



# Technical Assistance Consultant's Report

---

Project Number: TA 4848  
March 2008

## Cambodia: Preparing the Water Resources Management (Sector) Project (Cofinanced by the Government of France)

Prepared by  
TEAM Consulting Engineering and Management Co., Ltd  
S.D.C. Consulting Co., Ltd.

For Ministry of Water Resources and Meteorology, Royal Government of Cambodia

This consultant's report does not necessarily reflect the views of ADB or the Government concerned, and ADB and the Government cannot be held liable for its contents. All the views expressed herein may not be incorporated into the proposed project's design.

Asian Development Bank

(revised version)

## **Final Report**

---

**Cambodia: T.A. No. 4848: Water Resources Management (Sector) Project**

Prepared by:  
TEAM Consulting Engineering and Management Co. Ltd.  
S.D.C. Consulting Co. Ltd.

March 2008

**CURRENCY EQUIVALENTS**

(as of 30 October 2007)

Currency Unit – riel (KR)

KR1.00	=	US\$ 0.00024
US\$1.00	=	4,072 KR

**ABBREVIATIONS**

ADB	Asian Development Bank
AFD	Agence Française de Développement
DFW	Department of Forestry and Wildlife
DF	Department of Fisheries
FR	Final Report
EA	Executing Agency
EARP	Environmental Assessment and Review Procedures
EIA	Environmental Impact Assessment
EME	Environmental Monitoring and Evaluation
EMF	Environmental Management Framework
EMP	Environmental Management Plan
EMU	Environmental Management Unit
FWUC	Farmer Water User Community
IA	Implementing Agency
IEE	Initial Environmental Examination
IMT	Irrigation Management Transfer
IRC	Inter-ministerial Resettlement Committee
ISF	Irrigation Service Fee
MAFF	Ministry of Agriculture, Forestry and Fisheries
MEF	Ministry of Economy and Finance
MOWRAM	Ministry of Water Resources and Meteorology
MLMUPC	Ministry of Land Management, Urban Planning and Construction
MOE	Ministry of the Environment
NSDP	National Strategic Development Plan
NWISP	Northwest Irrigation Sector Project
OFID	OPEC Fund for International Development
O&M	Operation and Maintenance
PDAFF	Provincial Department of Agriculture, Forestry and Fisheries
PDE	Provincial Department of Environment
PDLMUPC	Provincial Department of Land Management, Urban Planning and Construction
PDWRAM	Provincial Departments of MOWRAM
PIMD	Participatory Irrigation Management and Development
PIU	Project Implementation Unit
PMO	Project Management Office
PPCC	Provincial Project Coordination Committee
PPME	Project Performance Monitoring and Evaluation
PPMS	Project Performance Management System
PRWG	Provincial Resettlement Working Group
RF	Resettlement Framework
RP	Resettlement Plan
SAW	Strategy for Agriculture and Water 2006-2010
SFFSN	Strategic Framework for Food Security and Nutrition in Cambodia 2007-2010
TSB	Tonle Sap Basin

## CONTENTS

I.	INTRODUCTION	1
II.	RATIONALE: SECTOR PERFORMANCE, PROBLEMS, AND OPPORTUNITIES	1
	A. Sector Performance Indicators and Analysis	1
	B. Analysis of Key Problems and Opportunities	3
III.	THE PROPOSED PROJECT	6
	A. Objective	6
	B. Impact and Outcome	7
	C. Component and Output	8
	D. Special Features	10
	E. Project Investment Plan	10
	F. Financing Plan	11
	G. Implementation Arrangements	13
IV.	PROJECT BENEFIT, IMPACT AND RISK	21
	A. Financial and Economic Benefits	21
	B. Social Benefit and Impact	22
	C. Environmental Impacts and Measures	23
	D. Risks Assessment	24
V.	CONCLUSION AND RECOMMENDATION	25

## APPENDIXES

1	Poverty and Vulnerability Map in Cambodia
2	Performance Indicators of Water Sector in Cambodia
3	External Assistance to Irrigated Agriculture
4	Cause–Effect Analysis
5	Project Design Framework
6	Development of Irrigation Infrastructure Component
7	Irrigated Agriculture and Livelihood support component
8	FWUC Development Component
9	Detailed Cost Breakdown
10	Detailed Breakdown of O&M Expenses
11	Project Schedule
12	Detailed Breakdown of Financing Plan
13	Institutional Arrangement
14-1	Short Resettlement Plan for O Mean Sub-project
14-2	Full Resettlement Plan for O Touk Subproject
14-3	Short Resettlement Plan for Spean Sraeng-Trapeang Ambel Subproject
15	Proposed Contract Packaging
16	Summary of Economic and Financial Analyses
17	Gender Action Plan

## SUPPLEMENTARY APPENDIXES

A-1	Water Sector Analysis
A-2	Agricultural Sector Overview and Linkages
B	Salient Information on Tonle Sap Basin
C	Relevant Lessons Learned
D	Institutional Analysis
E-1	FWUC Development: Strengthening the FWUC at O Mean
E-2	FWUC Development: Strengthening the FWUC at O Touk
E-3	FWUC Development: Strengthening the FWUC at Spean Sraeng–Trapeang Ambel
F	Detailed Cost Estimates
G	Selection Criteria and Eligible Subprojects
H	Environmental Assessment and Review Procedures
I	Resettlement Framework
J	Detailed Terms of Reference for Consulting Services
K	Poverty Reduction and Social Development Strategy
L	Participatory Rural Appraisal and Household Survey Methodologies
M-1	Summary Initial Environmental Examination for O Mean Subproject
M-2	Summary Initial Environmental Examination for O Touk Sub-Project
M-3	Summary Initial Environmental Examination for Spean Sraeng–Trapeang Ambel Sub-Project (Stung Sreng Sub-Basin)

## LIST OF TABLES

Table 1:	Project Investment Cost Estimates	11
Table 2:	Estimates of O&M Expenses	11
Table 3:	Financing Plan	12
Table 4:	Major Contract Packages and Financing Sources	17
Table 5:	Annual Disbursement Plan for Each Financial Source	18

## LIST OF FIGURE

Figure 1	Map of Tonle Sap Basin	2
Figure 2	Location Map of the Four Sub-basins	7

## I. INTRODUCTION

1. This document is the Final Report (FR) of the comprehensive study conducted by the Consultant<sup>1</sup> under TA No.4848-CAM: Water Resources Management (Sector) Project financed by the Asian Development Bank (ADB). As stated in the terms of reference for the TA, the TA will prepare a feasibility study for a proposed sector investment project to (i) rehabilitate small and medium-scale irrigation infrastructures, (ii) transfer facilities to farmer water user communities (FWUCs) through participatory irrigation management and development (PIMD) and (iii), improve agricultural extension services in selected provinces of the Tonle Sap Basin (TSB). The TA commenced on 12 March 2007 and subsequently, the following key reports have been prepared and submitted to ADB: (i) Inception Report submitted on 26 March 2007; (ii) First Progress Report submitted on 11 May 2007; (iii) Second Progress Report submitted on 15 August 2007; (iv) Feasibility Study Report of the O Touk Subproject submitted on 20 August 2007; (v) Feasibility Study Report of the O Mean Subproject submitted on 20 August 2007, and (vi) Feasibility Study Report of the Spean Sraeng-Trapeang Ambel Subproject submitted on 24 August 2007. These reports are the foundation on which this FR was generated. However, the FR has also incorporated views and advices of the officers concerned of ADB, Agence Development Francaise (AFD) and various government agencies, particularly the Ministry of Water Resources and Meteorology (MOWRAM) and Ministry of Agriculture, Forestry and Fisheries (MAFF). In addition, relevant information and knowledge available after submitting the three feasibility study reports have been taken into consideration.

2. In essence, the FR presents a Water Resources Management Sector Project (the Project) to be considered for financing jointly by ADB and OPEC Fund for International Development (OFID) on a sector lending basis, and by AFD on a grant basis. The project design follows ADB's policies and practices on sector lending, environmental and social safeguard, various implementation arrangements relevant to sector loan projects, and lessons learned from the implementation of completed and on-going projects in the water and irrigation sector. The project scope and content are in line with those described in para. 1 and 17 of the TOR of TA. To facilitate the processing of the proposed Project and a sector loan by ADB, the structure of FR has followed, to the possible fullest extent, the outline of ADB's Report and Recommendation of the President (RRP). To keep the main text of the FR concise, detailed analyses and reports are presented as appendices, both appendices attached to the FR and supplementary appendices presented as separate documents.

## II. RATIONALE: SECTOR PERFORMANCE, PROBLEMS, AND OPPORTUNITIES<sup>2</sup>

### A. Sector Performance Indicators and Analysis

3. The importance of water sector in economic development of Cambodia is clearly indicated by the contribution of agriculture to the national gross domestic product (GDP). In 2004, agriculture contributed 32.9% of the total GDP at current price, industry 29.2% and services 37.9%.<sup>3</sup> The water sector is also important to social development of the country, as about 82% of the Cambodian population (2005 figure) live in rural areas and most of them depend on agriculture. Consequently, the Royal Government of Cambodia (RGC/the Government) emphasizes efficient water resources management, especially irrigation and agricultural development which are core strategies for reducing rural poverty and enhancing

---

<sup>1</sup> The Consultant consists of TEAM Consulting Engineering and Management Co., Ltd. of Thailand, (TEAM) and S.D.C. Consulting Co., Ltd. of Cambodia (SDC).

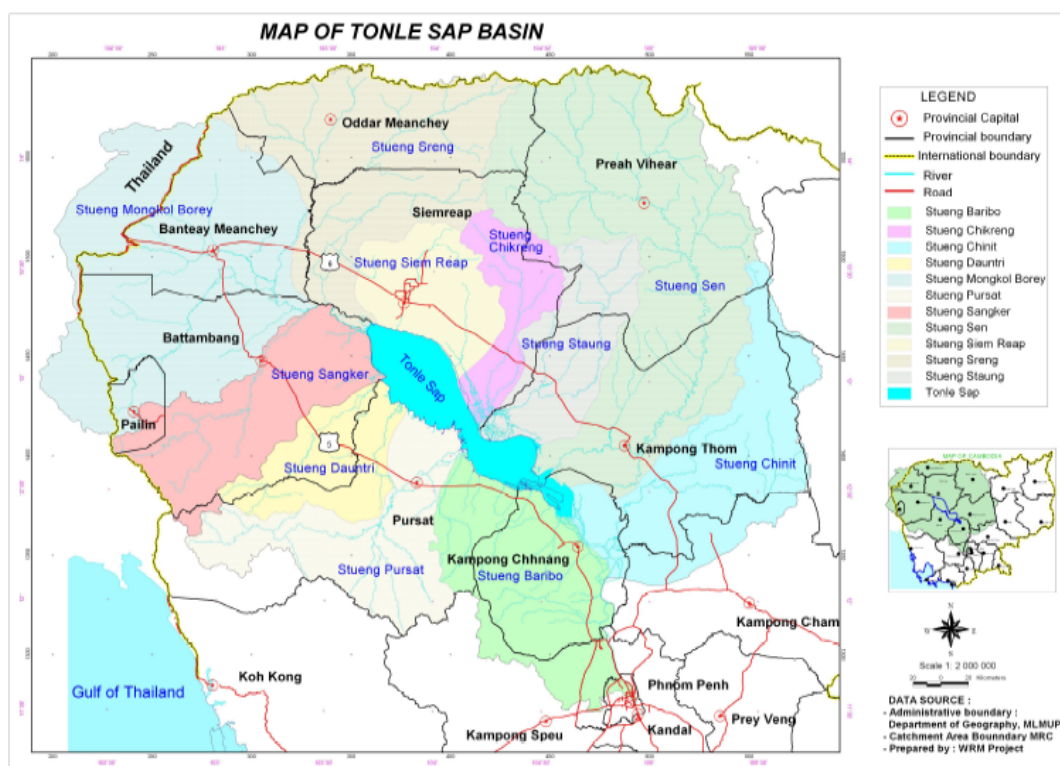
<sup>2</sup> Most of the information discussed in this Chapter are drawn from **Supplementary Appendix A-1: Water Sector Analysis** and **Supplementary Appendix A-2: Agricultural Sector Overview and Linkages**.

<sup>3</sup> ADB's Key Indicators of Developing Asian and Pacific Countries-2006.

food security: the two development problems high in the national development agenda.<sup>4</sup> Despite impressive economic performance over the past five years, poverty level in Cambodia is still high, about 34.7% of the population in 2004, particularly in rural areas which account for 90% of the poor.

4. Cambodia is richly endowed with water resources as indicated by a gross water volume of nearly 50,000 cubic meters per person per year. Its major freshwater resources are in the TSB which covers an area of about 82,000 square kilometers (km<sup>2</sup>), including the Tonle Sap Lake (see Figure 1: Map of Tonle Sap Basin). This area accounts for about 45% of the total area of Cambodia of 181,040 km<sup>2</sup>.<sup>5</sup> The TSB is comprised of 11 river basins (RBs), namely, Stung (St.)<sup>6</sup> Boribo, St. Chikreng, St. Chinit, St. Dauntri, St. Mongkol Borei, St. Pursat, St. Sangkar, St. Sen, St. Siem Reap, St. Sreng and St. Staung.<sup>7</sup>

**Figure 1 Map of Tonle Sap Basin**



5. Despite its rich water resources endowment, floods and droughts are common in Cambodia, particularly in the TSB, due to high variability in rainfall, uncertain duration of the dry seasons and sporadic drought spells during the wet season. Priority areas for flood interventions and for drought interventions were defined by the joint effort made by the Ministry of Planning, Education, Youth and Sports, the National Committee for Disaster Management and the United Nations World Food Programme under the project "Poverty and Vulnerability Analysis Mapping in Cambodia", from October 2002 to March 2003 (see Appendix 1). Most priority areas are in the TSB and they are high in poverty and food insecurity incidents.

<sup>4</sup> Strategic Framework for Food Security and Nutrition in Cambodia 2007-2010 (SFSN)

<sup>5</sup> CIA World Fact Book, April 17, 2007.

<sup>6</sup> Stung is Khmer language and means "river".

<sup>7</sup> Salient information on TSB and its 11 RBs are given in **Supplementary Appendix B**.

6. Management of water sector in Cambodia is still in an early stage of development. Sector performance indicators have not yet been established specifically for monitoring and evaluation of the performance of the water sector and sub-sectors, particularly the irrigation sub-sector. The National Strategic Development Plan 2006-2010 (NSDP) and ADB's Country Strategy and Program 2005-2009 have establish broad performance indicators, both output and outcome indicators, for the water and agriculture sectors. The indicators applicable to the water sector include (i) area under irrigation, (ii) economic losses from floods and droughts, (iii) sustainability of irrigation schemes, (iv) progress in the development of policy and institutional framework, and (v) progress in the development of information management system. The status of these indicators is given in Appendix 2. It will be essential to develop additional indicators for the water sector and its sub-sectors and the information system to support quantification of the indicators.

## **B. Analysis of Key Problems and Opportunities**

### **1. Water Sector Development Policies and Strategies**

7. At the sector level, water resources development in Cambodia is guided by the following key national policies and strategies.

- (i) **NSDP:** NSDP covers, among others, Rectangular Strategy, the National Water Resources Policy and in particular, the Strategic Development Plan of MOWRAM which reflects its emphasis on feasible investment in irrigation.
- (ii) **Rectangular Strategy:** The Rectangular Strategy promotes the development of agricultural sector to alleviate rural poverty and food insecurity.
- (iii) **Strategy for Agriculture and Water (SAW) 2006-2010:** SAW sets a long term development goal of the Water Resources, Irrigation and Land Management Program as "sustainable and pro-poor management of water resources, water management facilities, water related hazards and land resources that is integrated, efficient, and carried out in a river basin context." This goal will be realized through (a) institutional capacity building and management support program for agriculture and water sector, (b) food security support program, (c) agriculture and agri-business (value chain) support program, (d) water resources, irrigation and land management program, and (e) agricultural and water resources research, education and extension program.
- (iv) **National Irrigation and Drainage Strategy:** This strategy supports the joint formulation of multi-stakeholder river basin plans with Ministry of Agriculture, Forestry and Fisheries (MAFF), Ministry of Rural Development (MRD) and Ministry of Environment (MOE).

8. In addition to these broad policies and strategies, ADB also assisted the Government to formulate the Tonle Sap Basin Initiative in 2001 and the Tonle Sap Basin Strategy in 2003. The TSB Initiative and TSB Strategy focus on two core areas: rural development and the environment and human development in consistent with ADB's water policy and a worldwide trend towards managing land, water and biotic resources within a framework of basin units.

### **2. Institutional Arrangements for Water Resource Management**

9. At the policy level, MOWRAM is the principal agency for water resources management. However, as water and agriculture are related, MAFF is MOWRAM's strategic partner. At the implementation level, authorities are being delegated to provincial, district and commune levels in line with the Government's policy on deconcentration and decentralization. For irrigation use of water, MOWRAM adopts the participatory irrigation management and development (PIMD) and irrigation management transfer (IMT) through farmer water user communities (FWUCs) as



the tool for achieving the decentralization of responsibility for operation and maintenance (O&M) of irrigation facilities to the users. This arrangement is prescribed in the Water Law adopted by the National Assembly on 22 May 2007. A number of sub-decrees have been drafted and will be preceded to inter-ministerial meetings for comments and discussion prior to submitting to the Council of Ministers for approval. Circulars and declarations have been prepared and enforced for the purpose of proper management, operation and maintenance of irrigation systems.

### 3. Sector Problems and Issues

10. The following sector problems and issues could adversely affect the sector performance and thus, they need to be adequately addressed.

- (i) **Hydrological Station Network:** At present, the hydrological station network in Cambodia is still inadequate to provide basic data for technical planning.
- (ii) **Sector Management Information System:** An integrated management information system would be required to enhance efficiency and effectiveness of MOWRAM in water resources management.
- (iii) **Institutional Capacity of MOWRAM and PDWRAM:** Institutional Capacity of MOWRAM is hampered by inadequate number of qualified and experienced personnel. This is partly caused by the driven out of most professionals by the civil war and by the low level of official remuneration of government officials. Inadequate number of relevant specialists is a problem of both the Project Management Office (PMO, at MOWRAM)<sup>8</sup> and PDWRAMs (provincial offices of MOWRAM).
- (iv) **Sustainability of Irrigation Systems:** The sustainability of irrigation systems is currently threatened by inadequate capacity of FWUCs, their support organizations and financial support for O&M from MOWRAM to the FWUCs. The FWUCs would need financial support at least in the initial years before irrigation service fee (ISF) could be fully collected to meet the O&M expenses.
- (v) **Efficiency and Effectiveness of Water Use in Agriculture:** The Strategy for Agriculture and Water 2006-2010 identified some key issues that are relevant to the efficiency and effectiveness of water use in agriculture, including (i) relative importance of large, medium, and small households water management systems, (ii) relative importance of rice and other crops, (iii) relative importance of irrigable vs. rain-fed crop lands, and (iv) overlapping and unclear stakeholder responsibilities.
- (vi) **Investment Level:** The investment in the water sector development in Cambodia is still low compared to neighboring countries.
- (vii) **Watershed Conditions:** The TSB watershed is deteriorating as indicated by decreasing forest cover, soil erosion and flood magnitudes.
- (viii) **External Assistance:** To effectively reduce the impacts of droughts and enhance the effectiveness of irrigation schemes, large scale investment in storage reservoirs at **strategic** locations in the various river basins will be needed. At present, aid agencies still give low priority to large-scale investment (see **Appendix 3**).

### 4. Relevance of the Project to Government's and ADB's Strategies

11. The Project is directly relevant to the SAW and the Strategic Framework for Food Security and Nutrition in Cambodia 2007-2010 (SFFSN). It will implement the fourth

<sup>8</sup> As of October 2007, it was noted that this PMO could undergo another organizational change with expanded scope of work, etc., becoming the "National Project Management Office (NPMO)". It was felt however that in addition to the question of standard operational procedures, the new organization could continue to face this same problem of inadequate competency in several fields.

component of SAW: “water resources, irrigation management and land program” and the first objective of SFFSN: Food-insecure households increase food availability from their own agriculture and livestock production and from common property forests and fisheries”. This objective of the SFFN has four areas of focus, one of which is “management of water resources and irrigation”. The Project is consistent with ADB’s Country Strategy and Program 2005-2009 that aims at assisting the Government to achieve sustainable poverty reduction through broad-based economic growth, inclusive of social development and good governance. In particular, ADB’s Country Strategy and Program 2005-2009 advocates ADB’s leading role in agriculture and water resources development. The Project will continue ADB’s effort in the development of TSB made under a number of loans and technical assistance which are in line with ADB’s water policy.

## 5. Lessons Learned

12. The Consultant reviewed performance of a number of past and on-going projects implemented by MOWRAM. Information in other documents yields also many relevant lessons and valuable experiences.<sup>9</sup> The following key lessons have been duly considered in the project design:

- (i) **Institutional Capacity of PMO and PDWRAM:** Project management capacity of both PMO and PIUs under PDWRAM is constrained by inadequate number of personnel relative to the number of projects they are handling and will handle in the near future. Remuneration based on civil servant system neither encourages self-development of staff nor attract qualified and experienced personnel. In addition, the project management system and procedures at the project and subproject levels are still not efficient and effective.<sup>10</sup> Therefore, the Project will need to provide consultants to fill the capacity gaps of both PMO and PIUs and concurrently to develop capacity of both entities.
- (ii) **Additional Works after Subproject Completion:** The completed irrigation facilities in most cases need some additional works to ensure effective water distribution. Examples of these additional works include extension of tertiary canals, farm turnouts and check structures. These additional works are minor but, usually necessitated by some unforeseen factors in the design and inaccurate topographic data. Their costs should be included in the Project expense. Inadequate performance of the irrigation systems will also reduce incentive for the beneficiaries to pay the irrigation service fee.
- (iii) **Farmer Water User Community (FWUC):** The Consultant undertook a research of three case studies<sup>11</sup> and a review of secondary information on the subject. The findings and lessons learned clearly establish the importance of FWUC in helping sustain the irrigation schemes to be constructed under the Project. Therefore, the formulated Project will single out the establishment of efficient and effective FWUC as one project component and will provide adequate inputs and supports to ensure that the FWUC will be able to adequately function. The FWUC will be established as early as possible after a subproject has been proved feasible and endorsed for the construction, to enable the local farmers to participate in all stages of the subproject formulation and implementation. After transferring part of the irrigation schemes to FWUCs, it is desirable that MOWRAM should continue providing

<sup>9</sup> A detailed analysis of the relevant lessons learned is presented separately in **Supplementary Appendix C: Relevant Lessons Learned**.

<sup>10</sup> See **Supplementary Appendix D: Institutional Analysis**.

<sup>11</sup> They were FWUCs/WUGs at Prey Nup, Kap Sesh and Kamping Pouei projects. Details are provided in **Supplementary Appendix E: FWUC Development**

- support and close monitoring of the FWUCs, to ensure adequate time for the development of their capacities.
- (iv) The FWUCs will have to be born out of the consensus of the communities to take part in local resources management. Therefore, the establishment of an FWUC requires considerable efforts in community organization and training of the established FWUC. This type of work should be entrusted to local consultants or NGOs with extensive experience in community developments in Cambodia.
  - (v) **Land Titling:** The Project will include land holding surveys and resolution of the issue of land titles. The security of land ownership will provide incentives to farmers to manage and use an irrigation system more efficiently, and also minimize disputes between the water users and the Boards of FWUC.
  - (vi) **Land Acquisition and Resettlement:** Land acquisition and resettlement under this Project will be very small in magnitude as the subprojects will be small and, focus basically on rehabilitation of existing facilities. Nevertheless, the Project will accord importance to this aspect as any conflicts, although small, could interrupt the implementation. The land acquisition and resettlement framework has been proposed for use during subproject formulation and implementation. It is necessary to identify and formulate an action plan for land acquisition and resettlement as early as possible. The action plan will have to be implemented in close consultations with the Resettlement Unit under PMO. Activities under this subject should also be carried out in collaborations with the Resettlement Unit under the Ministry of Economy and Finance (MEF). The efficiency and effectiveness in handling the land acquisition and resettlement should be one of the project performance indicators.
  - (vii) **Community Organization for Subproject Implementation:** Implementation of each subproject should involve existing community organizations as much as possible. In every commune, the commune council is the key organization that is usually very active and responsive to external development initiatives. Members of the commune councils in the core subprojects have shown their keen and active interest in the proposed Project. They have clearly shown their collective leadership in voicing their opinion and, expressed their readiness to participate in the Project through development discussions and meetings. Therefore, in formulating the selected subprojects, community should be organized and its leaders should be identified as early as possible. The leaders will need to be involved both in subproject formulation and implementation. Their participation is especially crucial in organizing and activating FWUCs and in designing agricultural extension and supports that are appropriate to the people and practically effective.

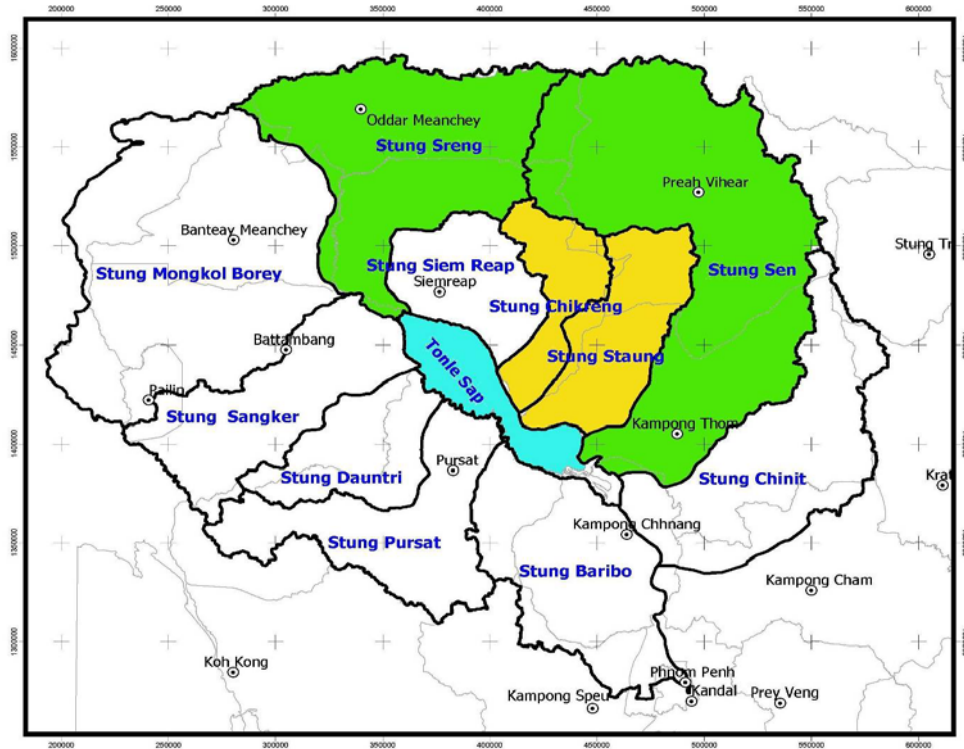
### III. THE PROPOSED PROJECT

#### A. Objective

13. The overall objective of the Project is to support the government's effort to reduce poverty and food insecurity of about 20,000 families in about 27 areas in four selected sub-basins of the TSB, namely, St. Sreng, St. Staung, St. Chikreng and St. Sen (see Figure 2: Map of the 4 RBs). The Project will achieve its overall objective through rehabilitating small to medium sized irrigation schemes to provide irrigation up to 20,000 ha of rice field areas. The four selected sub-basins are located in Siem Reap, Kampong Thom and Banteay Meanchay

provinces. Except Kampong Thom, the remaining provinces are also covered under the Northwest Irrigation Sector Project.<sup>12</sup> These sub-basins have the following common features:

**Figure 2 Location Map of the Four Sub-basins**



- Low land drained by tributary rivers of TSB;
- Significantly different rain falls and river flows during the wet and dry seasons;
- Not irrigated although some catchments have irrigation systems but they are severely damaged and not operational;
- Rice is the main crop during the wet season with very limited cultivation during the dry season;
- High poverty levels exceeding the national average of 34% (2004 figure); and
- Served by poor roads and public infrastructures.

## **B. Impact and Outcome**

14. The Project was formulated as a sector project consisting of about 27 subprojects, each covering a well-defined catchment area within the relevant sub-basin. As such, it is designed to bring about physical and institutional improvements at both the project area and the sector levels. At the project area level, it will improve irrigation water supply and crop production in each subproject area. In addition, it will improve the efficiency and effectiveness of existing or new FWUCs to be established under the Project. At the sector level, the Project will help improve institutional capacity of MOWRAM and PDWRAM. The Project will also involve the Provincial Department of Agriculture, Forestry and Fishery

<sup>12</sup> ADB Loan No. 2035-CAM: Northwest Irrigation Sector Project, approved in November 2003, also financed jointly by ADB (loan amount \$18 million equivalent and AFD grant No. CHK 3003.01 of \$3.74 million equivalent).

(PDAFF) in providing the agricultural extension and supports to the subproject areas, and the Provincial Department of Land Management, Urban Planning and Construction (PDLMUPC) for land titling.

15. The ultimate project outcomes will be poverty reduction and food security in the subproject areas, sustainability of the irrigation facilities provided under the Project and more effective management of the water sector. Intermediate outcomes will be enhanced agricultural productivity and production to be realized through (i) improved irrigation and agricultural supports and extension, and (ii) increased capacity of MOWRAM, PDWRAM and PDAFF to be realized through a custom-designed capacity building program and supports. At the farm level, tangible project outcomes will be efficient and effective on-farm management of irrigation water, improved soil and agricultural inputs for agricultural production. At the community level, the project outcome will be evident in the form of effective O&M of the irrigation facilities by the FWUCs being strengthened or established under the Project.

### **C. Component and Output**

16. To realize the expected project outcomes and impacts and to facilitate project implementation management the Project is divided into four components, namely: (i) development of irrigation facilities, (ii) agricultural development and livelihood support, including incremental agricultural extension, land titling, etc., (iii) establishment and development of FWUCs, and (iv) capacity building for efficient project management.

17. The project design is based on a cause-effect analysis of the development problems that the Project is initiated to address. A diagram of the cause-effect analysis to identify project interventions is given in Appendix 4. A logical framework summarizing project design and monitoring is presented in Appendix 5.

18. Description of each component is outlined below.

#### **1. Development of Irrigation Infrastructure**

19. This project component will rehabilitate existing irrigation facilities and/or construct new irrigation facilities in the selected subproject areas. Key tasks being carried out under this component include (i) selection of priority subproject areas within the four sub-basins, (ii) surveys and feasibility studies to formulate each selected subproject, (iii) appraisal of the proposed subprojects based on results of the feasibility studies, (iv) preparation of detailed engineering designs of irrigation facilities and tender documents for each approved subproject, (v) preparation of an implementation plan for each approved subproject, (vi) construction bidding, (vii) construction of the facilities by the selected contractors and construction supervision by the supervision consultants engaged by the implementing agencies, and (viii) commissioning and refinement of the operations of the completed irrigation facilities. An elaborated description of this component is given in **Appendix 6**.

#### **2. Irrigated Agriculture and Livelihood Support**

20. This project component will ensure that the investment in rehabilitation of irrigation infrastructure is properly translated into increased agricultural production through improved agricultural productivity, crop diversification, and farming systems. Land titling is also included under this component. Rice will remain the principal crop in the project area, and food security is the main goal of this component. The Project will encourage production of high value non-rice crops, livestock husbandry and fish culture. Key activities under this component include: (i) formation of a subproject agricultural stakeholders group; (ii) provision of incentive packages (seeds/seedlings and fertilizer) for seed improvement and tree planting programs; (iii) various extension methodologies, including formation of farmer

groups, on-farm demonstration and trials, identification and training of key farmers and study visits; and (iv) short technical courses on various topics to benefit the farmers, including rice production technology, seed multiplication, animal and fish husbandry, soil and water management, post-harvest. These agricultural development program and supports will be delivered under the framework of a 3-year service contract between the PIU and PDAFF, while agricultural specialists of the main Consultant (Irrigated Extension Team) will assist PDAFF staff with (i) on-site coordination and planning, (ii) training of trainers, and (iii) identification and contracting of NGO inputs.<sup>13</sup> Land tilting would be delivered under a service contract with the PDLMUCP. Appendix 7 presents details of this project component.

### 3. Establishment and Development of FWUC

21. This project component will provide supports to establish and/or develop an FWUC in each subproject area (see the proposal in Appendix 8.<sup>14</sup>) It will also provide supports to develop/strengthen institutional capacity of the newly established FWUCs and the existing FWUCs in all the subproject areas. Capacity building will cover (i) technical capacity in O&M of the irrigation facilities to be provided under the Project, (ii) management capacity to ensure that the FWUCs will be able to collect adequate revenue for O&M at the level to be agreed with MOWRAM, and (iii) technical capacity in on-farm water management and related planning and negotiation skills. As efficient and effective FWUCs are crucial to the sustainability of the irrigation systems to be constructed under the Project, the issue of FWUC development deserves to be a distinct project component.

### 4. Capacity Building for Efficient Project Management

22. This project component will provide supports to MOWRAM, PDWRAM and PDAFF to strengthen their capacity with the objective to expedite Project implementation and ensure effective Project management. The capacity building will cover (i) overall Project management including subproject selection and formulation (including feasibility studies), (ii) preparation of detailed design and tender documents of the subprojects proposed for implementation, (iii) community organization, establishment of FWUCs and capacity building of FWUCs, (iv) agricultural extensions and supports, and (v) implementation management of the subprojects. The provisions under this project component will include (i) international and national consultants to fill capacity gaps of MOWRAM, PDWRAM and PDAFF, and (ii) vehicles and office supplies.

23. As already mentioned, MOWRAM is relatively a new ministry but, has an extensive mandate over the development and management of water resources in the country. Its annual budget has also been rather limited although it has been receiving a large amount of assistance from various donor community and international funding agencies for implementing its projects and activities. Implementation of its development projects and selected policies progress slowly, due partly to the pending/lack of several sub-decrees to support the Water Law. In view of this, MOWRAM is in need of supports for both institutional strengthening and capacity building to enable it to cope effectively with the many challenging tasks ahead. For this purpose, a long-term international staff, an **Institutional** or a **Water Policy Advisor**, is proposed to be engaged and attached to MOWRAM for a minimum period of about three (3) years. MOWRAM should be able to screen and interview all the key candidates for this important advisory position. The selected Advisor is also expected to play an important role in enhancing the capacity of MOWRAM in coordinating and implementing the externally funded projects, including particularly the Project, in addition to providing MOWRAM with general advices and supports for policy dialogues, institutional strengthening, etc.

<sup>13</sup> Relevant experiences of both international and local NGOs should be important to the Project.

<sup>14</sup> More details on the FWUC development and lesson learned are given in the referenced **Supplementary Appendix E: FWUC Development**.

## D. Special Features

24. The Project as formulated has the following special features.

- (i) **Support of PIMD and IMT:** The Project will contribute to MOWRAM's effort in making further strides in the implementation of PIMD and IMT concepts and policies. In this regard, the Project will accord importance to the establishment and capacity building of FWUC. This task will require a social engineering approach in which people's awareness and sense of ownership will be created as a prerequisite for participation in the subprojects. The achievement will be closely monitored and evaluated.
- (ii) **Strengthening Capacity of PMO, PIU and PDAFF:** The Project appreciates capacity constraints of PMO, PIUs and PDAFF, and the need for development projects to move forward in parallel with the building up of capacities of these organizations. Based on the Consultant's experience, institutional capacity of public organizations in developing countries will increase gradually in tandem with economic growth in the "push and pull" manner. Therefore, the Project will provide consulting services not only to fill capacity gaps of the three organizations but also to help strengthen capacity of their staff as well as providing vehicles and equipment for efficient functioning of the organizations.
- (iii) **Irrigated Agriculture Development:** The Project recognizes the fact that irrigation alone does not always have impact on agricultural productivity and product. In this regard, irrigation water will need to be effectively utilized as an input to the development of agriculture at the household level. Soil improvement and conservation, new cultivation techniques, new agricultural opportunities and supports will have to be introduced. The household agricultural system will need to be planned aiming at both raising income from farm productions and increasing food production for family consumption. Therefore, both economic and livelihood aspects will be considered in agriculture development planning of each subproject.

## E. Project Investment Plan

### 1. Capital Cost

25. The project cost, inclusive of contingencies, taxes and duties and financing charge during construction, is estimated at US\$44.99 million equivalent, comprising of US\$17.97 million (39.94%) in foreign exchange and US\$27.02 million equivalent in local currency. A summary of the project investment cost is presented in Table 1 while more details are provided in **Appendix 9**.<sup>15</sup>

### 2. Operation and Maintenance Expenses

26. The O&M expenses of irrigation facilities under the Project were estimated for the 5-year period of project implementation during which a number of subprojects will be in operations. Shared responsibilities between MOWRAM and FWUCs on the O&M were also recommended, based on the pending full enforcement of sub-decrees on PIMD and IMT in Cambodia, see the details in Appendix 10.

27. It should be noted that the number of completed subprojects in operations will increase during the course of project implementation. Therefore, O&M expenses will already be incurred during the project implementation before loan closing and, increase as the Project moves toward completion. Based on the tentative project implementation schedule

<sup>15</sup> For the full details, see **Supplementary Appendix F: Detailed Cost Estimates**.

(see Appendix 11) and the contribution of loan proceeds on a declining basis,<sup>16</sup> total annual O&M expenses have been estimated and the figures can be summarized as in Table 2.

**Table 1: Project Investment Cost Estimates  
(US\$ million equivalent)**

	Item	Amount <sup>a</sup>
<b>A.</b>	<b>Base Cost<sup>b</sup></b>	
	Component 1: Development of Irrigation Infrastructure	26.63
	Component 2: Irrigated Agriculture and Livelihood Support	3.22
	Component 3: Establishment and Development of FWUC	2.84
	Component 4: Capacity Building for Efficient Project Management	5.44
	<b>Sub-total (A)</b>	<b>38.13</b>
<b>B.</b>	<b>Contingencies<sup>c</sup></b>	<b>5.76</b>
<b>C.</b>	<b>Financing Charges During Implementation<sup>d</sup></b>	<b>1.10</b>
	<b>Total (A+B+C)</b>	<b>44.99</b>

<sup>a</sup> Includes taxes and duties of US\$1.45 million.

<sup>b</sup> In constant price of mid-2007 price.

<sup>c</sup> Physical contingencies computed at 10% for civil works; and 5% for supplies and field research and development, training, surveys and studies. Price contingencies, computed at 2.4% per annum on both foreign exchange costs and local currency costs; include provision for potential exchange rate fluctuation under the assumption of a purchasing power parity exchange rate.

<sup>d</sup> Includes interest, commitment charges and front end fees. Interest during construction has been computed at the five-year forward London inter-bank offered rate plus a spread of 1.0%.

**Table 2: Estimates of O&M Expenses**

Year	No. of Sub-projects Completed	Estimated Annual O&M Expenses (US\$)	
		Total Cost	Of which: to be Covered by Loan Proceeds
2010	7/7	37,240	29,792
2011	11/18	159,120	119,848
2012	9/27	218,000	135,128
2013	0/27	218,000	91,528
2014	0/27	218,000	49,942

## **F. Financing Plan**

28. As shown also in Table 2, the Consultant proposes that the project financing should cover both capital investment and O&M expenses during project implementation till the loan account is closed. Financing of the O&M expenses should be justified as it would always

<sup>16</sup> The same modality as adopted for the implementation of NWISP.



take some years for the established FWUCs to fully function. Following some lessons learned from a successful case as well as an on-going project,<sup>17</sup> the proposed financing arrangements are sound in concept and should be adopted for this Project.

29. Based on consultations with the officers concerned of ADB and AFD, the Consultant further recommends a financing plan for the project investment, as summarized and shown in Table 3. A detailed breakdown of the financing plan is given in Appendix 12.

**Table 3: Financing Plan**

Source	Total (US\$ million)	Percent (%)
Asian Development Bank	17.54	38.99
Agence Francaise de Development	10.44	23.21
OFID <sup>a</sup>	10.00	22.22
Government	6.52	14.48
Beneficiaries	0.49	1.10
<b>Total</b>	<b>44.99</b>	<b>100.00</b>

a OPEC Funds for International Development

- (i) **ADB:** The ADB should provide a loan of US\$17.54 million equivalent from its Special Funds Resources, to finance about 39% of the total project costs. The loan will have a term of 32 years, including a grace period of 8 years, with an interest charge of 1% per annum during the grace period and 1.5% per annum thereafter.
- (ii) **AFD:** AFD should provide a grant of US\$10.44 million equivalent for parallel co-financing to cover the costs of the main Consultant, NGOs<sup>18</sup> and part of the trainings.
- (iii) **OFID:** The loan from OFID, the total amount of US\$10.00 million equivalent, will cover basically the cost of civil works.
- (iv) **Government:** The Government of Cambodia should finance part of the project investment cost amounting to US\$6.52 equivalent through budget appropriation to cover the local currency costs of counterpart officials, project offices and utilities, resettlement, part of the civil works and supplementary allowances for the project staff seconded by the Government.
- (v) **Beneficiaries:** The Beneficiaries should contribute part of O&M expense amounting to US\$0.49 million during the project period.

<sup>17</sup> The use of project fund to help finance part of the O&M at initial stage of development was proved helpful for the case of Prey Nup project. The NWISP, in line with the subsidy policy of MOWRAM, had arrangements to use the loan proceeds to finance the O&M expenses on a declining share basis over time, i.e., 100% of the O&M expenses for year 1 after completion of a subproject, 60% for year 2, 40% for year 3, 20% for year 4 and none thereafter. As of the reporting date, however, as there has been no subproject completed under the NWISP, it is not known whether MOWRAM and FWUCs could meet their financial contribution obligations on this matter.

<sup>18</sup> If appropriate, for both international and local NGOs.

## G. Implementation Arrangements

### 1. Implementation Period

30. Considering the time required for project appraisal and loan processing by ADB, it is expected that project implementation will commence in June 2008 and should be completed in about six (6) years in May 2014. The implementation schedule is given in the Appendix 11 duly referred to. It should be reviewed and updated quarterly during the course of project's implementation to reflect the latest developments regarding project financing and the implementation progress.

### 2. Organization for Project Management

31. There will be two levels of project implementation: the overall Project level and the subproject level. Organizations and functions at each level are different but inter-related. The Consultant has undertaken a review of organizational arrangements and management proposed under other on-going projects (especially, the NWISP) and found it applicable in many respects. Based also on some lessons learned, institutional arrangement for the present Project is proposed. Appendix 13 presents a diagram showing various organizations and parties involved and their relationships in the project's implementation and management. A matrix showing their respective functions are also given in the Appendix. However, the proposed organization for management at the Project and subproject levels is briefly described below.

32. **Project Level Organization:** The organization and management at this level will follow basically the established practices of the Government. The key body is the project steering committee (PSC) established in 2002. In the past, the PSC has been chaired by a representative from MEF (undersecretary of state level). However, the chairmanship is expected to be changed to the representative from MOWRAM. Others key members of PSC comprise of a national project coordinator from MOWRAM (undersecretary of state level) as the secretary and representatives (undersecretary of state or director levels) of MAFF, MOE and other concerned ministries. The PSC meets at least twice a year during which it effects inter-ministerial coordination and provides directives and guidance at the policy level to facilitate and expedite the implementation of all the externally-funded projects under MOWRAM.

33. MOWRAM will be the Executing Agency (EA), as it is the ministry with a mandate for planning and managing the use and conservation of water resources in the country. Specifically, the national project management office (PMO) within MOWRAM will manage the Project. The PMO is the transformed body of the FR which has been established since 2000, to manage all its externally funded projects of MOWRAM. Based on the results of institutional analysis of MOWRAM,<sup>19</sup> the Consultant proposes that the PMO appoints a project team of 3-4 staff (one of whom will be Deputy Project Manager) specifically for this Project. The Deputy Project Manager will assist the Project Manager (duly nominated by MOWRAM) who already has a number projects under his responsibility, in performing the overall and day-to-day management of the Project. Various technical and administrative support services will be provided by the existing units within the PMO and backed up by the main Consultant being engaged under the Project.

34. **Subproject Level Organization:** The organization and management at the subproject level will also have to follow the established practices of MOWRAM. PDWRAM in each province will be the implementing agency for the subprojects in the province through its project implementing unit (PIU). As the PIUs for the three project provinces exist, the existing

<sup>19</sup> The details are elaborated in the **Supplementary** Appendix D: Institutional Analysis.

PIUs are required to help manage the subprojects under this Project that fall in their provinces. Based on the results of the same institutional analysis, the Consultant proposes that an additional Deputy PIU Project Manager be appointed in each of the three PIUs specifically for this Project. As in the case of the PMO, the newly appointed Deputy PIU Project Managers will assist the respective PIU Project Managers in implementing the subprojects.

35. Similar to the central level arrangement, each province also has a functioning provincial project coordination committee (PPCC), under an umbrella of the existing ExCOM. The PPCC is chaired by a provincial deputy governor and comprising representatives (director level) of the provincial line departments directly concerned with the implementation of development projects of MOWRAM. The PPCC will be expected to play an important role in coordinating the work among different government offices in the same province. PDWRAM will be the key agency to link the PPCC with the Project by means of sharing the project information and seeking advice and assistance from PPCC.

### 3. Subproject Selection and Formulation

36. There will be a few steps involved when different agencies will be playing a different role as following.

- (i) **Subproject Selection.** Each PIU will select subprojects from the list of eligible subprojects based on the subproject selection criteria established under the Project.<sup>20</sup> The selected subprojects will be presented to PPCC/ExCOM for endorsement and necessary coordination before being submitted to PMO for approval.
- (ii) **Subproject Formulation and Appraisal.** The PMO will be responsible for conducting feasibility studies of the nominated and selected subprojects with assistance of consultants. The PMO will also evaluate and appraise the formulated subprojects, and prepare subproject proposals.
- (iii) **Approval for Subproject Funding.** The PMO will submit subproject proposals to MOWRAM for funding approval. For large subprojects or environmentally sensitive subprojects, approval from ADB and AFD would also be required subject to agreements between MOWRAM and ADB.

### 4. Environmental Impact Monitoring

37. Arrangements for environmental assessment of the selected subprojects and monitoring environmental performance of each subproject will follow both the national and ADB guidelines on the subject.<sup>21</sup>

38. At the Project level, the existing Environment Management Unit (EMU) in PMO will also be responsible for overseeing environmental aspect of the Project. The EMU is staffed by one environment specialist (seconded from the MOE) and one sociologist. The responsibilities of the EMU include (i) guiding and monitoring the preparation of initial environmental examination (IEE) required for each subproject at feasibility stage, (ii) timely submission of IEE reports to the concerned environmental agencies, ADB and AFD, for information or clearance<sup>22</sup> before detailed design and construction begin, (iii) ensuring that recommended environmental mitigation measures recommended in the IEE reports are incorporated into the design and civil work contracts and in subsequent operation of

<sup>20</sup> Details are given in Supplementary Appendix G: Selection Criteria and Eligible Subprojects.

<sup>21</sup> Similar to those being adopted into use by NWISP.

<sup>22</sup> In the case of **Category A** subprojects which require EIA.

subprojects, and (iv) ensuring that environmental monitoring is adequately reported in project review and progress reporting.

39. At the subproject level, each PIU has one environment specialist seconded from the Provincial Department of Environment (PDE). The environmental staff will (i) assist in preparing individual subproject IEE reports; (ii) ensure adoption of recommended mitigation measures during construction, (iii) monitor environmental performance of the subproject during construction and operation after subproject completion, and (iv) reporting the environmental monitoring results to the EMU.

40. The Consultant has prepared a draft environmental assessment and review procedures (EARP)<sup>23</sup> to be considered and used during project implementation.

41. Considering the work loads of environmental personnel at the project and subproject levels, they will need technical supports from consultants to be provided under the Project as part of the capacity building of the central and provincial environmental units.

## **5. Monitoring Resettlement and Land Planning**

42. The feasibility study of each selected subproject will identify (i) land that will have to be acquired for the construction and operation of subproject facilities and (ii) other negative social impacts caused by the subproject construction and/or operation that will have to be addressed. A land acquisition and resettlement action plan, in short a resettlement plan (RP), will have to be prepared as part of the subproject feasibility study and formulation for implementation. The RP for each subproject will follow a resettlement framework (RF) for the Project which will need approval of the Government and ADB. The Consultant has also prepared a draft RF to be considered for application in the project's implementation.<sup>24</sup>

43. Similar to environmental management, the conduct of land acquisition and resettlement under the Project will be managed at the project and subproject levels. At the project level, the existing resettlement unit of PMO will be responsible for (i) supervising the Provincial Resettlement Working Group (PRWG) in conducting landholding identification surveys, socioeconomic surveys, detailed measurements for identifying affected people and land adjustments/consolidations resolution process required for the RPs that will take place in conjunction with the feasibility study and subsequent detailed engineering design and (ii), preparing the RPs, and submitting them to the Inter-ministerial Resettlement Committee (IRC), ADB and AFD for endorsement and subsequent implementation through MEF.

44. At the subproject level, the staff in the PIU seconded from the Ministry of Land Management, Urban Planning and Construction (MLMUPC) will work in close collaborations with the PRWG to implement the RPs according to the procedures prescribed in the RF. Monitoring the implementation of the RPs should be entrusted to suitably qualified NGOs. It may be added that of the three core subproject areas, O Touk subproject requires a full resettlement plan (FRP) due to the member of affected people (APs) which exceeded 200 persons. For the remainders, only short resettlement plans (SRP) were prepared see a draft RP for each of the three core subprojects in Appendix 14.

## **6. Land Titling**

45. Under the Project, cadastral surveys will be carried out for identifying the existing farm plots for water allocation purpose. Result of the surveys will also facilitate the ease of irrigation service fee (ISF) collection by FWUC in each subproject area and importantly, the

<sup>23</sup> Details are given in Supplementary Appendix H: Environmental Assessment and Review Procedure. To ensure consistency, this document is adapted from the EARP for NWISP.

<sup>24</sup> Details are given separately in Supplementary Appendix I: Land Acquisition and Resettlement Framework.

government's policy on issuance of land titles.<sup>25</sup> It is expected further that the issued "land certificates" will facilitate the farmers in having a better access to credit facilities, etc. In each province, the PIU will contract the relevant PDLMUPC (as an IA) to undertake this task. The cost of land titling should be financed by the loan proceeds.

## 7. Contract Packaging and Procurement

46. To ensure efficient and cost effective procurement, construction, supply and consulting works to be procured under the Project, procurement should be arranged into a number of contract packages. Each contract package will consist of a number of contracts. The bidding could be for one or more contracts in the package as appropriate. Appendix 15 proposes "contract packages" with recommended "bidding procedures".

### a. Procurement

47. Procurement of contracts will follow principles and procedures of the financing source. Contracts to be financed from the ADB loan proceeds will follow the principles and procedures prescribed in ADB's *Guidelines for Procurement*. Considering the limited capacity of local contractors, international competitive bidding (ICB) procedures should be adopted for civil work contracts with estimated cost of more than US\$1,000,000 equivalent, and local competitive bidding (LCB) procedures for smaller civil work contracts with estimated cost below US\$1,000,000 equivalent. ICB will also be adopted for contracts for supply of vehicles, equipment and materials valued at more than US\$500,000 equivalent, and international shopping (IS) procedures for those valued US\$500,000 or less. Direct purchase arrangements should be applied for procuring small or off-the-shelf goods and materials valued at less than US\$100,000.

48. Procurement of large contracts will be centralized in the PMO. Major items of the procurements include civil works, construction of subproject infrastructures, provision of agricultural supports, including farm inputs and farmer trainings, cadastral surveys and land titling, vehicles and equipments. For procurement of civil works for subprojects smaller than 200 ha, they will be delegated to the PIUs. Procurement will include a number of packages, such as, civil works, agricultural supports and extension, cadastral surveys and land titling, supply of vehicles including cars and motorcycles, etc. The total amount of all the procurement, however, is estimated at US\$27.42 million equivalent.

### b. Consulting and Support Services

49. Consulting services should again be arranged into three (3) major contract packages: (i) main consulting services (the main Consultant); (ii) design and construction supervision services; and (iii) training and capacity building services. The scope of each contract package is outlined as follows.

- (i) **Main Consulting Services.** This contract package will cover categories of consulting services to be performed by the main Consultant including (i) project management support to PMO and PIUs, (ii) feasibility study of the remaining 24 subprojects to be selected from the list of eligible subprojects, and (iii), program design and arrangements for the various trainings, institutional strengthening and agricultural supports services required under the Project. These three categories of consulting services will be centralized in one single major contract to ensure that all the subprojects and other related development activities will be implemented under the same

<sup>25</sup> Issuing land titles to farmers is part of the NSDP 2006-2010, which has target to increase the number of land titles from the current 12% (of total land) to 24% in 2010.

conceptual framework with consistency and uniform level of quality. Under this contract, institutional capacity of PMO, PDWRAM/PIU and PDAFF will be enhanced and backed up by both international and national consultants.

- (ii) **Design and Construction Supervision Services.** This contract package will cover surveys, detailed design, and preparation of tender documents and construction supervision of about 27 subprojects. It will be divided into three (3) separate contracts of 10, nine (9) and eight (8) subprojects, respectively. The services will be provided by national consultants.
- (iii) **Training and Capacity Building Services.** Capacity building particularly of FWUCs is singled out as a separate contract considering the importance of FWUCs to the project sustainability. The scope of work will cover community organization to establish new FWUCs or revive existing FWUCs, capacity building of the FWUCs through appropriate mix of trainings, study visits and demonstrations. This contract package should have three separate contracts, one for each PIU.

50. All the consultants will work under supervision and guidance of the PMO and PIUs as appropriate. Team leader of the "main consulting services" contract will assist the PMO in overseeing works of consultants under the other two contracts, and coordinating activities of the consultants under all the contracts.

51. Table 4 presents a summary of the major contracts and the corresponding financing sources. Draft terms of reference and estimates of the inputs are presented in separate document.<sup>26</sup> The PMO will be responsible for the procurement of all consultant contracts. AFD-financed consulting services will be engaged in accordance with AFD's procedures. However, ADB should endorse the selection and engagement of the consultants based on their competence and experience. ADB-financed consulting services will be engaged in accordance with ADB's *Guidelines on the Use of Consultants* and other arrangements satisfactory to ADB for engaging domestic consultants.

**Table 4: Major Contract Packages and Financing Sources**

Items	Amount (US\$ million)	ADB+OFID	AFD	Government
<b>Procurements:</b>				
- Major civil works (27 cont.)	22.45	●		●
- Minor civil works (several)	1.10	●		●
- Agri. supports & extension	2.43	●	●	
- Vehicles, equipment, etc.	0.55	●		
- Cadastral surveys	0.75	●		
- Supports for farmers' training	0.14		●	
<b>Consulting services:</b>				
- Main Consultant	6.51		●	
- Design and supervision cons.	4.60	●		

<sup>26</sup> See for reference, Supplementary Appendix J: Draft Terms of References for Consulting Services.

- Capacity building, NGO	0.30	●
- Training services	0.68	●

## 8. Disbursement Projection and Arrangement

52. Tentative annual disbursements of each financial resource for the project investment are presented in Table 5.<sup>27</sup> The annual disbursements will need to be constantly revised and updated as the project implementation advances and costs of the subprojects can be increasingly confirmed.

**Table 5: Annual Disbursement Plan for Each Financial Source**

(Unit: US\$ million, equivalent)

	ADB+OFID	AFD*	Government	Beneficiaries	Total
<b>2008</b>	<b>0.62</b>	<b>0.31</b>	<b>0.05</b>		<b>0.98</b>
<b>2009</b>	<b>1.94</b>	<b>1.28</b>	<b>0.89</b>		<b>4.11</b>
<b>2010</b>	<b>7.27</b>	<b>2.36</b>	<b>1.93</b>	<b>0.01</b>	<b>11.57</b>
<b>2011</b>	<b>9.85</b>	<b>2.43</b>	<b>2.40</b>	<b>0.04</b>	<b>14.72</b>
<b>2012</b>	<b>6.31</b>	<b>1.78</b>	<b>1.10</b>	<b>0.09</b>	<b>9.28</b>
<b>2013</b>	<b>0.94</b>	<b>1.21</b>	<b>0.10</b>	<b>0.15</b>	<b>2.40</b>
<b>2014</b>	<b>0.61</b>	<b>1.07</b>	<b>0.04</b>	<b>0.20</b>	<b>1.92</b>
<b>Total</b>	<b>27.54</b>	<b>10.45</b>	<b>6.51</b>	<b>0.49</b>	<b>44.99</b>

\* The total grant sum earmarked by AFD is about US\$10.40 million equivalent. The balance is intended to be used for trainings and other related human resources development activities.

53. For the loan part of ADB and OFID, disbursement arrangements should be similar to those adopted in other ADB-financed projects. The ADB loan proceeds will be disbursed through imprest accounts and direct payment depending on agreements to be made between ADB and the Government. Imprest accounts are intended to ensure effective project implementation and timely disbursement. The following arrangements<sup>28</sup> are recommended for the implementation of the present Project:

- (i) The Government to open and maintain with the National Bank of Cambodia a first-generation imprest account for the PMO. Concurrently, a second-generation imprest account for the PIUs was to be opened with a recognized commercial bank, acceptable to ADB, in each of the project provinces.
- (ii) Opening of all the imprest accounts will be subject to the appointment of a qualified accountant (at MOWRAM level) and administrative staff (at PIU level) and the establishment by MOWRAM and the three PIUs concerned of accounting systems and internal control acceptable to ADB in accordance with the Project Accounting Manual issued by MEF (23 June 1998) and its amendments.
- (iii) Each imprest account should be managed in accordance with ADB's *Loan Disbursement Handbook* (January 2001). The initial total amount in each second-generation imprest account will not exceed US\$50,000, while the ceiling of the first generation-imprest account will not exceed US\$1,000,000.

<sup>27</sup> The figures are taken from the referenced Supplementary Appendix F (Detailed Cost Estimates).

<sup>28</sup> Referring to those which were adopted under the on-going ADB Loan 2035-CAM: NWISP.

- (iv) ADB's statement of expenditure procedures may be used to reimburse expenditures and liquidate imprest accounts for payments below the ceiling of US\$50,000 for the first-generation imprest account and the ceiling of US\$10,000 for the second-generation imprest accounts.

54. Based on the above imprest account arrangements, the Project will have one first generation imprest account at the PMO level and three second-generation imprest accounts at the provincial levels, one each at Kampong Thom, Siem Reap and Banteay Meanchey. The ceiling amounts should be the same.

## **9. Accounting, Auditing, and Reporting**

55. Accounting, auditing and reporting provide project control and feedbacks for project management decisions. As the Project is a sector project, there will be two levels of accounting, auditing and reporting. The information will flow from the subproject level upward to the overall project level. For the subproject implementation, the primary information will be systematically collected by consultants working in the field. In this context, arrangements for accounting, auditing and reporting should be as follows:

- (i) The PMO and PIUs establish and maintain separate records and accounts adequate to identify income and expenditures relating to the Project;
- (ii) PIUs review consultants' reports of each subproject and prepare for submitting to the PMO monthly financial reports and quarterly progress reports. The financial reports will describe financial status of each subproject under the PIU, including income and expenditures as well as status of the imprest account. Format and content of the monthly financial report will have to follow the Project Accounting Manual issued by MEF (23 June 1998) and its amendment. The quarterly progress reports will summarize the financial and physical progress of the implementation of each subproject, evaluate achievements against the targets, and draw conclusions on the subproject implementation performance.
- (iii) Based on the progress reports submitted by the PIUs, the PMO will prepare, for submitting to MOWRAM for onward submission to the Government, ADB and AFD, consolidated quarterly progress reports (including environmental monitoring) and a comprehensive annual progress report.
- (iv) Within 3 months after subproject completion, the PIUs will prepare and submit to the PMO a subproject completion report recording actual subproject inputs and outputs compared to those planned, evaluating the subproject implementation performance, and recalculating the FIRR and EIRR based on the actual subproject costs and latest developments in the subproject area.
- (v) MOWRAM will compile the consolidated project accounts and related financial statements to be audited annually by an independent external auditor selected through LCB and acceptable to ADB, AFD and OFID. The annual audit report will include a separate audit opinion on the use of the imprest accounts and statement of expenditure procedure. Audited financial statements and project accounts, together with the report of the auditor, will be submitted to ADB, AFD and OFID within 9 months of the close of the financial year of ADB.
- (vi) Within 3 months of project completion, the PMO will prepare and submit to ADB and AFD a project completion report, in ADB standard format.

## **10. Operation and Maintenance**

56. Irrigation infrastructures rehabilitated/constructed under the Project will require O&M during and after the project implementation. Operations of irrigation schemes are simple tasks, such as, opening and closing gates for water distribution control in line with the water allocation arrangements among water users, measuring flows into the system, and periodic



inspection of conditions of the facilities. Maintenance of irrigation schemes fall into three types of works: (i) routine maintenance covering small-scale work needed on a routine basis throughout the year and responsibility for which can be entirely transferred to the beneficiaries; (ii) periodic maintenance covering more substantial repairs that needs to be planned when the system is shut down; and (iii) emergency maintenance covering urgent or temporary repairs to maintain water delivery following sudden failure of the system.

57. Organization and financing of the latter two categories of maintenance are usually outside the capacity of the beneficiary communities and will have to be carried out by MOWRAM. In line with the Government policies on PIMD and IMT, at least for the initial period of some years, the beneficiaries, organized as FWUCs and water user groups (WUGs), will be responsible for overall O&M of the tertiary and quarterly canals while the Government (MOWRAM) will be responsible for the headwork, primary and secondary canals. MOWRAM will also be responsible for emergency maintenance of the overall infrastructure.

58. Following the practices and arrangements already adopted by one of the MOWRAM's on-going projects of similar nature,<sup>29</sup> it is recommended that O&M expenses during initial years of project's implementation be financed by the loan proceeds, government budget and water user fees to be collected by FWUCs. The Government should open a maintenance account in each project province to be replenished annually from a budgetary allocation. The provincial maintenance accounts will ensure timely disbursement of government counterpart funds and the continuity of adequate funds for O&M if the contribution from FWUCs is inadequate.<sup>30</sup> Disbursement from these maintenance accounts should be jointly managed and monitored by the respective PDWRAMs and PIUs, and regularly reviewed by the PMO and the funding agencies (particularly, ADB). The accounts should be subject to a separate audit opinion (as part of the overall project annual external audit). Similar arrangements will be used for participating FWUCs. The irrigation service fees (ISF) collected will be deposited to facilitate timely disbursement of beneficiary contribution to maintenance.

## **11. Project Performance Monitoring and Evaluation**

59. As part of the project management, project performance monitoring and evaluation (PPME) should commence as soon as possible. PPME will have to be carried out for each subproject and the results are consolidated to provide an overall project picture. For each subproject, PPME will progress from subproject implementation performance to operational performance after the subproject facilities are put into operations. PPME during the subproject implementation stage focuses only on inputs and outputs and quality of completed works. The results will be used to prepare quarterly and annual progress reports. PPME after the subproject completion focuses on subproject outcomes and impacts covering technical performance of the subproject facilities, environmental performance, use of irrigation water, changes in household income and livelihood, and performance of FWUCs.

60. To carry out PPME for each subproject, performance indicators and targets will have to be established. The performance indicators are already presented in the project design framework (ref. Appendix 5). The target setting will be based on the baseline data collected as part of the feasibility study for subproject formulation. The performance is evaluated against each performance indicator based on the variance between the set target and the actual achievement. It should be noted that the performance indicators for the PPME during subproject implementation will be different from those of the PPME during subproject

<sup>29</sup> Op. cit., the ADB-funded Northwest Irrigation Sector Project (NWISP).

<sup>30</sup> Referring again to the detailed breakdown of O&M expenses and the anticipated sources of fund shown in Appendix 10.

operation, and that project performance will be the consolidated performance of all subprojects. The Consultant suggests that PPME should be terminated after the project performance audit report is prepared within 3-5 years after project completion.

61. The PIUs will be responsible for carrying out PPME for each subproject. The PMO will be responsible for consolidating the PPME results of the subprojects to construct an overall project picture. In carrying out PPME, the PMO and PIUs should adopt ADB's project performance management system (PPMS). The PPME should also take into account experience gained from PPME of other ADB-financed projects implemented by MOWRAM.

## 12. Project Review

62. As practiced, during the initial 3 years of the Project, the funding agencies (ADB, AFD and OFID) and the Government will jointly carry out semi-annual reviews to (i) determine if all the proposed implementation arrangements are appropriate and in place, (ii) assess progress in selecting the subprojects, (iii) review the resettlement and land adjustment, (iv) review the study, design and construction programs and (v), review the conduct and outcomes of the capacity building and training activities. At the end of year 3, the funding agencies and the Government will undertake a comprehensive mid-term review in consultation with the PSC. Before this mid-term review, the PMO will prepare a comprehensive report identifying issues for the mission's consideration.

## IV. PROJECT BENEFIT, IMPACT AND RISK

### A. Financial and Economic Analysis

63. The Project will yield financial and social benefits to project beneficiaries in each subproject area and socio-economic benefits to the country. The financial and economic analyses of the three core subprojects were conducted and yielded positive results. With careful selection of the remaining subprojects, it is very likely that the financial and economic performance of the three core subprojects reflects the performance of the Project.

#### 1. Financial Analysis

64. The Project will help project beneficiaries to raise farm productivity through increase in agricultural water supply, improved on-farm management of water and soils, introduced better seeds and farming techniques, introduced supplementary productions (such as, vegetables, fruit trees and fish catch) and improved access to credit. The outcomes are increased household income and increased food supply for household consumption. For the three core sub-projects, the average additional value added per farm was found to be ranging from US\$205 to US\$423 per annum. Based on the incremental increase in this household income, investment in these subprojects was found to yield FIRR in the range of 8.3% and 12.5%, see below.

	O Mean	O Touk	SS-TA
FIRR, %	8.3	12.4	12.5
FNPV @ 2.59% (US\$)	1,329,047	1,736,363	9,839,153
FNPV @ 12% (US\$)	-351,192	26,286	197,598

65. As shown, comparing these FIRR against a Weighted Average Cost Capital (WACC) of 2.59%, and using this WACC as the discount rate for the FNPV's, it can be concluded that all 3 sub-projects are financially viable.

## 2. Economic Analysis

66. The Project will yield tangible and intangible economic benefits to the national economy. The major tangible benefits are incremental increase in farm production and productivity, thereby contributing to sustained growth of the agricultural sector. Intangible benefits are related to improved health of project beneficiaries due to improved food supply, improved productivity of project beneficiaries, increased water availability for domestic consumption and more efficient use of soil and water. For the three core subprojects, the project investment was found to yield economic benefits measured as EIRR between 13.5% and 19.7%, see the summary below.

	<b>O Mean</b>	<b>O Touk</b>	<b>SS-TA</b>
EIRR, %	13.5	19.7	19.3
NPV, US\$	136,011	515,142	2,775,078

67. Comparing these EIRR with the social opportunity cost of capital (12%), it can be concluded that the 3 sub-projects are economically viable, although O Mean is rather near the margin, due to its relatively higher construction cost.

## 3. Sensitivity Analysis

68. Financial and economic robustness of the Project is indicated by the sensitivity of the values of FIRR and EIRR to changes in major variables. The variables tested include change in investment cost, changes in yields of rice and other crops, and changes in prices of farm produces. The Project was found to be financially and economically robust.

69. Financial and economic robustness of the project is indicated by the sensitivity of the values of FIRR and EIRR to changes in major variables. The variables tested include change in investment cost, changes in yields of rice and other crops. If we compare the sensitivity of the sub-projects to changes in cost parameters, as compared with revenue parameters, all 3 projects were more sensitive to changes in the key revenue-side parameter of rice yield than to the cost-side parameter of civil works, with SI indices of 37.6%, 57.8%, and 40.4% for O Mean, O Touk and Spean Sraeng- Trapaeng Ambel respectively. O Mean and O Touk were also sensitive to changes in rice price (21.7% and 24.4%) as compared to other parameters, while in SS-TA the sensitivity to changes in rice price, benefits in general, cost of civil works, and size of service area was approximately equal (17% - 22%). A summary of the financial and economic analyses of the three core subprojects is presented in Appendix 16.

## B. Social Benefit and Impact

70. Major social benefits of the Project will include (i) poverty reduction, (ii) increased development awareness of people in the project area and their increased participation in development activities, (iii) enhanced knowledge and skills of the beneficiaries, and (iv) gender development through enhancing roles of women in economic development and management of local water resources. Each benefit can be briefly described below.

## 1. Poverty Reduction

71. The Project will help reduce poverty in the project area through (i) increasing household income realized from improved farm productivity and production of food for family consumption, (ii) improving food security for rice-deficient households, and (iii) improving access of marginal farmer households to irrigation through the improved distribution canal system. At present, the three project provinces are among the poorest provinces with poverty incidence between 29 and 54%, with pocket of higher poverty incidents. The Project will contribute to poverty reduction in the subproject areas in terms of both “cash income” and “food security”. The number of households with income lower than the poverty line would be reduced by 31% while the number of households with insufficient rice production for year-round consumption would be reduced by 47%.<sup>31</sup>

## 2. Increased People’s Development Awareness and Participation

72. During project implementation, formulation of each subproject will involve community organization and participatory consultations which will lead to the establishment of FWUCs and subordinate WUGs. In addition, the land titling to be implemented as part of the Project will assure ownership of land and increase incentive for efficient and effective land use. These efforts will increase people’s development awareness and their participation in community socio-economic development. Development interventions will become increasingly driven by development demand of the people and their specific knowledge of local conditions rather than by the supply pushed by government agencies. Therefore, development interventions should become more effective. Increased people’s development awareness and participation are a solid ground for further development of the rural sector.

## 3. Enhanced Knowledge and Skills of People

73. The Project will contribute to the development of human resource in the project area as knowledge and skills of people in the project area will be enhanced through various training arrangements. These coupled with the enhanced development awareness and participation will lay a strong basis for successful rural development in other sectors too.

## 4. Gender Development

74. As a significant number of households in the project area are headed by women, the project interventions will help to enhance opportunities of women in development leadership and in new economic opportunities. Special attention will be given to encouraging women to take active roles in FWUCs, on-farm management of water and soil resources, adoption of new agricultural production activities, etc.

75. Project strategies to realize the discussed social benefits and a gender development action plan (GAP) are described in Appendix 17.

## C. Environmental Impacts and Measures

76. Environmental assessment at the IEE level was conducted for each of the three core subprojects and the three IEE reports were submitted in August 2007.<sup>32</sup> Based on the IEEs of the three core subprojects and on consideration of the nature and scope of subprojects, it is very unlikely that the Project will create significant environmental impacts during its

<sup>31</sup> For further reference, the Consultant has prepared a draft of Poverty Reduction and Social Development Strategy, see **Supplementary Appendix K**. For implementing the Project, a document presenting the PRA and Socio-economic Survey Methodologies was also prepared and given in **Supplementary Appendix L**.

<sup>32</sup> A summary IEE of each core subproject is given in Supplementary Appendix M: Summary IEE Report of Core Subprojects.

construction and operations because (i) sizes of each command area will be kept smaller than 3,000 ha, (ii) construction of the three subprojects will be small in magnitude and simple in nature, (iii) operations and maintenance of the irrigation facilities will not generate wastes and will not result in significant changes of the environmental systems, (iv) no subproject sites will be located in ecological, cultural and historical sensitive areas, (v) all subprojects will be subject to an IEE to be reviewed<sup>33</sup> by MOE, ADB and AFD before design and construction activities begin and (vi), effective environmental management requirements during construction including impact mitigation measures will be included in all construction contracts for contractors to implement.<sup>34</sup>

## **D. Risks Assessment**

77. Project risks are events that could possibly happen and if happen could adversely affect the project performance. In the context of this Project, the Consultant has identified and assessed risks with impacts on project implementation performance and risks with impacts on project operation performance or project outcomes. Appropriate measures are proposed to avert the identified risks or minimize impacts of the risks. The results are summarized below.

### **1. Project Implementation Risks**

78. The following events could delay project completion or result in project cost overrun: (i) delay in the selection and appraisal of subprojects caused by inadequate capacity of PDWRAM and PMO; (ii) errors in subproject cost estimates and implementation planning due to inadequate capacity of the consultants; (iii) the number of subprojects is lower than the target due to actual construction costs higher than estimated costs; and (iv) delay in each stage of the implementation process due to inadequate capacity of PDWRAM and PMO. Mitigation measures to be adopted include (i) strengthening the capacity of PDWRAM and PMO; (ii) careful selection of consultants and close supervision; (iii) Government to request ADB/AFD/OPEC for advance actions with retroactive financing; (iv) increasing accuracy of the cost estimates by using actual cost data of similar past and ongoing projects; (v) subproject selection to consider unit cost per capita of beneficiaries; and (vi) consulting services to be provided to assist PDWRAM and PMO in project management.

### **2. Project Outcome Risks**

79. The following events could adversely affect sustainability of the irrigation systems or socio-economic benefits of the Project: (i) inadequate financial resources for the maintenance which could result from inadequate budget contribution from the Government and inadequate collection of water user fee; (ii) ineffective functioning and inadequate technical capacity of the FWUCs; (iii) low rates of adoption of introduced agricultural production technologies; and (iv) inadequacies in agricultural supports and extension. Risk mitigation measures included in the Project are: (i) loan proceeds to finance part of the O&M expenses during project implementation before loan account closing; (ii) Government to open a maintenance account in each of the three provinces under the Project; (iii) special attention to be paid to the community organization, the establishment of FWUCs and training of FWUCs' personnel; (iv) agricultural extension and supports provisions to be carefully designed, demand driven, and with full participation of beneficiaries; and (v) special attention to be given to capacity building of PDAFF and financial resource for effective implementation of agricultural extension and supports.

<sup>33</sup> Except for the case of Category A subprojects for which EIAs have to be prepared and submitted for prior approval..

<sup>34</sup> Referring again to the Supplementary Appendix H on Environmental Assessment and Review Procedures, which was prepared in accordance with the ADB *Guidelines for Environmental Assessment*.

## V. CONCLUSION AND RECOMMENDATION

80. The following major conclusions may be drawn:

- (i) Water sector is important to the socio-economic development of Cambodia;
- (ii) The water sector is however still at its early stage of development. A number of sector issues exist and need to be addressed;
- (iii) The water sector development is currently focused on irrigation with the objective to support agricultural development which is a major strategy to reduce rural poverty and enhance food security;
- (iv) The proposed Project is formulated as a sector project to continue the efforts of the Government, ADB, AFD and OFID in harnessing the economic potential of water resources to alleviate poverty in the rural and improve the food security;
- (v) Although the major thrust of the Project is on water resources development through the development of irrigation facilities, the Project includes agricultural development component to ensure efficient and effective use of the irrigation water, establishment and capacity building of FWUCs to ensure sustainability of operations and maintenance, and institutional capacity building of PMO and PIUs to ensure efficient project management;
- (vi) The Project is designed to cover about 27 subprojects in poor areas in and Kampong Thom, Siem Reap and Banteay Meanchey provinces. It will supply supplementary irrigation water to about 20,000 ha altogether and benefit about 72,000~75,000 people or about 14,400 households. One of the targets is to increase the average rice productivity from 1.0-1.5 t/ha at present to 2.5-3.0 t/ha. It will enable dry season cropping in about 1,000~2,000 ha compared with almost none at the present. With these incremental gains in agricultural production, average net increase in household income in the project area is expected to be about US\$205 – 423 per annum, depending on different land-uses.
- (vii) The Sector Investment Project was formulated following the same basis and set of assumptions adopted for the feasibility studies of the three core subprojects. Accordingly, the proposed Project is considered sound, technically, socio-economically, financially and environmentally.
- (viii) The Project will cost US\$44.99 million equivalent to implement. The investment cost structure is (i) development of irrigation systems which is about 71.4% of the total investment cost, (ii) agricultural extension and inputs about 8.1%, (iii) establishment and development of FWUCs about 7.0%, and (iv) capacity building for efficient project management about 13.5%.
- (ix) The Project's implementation and operational risks have been identified and practical mitigation measures are incorporated in the Project design and implementation arrangements to avert the risks or minimize impacts of the risks.
- (x) The Project is ready for further processing for financial support from ADB, AFD and OFID.

81. There are a number of issues or matters proposed in this Report that need agreement from MOWRAM and/or other agencies concerned apart from general issues pertaining to loan processing. Therefore, the Consultant recommends that the following issues be discussed during loan fact-finding and appraisal mission:

- (i) Opening of maintenance accounts for the project in each PIU;

- (ii) Advance actions with retroactive financing to enable MOWRAM to commence the process of consultant recruitment;
- (iii) Key performance indicators and targets for project performance evaluation;
- (iv) Terms of reference for consulting services and contract packaging;
- (v) Arrangements to be made with PDLMUPC regarding cadastral surveys for land titling;
- (vi) Arrangements to be made by MLMUPC for issuance of land titles;
- (vii) Arrangements to be made with PDMAFF regarding the agricultural extension and support component;
- (viii) Appointment of a project team in PMO and in PIUs specifically for this Project;
- (ix) Roles and responsibilities of PIUs being recommended.

## **Irrigated Agriculture and Livelihood Support**

---

### **Cambodia: T.A. No. 4848: Water Resources Management (Sector) Project**

Prepared by:  
TEAM Consulting Engineering and Management Co., Ltd.  
S.D.C. Consulting Co., Ltd.

This irrigated agriculture and livelihood support component has been prepared by the Consultant as a supplementary appendix of the final report of TA No. 4848-CAM, Water Resources Management (Sector) Project. The views expressed herein do not necessarily represent those of the Royal Government of Cambodia, the ADB Board of Directors, Management, or staff, and may be preliminary in nature.

March 2008



## CURRENCY EQUIVALENTS

(as of 30 October 2007)

Currency Unit – riel (KR)

KR1.00	=	US\$ 0.00024
US\$1.00	=	4,072 KR

## ABBREVIATIONS

ACR	Australian Catholic Relief
ADB	Asian Development Bank
ADC	Agricultural Development Committee
ADESS	Agriculture Development Support to seila
ADP	agricultural development plan
AEA	Agro-Ecosystems Analysis
ASDP	Agriculture Sector Development Program
ATSA	Agriculture Technology Services Association
BME	Benefit Monitoring and Evaluation
CAAEP	Cambodian Australia Agricultural Extension Project Phase II
CAVAC	Cambodia Agriculture Value Chain Programs
CEDAC	Center d'Études et de Développement Agricole Cambodgien
CEW's	Commune Extension Workers
DoA	Department of Agriculture
ECOSORN	Economic and Social Relaunch of Northwest Cambodia Project
EM	external monitor
FAO	Food & Agriculture organization
FFS	Farmer Field School
FIG	Farm Improvement Groups
FS	Feasibility Study
FWUC	farmer water user community
ha	hectare
GRF	Group Revolving Fund
IET	irrigation extension team
IMO	Independent Monitoring Organization
ISAEA	irrigation system agro-ecosystem analysis
ITE	Irrigated Extension Team
LIG	Livelihood Improvement Groups
M & E	monitoring and evaluation
MAFF	Ministry of Agriculture, Forestry and Fisheries
MFI	Micro Finance Institution
MLMUPC	Ministry of Land Management, Urban Planning and Construction
MOWRAM	Ministry of Water Resources and Meteorology
NGO	Non-Governmental Organization
NWISP	Northwest Irrigation Sector Project
PDAFF	Provincial Department of Agriculture, Forestry and Fisheries
PDWRAM	Provincial Department of Water Resources and Meteorology
PIU	Project Implementation Unit
PPTA	Project Preparation Technical Assistance
PRA	participatory rural appraisal
RGC	Royal Government of Cambodia
RPRP	Rural Poverty Reduction Project
TIP	Technical Implementation Procedures
TLSRDP	Tonle sap Rural Development Project

TNA	training needs assessment
TOR	Terms of Reference
VEW's	village extension workers
WRMSP	Water Resources Management (Sector) Project

## **CONTENTS**

A.	Introduction	1
B.	Proposed Component Activities	1
1.	Staff Training / Training of Trainers	2
2.	Agricultural Planning, Preparation and Coordination	2
3.	Farmer Training and Extension	3
4.	Off-Farm Skills Training and Apprenticeship	8
5.	Land Titling	8
C.	Implementation and Institutional Arrangements	9
1.	Role of PDWRAM	9
2.	Role of MAFF	9
3.	Role of PDAFF and DOA	9
4.	Role of Commune/Commune Plan	10
5.	Role of Consultants	11
6.	Agricultural Development Committee (ADC)	12
7.	Role of INGO's / NGO's	12
D.	Benefit Monitoring and Evaluation	12
E.	Total Cost of the Component	13
F.	Summary	15

## **LIST OF TABLES**

Table A7.1:	Potential Topics for Staff Training / ToT in the Component	10
Table A7.2:	Suggested Sub-Project KPIs for the Component	13

## **IRRIGATED AGRICULTURE AND LIVELIHOOD SUPPORT COMPONENT**

### **A. Introduction**

1. This project component aims at ensuring that the investment in rehabilitation of irrigation infrastructure is properly translated into improved livelihoods for the beneficiaries, including increased agricultural productivity and diversification, improved farming systems and marketing information, higher household income, etc. While rice remains the principle crop in the area, and food security the main goal of this component, this component will encourage production of high value non-rice crops in both wet and dry seasons, livestock husbandry and fish capture/culture which are expected to add significant value to rice production.

2. The Project recognizes the fact that irrigation alone and of itself will not necessarily lead to increased farm productivity and production, unless specific assistance is given with farmer organization, technical extension and demonstration. In the same way, increased agricultural productivity will not necessarily lead to poverty reduction and improved rural welfare unless: a) support for the wider agricultural value chain is included and b) agriculture itself is seen as one, albeit the main, option within the overall livelihood framework of a rural family. In certain seasons and locations, the value of working on one's own farm and producing one's own rice may represent a poor trade-off for less risky off-farm work paid in cash. Therefore key activities include not only comprehensive agricultural extension and training, but also land titling and training/apprenticeships in off-farm skills, all of which are aimed at adding value to the incremental agricultural production and increasing total farmer income.

3. This project component has been formulated, based on the outcome of the Consultant's comprehensive research on the existing factor endowments and general conditions of contemporary Cambodia and in particular, study results of the three core sub-projects areas, namely, O Mean, O Touk and Spean Sraeng–Trapeang Ambel. An overview on the sector and relevant linkages with agricultural production and productivity, extension, agricultural research, marketing and cooperatives, credit, institutions and actors, etc., is provided in Supplementary Appendix N.

### **B. Proposed Component Activities**

4. This project component will ensure that the investment in rehabilitation of irrigation infrastructure is properly translated into improved livelihoods for the beneficiaries, including particularly increased agricultural productivity and diversification, improved farming systems, improved capacities to access market and credit facilities, land titling, etc. While rice remains the principle crop in all the sub-project areas, and food security the main goal of this component, the Project will also encourage the adoption of improved sustainable conservation farming practices, including production of high value non-rice crops, livestock and fish.

5. Key activities under this component include (i) formation of a sub-project agricultural stakeholders group or ADC (Agricultural Development Committee) (ii) incentive packages (seeds/seedlings, fingerlings, fertilizer and lime) for seed improvement, soil remediation and fishpond production (iii) various extension methodologies, including formation of farmer groups, on-farm demonstration and trials, identification and training of key farmers and study visits and (iv) short technical courses on a range of beneficiary selected topics including rice production technology, seed multiplication, animal and fish husbandry, soil and water management, post-harvest, etc.

6. Each sub-project will receive 3 years of incremental agricultural extension funded by the project through the PIU and delivered by extension staff from the DoA. The latter will be supported for approximately 2 years per sub-project by 3 NGO coordinators referred to as an Irrigated Extension Team (IET); these will assist PDAFF staff with a) on-site coordination and planning b) training of trainers and c) identification and contracting of additional and specific NGO inputs where required. In addition to the above focus on farm development, the project would fund a certain number of training courses and apprenticeships in key off-farm skills, reflecting the reality that poverty reduction in rural areas cannot address on-farm income alone, but must assist in diversifying rural income and spreading the risks inherent in small farm production in developing countries. A description of key sub-components is given hereunder.

### **1. Staff Training / Training of Trainers**

7. As part of the capacity building for government agencies concerned, training of the PIUs' staff, as an example, will be provided by the international and domestic Consultant and also by NGOs where appropriate. Structured training will be supplemented by study visits to sites of interest in other projects and provinces. Assisted by relevant TA, a training team from MAFF will take the lead in training of provincial trainers and have overall responsibility for supervision and monitoring of the training program. Amongst other topics, training of the provincial trainers will include project orientation, training needs assessment, management & planning, feasibility in agricultural projects, extension planning and budgeting and gender mainstreaming in agriculture. Training of DoA staff by MAFF and provincial trainers is likely to include project orientation and ToT, extension techniques, ISAEA, extension methodologies, facilitation skills, seed multiplication technology and gender awareness/mainstreaming for extension workers. Training for both provincial and district staff will be complemented by study tours to sites of interest in terms of successful seed multiplication, sustainable cropping systems (especially conservation farming and SRI) animal and fish husbandry, establishment of farmer groups, farmer field schools, and farmer cooperatives.

8. In accordance with MAFF's sector-wide policy and strategy to mainstream gender issues, which was developed under ADB's ASDP, many of the PDAFF staff and District extension workers have been given training on gender in extension, and WRMSP will update this where necessary.

### **2. Agricultural Planning, Preparation and Coordination**

9. The incremental training and extension activities funded by the project must be: a) executed within the framework of existing commune, district and provincial extension plans activities and budgets and b) planned and coordinated on a sub-project wide basis (rather than by village or farmer group) to eliminate unnecessary duplication or contradiction over the whole command area and, to remain within the overall budget constraint for each sub-project. The 3-person Irrigated Extension Team from NGO's referred to above will assist the district extension workers to in this work of site-level planning, preparation and coordination.

#### **a. Agricultural Development Plan (3 year)**

10. A 3-year agricultural development plan (ADP) is the starting point for agricultural extension and support activities on each sub-project. Formulated by the Agricultural Development Committee (ADC), it represents a consensus between the key stakeholders of agricultural planning and development over each sub-project as a whole, expressed in the form of phased budget and activities. Its aim is to harmonize and coordinate development over the whole scheme, eliminating duplication (e.g., of demonstration or trial plot topics) or contradiction (e.g., between varieties, time of planting, pest control methods, environmental issues etc).

### **b. Beneficiary identification of extension needs**

11. One output of ISAEA is analysis of beneficiary preferences and needs in relation extension topics. These will therefore already have been identified in the FS, and will be confirmed again during formulation of the 3 year agricultural development plan, but with the additional input and perspectives of other stakeholders such as farmer leaders, extension workers and NGO staff.

### **c. Formation of farmers groups**

12. Formation of farmer groups is a basic first step in setting up an effective extension network at this stage. These will already exist in some sub-project locations, but the majority will have to be established anew for the target sub-projects. Although different foreign donor projects have given slightly different names to farmer groups, in essence the common purpose is the same, i.e., to facilitate extension and gain strength and bargaining power through mutual cooperation.<sup>1</sup> The formation and management of farmer groups will be one topic in the training of DoA staff.

13. A typical basic farmer group for extension purposes in Cambodia is around 20-30 persons. Later on, two farmer groups can be amalgamated to form a larger one with the minimum requirement of 30 families required to form a Farmer Cooperative and receive government subsidies under MAFF's Cooperative Promotion program.

14. Farmer groups are clearly differentiated from FWUCs, which are established for the purpose of and focused on the function of water management, and whose members in turn will be members of basic farmer groups. However, in order to properly coordinate water demand and supply with cropping system requirements, close coordination and communication will be necessary between the farmer groups, which are village centric, and the body which oversees and works for the command area as a whole, i.e., the FWUC.<sup>2</sup> While the rationale for this is easy to understand due to the central position of the FWUC on any irrigation scheme, the WRMSP PPTA feel that this may put too much burden on the FWUC during the first two years of their formation. Since all the individual members of the FWUC will be farmers themselves and belong to their own farmer group besides serving on the FWUC, it is considered that the ADC, of which the FWUC is a key member, will perform the role of site-wide agricultural coordination, made up as it is of FWUC, farmer group leaders, extension staff, NGO and project Consultant (EIT).

## **3. Farmer Training and Extension**

15. As stated above, training courses will be provided for agricultural staff and

<sup>1</sup> NWISP calls them "Farm Improvement Groups" (FIGs) and TLSRDP distinguishes between Livelihood Improvement Groups (LIGs) and Farming Systems Improvement (FSI) Groups, the former being the poorest and the latter not so poor. ASDP distinguishes between the "basic" or start-up farmer group of around 20 members which is village based, and the technical thematic groups which can be formed or joined after becoming a member of a basic group to learn a special TIP cropping or husbandry technique. NWISP proposes to organize farmer groups on the basis of poverty ranking, under the assumption that common poverty ranks will have common production targets, cropping systems and extension themes, i.e.: 1) the poorest will be focussed on increasing food security and rice production for home consumption 2) the medium will be aiming to sell a little surplus rice or maybe vegetables, while the least poor will target production of high value rice and other crops for sale.

<sup>2</sup> The NWISP's model also gives the FWUC a major role as incubator and coordinator of agricultural development and farmer groups.

beneficiaries alike, while extension will be directed exclusively toward beneficiary farmers and FWUC's. Farmer training is usually considered to be a sub-set of extension, albeit in a more structured and time limited form, often referred to as a "course", while extension covers any process of knowledge transfer of a period of time. As farmers in their own right, FWUC members will participate in all farmer extension programs, but specific technical training will be given to FWUC's collectively on various aspects of the crop production /water management interface, which may include technical elements of O & M and water control not given to farmers groups under the general agricultural extension program.

16. The incremental extension services funded by the project must complement and build on existing plans of all the relevant provinces, in terms of activities as well as funds. (As an example, the routine 3 year extension plans of Kampong Thom and Siem Reap provinces are provided in Supplementary Appendix N). In many sub-project areas, previous extension activities have already taken place, and there should be some continuity and consistency with these. The key elements of extension and training sub-programs are outlined below.

#### **a. Technical Implementation Procedures (TIPs)**

17. Commissioned and approved by MAFF before field use, TIPs comprise the entire package of information, procedures and materials necessary for an extension worker to pass on the technology to farmers, and are the main pillars of the government extension program. To date, there are TIPs on 32 projects, covering most main areas of crop, livestock and fish pond production. The number is growing too.<sup>3</sup> Based on these TIPs, appropriate materials may also be prepared specifically for use by the Project for on-farm trials and demonstrations.

#### **b. On-farm trials and demonstration**

18. Parameters regarding the on-farm trials and demonstration, i.e number, size, theme (single theme, Integrated Farming Systems, etc.), cost and duration (single or multiple years) for each sub-project will be jointly planned by the ADC in the 3-year agricultural development plan. These need to be planned on a sub-project wide basis (rather than by village or farmer group) to eliminate unnecessary duplication or contradiction over the whole command area and, to remain within the budget provision for each sub-project.

19. The topics could cover any single or integrated aspect of crop production, animal and fish husbandry, harvest, post-harvest, marketing or agro-processing, and would be expected to be related to and consistent with the beneficiary preferences for extension topics and TIP's identified by the ISAEA in the feasibility studies, but at this stage complemented by the technical experience and knowledge of the extension staff and other ADC stakeholders.

#### **c. Cropping systems improvement**

20. This may be considered to be the core of the extension activities, using any or all of the methods duly described, i.e., on-farm trials and demonstrations, farmer field schools and field days, delivery of TIPs, short structured training courses from government, NGO, the main Consultant or private sector trainers, study tours. The topics selected by each sub-project will first be identified in the ISAEA during FS, then confirmed again during formulation of the 3 year agricultural development plan. It is expected that any improved cropping systems recommended in the ISAEA will properly reflect latest developments in conservation farming and SRI already being promoted by MAFF.

---

<sup>3</sup> CAVAC aims to increase this number further with value chain and marketing TIPs

21. A fairly typical range of crop production topics have already been proposed by respondents in the feasibility studies for the Consultant's 3 core sub-projects, including: improved rice production, production of high value vegetables and water melon, use of pesticides and IPM, compost making and integrated (crops, livestock and fish) farming systems. Inevitably in an irrigation rehabilitation project aiming principally at improved food security, improved rice production (including SRI for transplanting areas and use of improved varieties) will be the central most important topic for TIPs and FFS. However, specific extension on production of high value vegetables and the formation of vegetable grower groups is likely to be requested in sub-projects better market outlets.

22. Apart from the lack of water control due to non-operational irrigation facilities, a major cause of low yields in the target areas was found to be the low emergence rate of farmer seed and heterogeneity of the seed stock in the majority of locations. In order to provide results and generate confidence in the newly rehabilitated facilities quickly, the factor of unviable seed needs to be eliminated as a cause of failure wherever possible. Following this, farmers will be given training in the on-site multiplication of good quality seed by AQIP and extension workers. Not all farmers will want to change their existing variety or seed stock, so free incentive packages of improved seed + fertilizer will be provided to early adopters.

23. Incentive packages for early adopters will include seed of newer improved varieties for transplanted (50kg) and broadcasting areas (150kg) , together with fertilizer (100 kg of DAP and 50kg of Urea. With around provision of free packages has been calculated at around 50% of the WRMSP's target 20,000 ha has been calculated as 5,000 ha for transplanted rice (nearly all of Kampong Thom uses transplanting) and 6,500ha for broadcast. Recipients of these packages will then repay 50% of the quantity into a communal seed bank, so that others may borrow.

#### **d. Soil Improvement**

24. Depending on the beneficiary preferences and soil constraints as identified in the ISAEA, extension and training may cover sustainable soil management and improvement themes, including compost and green manure making, recycling of residues and the use of lime to reduce extreme acidity and Al and Fe toxicity. Both O Touk and Spean Sreng-Trapeang Ambel have limited areas of toxic and shallow/hard pan soils and it is expected there will be other sub-projects like this. These areas may respond to applications of lime to kick-start a return to improved yields which can then be sustained by good management.

25. Provision has been made in the budget for sufficient lime to treat 1,000 ha with 2 dressings of lime at 1500/kg ha in years 1 and 3.

#### **e. Animal husbandry**

26. From the Consultant's feasibility studies of the core sub-projects, it is certain that extension on the production and health care of pigs will be requested on most sub-projects and at least 5 TIPs are available on this subject ("Multiple Pigs", "Semi-intensive Pigs", "Single Pig", "Sows" and "Swine Fever"). The project will also seek to create more village vets/animal health workers from lead farmers. Demonstrations and FFS can also include duck, chicken, pig or cattle fattening components. No incentive packages have been included in the budget, since the amounts of money and procedures for revolving credit on large animals are beyond the scope of this component. Extension will be given on the creation of group savings for investment in pig raising and cattle fattening micro-enterprises.

#### **f. Fish production**

27. Depending on the beneficiary preferences and interest, extension and training can



cover any or all of a) open water capture from reservoirs, b) separate pond cultivation and c), combined rice-fish systems. There is an existing TIP on “Small Pond Fish Culture” new extension materials from MAFF’s Dept of Fisheries on rice-fish cultivation methods, and various aquaculture courses from NGO. Study tours would be likely to include successful fish-rice cultivation being sponsored by MAFF’s Department of Fisheries in Takeo and Prey Veng provinces.

28. Incentives for early adopters of fish pond and fish-rice cultivation will be eligible for fingerling + feed + materials packages at a value of \$40 / pond enough for 400 (1 per 50ha) x 11m x 22m ponds.

#### **g. Training of key farmers as extension agents**

29. An important element of the sustainability of the proposed sub-projects is the sharing of the extension load and the continued presence of skills in the village and commune post-project. For this reason, an important aim of the extension program will be to train key farmers as village extension agents and animal health workers or “para vets”. These may later be paid a modest stipend by the community if their services are in demand.

#### **h. Farmer field schools and farmer days**

30. The Farmer Field School (FFS) concept was originally developed by the FAO, and is now a well proven and effective methodology around the developing world, including Cambodia. It has been employed by most of the foreign donor funded agricultural development projects, including ADESS, NIPM, NRE, NWISP, TLSRDP and CAVAC.

31. The FFS is a school without walls, usually made up of 25-30 farmers who meet half a day each week under the shadow of the trees, rest-houses, under or in the house located near the study field or experimental plots, to discuss and learn about better ways to grow the crops based on the holistic concepts of: a) “growing a healthy crop” and b) farmers own capacity to solve their problems in the field through better observation and understanding of agro-ecosystems. A typical FFS would take a theme like IPM rice production and last the duration of a season, where the plants studied would be on key farmers’ plots. In addition to facilitating a number of fundamental and farmer designed experiments in the FFS, unexpected problems are considered additional opportunities for learning. FFS are noted for having positive impacts not only on increased production and reductions in pesticide use, but also on leadership, social cohesiveness and community mobilization on local issues.

32. In implementing this activity, 3-year service contracts include provision for FFS for 1 farmer group in 5 (5 at a time, or 1 per 100ha) at an estimated cost of \$300 per school for an average duration of 20 weeks are proposed. Topics will be selected by the farmers groups, and included in the 3-year agricultural development plan.

33. The FFS methodology is compatible with TIP training and delivery, which will be the technical cornerstone of the extension package. FFS provides farmers with on-going support over the entire technology implementation cycle, and accommodate farmer record keeping which is the raw material for updating the household baseline survey for the component’s BME.

34. In addition, commune level farmer field days will be of 1-day duration and provide the opportunity for large numbers of farmers to meet and share experiences. Commune field days provide opportunity for farmer-to-farmer training of a large number of indirect

beneficiaries.<sup>4</sup>

#### **i. Study tours / exchange visits**

35. As for government staff above, study tours and exchange visits will be arranged for farmer beneficiaries, as farmer groups and together with FWUC's. It is expected that project-sites of and experiences from both on-going and completed projects in Cambodia, e.g., NWISP, TLSRDP, ASDA, CAVAC, ECOSORN, ADESS and RPRP will have something to offer. In addition, successful examples of SRI and rice-fish combinations in Takeo and other provinces should be of worth consideration.

#### **j. Post-harvest and agro-processing**

36. The chief focus of post-harvest extension will be to: a) increase farmers understanding of the quality factors that determine the price of rice they sell to millers and farm-gate traders, including harvesting and post-harvest methods b) how community/group savings can be used to create and upgrade storage conditions to reduce damage from weavils, rodents and moulds. There is already a TIP on improved post-harvest methods, and ATSA offers on post-harvest care. Both CAVAC and TLSRDP will provide support to vegetable producer groups in Kampong Thom in the form of drying/packing sheds which can be visited as study tour subjects, and TLSRDP aims to provide training to women's groups in food preparation and processing for snacks; given demand from beneficiaries, the same trainers could be used on WRMSP: the present Project.

#### **k. Access to credit and loan/savings group formation**

37. Since it is not ADB's policy to provide start-up funds for GRF's, the project will focus on training beneficiaries to access formal suppliers of credit and MFI's and, form loans / savings groups by themselves for various purposes, including micro-enterprise start-up capital. Depending on beneficiary preferences, it is recommended to use some of the 200 person-months of NGO to recruit experienced local consultants like CEDAC staff<sup>5</sup> to implement this training.

#### **l. Marketing and promotion of cooperatives**

38. The ISAEA should identify where marketing opportunities exist and beneficiaries express interest and preference in receiving marketing extension and mediation. Farmer groups will be taught how to access and use market and price information to increase bargaining/negotiating strength.<sup>6</sup> For a sub-project, since year 1 after construction will be focused on increasing production and adjusting to the new water supply, "extension and promotion of cooperatives" by MAFF's PCCT and DCCT extensionists would not start until year 2 and 3. The extensionists would explain the procedures and benefits of establishing/registering cooperatives, not only for group production and marketing, but for loan/savings and input supply.

<sup>4</sup> Experience from ADESS has also shown that they are very effective.

<sup>5</sup> CEDAC's "Saving for Self-Reliance" initiative was set up in 2003 to support farmers to establish and manage loan/savings groups. In 2007, these number 2,264 with 35,593 members, providing enhanced access to community-led saving and credit services

<sup>6</sup> CAVAC is aiming to produce TIPs on marketing/value chain and agro-processing topics, which can be used where relevant on WRMSP sub-projects.

### **m. Gender Issues**

39. Based on the particular imbalances and inequities faced by women beneficiaries per sub-project as identified in the FS's ISAEA and gender action plan,<sup>7</sup> particular attention will be given in the incremental extension activities to increasing awareness of gender inequities on the part of beneficiaries and staff. The aim will be to address and redress these imbalances by a process of a) gender awareness training, b) training of local women as motivators and gender extensionists and c), enhancing the role and status of women in the household and agricultural production cycle through farm and off-farm skills training, not just in the traditional areas of dressmaking, hairdressing, crafts, food processing and accounting/bookkeeping, but they should also be free to choose non-traditional options being offered by the project too.

40. The IET from the main Consultant will also supervise and monitor gender mainstreaming in the agricultural and FWUC extension and development work, and ensure satisfactory representation of women in the various community, water user and farmer groups in the project area and participants villages. If identified as a need in the ISAEA, the above processes will be supported and strengthened by the presence of NGO gender experts on site for periods of time; besides providing training themselves, these will act as a communications pivot with government and lobbyists to ensure that beneficiary communities are made aware of and benefit from all funds and programs for skills and gender awareness training available under the national program of the Ministry of Women 's Affairs and foreign donor projects, including the on-going domestic violence campaign.

### **4. Off-Farm Skills Training and Apprenticeship**

41. As the rural economy becomes increasingly diversified into secondary and tertiary production activities, and many small farms of less than one hectare become increasingly less viable as economic units, the need to balance the risky agricultural activities with less risky off-farm work increases. WRMSP proposes to offer to farmers and their teenage children "skills training" that can also be useful in enhancing their income from the development being taken place, such as, agro-processing. Any theoretical training in these fields is best combined with apprenticeship in local businesses, as a kind of hands-on counterpart. By paying the wages of apprentices, the project can offer a local business a measure of "free" labor in exchange for hands-on experience and learning.

42. After potential benefits and absorption potential for off-farm training have been identified during the FS phase, the IET members will work with government and NGO staff during the post-construction phase to match eligible and interested candidates with appropriate training courses, agencies and apprenticeships with local businesses.

### **5. Land Titling**

43. Land titles are a significant asset for Cambodian farmers as instruments to: 1) provide a better safeguard against the possibility of future land grabbing and 2) as an instrument of collateral for obtaining credit from formal MFI's and banks. In addition, the RGC already has the long term aim of providing land titles for all its citizens. A project like WRMSP, with large blocks of contiguous land and plot boundary surveys are already being carried out as part of detailed design, is a suitable opportunity for the MLMUPC to carry out its "systematic" approach for bulk processing of titles.

44. The Consultant had discussions with LMAP's Project Director concerning the feasibility and availability of LMAP to be involved in providing land titles to WRMSP

---

<sup>7</sup> Being presented separately as Appendix 17 of this Report, WRMSP.

beneficiaries and the modalities for cooperation, LMAP's readiness and interest in undertaking the cadastral mapping and issuing of titles have been confirmed. Through their provincial offices for an inclusive ceiling cost of US\$30/ha, a "systematic" approach for bulk processing of titles, i.e., large blocks of contiguous land making use of pre-cadastral plot boundary surveys done during detailed design will be carried out, avoiding any resolution of land disputes ("sporadic approach").

45. In order to pre-empt and protect against land grabbing attempts as a result of news about the increased value of land post-rehabilitation, it was advised that titles should be provided as soon as feasibly possible, i.e., the cadastral surveys and titling would be performed during the detailed design process just after the pre-cadastral or plot boundary surveys have been completed by the detailed design engineers, or at MLMUPC's earliest availability thereafter. Delivery of titles would be structured as a service contract between the PIU and the PLUPC or LMAP directly.

### **C. Implementation and Institutional Arrangements**

46. In implementing this project component, several government agencies, particularly the Project Implementation Units under PDWRAMs in all the project provinces, the communities involved, the consultants and NGOs will be involved for the effectiveness and high success of the Project. Their respective roles and responsibilities may be described as follows.

#### **1. Role of PDWRAM**

47. The role of PDWRAM in terms of this component will be to: a) manage the PIU with ultimate responsibility for performance and reporting b) make periodic payments into PDAFF accounts for i) PDAFF staff allowances and ii) supervise/monitor smooth execution of the incremental extension program c) as co-trainer with MOWRAM on the FWUC, to ensure that FWUC training schedules are properly coordinated with farmer group training and extension schedules.

#### **2. Role of MAFF**

In order to ensure involvement and commitment of MAFF as implementing agency in supporting irrigated agriculture nationwide, and following the model already established by NWISP, a training team from MAFF's Project Support Unit (PSU) will take the lead in training of provincial trainers and have overall responsibility for supervision and monitoring of the agricultural staff training program. They will be assisted in this task by relevant international and domestic consultants from the main TA and NGO teams.

#### **3. Role of PDAFF and DOA**

48. The role of the PDAFF in this project will: a) supply one of its staff as its representative in the PIU b) open and manage accounts to fund PDAFF operations on the PIU c) supervise and monitor execution of the incremental extension activities in all sub-projects in their province d) provide required inputs into pre-feasibility sub-project screening and feasibility studies from the point of view of soil suitability and agro-economic data e) provide project orientation and training to its district office staff f) pay any project allowances to its district staff. The role of the DoA is to supply and manage availability of extension workers to deliver the contracted incremental extension services to each sub-project for 3 years.

### a. Capacity building

49. The targets of government capacity building will be: a) key members of the PDAFF, especially the PDAFF member of the PIU and b) the DOA extension workers, including provincial and district “cooperative promotion” staff.

50. Probable training topics will include the items indicated in TableA7.1 below.<sup>8</sup> Before finalizing the training program, a training need assessment (TNA) will be carried out jointly between the main Consultant and PIU to establish the right topics and recipients, taking into account evaluations from previous training under other projects duly referred to.

**Table A7.1: Potential Topics for Staff Training / ToT in the Component**

Topic
<b>Project Planning and Management</b>
Human and resource management/administration
PPME / M & E
<b>Extension &amp; production technology</b>
Extension planning and facilitation skills
Extension methodologies (demplots/trials, farmer group formation, FFS, ISAEA, farmer days, TIP's)
Livestock health
Fish-rice cultivation + aquaculture
Seed multiplication technology
Marketing and value chain aspects
Gender in extension
<b>Subsidiary</b>
Computer training
English language

### b. Sustainability of support post-project

51. A principle reason for selecting PDAFF/DOA, rather than the main Consultant or NGO, to lead and be responsible for the 3 year incremental extension and support for agriculture is the factor of post-project continuity after the 3-year period. While IET staff and NGO will not have an enduring presence on site, the district extension network will continue, even if faces change. This will give a sense of ownership for the success of each sub-project to the district extension workers, and if the other **paralleled projects have succeeded in** creating commune and village extension workers from key farmers, the district extension staff will not be alone. Although the extension visits post-project will revert to the routine program level, they will not cease, continuity will be maintained and farmer groups should be strong enough to stand on their own two feet and make progress at a lesser level of support.

## 4. Role of Commune/Commune Plan

52. Commune Councils within the sub-projects are expected to play also an important role in the project's implementation process. Annual commune plans normally include all kinds of investment proposals and activities sought and planned by each the communes, including agricultural development. Rehabilitation of the irrigation sites will thus feature in a relatively high priority position in the annual commune plan, but typically agricultural development activities are given less prominence and detail. This will not hinder or constrain execution of the sub-project agricultural development plan, but the details of this plan should be integrated into the commune plan during the annual planning process.

<sup>8</sup> Care must be taken to avoid unnecessary duplication of topics and training recently given by other projects in the same provinces such as NWISP, TLSRDP and CAVAC.

53. To assist them with agricultural development planning, more than 50% of communes in Cambodia have already received training in AEA and had this analysis carried out for their commune. The ISAEA performed during the FS will take into account and build on the commune's AEA, if one already exists. In its turn, the 3-year agricultural development plan for each sub-project will take into account the ISAEA and the results will be fed back into the annual commune plan.

## **5. Role of Consultants**

54. The main Consultant, both international and domestic, will be used for a combination of 1) feasibility studies 2) detailed engineering design and construction supervision and 3) assisting MOWRAM, PIU and PDAFF with on-going coordination, facilitation and supervision of agricultural and FWUC development activities for around 2 years on each sub-project site post-construction. Item 2) above (Detailed design and construction supervision) will be tendered as a service provision contract outside of main Consultant, and is not directly relevant to this Appendix. Items 1) and 3) are discussed below.

### **a. Feasibility Studies**

55. The main Consultant team will include: a) an international agriculturalist, b) an international project economist/agricultural economist, c) a domestic agriculturalist and agricultural extension expert and d), a domestic agricultural economist.

56. The international agriculturalist will have overall responsibility for a) design and methodology for collection and analysis of all agriculturally related data in accordance with ADB guidelines and standards of international projects. This will include inputs to the ISAEA (design of forms/questionnaires/methodologies), analysis of existing and recommended cropping systems (crop type, yields, input levels), animal and fish husbandry gross margin analyses for use by the Project Economist in completing the farm budgets for cost-benefit calculations b) guidance and direction to the domestic agriculturalist. The international Project Economist will be responsible for deriving overall economic and financial feasibility statistics from the field data collection and analysis and guidance / direction to the domestic Agricultural Economist in carrying out the economic and financial calculations.

### **b. Post Construction Extension and Support**

57. The main Consultant will continue to assist MOWRAM and PDAFF staff with coordination, supervision, monitoring, training and extension activities for around 2 years post-construction on each sub-project. This support will be delivered by a 3-person team referred to as the Irrigation Extension Team or IET. These staff will be drawn from one or more domestic NGO's, but under the overall coordination and leadership of an INGO who will in turn be responsible and report to the main consultant.

58. The use of the term IET as well as its composition/roles and duties, builds on the model developed by the NWISP. The IET consists of 1) an irrigation engineer/water management specialist 2) an FWUC development and O & M specialist and 3) an agricultural extension specialist. It is proposed that these staffs are included in the main Consultant to reduce administrative delays and paperwork connected with tendering and approval procedures.<sup>9</sup>

<sup>9</sup> Under the NWISP proposal, the IET staff are recruited under a contract with an external service provider. At the time of writing, the NWISP's IET staff had not yet begun their field activities, so there has not yet been time to evaluate key performance and efficiency aspects of the IET, such as optimal duration of services on each site, key duties etc. Therefore at the time of implementation, Consultant for WRMSP will have to update itself regarding best practice and evaluation of lessons learned regarding the role of the IET.

59. The IET will play a key role in management, coordination and delivery of training and extension for FWUCs and farmer groups, where they will work in close collaboration with PIU involved agencies, especially PDWRAM, PDAFF, PoE and MLMUPC agencies. At a wider level, the IET represents both: a) the on-site presence of main Consultant in the latter's role of facilitation, coordination, supervision and monitoring for a period of around 2 years after construction and b) continuity of thinking/planning after the FS period; for example, members of the IET will have been involved or familiar with the ISAEA process during FS which identifies the need for assistance and inputs from NGO for training and community development purposes, thus are better able to translate these into an implementation plan.

## **6. Agricultural Development Committee (ADC)**

60. To ensure that there is good coordination, communication and joint planning between the key stakeholders in agricultural development on each sub-project, it is recommended to establish a site-level Agricultural Development Committee (ADC) of these the stakeholders during or shortly after construction. The primary members would be: 1) Key FWUC representatives, 2) farmer group leaders, 3) government extension workers (PDAFF / DOA), 4) members of the main Consultant's Extension Irrigation Team (IET) and 5), NGO staff involved in agricultural and FWUC development. The IET would assist the DOA extension workers to establish the ADC, which should be in existence as a coordinating mechanism for at least the 3 years of the incremental extension program, but could continue for longer depending on its usefulness and the wish of the stakeholders. One of the first tasks of the ADC will be to formulate a 3-year agricultural development plan and budget for the whole sub-project areas.

## **7. Role of INGO / NGO**

61. As stated above, an INGO and one or more NGOs will be recruited by the main TA to provide the post-project on-site support in the form of the 3 person IET. This support would be provided by AFD as part of their overall grant. In addition, another 450 mm of NGO support would be available to perform longer term residential community building tasks and when identified during FS or Agricultural Development Plan phases, to be divided between agricultural and FWUC support activities as necessary. In accordance with their traditional skills and competences as grassroots community developers, facilitators and educators, and building on the contribution of NGO in previous irrigation development projects such as Prey Nup Polders and St. Chinit, the twin roles of trainers and community developers are envisaged for NGO under the present Project too. Typical community building activities will be needs identification/PRA, gender and transparency awareness building, farmer group building, FWUC development, negotiation of compensation, leadership development, social impact monitoring, while typical NGO technical training courses include various kinds of IPM cultivation, aquaculture, compost making, SRI, etc.

62. For reasons of cost, replicability and domestic capacity building, it is felt that a) INGO should be used sparingly as backstopping supervisors and evaluators and b) even domestic NGO staff should be able to make key community building, social negotiation and lobbying contributions with several inputs of shorter duration, i.e not permanent residence on-site for 2 -3 years as in the St Chinit and Prey Nup sub-projects. Two or 3 NGO staff might work on 3 contiguous or close lying sub-projects at the same time, for 2 -3 months etc.

## **D. Benefit Monitoring and Evaluation**

63. Progress and Benefit Monitoring of the Irrigated Agriculture and Livelihood Support Component is a part of the overall WRMSP project monitoring, which is the responsibility of the PIU and will be used by the main Consultant in the Project Completion Report to

evaluate project impact and performance. It will commence with the Baseline Survey of households and PRA done by the main Consultant during the FS, and will be updated in year 2 and 3 after construction by the PDAFF as part of the PDAFF-PIU contract. The PDAFF member of the PIU will receive training in this activity from the main Consultant during the time of the Baseline Survey and again for the update when the Baseline Survey results are handed over to them by the main Consultant. One of the tasks of the IET will be to ensure that the PDAFF knows what and how to do this monitoring. Respondents selected for the Baseline Survey in the FS will be given record books covering the key indicators, so that the raw material for the year 2 and 3 updates can be collected and recorded progressively instead of having to remember all the answers.

64. Three year results from all those sub-projects which are ready before the end of WRMSP will form a major part of the whole project BME in the Project Completion Report to be completed by the Consultant.

65. Key performance indicators can be broadly divided into a) progress/performance and b) impact /benefit. Examples are given in the Table A7.2 below, but this is not meant to be exhaustive or mandatory, since the final indicators measured will also have to be tailored to available staff time and budget. BME must not become so time consuming or complicated as to burden respondents or staff and reduce the quality of the interventions themselves.

**Table A7.2: Suggested Sub-Project KPIs for the Component**

Progress/Performance		Impact / Benefit
1	Area planted and harvested by season and crop	Yield by season, crop and variety Sales and price obtained by crop
2	Type /amt of chemical inputs used	Effect of training (SRI, IPM etc) in reducing chemical inputs
3	No. demonstration plots	impact/effect of demplots by beneficiary scoring No. adopters due to demplots
4	No. agronomic trials completed	Scoring of impact/effect of trials by beneficiaries and extension staff
5	No TIPs implemented	<ul style="list-style-type: none"> <li>• impact/effect of study tours by beneficiary scoring</li> <li>• no. adopters of new technology</li> <li>• results (yields etc) obtained after TIP adopted</li> </ul>
6	No. study tours conducted	impact/effect of study tours by beneficiary scoring
7	No. technical courses given (govt. NGO or private)	impact/effect of technical courses by beneficiary scoring
8	No. FFS implemented	impact/effect of study tours by beneficiary scoring
9	No. of new farmer groups and members established	impact/effect of farmer group membership
10	No. of key farmers trained as a) extension agents b) farmer group leaders	
11	No. new fishponds created	Yields of fish/m2 pond/cycle Sales of fish
12	No. families raising livestock by species	Increase in livestock numbers Sales of livestock
13	No. of land titles certificated	Impact of certificates as instruments of land titles for collateral and other purposes
14	No. of activities and persons in gender action program	Beneficiary assessment of impact of the gender action program
15	No. loan/savings training given	No. membership and turnover of loan/savings groups started after training

#### **E. Total Cost of the Component**

66. The budget for this component includes provisions for:



- (i) Training of PDAFF / DOA staff /ToT;
- (ii) Fuel and operational expenses for 3 years of incremental extension work by DoA;
- (iii) Incentive seed + fertilizer packages for early adopters in the seed improvement program (5000 ha of transplanted and 6500 ha of broadcast);
- (iv) Provision of remedial lime for 1000ha of problem (Al or Fe toxic) soils;
- (v) Multi-year demonstration and trial plots and farmer field schools;
- (vi) Farmer group formation, meetings, field days and study tours;
- (vii) Beneficiary training, i.e delivery of TIP's, structured short technical courses from government and NGO, training of key farmers as farmer group leaders and village extension workers; and
- (viii) Off-farm skills training and apprenticeships.

67. Although the above service contract includes funds for short technical courses which may be delivered by NGOs, such as CEDAC or ATSA, it does not include the 200 man-months of NGO support for periods of residence on site assisting with agricultural development activities; these man-months are included in the main Consultant package, to be drawn down as and when required.

68. The revised cost of this Component represents a part of the total cost of new **Component 3** (namely, "Technical Support and Capacity Building" after inclusion of FWUC development sub-component) which is estimated at US\$5.45 million. Of the total, US\$ 4.27 million is investment cost and the rest (US\$ 1.18 million) is recurring one, as detailed below.

## **I Investment Costs** **US\$**

### Staff training

Project Management Training	140,670
Agricultural Staff training	68,380
FWUC Training	237,600

### Incremental Farmer Extension

Motorbikes	28,000
Incentive materials and equipment	1,321,480
Training village extensionists	142,300
Farmer group meetings	43,260
Farmer Field Schools	578,600
Study Tours	64,800
Short technical courses	135,000
TIP's implementation	232,200
Market information improvement	219,900
Credit and savings training	90,970

<u>Off-Farm Skills Training</u>	<u>315,900</u>
---------------------------------	----------------

<u>Land Titling</u>	<u>654,000</u>
---------------------	----------------

## **II Recurring Costs**

O & M motorbikes	113,100
Support for FWUC's who are not yet financially independent	1,065,000

## F. Summary

69. This Component will deliver a) 3 years of incremental agricultural extension and support on each sub-project site through the existing agricultural extension services, assisted by TA, both consultants and NGO's and b) training/capacity building of relevant provincial and district agricultural extension staff. Farmer extension will include both production and post-harvest, credit and marketing topics, as identified by beneficiaries and extension staff together. Whatever extension is prioritized and requested by beneficiaries, the project will always promote best practice technology as defined by international standards in the area of sustainable agriculture and conservation farming. In addition to its own incremental extension activities, the component will aim to optimize coordination and synergies between existing and planned agricultural development projects and programs, such as CAVAC, TLS Rural Development Project, ECOSORN, NWISP, Agricultural Sector Development Project (ASDP) and existing government extension programs. In addition to agricultural extension, the component will also fund and implement the provision of land titles to its estimated 14,000 beneficiaries, and provide training and apprenticeships in off-farm skills to selected appropriate beneficiaries.

70. Notwithstanding the different characteristics problems and resources of the different sub-project sites, the following generic sequence of activities can be roughly envisaged on each sub-project:

- (i) Modified (reduced) ISAEA completed during feasibility study to identify the key socio-economic parameters and beneficiaries development needs and preferences;
- (ii) Formation of the Agricultural Development Committee (ADC) on each sub-project site;
- (iii) Formulation of a 3-year agricultural development plan (ADP) for each the sub-project: this plan will be formulated by the ADC above, taking into account the ISAEA and PRA done during feasibility study. The ADP will include budget and action plans for all the sub-components and activities;
- (iv) Formation of farmer groups for extension purposes. As only a very few sites have already existing farmers groups, these will have to be established under the project extension;
- (v) Identification and training of key farmers as extension workers, farmer group leaders and farmer field school (FFS) hosts;
- (vi) Implementation of the 3-year incremental extension program, including:
  - Seed improvement program with incentive packages
  - Soil improvement program
  - Establishment of on-farm trial and demonstration plots
  - Extension and training visits by Irrigation Extension Workers from DOA to farmers' groups, based on TIP topics and other subject matter agreed in the ADP above
  - Structured short courses for farmers on topics agreed in the ADP (delivered by RGC, main Consultant, NGOs and private sector)
  - Establishment of one or more FFS and field days
  - Study tours/cross visits, and
  - Promotion of cooperatives at an appropriate stage.
- (vii) Provision of land titles

## **Summary of Economic and Financial Analyses**

### **Cambodia: T.A. No. 4848: Water Resources Management (Sector) Project**

Prepared by:  
TEAM Consulting Engineering and Management Co., Ltd.  
S.D.C. Consulting Co., Ltd.

This summary of economic and financial analyses has been prepared by the Consultant as an appendix of the final report of TA No. 4848-CAM, Water Resources Management (Sector) Project. The views expressed herein do not necessarily represent those of the Royal Government of Cambodia, the ADB Board of Directors, Management, or staff, and may be preliminary in nature.

March 2008

## **CURRENCY EQUIVALENTS**

(as of 30 October 2007)

Currency Unit – riel (KR)

KR1.00	=	US\$ 0.00024
US\$1.00	=	4,072 KR

## **ABBREVIATIONS**

ADB	Asian Development Bank
DAP	Di-ammonium Phosphate
EIRR	Economic Internal Rate of Return
FIRR	Financial Internal Rates of Return
FWUC	Farmer Water User Community
ha	hectare
O&M	Operation and Maintenance
PIR	Poverty Impact Ratio
PRA	Participatory Rural Appraisal
SER	Shadow Exchange Rate
SSTA	Spean Sraeng-Trapaeng Ambel
t/a	ton per hectare

## CONTENTS

A.	Introduction	1
B.	Summary of Subproject Scope	1
C.	Cost Data	2
1.	Investment Cost	2
2.	Operation and Maintenance Cost	3
3.	Prices of Farm Outputs and Inputs	5
4.	Cost of Farm Inputs	7
D.	Production and Income Estimates	7
1.	Incremental Increases in Crop Yields	8
2.	Production of Pigs and Fish	8
3.	Increased Farm Income	9
E.	Financial Feasibility	9
1.	Weighted Average Cost of Capital	9
2.	Calculation of FIRR	10
F.	Economic Feasibility	10
1.	Social Discount Rate	10
2.	Opportunity Cost of Dry Season Cropping	10
3.	Calculation of EIRR	11
G.	Sensitivity of Rates of Return	11
1.	O Mean Subproject	11
2.	O Touk Subproject	11
3.	SS-TA Subproject	12
H.	Poverty and Employment	14

## LIST OF TABLES

Table A16.1:	Summary of the Scope of the Three Core Subprojects, ha	2
Table A16.2:	Summary of Investment Cost, US\$ Equivalent	2
Table A16.3:	Estimation of Personnel Requirement and Operation Cost for each Subproject	4
Table A16.4:	Summary of Financial and Economic Prices	6
Table A16.5:	World Bank Commodity Price Forecasts (selected items)	7
Table A16.6:	Incremental Crop Yields	8
Table A16.7:	Projected Increased Production of Pigs and Fish	9
Table A16.8:	Net Farm Income, US\$ equivalent	9
Table A16.9:	Estimates of Opportunity Cost of Dry Cropping	10
Table A16.10:	Result of Sensitivity Analysis of Three Core Subprojects	13
Table A16.11:	Incremental Employment and Poverty Impact Ratio (PIR)	14



## SUMMARY OF ECONOMIC AND FINANCIAL ANALYSES

### A. Introduction

1. This appendix presents a summary of economic and financial analyses of the three core subprojects selected for detailed feasibility studies.<sup>1</sup> The three core subprojects are the O Mean (OM), O Touk (OT) and Spean Sraeng-Trapaeng Ambel (SSTA) subprojects. The objectives, the nature and scope of the three subprojects are similar. Their development objective is to reduce poverty and food insecurity in the three subproject areas principally through increasing agricultural production and productivity. Therefore, each subproject will (i) rehabilitate existing irrigation infrastructure to increase irrigation water supply, (ii) provide agricultural extension and supports to ensure the efficiency and effectiveness of irrigation and (iii), establishment and strengthen capacity of the Farmer Water User Community (FWUC) to ensure sustained operations and management of the rehabilitated irrigation system and equitable water allocation. Consulting services will be provided to assist the relevant Project Implementation Units in the subproject implementation.

2. To facilitate the reading of the main text, long tables are presented as attachments as appropriate at the end of this appendix.

### B. Summary of Subproject Scope

3. Table A16.1 presents a summary of scope of the three core subproject. It should be noted that command areas of the three subprojects are significantly different, 530 ha for the OM subproject, 1,030 ha for the OT subproject, and 5,070 ha for the SSTA subproject. Therefore, the three core subprojects represent small, medium and large subprojects. The results of financial and economic analyses of these core subprojects thus reflect the economic and financial viabilities of the entire spectrum of subproject sizes for the remaining subprojects.

---

<sup>1</sup> Originally, the studies were completed in August 2007. This summary presents the improved version of economic and financial analyses, taking into account the slight changes in operation and maintenance estimates and related unit costs made available additionally by MOWRAM and other reference sources.

**Table A16.1: Summary of the Scope of the Three Core Subprojects, ha**

Item	O Mean	O Touk	SS - TA
<b>Project Area</b>			
Net service area	530	1,030	5,070
Wet season irrigation capacity	530	1,030	5,070
Dry season irrigation capacity (4 yrs out of 5)	318	155	0
<b>Cropped area without project</b>			
Rainfed wet season broadcasted rice	-	-	4,920
Rainfed wet season transplanted rice	530	1,030	
Floating rice (broadcasted)	-	-	150
Irrigation transplanted rice	57	18	
Rice straw harvesting area	587	1,048	5,070
Water melon (hybrid)	10	6	40
Maize (dry season)	25	28	5
<b>Total annually cropped (wet season + dry season)</b>	<b>622</b>	<b>1,082</b>	<b>5,115</b>
<b>Cropped area with project</b>			
Irrigated wet season transplanted rice : short high yield variety	500	930	-
Irrigated wet season transplanted rice : aromatic	30	100	-
Irrigated dry season transplanted rice : short high yield variety (IRR66)	288	125	100
Irrigated wet season broadcasted rice	-	-	2,270
Irrigated wet broadcasted rice (aromatic)	-	-	200
Floating rice deep (up to 2 m)	-	-	1,300
Floating rice medium (up to 1 m)	-	-	1,300
Rice straw harvesting area	818	1,155	5,170
Water melon (hybrid) : irrigated, dry season	30	30	100
<b>Total annually cropped (wet season + dry season)</b>	<b>848</b>	<b>1,185</b>	<b>5,270</b>

**C. Cost Data****1. Investment Cost**

4. The investment cost consists of such major items as (i) construction cost covering land acquisition and resettlement, land preparation, earthworks, and concrete works, (ii) cost of environmental monitoring and evaluation for three years, (iii) community and agricultural development and (iv), consulting services for detailed engineering design and construction supervision. Table A16.2 summarizes the total investment cost of the three subprojects. Details of the investment cost estimates are given in Attachment 1.

**Table A16.2: Summary of Investment Cost, US\$ Equivalent**

Cost Elements	O Mean Subproject	O Touk Subproject	SS-TA Subproject
Base cost	1,187,991	537,466	4,222,175
Physical contingency,5%	59,400	26,873	211,109
Construction cost	1,247,391	564,339	4,433,284
Engineering services	99,791	45,147	221,664
Environmental monitoring	6,500	6,500	6,000
Land acquisition and resettlement	12,000	124,000	130,000
Community and agricultural development	132,500	257,500	912,600
<b>Total investment cost</b>	<b>1,498,182</b>	<b>997,486</b>	<b>5,703,548</b>



## 2. Operation and Maintenance Cost

5. The operation and maintenance (O&M) cost consists basically of (i) routine or recurrent O&M expenses and (ii) major repair cost.

### a. Recurrent O&M Cost

6. The recurrent O&M cost includes labor cost and cost of minor repair or maintenance of canals, reservoirs and concrete structures. Theoretically, the recurrent O&M cost should be estimated from the estimates of labor inputs and the nature and scope of minor repair works that would be required. Table A16.3 presents the Consultant's estimates of annual operator inputs and costs for the three core subprojects. The labor cost varies from US\$2.86/ha/annum for the OM subproject to US\$1.21/ha/annum for the SSTA subproject reflecting the economies of scale.

7. In practice, the recurrent O&M cost is normally set as a fixed cost per ha of irrigated area based on records of past actual expenses. MOWRAM advised the Consultant to use US\$10/ha/annum. This unit cost is US\$7.14 more than the labor cost estimated by the Consultant for the O&M subproject. This surplus would be more than adequate to cover the administrative cost of FWUC personnel and minor repair and maintenance works.

8. **Figures Adopted.** The Consultant therefore adopted MOWRAM's figure of US\$10/ha/annum.

### b. Major Repair Cost

9. **Repair Cycle.** Earth structure, such as unlined canals and reservoirs, would periodically need major repair works such as dredging, rehabilitating subsided or eroded embankments, etc. For concrete structure, major repair works may cover repainting, repair or change gate mechanisms, etc. The period of major repair normally ranges from 5 to 10 years depending on construction quality and such factors as use of canal embankments, flood flows and rainfall intensity. In Thailand, the Royal Irrigation Department normally carries out major repairs of irrigation systems on average every five years. The Northwest Irrigation Sector Project assumed an 8 year cycle.

10. **Repair Cost.** The major repair cost is normally assumed to be a fixed percentage of the construction cost. The Northwest Irrigation Sector Project assumed a figure of 30% for earthwork cost and 10% for structure costs. In Thailand, the major repair cost is 10% of canal construction cost.

11. **Figures Adopted.** The Consultant adopted the following major repair cycle and cost for estimation:

(a) Major repair to be carried out every 5 years.

(b) Major repair cost for the project is 10% of canal construction cost.

12. **Determination of Replacement Cost.** In case that the earth or concrete structure is rehabilitated, the construction cost that will be used as the basis for estimating the major repair cost should be the entire cost of the structure. As the cost of existing damaged structure is unknown, a replacement cost should be used. For example, in the case of the O&M subproject, the subproject will rehabilitate existing canals. Therefore, a replacement cost of the canal system has been worked out and used in estimating the major repair cost.

Table A16.3: Estimation of Personnel Requirement and Operation Cost for each Subproject

	Responsible Position	No. of Operator	Man-hour Estimation (person x hrs x weeks/month)																	
	Spean Sraeng - Trapeang Ambel Sub-project		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Remark	Unit Rate \$/m-m	Amount (\$)	Ave (\$/ha)	
1	For Main Barrage	8	16	16	16	16	32	32	128	256	256	256	128	32	1,184	Time spent varies accoeding to seasons.	60	403.6		
2	For Harvesting Gate	2	16	16	16	16	16	16	32	32	32	32	32	16	272	Ditto.	60	92.7		
3	For Trapeang Ambel Gate	4	16	16	16	168	168	168	448	448	448	448	448	168	2,960	Ditto.	60	1,009.1		
4	FWUC Committee	5	60	60	60	60	60	60	60	60	60	60	60	60	720	On ave: Meeting each week@3hrs.	100	409.1		
5	FWUC's Admin. Staff	3	264	264	264	264	264	264	264	264	264	264	264	264	3,168	Work every weekday.	60	1,080.0		
	Total	22													8,304			2,994.5	1.21	
	O Touk Sub-project																			
1	Reservoir/spillway Operator	1	8	8	8	8	8	8	16	28	28	28	16	8	172	Depending on the hydrologic condition.	60	58.6		
2	Left Canal Outlet Operator	1	84	84	84	84	84	84	84	84	84	84	84	84	1,008	Everyday @ 3 hr/day 4 weeks.	60	343.6		
3	Main Canal Outlet Operator	1	84	84	84	84	84	84	84	84	84	84	84	84	1,008	Ditto.	60	343.6		
4	Right Canal Outlet Operator	1	84	84	84	84	84	84	84	84	84	84	84	84	1,008	Ditto.	60	343.6		
5	FWUC Committee	5	60	60	60	60	60	60	60	60	60	60	60	60	720	On ave: Meeting each week@3hrs.	100	409.1		
6	FWUC's Admin. Staff	2	176	176	176	176	176	176	176	176	176	176	176	176	2,112	Work every weekday.	60	720.0		
	Total	11													6,028			2,218.6	2.15	
	O Mean Sub-project																			
1	Reservoir/spillway Keeper	1	8	8	8	8	8	8	16	28	28	28	16	8	172	Depending on the hydrologic condition.	60	58.6		
2	Left Canal Outlet Operator	1	84	84	84	84	84	84	84	84	84	84	84	84	1,008	Everyday @ 3 hr/day 4 weeks.	60	343.6		
3	Right Canal Outlet Operator	1	84	84	84	84	84	84	84	84	84	84	84	84	1,008	Ditto.	60	343.6		
4	FWUC Committee	5	60	60	60	60	60	60	60	60	60	60	60	60	720	On ave: Meeting each week@3hrs.	100	409.1		
5	FWUC's Admin. Staff	1	88	88	88	88	88	88	88	88	88	88	88	88	1,056	Work every weekday.	60	360.0		
	Total	9													3,964			1,515.0	2.86	
																		Ave	2.07	

## Notes:

1. No. of hours required in each month = no. of person x no. Hours/week x no. of weeks in a month
2. Number of working hours in a month ==> 176

Source : Consultant 's estimation

### 3. Prices of Farm Outputs and Inputs

13. Prices of farm outputs and inputs relevant to this Project, both financial and economic value, are summarized in Table A16.4. The financial prices were established through the Consultant's PRA and household surveys in the three subproject areas, other projects and secondary sources.

14. Agricultural input and output costs were derived in the field, while the latest unit costs and BoQ's from the on-going St. Chinit irrigation project were used for estimates of civil works and construction costs, in addition to costs and quantities for comparable construction in Thailand, such as the fish ladder in Spean Sreng – Trapaeng Ambel.

15. Assumptions used in the calculation of economic prices from the financial prices are as follows:

- Use of the world price numeraire.
- Use of the World Bank long term commodity forecasts (Table A16.5) and "Pink Pages" (May 2007) for current year for rice, Urea and DAP (Table A16-5 and Attachment 2).
- Values expressed in constant year 2007 prices to exclude inflation.
- The US dollar (US\$) is the main unit of account. The prevailing exchange rate of 4,000 KR per US\$ is used. Because the dollar is openly traded, the shadow exchange rate (SER) is also set at 4,000 KR per US\$. As a result, the SCF is 1.0<sup>2</sup>.
- For the principal traded project inputs and outputs (rice, DAP, Urea), import parity prices have been calculated (Attachments 3, 4, 5). Using these calculations, the economic farm gate price of rice is estimated at US\$ 160/ton (640,510 KR), as compared to a financial price of US\$ 138/ton, thus a ratio of 1.16. This results in a significant increase of economic net incremental benefits over the financial.
- For non-traded goods and services, conversion factors (CF) have been estimated (Attachment 6). The conversion factor of 0.9 has been used for all construction costs. The shadow wage rate for unskilled labor (SWRF) is estimated at 0.75. This reflects the growing out-migration of labor reducing rural labor supply at critical times.
- In the case of major tradable commodities (rice, urea, DAP), economic values are based on import parity pricing.
- Transfer payments such as taxes, duties and subsidies are excluded from calculation of economic values.

<sup>2</sup> Consultant's own estimate based on: a) procedures for calculation of SER as outlined in ADB publications (Guidelines for the Economic Analysis of Projects, Appendix XVI and ERD Technical Note No. 11 Shadow Exchange Rates for Project Economic Analysis: Toward Improving Practice at the Asian Development Bank; b) estimates from other ADB funded projects in Cambodia, such as, Northwest Irrigation Supply Project (NWISP) and Tonle Sap Lowland Irrigation Project and on-ADB projects; c) IMF's World Economic Outlook Update 2007 and World Bank Country Reports.

**Table A16.4: Summary of Financial and Economic Prices**

Item	Unit	Prices (2007 constant)			
		Financial		Economic	
		US \$	KR	US \$	KR
			4,000		4,000
<b>A. Outputs</b>					
Rice Paddy	\$/t	138	550,000	160	640,510
Straw	\$/t	9.5	38,000	8.55	34,200
Water melon	\$/t	100	400,000	90.00	360,000
Maize	\$/t	75	300,000	67.50	270,000
<b>B. Inputs</b>					
Seed					
Rice					
Traditional	\$/kg	0.16	620	0.14	558
Improved	\$/kg	0.35	1400	0.32	1,260
Nursery preparation (for 1ha planting)					
Land preparation	\$/ha	12.00	48,000	10.80	43,200
Fertilizers					
Urea	\$/kg	0.34	1,360	0.31	1,224
DAP	\$/kg	0.38	1,520	0.34	1,368
Manure	\$/t	25.00	100,000	22.50	90,000
Pesticides					
Folidol	\$/l	4.20	16,800	4.20	15,120
2,4-D	\$/kg	3.50	14,000	3.50	12,600
<b>C. Labor</b>					
Farm Labor	\$/person-day	1.75	7,000	1.31	6,300
Threshing (5% of crop)	\$/t	6.88	27,500	8.01	24,750
<b>D. Land preparation</b>	\$/ha	-	-	-	-
Tractor or draft animals + operator	\$/ha	15	60,000	11.25	54,000
Hand tractor	\$/ha	5	20,000	20,000	18,000
<b>E. Machine</b>					
Pumpset hire	\$/hour	2		2.00	
a/ Financial prices are from Consultant's PRA (May - July 2007) field work and commune databank					
b/ Economic prices for major traded commodities are derived from World bank Commodity Price Projections					
Economic prices for non traded goods, labor and other costs based on local financial prices adjusted					
by :	SCF =	0.9			
	SWR =	0.75			
Official exchange rate 2007	1 US\$=	4,000		KR	
Shadow Exchange Rate 2007	1 US\$=	4,000		KR	

**Table A16.5: World Bank Commodity Price Forecasts (selected items)**

	'06	'07	'08	'09	'10	'15
<b>A. Grains (nominal)</b>						
1. Maize, \$/mt	122	170	165	163	160	150
2. Rice, Thailand, 5%, \$/mt	305	320	320	315	310	300
3. Sorghum, \$/mt	123	170	165	163	160	150
4. Wheat, US, HRW, \$/mt	192	210	210	200	195	180
<b>B. Fertilizers (nominal)</b>						
1. DAP, \$/mt	260	350	333	316	300	250
2. Phosphate rock, \$/mt	44	46	46	47	47	45
3. Potassium chloride, \$/mt	175	180	165	150	160	150
4. TSP, \$/mt	130	225	210	205	200	180
5. Urea, \$/mt	223	320	310	300	290	260
<b>Page:</b> Country: World <b>Row:</b> Series <b>Column:</b> Time						

#### 4. Cost of Farm Inputs

16. Based on the price data in the Table A16.4 (Price Summary), the financial and economic costs of farm inputs per ha for the different models were determined for the three core subprojects with project and without project scenarios. The results are presented in Attachment 7. Under the with project scenario, it is assumed that farmers will spend more on inputs, especially seeds and fertilizers, than in the without project scenario. Consequently, under the with project scenario, the total cost of inputs for each model will increase.

17. Financial labor costs are US\$1.75 per day (7,000 KR) for men and women. The economic conversion factor of 0.75 has been applied to give a shadow wage rate of US\$1.31 (6,300 KR). The source for labor man-days for the different models under the with and without project scenarios was a combination of the Consultant's household survey and work done by the Technical Working Group on Agriculture and Water (TWGAW), Task force C2 in November 2006.

#### D. Production and Income Estimates

18. With subproject interventions, farmers in each subproject area will enjoy the following benefits: (i) major benefit-incremental increase in the amount of rice production; and (ii) supplementary benefits-incremental increase in production of non-rice crops and fish as well as livestock depending on the subproject. These benefits are measured as direct incremental increase in income or indirect incremental increase in income through saving in food expenses. The last two benefit items would however be minor in terms of financial value compared to that of the first benefit item.

19. In estimating the incremental benefits from crops, livestock and fish production, the sources of data for the assumptions regarding yields and input levels were as follows: a) without-project: based on Consultant's own field data collection from the three relevant sub-projects during the PRA phase b) with-project: these were derived from a combination of: i) actual results achieved in other comparable projects in Cambodia where similar commodities have been grown with irrigation and improved input levels such as SRI focus areas ii) enquiries during field data collection on the 3 sub-projects regarding yields achieved previously under irrigation and/or by farmers using pumped irrigation systems.

## 1. Incremental Increases in Crop Yields

20. Table A16.6 presents rice and water melon yields under the with project and without project scenarios.

**Table A16.6: Incremental Crop Yields**

Particulars	O Mean	O Touk	SS-TA
<b>Without Project</b>			
Wet season			
-rain fed transplanted (ordinary rice)	1.7	1.5	1.5
-floating rice (broadcast)	1.2	1.2	1
Dry season			
-irrigated (pumped) transplanted rice	2.2	2.5	2.5
-water melon	18	18	18
<b>With Project</b>			
Wet season			
-irrigated transplanted rice (HYV)	3.5	3.8	3
-rain fed transplanted (aromatic rice)	3	3	2.8
-floating rice (broadcast)	2.8	2.8	2.8-3.0
Dry season			
-irrigated (pumped) transplanted rice	3.8	3.8	3.5
-water melon	25	25	25

Note: <sup>(1)</sup> The projected "With Project" yields will not be achieved immediately, but would increase in stages of 60% and 80% of their peak in Year 4 (Yr = year of construction).

21. The increase in irrigation water supply will enable farmers in the three subproject areas to change from rain-fed varieties currently cultivated to irrigated transplanted high yield varieties. In addition, dry season cropping areas will also be increased. It is also expected that with available water in the dry season, farmers will switch from cucumber and corn to water melon or, other economic cash crops of higher market value.

## 2. Production of Pigs and Fish

22. In addition to cropping, the rehabilitation of reservoirs and canals and increased water supply would enable farmers to increase fish and livestock production. Pigs and fish are used as proxies (i.e. to represent a variety of livestock), since it is assumed that there will also be some increase in both cattle (for draught, manure and cash) and poultry (chickens and ducks). This incremental production is anticipated due to: (i) greater availability and control of water for fish (both in ponds and reservoir) and livestock during the dry season; (ii) improved crop production requires more manure and draught, and increased crop income provides the ability and confidence to invest in livestock; and (iii) 3 years of intensive extension including fingerling incentive packages. However, the exact levels of both existing and incremental production are difficult to estimate, so a conservative increase is projected for the three subprojects as shown in Table A16.7 below.

**Table A16.7: Projected Increased Production of Pigs and Fish**

Production, tons/annum	O Mean Subproject	O Touk Subproject	SS-TA Subproject
Without Project			
-pig	8	8	20
-fish	1	2	3
With Project			
-pig	20	35	50
-fish	15	20	20

### 3. Increased Farm Income

23. Based on the estimated farm productivity, farm output prices, and farm input costs, farm production and net income were estimated for each subproject for both the with project and without project scenarios. The results are presented in Attachment 8. The net income per ha was also determined.

24. It should be noted that the estimates for the with project scenario are for peak production from year 5 onward when crop benefits are assumed to peak at a stable state. This approach is sometimes referred to as *a flat peak model*, because it uses constant 2007 prices and does not attempt to predict longer term changes year-on-year such as a decline in yields in the without-project scenarios, or changes in real commodity prices such as those projected by the World Bank.

25. A summary table A16.8 below presents a summary of the net farm income (see also, the details in Attachment 8).

**Table A16.8: Net Farm Income, US\$ equivalent**

Particulars	O Mean	O Touk	SS-TA
<b>Without Project</b>			
-financial value	137	81	63
-economic value	207	144	143
<b>With Project</b>			
-financial value	423	237	205
-economic value	616	361	314

## E. Financial Feasibility

### 1. Weighted Average Cost of Capital

26. Financial viability of a public sector development project is normally determined by its financial internal rates of return (FIRR). The value of FIRR is compared with the weighted average cost of capital (WACC) of the project. The project is judged to be financially feasible if its FIRR is greater than its WACC.

27. For the Project, the cost of borrowing is very small, about 1% per annum if the loan will be provided from the ADB's Asian Development Fund. Considering a small share of government budget, about 15% of the investment cost, an inflation rate in Cambodia of about 3.9%, and the interest rate of about 15.5% for commercial borrowing, the WACC for the Project net of inflation will be 2.59% ( $=0.85 \times 1.0 + 0.15 \times (15.5 - 3.9)$ ).

28. The WACC of 2.59% was used as a benchmark for judging financial feasibility of the three subprojects.

## 2. Calculation of FIRR

29. The FIRR of the three subprojects in constant 2007 prices was calculated over a 30 year project life. Attachment 9 shows 3 tables showing the calculation of FIRR for the 3 core sub-projects. The results are summarized as follows:

	O Mean	O Touk	SS-TA
FIRR, %	8.3	12.4	12.5
FNPV @ 2.59% (US\$)	1,329,047	1,736,363	9,839,153
FNPV @ 12% (US\$)	-351,192	26,286	197,598

30. The FIRR of the O Mean subproject is lower than those of the other two subprojects due to its high investment cost per ha. All the three subprojects are financially feasible as their FIRR are higher than 2.59%.

31. Although O Mean has a lower FIRR than the O Touk and Spean Sraeng – Traapaeng Ambel sub-projects due to higher construction costs, the FIRR for all 3 sub-projects are significantly higher than the WACC (2.59%), and all the FNPV's are positive when the WACC is used as the discount rate. This confirms that all 3 projects are financially viable.

## F. Economic Feasibility

### 1. Social Discount Rate

32. Economic viability of a public sector development project is normally determined by its economic internal rates of return (EIRR). The value of EIRR is compared with a social discount rate which reflects the opportunity cost of resources used by the project.

33. A social discount rate of 12% was used as the cut-off rate for economic viability and in calculation of the switching value.

### 2. Opportunity Cost of Dry Season Cropping

34. In calculating economic benefits of dry season cropping, opportunity cost of dry season cropping should be deducted from the economic benefits. The reason is that opportunities exist for farmers to get employment during the dry season. Therefore, farmers will lose this potential income if they engage in dry season cropping.

35. Table A16.9 presents the estimate of opportunity costs of dry season cropping for only the O Mean and O Touk subprojects. There will be no dry season cropping for the Spean Sraeng-Trapeang Ambel subproject.

**Table A16.9: Estimates of Opportunity Cost of Dry Cropping**

Particulars	O Mean	O Touk
Dry season cropping area (ha)	318	155
Average plot size (ha)	0.7	1.2
Number of dry season beneficiaries	454	129
Affected households	30.0%	35.0%
Quantity	204	71
Standard man-days for dry season rice	100	100
% family labor	60.0%	60.0%
Man-days /HH to be compensated	60	60



Particulars	O Mean	O Touk
Total man-days compensation	8,177	4,249
Rate per man-day, US\$	1.3	1.3
Opportunity cost of dry season cropping	10,733	3,549

### 3. Calculation of EIRR

36. The EIRR of the three core subproject was calculated over a 30 year project life. Attachment 10 contains three tables showing the calculation of EIRR for the three core subprojects. The results are summarized below.

	O Mean	O Touk	SS-TA
EIRR, %	13.5	19.7	19.3
NPV, US\$	136,011	515,142	2,775,078

37. The EIRR of the O Mean subproject is lower than those of the other two subprojects due to its high investment cost per ha. However, all the three subprojects are financially feasible.

### G. Sensitivity of Rates of Return

38. Sensitivity of the FIRR and EIRR was tested against changes in major variables related to cost and revenue of the subprojects. Sensitivity indexes were calculated for both FIRR and EIRR. A switching value<sup>3</sup> was also determined but only for the EIRR.

39. As can be seen from table A16.10 in Appendix 16, the switching value is a kind of converse of the sensitivity index. As an example, a 4% decrease in rice yields will bring the EIRR to the cut-off rate of 12% in O Mean, while conversely it would take a decrease of 25% in the service area to bring the same effect. As detailed in the table, the economic and financial viability of O Mean and O Touk is highly sensitive to reductions in rice yield and price, but less sensitive to increases in the cost of civil works, which could tolerate an increase of 14% before becoming economically. Other major conclusions per core subproject can be given as following.

#### 1. O Mean Subproject

- (i) The subproject viability is highly sensitive to a decline in prices or yields of rice, as indicated by the high value of SI of both the FIRR and EIRR.
- (ii) The economic feasibility of the O Mean subproject will be adversely affected under various change scenarios as indicated by the EIRR below the 12% cut-off discount rate.
- (iii) The financial and economic feasibility is less sensitive to changes in service area, subproject life or subproject costs.

#### 2. O Touk Subproject

- (i) The sensitivity of the FIRR and EIRR follows the pattern of the O Mean subproject. The subproject financial and economic feasibility is most sensitive to rice yields as indicated by the value of SI for both FIRR and EIRR.

<sup>3</sup> A switching value is the % increase or decrease of a parameter which will take the IRR to the social opportunity cost of capital (presently estimated at 12%), or the NPV to zero (using the social opportunity cost of capital as the discount rate).

- (ii) The EIRR will remain above the cut-off discount rate with: (a) a decrease in project life of up to 6 years, (b) a decrease in rice prices of up to 32% and rice yields of up to 14%, (c) a decrease in benefits of 38%, (d) a decrease of service area of 78% and f) an increase of civil works cost of 117%.
- (iii) The feasibility of the OT subproject is least sensitive to changes in subproject service area, and civil work cost.

### 3. SS-TA Subproject

- (i) The feasibility of the SSTA subproject is also most sensitive to changes in rice prices and rice yields as is the case for the other two subprojects. The EIRR is more sensitive to changes in service area and cost of civil works more than the other two subprojects as indicated by its higher SI. It should also be noted that a *decrease* in the cost of civil works of only 10%, which is entirely possible since the contingencies alone are 5%, will bring the FIRR to 13.7% and the EIRR to 20.8%.
- (ii) The economic feasibility is more robust than the other two subprojects. The EIRR will remain above the cut-off discount rate with: (a) a decrease in project life of 20 years, (b) a decrease in rice prices of 28% and rice yields of 17%, (c) a decrease of benefits of 36%, (d) a decrease of service area of 28%, and (e) an increase of civil works cost of 34%.
- (iii) The feasibility is least sensitive to a decrease in project life (1% SI).

**Table A16.10: Result of Sensitivity Analysis of Three Core Subprojects**

Scenario	O Mean						O Touk						Spean Sraeng - Trapeang Ambel					
	FIRR	EIRR	Switch Value Fin Econ.	Sensitivity Index Fin Econ.			FIRR	EIRR	Switch Value Fin Econ.	Sensitivity Index Fin Econ.			FIRR	EIRR	Switch Value Fin Econ.	Sensitivity Index Fin Econ.		
Base Case	8.3%	13.5%					12.4%	19.7%					12.5%	19.3%				
Project life																		
5 years decrease	7.7%	13.1%	12 years	3.7%	2.0%		12.0%	19.6%	7 years	6 years	1.9%	0.7%	12.1%	19.1%	5 years	20 years	2.3%	1.0%
Rice price																		
15% decrease	5.2%	10.3%	7% decrease	21.3%	21.7%		8.7%	16.5%	2% decrease	32% decrease	26.5%	24.4%	9.0%	15.9%	1% decrease	28% decrease	22.5%	21.2%
Rice yield																		
10% decrease	4.9%	9.8%	4% decrease	35.0%	37.6%		4.4%	11.5%	1% decrease	14% decrease	55.2%	57.8%	4.3%	11.0%	1% decrease	17% decrease	40.4%	40.4%
Benefits																		
20% decrease	6.0%	10.3%	10% decrease	12.0%	16.3%		11.7%	18.2%	4% decrease	38% decrease	4.9%	9.8%	9.7%	15.6%	3% decrease	36% decrease	13.4%	17.4%
Service Area																		
20% decrease	7.6%	12.3%	25% decrease	4.0%	6.3%		11.0%	17.9%	14% decrease	78% decrease	8.4%	11.3%	9.5%	15.5%	2% decrease	28% decrease	14.4%	17.9%
Cost of Civil Works																		
20% increase	6.8%	11.5%	14% increase	8.0%	10.3%		11.3%	18.1%	9% increase	117% increase	6.9%	10.3%	10.7%	14.7%	4% increase	34% increase	8.4%	21.9%

## H. Poverty and Employment

40. The impacts of each subproject on employment and poverty were estimated. Table A16.11 presents the estimates of incremental employment and Poverty Impact Ratio (PIR) of each subproject. The PIR compares net economic benefits to the poor against net economic benefits to the subproject as a whole. The calculation tables are presented in Attachment 1. Results of beneficiaries' assessment of their wealth or poverty and of their rice self-sufficiency collected during the PRA are also presented in the same attachment.

**Table A16.11: Incremental Employment and Poverty Impact Ratio (PIR)**

Particulars	OM	OT	SSTA
Total annual incremental increase in employment, man-days	26,590	15,880	164,100
Average annual incremental increase in employment per 1 ha, man-days	50.0	9.0	32.4
Poverty Impact Ratio	55	46	46
Poverty rates, %	63.0	51.0	58.0
Rice self-sufficiency, %	85	83	45
Average farm size per household in the subproject area, ha	0.67	1.2	2.0
Average farm size per poor household, ha	0.5	0.6	0.77

41. For the SSTA subproject, although the SS area and the TA areas are combined and treated as a single subproject area, it should be noted that there are significant differences between residents of Bantey Meanchey province (Spean Sraeng) and Siem Riep province (Trapeang Ambel) in terms of wealth self-assessment, regardless of location north or south of the dike. The difference was visually confirmed by the Consultant on a number of visits. Although the land north of the dike in Siem Riep province is owned almost entirely by those living in the Trapeang Ambel communities, the villages represented by Spean Sraeng in the PRA lie in Bantey Meanchey, at the extreme remote edge of the province, and are significantly poorer than those villages sampled of Trapeang Ambel. In the Spean Sraeng sample, respondents estimated that 61% of their households were poor, while in Trapeang Ambel the figure was only 28%. Trapeang Ambel residents also rated themselves as more self-sufficient in rice than Spean Sraeng residents (32% versus 25%). Taken as a single project, with a weighting by number of households in each area, the weighted average number of poor households using self-ranking in the total Spean Sraeng- Trapeang Ambel subproject area is 45%. If rice self-sufficiency is also taken as a proxy indicator for poverty and combined with wealth self-ranking, a composite indicator of poverty is 58%.

## DETAILS OF INVESTMENT COST ESTIMATES

**Table A: O Mean Cost of Civil Works (Constant 2007 US\$)**

No.	Items	Quantity	Unit	Unit Cost (\$)	Total Cost (US\$)	
					Fin	Econ
1	<u>Land Clearing and Stripping</u>					0.9
1.1	Clearing	15,000	m. <sup>2</sup>	0.15	2,250	2,025
1.2	Stripping	15,000	m. <sup>2</sup>	0.12	1,800	1,620
					4,050	3,645
2	<u>Construction of Spillway</u>					
2.1	Earth excavation	38,500	m. <sup>3</sup>	1.5	57,750	51,975
2.2	Compaction earthfill	5,440	m. <sup>3</sup>	2.5	13,600	12,240
2.3	Lean concrete	154	m. <sup>3</sup>	50	7,700	6,930
2.4	Reinforced concrete	3,879	m. <sup>3</sup>	195	756,405	680,765
2.5	Bedding material	846	m. <sup>3</sup>	15	12,690	11,421
2.6	Handplaced rip-rap	1,966	m. <sup>3</sup>	12	23,592	21,233
2.7	Waterstop	393	m.	12	4,716	4,244
2.8	Handrail	114	m.	20	2,280	2,052
2.9	Masonry	35	m. <sup>3</sup>	15	525	473
2.10	Stone to mix in mass concrete	329	m. <sup>3</sup>	30	9,870	8,883
2.11	Miscellaneous	L.S.	-	1,500	1,500	1,350
	Total (2)				890,628	801,565
3	<u>Construction of Left Canal Outlet</u>					
3.1	Earth excavation	1,200	m. <sup>3</sup>	1.5	1,800	1,620
3.2	Compaction earthfill	280	m. <sup>3</sup>	2.5	700	630
3.3	Lean concrete	4	m. <sup>3</sup>	50	200	180
3.4	Reinforced concrete	39	m. <sup>3</sup>	195	7,605	6,845
3.5	Bedding material	56	m. <sup>3</sup>	15	840	756
3.6	Handplaced rip-rap	112	m. <sup>3</sup>	12	1,344	1,210
3.7	Sliding gate & hoist (φ0.80 m)	1	Set	800	800	720
3.8	Precast concrete pipe φ0.80 m.	25	m.	80	2,000	1,800
3.9	Demolish existing structure	L.S.	-	3,500	3,500	3,150
3.10	Miscellaneous	L.S.	-	1,000	1,000	900
	Total (3)				19,789	17,810
4	<u>Construction of Right Canal Outlet</u>					
4.1	Earth excavation	300	m. <sup>3</sup>	1.5	450	405
4.2	Compaction earthfill	100	m. <sup>3</sup>	2.5	250	225
4.3	Lean concrete	5	m. <sup>3</sup>	50	250	225
4.4	Reinforced concrete	137	m. <sup>3</sup>	195	26,715	24,044
4.5	Sliding gate & hoist (φ1.00 m)	1	set	900	900	810
4.6	Precast concrete pipe φ1.00 m.	23	m.	100	2,300	2,070
4.7	Miscellaneous	L.S.	-	1,000	1,000	900
	Total (4)				31,865	28,679
5	<u>Construction of Dam</u>					
5.1	Stripping	2,700	m. <sup>3</sup>	0.12	324	292
5.2	Compaction earthfill	15,750	m. <sup>3</sup>	2.5	39,375	35,438
5.3	Sub-base course material 0.30 m.thk.	270	m. <sup>3</sup>	30	8,100	7,290
5.4	Surface course material 0.15 m. thk. (Laterite)	135	m. <sup>3</sup>	6	810	729
5.5	Hand placed rip-rap	750	m. <sup>3</sup>	12	9,000	8,100
5.6	Bedding material	350	m. <sup>3</sup>	15	5,250	4,725
5.7	Miscellaneous	L.S.	-	1,500	1,500	1,350
	Total (5)				64,359	57,923

**Table A: O Mean Cost of Civil Works (Constant 2007 US\$)—Continued**

No.	Items	Quantity	Unit	Unit Cost (\$)	Total Cost (US\$)	
					Fin	Econ
6	<u>Construction of Conveyance Structures (Left Irrigation Area)</u>					
6.1	Check/Check Drop	1	ea.	3,500	3,500	3,150
6.2	Road crossing with check	1	ea.	6,500	6,500	5,850
6.3	Head regulator	1	ea.	8,000	8,000	7,200
6.4	Tail regulator	2	ea.	5,000	10,000	9,000
6.5	Earth excavation	1,200	m. <sup>3</sup>	1.5	1,800	1,620
6.6	Compacted earthfill	400	m. <sup>3</sup>	2.5	1,000	900
6.7	Miscellaneous	L.S.	-	1,000	1,000	900
	Total (6)				31,800	28,620
7	<u>Construction of Conveyance Structures (Right Irrigation Area)</u>					
7.1	Check/Check Drop	2	ea.	3,500	7,000	6,300
7.2	Road crossing with check	1	ea.	6,500	6,500	5,850
8.3	Head regulator	7	ea.	8,000	56,000	50,400
8.4	Tail regulator	8	ea.	5,000	40,000	36,000
8.5	Earth excavation	15,000	m. <sup>3</sup>	1.5	22,500	20,250
8.6	Compacted earthfill	5,000	m. <sup>3</sup>	2.5	12,500	11,250
8.7	Miscellaneous	L.S.	-	1,000	1,000	900
	Total (8)				145,500	130,950
	Grand total				1,187,991	1,069,192

<b>Add:</b>	<b>Physical contingencies</b>	5%	<b>59,400</b>	<b>53,460</b>
	<b>Total construction cost</b>		<b>1,247,391</b>	<b>1,122,651</b>
	<b>Engineering services (design + supervision)</b>	8%	<b>99,791</b>	<b>89,812</b>
	<b>Environmental monitoring</b>		<b>6,500</b>	<b>5,850</b>
	<b>Land acquisition and resettlement</b>		<b>12,000</b>	<b>10,800</b>
	<b>Community and agricultural development</b>		<b>132,500</b>	<b>119,250</b>
	<b>Total investment cost</b>		<b>1,498,182</b>	<b>1,348,364</b>
	<b>Annual Rcurrings Costs</b>			
	<b>O &amp; M Cost</b>	10 US\$/ha		
	<b>Annual O &amp; M</b>		<b>5,300</b>	<b>4,770</b>
	<b>Major maintenance every 5yrs</b>		<b>32,500</b>	<b>29,250</b>

Note: L.S. : lum sum estimate

Major maintenance cost is adopted from related irrigation system in Thailand.

According to new irrigation system development (no canal), major maintenace cost is equivalent 10% of canal construction cost.

In case of O Mean, no existing canal, the canal construction cost estimation is 323,470 US\$ US\$

10 % of canal construction cost is 32,347 US\$ used 32,500

**Table B: O Touk Cost of Civil Works (Constant 2007 US\$)**

No.	Items	Quantity	Unit	Unit Cost (\$)	Total Cost (US\$)	
					Fin	Econ
1	<u>Land Clearing and Stripping</u>					0.9
1.1	Clearing	10,000	Sq.m.	0.15	1,500.00	1,350
1.2	Stripping	10,000	Sq.m.	0.12	1,200.00	1,080
	Total (1)				2,700	2,430
2	<u>Construction of Emergency Spillway</u>					
2.1	Earth excavation	3,914	m. <sup>3</sup>	1.5	5,871	5,284
2.2	Compaction earthfill	648	m. <sup>3</sup>	2.5	1,620	1,458
2.3	Lean concrete	65	m. <sup>3</sup>	50	3,250	2,925
2.4	Reinforced concrete	224	m. <sup>3</sup>	195	43,680	39,312
2.5	Bedding material	72	m. <sup>3</sup>	15	1,080	972
2.6	Handplaced rip-rap	169	m. <sup>3</sup>	12	2,028	1,825
2.7	Rock Masonry	193	m.	12	2,316	2,084
2.8	Waterstop	8	m. <sup>3</sup>	15	120	108
2.9	Miscellaneous	L.S.	-	1,000	1,000	900
	Total (2)				60,965	54,869
3	<u>Construction of Main Canal Outlet</u>					
3.1	Earth excavation	1,340	m. <sup>3</sup>	1.5	2,010	1,809
3.2	Compaction earthfill	600	m. <sup>3</sup>	2.5	1,500	1,350
3.3	Lean concrete	12	m. <sup>3</sup>	50	600	540
3.4	Reinforced concrete	129	m. <sup>3</sup>	195	25,155	22,640
3.5	Bedding material	61	m. <sup>3</sup>	15	915	824
3.6	Handplaced rip-rap	144	m. <sup>3</sup>	12	1,728	1,555
3.7	Sliding Gate & Hoist ( 1.50x1.50 m)	2	Set	1500	3,000	2,700
3.8	Demolish existing structure	L.S.	-	3,000	3,000	2,700
3.9	Miscellaneous	L.S.	-	1,000	1,000	900
	Total (3)				38,908	35,017
4	<u>Construction of Left Canal Outlet</u>					
4.1	Earth excavation	1492	m. <sup>3</sup>	1.5	2,238	2,014
4.2	Compaction earthfill	400	m. <sup>3</sup>	2.5	1,000	900
4.3	Lean concrete	5	m. <sup>3</sup>	50	250	225
4.4	Reinforced concrete	56	m. <sup>3</sup>	195	10,920	9,828
4.5	Bedding material	65	m. <sup>3</sup>	15	975	878
4.6	Handplaced rip-rap	160	m. <sup>3</sup>	12	1,920	1,728
4.7	Sliding gate & hoist (φ0.80 m)	1	set	800	800	720
4.8	Precast concrete pipe φ0.80 m.	25	m.	80	2,000	1,800
4.9	Miscellaneous	L.S.	-	1,000	1,000	900
	Total (4)				21,103	18,993
5	<u>Construction of Right Canal Outlet</u>					
5.1	Earth excavation	1350	m. <sup>3</sup>	1.5	2,025	1,823
5.2	Compaction earthfill	350	m. <sup>3</sup>	2.5	875	788
5.3	Lean concrete	5	m. <sup>3</sup>	50	250	225
5.4	Reinforced concrete	50	m. <sup>3</sup>	195	9,750	8,775
5.5	Bedding material	50	m. <sup>3</sup>	15	750	675
5.6	Handplaced rip-rap	145	m. <sup>3</sup>	12	1,740	1,566
5.7	Sliding gate & hoist (φ1.00 m)	1	Set	900	900	810
5.8	Precast concrete pipe φ1.00 m.	20	m.	100	2,000	1,800
5.9	Miscellaneous	L.S.	-	1,000	1,000	900
	Total (5)				19,290	17,361

**Table B: O Touk Cost of Civil Works (Constant 2007 US\$)—Continued**

No.	Items	Quantity	Unit	Unit Cost (\$)	Total Cost (US\$)	
					Fin	Econ
6	<u>Construction of Conveyance Structures and canal improvement</u>					
6.1	Check/Check Drop	15	each	4000	60,000	54,000
6.2	Road crossing with check	15	each	7500	112,500	101,250
6.3	Head regulator	5	each	10500	52,500	47,250
6.4	Tail regulator	15	each	6500	97,500	87,750
6.5	Earth excavation	30000	m.3	1.5	45,000	40,500
6.6	Compacted earthfill	10000	m.3	2.5	25,000	22,500
6.7	Miscellaneous			2000	2,000	1,800
	Total (6)				394,500	355,050
	Grand total				<b>537,466</b>	<b>483,719</b>

<b>Add:</b>	<b>Physical Contingencies</b>	5%		<b>26,873</b>	<b>24,186</b>
	<b>Total construction cost</b>			<b>564,339</b>	<b>507,905</b>
	<b>Engineering services (design + supervision)</b>	8%		<b>45,147</b>	<b>40,632</b>
	<b>Environmental monitoring</b>			<b>6,500</b>	<b>5,850</b>
	<b>Land acquisition and resettlement</b>			<b>124,000</b>	<b>111,600</b>
	<b>Community and agricultural development</b>			<b>257,500</b>	<b>231,750</b>
	<b>Total investment cost</b>			<b>997,486</b>	<b>897,738</b>
	<b>Annual Rcurrings Costs</b>				
	<b>O &amp; M Cost</b>	10 US\$/ha			
	<b>Annual O &amp; M</b>			-	-
	<b>Major maintenance every 5yrs</b>			<b>31,700</b>	<b>28,530</b>

Note : Major maintenance cost is adopted from related irrigation system in Thailand.  
According to new irrigation system development (no canal), major maintenace cost is equivalent 10% of canal construction cost.  
In case of O Touk, no existing canal, the canal construction cost estimation is 317,000 US\$  
10 % of canal construction cost is 31,700 US\$ used 31,700 US\$



**Table C: Spean Sraeng Trapeang Ambel Cost of Civil Works (Constant 2007 US\$)**

No.	Items	Quantity	Unit	Unit Cost (\$)	Total Cost (US\$)	
					Fin	Econ
1	<u>Construction of Main Barrage</u>					0.9
1.1	Earth excavation	27,000	m. <sup>3</sup>	1.5	40,500	36,450
1.2	Compaction earthfill	3,840	m. <sup>3</sup>	2.5	9,600	8,640
1.3	Lean concrete	234	m. <sup>3</sup>	50	11,700	10,530
1.4	Reinforced concrete	2,293	m. <sup>3</sup>	195	447,135	402,422
1.5	Bedding material	385	m. <sup>3</sup>	15	5,775	5,198
1.6	Handplaced rip-rap	1,093	m. <sup>3</sup>	12	13,116	11,804
1.7	Vertical fixed wheel gate&hoist (6.0x6.25 m.)	4	Set	95,100	380,400	342,360
1.8	Bulkhead gate	1	Set	66,300	66,300	59,670
1.9	Steel sheet pile	360	m.	60	21,600	19,440
1.10	Handrail	80	m.	20	1,600	1,440
1.11	Miscellaneous	L.S.	-	3,000	3,000	2,700
	Total (1)				1,000,726	900,653
2	<u>Closer Dike Improvement (280 m.long)</u>					
2.1	Stripping	24,242	m. <sup>2</sup>	0.12	2,909	2,618
2.2	Earth excavation	12,500	m. <sup>3</sup>	1.5	18,750	16,875
2.3	Compaction earthfill	56,180	m. <sup>3</sup>	2.5	140,450	126,405
2.4	Handplaced rip-rap	1,512	m. <sup>3</sup>	12	18,144	16,330
2.5	Bedding material/Filter material	1,800	m. <sup>3</sup>	15	27,000	24,300
2.6	Rock toe	2,450	m. <sup>3</sup>	17	41,650	37,485
2.7	Laterite surface course (0.10 m.thk.)	258	m. <sup>3</sup>	6	1,548	1,393
2.8	Base course material (0.20 m.thk.)	515	m. <sup>3</sup>	30	15,450	13,905
2.9	Miscellaneous	L.S.	-	1,000	1,000	900
	Total (2)				266,901	240,211
3	<u>Existing canal outlet modification</u>					
3.1	Demolish existing platform and etc.	L.S.	-	3,500	3,500	3,150
3.2	Construction new floor, diaphragm wall, pier and platform (Reinforced concrete)	126	m. <sup>3</sup>	235	29,610	26,649
3.3	Installation new vertical fixed wheel gate and hoist ( -1.20x2.50 m.)	3	Set	3,800	11,400	10,260
3.4	New bulkhead gate	1	Set	3,300	3,300	2,970
3.5	Handplaced rip-rap	225	m. <sup>3</sup>	12	2,700	2,430
3.6	Bedding material	150	m. <sup>3</sup>	15	2,250	2,025
3.7	Miscellaneous (Anchorage, embedded part and etc.)	L.S.	-	3,000	3,000	2,700
	Total (3)				55,760	50,184
4	<u>Harvesting Regulator</u>					
4.1	Stripping	1,049	m. <sup>2</sup>	0.12	126	113
4.2	Earth excavation	2,800	m. <sup>3</sup>	1.5	4,200	3,780
4.3	Compaction earthfill	14,000	m. <sup>3</sup>	2.5	35,000	31,500
4.4	Lean concrete	53	m. <sup>3</sup>	50	2,650	2,385
4.5	Reinforced concrete	1,127	m. <sup>3</sup>	195	219,765	197,789
4.6	Bedding material	700	m. <sup>3</sup>	15	10,500	9,450
4.7	Handplaced rip-rap	1,400	m. <sup>3</sup>	12	16,800	15,120
4.8	Vertical fixed wheel gate&hoist (6.0x8.25 m.)	1	Set	148,000	148,000	133,200
4.9	Steel sheet pile	240	m.	60	14,400	12,960
4.10	Handrail	38	m.	20	760	684
4.11	Miscellaneous	L.S.	-	3,000	3,000	2,700
	Total (4)				455,201	409,681

**Table C: Spean Sraeng-Trapeang Ambel Cost of Civil Works—Continued**

No.	Items	Quantity	Unit	Unit Cost (\$)	Total Cost (US\$)	
					Fin	Econ
5	<u>Improving Main Barrage Tail Channel</u>					
5.1	Earth excavation	173,700	m. <sup>3</sup>	1.5	260,550	234,495
5.2	Compacted earthfill	100,700	m. <sup>3</sup>	2.5	251,750	226,575
5.3	Miscellaneous	L.S.	-	1,000	1,000	900
	Total (5)				513,300	461,970
6	<u>Flood Control Dikes</u>					
6.1	Stripping	179,820	m. <sup>2</sup>	0.12	21,578	19,421
6.2	Compacted earthfill	194,000	m. <sup>3</sup>	2.5	485,000	436,500
6.3	Miscellaneous	L.S.	-	2,000	2,000	1,800
	Total (6)				508,578	457,721
7	<u>Trapeang Ambel canal and conveyance structures</u>					
7.1	Stripping	73,926	m. <sup>2</sup>	0.12	8,871	7,984
7.2	Earth excavation	49,400	m. <sup>3</sup>	1.5	74,100	66,690
7.3	Compaction earthfill	54,436	m. <sup>3</sup>	2.5	136,090	122,481
7.4	Surface course 0.10 m. thk.	4,400	m. <sup>3</sup>	6	26,400	23,760
7.5	Subbase course 0.20 m. thk.	8,800	m. <sup>3</sup>	30	264,000	237,600
7.6	Cross drainage structure KM.0+750 (2-Φ1.00 m.)	1	each	11,000	11,000	9,900
7.7	Anlong canal head regulator, KM.1+050	1	each	5,900	5,900	5,310
7.8	Trapeang Chhuk canal head regulator, KM.1+550	1	each	5,800	5,800	5,220
7.9	Roveang canal head regulator, KM.2+100	1	each	5,900	5,900	5,310
7.10	Pier Svang canal head regulator, KM.2+600	1	each	10,100	10,100	9,090
7.11	Check structure, KM.2+650	1	each	56,200	56,200	50,580
7.12	Neary canal head regulator, KM.3+080	1	each	5,100	5,100	4,590
7.13	Kdol canal head regulator, KM.4+930	1	each	18,600	18,600	16,740
7.14	Road crossing with check, KM.5+150	1	each	40,200	40,200	36,180
7.15	Road crossing with check, KM.7+400	1	each	33,500	33,500	30,150
7.16	Miscellaneous	L.S.	-	5,000	5,000	4,500
	Total (7)				706,761	636,085
8	<u>Pier Svang canal and conveyance structures</u>					
8.1	Stripping	40,759	m. <sup>2</sup>	0.12	4,891	4,402
8.2	Earth excavation	3,420	m. <sup>3</sup>	1.5	5,130	4,617
8.3	Compaction earthfill	32,000	m. <sup>3</sup>	2.5	80,000	72,000
8.4	Head Regulator	10	each	5,300	53,000	47,700
8.5	Check structure	2	each	3,500	7,000	6,300
8.6	Tail Regulator	7	each	7,600	53,200	47,880
8.7	Miscellaneous	L.S.	-	2,000	2,000	1,800
	Total (8)				205,221	184,699
9	<u>Neary canal and conveyance structures</u>					
9.1	Stripping	8,991	m. <sup>2</sup>	0.12	1,079	971
9.2	Earth excavation	180	m. <sup>3</sup>	1.5	270	243
9.3	Compaction earthfill	6,200	m. <sup>3</sup>	2.5	15,500	13,950
9.4	Tail Regulator	1	each	7,600	7,600	6,840
9.5	Miscellaneous	L.S.	-	2,000	2,000	1,800
	Total (9)				26,449	23,804
10	<u>Kadol canal and conveyance structures</u>					
10.1	Stripping	33,886	m. <sup>2</sup>	0.12	4,066	3,660
10.2	Earth excavation	11,520	m. <sup>3</sup>	1.5	17,280	15,552
10.3	Compaction earthfill	27,648	m. <sup>3</sup>	2.5	69,120	62,208
10.4	Head Regulator	6	each	5,300	31,800	28,620
10.5	Check structure	1	each	3,500	3,500	3,150
10.6	Road crossing with check	2	each	5,700	11,400	10,260
10.7	Tail Regulator	7	each	7,600	53,200	47,880
10.8	Miscellaneous	L.S.	-	2,000	2,000	1,800
	Total (10)				192,366	173,130

**Table C: Spean Sraeng-Trapeang Ambel Cost of Civil Works—Continued**

No.	Items	Quantity	Unit	Unit Cost (\$)	Total Cost (US\$)	
					Fin	Econ
11	<u>Modification existing hydraulic structures along Spean Sraeng Dike</u>					
11.1	Installation sliding gate & hoist (2-Φ1.00 m.)	7	each	2,000	14,000	12,600
	Total (11)				14,000	12,600
12	<u>Improvement of Spean Sraeng Dike (elevation to meet +14.75)</u>					
12.1	Clearing	10,000	m. <sup>2</sup>	0.12	1,200	1,080
12.2	Compaction earthfill	20,000	m. <sup>3</sup>	2.5	50,000	45,000
12.3	Miscellaneous	L.S.	-	3,000	3,000	2,700
	Total (12)				54,200	48,780
13	<u>Control structure near rural road</u>					
13.1	Construction rockfill weir	L.S.	-	142,000	142,000	127,800
	Total (13)				142,000	127,800
14	<u>Fish Ladder</u>					
14.1	Excavation earth work	2,581	Cu.m.	1.5	3,872	3,484
14.2	Compacted earth work	1,367	Cu.m.	2.5	3,418	3,076
14.3	Reinforced concrete work	346	Cu.m.	195.00	67,470	60,723
14.4	Provided & Installed Cobble on floor	2	Cu.m.	100	200	180
14.5	Wire mesh & Frame	172	Sq.m	16	2,752	2,477
14.6	Provided & Installed sliding gate and hoist (2.0 x 2.0 m.)	1	set	2,000	2,000	1,800
14.7	Miscellaneous		-	1,000	1,000	900
	Total (14)				80,711	72,640
	<b>Grand Total</b>				<b>4,222,175</b>	<b>3,799,957</b>

<b>Add:</b>	<b>Physical Contingencies</b>	<b>5%</b>	<b>211,109</b>	<b>189,998</b>
	<b>Total construction cost</b>		<b>4,433,284</b>	<b>3,989,955</b>
	<b>Engineering services (design + supervision)</b>	<b>5%</b>	<b>221,664</b>	<b>199,498</b>
	<b>Environmental monitoring</b>		<b>6,000</b>	<b>5,400</b>
	<b>Land acquisition and resettlement</b>		<b>130,000</b>	<b>117,000</b>
	<b>Community and agricultural development</b>		<b>912,600</b>	<b>821,340</b>
	<b>Total investment cost</b>		<b>5,703,548</b>	<b>5,133,193</b>
	<b>Annual Rrcurrings Costs</b>			
	<b>O &amp; M Cost</b>	<b>10 US\$/ha</b>		
	<b>Annual O &amp; M</b>		<b>-</b>	<b>-</b>
	<b>Major maintenance every 5yrs</b>		<b>69,000</b>	<b>62,100</b>

Note : Major maintenance cost is adopted from related irrigation system in Thailand.  
According to new irrigation system development (no canal), major maintenace cost is equivalent 10% of canal construction cost.  
In case of SS-TA, no existing canal, the canal construction cost estimation is 687,900 US\$  
10 % of canal construction cost is 68,790 US\$ used 69,000 US\$



## Commodities Price Series 2007

Commodity	Unit	Annual averages			Quarterly averages					Monthly averages		
		Jan-Dec	Jan-Dec	Jan-Jun	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Apr	May	Jun
		2005	2006	2007	2006	2006	2006	2007	2007	2007	2007	2007
Grains												
Maize	b/ \$/mt	98.7	121.9	165.0	109.3	117.4	155.7	170.9	159.2	152.7	160.2	164.6
Rice, Thailand, 5%	b/ \$/mt	286.3	304.9	317.3	307.6	312.4	300.8	315.6	319.1	316.5	317.6	323.3
Rice, Thailand, 25%	\$/mt	265.4	277.1	295.0	276.0	284.6	276.1	292.6	297.4	296.0	295.8	300.5
Rice, Thailand, 35%	\$/mt	261.8	272.0	287.3	272.9	277.6	268.6	285.8	288.8	290.5	283.0	293.0
Rice,Thai, A1.Special	\$/mt	217.8	218.0	253.7	216.6	219.2	222.5	252.3	255.2	257.0	254.2	254.5
Sorghum	b/ \$/mt	96.2	122.9	163.3	111.7	118.0	158.6	175.2	151.4	149.5	150.0	154.7
Wheat, Canada	\$/mt	197.6	216.8	238.6	212.1	215.4	230.8	232.4	244.7	236.5	238.6	259.2
Wheat, US, HRW	b/ \$/mt	152.4	192.0	202.0	189.6	196.1	208.7	198.4	205.7	198.3	195.7	223.0
Wheat US SRW	\$/mt	135.7	159.0	180.9	144.0	153.0	193.5	173.7	188.1	175.3	180.8	208.4
Fertilizers												
DAP	\$/mt	247.0	260.3	387.8	266.9	260.3	254.2	344.5	431.1	432.4	426.4	434.5
Phosphate rock	b/ \$/mt	42.0	44.2	52.7	43.5	45.5	45.5	45.5	59.9	45.5	54.1	80.0
Pottasium chloride	\$/mt	158.2	174.5	180.2	177.3	174.6	175.0	175.6	184.8	177.5	180.0	196.9
TSP	\$/mt	201.5	204.9	n.a.	200.5	230.1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Urea, E. Europe, bagged	\$/mt	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Urea, E. Europe, bulk	\$/mt	219.0	222.9	294.3	228.1	210.4	234.0	297.4	291.3	288.5	296.3	289.0
World Bank commodity price indices for low and middle income countries( 1990 =100)												
Energy		233.4	281.0	269.6	298.6	300.7	257.9	250.1	289.1	284.4	284.8	298.0
Non Energy Commodities		121.9	151.9	169.6	153.4	156.0	158.5	163.7	175.5	174.5	176.3	175.6
Agriculture		113.0	126.6	137.9	127.8	126.3	127.8	135.6	140.3	137.9	139.6	143.4
Beverages		116.9	122.5	133.7	118.1	121.1	127.8	132.2	135.2	132.8	133.1	139.7
Food		109.9	120.6	133.2	120.5	118.0	124.5	129.9	136.5	131.8	135.6	142.3
Fats and Oils		122.9	126.4	164.8	119.4	127.1	140.4	155.3	174.3	165.2	173.9	183.9
Grains		103.2	120.9	136.6	117.4	121.7	133.1	137.5	135.7	132.2	133.6	141.4
Other Food		103.1	115.7	105.5	123.1	108.5	106.6	104.9	106.0	104.1	105.2	108.8
Raw Materials		114.1	137.4	147.1	144.3	140.8	132.0	145.3	148.9	149.5	149.7	147.4
Timber		122.5	139.9	150.0	138.7	142.0	146.0	149.1	151.0	151.5	150.8	150.6
Other Raw Materials		108.3	135.7	145.1	148.1	139.9	122.5	142.7	147.4	148.1	149.0	145.2
Fertilizers		134.9	143.5	158.3	135.7	151.8	151.8	151.8	164.8	151.8	159.6	183.0
Metals and Minerals		142.5	215.0	248.4	218.1	229.5	234.7	233.9	262.9	266.6	267.9	254.2

a/ Included in the petroleum index      b/ Included in the non-energy index      c/ Steel not included in the non-energy ind  
 \$ = US dollar    ¢ = US cent    bbl = barrel    cum = cubic meter    dmtu = Dry Metric Ton Unit    kg = kilogram    mmbtu = million British thermal un  
 mt = metric ton    toz = troy oz    n.a. = not available    n.q. = no quotation

Description of Price Series

Maize (US), no. 2, yellow, f.o.b. US Gulf ports

Rice (Thai), 5% broken, white rice (WR), milled, indicative price based on weekly surveys of export transactions, government standard, f.o.b. Bangkok

Rice (Thai), 25% broken, WR, milled indicative survey price, government standard, f.o.b. Bangkok

Rice (Thai), 35% broken, WR, milled, indicative survey price, government standard, f.o.b. Bangkok

Rice (Thai), 100% broken, A.1 Special, broken kernel obtained from the milling of WR 15%, 20%, and 25%, indicative price, government standard, f.o.b. Bangkok

Sorghum (US), no. 2 milo yellow, f.o.b. Gulf ports

Wheat (Canadian), no. 1, Western Red Spring (CWRS), in store, St. Lawrence, export price

Wheat (US), no. 1, hard red winter, ordinary protein, export price delivered at the Gulf port for prompt or 30 days shipment

Wheat (US), no. 2, soft red winter, export price delivered at the Gulf port for prompt or 30 days shipment

Development Prospects Group      1818 H Street, N.W. , MSN MC 2-200

Development Economics Vice Presidency      Washington, D.C. 20433 U.S.A.

World Bank      Tel. (202) 473 - 3862

July 5, 2007      Email GCM@worldbank.org



### Import Parity for Rice

Item	Unit	2007	2008	2009	2010	2015	
1	World market price in Bangkok <sup>(1)</sup>	constant \$/mt	318	320	315	310	300
	Less: Quality adjustment to 25% broken <sup>(2)</sup>	7%	22	22	22	22	21
2	Add: freight + insurance to Phnom Penh	constant \$/mt	30	30	30	30	30
3	CIF Cambodian border	constant \$/mt	326	328	323	318	309
	Border price at official exchange rate	4000	1,302,960	1,310,400	1,291,800	1,273,200	1,236,000
4	Economic border price (KR) @ SER = 1	4000	1,302,960	1,310,400	1,291,800	1,273,200	1,236,000
5	Add: port handling charges US \$ 3	KR/mt	12,000	12,000	12,000	12,000	12,000
6	Add: tsport and handling to Phnom P US \$ 7	KR/mt	28,000	28,000	28,000	28,000	28,000
7	Value at wholesalers Phnom Penh	KR/mt	1,342,960	1,350,400	1,331,800	1,313,200	1,276,000
8	Add: transport/marketing to Kampong Thom	KR/mt	28,000	28,000	28,000	28,000	28,000
			1,370,960	1,378,400	1,359,800	1,341,200	1,304,000
9	less: Adjustment to comparative quality <sup>(3)</sup>	5%	68,548	68,920	67,990	67,060	65,200
10	<b>Wholesale price at Kampong Thom mill</b>	KR/mt	1,302,412	1,309,480	1,291,810	1,274,140	1,238,800
11	Less: Marketing margin	5%	65,121	65,474	64,591	63,707	61,940
			1,237,291	1,244,006	1,227,220	1,210,433	1,176,860
12	Conversion of rice to paddy	55%	680,510	684,203	674,971	665,738	647,273
13	Less: milling cost	KR/mt	20,000	20,000	20,000	20,000	20,000
14	Millgate price	KR/mt	660,510	664,203	654,971	645,738	627,273
15	Less: transport – farm to mill	KR/mt	20,000	20,000	20,000	20,000	20,000
16	<b>Import parity price at farmgate</b>	KR/mt	640,510	644,203	634,971	625,738	607,273
	<b>Import parity price of rice at farmgate</b>	KR/kg	<b>641</b>	<b>644</b>	<b>635</b>	<b>626</b>	<b>607</b>
	Local farmgate price (at harvest time)		550	580	560	540	520
	Ratio of import parity to local farmgate price		1.16	1.11	1.13	1.16	1.17

Source: World Bank Prospects for the Global Economy - Commodity Forecasts (June 2007) Tab.

(1) Constant \$ FOB price Bangkok 5% broken

(2) Ratio of 25% broken to 5% broken is derived from World Bank Prospects for the Global Economy - Commodity Forecasts (October 2006)

(3) Adjustment from non-glutinous to glutinous (grown in project area).

### Attachment 4 to Appendix 16

### Import Parity for Urea

		Constant US					
Item		Unit	2007 ▶	2008	2009	2010	2015
		constant					
1	Urea bulk, spot, f.o.b. Yuzhnyy (Black Sea) <sup>(1)</sup>	\$/mt	290	280	270	260	240
3	Add: freight + insurance to Cambodia		70	70	70	70	70
4	CIF Sihanoukville US\$/t		360	350	340	330	310
7	Border price at official exchange rate	4000	1,440,000	1,400,000	1,360,000	1,320,000	1,240,000
	Economic border price (KR) @ SER =	1	4000	1,440,000	1,400,000	1,360,000	1,320,000
8	Add: port handling charges US \$	5	KR/mt	20,000	20,000	20,000	20,000
9	Add: tsport and handling to Phnom P	8	KR/mt	32,000	32,000	32,000	32,000
	Wholesalers margin US \$	12	KR/mt	48,000	48,000	48,000	48,000
11	Import parity at wholesalers Phnom Penh		KR/mt	1,492,000	1,452,000	1,412,000	1,372,000
14	Less: tsport (150km) + handling to retailers K Thom			27,500	27,500	27,500	27,500
17	Retail margin - 5% of wholesale	5%		63,000	63,950	45,193	45,121
19	Transport - K Thom to farm			14,000	20,000	20,000	20,000
20	Import parity price at farmgate			1,354,500	1,387,950	994,049	992,549
21	Import parity price at farmgate O Mean	KR/kg	1,355	1,388	994	993	
22	Local farmgate price at O Mean	KR/kg	1,400				
24	Ratio of import parity price to local farmgate price		0.97				

Source: World Bank Commodity Price Projections (Pink Pages, March 2007)

(a) Exchange rate: US\$ to KGS = 4,000.00





### Import Parity for Di-Ammonium Phosphate (DAP)

Item	Unit	2007	2008	2009	2010	2015
	constant					
1 DAP bulk, spot, f.o.b. US Gulf	\$/mt	390	450	400	350	300
3 Freight and insurance to Cambodia		120	120	120	120	120
4 CIF - Phnom Penh		270	330	280	230	
7 Cost of DAP in Cambodia (a)	KR/t	1,340,000	1,280,000	1,240,000	1,200,000	
8 Custom & handling charges (\$10)		0	40,000	40,000	40,000	
9 Import duty		0	0	0	0	
11 Wholesale taxes & duties (0% CIF)						
12 Wholesale margin (5% of CIF)		67,000	67,000	67,000	67,000	
13 Import parity at wholesale price		1,407,000	1,387,000	1,347,000	1,307,000	
14 Transport (100km) to retailers, loading, unloading		25,000	25,000	25,000	25,000	
16 Retail taxes and duties (0% of wholesale) (b)			0	0	0	
17 Retail margin - 5% of wholesale		70,350	72,350	72,350	72,350	
18 Transport - district to farm		25,000	72,350	72,350	72,350	
19 Import parity price at farmgate		1,527,350	1,556,700	1,516,700	1,476,700	
21 Import parity price at farmgate (c)	KR/kg	1,527	1,557	1,517	1,477	
22 Local farmgate price	KR/kg	1,500	1,500	1,500	1,500	
24 Ratio of import parity price to local farmgate price		1.02	1.04	1.01	0.98	

Source: World Bank Commodity Price Projections (October 2006)

(a) For exchange rate and standard conversion factor, see footnotes for rice price derivation

Attachment 6 to Appendix 16

### Estimated Conversion Factors for Project Farm Input in Domestic Price Numeraire

Item		Price	Tradable	DVA	Tax	Total	CF
Imported Pesticides, Fungicides, & Fertilisers	Financial	100	20	80	0	100	
	Economic		20	80		100	1
Imported Animal remedies, Vaccines etc	Financial	100	20	70	10	100	
	Economic		20	70		90	0.9
Cultivation equipment and small tools	Financial	100	20	55	25	100	
	Economic		20	55		75	0.75
Machine Hire	Financial	100	0	80	20	100	
	Economic		0	80		80	0.8
Straw	Financial	100		100	0	100	
	Economic		0	100		100	1
Green Fodder	Financial	100	20	80	0	100	
	Economic		20	80		100	1
Sacks and packaging	Financial	100	15	67	18	100	
	Economic		15	67		82	0.82
Vegetables	Financial	100	20	80	0	100	
	Economic		20	80		100	1
Organic Manure	Financial	100		100	0	100	
	Economic		0	100		100	1
Transportation	Financial	100	40	30	30	100	
	Economic		40	30		70	0.7
Seeds - Cereal/Forage	Financial	100	20	70	10	100	
	Economic		20	70		90	0.9



## COST OF FARM INPUTS PER HA FOR DIFFERENT CROPS (2007 CONSTANT PRICES)

**Table A: O Mean**

**A : Without project**

A - without project																					
Item	Unit	Price (\$)		Rainfed WS BC Rice			Rainfed WS TP Rice			Floating Rice (broadcast)			Irrig. DS TP Rice			Water Melon (hybrid)			Maize		
				Quantity	Cost (\$)		Quantity	Cost (\$)		Quantity	Cost (\$)		Quantity	Cost (\$)		Quantity	Cost (\$)		Quantity	Cost (\$)	
		Financial	Economic		Financial	Economic		Financial	Economic		Financial	Economic		Financial	Economic		Financial	Economic		Financial	Economic
Seed	kg	0.2	0.1	134	20.1	18.4	50	7.5	6.9	60	9	8.2	50.0	7.5	6.9	2.4	39.6	36.0	30	4.50	4.12
Nursery land prep	ha	12.0	10.8		-	-	1	12	10.8				1.0	12.0	10.8		0.0			-	-
Manure nursery	t/ha	25.0	22.5		-	-	0	0	0.0	0.25	6.25	5.6	0.5	12.5	11.3		0.0			-	-
Urea	kg	0.34	0.31	20	6.8	6.3	20	6.8	6.3	0	0	0.0	50.0	17.0	15.7	50.0	17.0	15.7	25	8.50	7.85
DAP	kg	0.38	0.37	11	4.2	4.1	25	9.5	9.2	50	19	18.5	50.0	19.0	18.5	50.0	19.0	18.5	25	9.50	9.24
Manure	t	25.0	22.5	0.8	20.0	18.0	0.5	12.5	11.3	0	0	0.0	0.5	12.5	11.3	0.5	12.5	11.3		-	-
Pest: foliolol	l	4.2	4.2	0.5	2.1	2.1	0	0	0.0	0	0	0.0	1.0	4.2	4.2	1.0	4.2	4.2		-	-
Pest: 2,4-D	kg	3.5	3.5	0	-	-	0	0	0.0	0.5	1.75	1.8		-	-	1.0	3.5	3.5		-	-
Labor (i)	p-day	1.8	1.3	35	61.3	45.9	60	105	78.8	31	54.25	40.7	80.0	140.0	105.0	35.0	61.3	45.9	40	70.00	52.50
Land Prep.	ha	18.8	16.9	1	18.8	16.9	0	0	0.0	1	18.75	16.9	1.0	18.8	16.9		0.0	0.0	1	18.75	16.88
Threshing/harvesting	t	6.8	6.9	1.65	11.2	11.3	0	0	0.0	2	13.6	13.7	4.5	30.6	30.9		0.0	0.0	1	6.80	6.86
Pump	hour	2.0	2.0		-	-		0	0.0	0	0	0.0	20.0	40.0	40.0	20.0	40.0	40.0	20	40.00	40.00
Total cost / ha					144.4	123.0		153.3	123.2		122.6	105.4		314.1	271.3		197.1	175.1		158.1	137.4

**B: With project**

B. With project		Price (\$)		Supp. Irrigated WS BC Rice			Irrigated WS TP Rice			Floating Rice (broadcast)			Irrig. DS TP Rice			Water Melon (hybrid)		
Item	Unit			Quantity	Cost (\$)		Quantity	Cost (\$)		Quantity	Cost (\$)		Quantity	Cost (\$)		Quantity	Cost (\$)	
		Financial	Economic		Financial	Economic		Financial	Economic		Financial	Economic		Financial	Economic		Financial	Economic
Seeds	kg	0.35	0.1	90	31.5	12.3	50	17.5	6.9	90	31.5	12.3	50	17.5	6.9	2.4	39.6	36.0
Nursery land prep	ha	12.00	10.8			-	1	12.00	10.8			-	1	12.0	10.8	0.0	0.0	0.0
Nursery manure	t/ha	25.00	22.5				0.25	6.25	5.6	0.25	6.25	5.6	0.50	12.5	11.3	0.0	0.0	0.0
Urea	kg	0.34	0.3	50	17.0	15.7	50	17	15.7	50	17	15.7	75	25.5	23.6	50.0	17.0	15.7
DAP	kg	0.38	0.4	100	38.0	37.0	100	38	37.0	50	19	18.5	150	57.0	55.4	100.0	38.0	37.0
Manure	t	25	22.5	2	50.0	45.0	2	50	45.0	-	0	-	2.0	50.0	45.0	1.0	25.0	22.5
Pest: folidol	l	4.2	4.2	0	-	-	1	4.2	4.2	-	0	-	1.0	4.2	4.2	1.0	4.2	4.2
Pest: 2,4-D	kg	3.5	3.5	0.5	1.8	1.8		0	-	1	1.75	1.8	1.0	3.5	3.5	1.0	3.5	3.5
Labor (i)	p-day	1.75	1.3	30	52.5	39.4	65	113.75	85.3	35	61.25	45.9	100	175.0	131.3	35.0	61.3	45.9
Land Prep.	ha	18.75	16.9	2	37.5	33.8	2	37.5	33.8	2	37.5	33.8	2	37.5	33.8	0.0	0.0	0.0
Threshing/harvesting	t	6.8	6.9	3.2	21.8	21.9	3.50	23.8	24.0	3.00	20.4	20.6	4.50	30.6	30.9	0.0	0.0	0.0
Pump	hour	2	2.0		-	-	0	0	-		-	-		-	-	0.0	0.0	0.0
Total cost / ha					250.0	206.8		320.0	268.2		194.7	154.2		425.3	356.5		188.6	164.8

WS = Wet Season; DS = Dry Season; TP = Transplanted; BC = Broadcast; Imp = Improved;

(i) hired labour considered for seedlings pulling, transplanting, and harvesting operations

Table B: O Touk

## A: Without project

Item	Unit	Price (\$)		Rainfed WS BC Rice			Rainfed WS TP Rice			Floating Rice (broadcast)			Irrig. DS TP Rice			Water Melon (hybrid)			Maize		
				Quantity		Cost (\$)	Quantity		Cost (\$)	Quantity		Cost (\$)	Quantity		Cost (\$)	Quantity		Cost (\$)	Quantity		Cost (\$)
		Financial	Economic				Financial	Economic		Financial	Economic		Financial	Economic		Financial	Economic		Financial	Economic	
Seed	kg	0.2	0.1	134	20.1	18.4	50	7.5	6.9	60	9	8.2	50.0	7.5	6.9	2.4	39.6	36.0	30	4.50	4.12
Nursery land prep	ha	12.0	10.8	-	-	-	1	12	10.8	-	-	-	1.0	12.0	10.8	-	0.0	-	-	-	-
Manure nursery	t/ha	25.0	22.5	-	-	-	0	0	0.0	0.25	6.25	5.6	0.5	12.5	11.3	-	0.0	-	-	-	-
Urea	kg	0.34	0.31	20	6.8	6.3	20	6.8	6.3	0	0	0.0	50.0	17.0	15.7	50.0	17.0	15.7	25	8.50	7.85
DAP	kg	0.38	0.37	11	4.2	4.1	25	9.5	9.2	50	19	18.5	50.0	19.0	18.5	50.0	19.0	18.5	25	9.50	9.24
Manure	t	25.0	22.5	0.8	20.0	18.0	0.5	12.5	11.3	0	0	0.0	0.5	12.5	11.3	0.5	12.5	11.3	-	-	-
Pest: foliolol	l	4.2	4.2	0.5	2.1	2.1	0	0	0.0	0	0	0.0	1.0	4.2	4.2	1.0	4.2	4.2	-	-	-
Pest: 2,4-D	kg	3.5	3.5	0	-	-	0	0	0.0	0.5	1.75	1.8	-	-	-	1.0	3.5	3.5	-	-	-
Labor (i)	p-day	1.8	1.3	35	61.3	45.9	60	105	78.8	31	54.25	40.7	80.0	140.0	105.0	35.0	61.3	45.9	40	70.00	52.50
Land Prep.	ha	18.8	16.9	1	18.8	16.9	0	0	0.0	1	18.75	16.9	1.0	18.8	16.9	-	0.0	0.0	1	18.75	16.88
Threshing/harvesting	t	6.8	6.9	1.65	11.2	11.3	0	0	0.0	2	13.6	13.7	4.5	30.6	30.9	-	0.0	0.0	1	6.80	6.86
Pump	hour	2.0	2.0	-	-	-	-	0	0.0	0	0	0.0	20.0	40.0	40.0	20.0	40.0	40.0	20	40.00	40.00
<b>Total cost / ha</b>					<b>144.4</b>	<b>122.9</b>		<b>153.3</b>	<b>123.2</b>		<b>122.6</b>	<b>105.4</b>		<b>314.1</b>	<b>271.3</b>		<b>197.1</b>	<b>175.1</b>		<b>158.1</b>	<b>137.4</b>

## B: With project

Item		Unit	Price (\$)		Supp. Irrigated WS BC Rice			Irrigated WS TP Rice			Floating Rice (broadcast)			Irrig. DS TP Rice			Water Melon (hybrid)		

WS = Wet Season; DS = Dry Season; TP = Transplanted; BC = Broadcast; Imp = Improved;

(i) hired labour considered for seedlings pulling, transplanting, and harvesting operations

**Table C: Spean Sraeng–Trapeang Ambel****A: Without project**

A. without project																		
Item	Unit	Price (\$)		Rainfed WS BC Rice			Rainfed WS TP Rice			Floating Rice (broadcast)			Irrig. DS TP Rice			Water Melon (hybrid) (pump assisted from stream or ponding)		
				Quantity	Cost (\$)		Quantity	Cost (\$)		Quantity	Cost (\$)		Quantity	Cost (\$)		Quantity	Cost (\$)	
		Financial	Economic		Financial	Economic		Financial	Economic		Financial	Economic		Financial	Economic		Financial	Economic
Seed	kg	0.2	0.1	134	20.1	18.4	50	7.5	6.9	60	9	8.2	50.0	7.5	6.9	2.4	39.6	36.0
Nursery land prep	ha	12.0	10.8		-	-	1	12	10.8				1.0	12.0	10.8		0.0	
Manure nursery	t/ha	25.0	22.5		-	-	0	0	0.0	0.25	6.25	5.6	0.5	12.5	11.3		0.0	
Urea	kg	0.34	0.31	20	6.8	6.3	20	6.8	6.3	0	0	0.0	50.0	17.0	15.7	50.0	17.0	15.7
DAP	kg	0.38	0.37	11	4.2	4.1	25	9.5	9.2	50	19	18.5	50.0	19.0	18.5	50.0	19.0	18.5
Manure	t	25.0	22.5	0.2	5.0	4.5	0.5	12.5	11.3	0	0	0.0	0.5	12.5	11.3	0.5	12.5	11.3
Pest: folidol	l	4.2	4.2	0.5	2.1	2.1	0	0	0.0	0	0	0.0	1.0	4.2	4.2	1.0	4.2	4.2
Pest: 2,4-D	kg	3.5	3.5	0	-	-	0	0	0.0	0.5	1.75	1.8	-	-	-	1.0	3.5	3.5
Labor (i)	p-day	1.8	1.3	35	61.3	45.9	60	105	78.8	31	54.25	40.7	80.0	140.0	105.0	35.0	61.3	45.9
Land Prep.	ha	18.8	16.9	1	18.8	16.9	0	0	0.0	1	18.75	16.9	1.0	18.8	16.9		0.0	0.0
Threshing/harvesting	t	6.8	6.9	1.65	11.2	11.3	0	0	0.0	2	13.6	13.7	4.5	30.6	30.9		0.0	0.0
Pump	hour	2.0	2.0		-	-		0	0.0	0	0	0.0	20.0	40.0	40.0	20.0	40.0	40.0
Total cost / ha					129.4	109.4		153.3	123.2		122.6	105.4		314.1	271.3		197.1	175.1

**B: With project**

B. With project		C. Without project																		
Item	Unit	Price (\$)		Irrigated WS BC Rice			Irrigated WS TP Rice			Floating Rice (broadcast)			Irrig. DS TP Rice			Water Melon (hybrid) (pump assisted from stream or ponding)				
				Quantity	Cost (\$)		Quantity	Cost (\$)		Quantity	Cost (\$)		Quantity	Cost (\$)		Quantity	Cost (\$)			
		Financial	Economic		Financial	Economic		Financial	Economic		Financial	Economic		Financial	Economic		Financial	Economic		
Seeds	kg	0.35	0.1	90	31.5	12.3	50	17.5	6.9	90	31.5	12.3	50	17.5	6.9	2.4	39.6	36.0		
Nursery land prep	ha	12.00	10.8			-	1	12.00	10.8			-	1	12.0	10.8	0.0	0.0	0.0		
Nursery manure	t/ha	25	22.5			-	0.25	6.25	5.6	0.25	6.25	5.6	0.50	12.5	11.3	0.0	0.0	0.0		
Urea	kg	0.34	0.3	50	17.0	15.7	50	17	15.7	50	17	15.7	75	25.5	23.6	50.0	17.0	15.7		
DAP	kg	0.38	0.4	100	38.0	37.0	100	38	37.0	50	19	18.5	150	57.0	55.4	100.0	38.0	37.0		
Manure	t	25	22.5	1	25.0	22.5	2	50	45.0	-	0	-	2.0	50.0	45.0	1.0	25.0	22.5		
Pest: folidol	l	4.2	4.2	0	-	-	1	4.2	4.2	-	0	-	1.0	4.2	4.2	1.0	4.2	4.2		
Pest: 2,4-D	kg	3.5	3.5	0.5	1.8	1.8		0	-	1	1.75	1.8	1.0	3.5	3.5	1.0	3.5	3.5		
Labor (i)	p-day	1.75	1.3	30	52.5	39.4	65	113.75	85.3	35	61.25	45.9	100	175.0	131.3	35.0	61.3	45.9		
Land Prep.	ha	18.75	16.9	2	37.5	33.8	2	37.5	33.8	2	37.5	33.8	2	37.5	33.8	0.0	0.0	0.0		
Threshing/harvesting	t	6.8	6.9	3.2	21.8	21.9	3.50	23.8	24.0	3.0	20.4	20.6	4.50	30.6	30.9	0.0	0.0	0.0		
Pump	hour	2	2.0		-	-	0	0	-		-	-	20.00	40.0	40.0	20.0	40.0	40.0		
Total cost / ha					225.0	184.3		320.0	268.2		194.7	154.2		465.3	396.5		228.6	204.8		

WS = Wet Season; DS = Dry Season; TP = Transplanted; BC = Broadcast; Imp = Improved;

(i) hired labour considered for seedlings pulling, transplanting, and harvesting operations



## AGRICULTURAL PRODUCTION AND REVENUE (2007 CONSTANT PRICES)

### Table A: O Mean

1 Without Project																
	Benefits	Area (ha)	Yield (t/ha)	Physical Production (t)	Price		Gross Revenue		Production Costs		Gross Cost		Net Income		Net Income Avg. 1 ha	
					Fin (\$/t)	Econ (\$/t)	Fin (\$)	Econ (\$)	Fin (\$/ha or t)	Econ (\$)	Fin (\$)	Econ (\$)	Fin (\$)	Econ (\$)	Fin (\$) <sup>(2)</sup>	Econ (\$) <sup>(2)</sup>
A	Crops															
	Rainfed WS <sup>(1)</sup> BC Rice	-	1.65	-	137.5	160	-	-	144	123	-	-	-	-	-	-
	Rainfed WS TP Rice	530	1.70	901	137.5	160	123,888	144,275	153	123	81,249	65,287	42,639	78,988	80.5	149.0
	Floating Rice (broadcast)	-	1.2	-	137.5	160	-	-	123	105	-	-	-	-	-	-
	Irrig. DS TP Rice	57	2.2	125	137.5	160	17,243	20,080	314	271	17,901	15,463	658	4,617	1.2	8.7
	Rice Straw	587		1,026	9.5	8.6	9,751	8,776			-	-	9,751	8,776	18.4	16.6
	Water Melon (hybrid)	10	18.0	180	100.0	90.0	18,000	16,200	197	175	1,971	1,751	16,030	14,449	30.2	27.3
	Cucumber						-	-								
	Maize (DS)	25	2.5	63	75.0	67.5	4,688	4,219	158	142	3,951	3,556	736	663	1.4	1.3
	Total crops	622		2,295			173,568	193,549			105,072	86,057	68,497	107,492	129	203.7
B	Pigs			8	1125	1012.5	9,450	8,505	900.0	810.0	7,560	6,804	1,890	1,701	3.6	3.2
C	Fish			1	1000	900	1,000	900	600.0	540.0	600	540	400	360	0.8	0.7
Total Annual		622					184,018	202,954			113,232	93,401	70,787	109,553	133.6	206.7

Project Benefitted Area (ha) 530  
W-O Project Annual Cropped Area (ha) 622  
Cropping Intensity (%) 117%

2 With Project Peak Production (Yr 4 onwards)																
	Benefits	Area (ha)	Yield (t/ha)	Physical Production (t)	Price		Gross Revenue		Production Costs		Gross Cost		Net Income		Net Income Avg. 1 ha	
					Fin (\$/t)	Econ (\$/t)	Fin (\$)	Econ (\$)	Fin \$/ha or t	Econ (\$)	Fin (\$)	Econ (\$)	Fin (\$)	Econ (\$)	Fin (\$) <sup>(2)</sup>	Econ (\$) <sup>(2)</sup>
A	Crops															
	Irrigated WS <sup>(1)</sup> TP Rice : short HYV	500	3.5	1,750	137.5	160.1	240,625	280,223	320	268	160,000	134,112	80,625	146,112	152.1	275.7
	Irrigated WS TP Rice : aromatic <sup>(3)</sup>	30	3.0	90	175.0	190.0	15,750	17,100	256	215	7,680	6,437	8,070	10,663	15.2	20.1
	Floating Rice (broadcast)		2.8	-	137.5	160.1	-	-	195	154	-	-	-	-	-	-
	Irrig. DS TP Rice : short HYV (IRR66)	288	3.8	1,094	137.5	160.1	150,480	175,244	425	356	122,486	102,666	27,994	72,577	52.8	136.9
	Rice Straw	818	3.0	2,934	9.5	8.6	27,877	25,089			-	-	27,877	25,089	52.6	47.3
	Water Melon (hybrid) : irrig DS	30	25	750	100.0	90.0	75,000	67,500	189	165	5,657	4,944	69,344	62,556	130.8	118.0
	Cucumber : irrig DS														-	-
	Maize														-	-
	Total crops			6,619			509,732	565,156			295,823	248,159	213,909	316,997	404	598
B	Pigs			20	1,125	1,013	22,500	20,250	900.0	810.0	18,000	16,200	4,500	4,050	8.5	7.6
C	Fish			15	1,000	900	15,000	13,500	600.0	540.0	9,000	8,100	6,000	5,400	11.3	10.2
Total Annual		848		6,654			547,232	598,906			322,823	272,459	224,409	326,447	423	616

Notes : 1) WS = Wet Season; DS = Dry Season; TP = Transplanted ; BC = Broadcast; HYV = Improved High Yielding Variety  
2) average 1 ha farm is assumed to plant each crop in the same proportion as in the full service area.  
3) e.g Pkarnlis

With Project Annual Cropped Area : wet + dry 848 ha  
W-O Project Annual Cropped Area : wet + dry 622 ha  
Incremental Cropping Intensity (%) 136%

Table B: O Touk

1 Without Project																
	Benefits	Area (ha)	Yield (t/ha)	Physical Produc- tion (t)	Price		Gross Revenue		Production Costs		Gross Cost		Net Income		Net Income Avg. 1 ha	
					Fin	Econ	Fin	Econ	Fin	Econ	Fin	Econ	Fin	Econ	Fin	Econ
					(\$/t)	(\$/t)	(\$)	(\$)	(\$/ha or t)	(\$)	(\$)	(\$)	(\$)	(\$)	(\$) <sup>(2)</sup>	(\$) <sup>(2)</sup>
A	Crops															
	Rainfed WS <sup>(1)</sup> BC Rice	-	1.30	-	137.5	160	-	-	144	123	-	-	-	-	-	-
	Rainfed WS TP Rice	1,030	1.50	1,545	137.5	160	212,438	247,397	153	123	157,899	126,878	54,539	120,519	53.0	117.0
	Floating Rice (broadcast)	-	1.2	-	137.5	160	-	-	123	105	-	-	-	-	-	-
	Irrig. DS TP Rice	18	2.5	45	137.5	160	6,188	7,206	314	271	5,653	4,883	535	2,323	0.5	2.3
	Rice Straw	1,048		1,590	9.5	8.6	15,105	13,595			-	-	15,105	13,595	14.7	13.2
	Water Melon (hybrid)	6	18.0	108	100.0	90.0	10,800	9,720	197	175	1,182	1,050	9,618	8,670	9.3	8.4
	Cucumber															
	Maize (DS)	28	2.5	70	75.0	67.5	5,250	4,725	158	142	4,425	3,983	825	742	0.8	0.7
	Total crops	1,082		3,358			249,780	282,642			169,160	136,795	80,620	145,848	78	142
B	Pigs			8	1125	1012.5	9,450	8,505	900.0	810.0	7,560	6,804	1,890	1,701	1.8	1.7
C.	Fish			2	1000	900	2,000	1,800	600.0	540.0	1,200	1,080	800	720	0.8	0.7
Total Annual		1,082					261,230	292,947			177,920	144,679	83,310	148,269	80.9	144.0

Project Benefitted Area (ha) 1,030  
W-O Project Annual Cropped Area (ha) 1,082  
Cropping Intensity (%) 105%

2 With Project Peak Production (Yr 5 onwards)																
	Benefits	Area (ha)	Yield (t/ha)	Physical Produc- tion (t)	Price		Gross Revenue		Production Costs		Gross Cost		Net Income		Net Income Avg. 1 ha	
					Fin	Econ	Fin	Econ	Fin	Econ	Fin	Econ	Fin	Econ	Fin	Econ
					(\$/t)	(\$/t)	(\$)	(\$)	(\$/ha or t)	(\$)	(\$)	(\$)	(\$)	(\$)	(\$) <sup>(2)</sup>	(\$) <sup>(2)</sup>
A	Crops															
	Irrigated WS <sup>(1)</sup> TP Rice : short HYV	930	3.0	2,790	137.5	160.1	383,625	446,756	320	268	297,600	249,448	86,025	197,308	83.5	191.6
	Irrigated WS TP Rice : aromatic <sup>(3)</sup>	100	3.0	300	175.0	190.0	52,500	57,000	256	215	25,600	21,458	26,900	35,542	26.1	34.5
	Floating Rice (broadcast)		2.8	-	137.5	160.1	-	-	195	154	-	-	-	-	-	-
	Irrig. DS TP Rice : short HYV (IRR66)	125	3.8	473	137.5	160.1	65,051	75,756	425	356	52,950	44,382	12,101	31,375	11.7	30.5
	Rice Straw	1,155	3.0	3,563	9.5	8.6	33,849	30,465			-	-	33,849	30,465	32.9	29.6
	Water Melon (hybrid) : irrig DS	30	25	750	100.0	90.0	75,000	67,500	189	165	5,657	4,944	69,344	62,556	67.3	60.7
	Cucumber : irrig DS														-	-
	Maize														-	-
	Total crops			7,876			610,026	677,477			381,806	320,231	228,219	357,245	222	347
B	Pigs			35	1,125	1,013	39,375	35,438	900.0	810.0	31,500	28,350	7,875	7,088	7.6	6.9
C.	Fish			20	1,000	900	20,000	18,000	600.0	540.0	12,000	10,800	8,000	7,200	7.8	7.0
Total Annual		1,185		7,931			669,401	730,914			425,306	359,381	244,094	371,533	237	361

Notes : 1) WS = Wet Season; DS = Dry Season; TP = Transplanted ; BC = Broadcast; HYV = improved High Yielding Variety  
2) average 1 ha farm is assumed to plant each crop in the same proportion as in the full service area.  
3) e.g Pkarnlis

With Project Annual Cropped Area : wet + dry 1,185 ha  
W-O Project Annual Cropped Area : wet + dry 1,082 ha  
Incremental Cropping Intensity (%) 109%



Table C: Spean Sraeng - Trapeang Ambel

1 Without Project																
	Benefits	Area	Yield	Physical Production	Price		Gross Revenue		Production Costs		Gross Cost		Net Income		Net Income Avg. 1 ha	
					Fin	Econ	Fin	Econ	Fin	Econ	Fin	Econ	Fin	Econ	Fin	Econ
					(\$/t)	(\$/t)	(\$)	(\$)	(\$/ha or t)	(\$)	(\$)	(\$)	(\$)	(\$)	(\$)	(\$) <sup>(2)</sup>
A	Crops															
	Rainfed WS <sup>(1)</sup> BC Rice    Spean Sraeng	4,920	1.0	4,920	137.5	160	676,500	787,828	129	109	636,481	538,384	40,019	249,444	7.9	49.2
	Rainfed WS TP Rice		1.50	-	137.5	160	-	-	153	123	-	-	-	-	-	-
	Floating Rice (broadcast) Spean Sraeng	150	1.0	150	137.5	160	20,625	24,019	123	105	18,390	15,805	2,235	8,214	0.4	1.6
	Irrig. DS BC Rice (pump assisted)	-	2.5	-	137.5	160	-	-	314	271	-	-	-	-	-	-
	Rice Straw	5,070		5,070	9.5	8.6	48,165	43,349			-	-	48,165	43,349	9.5	8.6
	Water Melon: (DS pumped/ponded) Trapeang Ambel	40	18.0	720	100.0	90.0	72,000	64,800	197	175	7,882	7,003	64,118	57,797	12.6	11.4
	Vegetables (represented by watermelon) <sup>4</sup>						-	-								
	Maize (DS)	5	2.5	13	75.0	67.5	938	844	158	142	790	711	147	133	0.0	0.0
Total crops	5,115		10,873			818,228	920,839			663,543	561,904	154,685	358,935	30.5	70.8	
B	Pigs			20	1125	1012.5	22,500	20,250	900.0	810.0	18,000	16,200	4,500	4,050	0.9	0.8
C	Fish			3	1000	900	3,000	2,700	600.0	540.0	1,800	1,620	1,200	1,080	0.2	0.2
	Total Annual	5,115					843,728	943,789			683,343	579,724	160,385	364,065	62.1	142.6

Project Benefitted Area (ha) 5,070  
W-O Project Annual Cropped Area (ha) 5,115  
Cropping Intensity (%) 101%

2 With Project Peak Production (Yr 4 onwards)																
	Benefits	Area	Yield	Physical Production	Price		Gross Revenue		Production Costs		Gross Cost		Net Income		Net Income Avg. 1 ha	
					Fin	Econ	Fin	Econ	Fin	Econ	Fin	Econ	Fin	Econ	Fin	Econ
A	Crops															
	Irrigated WS BC Rice Trapeang Ambel	2,270	3.0	6,810	137.5	160.1	936,375	1,090,469	320	268	726,400	608,867	209,975	481,602	41.4	95.0
	Irrigated WS BC Rice (aromatic) Trapeang Ambel	200	2.8	560	175.0	190.0	98,000	106,400	256	215	51,200	42,916	46,800	63,484	9.2	12.5
	Floating Rice BC Spean Sreng (1-2m depth)	1,300	2.8	3,640	137.5	160.1	500,500	582,864	195	154	253,045	200,428	247,455	382,437	48.8	75.4
	Floating Rice Spean Sreng (0-1m depth)	1,300	3.0	3,900	137.5	160.1	536,250	624,498	320	268	416,000	348,690	120,250	275,807	23.7	54.4
	Irrig. DS BC Rice (pumped/ponded) Trapeang Ambel	100	3.5	350	137.5	160.1	48,125	56,045	256	215	25,600	21,458	22,525	34,587	4.4	6.8
	Rice Straw	5,170		15,260	9.5	8.6	144,970	130,473			-	-	144,970	130,473	28.6	25.7
	Water Melon: (DS pumped/ponded) Trapeang Ambel	100	25	2,500	100.0	90.0	250,000	225,000	229	205	22,855	20,481	227,145	204,519	44.8	40.3
	Vegetables (represented by watermelon) <sup>4</sup>														-	-
	Total crops	5,270		33,020			2,514,220	2,815,748			1,495,100	1,242,839	1,019,120	1,572,909	201.0	310.2
B	Pigs			50	1,125	1,013	56,250	50,625	900.0	810.0	45,000	40,500	11,250	10,125	2.2	2.0
C.	Fish			20	1,000	900	20,000	18,000	600.0	540.0	12,000	10,800	8,000	7,200	1.6	1.4
	Total Annual	5,270		33,090			2,590,470	2,884,373			1,552,100	1,294,139	1,038,370	1,590,234	205	314

Notes : 1) WS = Wet Season; DS = Dry Season; TP = Transplanted ; BC = Broadcast; HYV = Improved High Yielding Variety

2) average 1 ha farm is assumed to plant each crop in the same proportion as in the full service area.

3) e.g Pkarmis

4) Chinese lettuce, egg plant, string bean, and cucumber

With Project Annual Cropped Area : wet + dry 5,270 ha  
W-O Project Annual Cropped Area : wet + dry 5,115 ha  
Incremental Cropping Intensity (%) 103%



# **CALCULATION OF FIRR (2007 CONSTANT PRICES)**

**Table A: O Mean**

Incremental Costs									Incremental Value of Production				Net Benefit Flow
Year	Capital costs (including contingencies)	O&M costs	Engineering & services (Design and supervision)	Resettle-ment and Compen-sation	Environ-mental Monit-oring	Comm-unity & Agricultural Development	Opportunity Cost of Dry Season Irrigation	Total Costs	Phased incremental crop benefits	Domestic water benefits	Livestock benefits	Fish benefits	Net benefits
			8%			\$ 250	/ha						
1	1,247,391		79,833	12,000	2,000			1,341,224					- 1,341,224
2		5,300	19,958		2,500	59,625	-	87,383	87,247	-	2,610	5,600	8,074
3		5,300			2,500	39,750	-	47,550	116,330	-	2,610	5,600	76,990
4		5,300				33,125	-	38,425	145,412	-	2,610	5,600	115,197
5		5,300					-	5,300	145,412	-	2,610	5,600	148,322
6		37,800					-	37,800	145,412	-	2,610	5,600	115,822
7		5,300					-	5,300	145,412	-	2,610	5,600	148,322
8		5,300					-	5,300	145,412	-	2,610	5,600	148,322
9		5,300					-	5,300	145,412	-	2,610	5,600	148,322
10		5,300					-	5,300	145,412	-	2,610	5,600	148,322
11		37,800					-	37,800	145,412	-	2,610	5,600	115,822
12		5,300					-	5,300	145,412	-	2,610	5,600	148,322
13		5,300					-	5,300	145,412	-	2,610	5,600	148,322
14		5,300					-	5,300	145,412	-	2,610	5,600	148,322
15		5,300					-	5,300	145,412	-	2,610	5,600	148,322
16		37,800					-	37,800	145,412	-	2,610	5,600	115,822
17		5,300					-	5,300	145,412	-	2,610	5,600	148,322
18		5,300					-	5,300	145,412	-	2,610	5,600	148,322
19		5,300					-	5,300	145,412	-	2,610	5,600	148,322
20		5,300					-	5,300	145,412	-	2,610	5,600	148,322
21		37,800					-	37,800	145,412	-	2,610	5,600	115,822
22		5,300					-	5,300	145,412	-	2,610	5,600	148,322
23		5,300					-	5,300	145,412	-	2,610	5,600	148,322
24		5,300					-	5,300	145,412	-	2,610	5,600	148,322
25		5,300					-	5,300	145,412	-	2,610	5,600	148,322
26		37,800					-	37,800	145,412	-	2,610	5,600	115,822
27		5,300					-	5,300	145,412	-	2,610	5,600	148,322
28		5,300					-	5,300	145,412	-	2,610	5,600	148,322
29		5,300					-	5,300	145,412	-	2,610	5,600	148,322
30		5,300					-	5,300	145,412	-	2,610	5,600	148,322
31		37,800					-	37,800	145,412	-	2,610	5,600	115,822
<b>Notes</b> 1) Annual O&M = 10 US\$/ha 2) Major maintenance (every 5 years) = 10% of canal construction cost according to new project development (adopted from related irrigation system in Thailand) 3) Incremental benefits are 50% and 75% of peak yr benefits in yrs 2 ad 3 respectively									FIRR				8.3%
									FNPV @ 2.59%				1,329,047
									FNPV @ 12%				- 351,192
									B/C ratio				0.8

Table B: O Touk

Year	Incremental Costs							Incremental Value of Production				Net Benefit	
	Capital costs (including contingencies)	O&M costs (1)	Engineering & services (Design and supervision)	Resettlement and Compensation	Environmental Monitoring	Community & Agricultural Development	Opportunity Cost of Dry Season Irrigation <sup>(1)</sup>	Total Costs	Phased incremental crop benefits (4)	Domestic water benefits	Livestock benefits	Fish benefits	Flow Net benefits
			8%			\$ 250	/ha						
1	564,339		45,147	124,000	2,000			735,486					- 735,486
2		10,300	22,574		2,500	115,875	-	151,249	47,232	-	5,985	7,200	- 90,832
3		10,300			2,500	77,250	-	90,050	70,847	-	5,985	7,200	- 6,018
4		10,300				64,375	-	74,675	118,079	-	5,985	7,200	56,589
5		10,300					-	10,300	147,599	-	5,985	7,200	150,484
6		42,000					-	42,000	147,599	-	5,985	7,200	118,784
7		10,300					-	10,300	147,599	-	5,985	7,200	150,484
8		10,300					-	10,300	147,599	-	5,985	7,200	150,484
9		10,300					-	10,300	147,599	-	5,985	7,200	150,484
10		10,300					-	10,300	147,599	-	5,985	7,200	150,484
11		42,000					-	42,000	147,599	-	5,985	7,200	118,784
12		10,300					-	10,300	147,599	-	5,985	7,200	150,484
13		10,300					-	10,300	147,599	-	5,985	7,200	150,484
14		10,300					-	10,300	147,599	-	5,985	7,200	150,484
15		10,300					-	10,300	147,599	-	5,985	7,200	150,484
16		42,000					-	42,000	147,599	-	5,985	7,200	118,784
17		10,300					-	10,300	147,599	-	5,985	7,200	150,484
18		10,300					-	10,300	147,599	-	5,985	7,200	150,484
19		10,300					-	10,300	147,599	-	5,985	7,200	150,484
20		10,300					-	10,300	147,599	-	5,985	7,200	150,484
21		42,000					-	42,000	147,599	-	5,985	7,200	118,784
22		10,300					-	10,300	147,599	-	5,985	7,200	150,484
23		10,300					-	10,300	147,599	-	5,985	7,200	150,484
24		10,300					-	10,300	147,599	-	5,985	7,200	150,484
25		10,300					-	10,300	147,599	-	5,985	7,200	150,484
26		42,000					-	42,000	147,599	-	5,985	7,200	118,784
27		10,300					-	10,300	147,599	-	5,985	7,200	150,484
28		10,300					-	10,300	147,599	-	5,985	7,200	150,484
29		10,300					-	10,300	147,599	-	5,985	7,200	150,484
30		10,300					-	10,300	147,599	-	5,985	7,200	150,484
31		42,000					-	42,000	147,599	-	5,985	7,200	118,784
Notes									FIRR				12.4%
									FNPV @2.59%				1,736,363
									FNPV @12%				26,286
									B/C ratio				1.0
1) Only used in the economic calculation													
2) Annual O&M = 10 US\$/ha													
3) Major maintenance (every 5 years) = 10% of canal construction cost according to new project development (adopted from related irrigation system in Thailand)													
4) Incremental benefits are 50% and 75% of peak yr benefits in yrs 2 and 3 respectively													

Table C: Spean Sraeng

Year	Incremental Costs							Incremental Value of Production				Net Benefit Flow	
	Capital costs (including contin- gencies)	O&M costs	Engineering & services (Design and supervision)	Resettle- ment and Compen- sation	Environ- mental Monit- oring	Comm- unity & Agricultural Develop- ment	Opportunity Cost of Dry Season Irrigation	Total Costs	Phased incremental crop benefits	Flood prevention benefits	Livestock benefits	Fish benefits	Net benefits
			5%			180	/ha						
1	3,096,846		154,842	130,000	2,000			3,383,689					- 3,383,689
2	1,336,437	19,013	66,822		2,000	410,670	-	1,834,942	276,619	-	6,750	6,800	- 1,544,772
3		38,025			2,000	273,780	-	313,805	414,929	-	6,750	6,800	114,674
4		50,700				228,150	-	278,850	691,548	-	6,750	6,800	426,248
5		50,700					-	50,700	864,435	-	6,750	6,800	827,285
6		119,700					-	119,700	864,435	-	6,750	6,800	758,285
7		50,700					-	50,700	864,435	-	6,750	6,800	827,285
8		50,700					-	50,700	864,435	-	6,750	6,800	827,285
9		50,700					-	50,700	864,435	-	6,750	6,800	827,285
10		50,700					-	50,700	864,435	-	6,750	6,800	827,285
11		119,700					-	119,700	864,435	-	6,750	6,800	758,285
12		50,700					-	50,700	864,435	-	6,750	6,800	827,285
13		50,700					-	50,700	864,435	-	6,750	6,800	827,285
14		50,700					-	50,700	864,435	-	6,750	6,800	827,285
15		50,700					-	50,700	864,435	-	6,750	6,800	827,285
16		119,700					-	119,700	864,435	-	6,750	6,800	758,285
17		50,700					-	50,700	864,435	-	6,750	6,800	827,285
18		50,700					-	50,700	864,435	-	6,750	6,800	827,285
19		50,700					-	50,700	864,435	-	6,750	6,800	827,285
20		50,700					-	50,700	864,435	-	6,750	6,800	827,285
21		119,700					-	119,700	864,435	-	6,750	6,800	758,285
22		50,700					-	50,700	864,435	-	6,750	6,800	827,285
23		50,700					-	50,700	864,435	-	6,750	6,800	827,285
24		50,700					-	50,700	864,435	-	6,750	6,800	827,285
25		50,700					-	50,700	864,435	-	6,750	6,800	827,285
26		119,700					-	119,700	864,435	-	6,750	6,800	758,285
27		50,700					-	50,700	864,435	-	6,750	6,800	827,285
28		50,700					-	50,700	864,435	-	6,750	6,800	827,285
29		50,700					-	50,700	864,435	-	6,750	6,800	827,285
30		50,700					-	50,700	864,435	-	6,750	6,800	827,285
31		119,700					-	119,700	864,435	-	6,750	6,800	758,285
FIRR									12.5%				
FNPV @ 2.59%									9,839,153				
FNPV @ 12%									197,598				
B/C ratio									1.1				
Notes													
1) Annual O&M =		10	US\$/ha										
2) Major maintenance (every 5 years) = 10% of canal construction cost according to new project development (adopted from related irrigation system in Thailand)													
4) Incremental benefits are 40, 60% and 80% of peak yr benefits in yrs 2, 3 and 4 respectively													



## Calculation of EIRR

Table A: O Mean

Year	Incremental Costs							Incremental Value of Production					Net Benefit Stream	
	Capital costs (inc. contingencies)	O&M costs (a)	Engineering & services (Design and supervision)	Resettle-ment and Compens-ation	Environ-mental Monit-oring	Comm-unity & Agri-cultural Develop-ment	Opportunity Cost of Dry Season Irrigation <sup>(1)</sup>	Total Costs	Phased incremental crop benefits (b)	Domestic water benefits	Livestock benefits	Fish benefits	Net benefits	
	0.9	0.9	0.9	Standard conversion factor										
				0.9	0.9	0.9								
1	1,122,651		71,850	10,800	1,800	-		1,207,101					- 1,207,101	
2		4,770	17,962		2,250	53,663	10,733	89,377	125,703	-	2,349	5,040	43,714	
3		4,770	-		2,250	35,775	10,733	53,528	167,604	-	2,349	5,040	121,465	
4		4,770				29,813	10,733	45,315	209,504	-	2,349	5,040	171,578	
5		4,770					10,733	15,503	209,504	-	2,349	5,040	201,391	
6		34,020					10,733	44,753	209,504	-	2,349	5,040	172,141	
7		4,770					10,733	15,503	209,504	-	2,349	5,040	201,391	
8		4,770					10,733	15,503	209,504	-	2,349	5,040	201,391	
9		4,770					10,733	15,503	209,504	-	2,349	5,040	201,391	
10		4,770					10,733	15,503	209,504	-	2,349	5,040	201,391	
11		34,020					10,733	44,753	209,504	-	2,349	5,040	172,141	
12		4,770					10,733	15,503	209,504	-	2,349	5,040	201,391	
13		4,770					10,733	15,503	209,504	-	2,349	5,040	201,391	
14		4,770					10,733	15,503	209,504	-	2,349	5,040	201,391	
15		4,770					10,733	15,503	209,504	-	2,349	5,040	201,391	
16		34,020					10,733	44,753	209,504	-	2,349	5,040	172,141	
17		4,770					10,733	15,503	209,504	-	2,349	5,040	201,391	
18		4,770					10,733	15,503	209,504	-	2,349	5,040	201,391	
19		4,770					10,733	15,503	209,504	-	2,349	5,040	201,391	
20		4,770					10,733	15,503	209,504	-	2,349	5,040	201,391	
21		34,020					10,733	44,753	209,504	-	2,349	5,040	172,141	
22		4,770					10,733	15,503	209,504	-	2,349	5,040	201,391	
23		4,770					10,733	15,503	209,504	-	2,349	5,040	201,391	
24		4,770					10,733	15,503	209,504	-	2,349	5,040	201,391	
25		4,770					10,733	15,503	209,504	-	2,349	5,040	201,391	
26		34,020					10,733	44,753	209,504	-	2,349	5,040	172,141	
27		4,770					10,733	15,503	209,504	-	2,349	5,040	201,391	
28		4,770					10,733	15,503	209,504	-	2,349	5,040	201,391	
29		4,770					10,733	15,503	209,504	-	2,349	5,040	201,391	
30		4,770					10,733	15,503	209,504	-	2,349	5,040	201,391	
31		34,020					10,733	44,753	209,504	-	2,349	5,040	172,141	
									EIRR					13.5%
									ENPV					136,011
									B/C ratio					1.1
Notes														
1) Off-farm employment lost as a result of planting/tending a dry season crop calculated as:														
dry season area (ha)		318	average land size (ha)		0.7	No dry season beneficiaries		454	No. affected		30%	Total HH	136	
mdays for dry season rice		100	% family labour		60%	mdays compensation/HH		60	Total mdays				8,177	
@ US\$		1.3 mday	Total opportunity cost of dry season irrigation					US \$	10,733					
2) Annual O&M = 10 US\$/ha														
3) Major maintenance (every 5 years) = 10% of canal construction cost according to new project development (adopted from related irrigation system in Thailand)														
4) Incremental benefits are phased in at 50% and 75% of peak yr benefits in yrs 2 ad 3 respectively														

Table B: O Touk

Year	Incremental Costs								Incremental Value of Production				Net Benefit Stream
	Capital costs (inc. contingencies)	O&M costs (a)	Engineering & services (Design and supervision)	Resettle-ment and Compensation	Environ-mental Moni-toring	Comm-unity & Agri-cultural Develop-ment	Opportunity Cost of Dry Season Irrigation <sup>(1)</sup>	Total Costs	Phased incremental crop benefits (4)	Domestic water benefits	Livestock benefits	Fish benefits	Net benefits
		0.9	5%	Standard conversion factor									
				0.9	0.9	0.9							
1	507,905												
2			40,632	111,600	1,800	-	3,549	665,486					- 665,486
3		9,270	20,316		2,250	104,288	3,549	139,672	67,647	-	5,387	6,480	- 60,159
4		9,270				69,525	3,549	84,594	101,471	-	5,387	6,480	28,744
5		9,270					3,549	12,819	169,118	-	5,387	6,480	168,166
6		9,270					3,549	12,819	211,398	-	5,387	6,480	210,445
7		37,800					3,549	41,349	211,398	-	5,387	6,480	181,915
8		9,270					3,549	12,819	211,398	-	5,387	6,480	210,445
9		9,270					3,549	12,819	211,398	-	5,387	6,480	210,445
10		9,270					3,549	12,819	211,398	-	5,387	6,480	210,445
11		37,800					3,549	41,349	211,398	-	5,387	6,480	181,915
12		9,270					3,549	12,819	211,398	-	5,387	6,480	210,445
13		9,270					3,549	12,819	211,398	-	5,387	6,480	210,445
14		9,270					3,549	12,819	211,398	-	5,387	6,480	210,445
15		9,270					3,549	12,819	211,398	-	5,387	6,480	210,445
16		37,800					3,549	41,349	211,398	-	5,387	6,480	181,915
17		9,270					3,549	12,819	211,398	-	5,387	6,480	210,445
18		9,270					3,549	12,819	211,398	-	5,387	6,480	210,445
19		9,270					3,549	12,819	211,398	-	5,387	6,480	210,445
20		9,270					3,549	12,819	211,398	-	5,387	6,480	210,445
21		37,800					3,549	41,349	211,398	-	5,387	6,480	181,915
22		9,270					3,549	12,819	211,398	-	5,387	6,480	210,445
23		9,270					3,549	12,819	211,398	-	5,387	6,480	210,445
24		9,270					3,549	12,819	211,398	-	5,387	6,480	210,445
25		9,270					3,549	12,819	211,398	-	5,387	6,480	210,445
26		37,800					3,549	41,349	211,398	-	5,387	6,480	181,915
27		9,270					3,549	12,819	211,398	-	5,387	6,480	210,445
28		9,270					3,549	12,819	211,398	-	5,387	6,480	210,445
29		9,270					3,549	12,819	211,398	-	5,387	6,480	210,445
30		9,270					3,549	12,819	211,398	-	5,387	6,480	210,445
31		37,800					3,549	41,349	211,398	-	5,387	6,480	181,915
									EIRR				19.7%
									ENPV				515,142
									B/C ratio				1.7
Notes													
1) Off-farm employment lost as a result of planting/tending a dry season crop calculated as:													
dry season area (ha)		155	average land size (ha)		1.2	No dry season beneficiaries		129	No. affected		35%	Total HH	45
mdays for dry season rice			100		% family labour	60%	mdays compensation/HH		60	Total mdays			2,704
@ US\$		1.3	mday		Total opportunity cost of dry season irrigation			US \$		3,549			
2) Annual O&M =		10	US\$/ha										
3) Major maintenance (every 5 years) =			10%		of canal construction cost according to new project development (adopted from related irrigation system in Thailand)								
4) Incremental benefits are phased in at 40%, 60% and 80% of peak yr benefits in yrs 2,3 and 4respectively													



Table C: Spean Sraeng–Trapeang Ambel

Year	Incremental Costs								Incremental Value of Production				Net Benefit Stream
	Capital costs (inc. contingencies)	O&M costs	Engineering & services (Design and supervision)	Resettle-ment and Compensation	Environ-mental Monit-oring	Comm-unity & Agri-cultural Develop-ment	Opportunity Cost of Dry Season Irrigation	Total Costs	Phased incremental crop benefits	Domestic water benefits	Livestock benefits	Fish benefits	Net benefits
	0.9	0.9	5%	Standard conversion factor									
				0.9	0.9	0.9							
1	2,787,162		199,498	117,000	1,800	-	-	3,105,459					- 3,105,459
2	1,202,794	17,111	99,749		1,800	369,603	-	1,691,057	388,472	-	6,075	6,120	- 1,290,390
3		34,223			1,800	246,402	-	282,425	582,707	-	6,075	6,120	312,478
4		45,630			-	205,335	-	250,965	971,179	-	6,075	6,120	732,409
5		45,630			-		-	45,630	1,213,974	-	6,075	6,120	1,180,539
6		107,730			-		-	107,730	1,213,974	-	6,075	6,120	1,118,439
7		45,630			-		-	45,630	1,213,974	-	6,075	6,120	1,180,539
8		45,630			-		-	45,630	1,213,974	-	6,075	6,120	1,180,539
9		45,630			-		-	45,630	1,213,974	-	6,075	6,120	1,180,539
10		45,630			-		-	45,630	1,213,974	-	6,075	6,120	1,180,539
11		107,730					-	107,730	1,213,974	-	6,075	6,120	1,118,439
12		45,630					-	45,630	1,213,974	-	6,075	6,120	1,180,539
13		45,630					-	45,630	1,213,974	-	6,075	6,120	1,180,539
14		45,630					-	45,630	1,213,974	-	6,075	6,120	1,180,539
15		45,630					-	45,630	1,213,974	-	6,075	6,120	1,180,539
16		107,730					-	107,730	1,213,974	-	6,075	6,120	1,118,439
17		45,630					-	45,630	1,213,974	-	6,075	6,120	1,180,539
18		45,630					-	45,630	1,213,974	-	6,075	6,120	1,180,539
19		45,630					-	45,630	1,213,974	-	6,075	6,120	1,180,539
20		45,630					-	45,630	1,213,974	-	6,075	6,120	1,180,539
21		107,730					-	107,730	1,213,974	-	6,075	6,120	1,118,439
22		45,630					-	45,630	1,213,974	-	6,075	6,120	1,180,539
23		45,630					-	45,630	1,213,974	-	6,075	6,120	1,180,539
24		45,630					-	45,630	1,213,974	-	6,075	6,120	1,180,539
25		45,630					-	45,630	1,213,974	-	6,075	6,120	1,180,539
26		107,730					-	107,730	1,213,974	-	6,075	6,120	1,118,439
27		45,630					-	45,630	1,213,974	-	6,075	6,120	1,180,539
28		45,630					-	45,630	1,213,974	-	6,075	6,120	1,180,539
29		45,630					-	45,630	1,213,974	-	6,075	6,120	1,180,539
30		45,630					-	45,630	1,213,974	-	6,075	6,120	1,180,539
31		107,730					-	107,730	1,213,974	-	6,075	6,120	1,118,439
EIRR									19.3%				
ENPV									2,775,078				
B/C ratio									1.7				
Notes													
1) Off-farm employment lost as a result of planting/tending a dry season crop calculated as:													
dry season area (ha) - average land size (ha) 1.2 No dry season beneficiari - No. affected 45% Total HH -													
mdays for dry season rice 100 % family labour 60% mdays compensation/HH 60 Total mdays -													
@ US\$ 1.3 mday <b>Total opportunity cost of dry season irrigation US \$ -</b>													
2) Annual O&M = 10 US\$/ha													
3) Major maintenance (every 5 years) = 10% of canal construction cost according to new project development (adopted from related irrigation system in Thailand)													
4) Incremental benefits are phased in at 40%, 60% and 80% of peak yr benefits in yrs 2,3 and 4 respectively													



# POVERTY ASSESSMENT (2007 CONSTANT PRICES)

Table A: O Mean

Poor's share of incremental costs and benefits <sup>(1)</sup>								Total Local Non-Government incremental costs and benefits								
Financial				Economic				Financial				Economic				
Post-const year	O&M costs	Crop Benefits	Wage Benefits <sup>(2)</sup>	Total	O&M costs	Crop Benefits	Wage Benefits <sup>(2)</sup>	Total	O&M costs	Crop Benefits	Wage Benefits <sup>(2)</sup>	Total	O&M costs	Crop Benefits	Wage Benefits <sup>(2)</sup>	Total
1	2,930	32,155	10,290	39,515	2,637	46,328	4,823	48,514	5,300	58,165	18,613	71,478	4,770	83,802	13,960	92,992
2	2,930	56,272	18,007	71,349	2,637	81,074	9,647	88,084	5,300	101,789	32,573	129,061	4,770	146,653	24,430	166,313
3	2,930	80,388	25,725	103,183	2,637	115,820	14,470	127,653	5,300	145,412	46,533	186,645	4,770	209,504	34,899	239,634
4	2,930	80,388	25,725	103,183	2,637	115,820	19,293	132,477	5,300	145,412	46,533	186,645	4,770	209,504	34,899	239,634
5	20,897	80,388	25,725	85,216	18,807	115,820	19,293	116,306	37,800	145,412	46,533	154,145	34,020	209,504	34,899	210,384
6	2,930	80,388	25,725	103,183	2,637	115,820	19,293	132,477	5,300	145,412	46,533	186,645	4,770	209,504	34,899	239,634
7	2,930	80,388	25,725	103,183	2,637	115,820	19,293	132,477	5,300	145,412	46,533	186,645	4,770	209,504	34,899	239,634
8	2,930	80,388	25,725	103,183	2,637	115,820	19,293	132,477	5,300	145,412	46,533	186,645	4,770	209,504	34,899	239,634
9	2,930	80,388	25,725	103,183	2,637	115,820	19,293	132,477	5,300	145,412	46,533	186,645	4,770	209,504	34,899	239,634
10	20,897	80,388	25,725	85,216	18,807	115,820	19,293	116,306	37,800	145,412	46,533	154,145	34,020	209,504	34,899	210,384
11	2,930	80,388	25,725	103,183	2,637	115,820	19,293	132,477	5,300	145,412	46,533	186,645	4,770	209,504	34,899	239,634
12	2,930	80,388	25,725	103,183	2,637	115,820	19,293	132,477	5,300	145,412	46,533	186,645	4,770	209,504	34,899	239,634
13	2,930	80,388	25,725	103,183	2,637	115,820	19,293	132,477	5,300	145,412	46,533	186,645	4,770	209,504	34,899	239,634
14	2,930	80,388	25,725	103,183	2,637	115,820	19,293	132,477	5,300	145,412	46,533	186,645	4,770	209,504	34,899	239,634
15	20,897	80,388	25,725	85,216	18,807	115,820	19,293	116,306	37,800	145,412	46,533	154,145	34,020	209,504	34,899	210,384
16	2,930	80,388	25,725	103,183	2,637	115,820	19,293	132,477	5,300	145,412	46,533	186,645	4,770	209,504	34,899	239,634
17	2,930	80,388	25,725	103,183	2,637	115,820	19,293	132,477	5,300	145,412	46,533	186,645	4,770	209,504	34,899	239,634
18	2,930	80,388	25,725	103,183	2,637	115,820	19,293	132,477	5,300	145,412	46,533	186,645	4,770	209,504	34,899	239,634
19	2,930	80,388	25,725	103,183	2,637	115,820	19,293	132,477	5,300	145,412	46,533	186,645	4,770	209,504	34,899	239,634
20	20,897	80,388	25,725	85,216	18,807	115,820	19,293	116,306	37,800	145,412	46,533	154,145	34,020	209,504	34,899	210,384
21	2,930	80,388	25,725	103,183	2,637	115,820	19,293	132,477	5,300	145,412	46,533	186,645	4,770	209,504	34,899	239,634
22	2,930	80,388	25,725	103,183	2,637	115,820	19,293	132,477	5,300	145,412	46,533	186,645	4,770	209,504	34,899	239,634
23	2,930	80,388	25,725	103,183	2,637	115,820	19,293	132,477	5,300	145,412	46,533	186,645	4,770	209,504	34,899	239,634
24	2,930	80,388	25,725	103,183	2,637	115,820	19,293	132,477	5,300	145,412	46,533	186,645	4,770	209,504	34,899	239,634
25	20,897	80,388	25,725	85,216	18,807	115,820	19,293	116,306	37,800	145,412	46,533	154,145	34,020	209,504	34,899	210,384
26	2,930	80,388	25,725	103,183	2,637	115,820	19,293	132,477	5,300	145,412	46,533	186,645	4,770	209,504	34,899	239,634
27	2,930	80,388	25,725	103,183	2,637	115,820	19,293	132,477	5,300	145,412	46,533	186,645	4,770	209,504	34,899	239,634
28	2,930	80,388	25,725	103,183	2,637	115,820	19,293	132,477	5,300	145,412	46,533	186,645	4,770	209,504	34,899	239,634
29	2,930	80,388	25,725	103,183	2,637	115,820	19,293	132,477	5,300	145,412	46,533	186,645	4,770	209,504	34,899	239,634
30	20,897	80,388	25,725	85,216	18,807	115,820	19,293	116,306	37,800	145,412	46,533	154,145	34,020	209,504	34,899	210,384
NPV				FNPV 726,151				ENPV 932,832				FNPV 1,313,516				ENPV 1,703,824
Poor's share of incremental crop and wage inc				55%												
Financial					Economic								Crops			
Poor's incremental annual income per HH (\$)				176					Poor's average incremental annual paddy production per HH (kg)				1,801			
Non-poor's incremental annual income/HH (\$)				409					Non-Poor's average incremental annual paddy production per HH (kg)				4,176			
Overall average incremental annual income/HH				236					Overall average incremental annual paddy production/HH (kg)				2,415			
1) Most benefits of the subproject are related to land ownership within the service area. Direct information is however not available regarding the share of the poor in the land of the subproject service area To make an estimate of the poor's service area land ownership, the data collected in the Consultant's PRA has been used																
2) It is assumed that poor households in the service area receive all of the incremental labor income on their own land. In addition the poor, as hired labor, are assumed to receive one half of the incremental labour income on the land of the non poor in the service area. While it is assumed that all of this 50% of hired labor wage is drawn from poor HHs within the service area, in fact some of this wage labor may go to poor HH outside the service area																
Commune / Village Context				Subproject service area information				Poor's share of subproject service area								
No. villages in Meanchey Commune				11	Subproject Service Area size (ha)				530	Poverty defined by paddy/person/year				300	kg	
Total no. HH				1311	Total no. beneficiary HH				790	Poverty defined by paddy/HH/year				1,530	kg	
No. villages in sub-project service area				10	Total poor HH				586	Local 'without project paddy yield/ha				1,700	kg	
Total no. HH				790	Percentage HH who are poor				74%	Poverty line defined by land in subproject area				0.9	ha	
Average HH size (People)				5.1	Average HH farm size (ha)				0.7	Average land size of poor in service area				0.50	ha	
										Poor's part of subproject area				293	ha	
										Poor's percentage of subproject area (%)				55.3%		

Table B: O Touk

Poor's share of incremental costs and benefits <sup>(1)</sup>									Total Local Non-Government incremental costs and benefits										
Financial					Economic				Financial				Economic						
Post-const year	O&M costs	Crop Benefits	Wage Benefits <sup>(2)</sup>	Total	O&M costs	Crop Benefits	Wage Benefits <sup>(2)</sup>	Total	O&M costs	Crop Benefits	Wage Benefits <sup>(2)</sup>	Total	O&M costs	Crop Benefits	Wage Benefits <sup>(2)</sup>	Total			
1	4,720	27,055	5,094	27,429	4,248	38,749	2,388	36,889	10,300	59,040	11,116	59,856	9,270	84,559	8,337	83,626			
2	4,720	47,346	8,914	51,541	4,248	67,811	4,776	68,339	10,300	103,319	19,453	112,472	9,270	147,978	14,590	153,298			
3	4,720	67,638	12,735	75,652	4,248	96,873	7,163	99,789	10,300	147,599	27,790	165,089	9,270	211,398	20,843	222,970			
4	4,720	67,638	12,735	75,652	4,248	96,873	9,551	102,177	10,300	147,599	27,790	165,089	9,270	211,398	20,843	222,970			
5	19,247	67,638	12,735	61,126	4,248	96,873	9,551	102,177	42,000	147,599	27,790	133,389	9,270	211,398	20,843	222,970			
6	4,720	67,638	12,735	75,652	4,248	96,873	9,551	102,177	10,300	147,599	27,790	165,089	9,270	211,398	20,843	222,970			
7	4,720	67,638	12,735	75,652	4,248	96,873	9,551	102,177	10,300	147,599	27,790	165,089	9,270	211,398	20,843	222,970			
8	4,720	67,638	12,735	75,652	4,248	96,873	9,551	102,177	10,300	147,599	27,790	165,089	9,270	211,398	20,843	222,970			
9	4,720	67,638	12,735	75,652	4,248	96,873	9,551	102,177	10,300	147,599	27,790	165,089	9,270	211,398	20,843	222,970			
10	19,247	67,638	12,735	61,126	4,248	96,873	9,551	102,177	42,000	147,599	27,790	133,389	9,270	211,398	20,843	222,970			
11	4,720	67,638	12,735	75,652	4,248	96,873	9,551	102,177	10,300	147,599	27,790	165,089	9,270	211,398	20,843	222,970			
12	4,720	67,638	12,735	75,652	4,248	96,873	9,551	102,177	10,300	147,599	27,790	165,089	9,270	211,398	20,843	222,970			
13	4,720	67,638	12,735	75,652	4,248	96,873	9,551	102,177	10,300	147,599	27,790	165,089	9,270	211,398	20,843	222,970			
14	4,720	67,638	12,735	75,652	4,248	96,873	9,551	102,177	10,300	147,599	27,790	165,089	9,270	211,398	20,843	222,970			
15	19,247	67,638	12,735	61,126	4,248	96,873	9,551	102,177	42,000	147,599	27,790	133,389	9,270	211,398	20,843	222,970			
16	4,720	67,638	12,735	75,652	4,248	96,873	9,551	102,177	10,300	147,599	27,790	165,089	9,270	211,398	20,843	222,970			
17	4,720	67,638	12,735	75,652	4,248	96,873	9,551	102,177	10,300	147,599	27,790	165,089	9,270	211,398	20,843	222,970			
18	4,720	67,638	12,735	75,652	4,248	96,873	9,551	102,177	10,300	147,599	27,790	165,089	9,270	211,398	20,843	222,970			
19	4,720	67,638	12,735	75,652	4,248	96,873	9,551	102,177	10,300	147,599	27,790	165,089	9,270	211,398	20,843	222,970			
20	19,247	67,638	12,735	61,126	4,248	96,873	9,551	102,177	42,000	147,599	27,790	133,389	9,270	211,398	20,843	222,970			
21	4,720	67,638	12,735	75,652	4,248	96,873	9,551	102,177	10,300	147,599	27,790	165,089	9,270	211,398	20,843	222,970			
22	4,720	67,638	12,735	75,652	4,248	96,873	9,551	102,177	10,300	147,599	27,790	165,089	9,270	211,398	20,843	222,970			
23	4,720	67,638	12,735	75,652	4,248	96,873	9,551	102,177	10,300	147,599	27,790	165,089	9,270	211,398	20,843	222,970			
24	4,720	67,638	12,735	75,652	4,248	96,873	9,551	102,177	10,300	147,599	27,790	165,089	9,270	211,398	20,843	222,970			
25	19,247	67,638	12,735	61,126	4,248	96,873	9,551	102,177	42,000	147,599	27,790	133,389	9,270	211,398	20,843	222,970			
26	4,720	67,638	12,735	75,652	4,248	96,873	9,551	102,177	10,300	147,599	27,790	165,089	9,270	211,398	20,843	222,970			
27	4,720	67,638	12,735	75,652	4,248	96,873	9,551	102,177	10,300	147,599	27,790	165,089	9,270	211,398	20,843	222,970			
28	4,720	67,638	12,735	75,652	4,248	96,873	9,551	102,177	10,300	147,599	27,790	165,089	9,270	211,398	20,843	222,970			
29	4,720	67,638	12,735	75,652	4,248	96,873	9,551	102,177	10,300	147,599	27,790	165,089	9,270	211,398	20,843	222,970			
30	19,247	67,638	12,735	61,126	4,248	96,873	9,551	102,177	42,000	147,599	27,790	133,389	9,270	211,398	20,843	222,970			
NPV			ENPV	528,697			ENPV	736,084				ENPV	1,153,723			ENPV	1,616,109		
Poor's share of incremental crop and wage income <sup>(2)</sup>				46%					46%										
Financial					Economic									Crops					
Poor's incremental annual income per HH (\$)					96				127	Poor's average incremental annual paddy production per HH (kg)					1,149				
Non-poor's incremental annual income/HH (\$)					163				224	Non-Poor's average incremental annual paddy production per HH (kg)					1,947				
Overall average incremental annual income/HH (\$)					124				167	Overall average incremental annual paddy production/HH (kg)					1,477				
1) Most benefits of the subproject are related to land ownership within the service area. Direct information is however not available regarding the share of the poor in the land of the subproject service area To make an estimate of the poor's service area land ownership, the data collected in the Consultant's PRA has been used																			
2) It is assumed that poor households in the service area receive all of the incremental labor income on their own land. In addition the poor, as hired labor, are assumed to receive one half of the incremental labour income on the land of the non poor in the service area. While it is assumed that all of this 50% of hired labor wage is drawn from poor HHs within the service area, in fact some of this wage labor may go to poor HH outside the service area																			
Subproject service area information									Poor's share of subproject service area										
Subproject Service Area size (ha)									1,030		Poverty defined by paddy/person/year					300		kg	
Total no. HH									1,336		Poverty defined by paddy/HH/year					-		kg	
Total poor HH									787		Local 'without project paddy yield/ha					1,700		kg	
Percentage HH who are poor									59%		Poverty line defined by land in subproject area					-		ha	
Average HH farm size (ha)									1.2		Average land size of poor in service area					0.60		ha	
											Poor's part of subproject area					472		ha	
											Poor's percentage of subproject area (%)					45.8%			

Table C: Spean Sraeng – Trapeang Ambel

Poor's share of incremental costs and benefits <sup>(1)</sup>									Total Local Non-Government incremental costs and benefits											
Financial					Economic				Financial					Economic						
Post-const year	O&M costs	Crop Benefits	Wage Benefits <sup>(2)</sup>	Total	O&M costs	Crop Benefits	Wage Benefits <sup>(2)</sup>	Total	O&M costs	Crop Benefits	Wage Benefits <sup>(2)</sup>	Total	O&M costs	Crop Benefits	Wage Benefits <sup>(2)</sup>	Total				
1	8,738	158,906	52,790	202,959	7,864	223,160	24,745	240,042	19,013	345,774	114,870	441,632	17,111	485,589	86,153	554,631				
2	8,738	278,086	92,383	361,731	7,864	390,531	49,491	432,158	19,013	605,105	201,023	787,115	17,111	849,782	150,767	983,437				
3	8,738	397,265	131,976	520,504	7,864	557,901	74,236	624,274	19,013	864,435	287,175	1,132,598	17,111	1,213,974	215,381	1,412,244				
4	8,738	397,265	131,976	520,504	7,864	557,901	98,982	649,019	19,013	864,435	287,175	1,132,598	17,111	1,213,974	215,381	1,412,244				
5	8,738	397,265	131,976	520,504	7,864	557,901	98,982	649,019	19,013	864,435	287,175	1,132,598	17,111	1,213,974	215,381	1,412,244				
6	8,738	397,265	131,976	520,504	7,864	557,901	98,982	649,019	19,013	864,435	287,175	1,132,598	17,111	1,213,974	215,381	1,412,244				
7	8,738	397,265	131,976	520,504	7,864	557,901	98,982	649,019	19,013	864,435	287,175	1,132,598	17,111	1,213,974	215,381	1,412,244				
8	8,738	397,265	131,976	520,504	7,864	557,901	98,982	649,019	19,013	864,435	287,175	1,132,598	17,111	1,213,974	215,381	1,412,244				
9	8,738	397,265	131,976	520,504	7,864	557,901	98,982	649,019	19,013	864,435	287,175	1,132,598	17,111	1,213,974	215,381	1,412,244				
10	8,738	397,265	131,976	520,504	7,864	557,901	98,982	649,019	19,013	864,435	287,175	1,132,598	17,111	1,213,974	215,381	1,412,244				
11	8,738	397,265	131,976	520,504	7,864	557,901	98,982	649,019	19,013	864,435	287,175	1,132,598	17,111	1,213,974	215,381	1,412,244				
12	8,738	397,265	131,976	520,504	7,864	557,901	98,982	649,019	19,013	864,435	287,175	1,132,598	17,111	1,213,974	215,381	1,412,244				
13	8,738	397,265	131,976	520,504	7,864	557,901	98,982	649,019	19,013	864,435	287,175	1,132,598	17,111	1,213,974	215,381	1,412,244				
14	8,738	397,265	131,976	520,504	7,864	557,901	98,982	649,019	19,013	864,435	287,175	1,132,598	17,111	1,213,974	215,381	1,412,244				
15	8,738	397,265	131,976	520,504	7,864	557,901	98,982	649,019	19,013	864,435	287,175	1,132,598	17,111	1,213,974	215,381	1,412,244				
16	8,738	397,265	131,976	520,504	7,864	557,901	98,982	649,019	19,013	864,435	287,175	1,132,598	17,111	1,213,974	215,381	1,412,244				
17	8,738	397,265	131,976	520,504	7,864	557,901	98,982	649,019	19,013	864,435	287,175	1,132,598	17,111	1,213,974	215,381	1,412,244				
18	8,738	397,265	131,976	520,504	7,864	557,901	98,982	649,019	19,013	864,435	287,175	1,132,598	17,111	1,213,974	215,381	1,412,244				
19	8,738	397,265	131,976	520,504	7,864	557,901	98,982	649,019	19,013	864,435	287,175	1,132,598	17,111	1,213,974	215,381	1,412,244				
20	8,738	397,265	131,976	520,504	7,864	557,901	98,982	649,019	19,013	864,435	287,175	1,132,598	17,111	1,213,974	215,381	1,412,244				
21	8,738	397,265	131,976	520,504	7,864	557,901	98,982	649,019	19,013	864,435	287,175	1,132,598	17,111	1,213,974	215,381	1,412,244				
22	8,738	397,265	131,976	520,504	7,864	557,901	98,982	649,019	19,013	864,435	287,175	1,132,598	17,111	1,213,974	215,381	1,412,244				
23	8,738	397,265	131,976	520,504	7,864	557,901	98,982	649,019	19,013	864,435	287,175	1,132,598	17,111	1,213,974	215,381	1,412,244				
24	8,738	397,265	131,976	520,504	7,864	557,901	98,982	649,019	19,013	864,435	287,175	1,132,598	17,111	1,213,974	215,381	1,412,244				
25	8,738	397,265	131,976	520,504	7,864	557,901	98,982	649,019	19,013	864,435	287,175	1,132,598	17,111	1,213,974	215,381	1,412,244				
26	8,738	397,265	131,976	520,504	7,864	557,901	98,982	649,019	19,013	864,435	287,175	1,132,598	17,111	1,213,974	215,381	1,412,244				
27	8,738	397,265	131,976	520,504	7,864	557,901	98,982	649,019	19,013	864,435	287,175	1,132,598	17,111	1,213,974	215,381	1,412,244				
28	8,738	397,265	131,976	520,504	7,864	557,901	98,982	649,019	19,013	864,435	287,175	1,132,598	17,111	1,213,974	215,381	1,412,244				
29	8,738	397,265	131,976	520,504	7,864	557,901	98,982	649,019	19,013	864,435	287,175	1,132,598	17,111	1,213,974	215,381	1,412,244				
30	8,738	397,265	131,976	520,504	7,864	557,901	98,982	649,019	19,013	864,435	287,175	1,132,598	17,111	1,213,974	215,381	1,412,244				
NPV			FNPV	3,782,658			ENPV	4,672,318				FNPV	8,230,934			ENPV	10,268,315			
Poor's share of incremental crop and wage income <sup>(2)</sup>				46.0%					45.5%											
Financial					Economic									Crops						
Poor's incremental annual income per HH (\$)					361				434	Poor's average incremental annual paddy production per HH (kg)					3,141					
Non-poor's incremental annual income/HH (\$)					594				765	Non-Poor's average incremental annual paddy production per HH (kg)					5,162					
Overall average incremental annual income/HH (\$)					459				572	Overall average incremental annual paddy production/HH (kg)					3,984					
1) Most benefits of the subproject are related to landownership within the service area. Direct information is however not available regarding the share of the poor in the land of the subproject service area To make an estimate of the poor's service area land ownership, the data collected in the Consultant's PRA has been used																				
2) It is assumed that poor households in the service area receive all of the incremental labor income on their own land. In addition the poor, as hired labor, are assumed to receive one half of the incremental labour income on the land of the non poor in the service area. While it is assumed that all of this 50% of hired labor wage is drawn from poor HHs within the service area, in fact some of this wage labor may go to poor HH outside the service area																				
Subproject service area information									Poor's share of subproject service area											
Subproject Service Area size (ha)									5070								Poverty defined by paddy/person/year		300	kg
Total no. HH									2,470								Poverty defined by paddy/HH/year		-	kg
Total poor HH									1,440								Local 'without project paddy yield/ha		1,000	kg
Percentage HH who are poor									58%								Poverty line defined by land in subproject area		-	ha
Average HH farm size (ha)									2								Average land size of poor in service area		-	ha
																	Poor's part of subproject area		2,330	ha
																	Poor's percentage of subproject area (%)		46.0%	