey Team

(From 2nd September to 11th September)

(1)	Team Leader	Hiroto MITSUGI	Deputy Resident Representative, JICA Cambodia Office
(2)	Chief Consultant / Irrigation Plan / Design	Toshikazu KAMBARA	Nippon Koei Co., LTD.
(3)	River / Hydrology	Hirofumi SADAMURA	Nippon Koei Co., LTD.
(4)	Construction Plan / Cost Estimate	Yutaka NIIKAWA	Nippon Koei Co., LTD.

Explanation of Alternative Study Results and 5th Field Survey

(From 4th October, 2004 to 8thOctober, 2004)

(1)	Chief Consultant / Irrigation Plan / Design	Toshikazu KAMBARA	Nippon Koei Co., LTD.
(2)	Construction Plan / Cost Estimate	Yutaka NIIKAWA	Nippon Koei Co., LTD.

Draft Final Report Explanation Team

(On 16th November, 2004)

(1)	Team Leader	Juro CHIKARAISHI	Resident Representative, JICA Cambodia Office

2. Survey Schedule

Inception Report Explanation and 1st field Survey Team

（From 10th November, 2002 to 23rd December,2004）

No.	Date (Day)	Official Member		Consultant Member	
		Activity	Lodging	Activity	Lodging
1	**November** 10 (Sun)	Tokyo - Bangkok - Phnom Penh.	Phnom Penh	Tokyo - Bangkok - Phnom Penh. (Chief Consultant / Irrigation Plan / Design ; Mr. Okada)	Phnom Penh
2	11 (Mon)	Site Survey, Courtesy call to Embassy of Japan, JICA office.	Phnom Penh	Same with the official member.	Phnom Penh
3	12 (Tue)	Courtesy call and discussion with MOWAM and Project team of Technical Service Center for Irrigation System Project Site Survey	Phnom Penh	Same with the official member.	Phnom Penh
4	13 (Wed)	Discussion with MOWRAM	Phnom Penh	Same with the official member.	Phnom Penh
5	14 (Thu)	Discussion with MOWRAM, Site Survey	Phnom Penh	Same with the official member. Arrival of second team (River / Hydrology ; Mr. Sawada, Agriculture / Water Management / O&M; Mr. Kurita and Physical Condition Survey ; Mr. Niikawa)	Phnom Penh
6	15 (Fri)	Singing of Minutes. Report to EOJ and JICA office Phnom Penh - Bangkok - Narita	Plane	Same with the official member. Data collection in Phnom Penh. Arrangement of subletting work.	Phnom Penh
7	16 (Sat))	Arrived at Narita		Data collection in Phnom Penh. Arrangement of subletting work.	Phnom Penh
8	17 (Sun)			Data collection in Phnom Penh. Arrangement of subletting work.	Phnom Penh
9	18 (Mon)			Data collection in Phnom Penh. Arrangement of subletting work.	Phnom Penh
10	19 (Tue)			Site survey.	Phnom Penh
11	20 (Wed)			Site survey.	Phnom Penh
12	21 (Thu)			Site survey.	Phnom Penh
13	22 (Fri)			Site survey.	Phnom Penh
14	23 (Sat)			Site survey.	Phnom Penh
15	24 (Sun)			Site survey.	Phnom Penh
16	25 (Mon)			Site survey.	Phnom Penh
17	26 ((Tue)			Site survey.	Phnom Penh
18	27 (Wed)			Site survey.	Phnom Penh
19	28 (Thu)			Site survey.	Phnom Penh
20	29 (Fri)			Site survey.	Phnom Penh
21	30 (Sat)			Site survey. Arrival of expert (Construction Plan /Cost Estimate)	Phnom Penh
22	**December** 1 (Sun)			Site survey.	Phnom Penh

No.	Date	Official Member		Consultant Member	
	(Day)	Activity	Lodging	Activity	Lodging
23	2 (Mon)			Site survey.	Phnom Penh
24	3 (Tue)			Site survey.	Phnom Penh
25	4 (Wed)			Site survey.	Phnom Penh
26	5 (Thu)			Site survey.	Phnom Penh
27	6 (Fri)			Site survey.	Phnom Penh
28	7 (Sat)			Site survey.	Phnom Penh
29	8 (Sun)			Site survey.	Phnom Penh
30	9 (Mon)			Site survey.	Phnom Penh
31	10 (Tue)			Site survey.	Phnom Penh
32	11 (Wed)			Site survey.	Phnom Penh
33	12 (Thu)			Site survey.	Phnom Penh
34	13 (Fri)			Site survey.	Phnom Penh
35	14 (Sat)			Site survey.	Phnom Penh
36	15 (Sun)			Site survey.	Phnom Penh
37	16 (Mon)			Site survey.	Phnom Penh
38	17 (Tue)			Site survey. Leaving of Agriculture / Water Management / O&M expert for Narita.	Phnom Penh
39	18 (Wed)			Site survey.	Phnom Penh
40	19 (Thu)			Site survey.	Phnom Penh
41	20 (Fri)			Report to EOJ, JICA Office and MOWRAM	Phnom Penh
42	21 (Sat)			Data arrangement.	Phnom Penh
43	22 (Sun)			Phnom Penh - Bangkok - Narita.	Plane
44	23 (Mon)			Arrived at Narita.	

2nd field Survey Team

(From 10th February, 2003 to 19th February, 2003)

	Date	(day)	Activity		
			River / Hydrology	Physical Condition Survey	Agriculture /Water Management/ O&M
1	10th Feb.	Sun	Tokyo – Bangkok – Phnom Penh	same with River/Hydrology	
2	11th Feb.	Mon	Courtesy call to JICA Cambodia Office, discussion with MOW RAM, field Survey	same with River/Hydrology	Tokyo – Bangkok – Phnom Penh
3	12th Feb.	Tue	Field Survey	same with River/Hydrology	same with River/Hydrology
4	13th Feb.	Wed	Field Survey	same with River/Hydrology	same with River/Hydrology
5	14th Feb.	Thu	Field Survey	same with River/Hydrology	same with River/Hydrology
6	15th Feb.	Fri	Field Survey	same with River/Hydrology	same with River/Hydrology
7	16th Feb.	Sat	Field Survey	same with River/Hydrology	same with River/Hydrology
8	17th Feb.	Sun	Field Survey	same with River/Hydrology	same with River/Hydrology
9	18th Feb.	Mon	Report to MOWRAM and JICA Cambodia Office Phnom Penh – Bangkok–	same with River/Hydrology	same with River/Hydrology
10	19th Feb.	Tue	Arrive at Narita	same with River/Hydrology	same with River/Hydrology

Draft Final Report Explanation Team

(From 12th March, 2003 to 18th March,2003)

No.	Date	(day)	Official Member		Consultant Member	
			Activity	Lodging	Activity	Lodging
1	12-Mar	Wed	Tokyo – Bangkok –Phnom Penh	Phnom Penh	Same with Official Member	Phnom Penh
2	13-Mar	Thu	Courtesy call and discussion with JICA Cambodia Office, MOWRAM and TSC.	Phnom Penh	Same with Official Member	Phnom Penh
3	14-Mar	Fri	Discussion with EOJ, Explanation of the Draft Final Report	Phnom Penh	Same with Official Member	Phnom Penh
4	15-Mar	Sat	Field survey	Phnom Penh	Same with Official Member	Phnom Penh
5	16-Mar	Sun	Preparation of report, Team meeting	Phnom Penh	Same with Official Member	Phnom Penh
6	17-Mar	Mon	Report to JICA Cambodia office and EOJ, Phnom Penh – Bangkok –	plane	Same with Official Member	Plane
7	18-Mar	Tue	Arrive at Narita		Same with Official Member	

3rd Field Survey Team

(From 23rd June, 2003 to 18th July, 2003)

No.	Date	Day	Activity			
			Chief Consultant/Irrigation Plan/Design	Gate/Mechanical Engineer	Physical Condition Survey	Construction Plan/Cost Estimate
1	23-Jun	Mon	Tokyo - Bangkok- Phnom Penh			
2	24-Jun	Tue	Courtesy call to JICA Cambodia Office, MOWRAM			
3	25-Jun	Wed	Field Survey			
4	26-Jun	Thu	Field Survey			
5	27-Jun	Fri	Field Survey			
6	28-Jun	Sat	Field Survey	Tokyo - Bangkok - Phnom Penh	Tokyo - Bangkok - Phnom Penh	
7	29-Jun	Sun	Field Survey	Field Survey	Field Survey	
8	30-Jun	Mon	Field Survey	Field Survey	Field Survey	
9	1-Jul	Tue	Field Survey	Field Survey	Field Survey	
10	2-Jul	Wed	Field Survey	Field Survey	Field Survey	
11	3-Jul	Thu	Phnom Penh - Bangkok-	Phnom Penh - Bangkok-	Field Survey	
12	4-Jul	Fri	Arrived at Narita	Arrived at Narita	Field Survey	
13	5-Jul	Sat			Field Survey	
14	6-Jul	Sun			Field Survey	
15	7-Jul	Mon			Field Survey	
16	8-Jul	Tue			Field Survey	Tokyo - Bangkok - Phnom Penh
17	9-Jul	Wed			Field Survey	Field Survey
18	10-Jul	Thu			Field Survey	Field Survey
19	11-Jul	Fri			Field Survey	Field Survey
20	12-Jul	Sat			Field Survey	Field Survey
21	13-Jul	Sun			Field Survey	Field Survey
22	14-Jul	Mon			Field Survey	Field Survey
23	15-Jul	Tue			Field Survey	Field Survey
24	16-Jul	Wed			Field Survey	Field Survey
25	17-Jul	Thu			Report to MOWRAM and JICA Cambodia Office	Report to MOWRAM and JICA Cambodia Office
26	18-Jul	Fri			Arrived at Narita	Arrived at Narita

4th Field Survey Team

(From 2nd September to 11th September)

No.	Date	Chief Consultant / Irrigation Plan / Design	Construction Plan / Cost Estimate	River / Hydrology
1	2-Sep Thu	Tokyo - Bangkok - Phnom Penh		
2	3-Sep Fri	Courtesy call to MOWRAM		
		Discussion with JICA Cambodia Office		
		Field survey		
3	4-Sep Sat	Field Survey		
4	5-Sep Sun	Field survey		
5	6-Sep Mon	Steering Committee Meeting		
		Report to JICA Cambodia Office		
		Preparation of Minutes of Meeting		Phnom Penh - Bangkok -
6	7-Sep Tue	Data Collection		Arrived at Narita
7	8-Sep Wed	Data Collection, field survey		
8	9-Sep Thu	Data Collection		
		Preparation of Minutes of Meeting		
9	10-Sep Fri	Signing of Minutes of Meeting		
		Report to MOWRAM		
		Report to JICA Cambodia Office		
		Phnom Penh - Bangkok -		
10	11-Sep Sat	Arrived at Narita		

Explanation of Alternative Study Results and 5th Field Survey

(From 4th October, 2004 to 8thOctober, 2004)

No.	Date	Day	Activity
1	4-Oct	Mon	Tokyo - Bangkok - Phnom Penh
2	5-Oct	Tue	Courtesy call and discussions with MOWRAM and JICA Cambodia Office
3	6-Oct	Wed	Steering Committee Meeting, Preparation of Minutes of Meeting
4	7-Oct	Thu	Signing of Minutes of Meeting, report to JICA Cambodia Office, Phnom Penh - Bangkok-
5	8-Oct	Fri	Arrived at Narita

Draft Final Report Explanation Team

(On 16th November, 2004)

No.	Date	Day	Activity
1	16-Nov	Thu	Explanation of Draft Final Report, Signing of Minutes of Meeting

３． List of Parties Concerned in the Recipient Country

A. Ministry of Water Resources and Meteorology

1. Lim Kean Hor	Minister
2. Veng Sakhon	Secretary of State/ Under Secretary of State
3. Bun Hean	Director Genral of Technique
4. Pich Veasna	Director, PICD
5. Theng Tara	Director, Water Resources Management and Conservation Dept.
6. Ngoun Pich	Dy. Director, Eng. Dept
7. Lim Theng	Dy. Director, Eng. Dept
8. Klok Sam Ang	Head International Cooperation Office
9. Chun Pene Long	Dirctor, SPWRAM Kandal
10. Te Auvkim	Director, DID
11. Hun Sochara	Dy. Director, Kandal Province Water Resources Office
12. Leng Saseh	Dy. Chief, Kandal Stung District Resources Office Water Supply and Sanitation Division

B. Ministry of Public Work and Transport

1. Chhin Kong Hean	Director General of Public Works
2. Tauch Chankosal	First Deputy Director General of Public Works
3. Yit Bunna	Director of Public Works Research Center
4. Lim Sidenine	Director of Road Infrastructure
5. Chreung Sok Tharath	Pjt. M'ger of Flood Emergency Reh. Pjt.

C. National Institute of Satistics, Ministry of Planning

1. Khin Song	Deputy Director of General Statistics Departme

D. Kandal Stung District Office

1. Prak San	Chief of District Office

E. Embassy of Japan

1. Gotaro OGAWA	Ambassador
2. Fumiaki TAKAHASHI	Ambassador
3. Katsuhiro SHINOHARA	Minister
4. Kazumi JIGAMI	Counselor
5. Yasunari UEDA	First Secretary
6. Ryutaro TAKAKU	Second Secretary
7. Fumio GOTO	Second Secretary

F. JICA Cambodia Office

1. Juro CHIKARAISHI	Resident Representative
2. Tomosuke HARA	Deputy Resident Representative
3. Hiroto MITSUGI	Deputy Resident Representative
4. Yukihoro KOIZUMI	
5. Jiro TAKEICHI	Project Formulation Advisor
6. Shoshiro HORIGOME	Technical Adviser

JICA Expert(MOWRAM)

1. Takanobu KOBAYASHI	Advisor

Irrigation Survice Senter

1. Akira Miyazaki	Chief Advisor (Team Leader)
2. Kenji YASUDA	Survey/ Planning
3. Yoji EBIHARA	Design / Water Management
4. Youichi IHARA	Construciton Management
5. Mikayo YAMAZAKI	Project Coordinator

4. Minutes of Discussions

Appendix 1 Minutes of Discussions on the Basic Design Study on the Project for Rehabilitation of Kandal Stung Irrigation System in the Kingdom of Cambodia (Inception Report, November, 2002)

MINUTES OF DISCUSSIONS
ON
THE BASIC DESIGN STUDY
ON THE PROJECT FOR
REHABILITATION OF
KANDAL STUNG IRRIGATION SYSTEM
IN
THE KINGDOM OF CAMBODIA

In response to a request form the Government of the Kingdom of Cambodia, the Government of Japan decided to conduct a Basic Design Study on the Project for Rehabilitation of Kandal Stung Irrigation System (hereinafter referred to as "the Project") and entrusted the study to the Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA sent to the Cambodia the Basic Design Study Team (hereinafter referred to as "the Team"), which is headed by Mr. Kazuo NAKAGAWA, Managing Director, Agricultural Development Cooperation Department, JICA, and is scheduled to stay in the country from 10 November to 23 December, 2002.

The Team held discussions with the officials concerned of the Government of Cambodia and conducted a field survey at the study area.

In the course of discussions and field survey, both parties confirmed the main items described on the attached sheets. The Team will proceed to further works and prepare the Basic Design Study Report.

Phnom Penh, 15 November, 2002

Mr. Kazuo NAKAGAWA
Leader
Basic Design Study Team
Japan International Cooperation Agency

H.E. Y KY HEANG
Secretary of State
Ministry of Water Resources and Meteorology

ATTACHMENT

1.Objective of the Project

The objective of the Project is to secure the water supply for irrigation and promote the production of agricultural products in the Project area through the rehabilitation of the existing irrigation facilities, which had been constructed by the Cambodian side.

2.Project site

The site of the Project is located in Kandal Stung District in Kandal Province, as shown in Annex-1.

3.Responsible and Implementing Agency

The responsible and implementing agency is Ministry of Water Resources and Meteorology (MOWRAM) as shown in Annex.2.

4.Items requested by the Government of Cambodia

After discussion with the Team, the items described in Annex-3 were finally requested by the Cambodian side. JICA will assess the appropriateness of the request and will recommend to the Government of Japan for approval.

5.Japan's Grant Aid Scheme

5-1. The Cambodian side has understood the Japan's Grant Aid Scheme explained by the Team, as described in Annex-4.

5-2. The Cambodian side will undertake the necessary measures, as described in Annex-5, for smooth implementation of the Project, as a condition for the Japanese Grant Aid to be implemented.

6.Schedule of the Study

6-1. Consultants will proceed to further studies in the Cambodia until 22 December, 2002.

6-2. JICA will dispatch consultant team again in order to survey for the river conditions in dry season around February, 2003.

6-3. JICA will prepare the draft report in English and dispatch a mission in order to explain its contents around March, 2003.

6-4. In case that the contents of the report is accepted in principle by the Government of the Cambodia, JICA will complete the final report and send it to the Government of the Cambodia by July, 2003.

7.Other relevant issues

7-1.The Cambodian side requested to include the study on the spillway as well as Tuk Thla and Kompong Tuol regulators since the spillway was a component of head-works. Both sides confirmed that these facilities were examined from the viewpoint of the utilization of the river water for irrigation with maintaining the existing flood flow capacity.

7-2. MOWRAM recognized the importance of establishment of the National Steering Committee (NSC) for the smooth implementation of the Project. For the time being, the Joint Coordination Committee of "The Technical Service Center for Irrigation System Project (TSC)" will play a role as the NSC. The NSC will be organized officially after "Exchange of Note (E/N)". Both sides confirmed expected functions and members of the NSC as shown in Annex 6.

7-3. Both sides confirmed that the target of irrigation was to secure the supplemental water supply to the Project area in wet season.

7-4.Both sides confirmed that the construction of secondary and tertiary canals be implemented by the Cambodian side shall be the minimum condition for implementing the Project. The Cambodian side shall formulate the construction plan for secondary and tertiary canals, and send first version to the Japanese side until middle December 2002, second version at the time of secondary survey by consultant team in February 2003, and final version at the time of the Explanation of Draft Final Repot in March 2003. The construction of secondary and tertiary canals will be implemented by the Cambodian side by their own responsibility according to the planned schedule with utilizing know-how and experience obtained through the activities of TSC.

7-5. The Japanese side expressed that the appropriate operation and maintenance for the facilities by MOWRAM shall be also the minimum condition for implementing the Project. The Cambodian side confirmed to formulate the operation and maintenance plan based on the draft final report

prepared by the Japanese side, and implement it with utilizing know-how and experience obtained through the activities of TSC.

7-6. The Cambodian side shall secure the necessary budget and personnel to operate and maintain the facilities of the Project.

7-7. The irrigation area of the Project will be determined in the course of the flow chart as shown in Annex 7.

7-8. The requested items described in Annex-3 will be further examined and determined in the course of the study by the Team in consideration of following criteria.

i) Farming Plan in Kandal Stung Area

ii) Natural conditions, especially for possible flood

iii) Managerial, technical and administrative viability

iv) Maintenance and running cost

v) Cost and Benefit

vi) Budgetary allocation of Japanese side

vii) Financial viability

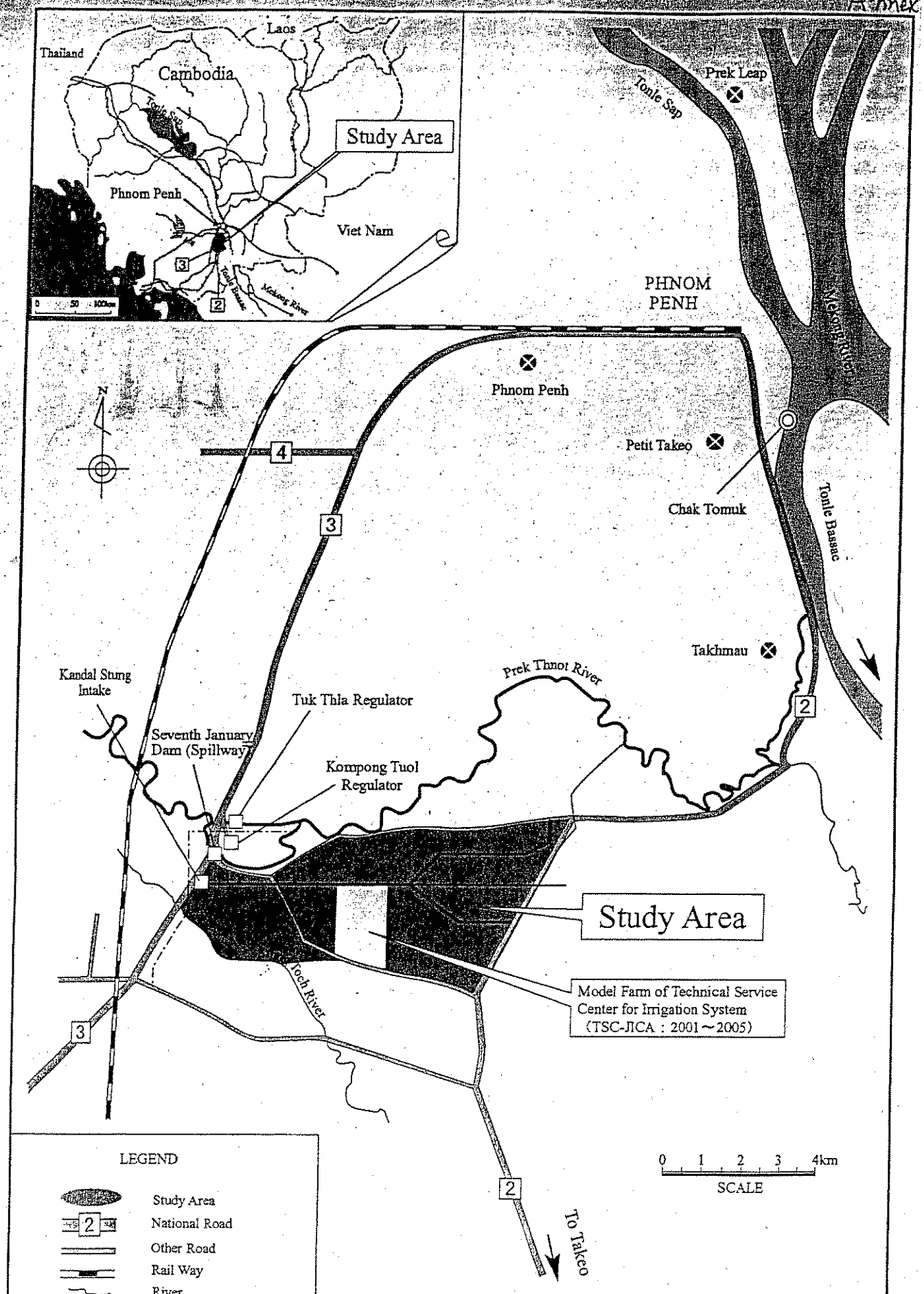
viii) No duplication of similar support by the Government of the Cambodia and other donors

7-9. Both sides understood that it was essential to secure the land for the improvement of the canals and roads including temporary office and storage yards etc. The Cambodian side promised that this matter shall be executed by the Cambodian side prior to the implementation of the Project.

7-10. Both sides confirmed that the necessary collaboration between the Project and TSC would enhance the effect and sustainability of the Project. Both sides will take necessary measures to collaborate among them especially for the construction of secondary and tertiary canals, and the operation and maintenance of the Project.

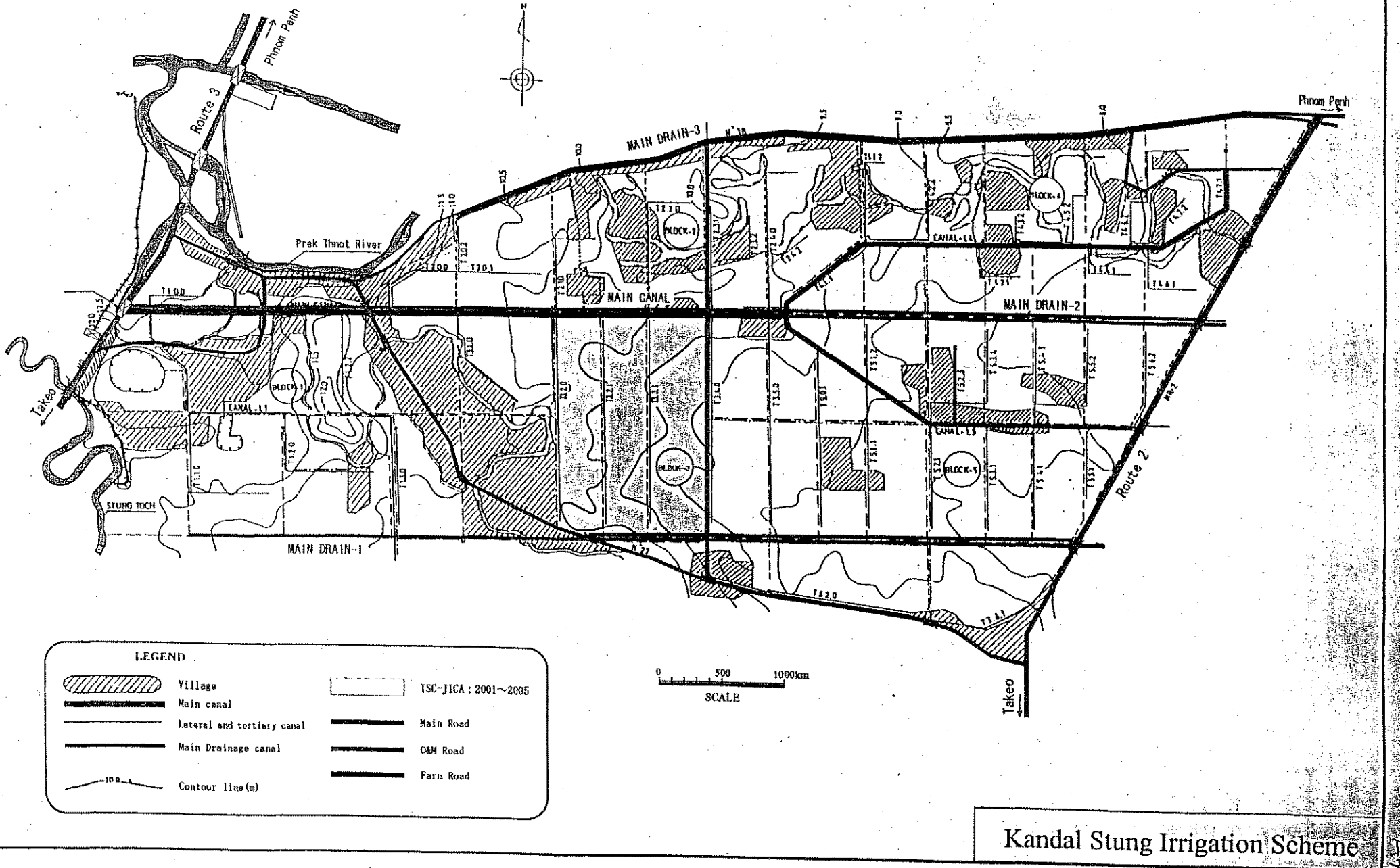
7-11. The Cambodian side confirmed that there would be no influence to the Project by implementing the newly approved irrigation project by the Government of Cambodia, which named as the "Integrated Development Project in the Western Side of Phnom Penh Municipality" at the upstream side of Tuk Thla regulator.

7-12. Both sides confirmed that the agricultural products in the Project area would not be for the export for Japan and be domestic supply for the poverty reduction in the Project area.



The Royal Government of Cambodia

Rehabilitation of the Kandal Stung Irrigation System in the Lower Prek Thnot Basin



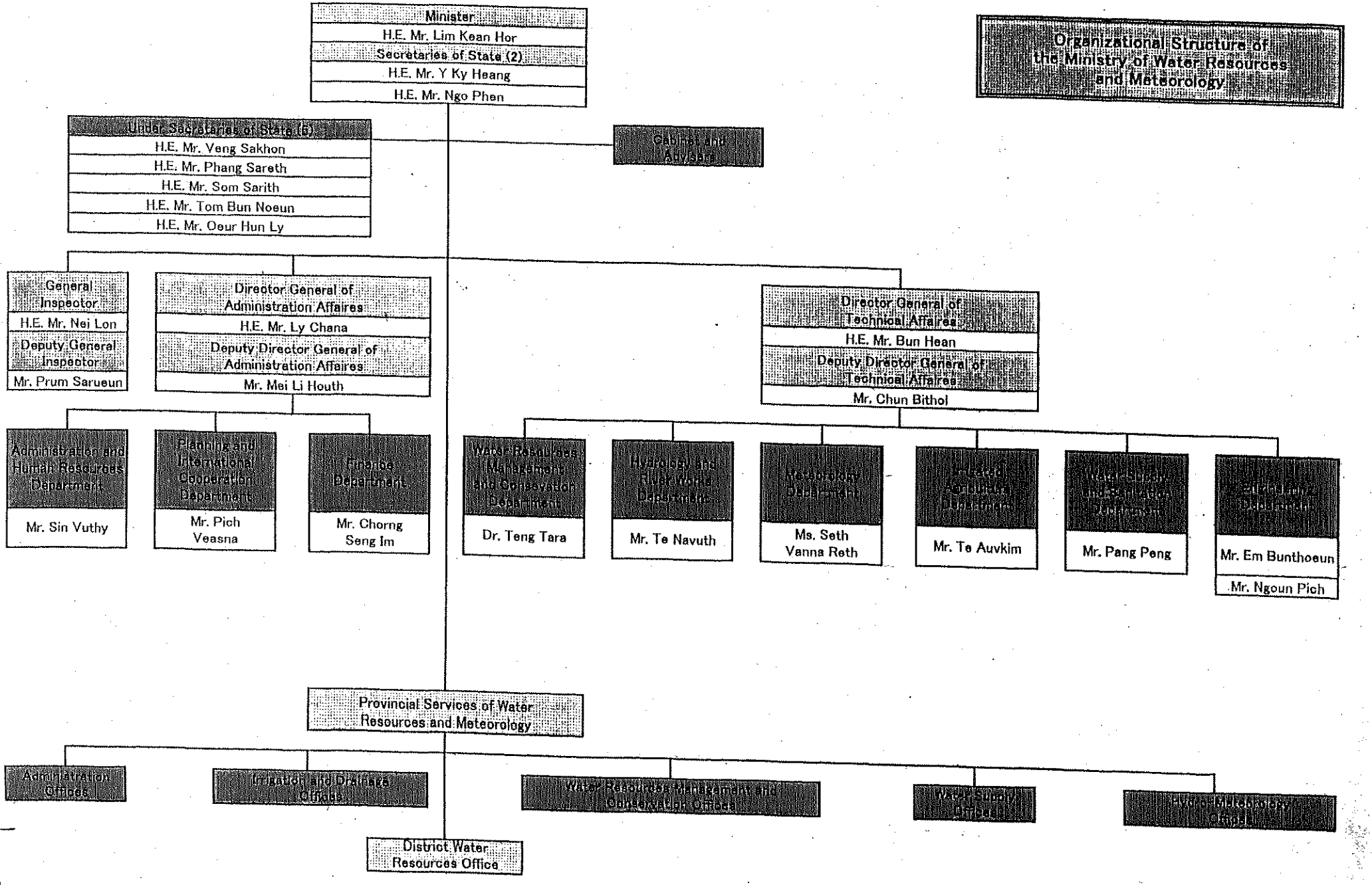
Kandal Stung Irrigation Scheme

A1-6

A3-2

Annex.2

Organizational Structure of the Ministry of Water Resources and Meteorology



Annex.3 Items Requested by Government of Cambodia (GOC)

The components of the Project requested by GOC are to rehabilitate the Kandar Stung Irrigation System. Requested facilities to be rehabilitated are as follows:

1) Regulators	:	- located on the Prek Thnot River - two places (Tuk Thla Regulator and Kompong Tuol Regulator)
2) Intake Structure	:	- located at right bank of the Prek Thnot river, - one place
3) Main Irrigation Canal	:	- concrete lined canal with 5.4km length, - one canal
4) Drainage Canal	:	- unlined earth canal with 18.0km length, - three canals
5) O&M Roads	:	- laterite paved road with 28.0km length
6) Farm Roads	:	- laterite paved road with 8.0km length, - three roads
7) Spillway (Seventh January Dam)	:	- located on the Prek Thnot River

Annex 4 : JAPAN'S GRANT AID SCHEME

1. Grant Aid Procedure

1) Japan's Grant Aid Program is executed through the following procedures.

Application	(Request made by a recipient country)
Study	(Basic Design Study conducted by JICA)
Appraisal & Approval	(Appraisal by the Government of Japan and Approval by Cabinet)
Determination of Implementation	(The Notes exchanged between the Governments of Japan and the recipient country)

2) Firstly, the application or request for a Grant Aid project submitted by a recipient country is examined by the Government of Japan (the Ministry of Foreign Affairs) to determine whether or not it is eligible for Grant Aid. If the request is deemed appropriate, the Government of Japan assigns JICA to conduct a study on the request. If necessary, JICA send a Preliminary Study Team to the recipient country to confirm the contents of the request.

Secondly, JICA conducts the study (Basic Design Study), using Japanese consulting firms.

Thirdly, the Government of Japan appraises the project to see whether or not it is suitable for Japan's Grant Aid Programme, based on the Basic Design Study report prepared by JICA, and the results are then submitted to the Cabinet for approval.

Fourthly, the project, once approved by the Cabinet, becomes official with the Exchange of Notes signed by the Governments of Japan and the recipient country.

Finally, for the implementation of the project, JICA assists the recipient country in such matters as preparing tenders, contracts and so on.

2. Basic Design Study

1) Contents of the Study

The aim of the Basic Design Study (hereinafter referred to as "the Study"), conducted by JICA on a requested project (hereinafter referred to as "the Project"), is to provide a basic

document necessary for the appraisal of the Project by the Government of Japan. The contents of the Study are as follows:

a) confirmation of the background, objectives and benefits of the Project and also institutional capacity of agencies concerned of the recipient country necessary for the Project's implementation;
b) evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from the technical, social and economic points of view;
c) confirmation of items agreed on by both parties concerning the basic concept of the Project;
d) preparation of a basic design of the Project; and
e) estimation of costs of the Project.

The contents of the original request are not necessarily approved in their initial form as the contents of the Grant Aid project. The Basic Design of the Project is confirmed considering the guidelines of Japan's Grant Aid Scheme.

The Government of Japan requests the Government of the recipient country to take whatever measures are necessary to ensure its self-reliance in the implementation of the Project. Such measures must be guaranteed even through they may fall outside of the jurisdiction of the organization in the recipient country actually implementing the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country through the Minutes of Discussions.

2) Selection of Consultants

For the smooth implementation of the Study, JICA uses a consulting firm selected through its own procedure (competitive proposal). The selected firm participates the Study and prepares a report based upon the terms of reference set by JICA.

At the beginning of implementation after the Exchange of Notes, for the services of the Detailed Design and Construction Supervision of the Project, JICA recommends the same consulting firm which participated in the Study to the recipient country, in order to maintain the technical consistency between the Basic Design and Detailed Design as well as to avoid any undue delay caused by the selection of a new consulting firm.

3. Japan's Grant Aid Scheme

1) What is Grant Aid?

The Grant Aid Program provides a recipient country with non-reimbursable funds to procure the facilities, equipment and services (engineering services and transportation of the products, etc.) for economic and social development of the country under principles in accordance with the relevant laws and regulations of Japan. Grant Aid is not supplied through the donation of materials as such.

2) Exchange of Notes (E/N)

Japan's Grant Aid is extended in accordance with the Notes exchanged by the two Governments concerned, in which the objectives of the project, period of execution, conditions and amount of the Grant Aid, etc., are confirmed.

3) "The period of the Grant" means the one fiscal year which the Cabinet approves the project for. Within the fiscal year, all procedure such as exchanging of the Notes, concluding contracts with consulting firms and contractors and final payment to them must be completed.

However, in case of delays in delivery, installation or construction due to unforeseen factors such as weather, the period of the Grant Aid can be further extended for a maximum of one fiscal year at most by mutual agreement between the two Governments.

4) Under the Grant, in principle, Japanese products and services including transport or those of the recipient country are to be purchased.

When the two Governments deem it necessary, the Grant Aid may be used for the purchase of the products or services of a third country.

However, the prime contractors, namely consulting, contracting and procurement firms, are limited to "Japanese nationals". (The term "Japanese nationals" means persons of Japanese nationality or Japanese corporations controlled by persons of Japanese nationality.)

5) Necessity of "Verification"

The Government of the recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be verified by the Government of Japan. This "Verification" is deemed necessary to secure accountability of Japanese taxpayers.

6) Undertakings required to the Government of the recipient country

a) to secure a lot of land necessary for the construction of the Project and to clear the site;

b) to provide facilities for distribution of electricity, water supply and drainage and other incidental facilities outside the site;

c) to ensure prompt unloading and customs clearance at ports of disembarkation in the recipient country and internal transportation therein of the products purchased under the Grant Aid;

d) to exempt Japanese nationals from customs duties, internal taxes and fiscal levies which may be imposed in the recipient country with respect to the supply of the products and services under the verified contracts;

e) to accord Japanese nationals whose services may be required in connection with the supply of the products and services under the verified contracts such as facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work;

f) to ensure that the facilities constructed and products purchased under the Grant Aid be maintained and used properly and effectively for the Project; and

g) to bear all the expenses, other than those covered by the Grant Aid, necessary for the Project.

7) "Proper Use"

The recipient country is required to maintain and use the facilities constructed and equipment purchased under the Grant Aid properly and effectively and to assign the necessary staff for operation and maintenance of them as well as to bear all the expenses other than those covered by the Grant Aid.

8) "Re-export"

The products purchased under the Grant Aid shall not be re-exported from the recipient country.

9) Banking Arrangement (B/A)

a) The Government of the recipient country or its designated authority should open an account in the name of the Government of the recipient country in an authorized foreign exchange bank in Japan (hereinafter referred to as "the Bank"). The Government of Japan will execute the Grant Aid by making payments in Japanese yen to cover the obligations incurred by the Government of the recipient country or its designated authority under the verified contracts.

b) The payments will be made when payment requests are presented by the Bank to the Government of Japan under an Authorization to Pay (A/P) issued by the Government of recipient country or its designated authority.

ANNEX-5: UNDERTAKINGS BY THE GOVERNMENT OF THE RECIPIENT COUNTRY

1. To secure a lot of land necessary for the Project;

2. To clear and level the site for the Project prior to the commencement of the construction;

3. To provide a proper access road to the Project site;

4. To provide facilities for distribution of electricity, water supply, telephone trunk line and drainage and other incidental facilities outside the site;

5. To undertake incidental outdoor works, such as gardening, fencing, exterior lighting, and other incidental facilities in and around the Project site, if necessary;

6. To ensure prompt unloading and customs clearance of the products purchased under the Japan's Grant Aid at ports of disembarkation in the Recipient Country;

7. To exempt Japanese nationals from customs duties, internal taxes and fiscal levies which may be imposed in THE RECIPIENT COUNTRY with respect to the supply of the products and services under the verified contracts;

8. To accord Japanese nationals whose services may be required in connection with the supply of the products and services under the verified contracts such facilities as may be necessary for their entry into THE RECIPIENT COUNTRY and stay therein for the performance of their work;

9. To bear commissions, namely advising commissions of an Authorization to Pay (A/P) and payment commissions, to the Japanese foreign exchange bank for the banking services based upon the Banking Arrangement (B/A);

10. To provide necessary permissions, licenses, and other authorization for implementing the Project, if necessary;

11. To ensure that the facilities constructed and equipment purchased under the Japan's Grant Aid be maintained and used properly and effectively for the Project; and

12. To bear all the expenses, other than those covered by the Japan's Grant Aid, necessary for the Project.

Major Undertaking to be taken by Each Government

No.	Items	To be covered by Grant Aid	To be covered by Recipient Side
1.	To secure land		●
2.	To clear, level and reclaim the site when needed		●
3.	To construct access roads		
	1) Within the site when required	●	
	2) Outside the site		●
4.	To rehabilitate main irrigation canal and its related structures		
	1) Rehabilitation of Regulators and Spillway (if required)	●	
	2) Construction of intake structure	●	
	3) Rehabilitation of main irrigation canal and its related structures	●	
	4) Rehabilitation of O&M Roads	●	
	5) Construction of secondary and tertiary irrigation canal and its related structures		●
	6) On-firm Works		●
5.	To rehabilitate drainage facilities		
	1) Rehabilitation of main drainage canals and its related structures	●	
	2) Secondary and tertiary drainage canals and its related structures		●
6.	To construct farm roads		
	1) Construction of farm roads	●	
	2) Rehabilitation of related structures	●	
7.	To bear the following commissions to the Japanese foreign exchange bank for the banking services based upon the B/A (Banking Arrangement)		
	1) Advising commission of A/P (Authorization to Pay)		●
	2) Payment commission		●
8.	To ensure unloading and customs clearance at port of disembarkation in recipient country		
	1) Marine (Air) transportation of the products from Japan to the recipient country	●	
	2) Tax exemption and custom clearance of the products at the port of disembarkation		●
	3) Internal transportation from the port of disembarkation to the project site		●
9.	To accord Japanese nationals whose services may be required in connection with the supply of the products and the services under the verified contact such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work.		●
8.	To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the supply of the products and services under the verified contracts.		●
9.	To maintain and use property and effectively the facilities constructed and equipment provided under the Grant.		●
10.	To bear all the expenses, other than those to be borne by the Grant, necessary for construction of the facilities as well as for the transportation and installation of the equipment.		●

Annex 6

(Draft)

National Steering Committee for The Project for Rehabilitation of Kandal Stung Irrigation System in The Kingdom of Cambodia

1. Functions

A National Steering Committee which consists of personnel from both the Japanese and Cambodian sides will meet at least XX a year and when necessary for the following objectives:

i. To provide the overall coordination of the project within the MOWRAM and will provide formal liaison with senior MOWRAM officials and with other involved Ministries and Department relevant,
ii. To review the overall progress of the project formulation and implementation,
iii. To review and exchange opinions on important issues in relation to the project,
iv. To provide advice to the project team for the better implementation and management of the project,

2. Composition of the committee

The National Steering Committee is composed of the following members:

i. Chairperson of the Committee, Under Secretary of State of MOWRAM
ii. Members:

- Project Director, Director General of Technical Affairs of MOWRAM
- Director of Planning and International Cooperation Dept., MOWRAM
- Director of Engineering Dept., MOWRAM
- Director of Irrigated Agriculture Dept., MOWRAM

- Director of Water Resource Management and Conservation Dept., MOWRAM
- Deputy Director of Engineering Dept., MOWRAM
- Director of Kandal Provincial Bureau of Water Resources and Meteorology
- CDC representative
- MAFF representative
- Resident Representative of the JICA office in the Kingdom of Cambodia
- JICA expert for MOWRAM
- Chief Advisor of TSC

3. Observers:

Officials of the Embassy of Japan in the Kingdom of Cambodia may attend the National Steering Committee meetings as observers.
Persons who are nominated by the Chairperson may also attend the National Steering Committee meeting.

Annex. 7

The procedure of the determination of the Project area

Requested area (1,950ha)

Technical Aspect

The necessary amount of irrigation water for future farming plan

The possible amount of irrigation water

↓

Improving facilities for securing water

↓

Cost for improving vs. Benefit (irrigation area)

↓

Technical Irrigable Area

Institutional and Management Aspect

the examination of the construction plan of secondary and tertiary canals

↓

the possible area which are maintained and operated by Cambodian side

1) the possible area which are maintained and operated by **MOWRAM** (allocation of budget and personnel, technical aspect)

2) the possible area which are maintained and operated by **Farmers** (The establishing of farmer groups, Sharing the fee of maintaining and operation)

↓

Manageable Area

↓

Project area

Appendix 2 Minutes of Discussions on Farm Roads

Minutes of Discussions

1. Subject: Conditions of Three Farm Roads in the Kandal Stung Irrigation System
2. Date and Place: 21 November 2002, Office of the Under Secretary of State, MOWRAM
3. Attendance H.E. Mr. Veng Sakhon: Under Secretary of State, MOWRAM
   K. Okada: Chief Consultant for Basic Design
   Y. Niikawa: Physical Conditions Surveyor of the

4. Discussions:

(1) The Consultant Team explained the present conditions of three farm roads that were proposed to be rehabilitated under the Project, based on the reconnaissance report prepared and submitted by the Team as per attached.

(2) The Consultant Team expressed his opinion that the conditions of three farm roads were in satisfactory level as a rural road. The Team recommended MOWRAM to conduct further survey on this matter by himself, if necessary.

(3) MOWRAM accepted the results of the survey by the Team and to exclude three roads from his request under the Project, since it was confirmed that three roads have been rehabilitated and in satisfactory conditions as a rural road.

Veng Sakhon

H.E. Veng Sakhon
Under Secretary of State
MOWRAM

K. Okada
Chief Consultant
Nippon Koei Co., Ltd.

22/Nov/02

Appendix 3 Letter of Ministry of Environment

KINGDOM OF CAMBODIA
NATION RELIGION KING

COUNCIL MINISTER
Ministry of Environment

No. 258 S>sß sCN

Phnom Penh, 31 December 2002

To : **Ministry of Water Resources and Meteorology**

Subject : **The case of recommendation and suggestion on the Kandal Stung Rehabilitation Project**

Reference : **Letter of Ministry of Water Resources and Meteorology No. 1796 fT] dated 27 November 2002**

Referring to the above subject and reference, I have the honor to inform Your Excellency Minister that : Ministry of Environment **accepted in principle** on the **Kandal Stung Irrigation Rehabilitation Project** that was requested by Ministry of Water Resources and Meteorology (MOWRAM) for recommendation and suggestion. According to the Sub-decree on Environmental Impact Assessment (EIA), the size of the mentioned project is less than the requirement in the annex of the Sub-decree. So, this project can be processed without the report of EIA.

However, this project is not connected with the annex of Ministry of Environment's Sub-decree, but MOE understand that during the implementation of this project it can be impacted to the Environment. So, MOE would like to recommend some point as follows:

During the implementation of this project, the owner should considered as follows:

- to keep natural water way in the region for using by people at down stream .
- to be assured no flooding in the village, road, camps and rice field of the people.
- to increase possibility of fish migration, bird and other animal in the case of seeing that it is necessary.
- to conduct the appropriated measure and efficiency to reduce the damage of irrigation system by flood.

Generally, the owner of the project has to assure the sustainable environment of both social and natural.

Please keep you informed on the above recommendation and suggestion.

Yours sincerely,

MOK MARET
Minister

CC: - General Directorate of Technical
- Chronicle - file

ព្រះរាជាណាចក្រកម្ពុជា

ជាតិ សាសនា ព្រះមហាក្សត្រ

រាជរដ្ឋាភិបាល

ក្រសួងបរិស្ថាន

លេខ ២៥៤ បស្ថ

រាជធានីភ្នំពេញ ថ្ងៃទី ០១ ខែ ... ឆ្នាំ ២០០២

គោរពជូន

ឯកឧត្តមរដ្ឋមន្ត្រីក្រសួងធនធានទឹក និងឧតុនិយម

កម្មវត្ថុ៖ ការពិនិត្យ និង ផ្តល់យោបល់លើគំរោងស្តារឡើងវិញប្រព័ន្ធស្រោចស្រព ។

យោង៖ - លិខិតលេខ ១៧៤៦ ធនឧ ចុះថ្ងៃទី ២៧ ខែ វិច្ឆិកា ឆ្នាំ ២០០២ របស់ក្រសួងធនធានទឹក និងឧតុនិយម ។

តបតាមកម្មវត្ថុ និងយោងខាងលើ ខ្ញុំមានកិត្តិយស សូមជំរាបជូនឯកឧត្តមរដ្ឋមន្ត្រីជ្រាបថា៖ ក្រសួងបរិស្ថានបានទទួលរបាយការណ៍ លើគំរោងស្តារឡើងវិញប្រព័ន្ធស្រោចស្រព ពីក្រសួងធនធានទឹក និងឧតុនិយមបានផ្ញើមកក្រសួងបរិស្ថានដើម្បីពិនិត្យនិងផ្តល់យោបល់ ។ យោងអនុក្រឹត្យស្តីពីកិច្ចដំណើរការវាយតំលៃហេតុប៉ះពាល់បរិស្ថាន ទំហំគំរោងស្តារឡើងវិញប្រព័ន្ធស្រោចស្រពនេះ គឺស្ថិតនៅក្រោមទំហំដែលបានកំណត់ក្នុងឧបសម្ព័ន្ធនៃអនុក្រឹត្យ ។ ដូចនេះ គំរោងនេះអាចដំណើរការបាន ដោយពុំចាំបាច់រៀបចំធ្វើរបាយការណ៍វាយតំលៃហេតុប៉ះពាល់បរិស្ថានទេ ។

ទោះបីជាយ៉ាងណា ក្តីគំរោងនេះពុំជាប់ក្នុងឧបសម្ព័ន្ធនៃអនុក្រឹត្យក្តី ក្រសួងយើងយល់ឃើញថា ក្នុងពេលដំណើរការស្តារ និងការប្រតិបត្តិគំរោង អាចនឹងមានផលប៉ះពាល់បរិស្ថាន ។ ដូចនេះ ក្រសួងសូមផ្តល់អនុសាសន៍ មួយចំនួនដូចខាងក្រោម៖

ក្នុងពេលដំណើរការស្តារឡើងវិញ និងប្រតិបត្តិគំរោង ម្ចាស់គំរោងត្រូវ៖

- រក្សាប្រភពទឹកធម្មជាតិ ក្នុងតំបន់គំរោងសំរាប់ប្រជាជនដែលរស់នៅខាងក្រោមខ្សែទឹក (down stream) ប្រើប្រាស់ ។
- ធានាកុំឱ្យមានការជន់លិចភូមិករ ផ្លូវ ផ្សារជំរំ និងដីស្រែប្រជាពលរដ្ឋ ។
- បង្កើតលទ្ធភាពនៃការចិញ្ចឹមត្រីរបស់ប្រជាកសិករ ពពួកសត្វស្លាប និងសត្វល្មូន ក្នុងការពិចារណាមើលប្រភពទឹកមានការចាំបាច់ ។
- ធ្វើយ៉ាងណាឱ្យមានសមធម៌ និងមានប្រសិទ្ធភាព ដើម្បីកាត់បន្ថយការខ្វះខាតទឹកប្រព័ន្ធស្រោចស្រព ដោយគ្រោះទឹកជំនន់ ។

ជារួម ភាគីម្ចាស់គំរោងត្រូវធានា ឱ្យបាននូវនិរន្តរភាពបរិស្ថានទាំងសង្គម និងធម្មជាតិ ។

សេចក្តីដូចបានជំរាបជូនខាងលើ សូមឯកឧត្តមមេត្តាជ្រាបជាពត៌មាន ។

សូមឯកឧត្តមទទួលនូវការគោរពរាប់អានដ៏ស្មោះអំពីខ្ញុំ ។

ម៉ុក មារ៉េត

ចំលងជូន

- អគ្គនាយកដ្ឋានបច្ចេកទេស
- ឯកសារ

លេខ ៤៨ ផ្លូវ ព្រះសីហនុ ... ភ្នំពេញ ... ទូរសារ ៨៥៥ 23 427844

Appendix 4 Budget Application of MOWRAM to the Ministry of Economy and Finance for construction of secondary and tertiary canals

ព្រះរាជាណាចក្រកម្ពុជា

ជាតិ សាសនា ព្រះមហាក្សត្រ

ក្រសួងធនធានទឹក និងឧតុនិយម

លេខ 094 ធទឧ

រាជធានីភ្នំពេញ ថ្ងៃទី 16 ខែ 01 ឆ្នាំ ២០០3

រដ្ឋមន្ត្រីក្រសួងធនធានទឹក និងឧតុនិយម

សូមគោរពជូន

ឯកឧត្តមទេសរដ្ឋមន្ត្រី រដ្ឋមន្ត្រីក្រសួងសេដ្ឋកិច្ច និងហិរញ្ញវត្ថុ

កម្មវត្ថុ: សំណើសុំថវិកាបដិភាគចំនួន ៧៦៧.៤៩៥.00 ដុល្លាអាមេរិក (ប្រាំពីររយហុកសិបប្រាំពីរពាន់បួនរយកៅសិបប្រាំដុល្លាអាមេរិកសំរាប់ស្ថាបនាប្រព័ន្ធស្រោចស្រពកណ្ដាលស្ទឹង ស្ថិតក្នុងស្រុកកណ្ដាលស្ទឹង ខេត្តកណ្ដាល

យោង: Minutes of Discussions on the Basic Design Study on the Project for Rehabilitation of Kandal Stung Irrigation System in the Kingdom of Cambodia dated on15th November,2002

ជូនភ្ជាប់: Kandal Stung Irrigation Project in Kandal Province

សេចក្ដីដូចមានចែងក្នុងកម្មវត្ថុ យោង និងភ្ជាប់ខាងលើនេះ ខ្ញុំសូមជំរាបជូនឯកឧត្តមទេសរដ្ឋមន្ត្រីមេត្តាជ្រាបថា រដ្ឋាភិបាលនៃប្រទេសជប៉ុនបានសន្យាផ្ដល់ហិរញ្ញប្បទានសំរាប់សិក្សាគ្រោងប្លង់ និងសាងសង់ប្រឡាយមេ ក្នុងប្រព័ន្ធស្រោចស្រព កណ្ដាលស្ទឹងស្ថិតក្នុងស្រុកកណ្ដាលស្ទឹងខេត្តកណ្ដាល ។ចំណែកឯប្រព័ន្ធស្រោចស្រពជាបន្ទុករបស់រាជរដ្ឋាភិបាលកម្ពុជា ។ គំរោងការ នេះនៅពេលស្ថាបនារួចវានឹងអាចអាចកាត់បន្ថយជំនន់ស្ទឹងព្រែកត្នោត ធានាដល់ការងារស្រោចស្រពស្រូវវស្សាចំនួន១៩៥០ហ.ត និងស្រោចស្រពស្រូវប្រាំងចំនួន ៣០០ហ.ត ដែលទិន្នផលស្រូវអាចនឹងកើនឡើងដល់ ៣.៥តោន/ហត ផ្គត់ផ្គង់ត្រីសំរាប់ប្រជាជន បរិភោគនិងជាផ្លូវគមនាគមន៍ផង ដែលជាកត្តារួមចំណែកយ៉ាងធំធេង ក្នុងការកាត់បន្ថយភាពក្រីក្ររបស់ប្រជាជននៅតំបន់ខាង លើ ចំនួន២៨០០ គ្រួសារដែលរស់នៅក្នុងឃុំចំនួន ៧ ក្នុងស្រុកកណ្ដាលស្ទឹង ខេត្តកណ្ដាល ។

អាស្រ័យហេតុនេះ សូមឯកឧត្តមទេសរដ្ឋមន្ត្រីមេត្តាពិនិត្យនិងសំរេចតាមការគួរ ។

សូមឯកឧត្តមទេសរដ្ឋមន្ត្រីមេត្តាទទួលនូវការគោរពដ៏ខ្ពង់ខ្ពស់អំពីខ្ញុំ ។

ចំលងជូន

- អង្គការ JICA
- អង្គភាព PMO
- "ដើម្បីមុខការ"
- ឯកសារ-កាលប្បវត្តិ

រដ្ឋមន្ត្រី

លឹម គានហោ

លេខ ៤៧ មហាវិថី ព្រះនរោត្តម រាជធានីភ្នំពេញ ទូរស័ព្ទ/ទូរសារលេខ : (៨៥៥) ២៣.៤២៦ ៣៤៥ / (៨៥៥) ២៣.៧២៥ ៩៨៩

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