8 IMPLEMENTATION ARRANGEMENTS

8.1 Execution and Implementation

281. The executing agency for implementation of the Project is the Ministry of Water Resources and Meteorology (MOWRAM) which has the overall mandate in the management of water resources and meteorology. Within the MOWRAM is the Farmer Water User Community (DFWUC) Department responsible for the over-all supervision of the Project. Under the Department of FWUC is the Project Management Unit (PMU) which was established by virtue of a Ministerial Letter No. 034DM-WRM dated 8 January 2014. It is headed by a Project Director who is the Deputy Director General for Technical Affairs and a Project Manager who is the Director of the Department of FWUC. It is composed of 13 designated personnel responsible for the over-all project implementation, planning, organization, monitoring and coordination of the various Project activities. It will coordinate with relevant Departments of MOWRAM and with other government Ministries at the central, provincial, district and commune levels, and with relevant Civil Society Organizations and Non-Government Organizations. It will work closely with the Project Management Implementation Consultants (PMIC) in the day-to-day operation of the Project. The PMIC will provide Technical Support to the PMU and will ensure that the PMU will be able to efficiently manage and implement the Project activities. At the Provincial level, the Provincial Department of Water Resources and Meteorology (PDWRAM) will be the arm of the PMU in coordinating with relevant Government Agencies and NGOs/CSOs. It will be responsible in the establishment and strengthening of Farmer Water User Communities (FWUC) at the Project level. The organizational structure shows the Project Management arrangement (Table 48). The Project management roles and responsibilities are presented as follows:

Table 48: Project Management Roles and Responsibilities

Project Implementation Organizations	Management Roles and Responsibilities
Ministry of Water Resources and Meteorology (MOWRAM)	**Executing Agency** Provides policy guidance to the Project
Department of FWUC in MOWRAM	**Implementing Agency** Over-all supervision of the Project
Project Management Unit (PMU)	**Overall project management, planning, organization and implementation.** Coordinates with ADB, AFD and with relevant government agencies and non-government organizations. Oversees Project planning, construction, operation and maintenance.

Project Implementation Organizations	**Management Roles and Responsibilities**
	Supervise and monitor the implementation of construction packages **Monitors project implementation and prepares Reports for submission to MOWRAM**
Project Management Implementation Consultants (PMIC)	Provide Technical Support to the PMU and guides the project implementation
Provincial Department of Water Resources and Meteorology (PDWRAM)	**Implementing arm of the PMU at the field level.** Supervises the establishment and strengthening of the FWUCs at the Irrigation system level Implements construction
Farmer Water User Communities (FWUC)	**Manage and operate the irrigation system at the** Secondary and Tertiary level in close coordination with the PDWRAM. Represent the interest of the Project Beneficiaries and coordinate closely with the PDWRAM and PMU regarding project implementation at project level.

282. Described below is the proposed involvement of the various Institutions in the Project Implementation Development Process which will be implemented in Prek Chik Irrigation System in Battambang province and the Taing Krasaing Irrigation System in Kampong Thom province.

Table 49: Institutional Roles in Project Activities

No.	PROJECT PROCESS AND ACTIVITIES	GOVERNMENT INSTITUTIONS	FWUC
1	SURVEY AND INVESTIGATION • Ocular Investigation • Conduct Survey (Topographic)	MOWRAM and PDWRAM	
	• Information Campaign	PMU conducts information campaign	• Farmers and water users are informed about the Project
		PMU coordinates with the Local Government and forms Membership Committee composed of 2-3 key farmers	• Start membership recruitment • Land and Membership Registration
	• System Walkthrough to identify the condition of the irrigation structures	PMU/PDWRAM/District initiates system walkthrough	• Farmers participate in system walkthrough

No.	PROJECT PROCESS AND ACTIVITIES	GOVERNMENT INSTITUTIONS	FWUC
3	DESIGN • Prepare Project Plans • Prepare Detailed Design • Present Detailed Design	PMU prepares Project Plans and Designs and presents this to the FWUC	• Formation of Farmer Water Users Group/sub-Group (FWUG/FWUSG) based on Tertiary Blocks • Election of FWUC Committee • Formulation of FWUC Statutes • Registration of FWUC
	• Final approval of Design		• Participates in the Final Approval of the Project Design
	• Memorandum of Agreement	PMU prepares the MOA and organizes MOA signing MOWRAM signs the MOA with FWUC	• FWUC signs the MOA with the approval of 2/3 of the members
	• Organizational Management Training	PMU conducts the Organizational Management Training	• FWUC participates in the Training
4	CONSTRUCTION • Construction Arrangements - Hiring of local laborers - Laborers are 40% women - Construction Schedule and location	PMU specifies construction arrangements and discuss these with Contractors. These become conditionality in the Contract such as the hiring of unskilled labor in the locality and at least 40% are women.	• FWUC identifies local workers • Coordinate with Contractors • Monitor Construction work • Discuss issues with PDWRAM and Contractors
5	OPERATION • Formulation of water distribution plan • Information to water users on water delivery schedule • Gate operation	PMU develops water distribution plan together with FWUC based on cropping calendar and water availability PMU finalizes the water delivery schedule with the FWUC	FWUC jointly develops the water distribution plan and agrees on the cropping calendar FWUC disseminates water distribution plan and schedule of water delivery to all farmers and water users
	• Formulation of the Cropping Calendar	PMU coordinates with the Provincial and District Agriculture Office on the cropping plan and the availability of the non-water agro-inputs (seeds, fertilizers, pesticide, herbicide, machinery)	FWUC will work closely with the PMU and the District Agriculture Office in the preparation of the Cropping Calendar. FWUC/FWUGs will participate in preparing cropping calendar plan

No.	PROJECT PROCESS AND ACTIVITIES	GOVERNMENT INSTITUTIONS	FWUC
		Cropping Calendar will be explained and disseminated to farmer water users	and disseminates this to farmers and water users
6	MAINTENANCE • Formulation of Maintenance Plan • Implement maintenance plan	PMU develops a maintenance plan for the Headworks and Main Canal and prepares a Maintenance Budget Monitor implementation of maintenance plan	FWUC prepares a maintenance plan for the secondary and tertiary canals and prepares maintenance Budget Implements maintenance plan

Table 50: Project Implementation Plan

Activities	Year 0				Year 1				Year 2				Year 3				Year 4				Year 5				Year 6			
	Qtr				Qtr				Qtr				Qtr				Qtr				Qtr				Qtr			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
A. DMF																												
Output 1: Enhanced efficiency and climate resilience of irrigation systems.																												
Activity 1.A Phase 1 Rehabilitation/Construction of Taing Krasaing and Prek Chik irrigation systems																												
Taing KS																												
Prek Chik																												
Activity 1.B Phase 2 Preparation of feasibility study for the additional 8 systems candidates included in the long-list, to cover an additional 10,000 ha in Prek Chik – Phase 2																												
Activity 1.C Increased focus and associated training in Joint Reservoir Operations in both core subprojects, to improve on water sharing and water scheduling arrangements between linked systems.																												

Activities	Year 0				Year 1				Year 2				Year 3				Year 4				Year 5				Year 6			
	Qtr				Qtr				Qtr				Qtr				Qtr				Qtr				Qtr			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Output 2 Improved water resource management.																												
Activity 2.1 Supply and installation of Hydro-Met stations for water resources monitoring (assisted by the ADB Flood and Drought Management Project)																												
Activity 2.2 Provision of training to the PDWRAM, FWUCs and the appropriate government agencies on Watershed Management, including planning for implementation.																												
Activity 2.3 Organization, mobilization and training of FWUCs in the command area (supported by the ADB Water Resources Development and Management Sector Project)																												
Output 3 Improved project management.																												
B. Management Activities																												
Consultant selection procedures																												
Mobilization of PIMC																												

Activities	**Year 0**				**Year 1**				**Year 2**				**Year 3**				**Year 4**				**Year 5**				**Year 6**			
	Qtr				Qtr				Qtr				Qtr				Qtr				Qtr				Qtr			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Procurement plan key activities to procure contract packages- EOI, RFP																												
Mobilization of Civil Works Contractors																												
Environment management plan key activities																												
Gender action plan key activities																												
Communication strategy key activities																												
Annual/Mid-term review																												
Project completion report																												

CAM: Preparing the Uplands Irrigation and Water Resources Management Sector Project

ADB PPTA 8702: CAM

Appendix 7

SUBPROJECT FEASIBILITY STUDY:
TAING KRASAING IRRIGATION SYSTEM

July 10, 2015

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Acronyms

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ACRONYMS

ADB	Asian Development Bank
ANR	Agriculture and Natural Resources
BA	Battambang
BOQ	Bill of Quantities
CAVAC	Cambodia Agricultural Value Chain Program
CGIARC	Consortium of International Agricultural Research Centers
CISIS	Central Irrigation System Inventory
CPS	Country Partnership Strategy
CSO	Civil Society Organization
DFAT	Australian Department of Foreign Affairs and Trade
DFR	Draft Final Report
DOHM	Department of Hydrology and Meteorology
DoLA	Department of Local Administration
EA	Executing Agency
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
ETo	Evapo-transpiration
FFS	Farmer Field School
FR	Final Report
FWUCs	Farmers Water User Communes
GAP	Gender Action Plan
GSM	Global System for Mobile communication
HARVEST	Helping Address Rural Vulnerabilities and Ecosystem Stability Program
JICA	Japan International Cooperation Agency
IFAD	International Fund for Agricultural Development
IR	Inception Report
ISC	Irrigation Service Center
ISF	Irrigation Service Fee
IWR	Irrigation Water Requirement
KT	Kampong Thom
LA	Local authorities
LARF	Land Acquisition and Resettlement Framework
LL	Long List
MAFF	Ministry of Agriculture, Forest and Fisheries
MEF	Ministry of Economy and Finance
MFI	micro-finance institution
MOU	Memorandum of Understanding
MOWRAM	Ministry of Water and Meteorology
MTR	Mid-Term Report
NBB	Needs-based Budget
NGO	Non–Government Organization
O&M	Operation and maintenance
OFWM	On-Farm Water Management
PAM	Project Administration Manual

PC	Prek Chik
PDAF	Priority Development Assistance Fund
PDWRAM	Provincial Department of Water Resources and Meteorology
PKC	Taing Krasaing Canal
PMU	Project Management Unit
PPTA	Project preparatory technical assistance
PRASAC	Programme de rehabilitation et d'appui au secteur agricole du Cambodge
PV	Prey Veng
RGC	Royal Government of Cambodia
Rice-SDP	Climate Resilient Rice Commercialization Development Program
RRP	Report and Recommendation to the President
SL	Short List
SP	Subproject
SPRSS	Summary Poverty Reduction and Social Strategy
SWAT	Soil and Water Assessment Tool
TK	Taing Krasaing
TNA	Training Needs Assessment
TSLRDP	Tonle Sap Lowlands Rural Development Project
TOR	Terms of Reference
TSC	Technical Service Center
TSSD	Tonle Sap Smallholder Development Project
UIWRMP	Uplands Irrigation and Water Resources Management Sector Project
WRMSDP	Water Resources Management Sector Development Program

MEASUREMENT UNITS AND SYMBOLS

%	Percent
Km	Kilometer
m	Meter
m^3	Cubic Meter
MCM	Million Cubic Meter
Km^2	Square Kilometer
Ha	Hectares

LOCATION

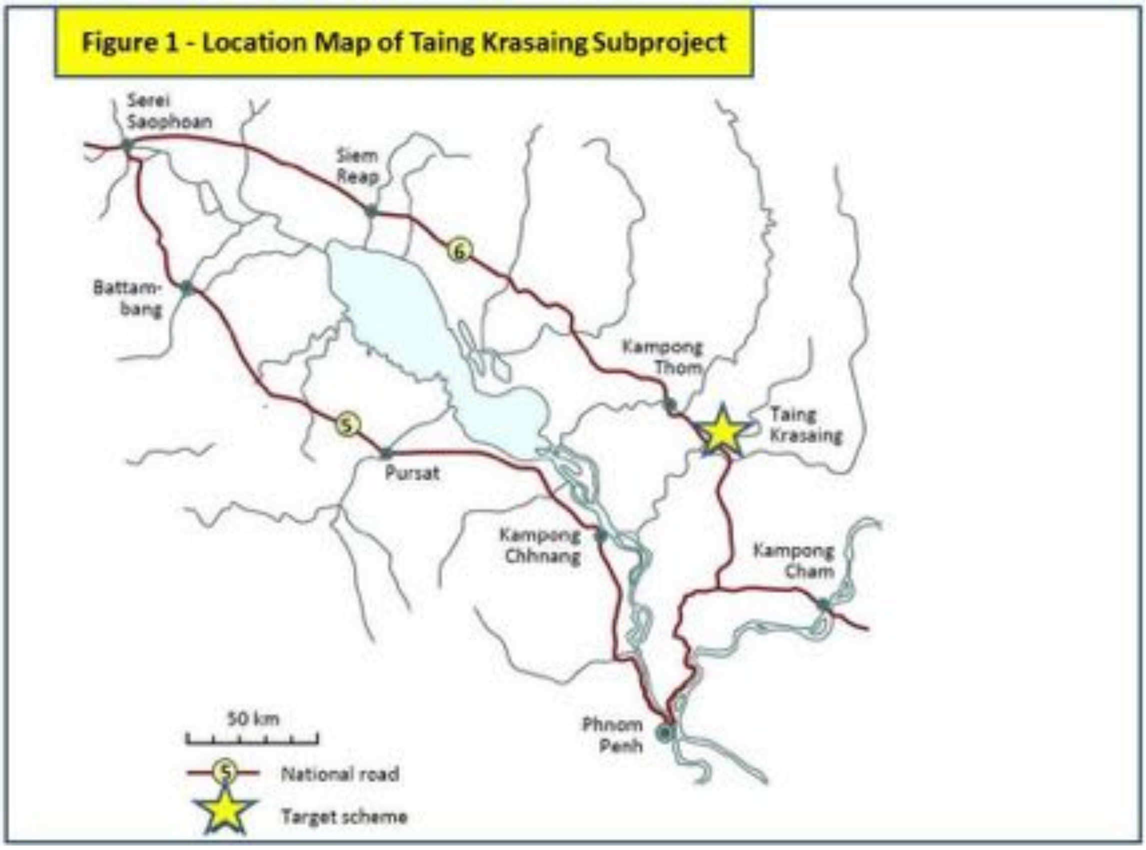


Figure 1 - Location Map of Taing Krasaing Subproject
Serei Saophoan
Siem Reap
6
Battambang
Kampong Thom
Taing Krasaing
5
Pursat
Kampong Chhnang
Kampong Cham
Phnom Penh
50 km
5
National road
Target scheme

EXECUTIVE SUMMARY

1.1 Key Subproject Features

1. **The System: Size and Sections**: The total irrigable area of Taing Krasaing is 9869 ha. The system is divided into 5 distinct sections (see Maps):

Section	Area (ha)	Name	Description - Characteristics
1	2664	Private Firms	Service only in Agreement with PDWRAM
2	2989	Tipou	High grounds – requires pumping of 3 m.
3	1370	CAVAC	Fully ready equipped – not in service
4	855	Chroab	Only partially developed as rainfed
5	1991	Kokoah	Fully developed as rainfed
	9869		

2. **On Service to Sections:** Only a small portion of Section 1 receives water at this time. Section 2 can only be irrigated with pump as it is approx. 2 meters higher as maximum water level in main canal, and thus cannot be served by gravity. The need for a pumping station to serve high grounds of Tipou Commune of 2900 ha is thus apparent. Section 3 is – as developed by CAVAC area – fully ready and equipped irrigation and drainage facilities including on-farm not served as no water can reach it. The new irrigation service area this will be 8669 ha (of which 2664 ha with Private Firms).

3. **The Main Canal:** The main canal is 22 km long, and has less than 0.20 m slope over the full length. It is in highly erosive soil; lining be required for 2.5 kilometer length of the last section at tail end. Full service is planned with retaining the wide canal and divide this in 7 mini-basins (zero slope), controlled through new and improved cross-regulators; this will reduce construction costs by minimizing reshaping. Two major breaches in right canal embankment of some 3 km length will be repaired and all missing drainage works provided, resulting in full drainage proofing for the all areas in the system. Taing Krasaing (as linked to Stung Chinit) is “water rich”, meaning enough water for 2 crops per year in 4-out-ot-5 years. It can be anticipated that Taing Krasaing will need to be provided with water from the more water-endowed Stung Chinit reservoir a few times per year for periods of 10-14 days as a supplementary source.

4. Cost Estimates for full rehabilitation, upgrading and modernizing are:

No.	Section	Cost (USD)	Irrigable area (ha)	Land Acquisition (Ha)	O&M Yearly (USD)
1	Headworks	10,800,172	N.A	N.A.	N.A.
2	Section 1	N.A.	2,664	N.A	N.A.
3	Section 2	5,000,000	2,989	20.00	224,175
4	Section 3	-	1,370	N.A.	25,728
5	Section 4	1,365,839	855	9.62	16,057
6	Section 5	8,812,982	1,991	41.50	37,391
TOTAL		25,978,992	9,818	71.12	303,351

1.2 Conclusions, Findings and Keys to Success in Taing Krasaing

1. **Technical issues on Irrigation Service and Drainage** can all be resolved in a more-than-satisfactory manner for system as a whole, but not for in parts. It is to be done in full to have benefits to all and spread out over system to all users and corners. Including Section 5 is essential.
2. **FWUCs** will need to be formed still, but time remains until water flows. Training Programs have been developed. Future FWUCs have been informed on all plans.

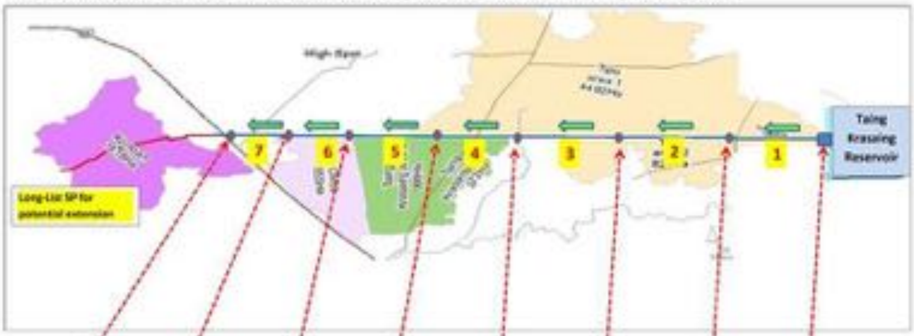
3. **The EIRR.** The Taing Krasaing irrigation subproject is expected to be economically viable in that the calculated economic internal rate of return (EIRR) is 24.7% and the economic net present value (ENPV) of the investment is $16.4 million (when applying a discount rate of 12%). Economic analysis is provided in **Appendix 1**.

4. **Water Productivity** (in USD/m3) for vegetables is approx. double to rice, pointing to the need to promote this as it generates more income and uses less water as compared to just rice-rice for 2 crops on 100% of the areas. However growing vegetable crops require labor intensive and farmers are required to be full time at the fields caring of the crops.
5. **Strict Construction Quality Monitoring on Specifications** is required.
6. **Careful and agreed Joint Reservoir Operation** in agreed and recorded agreement with Stung-Chinit and discipline in executing agreed timing of planting and irrigation scheduling for all sections.
7. **MOWRAM-PMU active and present** in field during implementation.
8. **Focus on combining Water and on Non-Water Agro-Inputs** in crop production process
9. **Use of Early Seed varieties (90-100 days)** – to be made available and to be used
10. **Prevention of “Water Leakage” and Waste of water** – originating in over-irrigation, indifference and negligence – by providers and users **to achieve an irrigation efficiency of at least 40%,** with provisions of associated training for both PDWRAM and FWUCs in learning to ”police” the water released into system.

11. **Fields demonstration and experiments** should be included to convince farmers to adapt with farming techniques etc., including a focus on vegetables production – water saving and increased income.
12. **Agreement with Private Firms** on water delivery and ISF/Water Charge is essential.
13. **Strengthening PDWRAM and Training FWUCs** are key issues.
14. **Strict adherence to water scheduling** with agreed cropping calendar and short-term maturing seeds used is one important way of dealing with Climate Change and expected rise in temperature (ETo to rise from 4.5 to 6.1 mm/day. Crop water requirements may grow by approx. 35% in next 35 years.
15. **On-Farm facilities development** is estimated at USD 300/hectare, where it concerns rain-fed lands already level and in such use for many years. Parts of Section 2 and 3 may require land clearing and shrub/small tree removal and this may cost up to USD500/hectare.
16. **Laser Land Leveling Technology** is available within MAFF, and its benefits may be considerable. Cost for such leveling may be up to USD 450/ha.

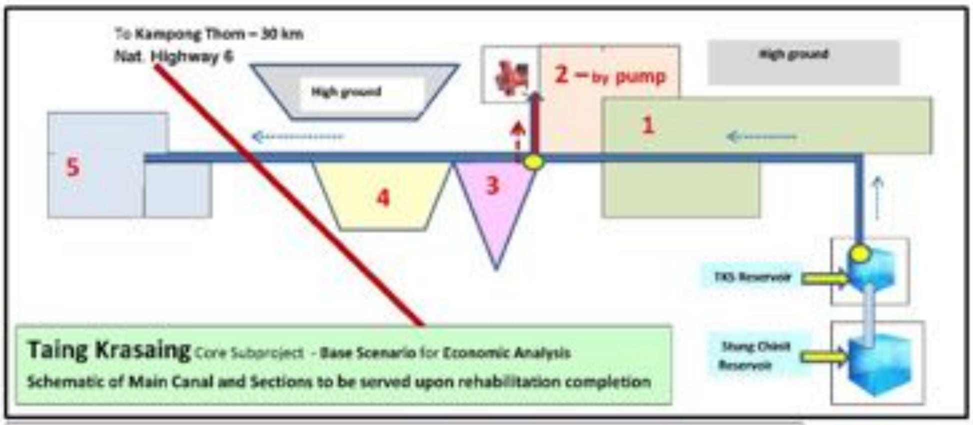
Key Maps:

Main canal of Taing Krasaing – Schematic – No. of Basins created along main canal – inflow controlled through cross-regulators



Basins	7	6	5	4	3	2	1	Totals
Station RD	RD 15+700 to 18+130	RD 14+100 to 15+700	RD 10+300 to 14+100	RD 6+700 to 10+300	RD 4+300 to 6+700	RD 2+100 to 4+300	RD 0+000 to 2+100	18.13 km
Basin length (m)	2430	1600	3800	3600	2400	2200	2100	18,130
Area Served (ha)	0	635	1543	1921	2461	2936	541	7405
Off-takes Left	1	5	2	5	3	3	1	22
Off-takes Right	2	2	5	1	3	3	3	20
Communes served	Chroab	Chroab	Ti Pou, Taing Kra Saing, Chroab	Ti Pou, Taing Kra Saing	Ti Pou	Ti Pou	Ti Pou	
Storage (MCM)	0.2499	0.2618	0.2856	0.4284	0.4522	0.1904	0.2886	2.16 MCM

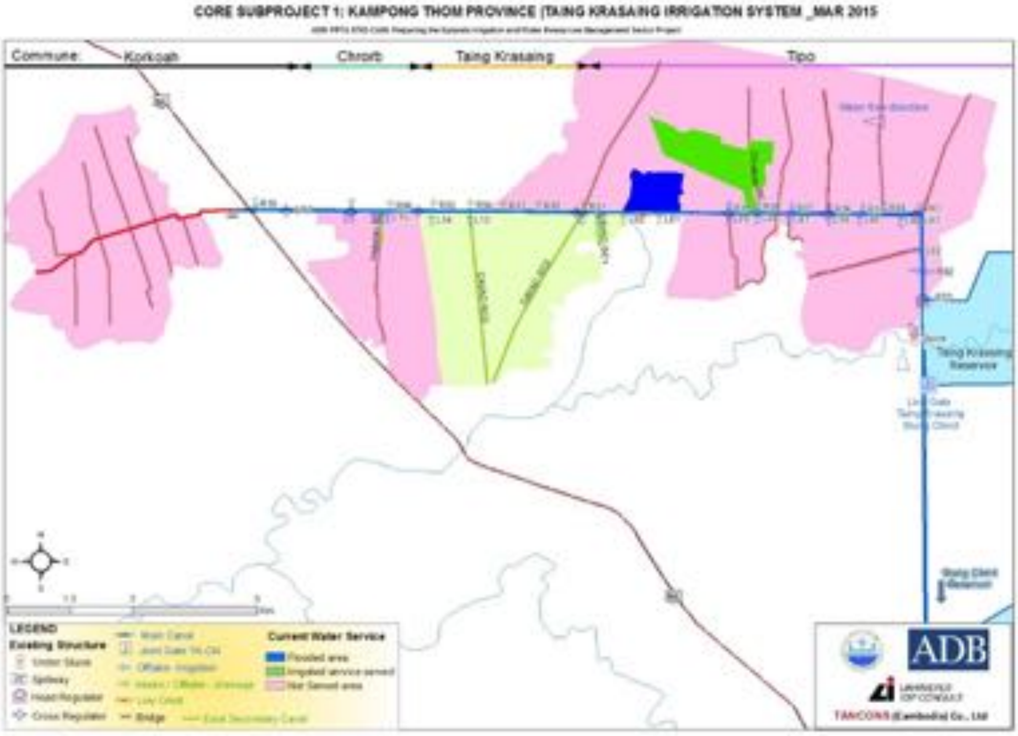
Note: 2.16 MCM = Withdrawal of 12 m3/sec over two days

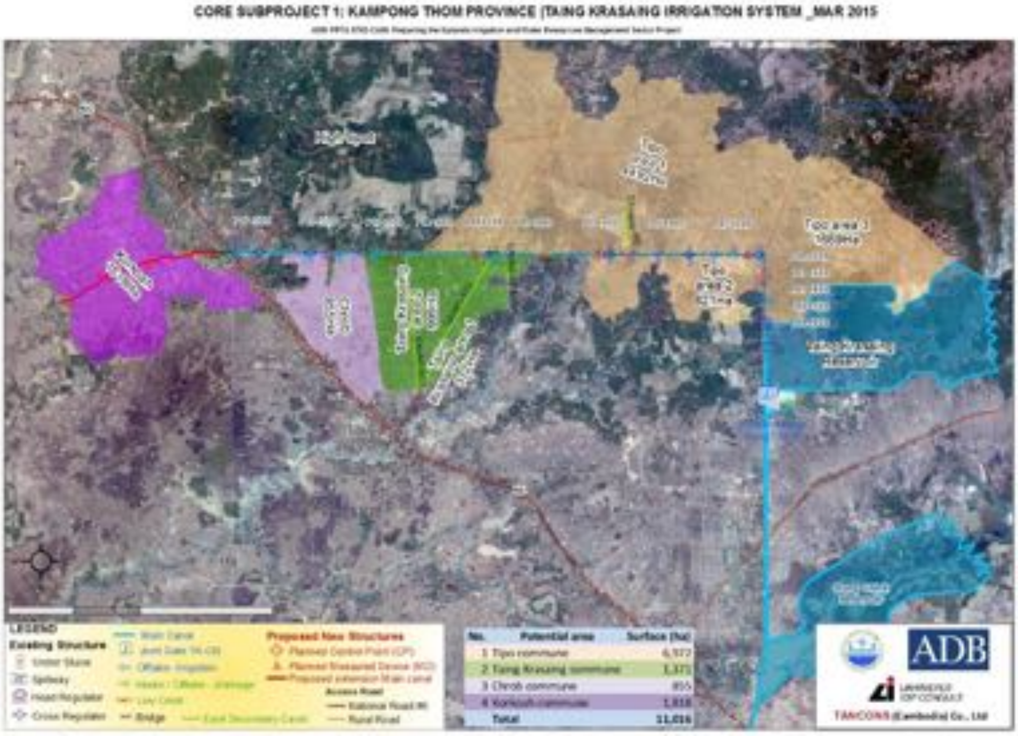


Five (5) distinct sections and key features

	Distinct Sections	Est. Area (ha)	Service	Status of land level	Right-of-Way
1	Private Firms	2500	gravity	N.A.	N.A.
2	Tipou	2500	pump	Rainfed 70%; land clearing 30%	Yes
3	CAVAC TKS	1200	gravity	Ready	Ready - none
4	Chroab	1800	gravity	Land Clearing 100%	Yes
5	Korkoah	1800	gravity	Rainfed 100% - ready	Yes
	Net irrigated	9800			

Note: Area of Tipou – Section 2 – is approx. 0.5 to 2.5 meters above full water level of main canal


CORE SUBPROJECT 1: KAMPONG THOM PROVINCE (TAING KRASAING IRRIGATION SYSTEM _MAR 2015
Commune:
Korkoah
Chrorb
Taing Krasaing
Tipo
Taing Krasaing Reservoir
LEGEND
Existing Structure
Current Water Service
ADB


CORE SUBPROJECT 1: KAMPONG THOM PROVINCE (TAING KRASAING IRRIGATION SYSTEM _MAR 2015
LEGEND
Existing Structure
Proposed New Structures
Taing Krasaing Reservoir
ADB

1 SUBPROJECT RATIONALE

5. The **Uplands Irrigation and Water Resources Management Sector Project** is planned to enhance agricultural and rural economic productivity through increased efficiency of irrigation systems and improved management of water resources in the uplands areas away from the Tonle Sap Lake, in Prey Veng, Kampong Thom and Battambang provinces. The Project area will comprise selected irrigation systems in the Kampong Thom and Battambang, which have potential for growing vegetables and fruits with paddy being the main crop. It will complement the impact and outcome of the Climate-Resilient Rice Commercialization Sector Development Program (Rice-SDP) approved on 27 June 2013. Rehabilitation and climate proofing of irrigation systems; construction of seed cleaning, drying, grading and storage facilities; and construction of paddy drying and storage facilities are being undertaken in these provinces under Rice-SDP. The uplands have potential for improving land and water productivity through improved irrigation systems and water resource management that will contribute to the intended outcomes of the Program. The Project would also help improve water management in lowlands and add value to the ongoing projects around Tonle Sap Lake financed by ADB.

6. The Project incorporates findings and recommendations of the sector strategy including (i) enhancing agriculture productivity, (ii) promoting diversification, (iii) supporting commercialization and connectivity (value chains and market linkages), (iv) supporting sustainable natural resource management, (v) environmental sustainability and climate change, (vi) gender development, and (vii) addressing institutional constraints. It addresses agriculture productivity constraints such as (i) low irrigation efficiency and water productivity, (ii) seasonal variations in water availability, (iii) inadequate operation and maintenance, and (iv) weak water resources management.

7. The Project will benefit from the policy reforms and institutional strengthening initiatives of the ADB-financed Water Resources Management Sector Development Program (WRMSDP). A comprehensive reforms process is ongoing under WRMSDP to provide enabling legal environment and restructured institutional set up, coupled with intense capacity building programs for the government institutions to ensure sustainable management of water resources. Though there are delays in approval of the sub-decrees to implement legal reforms, but those are expected before approval of the Loan. The Project will capitalize on the achievements of WRMSDP and further the implementation of policy reforms and institutional strengthening measures in the Project area. It shall also develop synergies with other ongoing and pipeline agriculture and natural resources (ANR) sector projects particularly those for environment and biodiversity conservation, climate change, and agribusiness value chain. The Project will (i) rehabilitate, modernize and climate proof irrigation systems and improve their performance and management, (ii) enhance land and water productivity through watershed management and land improvement, and (iii) improve management of water resources through participatory irrigation and water resource management.

Impact and Outcome

8. The expected Project impact will be increased farm incomes, and expected outcome will be enhanced water and agricultural productivity. The expected Project outputs will be (i) enhanced efficiency and climate resilience of irrigation systems, (ii) improved water resource management, and (iii) improved project management.

Output 1: Enhanced efficiency and climate resilience of irrigation systems.

9. To achieve this output, the UIWRMSP will support the following:

A. Rehabilitation and improvement of two existing irrigation systems:

1. Taing Krasaing

- Rehabilitation of headworks (including undersluice and spillway)
- Rehabilitation of 22 km Main Canal and installation of all structures for water control and distribution, and provision of all drainage works to resolve flooding and existing breaches in right embankment of 3 km.
- Construction of 48 km secondary and tertiary canals
- Installation of a pump system and associated distribution channels to lift water by a maximum of 3.5 meters for area of 2989 ha of developed rain-fed land.

Output 2: Improved water resource management.

10. To achieve this output, the UIWRMSP will support the following:

- Supply and installation of Hydro-Met stations for water resources monitoring (assisted by the ADB Flood and Drought Management Project)
- Provision of training to the PDWRAM, FWUCs and the appropriate government agencies on Watershed Management, including planning for implementation.
- Organization, mobilization and training of FWUCs in the command area (supported by the ADB Water Resources Development and Management Sector Project)

Output 3: Improved project management.

11. To achieve this output, the UIWRMSP will support the following:

1. Provision of Project Implementation Management Consultants to manage all activities under the project and provide on-the-job capacity building for PMU and MOWRAM personnel.

2 ASSESSMENT OF TAING KRASAING IRRIGATION SYSTEM

2.1 Description of the Project Site

2.1.1 Location

12. Taing Krasaing Irrigation Scheme is located 168 km from Phnom Penh. It is accessible by land with travel time of three to four hours passing through the national Road No. 6. Kampong Thom is bounded on the west by Kampong Chhnang and Siem Reap provinces, on the north by Preah Vihear and Siem Reap, on the south by Kampong Cham and Kampong Chhnang provinces.

13. The land area of Taing Krasaing Irrigation Scheme is in four Communes namely: Taing Krasaing, Tipou, Chroab and Kokoah. Within the four communes are 19 villages where the land area of the project is located.

Table 1: Administrative Scope and Coverage

Irrigation Schemes	Location and Coverage			
	Province	District	Communes	Villages
Taing Krasaing	Kampong Thom	Santuk	(1) Taing Krasaing	(1) Veang Cheung (2) Thomm Neath (3) Sangkom Thmei
			(2) Chroab	(1) Ou Kohkir (2) Sdok Sdam (3) Chey Mongkol (4) Tuol Vihear
			(3) Ti Pou	(1) Phlong (2) Kbal Bei (3) Trapeang Trom (4) Samraong (5) Choam Thnanh (6) Chouk Rumdoul (7) Thmei (8) Nimith
			(4) Korkoah/ (5) Kakaoh	(1) Sala Santouk (2) Chimeak (3) Santuk Krau (4) Santuk Knong

Source: PPTA Consultant.

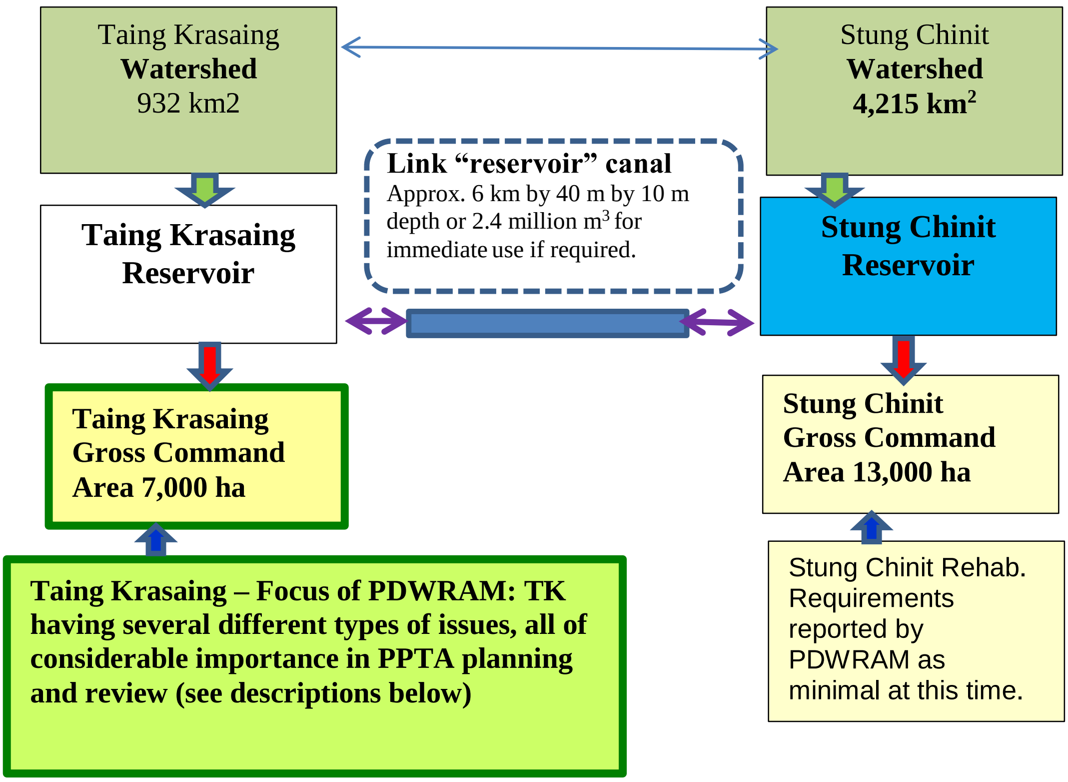
14. In Taing Krasaing, the average distance of the communes to the village offices is 2.95 km, to the District Office it is 8.19 km, to the nearest market it is 11.64 km, to the nearest school it is 2.24 km, to the nearest health center it is 2.41 km and to the nearest road it is 1.14 km.

2.1.2 Profile and Current Infrastructure Condition of the Taing Krasaing Irrigation System

15. The Taing Krasaing (TK) system is located some 25 km south-east of the city of Kampong Thom, close to National Highway No.6, around 185 kms or some four hours'

drive away from Phnom Penh. The TK system is supplied by a simple reservoir, levee-type protected in one-side only, with outlet-control gates (now cemented but currently not in use) on the Taing Krasaing river. The right main canal has a simple regulator structure, just some 100 meters to the right from the simple spillway. The TK system was constructed during the period 1975-1978, underwent rehabilitation in 2000, and had partial sections improved and modernized in 2005 and 2012. The watershed upstream is estimated at some 1100 km^2.

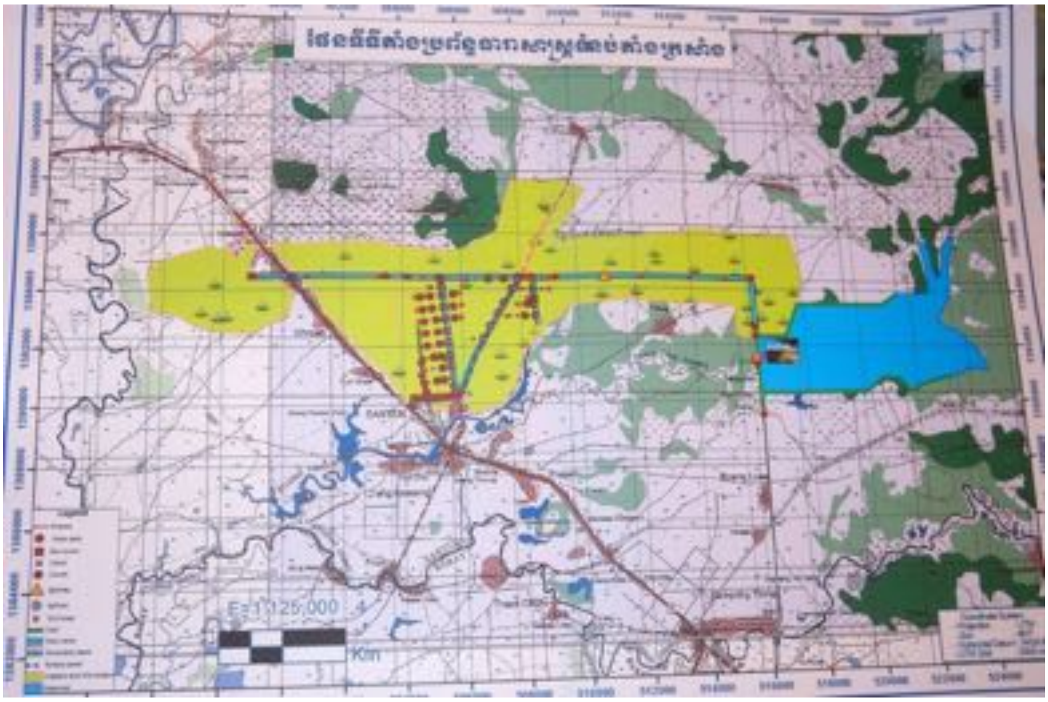
Figure 1: Schematic Representation of Overall Link Between the Two “Sister” Systems of Taing Krasaing and Stung Chinit



Source: ARUNA Technology Cambodia

16. The maps below were the only maps available through PDWRAMs and show the scope of Taing Krasaing (Map 1) and Stung Chinit (Map 2) as reference for field appraisal and reconnaissance.

Map 1: Starting Maps on Taing Krasaing



Source: PDRWAM Kampong Thom

Map 2: Starting Maps on Taing Krasaing and Stung Chinit

Source: PDRWAM Kampong Thom

17. The TK system is linked through a canal of some 7 kms to another system called Stung Chinit (SC), located south of the TK system. Stung Chinit, owing to a proportionately larger watershed, has more water and thus can be another supplementary source of water for TK. This link canal is in a straight line with cross regulators on both sides. Though regulator operations allow water to be transferred in both directions based on water levels in respective reservoir, in more than 70% of cases there is less water flowing from Stung Chinit to Taing Krasaing reservoir. The operations regulator is the PDWRAM, in close consultations with respective systems' Farmers Water User Communes (FWUCs).

18. The link reservoir canal is kept full-board, and has two outlet gates of recently modernized primary type canals, observed to be in very good conditions (area served to be determined) over the considerable area irrigated (area to be determined). From the field visits conducted by the PPTA team, together with PDWRAM head and staff as well as with the head of PMU of MOWRAM, the following observations were gathered:

- The headworks of Taing Krasaing (main regulator, open under-sluice energy dissipater and the rock-protected outflow reservoir spillway) all need various degrees of rehabilitation and upgrade.

- The main canal of Taing Krasaing takes off to the right - with a wide maintenance road in good condition alongside it on left - and runs for some 3 km; the canal/road combination then makes a 90^0 degrees left turn (at a tri-furcation), and runs from this point for over 17 km in a straight line (see blue lines on map 9). Over approximately the first 8 km from the head works, the canal has some 12 gates/regulators, but there are no secondary canals attached. These primary gates are apparently unused for some time, as confirmed by PDWRAM. No reason was forthcoming and reportedly there are no drawings available. PDWRAM indicated on-site that the construction of secondary canals from these primary outlet gates is the MOWRAM's priority which they would like to achieve under the project.

- Further downstream at approximately 9 km from head works, there are three brand new primary left off-takes gates (constructed in 2012), with fully constructed secondary canals attached including flow control structures and tertiary outlets, with fields in level conditions. Thus after a considerable stretch of apparent non-irrigation and undeveloped lands, irrigation actually starts after 10 km.

The Main Canal and Past Rehabilitation Works

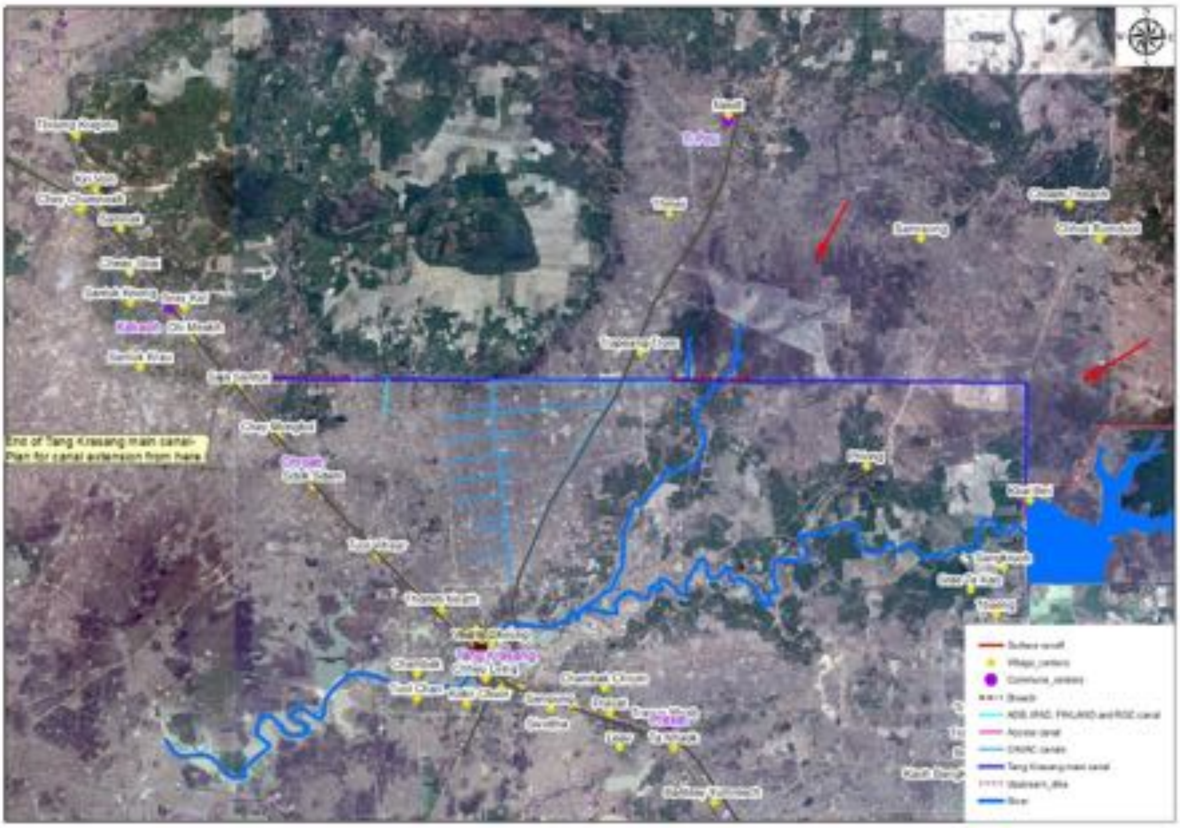
19. The **Taing Krasaing** main canal, originally called 6 January canal, was constructed under the Khmer Rouge in 1976-77. It was put in operation in 1978. During its first year of operation, the main canal right embankment between 7.5km to about 9.25km was washed away by the runoff from the North and Eastern highland bush/shrub land (see Map 9). The breach was rehabilitated in the same year by using manual labor. In 1979 the country was liberated from the Pol Pot regime and farmers were organized into solidarity groups. The main canal continued to be used and was maintained by these

groups by manual labor. The canal embankment was washed away again at the same location in the 1979 wet season. Farmers continued to make repairs at this breach location until around 1998 when repair efforts were abandoned and farmers looked for alternative paddy fields on the South side of NR6 within the Tonle Sap lake floodplain.

20. In 2007, MOWRAM undertook major rehabilitation works, reshaping the main canal and constructing new irrigation structures but leaving the right bank breach open. The breach was not repaired because MOWRAM was aware if the breach were closed, water would back up and submerge paddy fields and villages in Tipo commune to the west of the main canal. In 2012, the Cambodia Agricultural Value Chain Program (CAVAC) constructed lateral canals with irrigation structures with funding from Australian Department of Foreign Affairs and Trade (DFAT) and the Royal Government of Cambodia. In 2014, with funding from the ADB, International Fund for Agricultural Development (IFAD), Finland and RGC, another lateral length about 800m long was constructed, both to the east of the canal, as shown in Map 9 below.

21. According to the PDWRAM, the current dry season paddy covers an area of about 300-400 hectares. A Chinese company is cultivating about 200 ha of this land and the rest is cultivated by farmers. The PDWRAM also stated that most farmers are not cultivating dry season paddy because they are not sure if water will be available and in addition, they do not have any experience in cultivating it. This year, CAVAC in cooperation with the PDWRAM, will register farmers in the area under the command of the CAVAC laterals to demonstrate cultivation of dry season paddy. CAVAC will also extend the demonstrations to other farmers in the area. The PDWRAM reported that total command area under the main canal is about 7000ha and the area that currently could get supplementary irrigation water is about 2000ha, of which about 1600ha is under the command CAVAC lateral canals.

Map 3: Location map of Taing Krasaing Core Subproject



Source: Google Earth

2.1.3 Overall Assessment of Taing Krasaing for Feasibility

1. Straight main canal of 22 km length.
2. Broadcast rain-start rice production-oriented.
3. At present not under irrigation; Taing Krasaing irrigation system has never really worked, and the Taing Krasaing and Chroab communes, the CAVAC area of recent 2011-2014 construction cannot be served.
4. Flood problems from local run-off floods and both require new and large cross-drainage solutions.
5. No water measuring devices, inflow records or cropping season length, and records of area planted are either not available or poorly kept.
6. Farmer Water User Community (FWUCs), which function only informally, and whose members can be expected to have skeptical attitude in view of persisting water availability problems extend over 95% of the area.
7. No O&M (needs-based) budgets.
8. Taing Krasaing would in future (after repairs and modernizing rehabilitation) require federation-level reservoir operations, on which decisions are expected to be especially complex and difficult.
9. Taing Krasaing suffers from right-side cross drainage flash flood problems.

10. Taing Krasaing have increasingly endangered watersheds, under pressure of poor land use and destruction by continuous deforestation and land clearing, and with uncoordinated upstream water using developments underway and planned.
11. Taing Krasaing has poorly developed agro-inputs and non-water support systems, and need significant support to reach improved yields per hectare.
12. Taing Krasaing (as linked to Stung Chinit) is relatively water "rich"
13. Taing Krasaing is highly incomplete in many aspects; water service at present is available only to about 3% of the potential command area
14. Soils – in aspects of canal erosion and structural stability – required the need for geo-technical work for main canal structures is evident from on-site inspections.

3 SUBPROJECT DESIGN

3.1 Hydrology

22. There is limited capacity in MOWRAM for collecting and using water resources information. Data collection systems are poorly maintained. Data information systems are not kept up to date. Recommendations on water resource planning based on water resource data and information are not prioritized. Design flood standards adopted are low. Structural failure and damage from floods result from the low standards, as well as from poor quality estimates arising from data limitations.

23. Key data are inflows to and the capacities of Taing Krasaing and Stung Chinit reservoirs. Estimates in the literature of annual average inflow for Stung Chinit range from 43 to 65 m^3/s. Estimates of the capacity of Stung Chinit reservoir range from 7 to 36 mcm. There is no document which discusses Taing Krasaing irrigation development as a separate system. Most documents on Stung Chinit do not mention Taing Krasaing irrigation development, and none give Taing Krasaing reservoir capacity. One document, which assesses water availability and climate change, includes Taing Krasaing as an integral part of Stung Chinit irrigation development. The JICA study[1] which adopted a very large estimate of 34.6 mcm for the available combined storage defined a baseline scenario for Stung Chinit of 2960 ha of irrigation and found that irrigation reliability would drop from 100% to 85% by 2020. All other relevant documents only address Stung Chinit irrigation development.

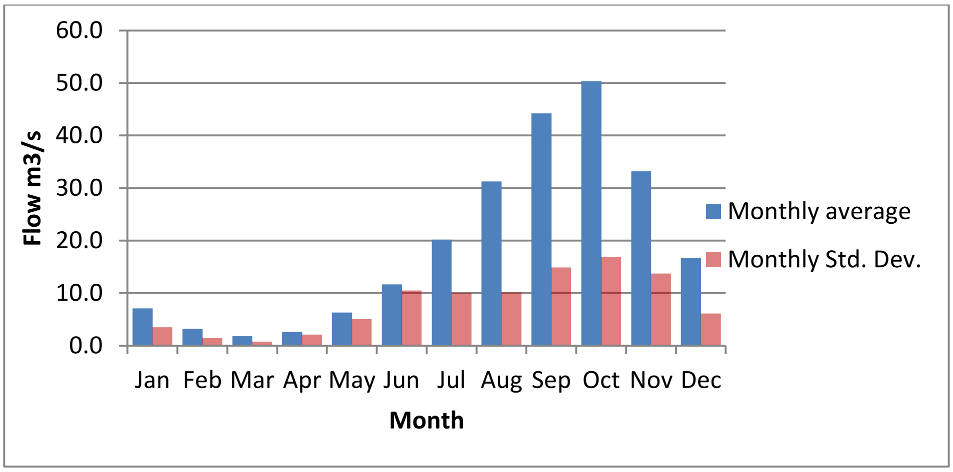
24. All reviews of Stung Chinit system state only limited dry season irrigation is practiced. The reasons for this, however, are stated to be related to farming systems and operational issues rather than lack of water.

25. It can be concluded from these studies that water is likely to become a limiting factor in increasing irrigated area in the combined Taing Krasaing/Stung Chinit irrigation system, particularly with projected impacts of climate change.

26. Information obtained from the Irrigation group in the PPTA shows that the design capacity of the main canal in Taing Krasaing is 14 m^3/sec. Inflows to Taing Krasaing and Stung Chinit reservoirs are shown in Figures 1 to 5 below. The yellow (m^3/s) and orange (mcm) highlighted figures in Tables 2 and 3 show the very low dry season flows. It is suggested that without substantial increases in both water storage and irrigation efficiency, it will not be possible to reliably irrigate during these months.

[1] JICA. Sep 2011. Summary Mid-Term Review: Project for Improvement of Agricultural River Basin Management. MOWRAM, Phnom Penh

Figure 2: Taing Krasaing Monthly Average Inflows and Standard Deviation



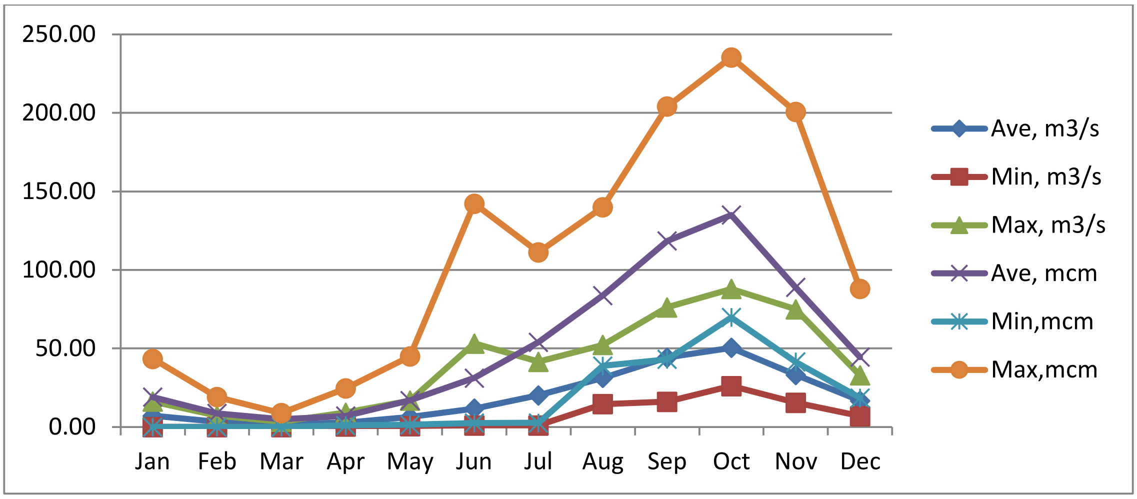
Source: PPTA Consultant.

Table 2: Taing Krasaing Reservoir Inflows Monthly Average, Dry, Minimum and Maximum Flows

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average. (m3/s)	7.1	3.2	1.8	2.6	6.3	11.6	20.2	31.3	44.2	50.4	33.2	16.6	19.1
Average (MCM)	19.1	7.8	4.8	6.7	16.9	30.2	54.0	83.8	114.6	135.0	86.1	44.6	603.5
Dry year (m3/s)	4.1	2.0	1.2	0.7	0.7	9.0	23.6	36.9	32.3	28.4	15.5	6.9	13.5
Dry year (MCM)	10.9	4.8	3.3	1.6	1.8	23.3	63.6	96.8	63.8	76.1	40.1	18.5	426.9
Max Year (m3/s)	16.2	7.1	3.3	9.2	16.8	53.1	41.5	52.3	76.2	87.9	74.9	32.8	28.4
Max Year (MCM)	43.4	17.2	8.8	23.8	44.9	137.7	111.2	140.0	197.5	235.4	194.2	88.0	900.1
Min Year (m3/s)	0.0	0.0	0.0	0.4	0.5	1.0	1.0	14.5	16.1	26.0	15.5	6.9	10.6
Min Year (MCM)	0.0	0.0	0.0	1.0	1.4	2.5	2.7	38.9	41.8	69.6	40.1	18.5	311.0

Note: The yellow (m^3/s) and orange (mcm) highlighted figures show the very low dry season flows.
Source: PPTA Consultant.

Figure 3: Average, Minimum and Maximum Inflows to Taing Krasaing Reservoir



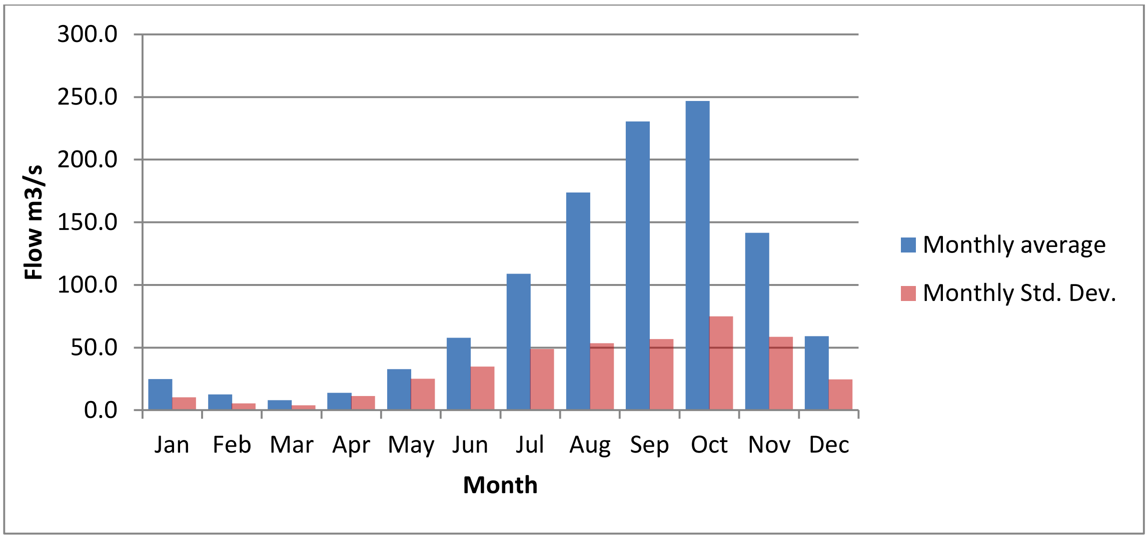
Source: PPTA Consultant.

Table 3: Stung Chinit Reservoir Inflows Monthly Average, Dry, Minimum and Maximum Flows

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average year (m3/s)	25	13	8	14	33	58	109	174	230	247	142	59	93
Average year (MCM)	67	34	22	37	86	155	292	466	617	661	379	159	2976
Dry year (m3/s)	23	12	6	10	11	32	60	121	170	168	89	40	61.8
Dry year (MCM)	62	31	17	26	29	85	162	325	457	449	238	108	1989
Max Year (m3/s)	41	23	19	42	111	125	215	270	333	403	280	115	165
Max Year (MCM)	111	62	50	113	299	335	576	724	892	1079	751	308	5300
Min Year (m3/s)	0	0	0	2	2	2	5	59	121	130	53	25	33
Min Year (MCM)	0	0	0	5	7	5	14	159	324	348	142	67	1072

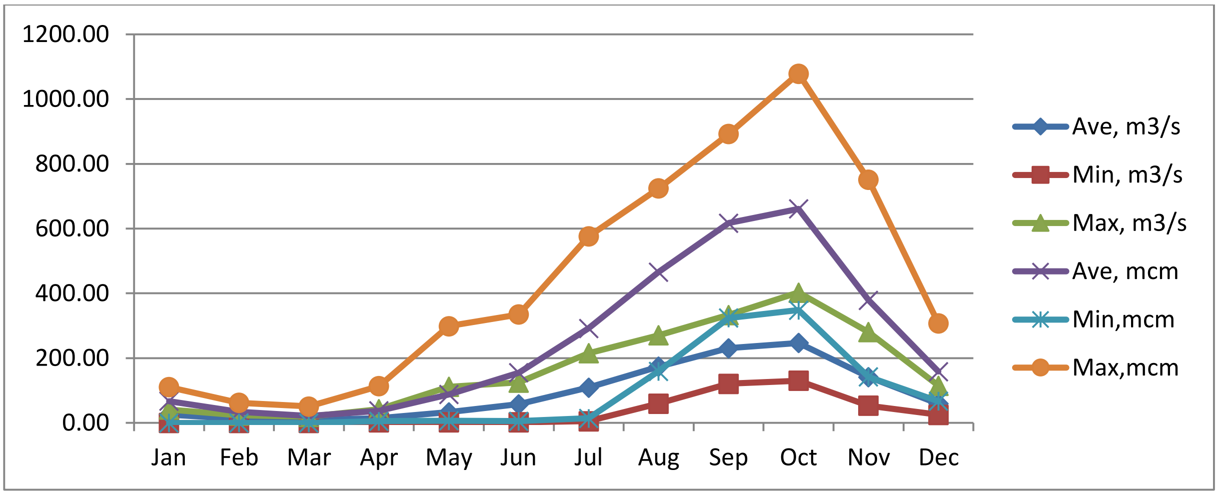
Note: The yellow (m^3/s) and orange (mcm) highlighted figures show the very low dry season flows.
Source: PPTA Consultant.

Figure 4: Stung Chinit Monthly Average Inflows and Standard Deviation



Source: PPTA Consultant.

Figure 5: Average, Minimum and Maximum Inflows to Stung Chinit Reservoir



Source: PPTA Consultant.

Flood flow estimates

27. Estimates have been made of design flows (Table 4) for various structures along the main Taing Krasaing canal and in the Taing Krasaing River downstream of the reservoir. The flood flow in the river has been made to allow later estimate of possible command area flooding.

Table 4: Design Flood Estimates for Taing Krasaing Subproject

	Taing Krasaing weir (1 in 100)	Taing Krasaing Canal siphon (1 in 50)	Stung Chinit weir (1 in 100)	Downstream Taing Krasaing weir (1 in 50)
Recommended design flow (m^3/s)	494	6.2	1920	490

Source: PPTA Consultant

Installation of Hydro-Met Stations

28. The current hydro-met network has been assessed and recommendations have been prepared for upgrading and extending the current network. Initial findings and recommendations are as follows: (i) that all stations locations need to have good road access particularly streamflow stations to which access in the wet season is important; (ii) new weather and rainfall stations should be located equidistant from existing stations, if possible; (iii) automatic monitoring, data storage and transmission equipment for rainfall, weather and stream height should be consistent with those currently used in the Cambodian Hydro-met Information System. The stations should be designed for solar-powered, stand-alone operation and able to store the collected data at the station in a logger until downloaded. Preliminary sites and costs estimates have been made, but need to be discussed with MOWRAM before being finalized and included in the DFR.

29. For rainfall and climate, a weather station is to be located within the total catchment area of each subproject. In addition, one automatic recording rainfall station in the upper catchment of each tributary of each subproject. The existing manual read rainfall stations used to estimate catchment rainfall distribution for the subprojects is to be upgraded to automatic recorders.

30. For determining stream water level and flow, following are the requirements:

- Existing stream gauge stations upgraded to rated automatic recording, ratings to be checked;
- New stream gauge stations installed and rated to give a record of flow upstream and downstream of head-works for each tributary of each subproject;
- Locations to be selected so that flow is straight, contained within a channel, with a hydraulic control that is not affected by backwater.

Costing of weather and flow stations and plan for cost and operating, data recording, and reporting are under development.

31. Water quality monitoring

- There is no water quality monitoring within either of the subproject areas.
- It is expected that increased intensification of irrigation will have potential water quality impacts on the water resources in the area;

- Random water quality testing will be conducted in the two canals for determining crop suitability and water quality suitability (1 to 2 samples only in both canals);
- The Initial Environmental Examination will consider and advise on water quality impacts and make appropriate recommendations.

32. The proposed hydro-met upgrade is as follows:

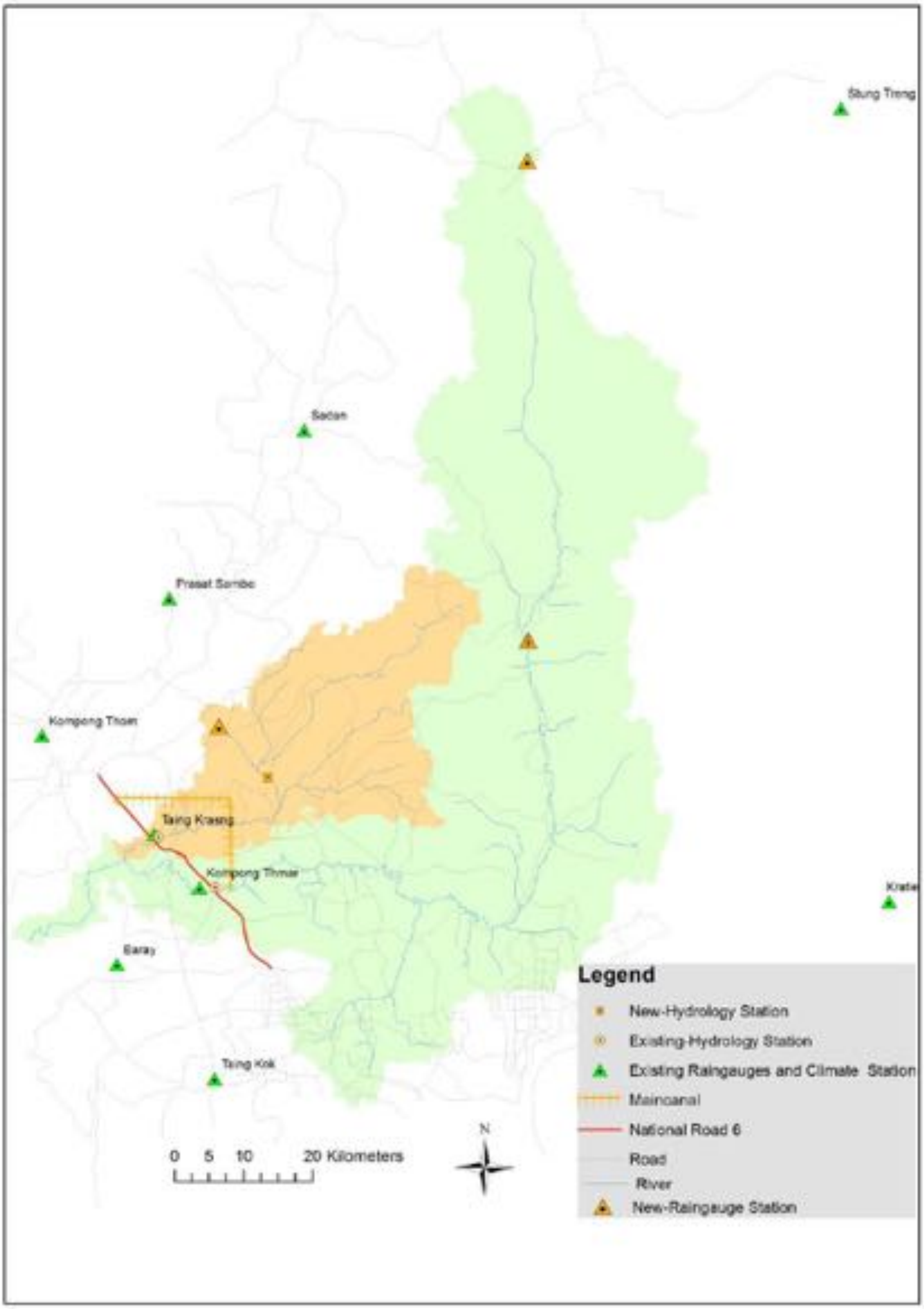
i. For river flow:

- establish two new automatic water level recorder and flow rating curve
- upgrade the manual read river height gauge to an automatic water level recorder and confirm an existing flow rating curve
- upgrade manual read river height gauge to an automatic water level recorder, and establish a flow cross-section, longitudinal sections for the river and flow rating curve

ii. (**For meteorology**

- establish three new automatic rainfall stations;
- upgrade four manual, daily read, rain gauge to an automatic rainfall stations;
- upgrade two manual, daily read, rain gauges to automatic weather stations;
- upgrade one automatic rainfall stations to automatic weather stations (with a manual rain gauge) .

Map 4: Location of Rainfall and Streamflow Stations, Taing Krasaing – Stung Chinit



Source: PPTA Consultant

Proposed Upgrade

Table 5: Instruments Used in Automatic Weather Stations in Cambodia

Parameter	**Instruments**	
	JICA	MRC
Rainfall	TE525WS	CS700
Temperature	HMP45C	CS105
Humidity		
Evaporation	Drück PDCR 1830-8388	-
Wind Speed	014A Met One	
Wind Direction	024A Met One	
Barometric Pressure	CS500 Vaisala	
Solar Radiation	Kipp and Zonen CM3	LI200
Sunshine Sensor	OTA Keiki Seisakusho	-

Source: PPTA Consultant

33. For streamflow monitoring, the intermittent flow expected at most river gauge locations will require a float operated shaft encoder. Where continuous flow is expected, alternatives of bubble sensor and radar sensor will be considered. Equipment will be installed in secure and weather-proof enclosures, similar to those currently in use by MOWRAM. Masts will be used at automatic weather stations to place wind sensors at an appropriate height and to install other sensors at a lower height for temperature, humidity, pressure and sunshine and to mount the enclosure.

34. A multi-channel data logger will be provided at each station for local storage and retrieval of data. Power supply will consist of a solar panel, a regulator and a rechargeable battery directly connected to the data logger. GSM modems plus two spares will be provided for data transmission from the stations to central locations at the PDWRAMs and in Phnom Penh. At this time, it is not known whether repairs and upgrades will be needed at central locations in PDWRAM, MOWRAM or in other central station locations such as in Pochentong to which data will need to be transmitted. These requirements will be discussed with MOWRAM during the next mission.

35. A budget allocation is proposed for the Department of Meteorology for assistance and communication during the installation, rehabilitation and calibration phase. During discussions with MOWRAM on hydro-met monitoring upgrades, consideration will be given to vehicle requirements. It may be prudent to provide a motorcycle to each of the PDWRAMs for transport to station locations for maintenance activities. It is expected that MOWRAM will have all necessary equipment for stream gauging required to establish rating curves at each stream flow station. Consultant support is proposed during the installation, rehabilitation and calibration period. The consultant should prepare and deliver technical training required as well as direct and supervise the installation, rehabilitation and calibration work.

3.2 Engineering and Irrigation-Hydraulic Design

36. The combined TOR of the PPTA specialists in water resources, irrigation management, hydraulic structures and engineering, on-farm water management and climate change is for providing a Feasibility Level report on Taing Krasaing:

1. develop a mechanism for assessing irrigation efficiency, irrigation water productivity, and water stress ratio
2. design rehabilitation/upgrading/modernization works for enhancing irrigation efficiency and water productivity of the core subprojects
3. prepare bill of quantities and bidding documents for the core subprojects
4. propose options for modernizing irrigation systems and incorporate those in the design of the core subprojects
5. assess the irrigation efficiency of the core subprojects, incorporate measures to improve the efficiency in design, and prepare guidelines for measuring the efficiency of irrigation systems to be rehabilitated under the Project
6. prepare irrigation schedules for the core subprojects
7. design an operational system for increasing the efficiency and productivity of irrigation systems for the core subprojects.
8. assess climate change risks
9. suggest adaptation measures to climate proof infrastructure
10. design climate proofing interventions for core subprojects and estimate their cost; and
11. prepare a training/awareness program for farmer's water user communes (FWUCs) to enhance climate change adaptation
12. propose options to improve on-farm water management practices
13. develop specific measures for reducing field application losses such as laser land leveling and high efficiency irrigation systems
14. estimate the cost of the proposed interventions for the subprojects; and design on-farm interventions for the core subprojects and estimate their cost

3.2.1 Engineering

37. Taing Krasaing main canal (TKMC) was originally called Canal No.6 and was constructed during the Khmer Rouge era. After major damage in 1979, about the time when the Khmer Rouge Regime collapsed, the Canal was subsequently repaired and maintained by community labor to secure irrigation water supplies. This effort came to an end in 1998 and farmers in Taing Krasaing area lost access to water supply for rice production. In about 2007 MOWRAM undertook major rehabilitation, reshaping the main canal and constructing new irrigation structures but leaving two breaches on the right embankment open to avoid water logging. However, these two breaches are the main cause of dysfunctionality of the Taing Krasaing System. Water cannot be supplied to the larger downstream irrigation area, which includes an area of 1200 ha newly developed by CAVAC in 2014, unless a vast area of farm land is flooded.

38. Erosion is another key issue for Taing Krasaing Core Subproject (TKS). A geotechnical investigation confirmed the design engineer's observation that, the soils in

Taing Krasaing area are highly erosive. The design options for the main canal and its structures take account of this finding.

39. Rehabilitation of TKS requires substantial engineering works including headworks, main canal and its structures, and secondary and tertiary distribution systems.

40. The headworks of TKMC consists of four existing structures - headworks gate, under-sluice, spillway and head regulator. Each of these structures are functioning, however, each requires additional downstream erosion protection.

41. The Main Canal is designed a series of 7 basins or small reservoirs as described later in this report. Basin 1 to basin 6 will remain earthen while the last basin will be lined using reinforced concrete. Soil backfilling to form the canal embankment accounts the majority of the earthworks. Excavation is minimized by retaining the existing shape for the majority of canal's length. Excavation will be required, however, for basin 7, which is to be constructed in the canal reach where erosion of the canal embankments has created a very wide shallow cross-section.

42. Several existing functional crossing structures will be retained, as will some of the existing offtake structures. However, a number of additional crossing structures (which will be used a control points) and offtake structures are required to modernize the canal system. The two breaches in the canal embankments will be closed, and a drainage over-pass will be provided to release flood waters from the right side to the left side of the main canal, and convey them to via a natural drainage line to the Taing Krasaing River.

1. TKS can be divided into 5 different sections:

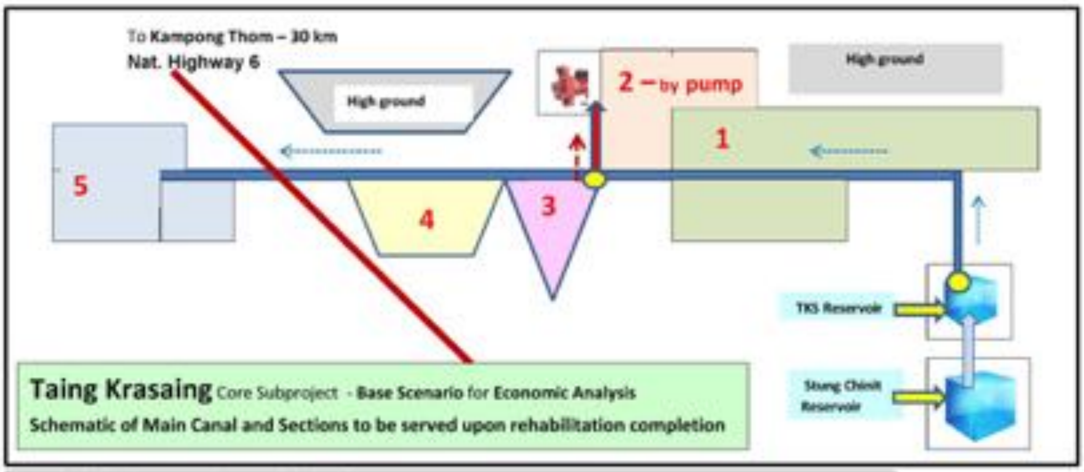
Section 1: In this section, private lands lie on both sides of the main canal, from headworks to about 6km. There will be no subproject activities in this section.

Section 2: This section covers about 2,900 hectares of command area in Tipou commune. The majority of defined irrigation area cannot be commanded by gravity from the main canal since the average ground level is about 2 to 3m higher than the full water supply level in the main canal. An electric pumping station with concrete lined distribution system is proposed for this section to provide the Tipou commune with reliable access to irrigation water.

Section 3 is located in Taing Krasaing Commune which is on the left hand side of Main Canal. One thousand two hundred hectares has been fully developed for irrigation by CAVAC program in 2004. No work, beyond construction of the main canal basin, is required in this section.

Section 4 is located in Chraob commune, which is on the left side of canal. A secondary canal of about 800m has been recently dug. This canal will be supplemented by a 15 kilometer length of secondary and tertiary canals to command 855 ha. A drain will also be constructed.

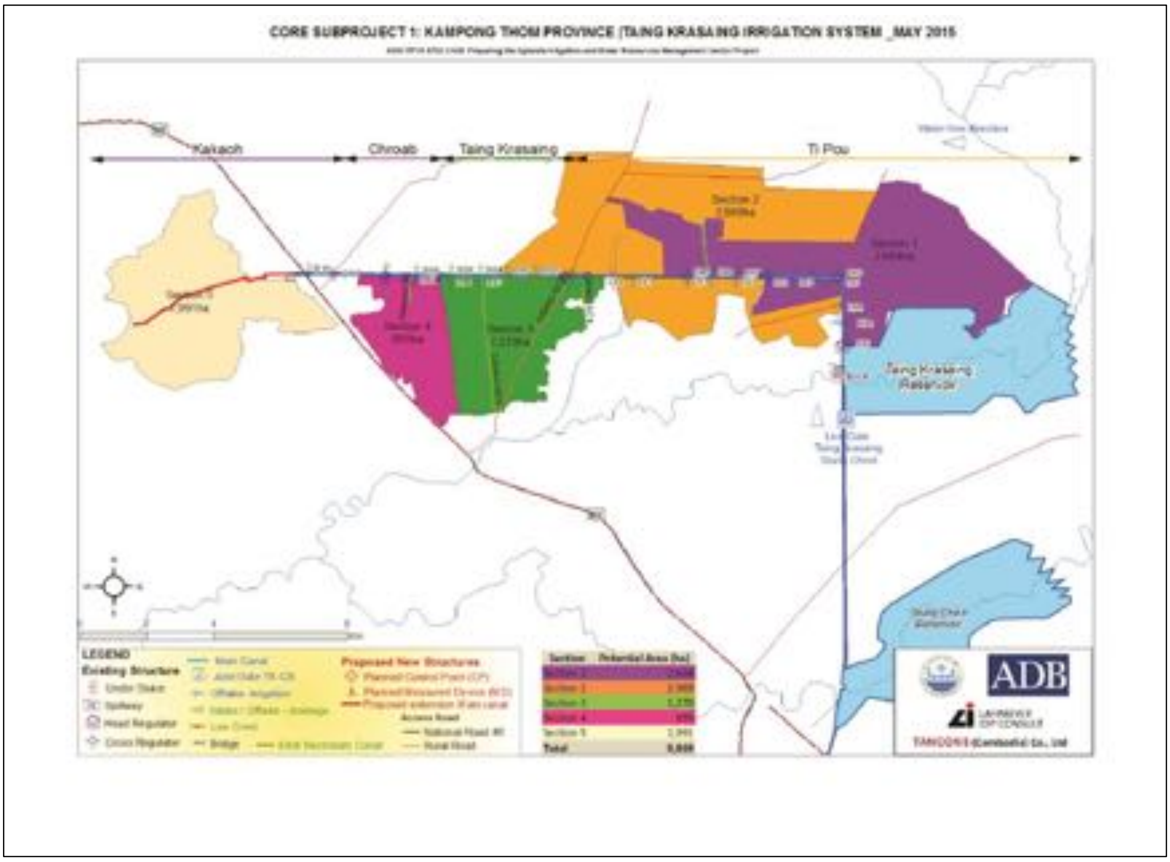
Section 5 is beyond National Road No.6 and will expand the irrigation area by approximately 1800 ha into Kokaoh commune.

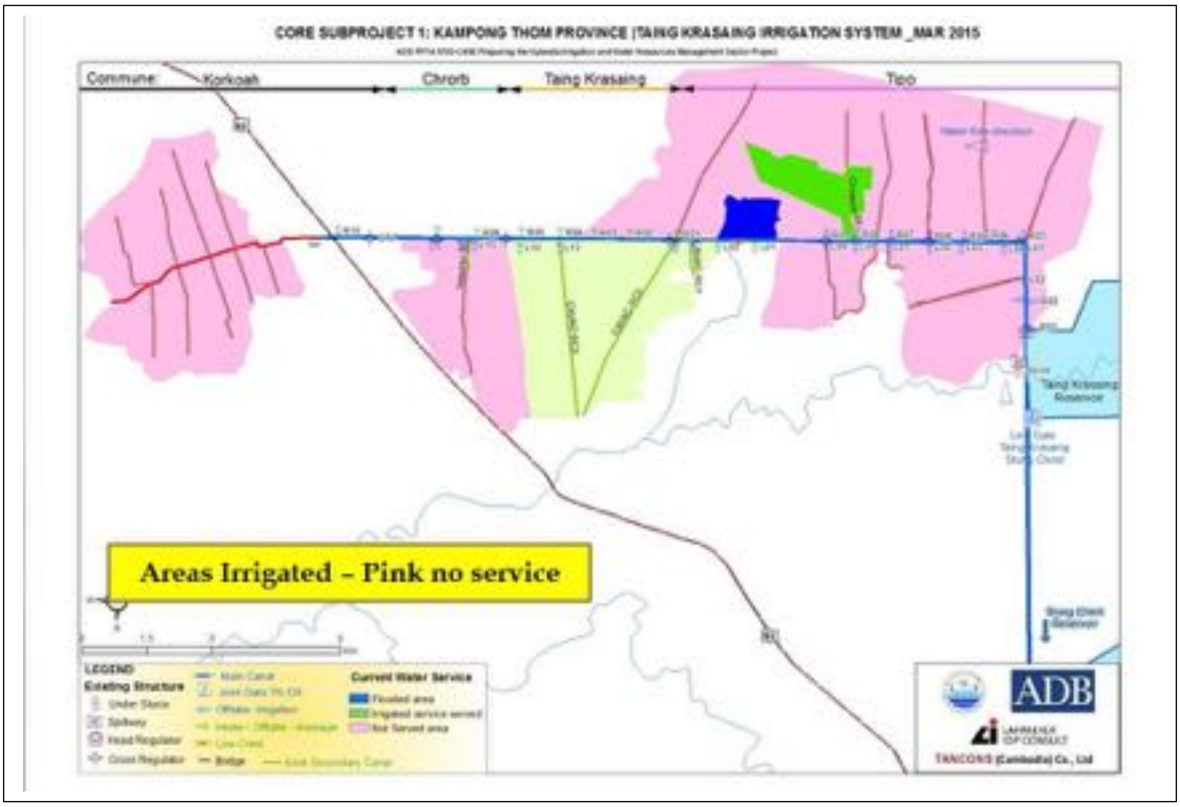


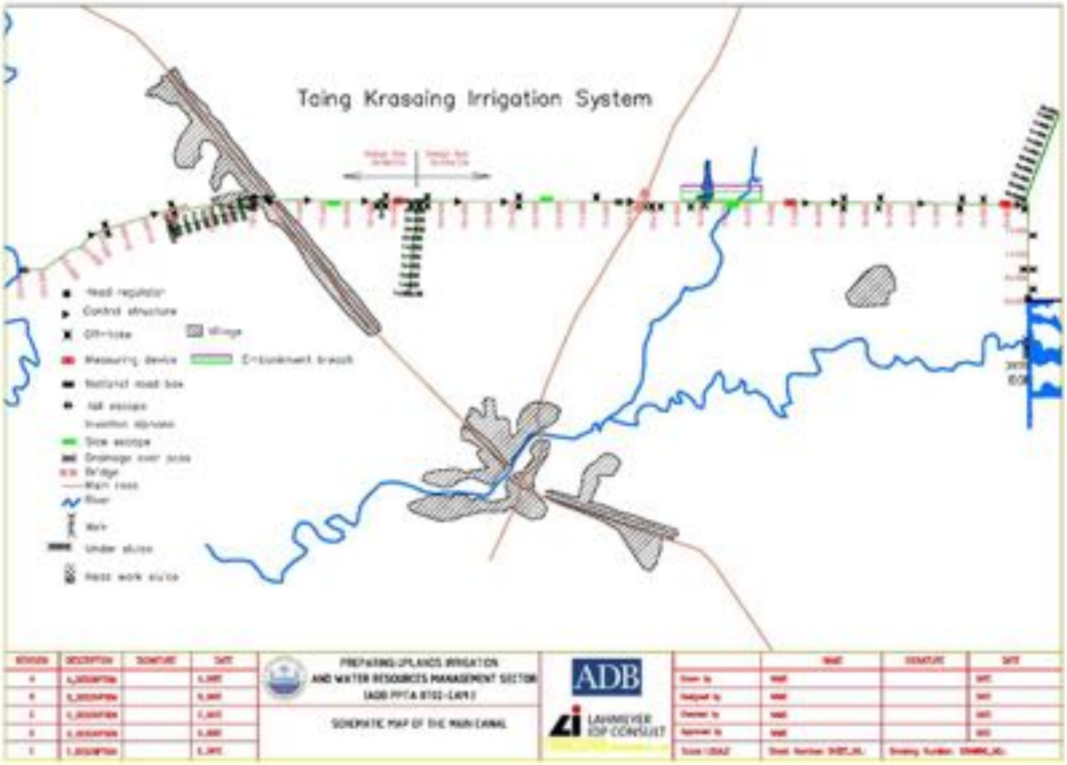
Five (5) distinct sections and key features

	Distinct Sections	Est. Area (ha)	Service	Status of land level	Right-of-Way
1	Private Firms	2500	gravity	N.A.	N.A.
2	Tipou	2500	pump	Rainfed 70%; land clearing 30%	Yes
3	CAVAC TKS	1200	gravity	Ready	Ready - none
4	Chroab	1800	gravity	Land Clearing 100%	Yes
5	Korkoah	1800	gravity	Rainfed 100% - ready	Yes
	Net irrigated	9800			

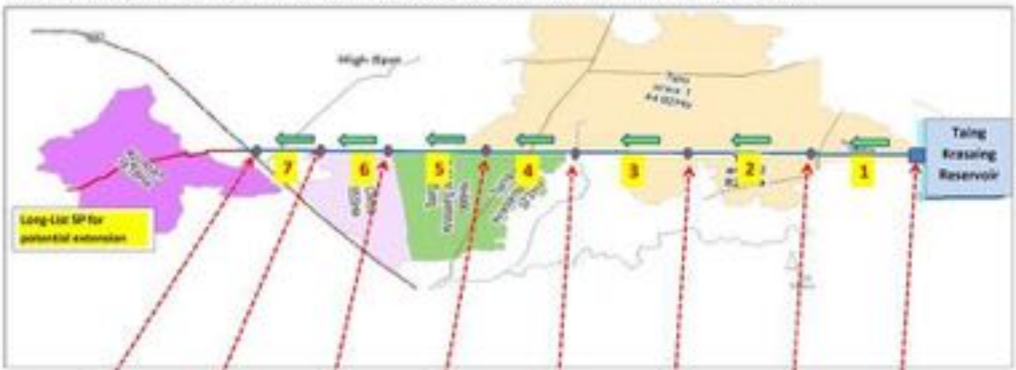
Note: Area of Tipou – Section 2 – is approx. 0.5 to 2.5 meters above full water level of main canal


CORE SUBPROJECT 1: KAMPONG THOM PROVINCE (TAING KRASAING IRRIGATION SYSTEM _MAY 2015
Kakaoh
Chroab
Taing Krasaing
Ti Pou
Taing Krasaing Reservoir
ADB


CORE SUBPROJECT 1: KAMPONG THOM PROVINCE (TAING KRASAING IRRIGATION SYSTEM _MAR 2015
Commune
Korkoah
Chrorb
Taing Krasaing
Tipo
Areas Irrigated – Pink no service
ADB



Main canal of Taing Krasaing – Schematic – No. of Basins created along main canal – inflow controlled through cross-regulators



Basins	7	6	5	4	3	2	1	Totals
Station RD	RD 15+700 to 18+130	RD 14+100 to 15+700	RD 10+300 to 14+100	RD 6+700 to 10+300	RD 4+300 to 6+700	RD 2+100 to 4+300	RD 0+000 to 2+100	18.13 km
Basin length (m)	2430	1600	3800	3600	2400	2200	2100	18,130
Area Served (ha)	0	635	1543	1921	2461	2936	541	7805
Off-takes Left	1	5	2	5	3	3	3	22
Off-takes Right	2	2	5	1	3	3	3	20
Communes served	Chroab	Chroab	Ti Pou, Taing Kra Saing, Chroab	Ti Pou, Taing Kra Saing	Ti Pou	Ti Pou	Ti Pou	
Storage (MCM)	0.2499	0.2618	0.2856	0.4284	0.4522	0.1904	0.2686	2.16 MCM

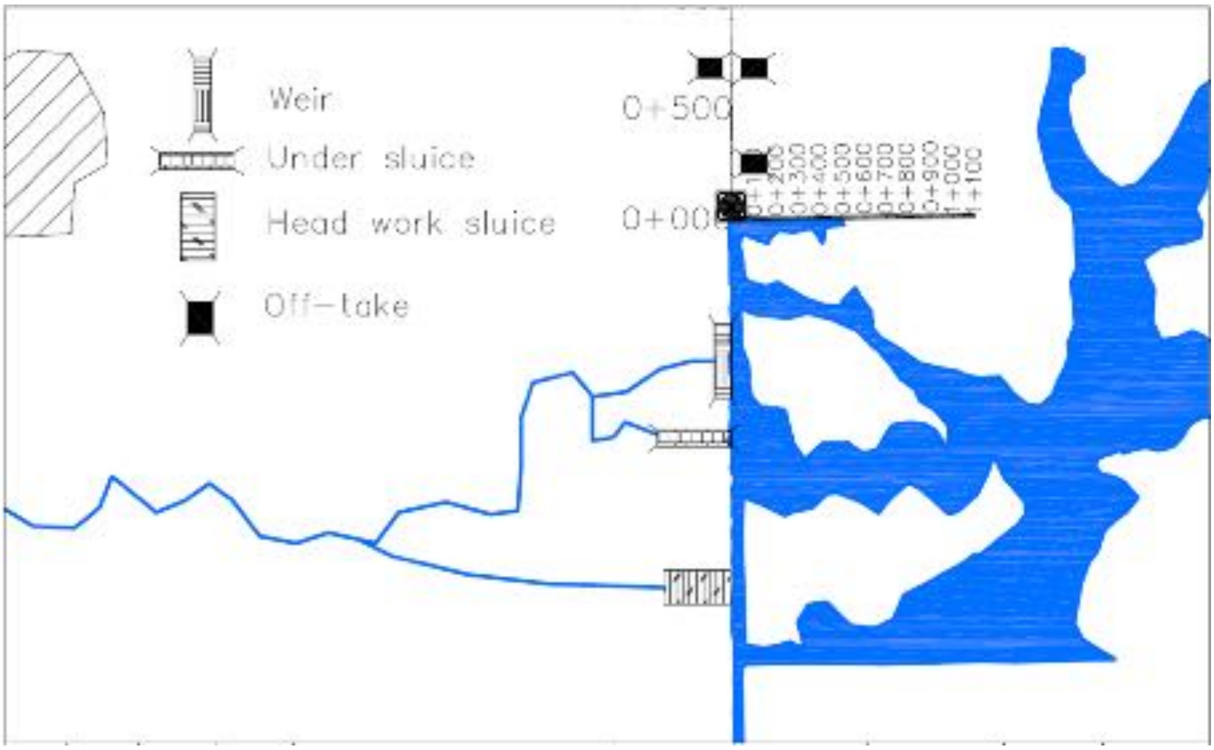
Note: 2.16 MCM = Withdrawal of 12 m3/sec over two days

3.2.2 Hydraulics design of Taing Krasaing Main Canal

Head Works

43. The headworks of TKMC consist of one spillway, one under sluice, one ogee weir and one canal head regulator, see Figure 66 below. The headworks are currently in critical state and require urgent rehabilitation.

Figure 6: Location of the Taing Krasaing Headwork Structures



- **Peak Runoff**

44. According to result from the hydrological analysis, peak runoff at 100 year recurrence interval at the location of the TKS head work is about 200m^3/s. The ogee weir and the spillway should safely discharge the computed peak flood.

45. According to the result from the topographical survey, the ogee weir crest length is 80m and the existing spillway consisting of nine opening with clear width of 2.2m wide each.

46. Flow through the head work is computed by the use of weir over flow formula and the computed discharge is analyzed as following:

- Lacey's wetted perimeter formula P $= 4.75\sqrt{Q}$, Q is discharge in m^3/s and P the required water way width in m. With the peak runoff of 200m^3/s, the computational result of the water way width required is 67.18m, which is less than the existing clear water way of 99.80m[2].

- The discharge formulas which were used to check the existing capacity of the spillway and the ogee weir are as following: If head over the crest of the weir or sill level of the spill way is less than 1.5 time the width of the crest, the weir shall behave like a broad crest weir, else the weir shall behave like a sharp crest weir.

47. The existing sill crest level of the spillway is 13.52mMSL, comparing to the crest level of the ogee weir of 16.24mMSL, which in this case the crest level of the spillway is lower than the crest of the ogee weir of 2.72m. For the design purpose the crest of the spillway is raised to the same crest level of the ogee weir. Discharge through the two structures is computed according to the above two weir formula and the computed discharges through the weir and the spillway is 166.36m3/s and 36.89m3/s, respectively when head over the crest is 1.1m, which in this case the reservoir water level is reaching to 17.34mMSL. Hence the combine flow through the two structures is 203.25m^3/s, which is larger than the computed peak discharge of about 200m^3/s.

48. The canal head regulator is not intended to release peak flood but to control river flow from the Taing Krasaing reservoir into the main canal and prevent excessive flow which would damage the main canal.

49. Adjacent to the weir to the South there is an under sluice which is at critical stage due the foundation soil at its downstream end is washed away into the stilling pool of the river. The under-sluice requires rehabilitation with the construction of an extension to the downstream chute with a supporting concrete column and construction of retaining wall preventing from further soil collapse underneath the structure and back fill to replace the collapsed soil. The function of the under-sluice is to flush sediment and release environmental or maintenance flow to the river downstream to keep the river healthy and to provide water rights in the downstream reach.

- **Ogee Weir**

50. The computed flow through the ogee weir is 203.25m^3/s and the weir is equipped with a stilling basin, the most common form of energy dissipator, converting the supercritical flow from the spillway into subcritical flow compatible with the downstream river regime. The straight forward - and often best method of achieving this transition is through a simple submerged jump formed in a rectangular cross-section stilling basin. The computed results of the stilling basin design for the ogee weir is that the stilling basin elevation should be laid at the elevation of 6.74mMSL with the required stilling basin length of 11m.

- **Spillway (Existing Pol Pot Head Sluice)**

51. The existing Pol Pot sluice is consisting nine openings, the sluice was designed to equip with stop-log as control gates. However during existing condition the logs were

[2] Out the total water way of 99.80m, clear width of the existing spillway is 19.80m and the width of the ogee weir is 80m.

removed but are replaced with concrete panel in each opening. The crest height of the concrete gate panels are much higher than the crest the ogee weir, which in this case most of the river flood is passed through the ogee weir and the under sluice. During existing condition the Pol Pot sluice is getting severe erosion of its downstream section at the end of its chute spillway.

2. The proposal is to rehabilitate Pol Pot sluice as following:

- The crest height of the control gates of the concrete block panel should be kept at the height of the ogee weir. This is done for the reason to bring the headwork sluice in operation to share some of the flood magnitude from the ogee weir. As during existing condition most of all the river flood is passed through the ogee weir and the under-sluice, which result in severe scouring of the down-stream slope of the ogee weir and back scouring underneath of the under sluice.
- In order to reduce scouring of its downstream section at the end of the chute spillway, the stilling basin is required.

3. The computed results of the stilling basin design for the spillway is that the stilling basin elevation should be laid at the elevation of 6.74mMSL with the required stilling basin length of 9m

- **Canal Head Regulator**

52. The existing canal head regulator has two openings with clear water way width each of 2.5m wide. According to the result of the topographical survey, the sill level of the head regulator is 14.09mMSL, with the maximum flood water level reaching 17.34mMSL, the head of water over the head regulator sill level is of 3.25m, and head lost over the head regulator is 1.1m.

53. With the mentioned head loss, flow through the head regulator was calculated according to the flow through orifice formula when the gates are open at 1 m height. The computed flow is found out of about 15.8m^3/s, which is already sufficient for required crop water requirement of the system. With the computed flow, the head regulator requires equipping with stilling basin of length 8.6m and the design level of the stilling basin which the jump will form is 13mMSL. This level is lower than the existing Head Regulator sill level of 1.1m.

3.2.3 Main Canal Design

- **Design Consideration**

54. According to the selected cropping pattern, the computed crop water requirements for the design of the main canal is 14m^3/s. The computed design flow is to be checked with the existing canal section. According to the results from the topographical survey the canal hydraulic parameters were obtained as shown in Table 6 below. The design canal bed gradient and the selected Manning roughness coefficient are also shown in the table.

Table 6: Selected Canal Hydraulic Parameters

Descriptions	Hydraulic Dimensions
The canal bed width (b) =	14.0 m
Canal slide slope	1:3 (V:H)
Canal depth from existing embankment	4.1m
Roughness coefficient, n	0.025
Design canal bed slope	0.00015

55. Using the defined canal hydraulic parameters the main canal capacity is computed with the use of Manning formula and the computed design discharge is found out to be $84m^3/s$, with normal flow velocity of about 0. 777m/s. Hence the main canal capacity could convey the flow far more than the required flow of $14m^3/s$ defined by the selected cropping pattern. The canal is run under sub critical flow condition with normal flow depth yn is higher than the critical flow depth yc. The canal safe from siltation and scouring as the design normal flow velocity Vn is higher than the none silting velocity Vnsilt and lower than the none scouring velocity Vnsc. In addition the normal flow velocity Vn is less than the critical flow velocity Vc and the design canal bed slope is less than the computed critical slope.

56. However during actual application, the canal Full Supply Level (CFL) could hardly drop as the main canal is designed as an extension storage basin connecting to the TKS reservoir, which in this case the main canal water is in most of the time stays stagnant. Table 7: Computation of Canal Hydraulic Parameters below shows the canal computed hydraulic parameters.

Table 7: Computation of Canal Hydraulic Parameters

Description				
The design discharge	(Disch)	=	84	m3/s
The design canal bed width	(b)	=	14	m
Normal flow depth in canal	(yn)	=	4.109	m
The canal free board	(Fb)	=	0.9	m
The design canal depth	(yn + Fb)	=	5.009	m
Cross-sectional flow area	(An)	=	108.167	m2
Wetted peri for normal flow	(Pn)	=	39.986	m
Normal flow velocity in canal	(Vn)	=	0.777	m/s
None scouring velocity	(Vnsc)	=	1.115	m/s
None silting velocity	(Vnsilt)	=	0.801	m/s
The design canal slope	(So)	=	0.0001	
Critical flow depth in canal	(yc)	=	1.397	m
Critical cross-sec flow area	(Ac)	=	25.422	m2
Wetted peri for critical flow	(Pc)	=	22.838	m
Critical flow velocity	(Vc)	=	3.304	m/s
Critical slope	(Sc)	=	0.006	
The canal is safe against erosion				
The permissible velocity	(Vp)	=	1.1	m/s

- **Geotechnical Investigation**

57. The results of the geotechnical investigation is showing that the in situ soil is characterized of low permeability with coefficient of permeability K ranging from 4.0E-04 cm/sec to 9.5E-05 cm/sec. In addition the soil is also characterized with low infiltration with saturated infiltration rate in the range from 8 mm/hours to 21.29 mm/hr. This means an earth canal is feasible for TKMC.

58. According to the recommendation of the Geotechnical soil investigation, for BH1 and BH2, see figure 7 even the in-situ soil characteristics are not within allowable limits as specified in the criteria for defining soil suitable quality for earth work structures, but the existing actual soil condition is not critically eroded s for BH3 and BH4, see Figure 7.

59. In addition some of the sub soil layers of BH1 and BH2, soil quality is within the allowable limits, not all the stratums are outside the allowable limits. Hence the main canal reach within these section from RD 0+000 to RD 15+500 could be feasible using the in situ earthen materials and the excavated soil could be used for canal embankment fills, provided that both side canal embankments are grass sodding of their side slopes and embankment top surfaces should be covered with laterite.

60. The remaining part of about 2.5km at the end of the main canal connected to National Road No.6, this section is definitely requires lining.

Figure 7: Borehole Locations

3.2.3.1 Cross Drainage Structures

61. The TKMC has been constructed to cross natural drainage paths, obstructing natural flow from the bush or shrub land to the north of the southern part of TKMC draining into the downstream reach of Taing Krasaing river and ultimately draining into the Tonle SapGreat Lake, see Figure 8

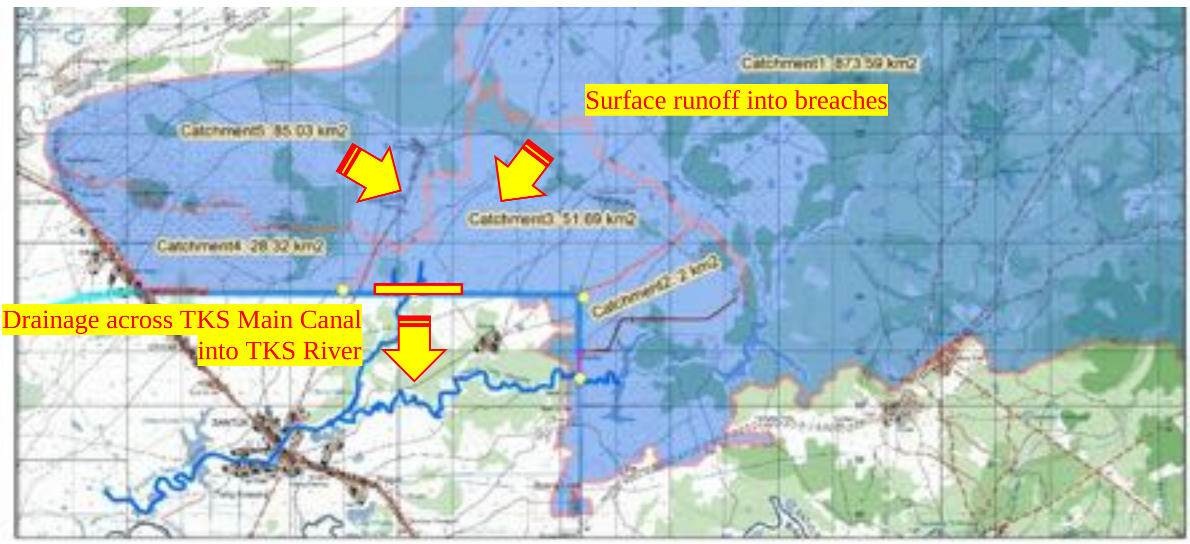
62. The topographical survey identified a major breach along the main canal right bank from RD 7+500 to RD 9+500. The breach needs to be closed with a right hand side embankment in order to bring the MC back into operation.

- **Peak Runoff Estimations**

63. Hydrological analysis was done to assess the flood magnitude at different outlet points for sizing of the drainage works, see Figure 8. Several methods were used for the computation of peak runoff from the upstream catchments of the TKS irrigation system, and these methods are the rational method, the GTFM (General Tropical Flood Model) and the regional flood frequency analysis and K- Water formula.

64. Peak runoff computations required for the design of drainage works for the TKS main canal are split into Catchment 1 (the location of weir outlet point), Catchment 2 (between Catchment 1 and Catchment 3), Catchment 3 (the major breach location) and Catchment 4 (downstream reach of the main canal), see Figure 8.

Figure 8: Drainage Outlet Points and Areas for Computation of Peak Flood, PPTA Team



65. The computed peak flood with different methods provides different results and for the cases of TKS irrigation system, the GTFM is most appropriate as this method is suitable for large catchments. Hence the selected peak runoffs to be used for the improvement of the existing head works, for the designing of cross drainage works at the location of major breach and at the location of canal downstream reach are shown in the below Table 8.

Table 8: Results of Peak Flood Computation

Catchments	Estimated Peak flood, m^3/s			
	1-in-20 Recurrence	1-in-50 Recurrence	1-in-100 Recurrence	Remarks
Catchment 1	150	170	200	At the gate head works
Catchment 2	2.6	2.9	3.0	Adjacent to catchment 3 to the West
Catchment 3	7	10.0	11	Inflow overpass drainage
Catchment 4	5.0	5.5	6.0	Adjacent to catchment 3 to the West

- **Hydraulic Design of Cross Drainage Works**

66. The peak flood from Catchment 1 is to be evacuated through the weir and the Pol Pot spillway as was previously mentioned. Peak runoff from Catchment 2 and Catchment 4 is intercepted by the right-hand side collector drain and conveyed to the cross drainage works and combined with peak runoff from Catchment 3, at the location of major breach[3] at which point the cross drainage work is planned, see Figure 8. The combine peak runoff from the three catchment at a 1 in 100 recurrence interval is estimated to be 20m^3/s, which should be safely released through the cross drainage works. The cross drainage work is proposed in the form of earthen canal of trapezoidal cross section and is to be designed to overpass the main canal from the right to left embankment, discharging into the downstream reach of Taing Krasaing River.

67. At the location of the proposed cross-drainage, the main canal is designed to be siphoned below the Super-passage drainage works. This option is proposed as (i) the canal bed elevation is lower than the natural land elevation, (ii) the length of the over pass drainage is much shorter than if the overpass was to be designed as an inverted siphon, and (iii) the drainage works can be constructed in the earthen materials. A lower cost for these three reasons.

68. The existing canal section has a right of way which is large enough to allow interception drains to be constructed along both sides, parallel to the canal embankments and at their outside edges. The interception drains will collect surface runoff from the Northern side catchment and excess runoff from the paddy fields in the command areas on both sides of the canal and convey the accumulated water to the overpass drainage works. In addition the left embankment collector drain would also collect excess water from TKMC side escapes and brings it to the natural stream.

69. Hydraulic calculation for the cross drainage works indicate:

- A canal siphon of three barrel compartments 1.5m high.
- The super-passage drainage waterway should have a bed width of 24m and a depth of 1m.

[3] the major breach is located at the location from RD 8km to around RD 9.5km

3.2.3.2 Canal Structures

70. For efficient water management of the TKMC, following irrigation structures are proposed:

- **Cross Regulator**

71. The TKMC currently has seven cross regulators. These numbers are sufficient for the operation of the main canal. The existing cross regulators are damaged at their downstream and upstream side slope protections, which requires rehabilitation using a reinforced concrete panel to protect the eroded side slopes.

72. A hydraulic calculation was performed to check the conveying capacity of the cross regulator, verify the design discharge of $14m^3/s$ and to check whether the structure required energy dissipation basin preventing from canal erosion at the downstream of the structure. According to the results, the seven cross regulators have enough capacity to convey the design flow of $14m^3/s$ and they do not require energy dissipation basins.

- **Side Escapes**

73. Two canal side escapes are planned, one at each canal embankment at around RD 6+000 m on the right hand side canal embankment and at RD 15+500 at the left hand side of canal embankment. The side escape is designed to have sufficient capacity to cope with canal flow when, once in a while, the gate operator forgets to close the gates at the head of the regulator or close the gates of cross regulators on time. If this happens canal water will over flow the side escape and discharge into the collector drain. The collector drain will then convey the excess water to the overpass drainage work and to the tributary river. The two side escapes which are proposed each with a length of 7.5m.

- **Measuring Devices**

74. The TKMC is designed to be function as a basin storage type of canal, as the existing canal section is already of large. This means each canal reach will always be full of irrigation water.

75. As water is stored in the storage basins of the main canal and flow velocities will be very low or zero, measuring devices (MD) will not function effectively. Hence to measure the amount of water use by each secondary canal (SC), MDs will not be installed in the main canal, but downstream of off-take structures.

76. There are several types of MDs in used such as weirs and Parshall flumes. At the SC level, an un-contracted weir with a rectangular shape is proposed and at the tertiary level a Parshall flume is proposed.

- **Foot Bridges**

77. Four wooden foot bridges are proposed to be newly constructed across TKMC at the location of the existing rural road crossing along the main canal. The foot bridges are design for pedestrians and for bicycles or for motorcycles.

- **Cattle Access Points**

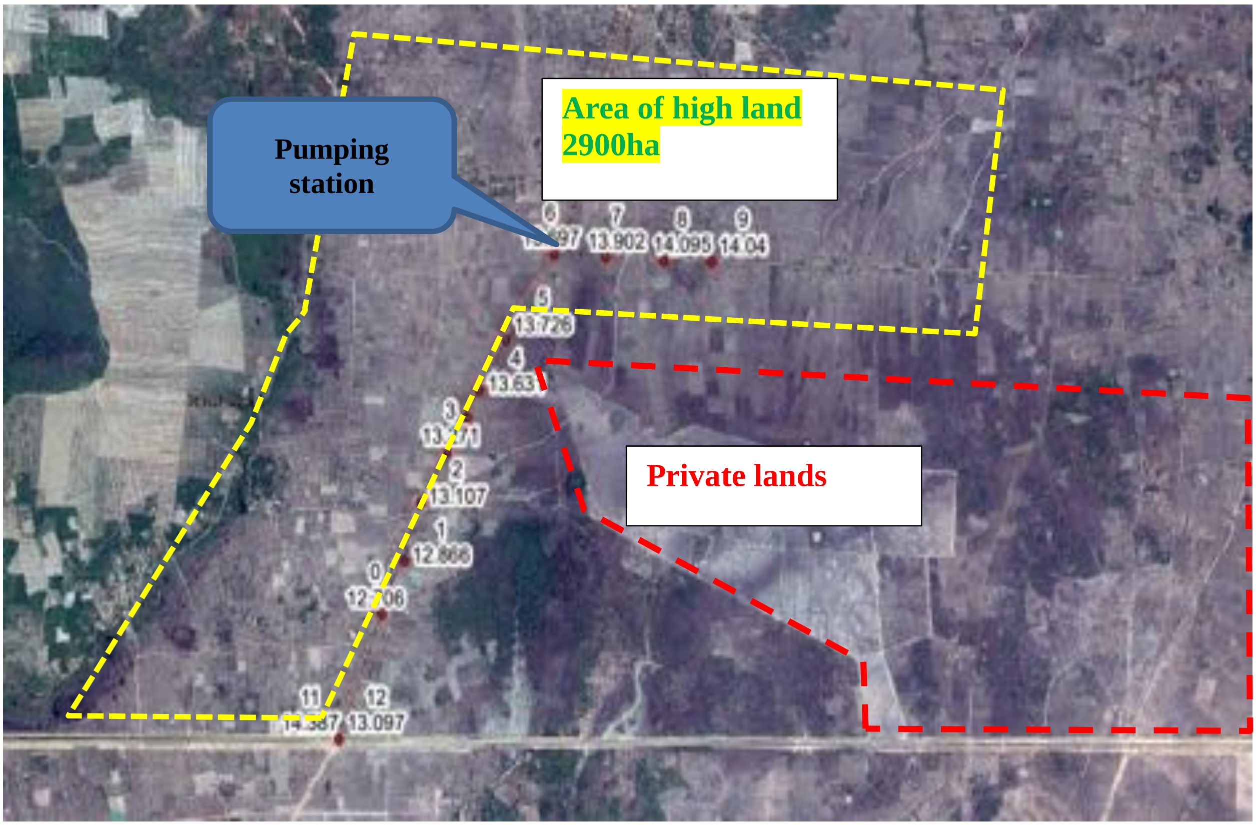
78. There are five cattle access points are proposed for TKMC. These facilities are provided so cattle access to canal water for drinking and for bathing.

3.2.4 Pumping to Highland Area in Tipou

79. About 30 percent of the potential command area of TKS, located on the right side of the main canal in Tipou commune, cannot be commanded by gravity from the Taing Krasaing main canal. Farmers in this highland area are expecting to benefit from canal upgrading. A pumped supply and distribution system has been designed to respond to the farmers' expectations.

80. An additional ground survey was undertaken by a survey team contracted by the PPTA establish ground levels in the declared irrigation area in Tipou commune. Once the average ground elevation has been determined, and with a knowledge of the main canal full water level (FWL) it is possible to define the area to which water could be gravitated. The 4500m survey route selected was along an existing access road northwards into the target area, see Figure 9 below.

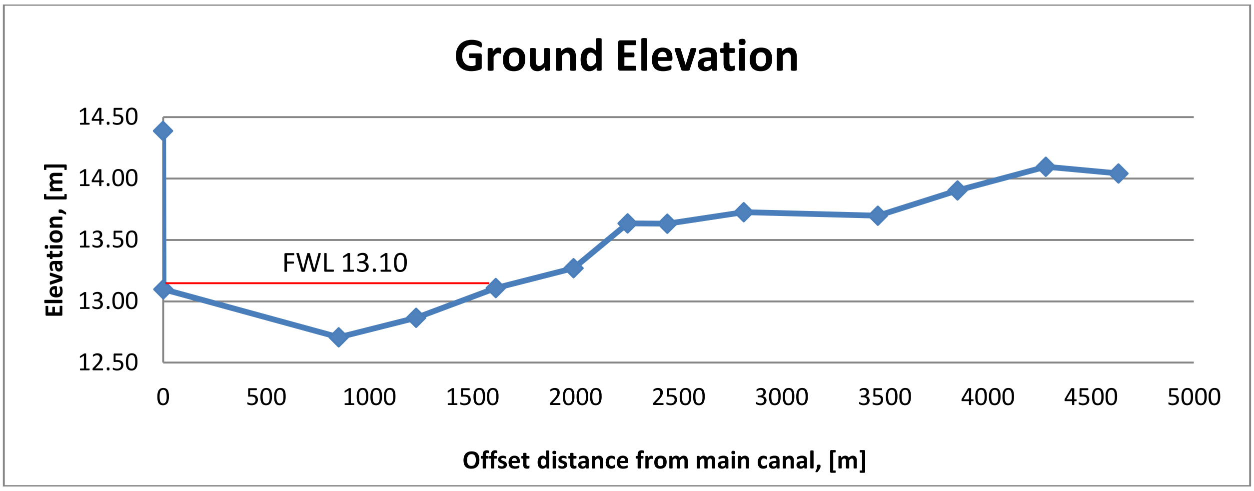
Figure 9: Survey Route and High Land, Tipou Commune, Taing Krasaing Core Subproject



The survey result is shown in

81. Figure 10 below. At the design FWL level at RD 9+330, TKMC can only command a distance of about 1,300m on the right side. Beyond this, pumping is required supply water to farmer's lands. The average ground level in the target high land area is about 2m above the FWL level in the Main Canal.

Figure 10: Elevations in the Area of High Land in Tipou Commune



82. The design provides for a pumping station to be installed at survey point No.6 (shown in Figure 9 above) about 3,500m from the main canal. The pumping station will supply irrigation water to the full defined command area of 2,900 hectares.

3.2.4.1 Pumping Station Design Considerations

83. Based on the survey and experiences in the design and construction of Chamlong Chrey Pumping Station in Kampot province, low lift submersible pumps will be used. [4]

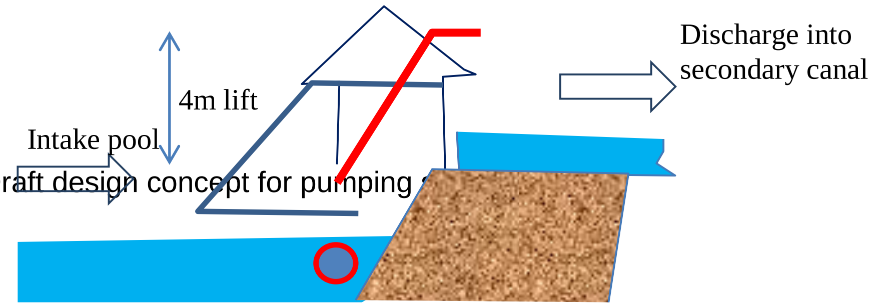


Figure 11. Draft design concept for pumping

The proposed pumps will be electrically driven to reduce of the cost and complexity of operation and maintenance (O&M). Experience shows the running cost of electric pumps is less than diesel powered pumps.

84. A simple, lower operating cost system will ensure pumping scheme reliability. Electricity which is use to run the submersible pumps is readily available in Taing Krasaing area. Such pumps give high efficiency, low running cost and require limited maintenance. There are fewer issues in starting and running electric pumps compared to diesel pumps. Three to five pump units will be required for the designed command area.

[4] Chamlong Chrey irrigation scheme is equipped with electric pumps and concrete lined distribution canals. The scheme was constructed by Cambodia Agricultural Value Chain (CAVAC - AusAID) in 2014. The system in now functioning well, providing a reliable irrigation water supply and good level of fee collection to support O&M.

85. The pump capacity required depends on crop water requirements, distribution system and water scheduling. TKS requires a supply of 1l/s.ha of irrigation, which is the same as that selected for the Chamlong Chrey pump system. Assuming a 10 day irrigation cycle and that the target irrigation area of 2900 hectares is divided into 3 blocks,, the pumping station will run for 24 hours a day with a discharge of 5 m^3/s for 3 days during the peak demand season. A stilling basin has been designed to reduce hydraulic energy which could cause canal embankment to be overtopped. This basin will be constructed adjacent to the pumping station.

3.2.4.2 Distribution canal for pumping station

86. A concrete lined canal is recommended for the Tipou's command area distribution system. Concrete lining provides a wide range of advantages although it has a slightly high cost:

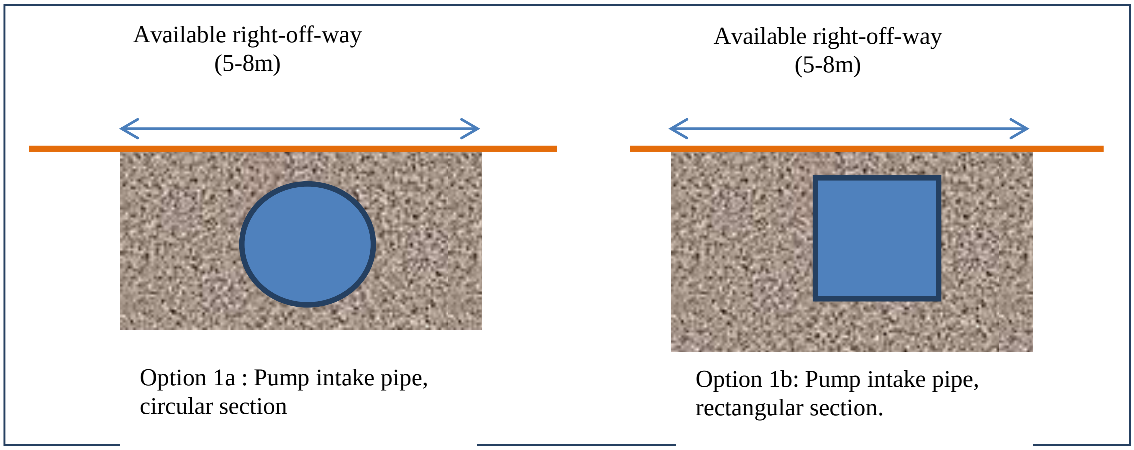
- Large reduction in water lost from the system, thereby **increasing irrigation efficiency**.
- Lower land acquisition costs since the average width of the concrete canals required is about 0.8m, compared to an overall width of about 10m for an earth canal.
- Very low maintenance requirements and longer life
- Shorter irrigation time since concrete canals allow high velocity
- Higher field irrigation efficiency since water can be delivered faster

87. The total length of secondary and tertiary distribution canals to supply water by gravity to every plot in the whole 2,900ha command area is approximately of 50km.

3.2.4.3 Intake canal

88. The survey results reported in Section 3.2.4 showed that the ground level of first 1300m of the intake line to the pumping station is above the FWL in the main canal. An open canal will be constructed for this length; the remainder will be an underground pipe. The underground pipe is selected for its lower cost from reduced land acquisition and lower water loss from evaporation. Farm plots within 1300m of the main canal will be supplied directly from the pump intake canal.

Figure 12: Pump Intake Pipe, Supplied from Open Canal



3.2.4.4 Taing Krasaing Main Canal Extension to Ko Koah Commune

89. The Kampong Thom Province Provincial Department of Water Resources and Meteorology proposes to extend the Taing Krasaing main canal beyond National Road No.6 so that the paddy field area to the west of the end of the main canal could also benefit from canal rehabilitation. However, the original main canal alignment is currently a village road used by local people.

90. The history of this development is the village road was converted to the canal during the Pol Pot regime, when all the land was in government ownership. After the country's liberation in 1979 local people converted the canal back into a village road. Through land titleling following the resumption of democracy, villagers who were living on the canal right of way were given a right to occupy the land. One section of the canal alignment was developed as a pagoda. It is, thus, impossible to extend the main canal following the original alignment through village and the pagoda.

91. A diversion route has been identified as an alternative, through discussions with Ko Koh Commune Council. A longitudinal survey has been made of the proposed alignment. To reduce land acquisition, a covered concrete culvert pipe will be used for the full 5.6km length to command an area of about 1,800ha.

92. The gross scheme irrigation requirement is about 1 l/s.ha, which allows for a net peak irrigation requirement is of about 0.7 l/s.ha occurring in the of month June with an efficiency of 40%. A continuous flow of about 1.8m^3/s is required for the 1,800ha command area, however if water is supplied for only 8hr/day, in accordance with the third system operational criteria, flow will need to be increased three times to 5.4 m^3/s. This flow of 5.4m^3/s has been used for pipe culvert design.

93. The pipeline has been designed to flow part full. Design guidelines published by the American Society of Civil Engineers (ASCE. 1982) and the Water Environment Federation, for a sanitary sewer pipe flowing under atmospheric pressure require a pipe

larger than 375mm in diameter, a $^3/_4$ full design flow depth and flow velocities between 0.60m/s and 3.5m/s. These guidelines ensure proper ventilation in the pipe and ensure the pipe does not become clogged with suspended solids; the guidelines also ensure solids are not deposited by specifying minimum permissible (or self-cleansing) velocities. Maximum permissible velocity is specified to prevent excessive scouring.

94. The topographical survey shows a natural land slope of about 0.0002. To ensure flow velocity in the pipe is within the specified range, the adopted design pipe slope is 0.001. Pipe diameter is 1.5m. The computed flow velocity city is 1.13m/s with an adopted pipe roughness coefficient of 0.015 and a flow depth of 1.01m. These parameters all fall within the above specified ranges.

3.2.5 Water Availability

95. The following tables have been developed from the hydrological data collected and applied to the base scenarios for both core subprojects; they form the basis for reservoir operations, irrigation scheduling in relation to crop water requirements, and determining possible cropping intensity.

Table 9: Inflows to Tiang Krasaing and Stung Chinit Reservoirs

Inflow in Joint Reservoirs of Tang Krasang and Stung Chinit river basins

Table 1: The **Dry Year** Monthly, Averages flow in m3/s and MCM in **Tang Krasang and Chinit** Reservoir

Watershed	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sub18TK	m3/s	6	3	2	2	3	5	11	23	31	36	23	12
Sub22Ch	m3/s	23	12	6	10	11	**32**	**60**	**121**	**170**	**168**	**89**	**40**
Total	m3/s	**29**	14	8	12	14	**36**	**71**	**144**	**201**	**203**	**111**	**52**
	MCM	78	38	21	31	37	98	191	385	539	545	299	140

Table 2: Normal Year Monthly Flow in m3/s and MCM in Tang Krasang and Chinit River Basin at Reservoir

Watershed		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sub22ch	m3/s	25	13	8	14	33	58	109	174	230	247	142	59
Sub18TK	m3/s	7	3	2	3	6	12	20	31	44	50	33	17
Total	m3/s	**32**	16	10	17	**39**	**69**	**129**	**205**	**275**	**297**	**175**	**76**
	MCM	86	42	27	44	105	186	346	549	736	796	468	203

Table 10: Monthly rainfall for Tang Krasaing and Stung Chinit catchments

Table: Monthly **Dry Years** Rainfall in millimeters At Kampong Thmar Raingauge Station for **Tang Krasang and Stung Chinit** watershed

M/Y	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Rainfall in mm
2002	0	0	6	202	87	312	88	154	465	124	16	1	1453
1993	10	4	2	22	151	181	196	217	265	288	108	0	1444
2009	0	33	100	59	266	149	172	247	363	50	1	0	1440
1992	11	0	0	153	267	133	337	243	184	0	0	0	1328
2005	0	0	5	23	109	144	331	88	271	208	117	22	1316
2010	0	0	12	65	116	136	183	115	208	289	38	0	1161
2004	0	33	11	70	75	282	224	130	201	127	5	0	1158
Average	3	10	19	85	153	191	219	170	279	155	41	3	1,329
Max	0	0	0	22	75	133	88	88	184	0	0	0	1,158
Min	11	33	100	202	267	312	337	247	465	289	117	22	1,453
0	0	0	1	23	82	135	138	104	194	30	1	0	1,160
1	10	33	36	163	266	288	332	244	383	288	110	7	1,446

3.2.6 Irrigation Efficiency

96. Designs for the rehabilitation and modernizing of the core subprojects and including considerations on irrigation scheduling as well as delivery operations included planning for a realistic irrigation efficiency. Improving irrigation efficiencies depends on more than just introducing modern physical works, as head works, gates and off-takes, control and measuring devices; it depends on who operates, who is involved in deciding quantities and timing, in deciding delivery schedules, elements of continuous, rotational and/or on demand flows. Obtaining a feasible high level of water delivery efficiency depends also on all items listed below:

1. Improving the capacity and willingness to manage a system
2. Improving the capacity and willingness to pay for irrigation services
3. Defining the irrigation services (based on ever-improvement efforts on best achievable cropping calendar)in a minimalist, non-complex way, such that it can be implemented
4. Understanding that FWUCs need the right to “voice” their opinion, and be approached in an egalitarian manner
5. Understanding that water users must often work 16 hours a day, and cannot be called to meetings at any time
6. Creating discipline and enforcing it, and establishing sanctions acceptable under Law and legal procedures, and among the community, often using just peer-fellow-water-user pressure. The PDWRAM and the FWUC committee members should be accountable to their duty otherwise sanction or replacement should be enforced.
7. All stakeholders have rights, roles and responsibilities which need to be defined and known to all and recorded.

97. Two terms are encountered repeatedly in PPTA-related documents and they center around the key definition on Selection Criteria 1:

1. Irrigation Efficiency (%) - ratio of water entering the system at head of main canal and crop water requirements, that can be bifurcated in conveyance efficiency (water lost in canals due to seepage) and field application losses (water entering the farm and actually used by crops); and
2. Irrigation Water Productivity ($ returned from crop production per cubic meter of water entering at head of main canal).

98. These definitions have guided the PPTA team as a starting point in the works of Irrigation Engineering and Agriculture, and subsequent Economics.

99. The reasons for the low irrigation efficiencies often encountered in many systems worldwide are many:

1. The lack of basic knowledge of water use efficiencies has several serious drawbacks: In the planning and design of irrigation systems a large safety margin is applied, as a consequence of which irrigation facilities like canals, structures,

and reservoirs are constructed with capacities that are too large; Investments are thus considerably higher than would otherwise be necessary;

2. The limited water resources are not optimally distributed and used, as a result of which much water goes to waste and less land can be irrigated;
3. Last but not least, the low overall irrigation efficiency creates harmful side-effects such as rising groundwater tables and soil salinization. To control the groundwater table a costly subsurface drainage system may be necessary and this will seriously affect the economy of the project.

100. The total amount of water used on irrigation systems may be reduced in three ways:

1. By reducing the water supplied to a system by reducing the amount of water abstracted through the intake, and then cascading this reduced supply through the system to encourage reduced demand;
2. By reducing the water demand of the system, and then operating or modifying the intake accordingly;
3. By improving the return of excess drainage water from the irrigation system back to the river system.

101. The first method is supply management (driving water saving from the top down), while the second and third methods involve demand management (promoting water saving within the system). It is likely that all three should work together.

102. Reducing the water demand of an irrigation system occurs in three ways:

1. Reducing the duration of irrigation need;
2. Reducing the total command area; and,
3. Reducing the specific water demand per command area.

103. These reduce water demand because of the following equation:

Water demand = time x command area x specific demand or, cubic meters volume = number of days x ha x l/sec/ha x 86.4

104. The three variables are inter-related, for example a shorter duration of irrigation supply can also compact the area irrigated. Once the total water demand has been reduced, the intake can be closed as described above. There are three ways of reducing the duration of irrigation need:

1. Season length of rice variety.
2. Field wetting up at the beginning of the season.
3. Field drying-off at the end of the season.

105. The movement of water through an irrigation system, from its source to the crop, can be regarded as three separate operations: conveyance, distribution, and field application.

1. Conveyance is the movement of water from its source through the main and (sub)lateral or secondary canals or conduits to the tertiary offtakes;
2. Distribution is the movement of water through the tertiary (distributary) and quaternary (farm) canals or conduits to the field inlet;
3. Field application is the movement of water from the field inlet to the crop.

106. The table below gives best estimates. The referred book above by Bos and Nugteren cites examples from over 20 countries, and has gone through several editions well into 2000's.

107. The situation today in the core subprojects is basically zero efficiency at both Taing Krasaing and Taing Krasaing: because these systems are broken, highly incomplete. In both Taing Krasaing and Taing Krasaing there is no scheduled irrigation water, just rain and floods.

108. Stung Chinit has been in operation over considerable length of time, and is being continuously being improved. Field visits showed large areas under crop (rice) as second or third crop. Reservoir is full, also because there is not and has never been a water demand from Taing Krasaing and developments proposed upstream have not yet come online.

Table 11: Irrigation Efficiencies in Two Core Subprojects

Table on Irrigation Efficiencies					17
	In Percent (%) All numbers estimates/approximates	e_c	e_d	e_a	e_t
1.a	Tang Krasang – If operated as is (WITHOUT – Before)	<5	<5	<5	
1.b	Tang Krasang –upon modernization (lining) WITH At start	(70)	(60)	(40)	17
1.c	Tang Krasang – WITH after 5 years	(70)	(70)	(50)	25
1.d	Tang Krasang – WITH after 10 years	(70)	(80)	(70)	40
	Compare to "Chicago" CAVAC Area as is Today	(70)	80	70	40
2.a	Preuk Chik – if operated as is – water supply restored	(60)	(60)	(40)	15
2.b	Preuk Chik –upon modernization (no lining) WITH Project	(70)	(60)	(50)	25
2.c	Preuk Chik – With after 5 years	(70)	(80)	(70)	40
3	Stung Chinit – as control reference for Tang Krasang	(70)	(80)	(70)	40

109. Based on previous experience, 40% is a maximum achievable efficiency after 10 years. Much needs improvement, not just structural and canal upgrading, but creating the discipline and information needs for operations never yet attempted among FWUCS and PDWRAMs. They are basically starting from zero. The good fortune is that Stung Chinit next door is only 10 km away, has been undergoing 20 years of various trainings to FWUCs and by now operates as a partially rotational, partially continuous supply system, doing reasonably well, and rather stable and well-maintained.

110. For core subprojects, in estimating water needs, and resulting water design capacities of main canals, these values will serve as starting points in Year 1 (approx.1 5 -20), and after 10 years reaching a quite reasonable and achievable 40% (conditional on several other non-physical aspects).

111. Obtaining high irrigation efficiencies requires a high degree of discipline, once a system with all controls and measuring devices is completed and handed over to PDWRAM and FWUCs. Measuring water becomes important right at the beginning when service will start in both core subprojects. FWUCs exist to co-operate and maintain irrigation facilities and to make sure the resources provided are used as good as possible by them. They should function as an extension of the PDWRAM. The PDWRAM logically should focus on and have the capacity and resources to provide specific time-based irrigation service, meeting the needs as specified in a yearly cropping plan, and following the O&M plan.

112. The following are factors that can make irrigation efficiency go easily **below 20%:**

1. **(ALLOWING) Over-irrigatio**n at upper and middle parts, not just theft, but plain indifference to discipline of a distribution schedule, leaking gates, open gates, thinking on seeing water in the system, that there is enough for all…
2. (**NOT) Policing outflow into drains, water wasted**, just thinking that keeping open the gates is pleasing the crops… Policing the drain during dry times is a MUST when there is irrigation.
3. **(NOT HAVING) Internal tertiary agreements between water users** when it is their turn…. They have to have a plan, and they stick to that.
4. (**NOT ADHERING TO) Agreement of water release from reservoir** that assume at least an irrigation efficiency of 70%, and if still water user are complaining they did not get served or did not get water, to ask sternly: "WHY?. We gave you the amounts you wanted…and still not enough."
5. **(GOING EASY ON) The enforcement of Pay ISF**: if a tertiary unit has been served not being somehow forced to pay may quickly result in an attitude of carelessness and indifference.
6. (**POOR) record keeping of inflow versus areas harvested and yields achieved**, to know the water productivity and improve on this yearly.

113. All systems worldwide that have 60% plus irrigation efficiency have a very large degree of **Discipline on above.** Service providers and service receivers have a variety of tasks and responsibility. Roles of each group are defined and water accounting is introduced and applied.

114. With crop water requirement worked out in detail, it is possible to assess the impact of irrigation efficiency on water release from reservoirs, irrigation scheduling for distribution. And field application facilities. Designs have been based on assuming the core subprojects can achieve a 40% efficiency through various measures, training and scheduling

115. For main canal design, the following irrigation efficiencies and associated crop water requirements were considered - including providing water for peak demand being land preparation/soaking at start of season:

1. at **30%** IRR EFF - crop water requirement is approx.. 11,000 m^3/ha
2. at **40**% IRR EFF - crop water requirement is approx. 8600 m^3/ha
3. at 50% IRR EFF - crop water requirement is 7200 m^3/ha.

116. This clearly shows that there is a big difference in meeting water needs between 30% and (say) 50%. Achieving to bring a system from 30% to 50% IRR EFF saves significant amounts of water, up to 33%. In view of climate change and the increased potential for drought and prolonged dry periods, attempting this with stubbornness is considered worthwhile, from all due diligence viewpoints.

117. Thus the conclusion:

HIGH IRRIGATION EFFICIENCY = Discipline Enforcement of all elements of Water Distribution and Leakage Avoidance

1. Efficiency at 40% means Leakage of 60%.
2. Origins: Weather, Physics, System Limitations but also Human Indifference and Negligence
3. FWUCs exist (also) to manage the system resources provided and be trained to do so (gently but sternly)
4. PDWRAM to have resources for specific time-based irrigation service for yearly cropping plan, and following the O&M plan – with monitored performance

118. It is essential to have a “Policed” Water Use and Distribution Plan and to enforce it. It is felt (as tested worldwide) that the Willingness and Capacity to MANAGE of service providers and service receivers (who should pay an agreed ISF without hesitation) depends on applying the above: leakage avoidance, policing the system and correcting wasteful water applications, and enforcement of agreed rules with sanctions.

3.2.7 Drainage Needs for Taing Krasaing

119. Drainage is the key issues for TKS. There appear two large breaches on the Main Canal and they are located in adjacent to each other, between RD 7+500 and RD 9+500. These two breaches received the runoff flood from a large catchment which used to drain

into Taing Krasaing River. The TKMC has never been able to command any area downstream of these breaches. The farmers with land a few hundred meters from the breach will be flooded in dry season when water level in the main Canal is raised to commanding fields downstream of the breach. Meanwhile flash flood from the catchment on the right side threatens the TKMC by overtopping the embankments, eroding the canal and its embankment slopes and destroying structures.

120. To avoid all above mentioned issues, the two breaches will closed, and a cross drainage structure (over pass) will be constructed on the Main Canal to release flood from right side into Taing Krasaing River. The main canal at that point will run under the drainage over pass as a siphon. Inception drain canals will also be dug along the outside of the canal embankments in order to enhance to surface water collection and take drainage to the over pass structure.

3.2.8 Water Productivity

121. Water Productivity (WP) is defined as the output in USD achieved from net benefit of a crop in the WITH project situation for each m^3 of water diverted and used. WP is expressed in USD/m^3.

122. Using data presented in the Agriculture and Economic Analysis Link reports, the water productivity has been calculated for several crops, foremost rice (paddy), but also crops (vegetables and others) farmers plant in both core subprojects under rainfed and at times under irrigation on limited basis.

Table 12: Net Profit for Various Crops per ha in USD and Water Productivity in USD/m3

	Crop	Average Net Profit per ha in USD	Average Crop Irrigation Water Requirement per hectare in m^3	Water productivity in USD per m^3	Drought sensitivity
1	Rice	700	7000	0.10	Medium-High
2	Cassava	1666	20000	0.08	High
3	Corn	1217	6500	0.18	Medium-High
4	Water Melon	1790	5000	0.35	Medium-High
5	Mung Bean	767	4000	0.19	Medium-High
6	Pineapple	3515	20000	0.17	High

123. The above table is developed using crop budgets for each crop for one hectare. Current prices for inputs and on markets have been used. Crop water requirements are based on conditions encountered in both core subprojects.

124. Average net profits have thus been calculated. For crop water requirements, this may have a range of 30% plus or minus the average, but the average has been used as a basic indicator. For prices, this may be 10% plus or minus. This water requirement depends on many elements, such as water applications and irrigation efficiency, field

layout and levelness, climate variations, and input availability and knowledge of farmers on how to use, and more. But in general, in many areas farmers are informed and capable of growing these crops successfully. Cassava and pineapple are therefore high in drought sensitivity.

125. Conclusions:

1. The table shows that pineapple, water melon and cassava have high profit margins per hectare, but that at same time pineapple and cassava have high water requirements, and thus these may be prohibited in view of lack of water in dry season. Mung Bean has a similar high productivity as it use less water than paddy-rice.
2. **If water availability is not an issue**, **growing these crops (other than rice) show a higher water productivity in comparison with rice.** This has been from the beginning a focus point of the Concept Paper and TOR on Uplands Irrigation and Water Resources Management Sector Project, and the above information shows the justification of such focus.

3.2.9 Joint Reservoir Operations (JOROP)

126. Taing Krasaing is linked to Stung Chinit. In view of construction schedules and completing all irrigation facilities, the issue of how and with what agreed upon procedures to develop a **Joint Reservoir Operation (JOROP)** for Taing-Krasaing – Stung Chinit (TKS-SC) is still not of immediate urgency (until 2018), but starting to plan for this should be of immediate concern to MOWRAM and PDWRAMs.

127. **For Taing Krasaing,** with the (seldom used) link to Stung Chinit, the larger of the two systems, the need to agree to receive water from Stung Chinit may be less pressing. Stung Chinit water users, may have known about this link to Taing Krasaing, but they never had any water sharing or associated agreements. Future areas served by the combined Taing Krasaing-Stung Chinit may be in excess of 20,000 ha, and while water availability suggests sufficient water, it will need strict coordination for Taing Krasaing to obtain water from the Stung Chinit reservoir in the dry season. For Taing Krasaing a full cropping intensity of 100% is possible and planned for the dry season.

128. TKS-SC can be considered water endowed, whereas Bassac-Dauntri will be put under stress soon after start of dry season, by early February each year, and water stored will be quickly used. For every hectare of watershed as proportional linked to each hectare irrigated, TKS-SC has a 6.7 times larger area catching and providing water. All figures shown provide key information which should be the basis for planning a JOROP water release.

129. What is important now is to become aware of the need to accept this JOROP of being of utmost importance. The data and figures presented hereafter should attest to this and be a starting point for planning what JOROP should include. Preliminary considerations are presented hereafter.

Table 13: Basic Data for Joint Reservoir Operations

BASIC DATA FOR JOINT RESERVOIR OPERATIONS

CAM-ADB Uplands Irrigation and Water Resources Management Sector Project

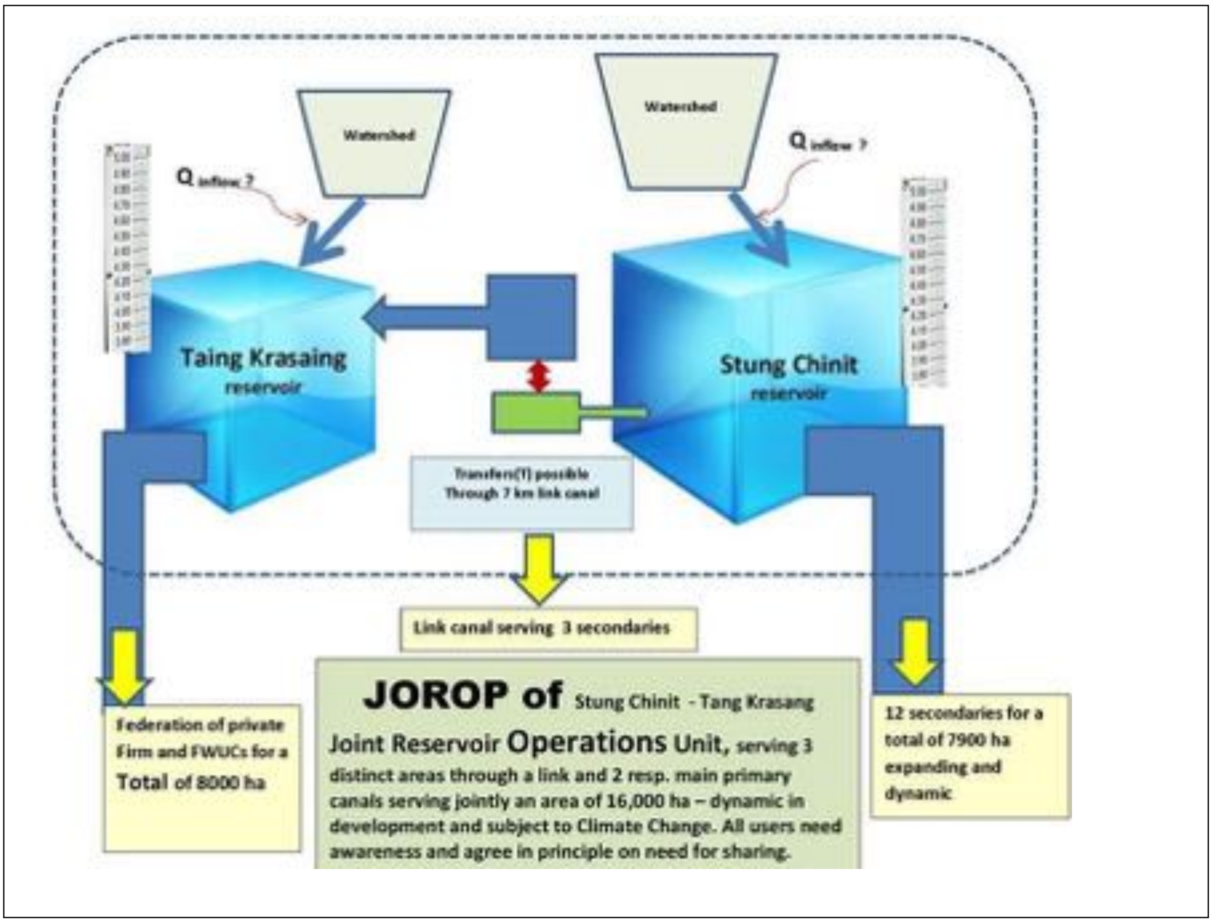
Note: All data best estimates from GIS maps and stream flow records available

	Reservoirs	Area Watersheds in km2	Storage Capacity in MCM	Area to be irrigated from both reservoirs combined (ha)
Joint Reservoir Operation for 2 systems	Taing Krasaing	932	7	19,000
	Stung Chinit	4,215	34	
	Total	5,147	41	19,000
Joint Reservoir Operation for 4 systems	Bassac	692	7	28,820
	Dauntri	583	12	
	Total	1,275	19	28,820

Watershed Catchment Area as basis for Irrigation Water Availability

	Characteristic Watershed and Irrigation Area	Taing-Krasaing – Stung Chinit	Bassac - Dauntri
1	Combined Catchment Area (CCA) (ha)	514,500	127500
2	Irrigable Area (IA) (ha)	19,000	30,000
3	Ratio CCA / IA	27.07	4.25
		6.3	1

Conclusion: The **Taing Krasaing** Irrigation area has **6.3** times more hectares available for catching rain water compared to **Prek Chik**.


Watershed
Watershed
Q inflow ?
Q inflow ?
Taing Krasaing
reservoir
Stung Chinit
reservoir
Transfers(T) possible
Through 7 km link canal
Link canal serving 3 secondaries
Federation of private Firm and FWUCs for a Total of 8000 ha
JOROP of Stung Chinit - Tang Krasang
Joint Reservoir Operations Unit, serving 3 distinct areas through a link and 2 resp. main primary canals serving jointly an area of 16,000 ha – dynamic in development and subject to Climate Change. All users need awareness and agree in principle on need for sharing.
12 secondaries for a total of 7900 ha expanding and dynamic

Considerations on establishing a JOROP for Taing Krasaing

130. A JOROP will be something new for PDWRAM of the Kampong Thom province. The investments made need an economic return, while those served with water need to feel and experience the water service is as agreed and expected. PDWRAM is the future guardian of achieving this, and will require much guidance and firm guidelines. PDWRAMs are already viewed as being weak in performance, under-staffed and under-resourced.

131. The anticipated and planned PMIC Consultancy will need this JOROP planning to become of their main tasks in relation to PDWRAM performance, strengthening and capacity building. the following is required to be discussed, recorded and achieved well in advance before starting actual reservoir operations, expected earliest in 2018:

1. Assessment of Legal Framework and required actions to establish such JOROP by law.
2. Description of Procedures, Rules and Responsibilities for a JOROP, for both at MOWRAM level, as well PDWRAM
3. Establishing a JOROP Operations and Management Board and deciding on a JOROP Board composition and forms of representations.
4. Establishing Meeting frequency, procedures and information to be decided and how to be released to Reservoir Stakeholders
5. Establishing rules for complaints about reservoir service, arbitrations and implementation of Board resolutions
6. Establishing what Information Bookkeeping will be required to keep track of water released, planting schedules agreed by coded system sub-sections. A JOROP should be required to provide information to general public, by setting yearly targets and provide information
7. Assuring installation and familiarity of use of Hydromet and Telemetry trough Department of Meteorology.
8. Requirement for Reporting to Board and key stakeholders in success being the respective FWUCs on Season and Yearly Release and Areas served.
9. Methods and information gathering to be used for Tracking of Areas Planted and Harvested.
10. Coordination with respective FWUCs in regularly quarterly meetings on areas to be served, crop water requirements, scheduling.
11. Inclusion of Representation of Districts, Communes and Village leaders in meetings, reporting and on JOROP Board.
12. Funding of JOROP to function within of PDWRAMs by including funds request for necessary activities.
13. Preparing for actions in case of drought and anticipating such event and how to provide timely information to reservoir and system water users framework
14. Relationship of a JOROP with key institutions associated with water use and best practices in cropping (MAFF), watershed and deforestation (Environment, MAFF), and others.

132. This will require further expansion and structure during project preparation under PMIC. Hereafter is an outline of initial considerations on planning a simple table for water release into systems.

	1 Start Season	2 Flow Release	3 Reserve Flow	4 Area Start	5 Code	6 Area Cumulative	7 Code
J1	Dry Season Irrigation End						
J2							
J3							
F1							
F2							
F3							
MA1							
MA2							
MA3							
A1							
A2							
A3							
MY1							
MY2							
MY3							
JN1							
JN2							
JN3	Wet Season Irrigation						
JL1							
JL2							
JL3							
A1							
A2							
A3							
S1							
S2							
S3							
O1							
O2							
O3							
N1	Dry Season Irrigation Start						
N2							
N3							
D1							
D2							
D3							

Information Bookkeeping Layout for JOROP Operations and Management

1. Planning Sheet as Basis for Water Releases and Areas to be brought on-line with planned service – per 10 days period – each month divided into three periods (first column).
2. Codes for areas to be served. To be specific for blocks. Key number may be 1 m^3/sec for every 800 ha.
3. Reserve flow released during key demands as land preparation and prolonged drought-no rainfall.
4. Areas served cumulative at any time under Column 6
5. Bookkeeping to be transparent and discussed with the Reservoir depending FWUCs and have their agreement, both as PLAN and as REALIZED assessed after each season.

3.2.10 Main Canal Operations Taing Krasaing

133. During wet season when the water level at the Tiang Krasaing Reservoir reaches its highest, the gates of the head regulator should be regulated so that only the required amount of flow is permitted to enter into the main canal and keep the main canal water level to its full supply level. However during dry season or when water level of the Taing Krasaing River drops to the crest of the weir, the head regulator gates should keep open at all times, and doing so, keep the water level in the main canal and in the Taing Krasaing Reservoir at same level. Such operation will allow TKMC to function as an extension of Tiang Krasaing Reservoir.

134. Operation of a storage basin type main canal is easier and more flexible than the operation of the free flow type. The free flow type operation requires proper scheduling between the upstream and downstream farmers, more importantly its operation requires frequently closing and opening of the CR gates and the gates of the off-take structures. However for the operation of the basin storage type canal, where water is always kept full in the canal, farmers could take water from the canal into the laterals at any time when it is needed: there is no scheduling required provided that there is water available at the reservoir head-works.

135. Advantages of reshaping of existing canal section for a basin type canal are:

- a reduction in earth moving: as there is no need to bring backfill soil from elsewhere to fill in the existing canal section, which would be necessary for a free flow type canal
- an additional water storage volume of about 2.1MCM is available
- less maintenance works since the low flow velocity will not cause canal erosion.

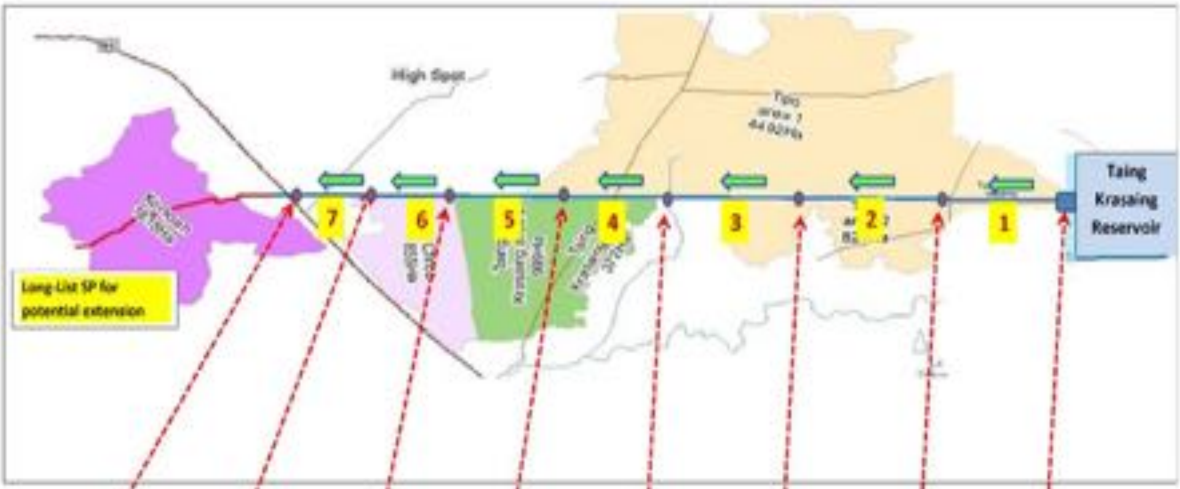
136. The main canal currently has seven existing cross regulators which are in good condition, except their upstream and downstream side slopes are critically eroded and required protection. The seven CRs will divide the main canal into seven basins see Figure 13. When irrigation water is off-taking, the main canal full supply level will drop. When there is a drop in surface water level in the main canal differential head will be created between the TKS reservoir and “basin” from which water is being taken. The differential head will cause an inflow of water from the reservoir into the main canal.

137. The seven basins are operated independently from each other most of the time, which mean the CR gates are always kept open. An important function of the CRs is for emergency repair of the main canal when there is a problem with the canal embankments in any one of the seven basins. In this situation the upstream and downstream CRs gates will be closed allowing the basin to be dewatered for repair of the main canal.

138. The main canal should be taken out of service for the dry season once in five years for de-silting. Siltation of the canal will occur from rill erosion of the canal embankments caused by rainfall.

Figure 13: Basin Operation of Taing Krasaing Main Canal

Main canal of Taing Krasaing – Schematic – No. of Basins created along main canal – Inflow controlled through cross-regulators



Basins	7	6	5	4	3	2	1	Totals
Station RD	RD 15+700 to 18+130	RD 14+100 to 15+700	RD 10+300 to 14+100	RD 6+700 to 10+300	RD 4+300 to 6+700	RD 2+100 to 4+300	RD 0+000 to 2+100	18.13 km
Basin length (m)	2430	1600	3800	3600	2400	2200	2100	18,130
Area Served (ha)	0	635	1543	1921	2461	2936	541	7405
Off-takes Left	1	5	2	5	3	3	3	22
Off-takes Right	2	2	5	1	3	3	3	20
Communes served	Chroab	Chroab	Ti Pou, Taing Kra Saing, Chroab	Ti Pou, Taing Kra Saing	Ti Pou	Ti Pou	Ti Pou	
Storage (MCM)	0.2499	0.2618	0.2856	0.4284	0.4522	0.1904	0.2886	2.16 MCM

3.2.11 Land Leveling

139. Uneven soil surface has a major impact on the germination, stand, and yield of crops due to inhomogeneous water distribution and soil moisture. Land leveling is essential to good agronomic, soil, and crop management practices.

140. Traditionally farmers level their fields using animal drawn or tractor-drawn levelers. These levelers are implements consisting of a blade acting as a small bucket for shifting the soil from higher to the low-lying positions. Even the best leveled fields using traditional land leveling practices are not precisely leveled and this leads to uneven distribution of irrigation water.

141. The common practices of irrigation in intensively cultivated irrigated areas are flood basin and check basin irrigation systems. These practices on traditionally leveled or unlevelled lands and lead to water logging conditions in low-lying areas and soil water deficit at higher spots.

142. The advanced method to level or grade the field is to use laser-guided leveling equipment. Laser land leveling is leveling the field within certain degree of desired slope using a guided laser beam throughout the field.

143. The introduction of laser leveling in the 1970's produced a silent revolution that has raised potential of surface irrigation efficiency to the levels of sprinkler and drip irrigation (Erie and Dedrick 1979). Laser-controlled land leveling equipment grades fields to contour the land for different irrigation practices. With sprinklers, a perfectly level field conserves water by reducing runoff and allowing uniform distribution of water. Furrow irrigation systems need a slight but uniform slope to use water most efficiently. Laser leveling can reduce water use by 20-30% and increase crop yields by 10-20%. The quality of land leveling in zero-slope fields can be estimated through the standard deviation (SD) of soil surface elevation. A field leveled with conventional equipment can attain a standard deviation of 20-30 mm, while using laser leveling the technical limit extends up to 10 mm. The introduction of laser leveling can result in more than 10% increase in application efficiency, while the cost of the leveling operation is two to three times that of standard tillage operation. Before starting the laser land leveling process, the field should be ploughed and a topographic survey be carried out. One of the measures to improve irrigation efficiency is zero-grade leveling for crop production. Zero-slope fields can be flushed or drained more quickly. Level fields allow for a more uniform flood depth, using less water and reducing pumping costs. Benefits from precision leveling of land extend for many years, although some minor land smoothing may be required from time to time due to field operations and weather conditions.

144. Land leveling is a precursor to good agronomic, soil and crop management practices. Resource conserving technologies perform better on well leveled and laid-out fields. Farmers recognize this and therefore devote considerable attention and resources in leveling their fields properly. However, traditional methods of leveling land are not only more cumbersome and time consuming but more expensive as well.

145. Very often most rice farmers level their fields under ponded water conditions. The others dry level their fields and check level by ponding water. Thus in the process of a having good leveling in fields, a considerable amount of water is wasted. It is a common knowledge that most of the farmers apply irrigation water until all the parcels are fully wetted and covered with a thin sheet of water. Studies have indicated that a significant (20-25%) amount of irrigation water is lost during its application at the farm due to poor farm designing and unevenness of the fields. This problem is more pronounced in the case of rice fields. Unevenness of fields leads to inefficient use of irrigation water and also delays tillage and crop establishment options. Fields that are not level have uneven crop stands, increased weed burdens and uneven maturing of crops. All these factors tend to contribute to reduced yield and grain quality which reduces the potential farm gate income. Effective land leveling is meant to optimize water-use efficiency, improve crop establishment, reduce the irrigation time and effort required to manage crop. Traditional methods of leveling land are cumbersome, time consuming, and expensive, so more and more farmers are turning to modern methods to level the land by laser.

3.2.11.1 Components of Laser Leveling System

146. A laser-controlled land leveling system consists of the following five major components:

(i) **Drag Scrapper/bucket:** The drag bucket can be either 3-point linkage mounted on or pulled by a tractor. This system is preferred as it is easier to connect the tractor’s hydraulic system to an external hydraulic by the 3-point-linkage system.

(ii) **Laser transmitter:** The laser transmitter mounts on a tripod, which allows the laser beam to sweep above the field.

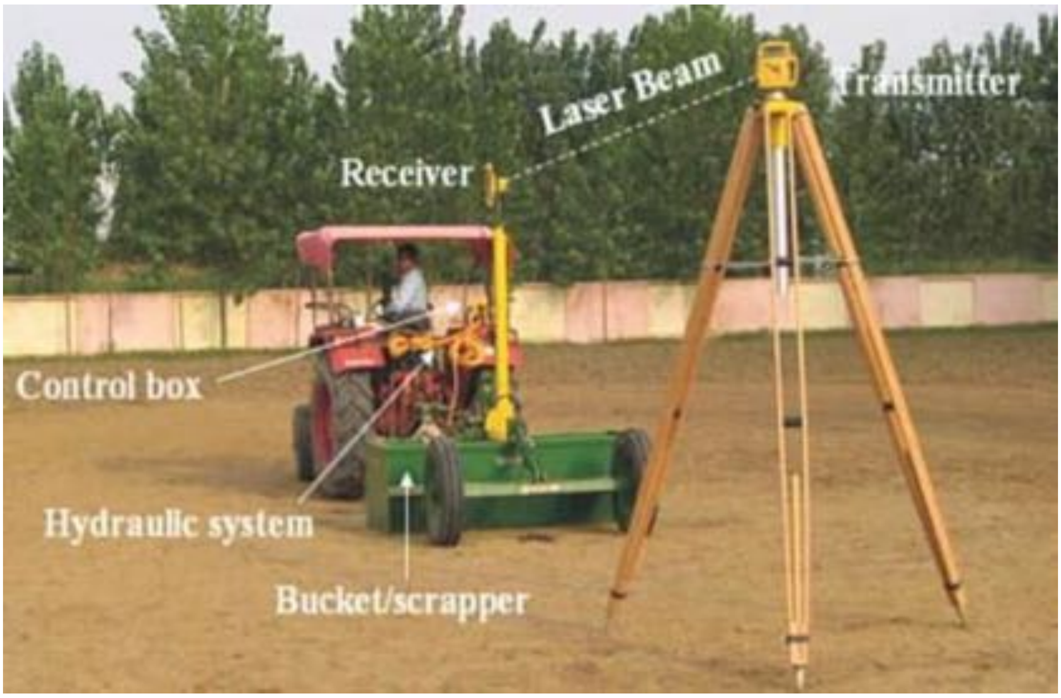
(iii) **Laser receiver:** The laser receiver is a multi-directional receiver that detects the position of the laser reference plane and transmits this signal to the control box.

(iv) **Control box:** The control box accepts and processes signals from the machine mounted receiver. It displays these signals to indicate the drag buckets position relative to the finished grade.

(v) **Hydraulic system:** The hydraulic system of the tractor is used to supply oil to raise and lower the leveling bucket.

Figure 14: Different Components of Laser Levelling System

Figure 15: Working Mechanism of Laser Leveler



147. The system includes a laser-transmitting unit that emits an infrared beam of light that can travel up to 700m in a perfectly straight line. The second part of the laser system is a receiver that senses the infrared beam of light and converts it to an electrical signal. The electrical signal is directed by a control box to activate an electric hydraulic valve. Several times a second, this hydraulic valve raises and lowers the blade of a grader to keep it following the infrared beam. Laser leveling of a field is accomplished with a dual slope laser that automatically controls the blade of the land leveler to precisely grade the surface to eliminate all undulations tending to hold water. Laser transmitters create a reference plane over the work area by rotating the laser beam 360 degrees. The receiving system detects the beam and automatically guides the machine to maintain proper grade. The laser can be level or sloped in two directions. This is all accomplished automatically without the operator touching the hydraulic controls.

3.2.11.2 Approach to land leveling

148. There are perhaps two land leveling philosophies:

(1) to provide a slope which fits a water supply; and,

(2) to level the field to its best condition with minimal earth movement and then vary the water supply for the field condition.

149. The second philosophy is generally the most feasible. Because land leveling is expensive and large earth movements may leave significant areas of the field without fertile topsoil, this second philosophy is also generally the most economic approach. Land leveling always improves the efficiency of water, labor and energy resources utilization. The leveling operation, however, can be the most intensively disruptive cultural practice applied to the field and several factors should be considered before implementing a land leveling project. Major topographical changes will nearly always reduce crop production in the cut areas until fertility can be replaced. Similarly, equipment traffic can so compact or pulverize the soil that water penetration is a major problem for some time. The farmer has many activities which contribute to his productivity and therefore require his skill and labor. The irrigation system should be designed with him (or her) in mind. A field leveled to high standards is generally more easily irrigated than one where undulations require special attention. Effective land leveling reduces the work in crop establishment and crop management, and increases the yield and quality.

150. **Seeding Practices:** Leveling reduces the time taken for planting, for transplanting and for direct seeding. Land leveling provides greater opportunity to use direct seeding. The possible reduction in labor by changing from transplanting to direct seeding is approximately 30 person-days per hectare.

151. **Efficiency of Water Use:** Rice farmers using animals or 2-wheel tractors rely on water to accumulate in the field before starting land preparation. The average difference in height between the highest and lowest portions of rice fields in Asia is 160 mm. This means that in an unleveled field an extra 80 mm to 100mm of water must be stored in the field to give complete water coverage. This is nearly an extra 10% of the total water requirement to grow the crop. Land leveling effectively terraces fields allowing water in the higher fields to be used in the lower fields for land preparation, plant establishment and irrigation.

152. **Options for Land Leveling:** Draft animals, such as buffaloes and oxen, 2- wheel tractors or 4-wheel tractors can all be used as power sources to level a field. Different systems require different field conditions and operating time to complete the task.

1. Draft animals and 2-wheel tractors or power tillers using harrows and leveling boards. These leveling techniques require total water coverage of the field and require 7 to 8 days for a 2- wheeled tractor and 12 days per hectare of land using draft animals

2. 4-wheel tractor using rear mounted tractor blades or drag buckets. 4-wheel tractors are very effective for leveling both wet and dry fields. Wet fields are

best leveled with a rear-mounted tractor blade. Dry fields are best leveled using hydraulically operated drag buckets. Tractor work rates are dependent on the tractor's capacity and the amount of soil to be moved. It takes approximately 8 hours to level 1 hectare with a rear mounted tractor blade. This reduces to about 4 hours when using a drag bucket

3. 4-wheel tractor with a laser-controlled bucket. The use of laser-controlled equipment results in a much more level field – up to 50% better than leveling using other techniques

3.2.11.3 Benefits of land leveling

153. Research in India and Cambodia has shown the following benefits:

1. Benefits of laser land leveling over conventional land leveling:
   - Reduction in time and water for irrigation
   - Uniform distribution of water
   - Less water consumption in land preparation
   - Precise level and smoother soil surface
   - Uniform moisture environment for crops
   - Lesser weeds in the field
   - Good germination and growth of crop
   - Uniformity in crop maturity
   - Reduced seed rate, fertilizers, chemicals and fuel requirements
2. Benefits of precise land leveling:
   - Saves irrigation water >35 %
   - Reduced weed in the field
   - Increase in field areas about 3.5 %
   - Reduce farm operating time by 10 %
   - Assist top soil management
   - Saves labor costs
   - Saves fuel/electricity used in irrigation
   - Increase productivity up to 50 %

1. **Yield:** Research has shown a large increase in rice yield due to good field leveling. Results of land leveling experiments conducted by CIAP in Cambodia, 1996-1999, shows that, for the same rice varieties and the same fertilizer input, the average increase in crop yield was 24% or 530 kg ha. In two experiments conducted at different localities, a strong correlation was found between the levelness of the land and crop yield.

2. **Weed Control:** Land leveling increases yield. A large part of this increase is due to improved weed control. Improved water coverage from better land leveling reduces weeds by up to 40%. This reduction in weeds results in less time for crop weeding. A reduction from 21 to 5 labor-days per hectare is achieved. This represents a reduction of up to 16 person-days per hectare- a 75%decrease in the labor required for weeding.

3. **Farm Operation:** Land leveling makes possible the use of larger fields. Larger fields increase the farming area and improve operational efficiency. Increasing field sizes from 0.1 hectare to 0.5 hectare increases the farming area by between 5% and 7%. This increase in farming area gives the farmer the option to reshape the farming area that can reduce operating time by 10% to 15%.

3.2.11.4 Laser leveling in the Core Subprojects

154. Lands and plots will benefit from land leveling. Areas in Section 2, 4 and 5 in Taing Krasaing should be assessed to determine specific needs. The time for this would be considerable and will require field reconnaissance using detailed topographic maps. This time has not been available during the PPTA period but can be effectively done during project implementation.

155. It should be noted however that field checking has shown that many plots are reasonably level as they have been tilled and leveled over many decades each wet season as rain-fed lands. The exception is in part of Section 2 and 3 in Taing Krasaing where land clearing will still be required and it can be anticipated that laser leveling will be required. Land Leveling familiarity in MAFF

156. The MAFF is familiar with Laser Land Leveling and has the equipment to perform this. Contact institution: Department of Agriculture Mechanic managed by Dr. Chan Saruth, as Director Phone address: 012 82 88 83.

157. Department of Agriculture Mechanics has five sets of Laser System mechanics for land leveling available. The cost per hectare ranges from $450 to $600/ha, according to levelness of field: lower or higher than 30cm.

158. The procedures for obtaining a Land leveling contract with MAAF are reported as:

1. Project should inform the Department of Agriculture Mechanic about the site of land to be leveled and location village, commune and District.

2. Technical staff of above Department will evaluate the real situation of each site to be to be leveled by Laser System.

3. After field visit of Department of Agriculture Mechanic technical staffs, both parties will be negotiated the price or land leveling cost for each location;

4. After both parties agree, a contract will be signed with MAFF.

3.2.11.5 Conclusion

159. Laser leveling is a resource-conservation technology. It changes the way crops are produced by adding to resource-use efficiency of critical inputs while it does not disturb and harm the ecosystem. The awareness on direct and indirect benefits derived from laser land leveling technology is still low in the developing countries as Cambodia. To increase its popularization and large-scale adoption, initiatives as further research, extension, participatory, economic and policy initiatives will be required.

3.2.12 Technical Drawings

160. The detail technical drawings for Main Canal and all relevant structures on the headwork and structures on the Canal of Taing Krasaing subproject are produced in accordance with the design guidance provided by both hydraulic and irrigation engineer. A computer program-- Autodesk AutoCAD 2013 is used for producing all these drawings, and they are converted and combined in a PDF formatted file. The drawings are set up on A3 paper, and landscape format. A list of drawings is tabulated and attached in a separated file. There are 74 drawing sheets for Taing Krasaing, and are converted in the PDF. Two AutoCAD operators were deployed between late February and end of May 2015 to handle this workload.

161. The first sheet of the drawing set is the “General Note” in which descriptions of technical terms, legends and symbols used in whole drawings set are given. The second and third sheets are the “Project Location Map” and “Layout Map” of the core subproject respectively. Following this three general sheets, there come in a consequence the detail drawings of Main Canal and all structures (existing and new) on both headwork and Main Canal. These drawings are available to ADB and MOWRAM on CD and USB memory stick.

List of Drawings on Taing Krasaing Core Subproject

All Drawings in A3 size

No.	Items	Number of Sheets
1	**General Note**	1
2	**Project Location Map**	1
3	**Layout Plan**	1
4	**Main Canal long profile and cross section**	25
5	**Headworks**	
5.1	Headwork	3
5.2	Under Sluice	3
5.3	Spillway	3
5.4	Head Regulator	1
6	**Main Canal facilities**	
6.1	Cross Drainage	10
6.2	Site Escape on Main Canal	3
6.3	Cross Regulator (on Main Canal), Existing	3
6.4	Cross Regulator (on Main Canal), New	7
6.5	OffTake type I (a) (Pipe Culvert with 1 gate) , from Main Canal	1
6.6	OffTake type I (b) (1 cell Box Culvert,1 gate) , from Main Canal	1
6.7	OffTake type I (c) (2 cells Box Culvert,1 gates) , from Main Canal	2
6.8	Offtake from Main Canal (New Structure)	4
6.9	Foot bridge, on Main Canal	4
Total		73

3.2.13 Surveys

3.2.13.1 Topographical survey

4. Topographical survey in subproject Taing Krasaing was done in March 2015 by a consulting team using three types of equipment—Total Station, Digital Auto Level, and Handheld GPS. The purpose of this survey is to collect information about the ground elevation and others elevations of some necessary canals and existing structures with which engineers will be able to make a decision on design option for each individual infrastructure and the system as a whole.

5. All headwork structures and 22 km in total length of Main Canal in Taing Krasaing core subprojects were surveyed. Three alignments of secondary canals are also included in the survey works. The results of the survey have been processed into Excel and AutoCAD (Version 2013) software which allows PPTA engineers to reprocess. The outcomes of the processed survey result show, on the one hand, that the average slope of the TKMC is very flat, and this is one of the reasons a “basin type” canal has been selected.

6. With this topographical data, engineers are able to make a clear decisions, adjusting the existing structures and designing new structures. It allows also engineers to produce technical drawings, bill of quantities, unit costs for canals and structures; thus better estimate the overall costs for each core subproject.

3.2.13.2 Differential GPS ground survey

7. An additional ground survey was conducted in Mid-May 2015 by a local survey team a long an existing access road, starting from TKMC at about RD 19+330 toward high lands area in Tipou commune on the right hand side of the Canal. The main purpose of this survey was to see the difference between ground elevation within the command area of 2,900 hectares in Tipou commune and FWL in TKMC. The outcomes of the survey shows TKMC can only command water to irrigate farmer’s lands within 1 kilometer on the right side of TKMC. Beyond that pumping is required. In addition, the survey shows that the average level within the irrigation area in Tipou commune is 2.5m higher than FWL level. To supply water to this higher part of irrigation area, a pumping station is proposed.

3.2.13.3 Geotechnical survey

8. Erosion of canal slopes and instability of structures has been observed in both core subproject areas. The soil in Taing Krasaing is sandy and has resulted in high rates of erosion in TKMC and its embankments. To fully understand the soil conditions, a geotechnical survey was made for 4 different boreholes in different locations along TKMC. The results of the survey allow design engineers to make appropriate designs for TKMC, its embankments and associated structures.

9. The results of the geotechnical investigation in TKS show the soil the last 2.5km section of the main Canal is highly erosive. This means that the side slopes of both Canal and its embankments will require special protection. to the proposed design is to line the canal slopes in this last section with reinforced concrete. Soil within the remaining length

of the canal is less erosive and does not require lining. The survey results confirmed that a “basin type” canal is appropriate. The water velocity in the canal will be very slow and will not erode the canal bed and slopes, rather it will allow sedimentation which will cover the wetted soil area making it impervious and reducing percolation.

3.2.14 Guidelines to Contractor for Taing Krasaing

162. Prior to construction the contractor should conduct a topographical survey to verify all the available BM points and install additional BMs as needed. Water should be completely drained from the TKS main canal and the reservoir. The cross regulator gate within the link canal should be closed to prevent water from the Stung Chinit reservoir accessing to the TKS construction site during construction work.

163. After water is drained from the reservoir, the contractor should start the construction of the spillway sill, reaching to the crest elevation of 16.24 m MSL. At same time the contractor should pump all water from the pool downstream of the spillway, the under-sluice and the weir. After pumping, when the foundation soil is dry enough, the contractor should start construction of the downstream protection works of the spillway, the under-sluice and the weir.

164. Water should be completely emptied from the main canal, before reshaping works of the main canal are started. The contractor shall identify and verify all the existing BMs along the canal and install additional BMs within the canal reach where that is needed. BMs that are located on the canal embankment should be transferred to safe locations away from the canal right of way; a distance of more than 20m is recommended to prevent them from being disturbed during construction.

165. When the canal is completely dry the contractor should start fixing all the canal structures, such as head-regulator, cross regulators and off-take structures as described in the engineering design section. The new cross-drainage works should be constructed at RD 8+500 m, the design dimension and elevations are shown in the technical drawing. From RD 15+500 to RD 18+000, main canal section should be lined with dimension as specify in the technical drawing.

166. The contractor should ensure construction safety and standards, identify locations for storing of construction materials on site, and establish a site office locations/camp. He should inform the communities about the work and the contractor’s team should be presented to people in the area during the construction period. He should carefully follow the project Environmental Management and Mitigation Plans during construction works as specified in the project report and follow the RGC labor laws including preventing work by child labor.

167. The construction schedule should be adhered to strictly. When delay is anticipated, the contractor should report to the PMU engineer on time, otherwise penalty will be enforced. He should provide construction statement methodologies describing methods of concrete mixing, concrete pouring, form work to be used (wooden materials or steel).

Earth work should done using heavy machineries consisting of bulldozers, excavators, dump trucks, water trucks and compacted rollers. The contractor shall provide organization chart showing the require contractor personnel such as project manager, site manager, geotechnical investigation and topographical survey team. He should provide sketch map showing the location of site office, office camp, and storage facility/warehouse garage for parking of heavy machineries. Identifying of location of quarry site with access road and moving paths of the machineries at site.

3.2.15 Bill-of-Quantities

168. The quantity of the materials which will be used for the construction canals and structures of the core subprojects are derived from the details technical drawings produced by AutoCAD software for each individual structure and canal. One separate Bill of Quantity is prepared for all concerned construction materials required for construction work of a structure or a unit length of canal (in Kilometer). Microsoft Excel is used for preparing the BoQ. The Summary of the Bill appears on the first sheet, and it is followed by Bill No.1 and Bill No.2 which cover the contract implementation items such as Mobilization and Demobilization of equipment, Site camp etc.

169. There are 13 Bills for Taing Krasaing. These BOQ will be used as the key part of the Bidding Documents.

3.2.16 Biddings Documents

170. A standard bidding document format of ADB will be used for tendering both core and others subprojects. These have been developed and provided for Advance Contracting to the Procurement specialist under direct-hire supervision of ADB. The Bidding Documents have been submitted and reviewed in early May 2015, and have been submitted to MOWRAM-PMU by third week of May 2015. These Documents were provided to MEF by MOWRAM-OMU for review and approval on June 1, and are pending the acceptance and subsequent return to ADB.

3.2.17 Cost Estimates

171. The cost estimates for each element (Canal and structures) of the core subproject are derived from the quantity of the construction materials and the market unit rate and labor rate in 2014 with 4 percent addition to cover inflation. The unit rate is averaged from a number of construction projects, and in majority of them are of CAVAC projects in the same project area—Kampong Thom. The cost estimates for each unit of canal and structure for both core subprojects are generated in the same sheet of related Bill of Quantity as described in the section above. A summary sheet gives the total estimated cost of the core subproject while the rest of the Bills give the unit cost of one kilometer of Canal, and unit cost of each structure. The BOQ will be brought forward to be a key part of the bidding documents.

3.2.18 Construction Specification

10. The Construction Specification is a part of the bidding documents which is use to guide both Engineer(s) and contractor to make sure that the construction of the irrigation infrastructures in the two core subprojects and all other subprojects meet the required standard.

11. The Construction Specification is divided into 11 main chapters. Chapter 1 and chapter 2 give the general introduction for contractor(s) and Engineer(s) to start the construction works. The description of different categories of works (like earthwork, concrete works, flow measurement and stone masonry etc) will be shown in chapter 3 to 10. The last chapter (11) describes materials and others facilities which will be required by engineer(s) including construction supervisor(s) to use for the purpose of construction supervision works like Digital camera, Handheld GPS, tapes, soil test and concrete equipment etc.

3.2.19 System Maintenance of Taing Krasaing

12. The responsibilities for maintenance should be made clear in written documents. In addition, documents detailing responsibilities for sharing, and for budget request for the maintenance could be working out. Main concern on maintenance of irrigation facilities is a lack of maintenance budget, and these issues are to be included in system design.

13. O&M for major irrigation facilities not only requires the preparation of written documents on O&M provisions, but also a detailed budget to implement the provisions. In cases where funds are insufficient for comprehensive operation and maintenance works a detailed budget will assist in assigning funds to the most critical areas.

14. The cost estimates for annual Operation and Maintenance (O&M) for both the Taing Krasaing core subprojects are based on current costs in Stung Chinit. The Stung Chinit FWUC collects 15 USD per hectare per year in irrigation service fees. However, according to the Head of the FWUC, this amount is insufficient to cover all the necessary maintenance works. For this reason, the O&M for Taing Krasaing is estimated at USD 18.78 per ha/year, increased by 25% to cover all maintenance costs. This results in an estimated annual O&M cost is 150,000 USD per year for a command area of 8,000 hectares for Taing Krasaing.

3.2.20 Link to Agriculture Support

15. The assessment of rehabilitating, upgrading and modernizing the two core subprojects included an in-depth review of present cropping calendars. The preferred crop by farmers – when provided with additional water for both wet and dry season - is rice, an experience gained in other recently improved systems elsewhere. Farmers confirm this.

16. A key observation has been that in almost all areas of the core subprojects that farmers use rice seed varieties of low quality, use broadcast seeding, and requiring water (rain and/or irrigation) for 120 to up to 150 days and longer. This is confirmed in the Cambodian National Status Water Status Report 2014 by the ADB-WRDMSP.

17. This points to the apparent and obvious need to review and include the use of non-water agro-inputs in the overall crop production process and associated cropping calendar. The benefits used in the Economic Analysis use this assumption of better seeds of shorter duration on the field during irrigated period in both wet and dry season. This assumption is also used in developing what should and can be grown based on water available at intake/regulator at the reservoirs supplying both systems.

18. Expected benefits from project investments are both water-based and improved crop production and inputs applied. Support to the district extension services is required - again in line with the many recommendations in the Cambodian National Status Water Status Report 2014 by the ADB-WRDMSP. Provisions to facilitate this have been provided and are included in the Supporting Link Document on Financial Analysis, as well as expertise provided in the TOR for the Project Management and Implementation Consultancy (PMIC).

3.2.21 On-farm Water Management

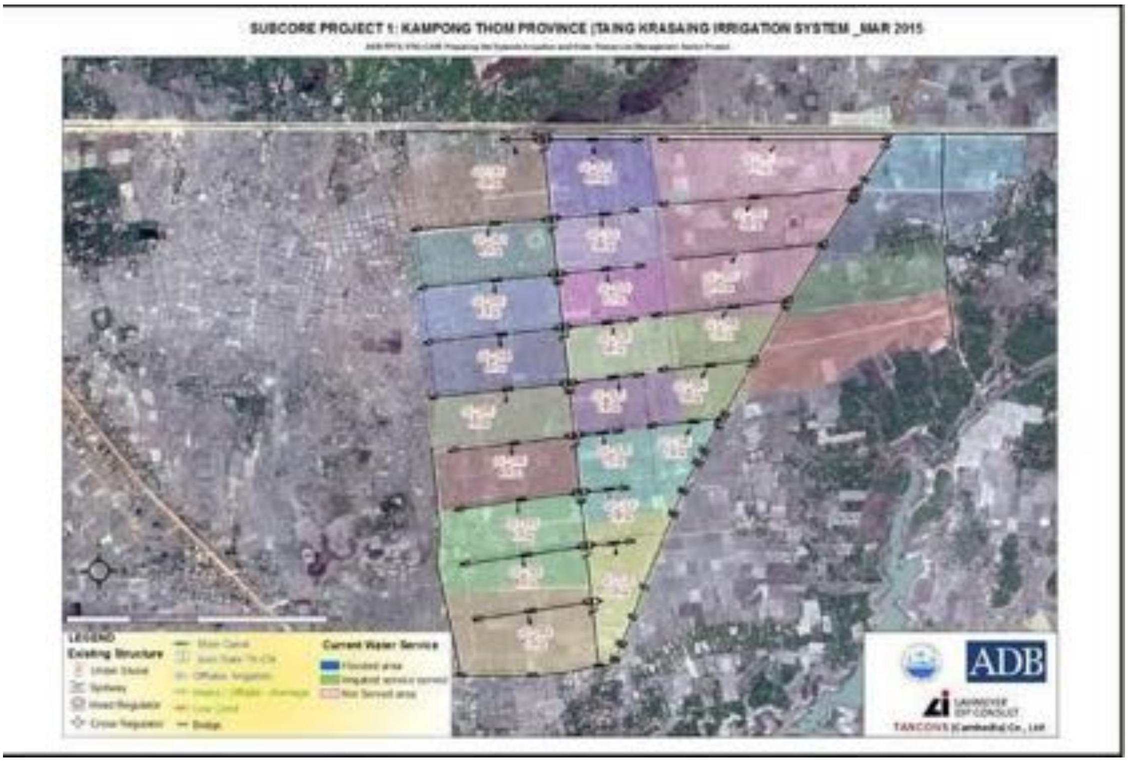
172. Within the two core subproject areas, only the CAVAC part of the Taing Krasaing has received attention in recent years (2011-2014). This area has settings and soil which are comparable to other parts of TKS and it has fully developing on-farm water management facilities, distribution network and water courses, including drainage.

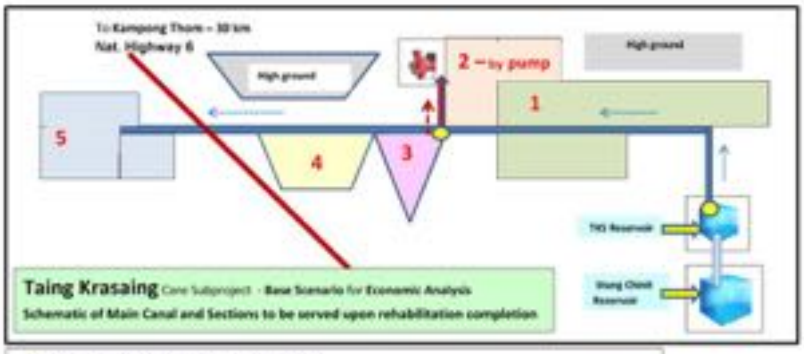
173. The OFWM layout of the CAVAC area (Section 3) has been analyzed to understand the development of social water management from recent experience inside one of the core subprojects:

1. Earth tertiary canals (TC) range in length from 400-1,200m, with an average length of approximately.750m
2. The total length of 20 TCs is 15.5km
3. Total command area of 1,200ha is divided into 22 OFWM blocks
4. Block area range between 24-77ha
5. Gates are provided at the top end of each TC. The TC include check structures to control water flow
6. 10-20 intakes are provided along each TC. The intakes, made from 15cm PVC pipe, supply water for adjacent plot of 2ha

7. Peak water requirements are at the start of wet and dry seasons when water is taken for land soak and land preparation (pudding)
8. On average, in each block, some 15-20 farmers from 1-3 villages may be involved

Figure 16: Section 3, CAVAC Taing Krasaing Development





Five (5) distinct sections and key features

	Distinct Sections	Est. Area (ha)	Service	Status of land level	Right-of-Way
1	Private Firms	2500	gravity	N.A.	N.A.
2	Tipou	2500	pump	Rainfed 70%; land clearing 30%	Yes
3	CAVAC TKS	1200	gravity	Ready	Ready - none
4	Chroab	1800	gravity	Land Clearing 100%	Yes
5	Korkoah	1800	gravity	Rainfed 100% - ready	Yes
	Net irrigated	9800			

Note: Area of Tipou – Section 2 – is approx. 0.5 to 2.5 meters above full water level of main canal

174. The following were issues were identified as important activities for FWUC development of the Tertiary and On-Farm distribution system:

1. All farmer/water users need to agree on the location of alignment and field channel
2. Farmers need to discuss and contribute land (right of way) for TC construction
3. TCs construction and maintenance is also a cooperative activity
4. Work can only be achieved by working jointly – water requirement are set at the block level
5. Within the tertiary block, it is required to establish and follow internal rules with sanctions for sharing water and maintaining the canal, and for conflict resolution
6. Water users became quickly aware that there is a need to adopt a common cropping calendar
7. The common cropping calendar encouraged efforts to consolidate to get common irrigation schedule
8. The need for land leveling and bush clearing varies, and depends on the weather

Project investment:

- Drainage gate on main canal
- Construction of secondary and tertiary canals and attached structures
- Establish and support Farmer Water User Community

Infrastructures Canal and Structures on 1,200 ha:

- 3 Secondary canals
- 3 Gates – left off-takes from main canal
- 1 drain escape – left off-take from main canal
- 30 Gates of TC intakes
- 19 check structures as water distribution control points

The partners in developing this Secondary Block of Taing Krasaing (Section 3) included:

- 1 District - Santuk
- 2 Communes – Taing Krasaing and Prasat
- 7 Villages
- 800 farmers

Cost and expenditures

175. Cost associated with the development of Tertiary and On-Farm facilities for constructions in the CAVAC Taing Krasaing core subproject amounted to USD 49,000 for all canals, small structures, water courses to serve 100ha of irrigated area, **or USD 490 per hectare**.

176. The required length of TC in a 100 ha block was 1,820m which was constructed at a unit cost of USD 27/meter length.

3.2.22 Use of Satellite Images (remote sensing)

19. At the start of the project the ADB provided the PPTA Team with links and contacts to **GISAT**, a Prague, Czech Republic based contractor working for an ADB funded project (Rapid WRM Demonstration Products for ADB in GMS – Greater Mekong Sub-Region) for EOSAP - Earth Observation for a Transforming Asia Pacific. The PPTA team was requested to provide coordinates for Taing Krasaing and Taing Krasaing. The photo map below shows the areas as requested by the PPTA team. The request resulted in a complete set of satellite images being provided for Taing Krasaing by March 30, 2015. These images are accessible through Website Links of gisat; The website links are:

http://eotap.gisat.cz/Tang-Kasang-Map-Index.html

20. The images have been used for clarifying the canal alignment and delineating the irrigation command area with confirmation from discussion with local communities. Imaginary is available for complete area of Taing Krasaing and Stung Chinit

21. In the future, satellite images can be made available for different purposes – through new contacts and discussion through ADB channels – for implementation of the Uplands Irrigation project. A new ESA satellite was launched summer 2015, and will be providing dynamic, near-real-time data on parameters such as rainfall, river flow, groundwater, areas planted and even construction progress at agreed fixed dates (weekly – monthly). Some preparation and planning is required - specific questions related to this data need to be formulated and software programmed.

22. This data can include – based on information provide through on-line joint conference discussions –locations for the canal alignment and structures and changes therein, mapping landholdings of the two core subprojects, monitoring land uses, monitoring cropping production and cropping patterns over a year period. The eotap will be the only and key source of these imagery data. The display below shows various details of such images.

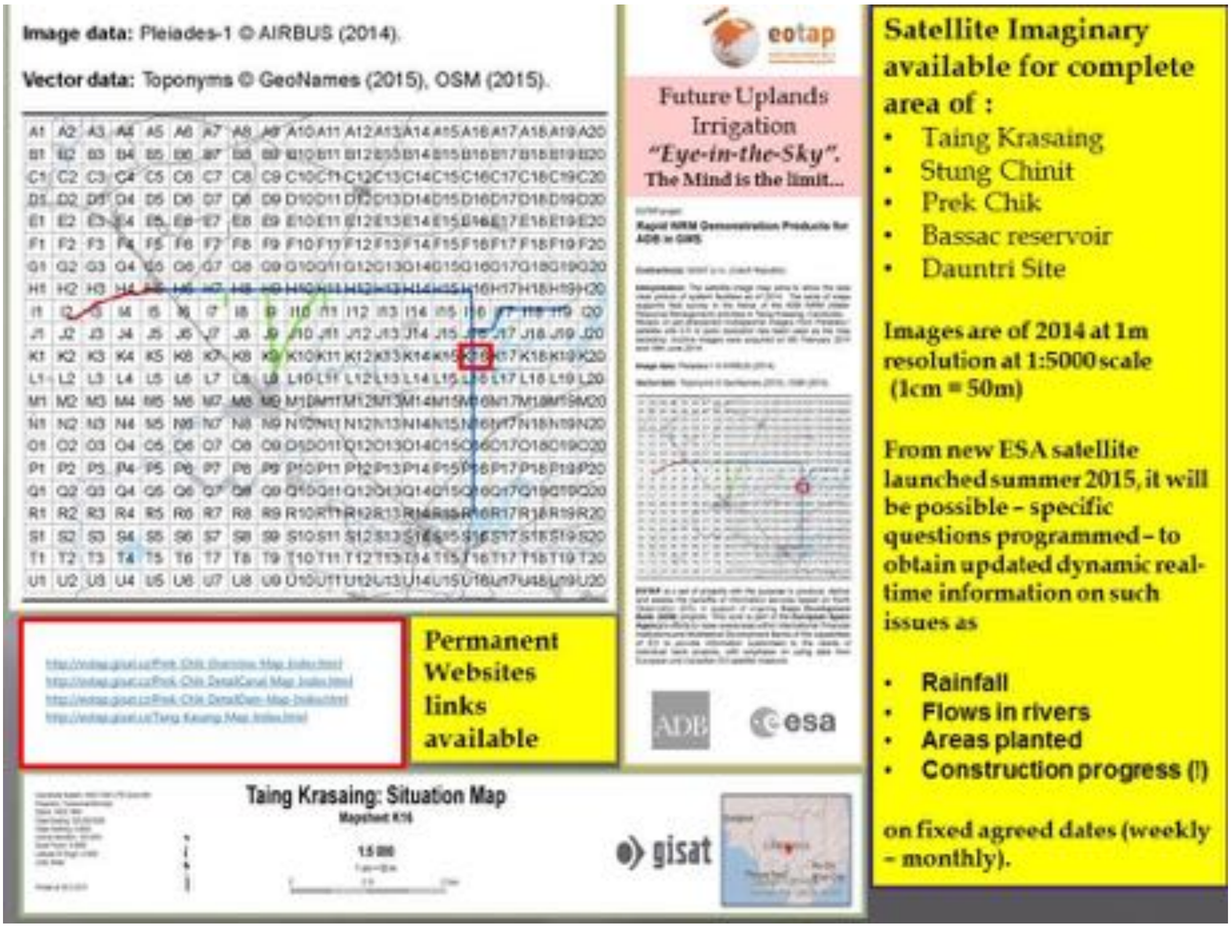


Image data: Pleiades-1 © AIRBUS (2014).
Vector data: Toponyms © GeoNames (2015), OSM (2015).
eotap
Future Uplands Irrigation
"Eye-in-the-Sky".
The Mind is the limit...
Satellite Imaginary available for complete area of :
Taing Krasaing
Stung Chinit
Prek Chik
Bassac reservoir
Dauntri Site
Images are of 2014 at 1m resolution at 1:5000 scale (1cm = 50m)
From new ESA satellite launched summer 2015, it will be possible – specific questions programmed – to obtain updated dynamic real-time information on such issues as
Rainfall
Flows in rivers
Areas planted
Construction progress (!)
on fixed agreed dates (weekly – monthly).
Permanent Websites links available
ADB
esa
Taing Krasaing: Situation Map
gisat

3.2.23 Climate Change

23. The TOR request that in regard climate change that the PPTA team should:

(i) assess climate change risks; suggest adaptation measures to climate proof infrastructure;
(ii) design climate proofing interventions for core subprojects and estimate cost; and
(iii) prepare training/awareness program for farmers water user communes (FWUCs) to enhance climate resilience.

24. Climate change expresses itself in either more rain due to storms of greater intensity or in longer periods of less and even no rain. The result is either more floods, larger and of greater capacity to destroy or impact crops and facilities, or in case of drought causing crops to not mature but to reduce to wilting and ultimate dying and drying out.

25. Climate change in the core subproject will impact the systems and their performance in the following manner:

(i) To anticipate drought, through increasingly prolonged period of no rainfall, both during the dry season, but also during the wet season;
(ii) Through less discharge in associated rivers, with streams running dry earlier, which will impact water available for storage and subsequent diversion and use in system;
(iii) Increase in evaporation and associated evapo-transpiration, which will increase crop water requirements over the season during the period after planting and while in growth and maturing stages;
(iv) More frequent flash floods of greater intensity and durations

26. Taing Krasaing will operate through its reservoir depending on inflow. Climate change may impact this supply system, and less storage is one potential result. Better flood management and measures to anticipate floods and better preparedness for droughts are thus a key requirements and need to be included in all planned measures. Modernization thus includes better preparedness for climate change,

The focus of the PPTA has been in all designs

27. To resolve all drainage problems in both core subprojects. Drainage issues were considerable, and causes and impact were identified. Both canals will require considerable drainage works and these have been reviewed at each location in great detail. Chapter on Drainage works reports on this aspect.

28. Required drainage works have not been calculated separately as they are intertwined with irrigation related canal performance. But all measures, major in Taing Krasaing in the breaches in the canal right embankment, will be corrected and improved to high standard requirements.

29. As stated in various chapters of this Link Supporting Document, the main canal had poor design, in respect of irrigation but also in regard drainage and need to remove water away from lands where flash flooding regularly destroyed crops.

30. To avoid droughts by avoiding the possibility of crops on the fields at times of no rain. This meant to assure that two subsequent crops – starting at wet season and the harvest occurring no later than 220 days – has been at the basis of all planning, scheduling, design capacities and distribution plans. Use of shorter duration rice seed varieties has been advocated strongly and repeatedly, and incorporated to compact the cropping calendar.

31. Both these measures above are considered as being essential to climate proofing of systems, seemingly at the opposite end of potential problems: no water or too much.

32. A study of considerable relevance to the overall Stung Chinit watershed (of the Taing Krasaing river is ultimately a part and the two systems are linked and can share water from their respective reservoirs) has recently been presented as the **"Assessment of Water Resources for improved water governance under climate change for the STUNG CHINIT RIVER CATCHMENT,** January 2015, by Tes Sopharith in a MOWRAM IRDC project.

33. His conclusion are of immediate relevance to the Taing Krasaing core subproject, but in general also to Taing Krasaing, as climate data used and models to predict impact are valid for all areas adjacent and bordering the Tonle Sap lake.

34. The findings of this study are presented in the Table below

Table		Base Year	Future	**Change**
	Climate Change Aspect	**2015**	**2050**	**± %**
1	ETo (mm/day)	4.5	6.1	**+ 35**
2	Irrigation Rice Water Requirement m^3/ha – WET	8000	10000	**+ 25**
3	Irrigation Rice Water Requirement m^3/ha – DRY	13000	17000	**+30**
4	Cash Crop water Requirement (m^3/ha)	6100	8200	**+35**
5	Rain – Wet Season (mm)	1348	1493	**+ 11**
6	Rain – Dry Season (mm)	251	147	**-42**

35. **Row 1** in the table shows what temperature rise between the baseline date 2015 and forward projected will do to evapotranspiration as the last column shows the impact. Overall crop water requirements **(Rows 2, 3 and 4)** may increase between 25 and 35% in next 35 years.

36. **Row 5 and 6** show the impact of climate change on rainfall: 11% more in wet season, but a major 42% less in dry season. The message here is clear in that there is the need to manage irrigation such that the dry season impact on crops – some 2 months after start – is avoided at all cost.

37. The study presents in its findings the following:

	Finding	**Mitigating Measure**

1	Active management of the Stung Chinit reservoir, combined with inflows at Taing Krasaing, will allow for a dry season crop that covers 50% of crop area.	Establish basin wide water sharing rules; storage operational plan; water use metering; annual water use reporting.
2	Appropriate operating and planning for water allocation, planning crop calendar as well as selected cropping patterns.	Improvement and strengthening of the hydro-meteorological forecasts - long- (6 months) and medium-term (3 months) river forecasts for water availability in advance.

38. Both findings have been anticipated in all measures on drainage, on reservoir operations for both core subprojects, and in designs for allowing increasingly compacted cropping calendars of shorter duration, no longer that a maximum of 200-230 days, away from the use of long-standing late-maturing traditional seed varieties. This switch from 150 days seeds to 90-100 days seed varieties and fast turn-around time, for both crops wet and dry combined no longer than 220 days on the field between July and February.

39. Training courses designed for FWUCs outline to use considerable time and material for farmers to become aware and apply to adopt this. It is not viewed as something specific but as part of good management of the system, away from lackadaisical approach to cropping in an unplanned manner.

3.3 Agriculture

3.3.1 Assessment of Field and Practices in the two Core Subprojects

177. Presented below in Table 14 is the assessment of Key Agro-Inputs in both core subprojects.

Table 14: Overview Table on Agricultural Practices in the Rice-Based Core Subprojects

1	**Rice Seed**
	Use traditional rice varieties with low yield potential. There is very little renewal by regularly purchasing commercial seed. Rice varieties lose their purity rapidly; therefore certified or commercial seed should be planted at least every 3 to 4 crop cycles. The value of pure seed was demonstrated in on-farm trials conducted in1995-96. IR66 seed was given to 10 farmers who also produced their own IR66 seed. The estimated yields of the CIAP/PRASAC IR66 (pure) and the farmers' IR66 (impure) were 5.8 and 4.8 t ha, respectively. Without changing the variety, yield was increased by about 21 %, just by using pure seed. Apart from a reliable supply of sufficient irrigation water, the introduction of high quality seed of high yielding varieties in demand in the market is fundamental to improving productivity and profitability of rice.
2	**Seed Multiplication**
	Farmers will need and will get support to produce commercial rice seed of high yielding varieties in demand in the market. The Tonle Sap Smallholder Development Project (TSSD) has now supported the establishment of eight seed producer groups in Kampong Thom province and also facilitated a number of rice grain producer groups to enter into contract arrangements with a miller. In return for the farmers growing a specific variety, the millers are prepared to pay a premium price and to supply commercial seed to the farmers. That model will be used to start commercial seed production on Taing Krasaing and Taing Krasaing irrigation systems.
3	**Seed Quality**
	High quality seed comes at a price and a retail price of $0.8 to 1 dollar per kilo will be needed to make seed multiplication economic. The current practice of broadcasting seed at up to 250 kg per hectare (partly to control weeds and especially in the dry season) will not be an economically viable practice. Farmers will need to be supported to move away from broadcasting seed to direct drilling of seed and to use other, better methods of weed control.
4	**Harvesting**
	Most rice is now harvested mechanically using combine harvesters and Taing Krasaing farmers estimate that harvesting losses can be 20% or more. The main reason for this is uneven ripening. Uneven grain size also has implications for rice millers. The average milling recovery of rice in Cambodia is around 60%. While old and inefficient milling machinery will be a contributory cause for this poor quality, uneven says and unevenly

	ripe grain will also be major factors. Nationally 65% recovery would be an acceptable figure but 70% is achievable with good quality grain and efficient milling. Contract growing arrangements between farmers and millers will be promoted.
5	**Varieties**
	In order to improve cropping intensity and make more efficient use of irrigation water the growing of short season non-photoperiod sensitive rice varieties will be promoted. Cropping calendars will be designed to minimise the period that crops will be exposed to the most drought-prone periods. There is proven demand from Vietnam and Thailand for particular varieties and seed of these will be made available.
Key Finding: Introducing good quality seed of high yielding varieties that have good market demand and respond to improved management, including fertilizer, is fundamental to improving productivity, increasing farmer income and raising water use efficiency.	
6	**Farmer Training**
	Farmer training will be key to bringing about the adoption of modern production technology. The farmer field school (FFS) model is proving to be a successful approach to farmer training. Farmers will be supported to set up farmer field schools (FFS). The ideal number of farmers per FFS is regarded to be around 30 and typically they would meet every two weeks. In an FFS farmers work to solve their own problems and each FFS will have an external facilitator who will train the farmers on the FFS system. Each facilitator will be responsible for 10 field schools. A lesser number of extension agents will also be required to give technical support.
7	**New technology**
	Where new technology, especially mechanization, is demonstrated and proven popular and the demand exists, entrepreneurial farmers will be supported to invest in machinery.
8	**Other Crops**
	Cambodia imports around 70% of its requirements of some vegetables, mainly from Vietnam. Much of this could be produced domestically but the lack of knowledge, organized marketing and necessary infrastructure are barriers. There are also some soils currently being used for rice production which are less than ideal, mainly due to their sandy free-draining structure which leads to very high water demand for paddy rice production. Under irrigation and under good management these soils can be very productive for a range of other high-value crops that have the potential to give higher returns than rice and use less water. Opportunities will be pursued to promote crop diversification.
9	**Irrigation water requirement (IWR)**
	The water requirement for pre-saturation of rice land is theoretically 150 to 200mm but if the pre-saturation period is long (24 to 48 days) or if the soil is sandy and free draining this figure can rise considerably. In addition, a water layer (usually at 100 mm) is established at this time. 50% of the total irrigation water requirement can be used for pre-

	saturation and establishing a water layer. Deep percolation rate (water that percolates below the rooting zone) will also have a big influence on the IWR. Part of the soil preparation process is working to reduce deep percolation. Percolation rates can vary from 2 mm per day to 7 or 8 mm per day. For a 90 day crop of rice every millimetre increase in percolation rate will lead to an increased IWR of 1400 m³ per hectare on a new irrigation scheme operating at 50% water use efficiency.
10	**Cropping Calendars**
	The cropping calendar is based on a rotation of rice following rice, where there is sufficient water to grow a wet season and a dry season crop. Where a two crop programme is planned short season rice varieties will be planted. Where there is no sufficient water for a dry season crop, there is one medium season rice crop. Depending on water availability and on farmers' preferences and a market being identified, a vegetable or other cash crop may be planted. It will be an objective of the project to increase cropping intensity and farm income, where possible, by the introduction of a more diversified cropping calendar.
11	**Soils**
	Classified according to the FAO's soil classification system the command area has three main soil types, Acrisols, Arenosols and Cambisols. The acrisols low fertility and low pH which can bring toxic amounts of aluminium into solution can pose limitations to its agricultural use for crop production. Arenosols are soils which have a sandy textured profile extending deeper than 50 cm. These soils may be more free-draining which can have implications for water requirement for irrigated rice production. They have high potential for other crops under irrigation. Cambisols are developed in medium and fine-textured materials derived from a wide range of rocks, mostly in alluvial, colluvial and aeolian deposits. Most of these soils make good agricultural land and are intensively used.

178. Tables 15 and 16 present crop water requirements for dry seeded rice in low rainfall and normal rainfall rice for broadcast dry seeded short and medium season varieties. On average water requirement for wet seeded crops will be 10% higher and for transplanted crops may be 35% higher.

Table 15: Crop Water Requirements in Low Rainfall Years

Variety type	Sowing date	Seeding method	Water requirement (mm)
Short season	April 1	Broadcast	850
	May 1		760
	November 1		900
Mid-season	June		630

Table 16: Crop Water Requirements in Normal Rainfall Years

Variety type	Sowing date	Seeding method	Water requirement (mm)
Short season	April 1	Broadcast	760
	May 1		620
	November 1		850
Mid-season	June		580

3.3.2 Other Development Projects

179. A number of other projects are being implemented in the project area. The **Cambodia Agriculture Value Chain Programme** (CAVAC) supports poverty reduction through long-term agricultural growth. More specifically, CAVAC focuses on sustainable growth in rice-based farming systems in the provinces of Kg. Thom, Takeo and Kampot.

180. The ADB-financed **Tonle Sap Poverty Reduction and Smallholder Development Project** will foster community-driven development through investments in productivity improvement, rural infrastructure, and capacity development in 196 communes in the provinces of Banteay Meanchey, Kg. Cham, Kg. Thom, and Siem Reap.

181. The **Tonle Sap Lowlands Rural Development Project** supports community mobilization for the implementation of development plans and construction of small scale infrastructure to enhance rural incomes and thereby relieve pressures on the natural resource base of the Tonle Sap basin. It will increase options for people to develop the necessary skills and to access additional financial resources to enable pursuit of new livelihood activities.

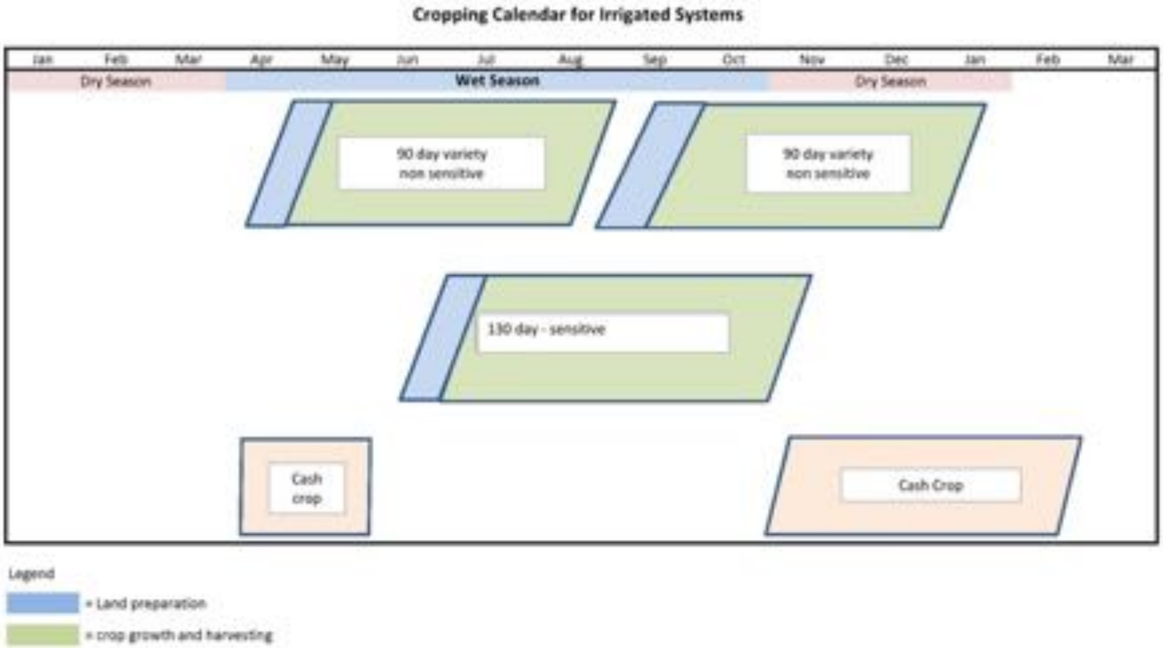
182. The **Helping Address Rural Vulnerabilities and Ecosystem Stability (HARVEST) Program** is a 5-year, $8 million USAID-funded Program, ending in 2015, to improve food security through enhanced agricultural development and rational management of natural resources. The program engages local NGOs for the implementation of day-to-day initiatives. It is being implemented in Kg. Thom, Siem Reap, Battambang and Banteay Meanchey.

183. The JICA-funded **Agriculture Production Project** whose first phase commenced in 2003 worked with rice in Kampong Thom and Battambang. Among other technologies, it demonstrated the drum seeder for the row sowing of pre-germinated rice seed, a technique that is gaining traction in a number of Asian countries with the declining popularity of transplanting. This technique has a number of advantages over broadcasting, including lower seeding rates, facilitating mechanical weed control and more uniform plant stands. Given the significant development partner presence within the provinces, it is critical to achieve good inter-project coordination.

3.3.3 Crop Calendars

184. **Taing Krasaing.** On the assumption that water from Stung Chinit will be shared with Taing Krasaing, the subproject has the potential to achieve 200% cropping intensity. To achieve this, it will be necessary to grow short season varieties.

Figure 17: Cropping Calendar for Irrigated Systems



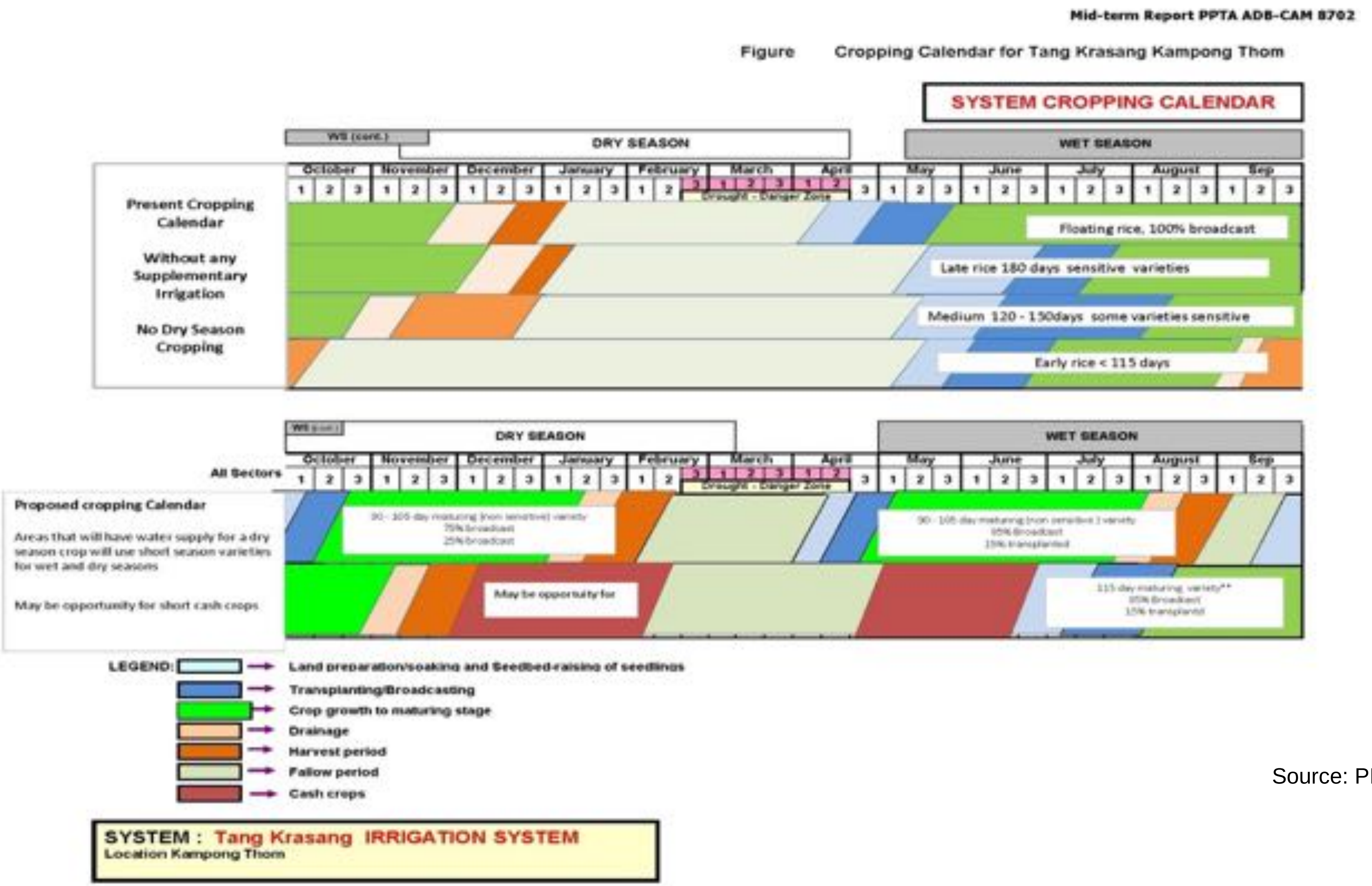
The cropping calendar is based on rice following rice rotation where there is sufficient water to grow a wet season and a dry season crop. Where a two crop programme is planned short season rice varieties will be planted.
Where there is not sufficient water for a dry season crop there is one medium season rice crop. Depending on water availability and on farmers preferences and a market being identified a vegetable are other catch crop may be planted.
It will be an objective of the project to increase cropping intensity and farm income, where possible, by the introduction of a more diversified cropping calendar

Irrigation Water Requirement

		Wet Season Efficiency 50%	40%	30%	Dry Season Efficiency 50%	40%	30%
		Cu.M/crop			Cu.M/crop		
Low Rainfall Yr	**Short season Variety**	**12,000**	15,000	**20,000**	**14,500**	**18,000**	**24,500**
	Med season variety	**13,000**	16,000	**22,000**			
Normal Rainfall Yr	**Short season Variety**	**9,000**	11,000	**15,000**	**14,000**	**17,500**	**23,000**
	Med season variety	**11,500**	14,000	**19,000**			

Irrigation water requirement (IWR). The water requirement for pre-saturation of rice land is theoretically 150 to 200mm but this figure can rise considerably if the pre-saturation period is long (24 to 48 days) or if the soil is sandy and free draining. In addition a water layer (usually 100 mm) is established at this time. 50% of the total irrigation water requirement can be used for pre-saturation and establishing a water layer. Deep percolation rate (water that percolates below the rooting zone) will also have a big influence on the IWR. Part of the soil preparation process is working to reduce deep percolation. Percolation rates can vary from 2 mm per day to 7 or 8 mm per day. For a 90 day crop of rice every millimetre increase in percolation rate will lead to an increased IWR of 1400 m^3 per hectare on a new irrigation scheme operating at 50% water use efficiency.

Figure 18: Cropping Calendar for Taing Krasaing



Source: PPTA Consultant

3.4 Watershed Management

3.4.1 Assessment of the Taing Krasaing Watershed

The watershed above the Taing Krasaing reservoir (932 km^2) is located in Kampong Thom Province in the eastern part of the Tonle Sap drainage basin. The watershed consists of flat, alluvial flood plains surrounded by mountains. The land use as reported in 2006 was shared between about 81% forest cover, 6 % under paddy cultivation and the rest is under other agricultural uses and household area (Kosal, August 2013, using MAFF data from 2006).

185. Livelihoods have traditionally relied on rice as the main crop, although cash crops and vegetables including potatoes, watermelon, maize and mung beans are also grown. Upland rice, cashew nut, cassava and other vegetables are grown on small parcels in the upland forest areas upstream of the reservoir. It is also observed that there are also rubber and acacia plantations in the area. Farmers mainly rely on a single wet season rice crop, with water supplied by water traps, surface water pumped from rivers and canals, and hand-dug wells. Given the annual dry/wet season cycle, agriculture that is not supplied by irrigation is largely rain-fed. Fishing, mainly conducted in rice paddies as well as in streams and ponds, is a major livelihood activity and provides households with protein. Many households in and around the reservoir area travel seasonally to the Tonle Sap Lake for fishing and fuel wood collecting during the dry season. Local people also collect fuel wood for domestic use and sale. In addition, numerous small-scale enterprises engage in timber extraction as well as processing and treatment of hardwoods for sale elsewhere (IUCN, February 2014). There are several economic land concessions and mine concessions in the Taing Krasaing watershed.

3.4.2 Issues

186. PDWRAM in Kampong Thom reports (in March 2015) that siltation in the Taing Krasaing reservoir has become a significant challenge in the last five years. Major issues include changed land use and a consequential loss of forest cover. Even when the land concessions are operated in an orderly fashion, a shift from natural forest to forest plantations (rubber, acacia) or industrial crops (including cassava) may increase the specific sediment yield. (On the other hand, a part of the sediments thus released in headwater areas is likely to be captured on the flat flood plains between the headwater areas and the reservoir).

3.4.3 Governance and Institutional Arrangements

187. There are no governance modalities in place for management of the watersheds. A FWUC was re-established in 2014 (after renovation of the main canal) to provide management arrangements for the areas irrigated from Taing Krasaing reservoir. It will be operational from 2016. Irrigation service fee criteria and rates are in preparation. The irrigation service fees will be managed by the FWUCs. In the past, an insufficient number of farmers contributed to the maintenance, due to lack of benefits from the scheme. As a result, the FWUCs were unable to provide the required maintenance of the canals (CGIAR February 2014). PDWRAM in Kampong Thom has 27 staff members, including three engineers. This is inadequate for management and

technical backstopping for this irrigation scheme (as well as several other schemes in the province, and other administrative tasks). The PDWRAM does not have a clear mandate for management of the watershed.

3.4.4 Proposed Corrective and Preventive Measures

188. Viable structural corrective and preventive measures are under advisement. The following have been identified for further consideration:

- Check dams/siltation basins to be established upstream of the reservoirs. At this stage, the feasibility of such facilities is not quite obvious. They are best located on a sloping terrain in support of the capacity-surface area ratio (the less slope, the larger area is needed); but this would require a location at some distance from the reservoirs as well as road access (possibly requiring land acquisition and vegetation clearance, and a related need of Environmental Impact Assessments) and with a risk of contributing to the sediment yield.

- Silt captured far from the reservoir would to some extent be retained anyway on the flood plain between the trap and the reservoir; whereas some silt would be released downstream of the trap - possibly a major part (due to higher peak flows, which will in turn be caused by upstream deforestation). O&M implications, including removal of the captured sediments, need to be evaluated.

- A compartmentalization of the reservoir. This might feature a better O&M efficiency, with no more than 1 m^3 to be removed for each m^3 reaching the reservoir, as compared with more than 1 m^3 to be removed from an upstream silt trap (depending on the distance from the reservoir). Possibly, access would be more convenient. Since the bunds do not need to be impermeable, the required landfill may be excavated from the reservoir (adding a bit to its storage capacity). A cost estimate is in preparation.

189. Some highly attractive measures are outside the mandate of MoWRAM and would require inter-agency collaboration:

- Re-development of idle lands on the flood plains and in the surrounding mountains (including reforestation and sustainable forest utilization) is a clear development opportunity with multiple economic, social and environmental benefits.

- Promotion of *'good practices'* for soil management, vegetation cover and surface runoff among all land owners and concession holders in the watersheds. This may be to mutual benefit, since upstream erosion can cause local damage, apart from downstream siltation.

  (A related initiative would be promotion of *'good practices'* for use of pesticides and fertilizers).

- Discontinuation of irregular forest clearance.

190. There is a scope for support to the water users beyond the supply of irrigation water: Technological support to cultivation and livestock breeding, including piloting of improved or new production systems; extension services in support of appropriate soil management (including composting); and response to livestock diseases and pest attacks (including appropriate use of pesticides). Community participation, involvement and contribution are still some way from sustainable operation and maintenance of the watershed conditions. This will require technical support (capacity-building, guidelines and manuals, and efficient real-time information flows), as well as continuous coaching and backstopping by PDWRAM. Consultation with MAFF is still required as MAFF will be the implementing agency of any support measures.

4 SOCIOECONOMIC AND SOCIAL SAFEGUARD

4.1 Social, Poverty and Gender Analysis

4.1.1 Socio-Economic Conditions

4.1.1.1 Land Area and Agriculture Situation

191. Cambodia has a total land area of 181,035 km2 with a total estimated population of 15 million people of which 48.9% is male and 51.1% is female. There are 2.6 million households out of which 1.876 million households are engaged in agriculture. The percentage of people living below the poverty line was 35.1% in 2004, decreasing to 29.3% in 2008, and further decreased to 22.9% in 2012. The total land area for arable and permanent crops is estimated at 4.5 million ha in 2013, of which 3.99 million ha are arable land and 0.51 million ha are planted with permanent crops such as fruit trees. The country is divided into four regions with the following number of land holdings as indicated in Table 17. The Core-Sub-Projects namely Taing Krasaing Irrigation Scheme which is located in Kampong Thom province and the Taing Krasaing Irrigation Scheme located in Battambang province are both in the Tonle Sap Lake Region.

Table 17: Regions and Number of Agricultural Landholdings[5]

Regions	Number of Agricultural Holdings	Proportion (%)
Cambodia	1,876,712 km^2	100%
Plain	869,305	46.35
Tonle Sap Lake	614,369	32.75
Coastal	139,433	7.43
Plateau and Mountainous	252,605	13.47

Source: PPTA Consultant.

192. Land tenure arrangement shows that majority of the land are owned with 98.55% in Kampong Thom province where the Taing Krasaing Irrigation Scheme is located.

Table 18: Land Tenure Arrangement[6]

Region / Province	% of Parcels by Land Tenure				Total No. of Parcels
	Owned	Rented with payment (Money or Harvest)	Rented Free	Other Land Tenure	
Cambodia	97.91	1.53	0.36	0.21	3,731,551
Tonle Sap Lake Region	97.58	1.77	0.50	0.15	1,148
Kampong Thom	98.55	1.18	0.18	0.10	230,841

Source: PPTA Consultant.

[5] *Ibid*, p.8

[6] *Ibid*, p.11

193. The total landholdings that use irrigation is estimated at 32% for the whole country. Kampong Thom has 20% of its total landholdings that use irrigation but only 5.5% use government irrigation facilities.

Table 19: Landholding that Use Irrigation[7]

Region/Province	Landholding that used Irrigation (%)	Landholding that use Government Irrigation Facilities (%)
Cambodia	32%	
Tonle Sap Lake Region	23%	
Kampong Thom	20%	5.5%

Source: PPTA Consultant.

4.1.1.2 Location of Project Area

52. The Taing Krasaing Irrigation Scheme is located in Kampong Thom province. Kampong Thom has 13% of the agricultural landholding with an average of 1.75 ha per landholding as compared to Tonle Sap Lake Region which has an average 2.3 ha and an average of 1.6 ha for the whole country.

Table 20: Agricultural Landholdings in Project Areas

Region/Province	Total Agricultural Landholding Area (Ha)	Average Area per Holding (Ha)
Cambodia	3,071,383.83	1.637
Tonle Sap Lake Region	1,447,620.55 (47%)	2.356
Kampong Thom	195,057.65 (13%)	1.754

Source: PPTA Consultant.

4.1.1.3 Project Land Area

194. In Taing Krasaing Irrigation Scheme the total land area of the four communes is 43,300 ha. When constructed, the project will benefit 9,869 ha of Riceland, which is 23% of the total land area of the communes. In 2014-2015 cropping season, 11,686 ha of land have been planted during the wet season and no area planted during the dry season. There is 1,200 ha presently irrigated in Taing Krasaing Commune.

Table 21: Project Land Area

Irrigation Schemes	District And Communes	Total Land Area (Ha)[8]	Project Area (Ha)			
			Gross Command Project Area[9]	Existing Area Irrigated	Cropped Area (2014-2015)	
					Wet	Dry
Taing Krasaing	**Santuk District**					
	Taing Krasaing	6,700	1,370	1,200[10]	1,575	0
	Tipou	21,900	5,653	0	6,529	0

[7] Ibid, p.14
[8] District Agriculture Office, 2015
[9] Based on Project Design
[10] Cambodian Agricultural Value Chain Program (CAVAC) Area with existing FWUC

Irrigation Schemes	District And Communes	Total Land Area (Ha)[8]	Project Area (Ha)			
			Gross Command Project Area[9]	Existing Area Irrigated	Cropped Area (2014-2015)	
					Wet	Dry
	Chraob	5,700	855	0	1,948	0
	Kokoah	9,000	1,991	0	1,634	0
	Total	43,300	9,869	1,200	11,686	0

Source: PPTA Consultant.

4.1.1.4 Population

195. In the Taing Kraisang Irrigation Scheme, the total population of the four communes is 39,357 with 52% comprising the female population. Total number of households is 7,939 households, 13% of which are female-headed households (FHH). Out of the total population, there are 11,686 farmers which comprise 30% of population in four communes

Table 22: Population[11]

Irrigation Schemes	District And Communes	Population			Households			Farmer Beneficiaries[12]
		Total	Male	Female	Total	FHH	MHH	
Taing Krasaing	**Santuk District**							
	Taing Krasaing	13,343	6,577	6,766	2,647	387	2,260	3,330
	Tipou	9,728	4,698	5,030	1,929	215	1,714	7,062
	Chroab	4,861	2,264	2,597	991	107	884	4,940
	Kokoah	11,425	5,479	5,946	2,372	347	2,025	3,846
Total		39,357	19,018 (48%)	20,339 (52%)	7,939	1,056 (13%)	6,883	11,686

Source: PPTA Consultant.

196. In the Taing Krasaing Irrigation Scheme, the age distribution is 12.5% in ages 0-5 years old, 29.5% in ages 6-17 years old and 51% in ages 18-60 years old, with 6.5% of those 61 years and above. This means that 51% of the population is in productive working age.

Table 23: Age Distribution of Population

Irrigation Schemes	District And Communes	Population	Age Distribution (%)			
			0 – 5 years old	6-17 years old	18-60 years old	61 and above
Taing Krasaing	**Santuk District**					
	Taing Krasaing	13,343	13.1	30.3	48.8	7.9
	Tipou	9,728	14.6	29.9	50.3	5.2
	Chroab	4,861	11.2	27.8	55.7	5.3
	Kokoah	11,425	11.4	30.2	50.9	7.6
Sub-Total		39,357	12.6	29.6	51.4	6.5

[11] Commune Database, National Institute of Statistics, 2013
[12] District Agriculture, Forestry and Fisheries Office

Irrigation Schemes	District And Communes	Population	Age Distribution (%)			
			0 – 5 years old	6-17 years old	18-60 years old	61 and above
Total		88,247	14.2	29.5	50.2	6.0

Source: PPTA Consultant.

4.1.1.5 Landholding and Ownership

197. The average size of a farmer's landholding is from one to three ha. In Taing Krasaing, there are 522 farmers who own less than one ha of land. This is 2.7% of the total farmers. There are 170 farmers who do not own their farmland. The total farmers who own less than one ha of land is 1,859 while 1,322 farmers do not own their land as summarized in Table 24.

Table 24: Size of Landholding and Ownership[13]

Irrigation Schemes	District And Communes	Farmers		Farmers Owning Less than 1 ha[14]		Farmers who do not own rice land[15]	
		Total	Average Size of Land-holding	No.	%	No.	%
Taing Krasaing	**Santuk District[16]**						
	Taing Krasaing	3,330	1.5	509	15.40	159	5
	Tipou	7,062	1.5	0	0	0	0
	Chroab	4,940	1.5	0	0	0	0
	Kokoah	3,846	1.5	13	0.34	11	0.29
Sub-Total		11,686	1.5	522	4.5	170	1.5
Total		**18,349**		**1,859**	**10**	**1,322**	**7.2**

Source: PPTA Consultant.

4.1.1.6 Sources of Income

198. The main sources of income of people in the Project areas comes from agriculture, craftwork and service as summarized in table 25. Agriculture includes rice farming, planting of short and long term crops and vegetables, and from fishing and livestock. Craftwork includes woodcraft and furniture making, metal and aluminum works, cooking of foodstuff, production of tire, plastics and rubber goods, textile and clothing production. Service work includes trading, repair works and transport services.

199. In the Taing Krasaing Irrigation Scheme, 93.5% are in rice production, 0.04% on vegetable and 0.84% on fishing. Only 0.035% is on craftwork and 2.23% from service work.

[13] Commune Database 2012 and Provincial Data Book 2009

[14] Commune data provided during meetings of PPTA Team with Commune Officials on 2 May and 7 May 2015

[15] Commune data provided during meeting of PPTA Team with Commune Officials on 2 May and 7 May, 2015

[16] Calculated based on total number of families who are rice farming in 2008, Source? (from Ron)

Table 25: Sources of Income or Occupation of Families

Irrigation Schemes	District And Communes	Agriculture (%)			Craft Work (%)	Service (%)	Others (%)
		Rice	Vegetable	Fish			
Taing Krasaing	**Santuk District**						
	Taing Krasaing	88.33	0.08	3.1	0	6.54	0.72
	Tipou	99.33	0	0.26	0	0.41	0
	Chroab	92.53	0	0	0.1	1.01	5.95
	Kokoah	93.8	0.08	0	0.04	0.97	4.09
Total Average		**93.50**	**0.04**	**0.84**	**0.035**	**2.23**	**2.70**

Source: PPTA Consultant.

4.1.1.7 Agriculture Situation in the Project Areas (2014-2015)

200. The agriculture situation in the project areas is based on the 2014-2015 cropping season. It describes the irrigated, rain-fed and flooded area, the rice varieties planted, agriculture method used from land preparation to harvesting, drying and marketing. It also presents the average yield/ha and the gross and net market value. It presents the credit practices of the farmers and their major problems encountered by the farmers. Presented in Table 26 is the agriculture situation in Taing Krasaing Irrigation Schemes.

Table 26: Agriculture Situation (2014-2015)

Agriculture Data	Taing Krasaing[17]
Irrigated Rice Area	• 1,200 ha (CAVAC Area) • Remaining Command area not irrigated
Rainfed Rice Area (Ha) • Rice Crop • Fruit Trees and Vegetables	 • 11,686 Ha • No data
Flooded Area (Ha)	• Around 1,000 ha in Tipou Commune (water-logged area) • Damage to crops in 2011 to around 1,590 ha[18](Veang Chung, Thomm Neath, Sangkom Thmei in Taing Krasaing Commune; Ou Kohkir, Sdok Sdam, Chey Mongkol, Tuol Vihear in Charaob; and Sala Santouk, Chimeak, Santuk Krau and Santuk Knong in Kokoh Commune)
Farmers Affected by Flood	• Around 500 farmers (estimate based on average land holding of 2 ha)
Rice Varieties Planted • Early Variety • Medium Variety • Late growing Variety • Floating Rice Variety	 15% 43% 33% 9%
Agriculture Method Used • Land Preparation ○ By Cow/Buffalo ○ By hand tractor ○ By big Tractor	 0% Farmers 95% Farmers 5% Farmers
• Land Leveling	1% rent tractor
• Transplanting or • Broadcasting	20% 80%

[17] Ibid

[18] Data from Mr. Nov Ra, Chief Office of Agriculture of Santuk District in Taing Krasaing and District Agriculture, Forestry and Fisheries Office, Moung Ruesei, 2013

Agriculture Data	Taing Krasaing[17]
Agro Inputs used • Fertilizer • Seeds • Herbicides and Mechanical control (plowing the rice field again 20 days after sowing to destroy weeds)	Most farmers use chemical fertilizer (DAP 18-46-0, NPK 16-20-0, Urea 46-0-0) 90% use their own seeds from previous crop and 10% buy seeds from station/Provincial Agriculture Department 100% use herbicide for weed control and re-plowing after 20 days of seed sowing.
Harvesting • Manual Labor • Machine	80% used manual labor 20% by combine harvester machine
• Drying	Most farmers use sunlight for drying in 2-3 days to reduce moisture by 14% for better storage
• Post-harvest Losses	10-15% during harvest and 15% post-harvest
• Marketing of product	Extra rice not consumed are sold to private rice buyer at farm gate price of 720-1,300 Riels/kg
• Average Yield (tons/ha) • Kg/ha	1.5 tons/ha (1,500 kg/ha) = Range from 800 kg/ha to 1,500 kg/ha
• Gross and Net Market Value of Rice Produce (USD)	450 USD (Gross Value) 215 USD (Net Value after production cost)
Livestock • Cows for selling • Buffalo • Pigs • Chicken	90% 10% 20% 100%
Credit • Micro Finance/Credit Institutions (2-3%/month interest rate) • Money Lenders (5-6%/month)	80% of farmers 20% of farmers
Major Problems of Farmers	• No water • Lack of irrigation canals • Poor soil quality • Some farmlands are of high elevation • Farmers do not use commercial seeds but from their previous seed stock which give lower yield • Seeds are not available in market • Farmers use huge quantity of seeds for broadcasting (150-200 kg/ha) • Poor technical know-how for rice planting, weed and pest control • Prices of agro inputs are high and agro-produce are low • Poor conditions of and inadequate access roads from farm fields to markets • Limited training on improved agriculture methods (farmer-field schools and demonstration plots) and livestock rearing • High credit interest rates

Source: PPTA Consultant.

4.1.1.8 Poverty Situation in the Project Area

201. Cambodia's poverty rate had decreased by 12.2% from 35.1% in 2004 to 22.9% in 2012. The capital city of Phnom Penh had a 6.8% poverty rate in 2004 and went down to 0.1% in 2012. Poverty rate in rural areas is higher than the urban area with 13.5% in 2013 compared to 19% for urban areas in the same year.

Poverty Line

202. The poverty lines have been recalculated in 2009 showing new poverty lines on food and non-food. Poverty lines had been calculated for Phnom Penh, other urban areas and rural areas showing the following:

Table 27: Poverty Line[19]

Particulars	Phnom Penh		Other Urban Area		Rural Area	
	Riels / Month / Capita	Kilo-calories	Riels / Month / Capita	Kilo-calories	Riels / Month / Capita	Kilo-calories
Food Poverty Line	94,945	2,200	79,293	2,200	69,963	2,200
Non-Food allowance	98,106	-	53,032	-	35,350	-
Water	-	-	61	-	1,247	-
Total	193,052 / month 6,347 / day	2,200	132,386 / month 4,352 / day	2,200	106,560 / month (27 USD / month) (3,503 / day= 0.87 USD / day)	2,200

Source: PPTA Consultant.

Poverty Rates in the Project Area

203. In 2012, poverty rates in Kampong Thom had decreased from 41% in 2004 compared to 29.1% in 2012 as shown in Map 5 and Table 27. Compared to Battambang Province in 2012, Kampong Thom has higher poverty rate.

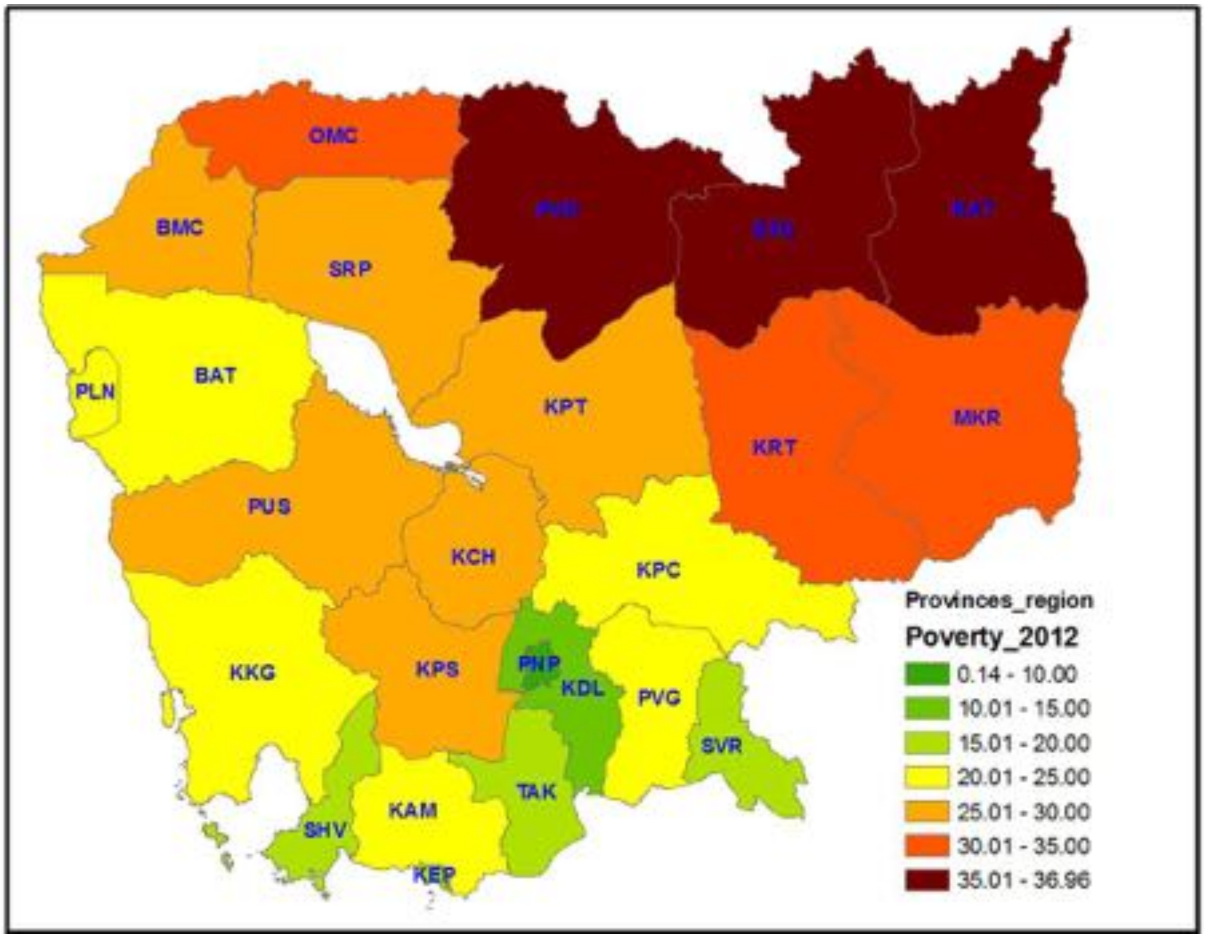
204. The poverty rate of communes that are within the project area shows 30.5 % in Santuk District in Kampong Thom. However, the poorest commune is Ti Pou with 39% poverty rate, located in Santuk District, Kampong Thom province located in the Taing Krasaing Irrigation Scheme.

205. Poverty rate computation is based on Commune Database using 13 indicators reflective of the standard of living which measures the ratio of families with: (1) latrine; (2) television; (3) motorcycle; (4) bikes; (5) size of family; (6) concrete homes; (7) thatched roof; (8) literacy rate of women aged 16-60; (9) ratio of men from 18-60 years old to total population; (10) women delivery

[19] Poverty in Cambodia – a New Approach, Ministry of Planning, April 2013

by traditional midwife; (11) out-of school children from 6-14 years old; and (13) with water source with a distance of 150 meters from home.

Map 5: Location Map of Project Area and Poverty Rate, 2012



206. Poverty rates in Kampong Thom decreased by 12% from 41.1% in 2004 to 29.1% in 2012. In Taing Kraisang, the lowest poverty rate is in Taing Krasaing Commune at 24.3% while the highest is in Tipou Commune at 39%.

Table 28: Poverty Rate in the Project Area[20]

Sub-Projects (Irrigation Schemes)	Location and Coverage	Poverty Rate (%)			
		2004	2008	2012	Trend 2004-2012
	Cambodia	35.1	29.3	22.9	Decreased By 12.2%
	Phnom Penh	6.8	0.3	0.1	Decreased by 6.7%
	Other Urban Area			13.5 (2013)	
	Rural Area			19.0 (2013)	
Taing Krasaing	**Kampong Thom Province**	41.1	36.5	29.1	Decreased by 12%
	Santuk District	41.1	36.8	30.5	
	• Taing Krasaing	34.3	29.0	24.3	
	• Chroab	40.5	37.3	26.7	
	• Ti Pou	47.2	44.7	39.0	
	• Korkoah	43.8	38.1	29.3	

Source: PPTA Consultant.

207. **Poverty Assessment**: Around 30% of the total population of the four communes are farmers. Main source of income is derived from agriculture (91%). Poverty finds its roots on this source of income because of its dependence on several factors (i.e. irrigation, agriculture inputs and technology, efficient water management, sufficiency of water at the source, type of soil, weather condition) thus providing insufficient opportunity for farmers to have a stable and sufficient income to meet their needs.

208. The main factors that cause poverty as identified by the people in the project areas are (i.) poor soil condition, (ii.) lack of water in the canals for crop irrigation during the dry season, (iii) lack of irrigation canals (secondary and tertiary); (iv) non-use of appropriate agriculture technologies (v) padi seeds are not available in the market; (vi) high price of agro-inputs; (vii) poor access road to market; (viii)high interest rates of loans; and (ix) lack of job opportunities in the locality.[21]

[20] Poverty Reduction by Capital, Provinces, Municipalities, Districts, Khans and Communes, Sangkats Based on Commune Database (CDB), 2004-2012, Ministry of Planning, July 2012

[21] Focus Group Discussion (FGD) conducted in Taining Krasaing and Preaek Chik

4.1.2 Gender

209. Cambodian women are the most economically active in Asia and while gender attitudes are changing, significant gender inequalities continue to persist. Cambodia has the lowest levels of gender equity in Asia, due to poor access to health and education services, productive employment opportunities and land ownership[22]. The main gender issue in Water Resource Management (WRM) is that fewer women participate in this sector. It is due to the cultural belief that this role is for men, even though women are able to participate and work in WRM. This led to women not being motivated to participate in this sector. The other reasons are the attitude of men (husbands) not allowing the women (wives) to work with other men and that women's having reproductive workload of taking care of the children, cooking, cleaning the house and managing the farm while their husbands or parents migrate to Thailand or Phnom Penh to look for work.[23]

210. Based on the above issues on gender inequality in water resource management, the Upland Irrigation and Water Resources Management Sector Project in Cambodia - ADB PPTA 8702-CAM (The Project) does not only focus on rehabilitation of existing irrigation scheme, but also on social and gender issues. The Gender and Social Team (GST) conducted a study (through interviews and focus group discussion) at national level and in the communities of the Sub-Project areas to find out the real issues and needs of women in their participation in WRM and in Agriculture sector. The Project takes serious consideration in gender integration and in addressing the gender issues identified during the survey which became the basis in preparing the Gender Action Plan (GAP). The proposed GAP includes the integration of gender awareness and gender mainstreaming within the implementing agency (MOWRAM and PDWRAM) at the national, provincial, district and field levels, increasing participation, decision making of women as member in the FWUCs, developing women's leadership skill, and in occupying leadership positions in the Farmer Water User Communities (FWUC) in the Sub-Project areas, and also strengthening the capacity of MOWRAM staff national and sub-national levels as well as local Authorities to support FWUCs. The GAP supports MOWRAM's Gender Mainstreaming Strategy and Action Plan for 2014-2018, specifically objective 4 which ensures that all services in the water resources and meteorology sector bring more benefits to women in the communities.[24]

211. Based on the findings, the conclusions are :

i. The gender division of labor in WRM shows that women have less access and control but has greater participation in agriculture activities. Because of cultural constraints and belief, women's participation is limited.
ii. Women lack the confidence and belief that they are capable of participating actively and equally as men in WRM, even though they are already actually doing the work in the field. But their participation is not given any value so it remains invisible.

[22] UN-DAF, 2010, and UNDP, 2010, Gender and Climate Change: Oxfam America, 2010;
[23] Result of FGD conducted in May, 2015 at the target communes of Taing Krasaing and Taing Krasaing irrigation schemes;
[24] Objective 4 of MOWRAWM Gender Mainstreaming Strategy and Action Plan 2014-2018, page 9;

iii. According to socio-economic data in Taing Krasaing and Taing Krasaing Irrigation schemes, women constitute 51% of the population with 14% female-headed households. They are the most vulnerable in the farming communities because they have to remain in the commune to take care of the children, handicapped and older people, their farm and to participate in community and FWUC activities as their husbands look for work outside the commune and go to neighboring country. The women are left with the multiple tasks of domestic, productive, and community activities. They need to look for daily support to feed their families.

iv. Because of the impact of climate change the farmland lack water, which leads to low production. The women headed households become the most vulnerable.

v. Though women participate in meetings with their attendance higher than men, they do not participate in decision-making. They lack the confidence to share their opinion and views. Because of this, there are very few women leaders in the FWUC. The gender guideline of MOWRAM on FWUC does not provide in developing the leadership skills of women farmers. It only states that women should be encouraged to participate in the election. It does not prepare and enabling environment for women to be able to do so.

vi. According to the findings of the study, almost all women farmers want to work in construction work as skilled labor. And they also want to receive training on construction technique if possible.

vii. Both men and women have equal access to agricultural production including livestock, crops and rice production, however women have less control in agricultural production. This is because of the cultural belief that women cannot do as men do; women are not supported and encouraged by their husbands as well as community to participate in water resource management and apply modern agriculture techniques.

viii. Training needs expressed by women to improve their participation in agriculture, irrigation and water resources management are: appropriate agriculture technology, gender awareness, leadership training, water resource management and better technology in pig and chicken raising.

ix. The capacity of GMAG is still limited. Lack of budget to implement the Gender Mainstreaming Action Plan is also one constraint.

212. Presented in **Table 29** is the summary of the key gender issues that are relevant to the project, including those identified in the gender analysis carried out during the project preparation with the proposed mitigation measures:

Table 29: Key Gender Issues and Mitigation Measures

Key Gender Issues	Mitigation Measurable
• Low participation of women in water management activities due to cultural belief that this is men's role.	Provide awareness raising gender concept and gender role in water management for communities in the target communes.
• Low literacy of women. Most women cannot read and write thus prohibiting them from occupying leadership post in the FWUC.	Provide a leadership and effective communication training for the women.
• Lack of confidence to participate in discussion and decision making because they are shy and not able to verbalize their opinion.	• FWUC development should encourage participation of men and women farmer water users. Women should be encouraged to participate in discussions during meeting.

Key Gender Issues	Mitigation Measurable
	• Provide training on leadership for women FWUC members.
• Very few women occupy leadership position. In Taing Krasaing Irrigation scheme, there is an existing FWUC organized by Cambodia Agricultural Value Chain program (CAVAC) of the Australian Department of Foreign Affairs and Trade. Only one out of five board members is a woman and out of 53 Committee members only 4% are women.	• Disseminate gender awareness raising for communities before FWUC election to increase community belief that women are able to work for Water Management as well as be FWUC leaders.
• Women are busy with domestic (housekeeping, taking care of children, washing, cooking, home gardening and poultry raising and with productive work in the farm, thus giving them limited time to participate in FWUC activities. This is caused by the high migration of men to look for work opportunities outside the village and the attitude of men who do not want their wives to be exposed to other men.	• Meeting/training schedule should consider women's schedule. • Awareness raising on Gender Concept for communities in the target communes.
• Lack of skill of women to participate in skilled and unskilled work for construction.	Potential women skilled or unskilled workers should be provided with training or orientation for construction. Contractors should be oriented to recruit women workers and include this in the Contract stipulation. Women can also be tapped to work as record keepers.
• Construction companies usually use labor from outside the communities preferring to hire men for skilled and unskilled labor. They do not also pay equally for the same work done for men and women.	Gender equality and equity including (1) at least 40% of women participate in unskilled work for construction; (2) equal pay for equal work for both men and women. This condition will be included in the TOR of construction companies.
• Training materials used for FWUC are mostly in written form and not easily understandable to women who cannot read and write.	Produce more pictures to include in the training materials ensuring that training will be easy for women to understand, especially for women who cannot read and write. Training method should avoid the lecture type but more on structured learning exercises and group dynamics exercises.
• FWUC has very low women membership. Example is in Taing Krasang where only one woman is a member of the Board and out of 53 Committee members only 4% are women.	Disseminate gender awareness raising for communities before FWUC election to change community belief that women are able to work for Water Management as well as be FWUC member, in order to increase number of women elected.
• GMAG of MOWRAM and GFP in the province have limited capacity to support the FWUC gender issues and concerns.	Strengthen capacity of GMAG and GFP on gender role, gender issues and concern in WRM as well as gender issues in the project.

Source: PPTA Consultant.

4.1.2.1 Proposed Gender Action Plan

213. The GAP was developed in accordance with the project activities and based on the findings of the study in the six communes of within the project area located in three districts in the province of Battambang and Kampong Thom. In implementing the proposed GAP, the mitigation measures on the issues identified in the study conducted are addressed. The GAP focuses mainly on the strengthening of the government institution (MOWRAM and PDWARM) and the FWUCs

with regards to gender plan implementation. It proposes to include gender issues in almost all project activities and training ensuring that both men and women get benefit from the project equally. It also provides opportunity for women farmers to have access and control over water resource as well as agriculture production for the improvement of their livelihood. The GAP also pays attention for the project management, monitoring and reporting. Sex-disaggregated data should be included in project progress report.

Table 30: Gender Action Plan

Project Activities	Proposed Gender Action Plan	Person / Institution responsible
Strengthening of Government Institution (MOWRAM and PDWRAM)		
Project Orientation	Ensure that GAP is included in the agenda of the project orientation workshop.	Project Gender Specialist / MOWRAM GMAG
Training, Information dissemination, workshop, Exchange Visits, Field visits and Study Tour	Provide workshop on gender role in WRM and in agricultural production for gender focal point at national level (MOWRAM GMAG) and to the gender focal points at the two provinces. GFPs from national and sub-national levels and project gender specialist are included in the list of participants for field visit and study tour exchange experience	Project Gender Specialist / MOWRAM and PDWRAM Gender Focal Points
Project Planning	Review and update training for women farmers in the FWUC and include in the over-all Training Plan of the Project. MOWRAM Gender Focal Points both at national and sub-national should conduct gender training with assistance from the project Gender Specialist. Women will be encouraged to speak out during meetings. They should also sit in front instead of always at the back of the meeting room. This will give importance to women and will help build their confidence in speaking out and participating in the meeting and other FWUC activities. Conduct meeting with women farmers separately (especially on the early stage of the Project) ensuring that their ideas will be collected in developing Gender project plans.	Gender Specialist / MOWRAM Gender Focal Point (from GMAG) / MOWRAM
FWUC formation and Strengthening	Gender awareness including gender concept, gender role, gender in WRM and gender in agriculture will be disseminated to community people before election of FWUC to ensure that the community of farmers give equal importance to the contribution and participation of women. In this way, more women can be voted as officers of the FWUC. Ensure that women as FWUC are given equal opportunity with men to participate in Project training. Scheduling of FWUC meeting should consider the women's homework activities and schedule. Disseminate the FWUC sub-Decree, specifically	MOWRAM, Gender Focal Point, Project Gender Specialist

Project Activities	Proposed Gender Action Plan	Person / Institution responsible
	on gender issues.	
Gender awareness and leadership trainings for Gender Focal Points.	Provide coaching on gender awareness and leadership for GFP to ensure that they are able to conduct training within MOWRAM and PDWRAM officials and to Women FWUCs.	Project Gender Specialist
Construction Management and Supervision	At least 40% of women participate during the presentation of Project design and in the discussion and planning of the water distribution and cropping plans. Gender equity and labor arrangements should be included in contract of construction companies that (1) at least 40% of unskilled labor will be given to local women during construction; (2) Ensure that there are no children (below 18 year old) engaged in labor work; and (3) there should be equal pay for equal work for both men and women. If possible, provide orientation and training to women on construction work such on canal measurements and work specifications to ensure the quality of construction work. Women who can read and write can also be hired as record keepers.	MOWRAM, GFP, Project Gender Specialist
On- farm water management	Include a topic on gender role in water resource management for on-farm water management training. Ensure that women farmers will be encouraged to participate in on-farm water management. Encourage both husband and wife to register as members in the FWUC. Encourage women farmers to participate actively in meetings and in decision-making during FWUC meetings.	
Operation and maintenance (O&M)	Ensure that women will take part in the O&M activity. Ensure the women members will have equal opportunity to participate in O&M training.	GFPs

4.2 Resettlement

214. The project is classified as category B for involuntary resettlement. No land acquisition is required for Taing Krasaing and Prek Chik main canals and shall not cause involuntary resettlement but improvement of distribution canals may need acquisition of small strips of land. Resettlement framework has been prepared to guide the preparation of social safeguards assessment and resettlement plans of distribution canals of the two systems and other subprojects, and to ensure compliance with ADB's SPS 2009 and government regulations. The subprojects, if assessed as Category A, will not be financed from the Project. Adequate resources have been allocated for preparation, implementation, monitoring and reporting of resettlement plans. The Framework has been disclosed.

5 INSTITUTIONAL ASSESSMENT

5.1 Stakeholder Analysis

215. Based on the stakeholder analysis conducted, the main agency that has a direct stake in the implementation of the Uplands Irrigation and Water Resources Management Sector Project (UIWRMSP) are the Government Institutions, Civil Society Organizations, Beneficiaries (water users and farmers, Private Sector (Contractors, equipment manufacturers). Presented in **Table 31** is the summary of the stakeholder analysis conducted:

Table 31: Stakeholder Analysis

Stakeholder Group	Interest	Mandate
A. Government		
• Ministry of Water Resources and Meteorology (MOWRAM), - Farmer Water User Community Department (FWUC Department) - Provincial Water Resources and Meteorology Department (PDWRAM)	Executing and Implementing Agency	Lead the management of the water resources and meteorology in the country Supervise and monitor project implementation
• Ministry of Agriculture Fisheries and Forestry (MAFF) - Provincial and District Agriculture Office	Provides guidance and support to farmers in the Project area on agriculture production and in developing the cropping calendar in line with the water distribution plan.	Responsible for agriculture development, product safety, use of chemicals in agriculture, fisheries policy and industry development, fishing regulations, forestry policy, forestry development and regulations
• Ministry of Interior - District - Commune - Village	Supports the irrigation and agriculture development within the Districts, communes and villages that are within the Project command area. Provides support in community mobilization for meetings and on conflict resolution to ensure law enforcement.	Responsible for public administration throughout Cambodia's 24 provinces and 186 District and governs the national police and administration of law enforcement. Delivery of community level infrastructure and public services within their jurisdiction
B. Beneficiaries and Project Affected Persons or Groups		
• Farmers	Main project beneficiary Interested to increase productivity of their land through irrigation, improvement in water management and in crop production.	Represent their own interest to improve their condition

Stakeholder Group	Interest	Mandate
• Water Users Groups - Famer Water User Communities (FWUC) - Private Companies such as the Chinese, Korean and Vietnamese Companies in Taing Krasaing Irrigation Scheme)	Functional and efficient irrigation system that will benefit its farmer members. Represent the interest and welfare of its members. Maximum benefit for their farms that use water from the irrigation scheme. Better service delivery from PDWRAM with the improved irrigation scheme.	Legal autonomous entity serving the common interest of people through the use of an irrigation system in an effective and sustainable manner aimed at enhancing economic and social development and poverty reduction. (**Art. 7** FWUC Sub-Decree) To operate as a business enterprise for profit
Civil Society Organizations and NGOs		
• Irrigation Service Center (ISC)	Service provider to FWUCs in need of organizational, financial management and operation and maintenance assistance	Provide long term service to FWUCs on training and capacity building
• Sre-Khmer	Service provider on improved Agriculture practices	Provides agriculture training to farmers using Farmer Field School (FFS) method and Integrated Pest Management (IPM). Provides input to demonstration plots used on FFS.
• VSG	Community Development	Implements program on Community Development
• ACLEDA, CANADIA, PRASAC, AMET, Vision Fund, AMK, CREDIT, KHL, SHILANITIH, TPC, Hatha Kaksikor	Private banks and micro-finance institutions.	Provides Loan and Credit to its groups
• CARITAS	Forms Agriculture Cooperatives and Women's Loan and Savings Group	Community Development, Human Resource Development and Agriculture assistance to its program beneficiaries
• KHEN, BFD, HEALTH EAR, RHAC	Provides health and education program and awareness raising on health care, hygiene and sanitation	Health and Education Hygiene and Sanitation
Private Sector		
• Construction Companies	Contractual work on construction of irrigation scheme infrastructure	Contractual arrangement on construction services for the irrigation scheme improvement
• Equipment Companies	To provide equipment for project construction either on sale or rental basis	Provides equipment through sale or rental
International Development Partners		
• Asian Development Bank	Support to irrigation and agriculture improvement through Loan and Grant	Development Assistance

Stakeholder Group	Interest	Mandate
• AFD and French Government	Support to Irrigation system improvement and the CISIS program in MOWRAM	Development Assistance
• AusAid	CAVAC program implemented in Taing Krasaing Commune	Supports Cambodian Agriculture Value Chain program (CAVAC) implemented in Taing Krasaing

216. The key stakeholders involved in the project are the Government institutions such as MOWRAM and PDWRAM, FWUC Department, Project Management Unit (PMU) and the Farmer Water User Community (FWUC) at the Core Sub-Project Areas. Their composition and functions are described as follows:

5.1.1 Ministry of Water Resources and Meteorology

217. The Ministry of Water Resources and Meteorology (MOWRAM) was created in 1999 based on Proclamation NS/RKM/0699108 dated 23 June 1999. Its overall mandate is to lead the management of the water resources and meteorology. The main objectives of MOWRAM are the following[25]:

- To carry out scientific research on the potential of underground and surface water resources to establish scientific knowledge;
- Set directions and roadmap on short, medium and long term plans with respect to water consumption in order to fulfill the needs of the country's development and preserve those of the urban and rural population;
- Control and monitor all activities related to water consumption to mitigate the risks;
- Prepare and draft laws and regulations linked to use of water and control procedures;
- Gather documents and build technical data on climate, hydrology and water use within the country and abroad and find for scientific return of investment for scientific research;
- Raise awareness of industries, NGOs, civilian communities, and the population about development and exploitation of water resources and provide technical advice; and
- Collaborate in the management of the Mekong Basin considering both the management of water resources and meteorology.

218. MOWRAM takes responsibility in monitoring and managing all activities related to water resources and meteorology. It is headed by a Minister and under him are 7 Secretaries of State and 7 Under Secretaries. There are 12 Departments at the central level and 24 Provincial Departments and District Water Resources Offices. The total number of personnel is 1,258, out of which 633 are based at the central level and 625 (54 female + 571 male) are based in the Phnom Penh municipality and the 24 provinces.

[25] MOWRAM's website www.cambodiameteo.com

5.1.2 Provincial Department of Water Resources and Meteorology (PDWRAM)

219. There are 24 Provincial offices of the PDWRAM with 625 personnel (54 female + 571 male). The functions of the PDWRAM are stated as follows:[26]

- Planning and organizing the development program of the Ministry at the provincial level;
- Operation and maintenance of major irrigation works;
- Management of FWUCs and other farmer bodies with responsibility for supporting the irrigation

Scheme operation and maintenance;

- Management of the collection of the Irrigation Service Contributions (ISC) by the FWUCs and control of expenditure from the ISC account;
- Oversight of construction of irrigation and flood protection works at the provincial level; and
- Minor procurement and disbursements associated with construction projects.

220. The PDWRAM is headed by a Director and supported by 2 Deputy Directors which head the Office of the Conservation and Management and the Office of Hydrology and Meteorology. Directly under the Director are the Offices of the Administration and Personnel and the Office of Irrigated Agriculture.[27]

221. Over-all the number of PDWRAM staff is 625 with only 9% women. In Battambang province, there are 67 staff with 12% women, while in Kampong Thom[28], there are 27 staff with 4% women. Presented in Table 32 is the number of PDWRAM staff:

Table 32: PDWRAM Staff in the Provinces involved in the Project Implementation

Province	Number of Staff		
	Female	Male	Total
Cambodia (24 Provinces)	54 (9%)	571	625
• **Kampong Thom Province**	1 (4%)	26	27

5.1.3 Project Management Unit

222. The **Project Management Unit (PMU**) was established by virtue of a Ministerial Letter No. 034DM-WRM dated 8 January 2014. It is headed by a Project Director who is the Deputy Director General for Technical Affairs and a Project Manager who is the Director of the

[26] MOWRAM's website www.cambodiameteo.com and Report on Institutional Arrangement for the Management of Water Resources in Cambodia, WRMSDP, Feb 2015,

[27] PDWRAM Organizational structure of Kampong Thom, based on 4 June 2015 interview with the Director

[28] PDWRAM Kampong Thom, 4 June 2015 Interview with Director

Department of FWUC. It is composed of 13 designated personnel responsible for the over-all project implementation, planning, organization, monitoring and coordination of the various Project activities. It will coordinate with relevant Departments of MOWRAM and with other government Ministries at the central, provincial, district and commune levels, and with relevant Civil Society Organizations and Non-Government Organizations.

223. The **Project Management Unit (PMU)** is based at the **FWUC Department** in MOWRAM. Its overall function is to oversee the implementation of the Project and supervise the implementation of the construction packages based on Project schedule. This will require the close coordination with the Project Management Implementation Consultants (PMIC). Implementation period for the Project is for six (6) years. The composition of the PMU is as follows:

1. Mr. Chann Sinath, Deputy Director General for Technical Affairs and Project Director PMU
2. Mr. Huy Vantha, Director of Department of FWUC and Project Manager
3. Ms. Bun Sida, Vice Chief office of Training and Research of DOFWUC and Administration and Financial Officer
4. Mr. Keo Sovathapheap, Deputy Director of Department of FWUC and Technical Officer
5. Mr. Tan Naren, Chief of FWUC Management's Office and FWUC Officer
6. Mr. Mao Hak, Deputy Director General for Technical Affair and Hydrology and River Officer
7. Mr. Um Rina, Director of Department of Meteorology and Meteorology Officer
8. Ms. Laing Sokim, Vice Chief office of Training and Research of DOFWUC and Procurement Officer
9. Mr. Im Soursdey, Vice Chief of FWUC Management's Office and Assistant to Technical Officer
10. Mr. Sok Boren, DOFWUC's Staff, Assistant to Procurement Officer
11. Mr. Kim Vann, DOFWUC's Staff and Assistant to Financial Officer
12. Mr. Phan Sophy, Chief of Instrument Management Office and Assistant to Meteorology Officer
13. Mr. Sren Sotha Staff of Hydrology and River Work's Department and Assistant to Hydrology Officer

224. The **Department of FWUC** was created based on **Sub-Decree No. 73** on the Establishment of the FWUC. It was signed on 30 June 2008. On 12 March 2015, the Sub-Decree on the Procedures for the Establishment, Dissolution, Roles and Duties of FWUC was signed by the Prime Minister. In **Article 5** of the FWUC Sub-Decree, the MOWRAM is given the full competence for the overall management of the FWUC and is vested with the following roles and responsibilities:

- Administer the FWUC and all irrigation schemes;
- Endorse the application for the registration of the FWUC;
- Refuse to establish or dissolve the FWUC;
- Provide guidance of the FWUC's Statute and its internal regulations;

- Facilitate with concerned institutional stakeholders on the implementation and development of the FWUC management;
- Coordinate and facilitate the election of the FWUC Committees;
- Settle disputes within the FWUC context;
- Seek funding sources to support the FWUCs;
- Provide training to enhance the capacity of FWUCs
- The PDWRAM/Municipality of Water Resources and Meteorology shall register all FWUCs in the FWUC registry, after endorsement by MOWRAM.

225. Analyzing the roles and responsibilities of MOWRAM and PDWRAM based on the stipulations in **Article 5,** requires the necessary Staff with the right qualification to establish and strengthen the FWUC. In order for the FWUC to actively participate in the project implementation process and to develop the feeling of ownership and responsibility towards the irrigation system requires skilled and qualified personnel (usually referred to as the Community Organizers).

5.1.4 Farmer Water User Community (FWUCs)

226. In 29 June 2007 the Law on the Management of Water Resources in Cambodia was issued. The Sub-Decree was issued on 12 March 2015 on the Procedures for the Establishment, Dissolution, Roles and Duties of the FWUC. It defines the FWUC as a legal autonomous entity aimed at using the irrigation system for its agriculture production, as well as for the sustainable use, maintenance and development. MOWRAM is given the tasks for the overall management of the FWUCs.

227. In Taing Krasaing Irrigation Scheme, there is an existing FWUC organized under the Cambodian Agricultural Value Chain Program (CAVAC). The CAVAC area covers only around 1,200 ha of the Project command area. Constructed under the Program are 3 Secondary canals, 3 Gates – left off-takes from main canal, 1 drain escape – left off-take from main canal, 30 Gates of Tertiary Canal intakes and 19 Check structures - Control Points. The 1,200 ha that is served under the CAVAC has 800 farmers.

228. The FWUC Sub-Decree of March 2015 specifies under Article 5 the role of MOWRAM in the FWUC's overall management. These are specified as follows:

1. Administer the FWUC and all irrigation schemes
2. Endorse the application for registration of a FWUC
3. Refuse or dissolve a FWUC
4. Provide guidance on the FWUC's statute and its internal regulations
5. Facilitate with concerned institutions and stakeholders on the implementation and development of the FWUC management
6. Coordinate and facilitate the elections of the FWUC Committees
7. Settle disputes within the FWUC context
8. Seek other funding sources to support the FWUCs
9. Provide training to enhance the capacity of FWUCs

10. Provincial Department of Water Resources and Meteorology (PDWRAM) shall register all FWUCs in the FWUC registry , after endorsement by MOWRAM

Based on Article 7 of the FWUC Sub-Decree the criteria for FWUC establishment are as follows:

- The farmers that use water within the same irrigation scheme or part thereof will compose the FWUC members
- Compliance with the technical standard of MOWRAM
- Participation in the election of those who use the irrigation system under the FWUC competence, with support of two third (2/3) voters.
- Based on the laws, regulation and concerned legal documents

5.2 Institutional Risks Assessment

229. The institutional assessment and mitigation measures in project implementation is presented in **Table 33.** It focuses on MOWRAM/PDWRAM, the FWUCs, Irrigation infrastructure and the Private Companies within the Project area.

Table 33: Institutional Risks and Mitigation Measures in Project Implementation

PARTICULARS	RISKS	MITIGATION MEASURES
INSTITUTIONS		
MOWRAM/PDWRAM	1. MOWRAM/PDWARM has limited number of personnel to implement the Project. The FWUC Department has personnel at the Central level but no Office and personnel at the Province and District.	• Recruit additional personnel with the right qualification and experience for the FWUC Department at the central, provincial and district levels.
	2. Existing personnel at the FWUC Department has limited capacity to fully implement the FWUC establishment and strengthening	• Provide the necessary capacity building to FWUC Department and for additional personnel to be recruited
	3. The process of organizing the FWUC is explained in the Prakas 306 issued on July 2000, Chapter 5: the 10 steps for Creation of FWUCs and Circular 151 However, it does not clearly state how this will be conducted. Organizing framework and process from establishment to strengthening should explain how FWUC will be able to efficiently manage the O&M of the irrigation system and with accountability	• Develop a FWUC Organizing Framework for the Project identifying the activities to be implemented within the Project Cycle.
Farmer Water User Communes (FWUC)	4. FWUC will remain as “paper Organizations” that are weak,	• Well defined FWUC Organizing Framework within MOWRAM/PDWRAM

PARTICULARS	RISKS	MITIGATION MEASURES
	inefficient and not active. Farmers are not interested to join the FWUC because they do not see the immediate benefits of the Project. Farmers farm land have not been previously irrigated and will need a build-up period before it becomes productive by following the recommended advise on improved agriculture production, cropping calendar and on water distribution plan.	• FWUC Personnel that have undergone training Can be designated as FWUC Organizers • Farmers should be given advice and guidance on the appropriate agriculture production techniques. • Cropping Calendar should be synchronized with the Water Distribution Schedule and should be agreed upon within the FWUC and disseminated to all farmer-water users within the Irrigation scheme.
Coordination with other Agencies	• Lack of coordination between PDWRAM and Provincial Agriculture Office to develop a synchronized water distribution and cropping calendars that will be planned together with the FWUCs, the PDWRAM and Provincial Department of Agriculture, Forestry and Fisheries (PDAFF)	• Synchronized Planning of MOWRAM/PDWRAM and FWUC in developing and planning a water distribution and crop production plan. The plan should be reviewed at the end of the year and updated, then disseminated to all farmers and Farmer Water Groups and Sub-Groups at the tertiary and secondary level of the command area. (Refer to Strategy for Agriculture and Water 2010-2013 Output B on Institutional Capacity Building and Human Resource Development and the Implementing Pillars of the Strategy on Food Security, Water Resource Management and Agricultural Land Management and Agriculture Business and Marketing)
Irrigation Infrastructure	• No secondary and tertiary canals to be constructed • FWUCs unable to mobilize resources for development of tertiary and quaternary canals	• Project will construct the secondary and tertiary canals until the tertiary gate and will assist FWUC in planning the quaternary canals. • FWUCs will mobilize resources and continue the construction until the farmers' farm
Private Companies (Chinese, Korean and Individual Agriculture Companies)	• Companies will continue to buy land from small farmers and expand their operations thus getting the maximum benefit from the Project and depriving the small farmers of their source of livelihood. Farmers will continue to sell their lands because of the difficulty in supporting their families when crops are damaged by floods, droughts or pestilence.	• MOWRAM to review the impact of the Private companies and propose regulation on how to protect the small farmers and to ensure that these companies will not be in control of the major Irrigation infrastructure

5.3 Social Risks Assessment and Mitigation Measures

230. The social risks identified in Taing Krasaing Irrigation Scheme and mitigation measures are presented in Table 34.

Table 34: Social Risks Assessment

No	Risks	Taing Krasaing	Mitigation Measures
1	FWUC Organizing will require an assisted process of establishment and strengthening from pre-construction, construction until O&M of the Project.	There is a FWUC in Taing Krasaing Commune organized under the CAVAC. However, this FWUC covers only 1,200 ha with 800 farmers, of the total command area of 9,869 ha. with 11,686 farmers in 4 Communes. Based on meetings held in the project area in May and June 2015, the farmers and the local authorities have shown their interest and commitment to form the FWUC.	PMU should assign specific FWUC Organizers for each Irrigation System. The recommended Process of FWUC Organization is presented in Table 7 below.
2	Presence of Private Companies can pose a risk if they are able to have a control on irrigation infrastructure thus depriving farmers from getting water.	There are several Private Companies within the project command area. Chinese Company in Tipou Commune owning around 350 ha planted with rice, corn, mangoes. Cambodian Company in Tipou Commune with 50 ha planted with rubber. Korean Company at Tipou Commune with 100 ha planted with cassava 4 Private individually owned, around 220 ha planted with rubber (upland portion of Tipou Commune)[29]	MOWRAM and PDWRAM should monitor these Private Companies and have an Agreement with regarding the water delivery, ISF and control of infrastructure. Design of Project should consider this problem, so as not to allow the Private companies to control parts of the irrigation system.
3	Construction of secondary and tertiary canals will require Right-of-Way	Around 71.12 ha will be required: Tipou Commune: 20 ha Chroab : 9.62 ha Korkoah : 41.5 ha	Project design will consider existing water ways and also location between 2 land-owners to distribute and minimize impact on loss of property. Minimize damage to crops by constructing during dry and fallow period. Detailed measurement survey should be conducted to determine losses (land, trees, crops, infrastructure, cultural and religious structures) and include in the Resettlement Plan.
4	Women farmers will not be active in FWUC activities due to low motivation, lack of awareness and capacity	. In the FWUC in Taing Krasaing Commune, it was noted that women's attendance in meetings are high but they don't participate in decision making. Low awareness on the	The Gender Action Plan considers these issues and propose specific activities to address these. (See also Table 8)

[29] Based on interview of PDWRAM Chief of District, 4 June 2015

No	Risks	Taing Krasaing	Mitigation Measures
	and cultural belief that irrigation and water management should involve only the men. Difficulty in mobilizing 40% of women to participated in construction work.	importance of women's participation in Project activities and lack of confidence of women to participate and voice their views during meetings.	

5.4 Assessment of Training for MOWRAM, PDWRAM and PMU

231. Based on the assessment of training in WRMSDP, the training for MOWRAM and PDWRAM will include all personnel at the central and provincial levels. This means that the existing staff who will be involved in the UIWRM project will also be trained. However, only three training modules have been approved for implementation, including training for FWUCs. For the Uplands Irrigation and Water Resources Management Sector Project (UIWRMSP) it is advised that the following training modules be developed and conducted, as enumerated in the Table below. Modules on Project Planning and Management, Climate Change will not be implemented on the assumption that these will already be conducted by WRMSDP.

Table 35: Training Plan for the Project incorporating Training from WRMSDP

WRMSDP Training Plan (Approved)			UIWRMSP Training Plan (Proposed for Project)		
No.	**Training Module**	**Participants**	**No.**	**Training Module**	**Participants**
	For MOWRAM and PDWRAM			For MOWRAM, PDWRAM and other Institutions	
1	General Training on Project Planning and Management, Climate Change Adaptation and Gender Mainstreaming in IWRM	MOWRAM and PDWRAM	1	Project Orientation and Presentation of Project Plans	PMU 2 PDWRAMs in Battambang and Kampong Thom 3 District WRAMs MAFF, MOWA and Local Government at Districts, Communes and Villages = 50 participants
2	Operation and Maintenance	PDWRAM and Selected MOWRAM	2	FWUC Formation and Strengthening	PMU (13) PDWRAMs in Battambang (2) and Kampong Thom (2) 3 District WRAMs (6) = 23 participants
3	On-Farm Water Management and O&M for FWUCs	PDWRAM	3	Gender Awareness and Gender Action Plan	PMU (13) PDWRAMs in Battambang (2) and Kampong Thom (2) 3 District WRAMs (6) = 23 participants
			4	Data Management for Hydro and Meteorological Data and O&M for Meteorological Equipment	PMU (1) Dept of Meteorology (2) Dept of Hydrology and River works (2)

WRMSDP Training Plan (Approved)			UIWRMSP Training Plan (Proposed for Project)		
No.	**Training Module**	**Participants**	**No.**	**Training Module**	**Participants**
					2 PDWRAMs in Battambang and Kampong Thom - Meteorology (2x 4=8) - Hydro (2x4=8) = 21 participants
			5	Financial Management and Accounting System	MOWRAM - PMU Finance (2) - Finance Department (8) 2 PDWRAMs (2x4=8) = 18 participants
			6	Procurement Procedures	MOWRAM (2) PMU (2) = 4 participants
			7	Environmental Awareness	PMU (13) PDWRAMs in Battambang (2) and Kampong Thom (2) 3 District WRAMs (6) = 23 participants
			8	Construction Management and Supervision	MOWRAM (2) PMU (2) 2 PDWRAMs (2) 3 Districts WRAMs (3x2 = 6) = 12 participants
			9	On-Farm Water Management	MOWRAM (2) PMU (2) 2 PDWRAMs - IAD (2x2 = 4) 3 District WRAMS (3x2 = 6) = 14 participants
			10	Operation and Maintenance	PMU (2) 2 PDWRAMs - IAD (2x2 = 4) 3 District WRAMS (3x2 = 6) = 12 participants
				For FWUCs in Preaek Chik and Taing Krasaing Irrigation Schemes	
1	On Farm Water Management and Operation and Maintenance (O&M) for FWUCs		1	Project Orientation and Information Campaign	2 Irrigation Schemes: Preaek Chik (PC) in Battambang and Taing Krasaing (TK) in Kampong Thom provinces 3 Districts 8 Communes 30 Villages = 18,000 farmers
			2	Legal Documents	2 FWUCs (2 x 10 = 20 participants)

WRMSDP Training Plan (Approved)			UIWRMSP Training Plan (Proposed for Project)		
No.	**Training Module**	**Participants**	**No.**	**Training Module**	**Participants**
			3	FWUC General management and Administration	2 FWUCs (2 x 10 = 20 participants)
			4	Operation and Maintenance	2 FWUCs (2 x 10 = 20 participants)
			5	Water Management	2 FWUCs (2 x 10 = 20 participants)
			6	Irrigation Service Fee	2 FWUCs (2 x 10 = 20 participants)
			7	Financial Management	2 FWUCs (2 x 10 = 20 participants)
			8	FWUC Election (procedures, preparation, requirements)	2 FWUCs (2 x 10 = 20 participants)
			9	Gender Training	2 FWUCs (2 x 10 = 20 participants)
			10	Construction Management (Work Arrangement)	2 FWUCs (2 x 10 = 20 participants)
			11	Water Distribution Plan and Cropping Calendar Plan	2 FWUCs (2 x 10 = 20 participants)
			12	Improved Crop Production Practices and Value Chain	2 FWUCs (2 x 10 = 20 participants)

6 FINANCIAL ASSESSMENT

232. The TOR for financial sustainability comprise the following tasks:

i. preparing projections of incremental recurrent costs, including operating and maintenance expenditures required to ensure sustainability of project benefits; and,
ii. undertaking an assessment of the executing and implementing agencies' capacity to fund recurrent costs and financial sustainability of irrigation systems.

233. The PPTA has come up with estimates of incremental recurrent costs which are discussed in the next section. Indicators of the executing agencies' capacity to provide for these include (i) existence of appropriate policies and guidelines which are known to all stakeholders and (ii) appropriate budgetary mechanisms which are in place to ensure that the required O&M funds are planned for, estimated and proposed within a budgetary process.

6.1 Indicative Budget Provision for Taing Krasaing

234. To determine how much is the annual O&M budget which the government needs to provide for, O&M cost was first projected for a 5 year period after the systems are operational. The cost sharing responsibilities (FWUC and PDWRAM) for these are still being defined, so for this exercise it is assumed that the cost responsibility is shared equally by the FWUC and the PDWRAM. This may change depending on government policy that may increase the FWUC share. The estimated average O&M cost per hectare is estimated at KHR 124,181 in 2015 prices increasing to KHR 142,500 in the first year of operation in 2018 as shown in Table 36.

Table 36: Taing Krasaing: Average O&M Cost/ha based on 50:50 cost sharing

	Cost/ha		Cost Sharing	
			PDWRAM	FWUC
Costs in 2015 Prices	$	KHR		
Section 2	224,175			
Section 3	25,728			
Section 4	16,057			
Section 5	37,391			
Subtotal	303,351	1,225,538,040	612,769,020	612,769,020
Total Hectares	9,869			
Average O&M per hectare	31	124,181		
Costs in Current Prices		KHR		
Project Year				
Year 1- 2018		142,500	703,166,545	703,166,545
Year 2 - 2019		147,488	727,777,374	727,777,374
Year 3 - 2020		152,650	753,249,582	753,249,582
Year 4 - 2021		157,992	779,613,317	779,613,317
Year 5 - 2022		163,522	806,899,783	806,899,783

235. The O&M cost per hectare of KHR 124,181 is much higher than the costs of Taing Krasaing due to the following:

- Pumping cost for Section 2 of Taing Krasaing works, there is no pumping for Taing Krasaing
- Stability of soils in Taing Krasaing compared with the highly sandy soil with great permeability and erosive capacity of the soil in Taing Krasaing. As confirmed in the geo technical survey, this type of soil goes through the entire length of the main canal. The survey further confirmed that the last 7 kilometers of the main canal has the characteristic of being of the highest erosive class of soil.

236. The government has identified a subsidy scheme whereby FWUCs would receive a reducing ISF subsidy supplement over the first 5 years of their operation. However, this is not yet set out in the Sub-decree[30]. A practical way for MEF to implement this has not been found and as yet no FWUC has received this government support. MEF and MOWRAM have proposed a new way for providing support through a matching grants scheme. Details of how to bring this scheme into fruition now need to be developed.[31] For this exercise, it is assumed that the subsidy to be provided to the FWUC will equal the required cost share of the FWUC in the O&M costs of a scheme less any amount provided from the ISFs. Any amount that the ISFs cannot cover in the initial years are considered as the subsidy needed and to be provided by the government. Any amount in excess, is considered additional contribution to the recovery of the PDWRAM cost share and will reduce the required budget provision.

237. Since there are no operational FWUCs in Taing Krasaing, it is assumed that at the start of operations, the FWUCs will be able to implement at the very least, ISFs at the current levels of the ISF of the Stung Chinit FWUC which are KHR 60,000 for the farmers and KHR 30,300 for private firms. KHR 60,000 can be the assumed level of willingness to pay for ISF based on the situation in Stung Chinit. Stung Chinit's efforts to increase this to 90,000 was refused by the members and the proposal is still pending more discussion. It is believed that more time to demonstrate the benefits of the improved system and a focused information and awareness program targeting the farmers' perceptions of the need for cost recoverable ISFs to generate an increase in the willingness to pay. Table 37 shows that using the Stung Chinit ISFs, the farmer rates will cover about half of the full O&M costs and almost 100% of the shared cost. The ISF paid by the private firms will cover only 24% of the full O&M costs/ha and about half of the shared costs.

[30] Subdecree on The procedures for the Establishment, Dissolution, Roles and Duties of FWUC

[31] Cambodian National Water Status Report 2014

Table 37: Cost Recovery of Taing Krasaing Irrigation Schemes using Current ISF of Stung Chinit FWUC

		Taing Krasaing	
		Farmers	Private Firms
AT FULL COST (100%)			
A	O&M Cost/ha (KR)	124,180.57	124,180.57
B	ISF (KR)	60,000.00	30,300.00
	($)	14.85	7.50
	% Cost Recovery (B/A)	48%	24%
AT SHARED COST (50%)			
A	O&M Cost/ha (KR)	62,090.28	62,090.28
B	ISF (KR)	60,000.00	30,300.00
	($)	14.85	7.50
	% Cost Recovery (B/A)	97%	49%

238. The base scenario then considers a more conservative picture for ISF rates for the Taing Krasaing farmers starting at KR 60,000 and increasing by 50% to 90,000 in year 3. However for the private parties it is assumed that at the very least, they can immediately implement an ISF equal to that of the farmers.

239. An alternative scenario was developed which assumes that the private firms can increase their contribution to recover full O&M costs within a five year period. This assumption is also pending the review of private firms ISFs as discussed in the previous paragraph and an annual review of cost recovery and financial performance of the Taing Krasaing Irrigation System.

Table 38: Taing Krasaing (Base Scenario) Calculation of O&M Budget Needed

		Year 1 2018 Year 3 of project	Year 2 2019	Year 3 2020	Year 4 2022	Year 5 2023
A	**SURPLUS/(DEFICIENCY TO BE REQUESTED FROM THE GOVERNMENT)**					
	RECEIPTS					
1	ISF Farmers					
	Hectares	7,205	7,205	7,205	7,205	7,205
	ISF/ha	60,000	60,000	90,000	90,000	90,000
	Increase in fees		0%	50%	0%	0%
	Total	432,300,000	432,300,000	648,450,000	648,450,000	648,450,000
2	ISF- Private Parties					
	Hectares	2,664	2,664	2,664	2,664	2,664
	ISF/ha	60,000	60,000	90,000	90,000	90,000
	Increase in fees		0%	50%	0%	0%
	Total	159,840,000	159,840,000	239,760,000	239,760,000	239,760,000
	Total	592,140,000	592,140,000	888,210,000	888,210,000	888,210,000
	O&M EXPENDITURES					
	Share of FWUC Assuming 50:50 cost sharing (a)	703,166,545	727,777,374	753,249,582	779,613,317	806,899,783
	FWUC Surplus/ (Deficiency to be requested from government)	(111,026,545)	(135,637,374)	134,960,418	108,596,683	81,310,217
B	**SUMMARY OF BUDGET TO BE PROVIDED BY THE GOVERNMENT**					
	Share of PDWRAM Assuming 50:50 cost sharing (a)	703,166,545	727,777,374	753,249,582	779,613,317	806,899,783
	FWUC budget					
	Deficiency (to be requested as subsidy, added to budget to be provided by government)	111,026,545	135,637,374			
	(deducted from budget to be requested from			134,960,418	108,596,683	81,310,217
	Total budget requirement	814,193,089	863,414,747	618,289,163	671,016,634	725,589,566

(a) Cost sharing between FWUC and PDWRAM (This may change depending on government policy that may increase FWUC share.)

Table 39: Summary of Scenarios

SCENARIO SUMMARY	Year 1 2018	Year 2 2019	Year 3 2020	Year 4 2022	Year 5 2023
	Year 3 of project				
BASE SCENARIO: PRIVATE PARTIES ISF TO EQUAL FARMERS ISF					
1 Farmers (a)					
Average Annual ISF/ha	60,000	60,000	90,000	90,000	90,000
Average O&M Cost//ha	142,500	147,488	152,650	157,992	163,522
% cost recovery of full costs	42%	41%	59%	57%	55%
% cost recovery of shared cost (50:50	71,250	73,744	76,325	78,996	81,761
	84%	81%	118%	114%	110%
2 Private Parties (b)					
Average Annual ISF/ha	60,000	60,000	90,000	90,000	90,000
Average O&M Cost//ha	142,500	147,488	152,650	157,992	163,522
% cost recovery of full costs	42%	41%	59%	57%	55%
3 Total Budget Requirement (KHR Million)	814.19	863.41	618.29	671.02	725.59
ALTERNATIVE SCENARIO: PRIVATE PARTIES ISF TO COVER FULL COSTS IN 5 YEARS					
1 Farmers (a)					
Average Annual ISF/ha	60,000	60,000	90,000	90,000	90,000
Average O&M Cost//ha	142,500	147,488	152,650	157,992	163,522
% cost recovery of full costs	42%	41%	59%	57%	55%
Amount of shared cost (50:50)	71,250	73,744	76,325	78,996	81,761
% cost recovery of shared cost (50:50	84%	81%	118%	114%	110%
2 Private Parties (b)					
Average Annual ISF/ha	60,000	60,000	150,000	150,000	150,000
Average O&M Cost//ha	142,500	147,488	152,650	157,992	163,522
3 % cost recovery	42%	41%	98%	95%	92%
Total Budget Requirement (KHR Million)	814.19	863.41	458.45	511.18	565.75

(a) Actual ISF to be implemented will be based on a review of ISF and Farmers' perception of services derived, capacity and willingness to pay. Actual ISF adjustments will be based on annual review of cost/financial recovery

(b) Actual ISF to be implemented will be based on a review of nature and volume of water use of private users. Actual ISF adjustments will be based on annual review of cost/financial recovery

6.2 Conclusion for Taing Krasaing

240. The base scenario shows that the Taing Krasaing irrigation systems will require a budget provision of around KHR 814 million in the first year of operation including a subsidy of KHR 111 million for the cost share of the FWUC. From Year 3 onwards, the FWUC will be able to generate surpluses and contribute more to the recovery of the systems, thereby reducing the amount of budget provision needed from the government. The MEF needs to be prepared to provide these

budget requirements in line with the government policy to provide for O&M of irrigation systems. To a large extent, the financial sustainability of the Taing Krasaing irrigation system depends on this.

241. The O&M costs need to be reviewed prior to 2018 and during loan implementation. The updated cost will need to be the basis of the actual ISF to be collected and the recalculation of the budget provision required. Future adjustments will need to be based on an annual review of cost recovery and financial performance of the Taing Krasaing Irrigation System.

242. Increasing cost recovery depends to a large extent on willingness to pay of the farmers and the contribution of the private firms. In the coming years, increasing cost recovery depends to a large extent on increasing ISF collections which in turn depends on willingness to pay of the farmers and the contribution of the private firms. To gradually achieve a state of full cost recovery in the medium to long term, the following are proposed:

1. A focused information and awareness program targeting the farmers' perceptions into the benefits from the irrigation schemes, and the need for cost recoverable ISFs to maximize these benefits. The actual provision of agreed service, yearly planned by season, recorded and assessed on whether it was achieved in joint meetings with PDWRAM - with actions on any failures - and the assistance in production issues to obtain the benefits of the improved system is expected to generate an increase in the willingness to pay.

2. A review of ISF policy needs to be done, particularly in the case of private firms. This review should cover

    (i) an analysis of characteristics of the private firm as a water user in terms of volumes of water needed and their timing based on cropping patterns (e.g. private firms may need more accurately measured volumes and reliable water supplies and may grow different crops at different times),

    (ii) a discussion and agreement – by season – with PDWRAM and FWUC on how and when they would like to draw water from main canal, and at what Operational arrangements this requires,

    (iii) provide a more detailed analysis of the benefits/contribution of the irrigation systems to the private firms,

    (iv) assess jointly the options and ways for water delivery, i.e. for example the possibility of bulk water sales to private firms, and how, when and with what enforcement/sanctions this will be done to allow recovery of investment cost in addition to O&M cost. This should be recorded and signed, providing all necessary details, in order to obtain a fair price for water delivery charges.

(v) Agreement by MEF, MOWRAM, PDWRAM and FWUC on how funds collected from private firms are to be used for what purposes, in view of possibility that this may exceed actual system O&M cost

243. The study can be the basis for MOWRAM to develop policy and guidelines to obtain recorded agreements with the private firms, including agreements on ISFs to be yearly reviewed based on financial performance of the irrigation schemes. Such financial information needs should be accessible and transparent to all stakeholders. This is to be achieved with a sense of urgency. Pending such a review, it is assumed that ISF rates for the private firm will be equal to that of farmers.

7 ECONOMIC ASSESSMENT

244. This report presents the economic analysis undertaken for the subproject. The economic analysis of the subproject investment was undertaken in accordance with the principles and procedures set out in the ADB guidelines.[32] All benefits and costs are examined in order to assess the viability of the subproject as well as to identify its expected impact on various sectors of the local society, including the poor.

245. For this analysis, the costs and benefits within the Taing Krasaing irrigation command area are calculated for two alternative situations: "with the project" and "without the project". In the "without project' scenario, most parts of the command area are not irrigated. The analysis took account of what may be grown on the land without the irrigation system. The intent is to identify the incremental value of production attributable to the project (over its expected useful life) and compare this value to the incremental cost of implementing the subproject and of operating and maintaining the rehabilitated and new infrastructure over time.

246. To develop a model for the analysis, certain assumptions were made regarding future practice (both "with" and "without" the project) and about the valuation of inputs and outputs. These include:

(i) Project life is assumed at 25 years. Assuming adequate maintenance, the irrigation system should be able to maintain its expected benefits for 25 years before another major renovation may be required.
(ii) "Without" the project assumes present cultivation patterns and technology are expected to continue for the life of the project.
(iii) "With" the project, the full command area is expected to continue to be adequately irrigated throughout the life of the project, allowing farmers to adopt appropriate cropping patterns and technology.[33]

[32] Include the *Cost-Benefit Analysis for Development – A Practical Guide (2013);* Guidelines for the Economic Analysis of Projects (1997); *ADB Handbook for the Economic Analysis of Water Supply Projects (1999);* and *Framework for the Economic and Financial Appraisal of Urban Development Sector Projects (1994)*.

[33] It is assumed that whatever changes that will occur in the future (to the economy, climate, etc.) are expected to affect both the "with" and "without" project scenarios equally and maintaining the incremental differences in benefits and costs associated with the project's implementation.

(iv) Some agricultural outputs may be consumed by the farm households, but are valued as if sold.
(v) Some agricultural inputs such as farm labor are provided by the farm household but are valued at the market rate as if hired.
(vi) Values are expressed in constant 2015 prices so as to exclude inflation.
(vii) The U.S. dollar ($) is the unit of account. The exchange rate used is KHR4,040 per U.S. dollar which is the average rate for the last six months prior to the time of this study.

247. Financial prices used in this analysis were determined through field visits conducted by the PPTA team. These prices have been cross-checked with prices identified in other projects and in some secondary sources.

248. In order to assess the Project's contributions (and costs) to the economy of Cambodia it is necessary to convert financial values into their economic equivalents. Economic valuations exclude transfers from one part of society to another (i.e. taxes and subsidies) and compares project benefits and real opportunity costs to the economy by translating all prices into a common, undistorted value. Additional basic assumptions[34] used in the economic analysis include:

(i) The analysis uses the domestic price numeraire and for traded goods a shadow exchange rate factor (SERF) of 1.1 is applied.
(ii) For rural labor, a shadow wage rate factor (SWRF) of 0.9 is applied. The SWRF reflects the productivity of rural labor in the area.
(iii) Transfer payments such as taxes and subsidies are excluded in the calculation of economic values.
(iv) To calculate the economic net present value (ENPV) of the subproject, a discount rate of 12% is used as representing the opportunity cost of the capital invested.

7.1 "Without Project" and "With Project" Situation

249. **"Without Project" Situation**. The Taing Krasaing system is located some 25 km southeast of the city of Kampong Thom and 185 km from Phnom Penh. It was constructed during the period 1975–1978, underwent rehabilitation in 2000 and had some sections improved and modernized in 2005 and 2012. The irrigation system is supplied by a single reservoir from the Taing Krasaing river with levee-type protection on one side only and with non-functional outlet-control gates. The watershed upstream is estimated at some 1,100 km^2. It is linked through a 7-km canal to another system called Stung Chinit located south of the Taing Krasaing system. Stung Chinit, which has a proportionately larger watershed, has more water and thus can be used as supplementary source of water for Taing Krasaing.

250. The main canal of Taing Krasaing runs alongside a wide maintenance road which is relatively in good condition. The road/canal combination runs for some 3 km then makes a 90^o

[34] ADB. 2013. *Report and Recommendation of the President to the Board of Directors: Cambodia Climate Resilient Rice Commercialization Sector Development Program, Linked Document on Economic Analysis*. Manila.

degrees left turn (at a tri-furcation), and runs for another 17 km in a straight line. There are 12 gates/regulators constructed on the main canal, however, no secondary canals are attached to these.

251. Further downstream at approximately 9 km from headworks, there are three primary left off-take gates constructed in 2012, with fully constructed secondary canals attached including flow control structures and tertiary outlets to fields in level condition. Thus, after a considerable stretch of apparent non-irrigation and undeveloped lands, irrigation actually commences and covers about 10,000 ha.

252. Technical verification confirms that the Taing Krasaing system has never really functioned as an irrigation system much served the adjacent communes. Only Taing Krasaing, Kokaoh and part of Chrob are currently planted with paddy rice during wet season. During dry season, only about 400 hectares are planted with other crops such as cassava, corn, water melon, mungbean and pineapple. Flooding problems are experienced in the area caused by local run-off floods and requires cross drainage solutions. Two major breaches with lengths of about 1 to 2 km located on the right embankment need to be resolved. Furthermore, the system has no water-measuring device, no inflow and cropping season records and no budget for operations and maintenance (O&M).

253. **"With Project" Situation.** The proposed improvement is expected to provide water to four communes covering a total area of 9,869 ha. Command area includes the following communes:

Table 40: Taing Krasaing Subproject Command Area

Commune	**Land Ownership**	**Total Area** (hectare)
Tipo (Section 1)	Private companies	2,664
Tipo (Section 2)	Farmer land	2,989
Taing Krasaing	Farmer land	1,370
Chrob	Farmer land	855
Korkoah	Farmer land	1,991
Total		9,869

Source: PPTA Consultant

254. Proposed physical improvements to the system are as follows:

(i) Rehabilitation of headworks (including undersluice and spillway);
(ii) Rehabilitation of 22 km main canal and installation of all structures for water control and distribution;
(iii) Provision of all drainage works to resolve flooding and existing breaches in right embankment of 3 km;
(iv) Construction of 48 km secondary and tertiary canals;
(v) Installation of a pump system and associated distribution channels to lift water by a maximum of 3 meters for area of 2,960 ha of developed rain-fed land.
(vi) Laser land levelling of 2,000 ha land (from ADB financed Rice Commercialization Program).

255. Other components of the subproject includes the following:

i. Installation of Hydro-Met stations in the watersheds for water resources monitoring (to be installed with collaboration of ongoing ADB funded Flood and Drought Risk Management and Mitigation Project)
ii. Provision of training to the PDWRAMs, FWUCs and the appropriate government agencies.
iii. Organization, mobilization and training of FWUCs in the command area.
iv. Involving FWUCs in the subprojects design and supervision of works, and operation and maintenance as per their role and responsibilities defined in the recently approved law – Sub-decree on the Procedures for the Establishment, Dissolution, Role and Duties of FWUC, Royal Government of Cambodia, 12 March 2015.
v. Design joint reservoir operations for Stung Chinit and Taing Krasang Reservoir.

7.2 **Economic Costs**

256. It is estimated that these civil works will have a base cost of $25.5 million. Total cost including project management, construction supervision and detailed engineering design, on-farm preparation and physical contingency will reach $34.6 million. In economic prices the total cost is $31.7 million. Details are shown in the following table:

Table 41: Investment Cost – Taing Krasaing ($)

	Expenditure Category	Total Basic Financial Cost ($) [a]	Breakdown of Total Basic Cost ($)				Total Economic Cost [b]
			Foreign Component	Local Component			
				Materials	Labor		
					Skilled	Unskilled	
1	Main canal and headworks	10,800,172	1,728,028	7,236,115	540,009	1,296,021	9,857,612
2	Section 1 - Tipou 1	-	0	0	0	0	0
3	Section 2 - Tipou 2	5,000,000	800,000	3,350,000	250,000	600,000	4,563,636
4	Section 3 - Cavac TK	-	0	0	0	0	0
5	Section 4 - Chroab	1,297,547	207,608	869,356	64,877	155,706	1,184,307
6	Section 5 - Karkoah	8,372,332	1,339,573	5,609,462	418,617	1,004,680	7,641,656
	SUBTOTAL	25,470,051	4,075,208	17,064,934	1,273,503	3,056,406	23,247,210
7	Project Management/Consulting Services	3,775,000	1,510,000	1,132,500	1,132,500	0	3,569,091
8	Onfarm preparation cost	2,917,500	466,800	1,954,725	145,875	350,100	2,662,882
9	Physical Contingency [c]	2,470,000	395,200	1,654,900	123,500	296,400	2,254,436
	T O T A L	34,632,551	6,447,208	21,807,059	2,675,378	3,702,906	31,733,619

Note [a] Based on May 2015 prices.

[b] Conversion of financial to economic costs was based on the following shadow pricing:

Shadow exchange rate factor (SERF) = *1.1*

Shadow wage rate factor (SWRF) = *0.9*

Taxes and Duties = *10%*

[c] Physical Contingency = *10%*

Source: PPTA Consultant.

257. Based on the technical study, annual routine operation and maintenance (O&M) expenditure for the rehabilitated system is expected to amount to $25 per hectare plus an additional $75 per hectare for the Tipou areas that need pumping. After seven years there will be a need for substantial periodic maintenance expenditures amounting to roughly 30% of the construction cost or about $6.97 million in economic cost. This amount needs to be allocated every seven years thereafter. Both routine and periodic maintenance will be conducted during non-crop periods in order to minimize disruption to crop production while repairs are being done.

258. This irrigation subproject will involve land acquisition of about 34.2 has for the construction of the secondary and tertiary irrigation canals. Whether the required land will be purchased or donated for the use of the project, it has an economic cost due to change in land use. This change is expected to result to loss in agricultural production. For this subproject, the net rice production per hectare for the next 25 years in the without project situation was used as parameter to compute for the economic cost of land. This was included in the subproject resource outflow.

7.3 Economic Benefits

259. The following economic benefits were considered in evaluating the economic viability of the proposed irrigation investments:

260. **Economic value of incremental increase in crop production**. This was determined based on the increased crop production from “without project” to “with project” situations. Two crops were considered: paddy rice as the main crop covering about 90% of the command area and the other 10% allocated for other crops such as cassava, corn, pineapple, mungbean and water melon. The economic value was computed by multiplying the following factors: area of land used in planting (in hectare); cropping intensity (in percentage); average yield (in ton/hectare); and farm gate price of crop (in $/ton). Crop production cost is deducted from the gross production value to derive the net benefit.[35] Incremental benefit is then calculated by deducting the without project situation from the “with project” situation.

261. As discussed, the main economic incremental benefit is the producer surplus. As such, the farmers’ willingness to pay (WTP) serves as an enabling condition for the producer surplus to materialize. The WTP was established based on a series of focus group discussions conducted during the PPTA study. Because there is not yet functional farmer’s water user community in both proposed subproject sites, the PPTA team interviewed the farmers’ groups in another functional irrigation scheme, Stung Chinit[36], financed by ADB, with similar pre-project situation to that of the proposed subprojects. The focus group discussions observed that the current irrigation service fee in Stung Chinit is currently KHR60,000 per hectare per crop. This service fee level can be assumed to be the WTP of irrigation water users since the actual collection having reportedly

[35] This cash flow stream of benefits does change over time in line with the World Bank commodity price projections for rice and major inputs such as fertilizer.

[36] Stung Chinit Irrigation System (SCIS FWUC) is located at Kampong Thom province with coverage area of 2,803 ha. It was established in 2002 and received financial and technical support from ADB and Agence Française de Developpement (AFD). The Stung Chinit project was completed in 2008. Thereafter, it received the strong support from the Irrigation Service Center (ISC), a non-government organization.

been 90%. Based on ADB's experienced in irrigation sector in Cambodia, this fee level together with 90% collection efficiency, operation and maintenance can be carried out reasonably to support the producer surplus to be achieved.

262. **Avoided crop damages due to flooding.** As reported by the farmers and recorded by the District Agriculture Office, severe flood occurrences happen in the area at least once in five years affecting about 70% of crops in 1,590 hectares. Avoided crop damages due to flooding were computed by multiplying the total area affected by flood (in hectares); average rice production (in ton/hectare); economic price of rice ($/ton); number of flooding incidence in five years (number); percentage of crops damaged during flooding incidence (in percentage).

263. Other benefits that were not quantified and valued in the analysis include the following: improved health and nutrition of project beneficiaries; increased water availability for agricultural activities; training of PDWRAMs, FWUC members and other relevant agencies; and more efficient management and monitoring of water resources. Furthermore, the design of a joint reservoir operation for Taing Krasaing and Stung Chinit reservoirs will further provide sustainable supply of water in the command area.

264. Summary of data and parameters used in the valuation of economic benefits are shown in the following table while detailed annual estimates are shown in Tables 23 to 29.

Table 42: Summary of Factors and Parameters Used

Parameter	Value
Command Area	9.869 ha
Without project (2015)	
Cultivated land in wet season (paddy rice)	3,618 ha
Cultivated land in dry season (other crops)	493 ha
Areas affected by severe flooding	1,590 ha
With project, Year 7 (2022)	
Cultivated land in wet season (paddy rice)	9.869 ha
Cultivated land in dry season (rice & other crops)	9.869 ha
Incremental Subproject Output – Paddy Rice	
Without project (2015)	
Yield	1.5 t/ha
Cropping intensity	100%
Farm gate price	$300/t
Production cost	$122/t
With project, Year 7 (2022)	
Yield	3 – 4 t/ha
Cropping intensity	200%
Farm gate price	$387/t
Production cost	$261/t
Incremental Subproject Output – Other Crops	
Without project (2015)	
Yield	14.9 t/ha
Cropping intensity	100%
Farm gate price	$324/t
Production cost	$130/t
With project (year 7 - 2022)	

Parameter	Value
Yield	20.5 t/ha
Cropping intensity	100%
Farm gate price	$324/t
Production cost	$127/t

Sources: UIWRMSP PPTA, Engineering and Irrigation Report (Supplementary Appendix No. 1) and Agriculture Report (Supplementary Appendix No. 3).

7.4 Results of Economic Analysis

265. **Economic Returns.** The main quantifiable benefits of the subproject are the net incremental value of crop production and avoided crop damages due to flooding. Costs are similarly projected with investment costs falling in the first three years followed by annual maintenance expenditures in each subsequent year and periodic maintenance cost every seventh year of operation. To calculate the cash flow of net project economic benefits, the cost cash flow is subtracted from the benefit cash flow. This annual cost and benefit stream is determined to calculate the economic returns of the subproject.

266. The Taing Krasaing irrigation subproject is expected to be economically viable in that the calculated economic internal rate of return (EIRR) is 24.7% and the economic net present value (ENPV) of the investment is $16.4 million (when applying a discount rate of 12%). These strong economic results are due to the substantial size of the economic benefit stream relative to the economic construction cost of $34.6 million or $3,215 per hectare of command area.

267. Variations in the base case scenario were likewise tested to determine the best possible project package and how changes in the technical scope will affect the economic returns. The results indicate that the exclusion of Tipou 1 and Tipou 2 will give a lower EIRR which means that more benefits will be given up with the non-implementation of these two sections. Significantly, the exclusion of Kokaoh shows a higher EIRR indicating that the possible exclusion of this section is actually more beneficial to the area in general. The reasons for the possible variation in technical scope are based on the following circumstances that may possibly happen during implementation:

Table 43: Possible Variations to the Technical Scope of the Base Scenario

Variation	Possible Issues in Implementation	EIRR	NPV
Base Case – inclusion of all sections		22.7%	12.7
Variation 1 – exclusion of Tipou 1	The land in this section is owned by private companies so the Government might decide to bypass this area and prioritize the farmer lands.	13.7%	1.9
Variation 2 – exclusion of Tipou 2	The elevation of this section is higher ranging from 2.5 to 5 meters. There is a need to pump the water to a reservoir in order to bring water to the farmers	14.3%	2.36

Variation	Possible Issues in Implementation	EIRR	NPV
	by gravity. Annual O&M costs are expected to be higher due to pumping costs.		
Variation 3 – exclusion of Kokaoh	There is a resettlement issue in the area. However, the technical proposal is to construct an underground freeflow piped canal to avoid the existing structures in the canal alignment.	24.4%	10.9
Variation 4 – exclusion of Tipou 2 and Kokaoh	Refer to variations 2 and 3.	12.8%	0.5

EIRR = Economic Internal Rate of Return, NPV = Net Present Value
Source: PPTA Consultant.

268. **Sensitivity Analysis.** The reported economic returns of the subproject are based upon the assumption that costs and benefits over the life of the project will be as calculated. The future, of course, may be affected by a number of unforeseen events which can adversely change the expected result. It is useful to examine particular risks and check the impact they may make to the economic returns of the project. Some of these risks include the following:

269. <u>Increase in Investment Cost</u>**:** Care has been taken to accurately estimate the cost of the Taing Krasaing irrigation system. One of the sensitivity tests undertaken involves the possibility of actual cost being higher than the estimated cost. To determine the vulnerability of economic returns to higher construction costs, a 10% increase in costs was included in the estimation. This cost increase causes the EIRR to fall to 20.2%, a decline of 2.5% from the base EIRR. The sensitivity indicator for this level of cost increase is 1.58, while the level of increase at which the EIRR would fall below the acceptable 12% level (the switching value)[37] is at 63%.

270. <u>Increase in O&M cost</u>**:** Similar to investment costs, the possibility of O&M costs increasing than what was estimated may occur in the future. A test of the impact of a 10% increase in costs was done to determine how vulnerable the resulting EIRR to such an increase. The cost increase causes a very insignificant change in EIRR with a sensitivity factor of 0.23 and switching value of 434%.

271. <u>Decrease in Overall Benefits</u>**:** An overall decline in total benefits by 10% was also tested defining no particular factor. With this general assumption, EIRR would fall to 19.5%, still above the required 12% threshold level. Sensitivity factor is -3.11 and switching value is -32%.

272. <u>Decrease in Command Area</u>**:** If the benefitted area of the Taing Krasaing system were not to reach its anticipated level of 9,869 ha, the economic returns can be expected to decrease from the base-case level. A 10% decrease in the command area drops the EIRR to 21.5% and ENPV to $10.9 million.

[37] The switching value is the percent change in the risk variable that will make the EIRR fall to the level of the opportunity cost of capital (which is assumed to be 12%).

273. Decrease in Cropping Intensity**:** With available irrigation water, cropping intensity is expected to increase in the "with project" situation. However, in case this decreases by 10%, EIRR would decrease to 18.1% and ENPV to $7.0 million.

274. Decrease in Yield Increment: The average paddy rice yield when progressing from rainfed to irrigation water has been assumed to increase from 1.5 t/ha to 4 t/ha. If this increment were to decrease by 10%, the EIRR would drop to 20.7% and ENPV to $9.8 million.

275. Increase in Price of Crops: Rice prices are assumed to change over time along the lines predicted by the World Bank commodity price projections. Any drop in prices can affect future cash flow and project returns can be expected to fall. A 10% drop in price of paddy rice and other crops causes the EIRR to fall to 12.7% and ENPV to $0.8 million.

276. Benefits delayed by two years: Any delay in implementation schedule can impact on the benefits materializing for target beneficiaries. An assumed two-year delay will decrease EIRR and ENPV to 14.5% and $3.9 million, respectively.

277. Decrease in cultivated area: If the cultivated area were to decrease by 10% from the base-case level, EIRR will decrease to 20.9%. The sensitivity factor is at -1.4 while the switching value is at -73%.

278. Decrease in project life: The project is originally assumed at 25 years but if this will decrease to say 5 years, then EIRR drops to 10.0% which is below the assumed opportunity cost of 12%.

279. Decrease in cultivated area and project life: A simultaneous change in cultivated area and project life will adversely affect the result, dropping the EIRR to 6.7% which is below the assumed opportunity cost of 12%.

280. The level of economic returns, along with the results of the sensitivity analysis of various risks, indicates that the Taing Krasaing subproject investment is likely to pay for itself. However, a decrease in the project life puts EIRR below 12%, more so if this will be combined with other risks mentioned above.

Table 44: Summary Results of Base Case and Sensitivity Tests

Results of Evaluation	Change	NPV	EIRR	Sensitivity Indicator	Switching Value
Base Case		12.7	22.7%		
Sensitivity Scenarios					
Case 1 - Increase in Capital Costs	10%	10.7	20.2%	1.6	63%
Case 2 - Increase in O&M Costs	10%	12.4	22.4%	0.2	434%
Case 3 - Decrease in overall benefit	-10%	8.7	19.5%	-3.1	-32%
Case 4 - Decrease in command area	-10%	10.9	21.5%	-1.4	-71%
Case 5 - Decrease in cropping intensity	-10%	7.0	18.1%	-4.4	-23%
Case 6 - Decrease in yield increment	-10%	9.8	20.7%	-2.3	-44%
Case 7 - Decrease in price of rice	-10%	0.8	12.7%	-9.4	-11%
Case 8 - Decrease in cultivated area	-10%	10.9	20.9%	-1.4	-73%
Case 9 - Decrease in project life (no. of years)	5	(0.9)	10.0%		
Case 10 - Combination of cases 8 & 9		(2.5)	6.7%		
Case 11 - Benefits delay by 2 years		3.9	14.5%		

SI = sensitivity indicator (ratio of % change in IRR above the cut-off rate to percentage change in selected variable)
SV = switching value (percentage change in selected variable to reduce the IRR to cut-off rate).
Source: PPTA Consultant.

7.5 Financial Household Returns

281. As an impact of the project, it was estimated that farmer households in Taing Krasaing will gain a significant increase in their net revenue from paddy rice production of about $658/farmer household/year based on an average landholding of 1.5 hectares.

282. Without the project, the farmer households are getting a yield of 1.5 tons/hectare at average farm gate price of $300/ton. This gives a farmer household an average net annual revenue of $360 or $30 per month.[38] With the implementation of the project, the yield is projected to increase to 3 tons/ha. Average farm gate price of paddy rice is likewise expected to increase to $500/ton with the use of good quality seeds. Based on the average landholding, the projected average net annual revenue of farmer households is $1.018 or $85 per month.

283. Furthermore, starting at year seven of the subproject, an estimated 181,870 incremental labor days valued at $0.91 million will be required annually in the production of paddy rice and other crops.

7.6 Benefit Distribution and Poverty Impacts

284. The subproject will directly benefit 11,686 farmers in four communes in Santuk District where the Taing Krasaing irrigation system is located. It will directly affect 91% of the population that derive their main income from rice and vegetable crops. Poverty finds its roots on this source of income because of its dependence on a lot of factors (irrigation, agriculture inputs and technology, efficient water management, sufficiency of water at the source, type of soil, weather

[38] UIWRMSP PPTA Report on Poverty and Socio-Economic Condition (Appendix 12).

condition) thus providing insufficient opportunity for farmers to have sufficient and stable income to meet their needs. The main factors that cause poverty which are identified by the people in the project areas are the poor soil condition, lack of water in the canal for irrigation of crops during the dry season, people do not use the appropriate agriculture technologies, and lack of job opportunities in the locality.[39]

285. The implementation of the project will try to tackle these factors that cause poverty by enhancing agricultural and rural economic productivity through increased efficiency of irrigation systems and improved management of water resources. The subproject will help decrease the poverty rates in the four communes which range from 24% to 39%.[40]

286. Project sustainability is strongly affected by who benefits, and by how much, relative to who pays. Main beneficiary groups or stakeholders for this subproject are identified as the government, local economy, labor sector and the farmers. The distribution of the economic benefits and costs over and above financial revenues and expenses are estimated to determine the extent to which public investment policy can affect the share that the various sectors derive from the project. The following table on benefit distribution shows the result of this analysis:

[39] Focus Group Discussion (FGD) conducted in Taining Krasaing and Preaek Chik

[40] Ministry of Planning. 2012. Poverty Reduction by Capital, Provinces, Municipalities, Districts, Khans and Communes, Sangkat. Phnom Penh.

Table 45: Distribution of Economic Benefits

	Financial Present Value	Economic Present Value	Economic minus Financial	Government	Economy	Labor	Farmers
Total Project Benefits	1.5	43.6	42.1				42.1
Project Costs							
Traded	2.0	2.7	0.8		(0.8)		
Unskilled labor	1.8	1.6	(0.2)			0.2	
Non-traded	11.5	9.5	(1.9)		1.9		
Total Project Costs	15.2	13.9					
Net Benefits (Losses)	(13.7)	29.7	43.4	(13.7)			
Benefits (Losses)				(13.7)	1.1	0.2	42.1

Source: PPTA Consultant.

287. Another analysis was undertaken to determine the impact of the subproject to the poor sector of the community. The particular focus on net benefits that go to the poor is pertinent in this agricultural project. Computed poverty impact ratio (PIR) for this subproject is 30%. Details are presented in the following table:

Table 46: Poverty Impact

Particulars	Gov't. / Economy	Labor	Community	Total
Benefits (Losses)	1.13	0.24	42.06	43.43
Financial Return to Governmen	(13.72)			(13.72)
Total Benefits (Losses)	(12.58)	0.24	42.06	29.71
Proportion of Poor (%)	0.30	0.67	0.30	
Benefits to Poor	(3.73)	0.16	12.48	8.90
Poverty Impact Ratio (%)				30.0%

7.7 Conclusion

288. The proposed Taing Krasaing irrigation system is expected to make important contributions to the local economy, increasing paddy production and household income significantly. The scheme is economically viable. It will also play a role in the commercialization of rice production. Its expected 52,166 tons per year of incremental paddy production will almost certainly all be marketed given that the local population already has more than enough for its own consumption. Similarly, crop diversification has high potentials for other crops such as cassava, corn, mungbean, pineapple and watermelon have high potentials and will provide good production value to the farmers.

Table 47: Economic Price Estimates for Internationally Traded Outputs (Rice)

		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Rice Paddy												
Thailand (current $) [a]	$/t	415	411	408	404	401	397	394	390	387	383	380
Thailand (constant 2010 $) [a]	$/t	393	382	373	364	355	346	338	329	321	313	305
MUV (2010 = 1.0) [b]	2010	1.06	1.08	1.09	1.11	1.13	1.15	1.17	1.19	1.21	1.23	1.25
MUV (2015 = 1.0) [b]	2015	1.00	1.02	1.04	1.05	1.07	1.09	1.10	1.12	1.14	1.16	1.18
Rice FOB Bangkok (constant 2015 $)	$/t	415	404	394	384	375	366	357	348	339	330	322
Quality Adjustment [c]	$/t	332	323	315	307	300	293	285	278	271	264	258
Freight, insurance, etc.	$/t	60	60	60	60	60	60	60	60	60	60	60
CIF Sihanoukville	$/t	272	263	255	247	240	233	225	218	211	204	198
Freight & handling Sihanoukville to project area	$/t	24	24	24	24	24	24	24	24	24	24	24
Conversion to paddy [d]	$/t	149	144	139	134	130	125	121	117	112	108	104
Milling charge net of bran and husks	$/t	0	0	0	0	0	0	0	0	0	0	0
Handling and transport farm to mill [e]	$/t	6	6	6	6	6	6	6	6	6	6	6
Economic farmgate price per ton	$/t	143	138	133	128	124	120	115	111	107	103	99
Economic farmgate price per kg	$/kg	0.14	0.14	0.13	0.13	0.12	0.12	0.12	0.11	0.11	0.10	0.10
Financial - Non-fragrant variety	$/t	300	289	279	269	260	250	241	232	224	215	207
Economic - Non-fragrant variety	$/t	330	318	307	296	285	275	266	256	246	237	227
Financial - Fragrant variety	$/t	500	481	464	448	433	417	402	387	373	358	344
Economic - Fragrant variety	$/t	550	529	511	493	476	459	443	426	410	394	379

[a] WB Commodity Price Projections prepared January 22, 2015 for 2013 through 2025. (Thailand, 5% broken, white rice, milled, fob Bangkok)

[b] Manufacturing Unit Value Index

[c] Adjustment for quality relative to the standard of Thai white rice, 5% broken = 20%

[d] Standard conversion factor (SCF) applied on half the amount of handling, transportation and milling = 0.9

[e] Conversion factor of paddy to rice = 60%

Table 48: Economic Price Estimates for Internationally Traded Inputs (Urea)

		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Urea												
Eastern Europe (current $) [a]	$/t	300	298	296	294	292	290	288	286	284	282	280
Eastern Europe (constant 2010 $) [a]	$/t	284	277	270	264	258	253	247	241	236	230	225
MUV (2010 = 1.0) [b]	2010	1.06	1.08	1.09	1.11	1.13	1.15	1.17	1.19	1.21	1.23	1.25
MUV (2015 = 1.0) [b]	2015	1.00	1.02	1.04	1.05	1.07	1.09	1.10	1.12	1.14	1.16	1.18
Urea FOB Eastern Europe (constant 2015 $)	$/t	300	292	286	279	273	267	261	255	249	243	237
Freight, insurance, etc.	$/t	60	60	60	60	60	60	60	60	60	60	60
CIF Sihanoukville	$/t	360	352	346	339	333	327	321	315	309	303	297
Freight & handling Sihanoukville to project area	$/t	24	24	24	24	24	24	24	24	24	24	24
Handling and transport to farmgate [c]	$/t	6	6	6	6	6	6	6	6	6	6	6
Economic farmgate price per ton	$/t	389	382	375	369	362	356	350	344	338	332	327
Economic farmgate price per kg	$/t	0.39	0.38	0.38	0.37	0.36	0.36	0.35	0.34	0.34	0.33	0.33

[a] WB Commodity Price Projections prepared January 22, 2015 for 2013 through 2025. (Bagged, f.o.b. Eastern Europe (varying origins)

[b] Manufacturing Unit Value Index

[c] Standard conversion factor (SCF) applied on half of handling and transportation cost = 0.9

Table 49: Economic Price Estimates for Internationally Traded Inputs (DAP)

		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
DAP (diammonium phosphate)												
US (current $) [a]	$/t	450	449	448	447	446	445	444	443	442	441	440
US (constant 2010 $) [a]	$/t	426	417	409	402	395	388	381	374	367	360	353
MUV (2010 = 1.0) [b]	2010	1.06	1.08	1.09	1.11	1.13	1.15	1.17	1.19	1.21	1.23	1.25
MUV (2015 = 1.0) [b]	2015	1.00	1.02	1.04	1.05	1.07	1.09	1.10	1.12	1.14	1.16	1.18
DAP FOB US Gulf (constant 2015 $)	$/t	450	441	433	425	417	410	402	395	388	380	373
Freight, insurance, etc.	$/t	60	60	60	60	60	60	60	60	60	60	60
CIF Sihanoukville	$/t	510	501	493	485	477	470	462	455	448	440	433
Freight & handling Sihanoukville to project area	$/t	24	24	24	24	24	24	24	24	24	24	24
Handling and transport to farmgate [c]	$/t	6	6	6	6	6	6	6	6	6	6	6
Economic farmgate price per ton	$/t	539	530	522	514	507	499	492	484	477	470	462
Economic farmgate price per kg	$/t	0.54	0.53	0.52	0.51	0.51	0.50	0.49	0.48	0.48	0.47	0.46

[a] WB Commodity Price Projections prepared January 22, 2015 for 2013 through 2025. (Standard size, bulk, spot, f.o.b. US Gulf)

[b] Manufacturing Unit Value Index

[c] Standard conversion factor (SCF) applied on half the amount of handling & transportation = 0.9

Table 50: Command Area Land Use With and Without the Project: Taing Krasaing, Kampong Thom Province

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2030	2040
Land Area (has.)												
By Commune												
Tipou 1	2,664	2,664	2,664	2,664	2,664	2,664	2,664	2,664	2,664	2,664	2,664	2,664
Tipou 2	2,989	2,989	2,989	2,989	2,989	2,989	2,989	2,989	2,989	2,989	2,989	2,989
Cavac Taing Krasaing	1,370	1,370	1,370	1,370	1,370	1,370	1,370	1,370	1,370	1,370	1,370	1,370
Chroab	855	855	855	855	855	855	855	855	855	855	855	855
Korkoah	1,991	1,991	1,991	1,991	1,991	1,991	1,991	1,991	1,991	1,991	1,991	1,991
Subtotal	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869
By Cultivated Crop												
Paddy Rice	8,882	8,882	8,882	8,882	8,882	8,882	8,882	8,882	8,882	8,882	8,882	8,882
Other Crops	987	987	987	987	987	987	987	987	987	987	987	987
Subtotal	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869
Command Area Land Use (has.)												
Without project												
Wet Season												
Paddy Rice	3,618	3,618	3,618	3,618	3,618	3,618	3,618	3,618	3,618	3,618	3,618	3,618
Fallow	6,252	6,252	6,252	6,252	6,252	6,252	6,252	6,252	6,252	6,252	6,252	6,252
Subtotal	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869
Dry Season												
Paddy Rice	-	-	-	-	-	-	-	-	-	-	-	-
Other Crops	493	493	493	493	493	493	493	493	493	493	493	493
Fallow	9,376	9,376	9,376	9,376	9,376	9,376	9,376	9,376	9,376	9,376	9,376	9,376
Subtotal	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869
With project												
Wet Season												
Paddy Rice	3,618	3,618	3,618	8,882	8,882	8,882	8,882	8,882	8,882	8,882	8,882	8,882
Fallow	6,252	6,252	6,252	987	987	987	987	987	987	987	987	987
Subtotal	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869
Dry Season												
Paddy Rice	-	-	-	1,962	5,651	6,899	8,403	8,882	8,882	8,882	8,882	8,882
Other Crops	493	493	493	395	592	790	987	987	987	987	987	987
Fallow	9,376	9,376	9,376	7,513	3,626	2,181	480	-	-	-	-	-
Subtotal	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869

Table 51: Crop Yield and Intensity – With and Without the Project: Taing Krasaing, Kampong Thom Province

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2030	2040
Crop Yield (t/ha)												
Without project												
Wet Season												
Paddy Rice	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Dry Season												
Paddy Rice	-	-	-	-	-	-	-	-	-	-	-	-
Other Crops	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9
With project												
Wet Season												
Paddy Rice	1.5	1.5	1.8	2.1	2.4	2.4	2.7	3.0	3.0	3.0	3.0	3.0
Dry Season												
Paddy Rice	-	-	2.5	2.5	3.2	3.2	4.0	4.0	4.0	4.0	4.0	4.0
Other Crops	14.9	14.9	14.9	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5
Cropping Intensity (%)												
Without project												
Wet Season												
Paddy Rice	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Dry Season												
Paddy Rice	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Other Crops	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
With project												
Wet Season												
Paddy Rice	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Dry Season												
Paddy Rice			100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Other Crops	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table 52: Crop Production Volume (in ton) and Value ($ million) Without and With Project: Taing Krasaing, Kampong Thom Province

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2030	2040
Total Crop Production (tons)												
Without project												
Wet Season												
Paddy Rice	5,426	5,426	5,426	5,426	5,426	5,426	5,426	5,426	5,426	5,426	5,426	5,426
Dry Season												
Paddy Rice	-	-	-	-	-	-	-	-	-	-	-	-
Other Crops	7,333	7,333	7,333	7,333	7,333	7,333	7,333	7,333	7,333	7,333	7,333	7,333
With project												
Wet Season												
Paddy Rice	5,426	5,426	6,512	18,652	21,317	21,317	23,982	26,646	26,646	26,646	26,646	26,646
Dry Season												
Paddy Rice	-	-	-	4,904	18,082	22,075	33,610	35,528	35,528	35,528	35,528	35,528
Other Crops	7,333	7,333	7,333	8,093	12,139	16,185	20,231	20,231	20,231	20,231	20,231	20,231
Economic Farmgate Price ($/ton)												
Rice												
Without project	289	279	269	260	250	241	232	224	215	207	207	207
With project	481	464	448	433	417	402	387	373	358	344	344	344
Other crops	324	324	324	324	324	324	324	324	324	324	324	324
Gross Crop Production ($ mil)												
Without project												
Wet Season												
Paddy Rice	1.57	1.51	1.46	1.41	1.36	1.31	1.26	1.21	1.17	1.12	1.12	1.12
Dry Season												
Paddy Rice	-	-	-	-	-	-	-	-	-	-	-	-
Other Crops	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38
With project												
Wet Season												
Paddy Rice	1.57	1.51	2.92	8.07	8.90	8.58	9.29	9.93	9.55	9.17	9.17	9.17
Dry Season												
Paddy Rice	-	-	-	2.12	7.55	8.88	13.02	13.24	12.73	12.23	12.23	12.23
Other Crops	2.38	2.38	2.38	2.62	3.93	5.24	6.55	6.55	6.55	6.55	6.55	6.55

Table 53: Incremental Crop Production – With and Without the Project: Taing Krasaing, Kampong Thom Province

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2030	2040
Production Cost ($ mil)												
Without project												
Wet Season												
Paddy Rice	0.68	0.68	0.68	0.67	0.67	0.67	0.67	0.66	0.66	0.66	0.66	0.66
Dry Season												
Paddy Rice	-	-	-	-	-	-	-	-	-	-	-	-
Other Crops	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
With project												
Wet Season												
Paddy Rice	0.68	0.68	1.71	4.89	5.58	5.58	6.27	6.96	6.95	6.95	6.95	6.95
Dry Season												
Paddy Rice	-	-	-	1.29	4.74	5.78	8.79	9.28	9.27	9.26	9.26	9.26
Other Crops	0.93	0.93	0.93	1.03	1.54	2.05	2.57	2.57	2.57	2.57	2.57	2.57
Net Value of Crop Production ($ mil)												
Without project												
Wet Season												
Paddy Rice	0.89	0.83	0.78	0.74	0.69	0.64	0.60	0.55	0.51	0.46	0.46	0.46
Dry Season												
Paddy Rice	-	-	-	-	-	-	-	-	-	-	-	-
Other Crops	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42
With project												
Wet Season												
Paddy Rice	0.89	0.83	1.21	3.18	3.31	3.00	3.02	2.97	2.60	2.22	2.22	2.22
Dry Season												
Paddy Rice	-	-	-	0.84	2.81	3.10	4.23	3.96	3.46	2.97	2.97	2.97
Other Crops	1.45	1.45	1.45	1.59	2.39	3.19	3.99	3.99	3.99	3.99	3.99	3.99
Incremental Value of Net Crop Production ($ mil)												
Wet Season												
Paddy Rice	-	-	0.43	2.44	2.62	2.35	2.42	2.42	2.09	1.76	1.76	1.76
Dry Season												
Paddy Rice	-	-	-	0.84	2.81	3.10	4.23	3.96	3.46	2.97	2.97	2.97
Other Crops	0.02	0.02	0.02	0.17	0.97	1.77	2.56	2.56	2.56	2.56	2.56	2.56
Total	0.02	0.02	0.45	3.45	6.40	7.23	9.22	8.95	8.11	7.29	7.29	7.29

Table 54: Benefit Savings from Avoided Flood Damages: Taing Krasaing, Kampong Thom Province

				2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2040
Flooded Area														
Flooding incidence -	once in	5	years	5	5	5	5	5	5	5	5	5	5	5
Area affected (has.)		1,590		1,590	1590	1590	1590	1590	1590	1590	1590	1590	1590	1590
Ave. rice production per hectare (t/ha)		1.5		1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Economic price of rice per ton ($/t)				289	279	269	260	250	241	232	224	215	207	207
Economic price of rice per hectare ($/ha)				433	418	403	389	376	362	349	335	323	310	310
Percentage of rice damaged by flood		70%		70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%
Total crop production lost ($)				482,055	465,211	449,076	433,295	418,047	402,975	388,081	373,365	359,003	344,818	344,818
Annual crop production lost ($ mil)				0.10	0.09	0.09	0.09	0.08	0.08	0.08	0.07	0.07	0.07	0.07

Table 55: Economic Opportunity Cost of Land: Taing Krasaing, Kampong Thom Province

		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2040
Economic opportunity cost of land												
Total area required (has.)	34.2	14.3	34.2	34.2	34.2	34.2	34.2	34.2	34.2	34.2	34.2	34.2
Ave. rice production without project (t/ha)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Economic price of rice per ton ($/t)		289	279	269	260	250	241	232	224	215	207	207
Economic price of rice per hectare ($/ha)		433	418	403	389	376	362	349	335	323	310	310
Total crop production lost ($ mil)		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Table 56: Result of Economic Evaluation: Taing Krasaing, Kampong Thom Province ($ million)

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2030	2040
Costs												
Investment cost	1.59	3.17	3.17	7.93	11.11	4.76	-	-	-	-	-	-
Regular O&M cost	-	-	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
Periodic maintenance cost	-	-	-	-	-	-	-	-	-	6.97	-	-
Opportunity cost of land	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Total Costs	1.59	3.19	3.66	8.42	11.59	5.25	0.49	0.49	0.49	7.46	0.49	0.49
Benefits												
Increased production from farmlands	0.02	0.02	0.45	3.45	6.40	7.23	9.22	8.95	8.11	7.29	7.29	7.29
Savings from flood damages	-	-	0.09	0.09	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.07
Total Benefits	0.02	0.02	0.54	3.54	6.49	7.31	9.30	9.02	8.19	7.36	7.36	7.36
Net Cash Flow (Base Case)	(1.57)	(3.17)	(3.12)	(4.89)	(5.11)	2.06	8.81	8.54	7.70	(0.10)	6.88	6.88
Sensitivity Tests:												
Case 1 - Increase in Capital Costs	(1.73)	(3.48)	(3.44)	(5.68)	(6.22)	1.58	8.81	8.54	7.70	(0.10)	6.88	6.88
Case 2 - Increase in O&M Costs	(1.57)	(3.17)	(3.17)	(4.93)	(5.16)	2.01	8.77	8.49	7.65	(0.15)	6.83	6.83
Case 3 - Decrease in overall benefit	(1.57)	(3.17)	(3.18)	(5.24)	(5.76)	1.33	7.88	7.63	6.88	(0.83)	6.14	6.14
Case 4 - Decrease in command area	(1.57)	(3.17)	(3.05)	(4.83)	(5.14)	1.95	8.62	7.94	7.15	(0.60)	6.37	6.37
Case 5 - Decrease in cropping intensity	(1.57)	(3.17)	(3.39)	(5.45)	(5.96)	1.13	7.69	7.44	6.70	(1.02)	5.69	5.69
Case 6 - Decrease in yield increment	(1.57)	(3.17)	(3.12)	(5.04)	(5.35)	1.74	8.41	8.14	7.30	(0.50)	5.96	5.96
Case 7 - Decrease in price of rice	(1.57)	(3.16)	(3.28)	(5.80)	(6.78)	0.15	6.28	5.91	5.16	(2.55)	4.42	4.42
Case 8 - Decrease in cultivated area	(1.57)	(3.17)	(3.25)	(5.30)	(5.82)	1.27	8.23	8.38	7.58	(0.18)	6.80	6.80
Case 9 - Decrease in project life (no. of years)	(1.57)	(3.17)	(3.12)	(4.89)	(5.11)	2.06	8.81	8.54	7.70	(0.10)		
Case 10 - Combination of cases 8 & 9	(1.57)	(3.17)	(3.25)	(5.30)	(5.82)	1.27	8.23	8.38	7.58	(0.18)		
Case 11 - Benefits delay by 2 years	(1.59)	(3.19)	(3.66)	(8.42)	(11.06)	(1.71)	6.00	6.82	8.81	1.56	6.88	6.88

Results of Evaluation	Change	NPV	EIRR	Sensitivity Indicator	Switching Value
Base Case		12.7	22.7%		
Sensitivity Scenarios					
Case 1 - Increase in Capital Costs	10%	10.7	20.2%	1.6	63%
Case 2 - Increase in O&M Costs	10%	12.4	22.4%	0.2	434%
Case 3 - Decrease in overall benefit	-10%	8.7	19.5%	-3.1	-32%
Case 4 - Decrease in command area	-10%	10.9	21.5%	-1.4	-71%
Case 5 - Decrease in cropping intensity	-10%	7.0	18.1%	-4.4	-23%
Case 6 - Decrease in yield increment	-10%	9.8	20.7%	-2.3	-44%
Case 7 - Decrease in price of rice	-10%	0.8	12.7%	-9.4	-11%
Case 8 - Decrease in cultivated area	-10%	10.9	20.9%	-1.4	-73%
Case 9 - Decrease in project life (no. of years)	5	(0.9)	10.0%		
Case 10 - Combination of cases 8 & 9		(2.5)	6.7%		
Case 11 - Benefits delay by 2 years		3.9	14.5%		

SI = sensitivity indicator (ratio of % change in IRR above the cut-off rate to percentage change in selected variable).
SV = switching value (percentage change in selected variable to reduce the IRR to cut-off rate).

8 IMPLEMENTATION ARRANGEMENTS

8.1 Execution and Implementation

289. The executing agency for implementation of the Project is the Ministry of Water Resources and Meteorology (MOWRAM) which has the overall mandate in the management of water resources and meteorology. Within the MOWRAM is the Farmer Water User Community (FWUC) Department responsible for the over-all supervision of the Project. Under the Department of FWUC is the Project Management Unit (PMU) which was established by virtue of a Ministerial Letter No. 034DM-WRM dated 8 January 2014. It is headed by a Project Director who is the Deputy Director General for Technical Affairs and a Project Manager who is the Director of the Department of FWUC. It is composed of 13 designated personnel responsible for the over-all project implementation, planning, organization, monitoring and coordination of the various Project activities. It will coordinate with relevant Departments of MOWRAM and with other government Ministries at the central, provincial, district and commune levels, and with relevant Civil Society Organizations and Non-Government Organizations. It will work closely with the Project Management Implementation Consultants (PMIC) in the day-to-day operation of the Project. The PMIC will provide Technical Support to the PMU and will ensure that the PMU will be able to efficiently manage and implement the Project activities. At the Provincial level, the Provincial Department of Water Resources and Meteorology (PDWRAM) will be the arm of the PMU in coordinating with relevant Government Agencies and NGOs/CSOs. It will be responsible in the establishment and strengthening of Farmer Water User Communities (FWUC) at the Project level. The organizational structure shows the Project Management arrangement (Table 57). The Project management roles and responsibilities are presented as follows:

Table 57: PIO Management Roles and Responsibilities

Project Implementation Organizations	Management Roles and Responsibilities
Ministry of Water Resources and Meteorology (MOWRAM)	**Executing Agency** Provides policy guidance to the Project
Department of FWUC in MOWRAM	**Implementing Agency** Over-all supervision of the Project
Project Management Unit (PMU)	**Overall project management, planning, organization and implementation.** Coordinates with ADB, AFD and with relevant government agencies and non-government organizations. Oversees Project planning, construction, operation and maintenance.

Project Implementation Organizations	Management Roles and Responsibilities
	Supervise and monitor the implementation of construction packages **Monitors project implementation and prepares Reports for submission to MOWRAM**
Project Management Implementation Consultants (PMIC)	Provide Technical Support to the PMU and guides the project implementation
Provincial Department of Water Resources and Meteorology (PDWRAM)	**Implementing arm of the PMU at the field level.** Supervises the establishment and strengthening of the FWUCs at the Irrigation system level Implements construction
Farmer Water User Communities (FWUC)	**Manage and operate the irrigation system at the** Secondary and Tertiary level in close coordination with the PDWRAM. Represent the interest of the Project Beneficiaries and coordinate closely with the PDWRAM and PMU regarding project implementation at project level.

290. Described below is the proposed involvement of the various Institutions in the Project Implementation Development Process which will be implemented in Prek Chik Irrigation System in Battambang province and the Taing Krasaing Irrigation System in Kampong Thom province.

Table 58: Institutional Roles in Project Activities

No.	PROJECT PROCESS AND ACTIVITIES	GOVERNMENT INSTITUTIONS	FWUC
1	SURVEY AND INVESTIGATION • Ocular Investigation • Conduct Survey (Topographic)	MOWRAM and PDWRAM	
	• Information Campaign	PMU conducts information campaign	• Farmers and water users are informed about the Project
		PMU coordinates with the Local Government and forms Membership Committee composed of 2-3 key farmers	• Start membership recruitment • Land and Membership Registration
	• System Walkthrough to identify the condition of the irrigation structures	PMU/PDWRAM/District initiates system walkthrough	• Farmers participate in system walkthrough

No.	PROJECT PROCESS AND ACTIVITIES	GOVERNMENT INSTITUTIONS	FWUC
3	DESIGN • Prepare Project Plans • Prepare Detailed Design • Present Detailed Design	PMU prepares Project Plans and Designs and presents this to the FWUC	• Formation of Farmer Water Users Group/sub-Group (FWUG/FWUSG) based on Tertiary Blocks • Election of FWUC Committee • Formulation of FWUC Statutes • Registration of FWUC
	• Final approval of Design		• Participates in the Final Approval of the Project Design
	• Memorandum of Agreement	PMU prepares the MOA and organizes MOA signing MOWRAM signs the MOA with FWUC	• FWUC signs the MOA with the approval of 2/3 of the members
	• Organizational Management Training	PMU conducts the Organizational Management Training	• FWUC participates in the Training
4	CONSTRUCTION • Construction Arrangements - Hiring of local laborers - Laborers are 40% women - Construction Schedule and location	PMU specifies construction arrangements and discuss these with Contractors. These become conditionality in the Contract such as the hiring of unskilled labor in the locality and at least 40% are women.	• FWUC identifies local workers • Coordinate with Contractors • Monitor Construction work • Discuss issues with PDWRAM and Contractors
5	OPERATION • Formulation of water distribution plan • Information to water users on water delivery schedule • Gate operation	PMU develops water distribution plan together with FWUC based on cropping calendar and water availability PMU finalizes the water delivery schedule with the FWUC	FWUC jointly develops the water distribution plan and agrees on the cropping calendar FWUC disseminates water distribution plan and schedule of water delivery to all farmers and water users
	• Formulation of the Cropping Calendar	PMU coordinates with the Provincial and District Agriculture Office on the cropping plan and the availability of the non-water agro-inputs (seeds, fertilizers, pesticide, herbicide, machinery)	FWUC will work closely with the PMU and the District Agriculture Office in the preparation of the Cropping Calendar. FWUC/FWUGs will participate in preparing cropping calendar plan

No.	PROJECT PROCESS AND ACTIVITIES	GOVERNMENT INSTITUTIONS	FWUC
		Cropping Calendar will be explained and disseminated to farmer water users	and disseminates this to farmers and water users
6	MAINTENANCE • Formulation of Maintenance Plan • Implement maintenance plan	PMU develops a maintenance plan for the Headworks and Main Canal and prepares a Maintenance Budget Monitor implementation of maintenance plan	FWUC prepares a maintenance plan for the secondary and tertiary canals and prepares maintenance Budget Implements maintenance plan

Table 59: Project Implementation Plan

Activities	Year 0				Year 1				Year 2				Year 3				Year 4				Year 5				Year 6			
	Qtr				Qtr				Qtr				Qtr				Qtr				Qtr				Qtr			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
A. DMF																												
Output 1: Enhanced efficiency and climate resilience of irrigation systems.																												
Activity 1.A Phase 1 Rehabilitation/Construction of Taing Krasaing and Taing Krasaing irrigation systems																												
Taing KS																												
Taing Krasaing																												
Activity 1.B Phase 2 Preparation of feasibility study for the additional 8 systems candidates included in the long-list, to cover an additional 10,000 ha in Taing Krasaing – Phase 2																												
Activity 1.C Increased focus and associated training in Joint Reservoir Operations in both core subprojects, to improve on water sharing and water scheduling arrangements between linked systems.																												

Activities	Year 0				Year 1				Year 2				Year 3				Year 4				Year 5				Year 6			
	Qtr				Qtr				Qtr				Qtr				Qtr				Qtr				Qtr			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Output 2 Improved water resource management.																												
Activity 2.1 Supply and installation of Hydro-Met stations for water resources monitoring (assisted by the ADB Flood and Drought Management Project)																												
Activity 2.2 Provision of training to the PDWRAM, FWUCs and the appropriate government agencies on Watershed Management, including planning for implementation.																												
Activity 2.3 Organization, mobilization and training of FWUCs in the command area (supported by the ADB Water Resources Development and Management Sector Project)																												
Output 3 Improved project management.																												
B. Management Activities																												
Consultant selection procedures																												
Mobilization of PIMC																												

Activities	**Year 0**				**Year 1**				**Year 2**				**Year 3**				**Year 4**				**Year 5**				**Year 6**			
	Qtr				Qtr				Qtr				Qtr				Qtr				Qtr				Qtr			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Procurement plan key activities to procure contract packages- EOI, RFP																												
Mobilization of Civil Works Contractors																												
Environment management plan key activities																												
Gender action plan key activities																												
Communication strategy key activities																												
Annual/Mid-term review																												
Project completion report																												

Appendix 8: ECONOMIC AND FINANCIAL ANALYSIS

A. Introduction

1. The Uplands Irrigation and Water Resources Management Sector Project will enhance agricultural and rural economic productivity through increased efficiency of irrigation systems and improved management of water resources in uplands, areas away from the Tonle Sap Lake, in Kampong Thom and Battambang provinces.

2. Water is the key input to agricultural production, productivity increase and economic growth. Rainfall distribution and river discharges have significant seasonal variability in Cambodia thus adversely affecting sustained agriculture production and increasing vulnerability. Climate change is likely to further exacerbate the situation. Timely availability of water and its efficient management is of prime importance to agriculture productivity and for diversifying agriculture and rural economy. Improving agricultural productivity, diversification, and managing irrigation systems and water resources are among major thrusts of the Government's National Strategy: Rectangular Strategy on Growth, Employment, Equity and Efficiency.[1] The ADB's Country Partnership Strategy also focuses on inclusive economic growth through physical infrastructure, agriculture and irrigation, among others.[2]

B. Methodology

3. This report presents the economic analysis undertaken for the subproject. The economic analysis of the subproject investment was undertaken in accordance with the principles and procedures set out in the ADB guidelines[3]. All benefits and costs are examined in order to assess the viability of the subproject as well as to identify its expected impact on various sectors of the local society, including the poor. For this analysis the costs and benefits within the Prek Chik and Taing Krasaing irrigation command area are calculated for two alternative situations: "with" the project and "without" the project. In the "without" project scenario most of the command areas are not irrigated. The analysis took account of what may be grown on the land "without" the irrigation system. The intent is to identify the incremental value of production attributable to the project (over its expected useful life) and compare this value to the incremental cost of implementing the project and of operating and maintaining the rehabilitated and new infrastructure over time.

4. To develop a model for the analysis, certain assumptions were made regarding future practice (both "with" and "without" the Project) and about the valuation of inputs and outputs. These include:

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[1] Royal Government of Cambodia Ministry of Planning. 2014. *National Strategic Development Plan 2014-2018*. Phnom Penh.

[2] Asian Development Bank. 2013. *Country Partnership Strategy for Cambodia, 2014-2018.* Manila.

[3] Include the *Cost-Benefit Analysis for Development – A Practical Guide (2013);* Guidelines for the Economic Analysis of Projects (1997); *ADB Handbook for the Economic Analysis of Water Supply Projects (1999);* and *Framework for the Economic and Financial Appraisal of Urban Development Sector Projects (1994)*.

(i) Project life is assumed at 25 years. Assuming adequate maintenance, the irrigation system should be able to maintain its expected benefits for 25 years before another major renovation may be required.
(ii) "Without" the project assumes present cultivation patterns and technology are expected to continue for the life of the project.
(iii) "With" the project, the full command area is expected to be adequately irrigated throughout the life of the project, allowing farmers to adopt appropriate cropping patterns and technology. [4]
(iv) Some agricultural outputs may be consumed by the farm households, but are valued as if sold.
(v) Some agricultural inputs such as farm labor are provided by the farm household but are valued at the market rate as if hired.
(vi) Values are expressed in constant 2015 prices so as to exclude inflation.
(vii) The US dollar ($) is the unit of account. The exchange rate used is KR 4,040 per US dollar which is the average rate for the last six months prior to the time of this study.

5. Financial prices used in this analysis were determined through field visits conducted by the PPTA team. These prices have been cross-checked with prices identified in other projects and in some secondary sources.

6. In order to assess the subprojects' contributions (and costs) to the economy of Cambodia it is necessary to convert financial values into their economic equivalents. Economic valuations exclude transfers from one part of society to another (i.e. taxes and subsidies) and compares project benefits and real opportunity costs to the economy by translating all prices into a common, undistorted value. Additional basic assumptions[5] used in the economic analysis include:
(i) The analysis uses the domestic price numeraire and for traded goods a shadow exchange rate factor (SERF) of 1.1 is applied.
(ii) For rural labor, a shadow wage rate factor (SWRF) of 0.9 is applied. The SWRF reflects the productivity of rural labor in the area.
(iii) Transfer payments such as taxes and subsidies are excluded in the calculation of economic values.
(iv) To calculate the economic net present value (ENPV) of the subproject, a discount rate of 12 percent is used as representing the opportunity cost of the capital invested.

C. Existing Situation

7. **Prek Chik.** The Prek Chik system is located some 72 kms from the city of Battambang and 297 kms from Phnom Penh. Construction of the Prek Chik canal was started in 1977. It was still unfinished when construction work ceased in the latter part of 1978. After the country was liberated in 1979, the partly finished canal was left unutilized until some minor repairs were made in 2003. Major rehabilitation work was done in 2010 with funding from the Japanese Government to bring the canal into operation. This construction was completed in 2012. Current

[4] It is assumed that whatever changes that will occur in the future (to the economy, climate, etc.) are expected to affect the "with" and "without" project scenarios roughly equally --- maintaining the incremental differences in benefits and costs associated with the project's implementation.
[5] ADB. 2013. *Report and Recommendation of the President to the Board of Directors: Cambodia Climate Resilient Rice Commercialization Sector Development Program, Linked Document on Economic Analysis*. Manila.

rehabilitation work is focused on the main canal and its irrigation structures. The reported potential command area is about 20,000 hectares. However, the current area of wet season rice grown with supplemental irrigation is just about 2,500 hectares while the current dry season paddy cultivation is only about 30 hectares. Currently, all dry season irrigation is in ‘Prek Chik commune which is on the upstream reach of the irrigation system.

8. Water availability from Bassac Reservoir which has been undergoing gate repairs is a major issue. Flood problems from local run-off require cross-drainage solution. Over the whole right side of the main canal, the lack of drainage facilities passing under the canal has resulted to the main canal being used as drainage through inlets constructed specifically to llow flood and drainage waters during medium to high intensity storms to enter the canal. The main canal becomes in fat the major relief drain to discharge flood waters downstream through off-takes.

9. The system has no water measuring device, inflow records, cropping season duration and no budget allocation from the Government.

10. **Taing Krasaing**. The Taing Krasaing system is located some 25 kms southeast of the city of Kampong Thom and 185 kms from Phnom Penh. It was constructed during the period 1975-1978, underwent rehabilitation in 2000 and had some sections improved and modernized in 2005 and 2012. The irrigation system is supplied by a single reservoir from the Taing Krasaing river with levee-type protection on one side only and with non-functional outlet-control gates. The watershed upstream is estimated at some 1,100 km^2. It is linked through a 7-km canal to another system called Stung Chinit located south of the Taing Krasaing system. Stung Chinit, which has a proportionately larger watershed, has more water and thus can be used as supplementary source of water for Taing Krasaing.

11. The main canal of Taing Krasaing runs alongside a wide maintenance road which is relatively in good condition. The road/canal combination runs for some 3 kms then makes a 90^o degrees left turn (at a tri-furcation), and runs for another 17 kms in a straight line. There are 12 gates/regulators constructed on the main canal, however, no secondary canals are attached to these.

12. Further downstream at approximately 9 kms from headworks, there are 3 primary left off-take gates constructed in 2012, with fully constructed secondary canals attached including flow control structures and tertiary outlets to fields in level condition. Thus, after a considerable stretch of apparent non-irrigation and undeveloped lands, irrigation actually commences and covers about 10,000 has.

13. Technical verification confirms that the Taing Krasaing system has never really functioned as an irrigation system much served the adjacent communes. Only Taing Krasaing, Korkoah and part of Chrob are currently planted during wet season. During dry season, only about 400 ha are planted by other crops. Flooding problems are experienced in the area caused by local run-off floods and requires cross drainage solutions. Two major breaches with lengths of about 1 to 2 kms located on the right embankment needs to be resolved. Furthermore, the system has no water-measuring device, no inflow and cropping season records and no budget for operations and maintenance (O&M).

D. Proposed Subprojects

14. **Prek Chik.** The proposed improvement is expected to provide water to four communes covering a total area of 8,346 hectares or about 80% of the command area of 10,432 hectares. Proposed physical improvements to the system are as follows:

(i) Rehabilitation of headworks (including raising of spillway by 1.5 meters)
(ii) Rehabilitation of 28 kms Main Canal and installation of all structures for water control and distribution, and provision of all drainage works
(iii) Secondary and Tertiary Canals - Part 1 – for a length of 70.2 km, to be able to cover 10,400 ha of net irrigated lands in Phase I.

15. **Taing Krasaing.** The proposed improvement is expected to provide water to four communes covering a total area of 9,869 has. The proposed physical improvements to the system are as follows:

(i) Rehabilitation of headworks (including undersluice and spillway);
(ii) Rehabilitation of 22 kms main canal and installation of all structures for water control and distribution;
(iii) Provision of all drainage works to resolve flooding and existing breaches in right embankment of 3 kms;
(iv) Construction of 48 kms secondary and tertiary canals;
(v) Installation of a pump system and associated distribution channels to lift water by a maximum of 3 meters for area of 2960 ha of developed rain-fed land.

16. Other components for the two subprojects include the following:

(i) Installation of Hydro-Met stations in the watersheds for water resources monitoring (to be installed with collaboration of ongoing ADB funded Flood and Drought Risk Management and Mitigation Project)
(ii) Provision of training to the PDWRAMs, farmer water user communes (FWUCs) and the appropriate government agencies.
(iii) Organization, mobilization and training of FWUCs in the command area.
(iv) Involving FWUCs in the subprojects design and supervision of works, and operation and maintenance as per their role and responsibilities defined in the recently approved law – Sub-decree on the Procedures for the Establishment, Dissolution, Role and Duties of FWUC, Royal Government of Cambodia, 12 March 2015.
(v) Design joint reservoir operations for Stung Chinit and Taing Krasang Reservoir in Kampong Thom province and Dauntri and Bassac Reservoir in Battabang province.

E. Subproject Benefits

17. The following economic benefits were considered in evaluating the economic viability of the proposed irrigation investments:

18. **Economic value of incremental increase in crop production**. This was determined based on the increased crop production from “without project” to “with project” situations. Two crops were considered: paddy rice as the main crop covering about 90% of the command area and the other 10% allocated for other crops such as cassava, corn, pineapple, mungbean and water melon. The economic value was computed by multiplying the following factors: area of land used in planting (in hectare); cropping intensity (in percentage); average yield (in ton/hectare); and farm gate price of crop (in $/ton). Crop production cost is deducted from the

gross production value to derive the net benefit.[6] Incremental benefit is then calculated by deducting the "without project" situation from the "with project" situation.

19. As discussed, the main economic incremental benefit is the producer surplus. As such, the farmers' willingness to pay (WTP) serves as an enabling condition for the producer surplus to materialize. The WTP was established based on a series of focus group discussions conducted during the PPTA study. Because there is not yet functional farmer's water user community in both proposed subproject sites, the PPTA team interviewed the farmers' groups in another functional irrigation scheme, Stung Chinit[7], financed by ADB, with similar pre-project situation to that of the proposed subprojects. The focus group discussions observed that the current irrigation service fee in Stung Chinit is currently KHR60,000 per hectare per crop. This service fee level can be assumed to be the WTP of irrigation water users since the actual collection having reportedly been 90%. Based on ADB's experienced in irrigation sector in Cambodia, this fee level together with 90% collection efficiency, operation and maintenance can be carried out reasonably to support the producer surplus to be achieved.

20. **Avoided flood crop damages.** As reported by the farmers, severe flood occurrences happen in the area at least once in five years. These were computed by multiplying the total area affected by flood (in hectare); average rice production (in ton/hectare); economic price of rice ($/ton); number of flooding incidence in five years (number); percentage of crops damaged during flooding incidence (in percentage).

21. Other benefits that were not quantified and valued in the analysis include the following: improved health and nutrition of project beneficiaries; increased water availability for agricultural activities; training of PDWRAMs, FWUC members and other relevant agencies; and more efficient management and monitoring of water resources. Furthermore, the design of joint reservoir operations for Taing Krasaing and Stung Chinit reservoirs in Kampong Thom and Dauntri and Bassac reservoirs in Battambang will further provide sustainable supply of water in the command areas.

22. Summary of data and parameters used in the valuation of economic benefits are shown in the following table:

Table 2: Summary of Factors and Parameters Used

Parameter	Prek Chik	Taing Krasaing
Command Area	10,432 ha	9.869 ha
Without project (2015)		
Cultivated land in wet season (rice)	7,302 ha	3,618 ha
Cultivated land in dry season (other crops)	522 ha	493 ha
Areas affected by severe flooding	256 ha	1,590 ha
With project (year 7 - 2022)		
Cultivated land in wet season (rice)	7,302 ha	9.869 ha
Cultivated land in dry season (other crops)	1.043 ha	9.869 ha
Incremental Subproject Output – Rice		
Without project (2015)		

[6] This cash flow stream of benefits does change over time in line with the World Bank commodity price projections for rice and major inputs such as fertilizer.

[7] Stung Chinit Irrigation System (SCIS FWUC) is located at Kampong Thom province with coverage area of 2,803 ha. It was established in 2002 and received financial and technical support from ADB and Agence Française de Developpement (AFD). The Stung Chinit project was completed in 2008. Thereafter, it received the strong support from the Irrigation Service Center (ISC), a non-government organization.

Parameter	Prek Chik	Taing Krasaing
Yield	1.8 t/ha	1.5 t/ha
Cropping intensity	70%	100%
Farm gate price	$300/t	$300/t
Production cost	$122/t	$122/t
With project (year 7 - 2022)		
Yield	5 t/ha	3 – 4 t/ha
Cropping intensity	70%	200%
Farm gate price	$395/t	$387/t
Production cost	$132/t	$261/t
Incremental Subproject Output – Other Crops		
Without project (2015)		
Yield	15 t/ha	14.9 t/ha
Cropping intensity	10%	10%
Farm gate price	$324/t	$324/t
Production cost	$130/t	$130/t
With project (year 7 - 2022)		
Yield	21 t/ha	20.5 t/ha
Cropping intensity	10%	10%
Farm gate price	$324/t	$324/t
Production cost	$127/t	$127/t

F. Subproject Costs

23. **Prek Chik**. It is estimated that the civil works will cost $16.0 million. Total cost including project management, construction supervision and design, on-farm preparation and physical contingency will amount to $25.4 million. In economic prices the total cost is $23.3 million.

24. **Taing Krasaing**. The civil works base cost of the subproject rehabilitation is estimated at $25.5 million. Total cost including contingencies as well as construction supervision and design, project management and on-farm preparation will reach $34.6 million. In economic prices the total cost is $31.7 million.

25. **O&M Costs.** Based on the technical study, annual operation and maintenance (O&M) expenditure for the rehabilitated system is expected to amount to $25 per hectare plus an additional $75 per hectare for the areas in Taing Krasaing that need pumping. After seven years there will be a need for substantial periodic maintenance expenditures --- amounting to roughly 30% of the construction cost or about $4.38 million and $ 6.97 million in economic costs for Prek Chik and Taing Krasaing, respectively. These amounts will be allocated every seven years thereafter. Both regular and periodic maintenance activities will be conducted during non-crop periods in order to minimize disruption to crop production while repairs are being done.

26. **Economic Cost of Land.** The irrigation subprojects will involve land acquisition for the construction of the secondary and tertiary irrigation canals of about 81 hectares in Prey Chik and 34 hectares in Taing Krasaing. Whether the required land will be purchased or donated for the use of the project, it has an economic cost due to change in land use. This change will in turn result to lost in agricultural production. For the two subprojects, the net rice production per hectare in the without project situation was used as parameter to compute for the economic cost of land.

G. Economic Returns

27. **Prek Chik.** The Prek Chik irrigation subproject is expected to be economically viable in that the calculated economic internal rate of return (EIRR) is 24.0% and the economic net present value (ENPV) of the investment is $9.5 million at the economic discount rate of 12%.

28. **Taing Krasaing.** The Taing Krasaing irrigation subproject is expected to be economically viable in that the calculated economic internal rate of return (EIRR) is 22.7% and the economic net present value (ENPV) of the investment is $12.7 million (when applying a discount rate of 12%).

29. For both subprojects, sensitivity tests for EIRR suggest that the economic analyses are overall highly robust, i.e., all EIRR being in the range of 18.5-23.8% for Prey Chik and 12.7-22.4% for Taing Krasaing when tested with foreseeable and probable risks such as 10% increase each in capital cost and O&M costs; 10% reduction each in overall benefits, command area, cropping intensity, yield increment, price of rice, and actually cultivated area; and delays of benefits by 2 years.

30. As part of project risk management strategy, two extreme cases are also tested, i.e., a five-year decrease in project economic life, and a combination of a five-year decrease in project economic life and a ten-percent reduction in cultivated areas. It is observed that the EIRRs of both subprojects are in the range of 5.4-11.4%, suggesting that good operation and maintenance is the key to the project’s sustainability and hence must be emphasized and planned well with all stakeholders right from the inception mission of the project.

H. Financial Household Returns

31. **Prek Chik.** As an impact of the project, it was estimated that farmer households in Prey Chik will gain a significant increase in their net revenue from paddy rice production of about $2,812/farmer household/year based on an average landholding of 2 hectares.

32. Furthermore, starting at year seven of the subproject, an estimated 116,525 incremental labor days valued at $0.58 million will be required annually in the production of paddy rice and other crops.

33. **Taing Krasaing.** It was estimated that farmer households in Taing Krasaing will gain a significant increase in their net revenue from paddy rice production of about $658/farmer household/year based on an average landholding of 1.5 hectares.

34. Furthermore, starting at year seven of the subproject, an estimated 181,870 incremental labor days valued at $0.91 million will be required annually in the production of paddy rice and other crops.

I. Distribution of Net Economic Benefits and Poverty Impacts

35. **Prek Chik**. The subproject will directly affect the 91% of the population that derive their main income from rice and vegetable crops. The Project will help decrease the poverty rates in communes covered within the project area which ranges from 23.5% to 34.5%. The distribution of the economic benefits and costs over and above financial revenues and expenses are estimated to determine the extent to which public investment policy can affect the share that the

various sectors derive from the project. The following table on benefit distribution shows the result of this analysis:

Table 5: Distribution of Economic Benefits

	Financial Present Value	Economic Present Value	Economic minus Financial	Government	Economy	Labor	Farmers
Total Project Benefits	0.47	31.40	30.93				30.93
Project Costs							
Traded	2.28	2.00	(0.28)		0.28		
Unskilled labor	2.21	1.07	(1.14)			1.14	
Non-traded	13.91	6.59	(7.32)		7.32		
Total Project Costs	18.40	9.66					
Net Benefits (Losses)	(17.93)	21.74	39.66	(17.93)			
Benefits (Losses)				(17.93)	7.60	1.14	30.93

36. Computed poverty impact ratio (PIR) for this subproject is 30.8%. Details are presented in the following table:

Table 6: Poverty Impact

Particulars	Gov't. / Economy	Labor	Community	Total
Benefits (Losses)	7.60	1.14	30.93	39.66
Financial Return to Governme	(17.93)			(17.93)
Total Benefits (Losses)	(10.33)	1.14	30.93	21.74
Proportion of Poor (%)	0.29	0.67	0.29	
Benefits to Poor	(2.98)	0.76	8.92	6.70
Poverty Impact Ratio (%)				30.8%

37. **Taing Krasaing.** In Taing Krasaing, around 83% of the total population of the four communes are farmers. The project will help decrease the poverty rates in communes covered within the project area which ranges from 24% to 39%. The distribution of the economic benefits and costs over and above financial revenues and expenses are estimated to determine the extent to which public investment policy can affect the share that the various sectors derive from the project. The following table on benefit distribution shows the result of this analysis:

Table 6: Distribution of Economic Benefits

	Financial Present Value	Economic Present Value	Economic minus Financial	Government	Economy	Labor	Farmers
Total Project Benefits	1.5	43.6	42.1				42.1
Project Costs							
Traded	2.0	2.7	0.8		(0.8)		
Unskilled labor	1.8	1.6	(0.2)			0.2	
Non-traded	11.5	9.5	(1.9)		1.9		
Total Project Costs	15.2	13.9					
Net Benefits (Losses)	(13.7)	29.7	43.4	(13.7)			
Benefits (Losses)				(13.7)	1.1	0.2	42.1

Source: PPTA Consultant.

38. Computed poverty impact ratio (PIR) for this subproject is 30%. Details are presented in the following table:

Table 7: Poverty Impact

Particulars	Gov't. / Economy	Labor	Community	Total
Benefits (Losses)	1.13	0.24	42.06	43.43
Financial Return to Government	(13.72)			(13.72)
Total Benefits (Losses)	(12.58)	0.24	42.06	29.71
Proportion of Poor (%)	0.30	0.67	0.30	
Benefits to Poor	(3.73)	0.16	12.48	8.90
Poverty Impact Ratio (%)				30.0%

J. Conclusion

39. The proposed irrigation systems in both Prek Chik and Taing Krasaing are expected to make important contributions to the local economy, increasing paddy production and household income significantly. The schemes are economically viable. They will also play a role in the commercialization of rice production. The expected incremental paddy rice production in Prek Chik of 19,508 tons per year and 52,166 tons per year for Taing Krasaing will almost certainly all be marketed given that the local population already has more than enough for their own consumption. Similarly, crop diversification for other crops such as cassava, corn, mungbean, pineapple and watermelon have high potentials and will provide good production value to the farmers.[8]

[8] Detailed analysis supporting the economic and financial analysis is in Supplementary Document 18: Detailed Economic and Financial Analysis and associated MS-Excel models available upon request.

Table 8: Result of Economic Evaluation: Prek Chik, Battambang Province ($ million)

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2030	2040
Costs												
Investment Costs	1.16	2.33	2.33	5.82	8.15	3.49	-	-	-	-	-	-
O&M Costs	-	-	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
Periodic Maintenance	-	-	-	-	-	-	-	-	-	4.38	-	-
Opportunity cost of land	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Total Costs	1.21	2.37	2.63	6.12	8.45	3.79	0.29	0.29	0.29	4.67	0.29	0.29
Benefits												
Increased production from farmlands	-	-	1.80	3.64	4.18	4.63	6.16	5.80	5.45	5.11	5.11	5.11
Savings from flood damages	-	-	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Total Benefits	-	-	1.82	3.65	4.19	4.64	6.17	5.81	5.47	5.12	5.12	5.12
Net Cash Flow (Base Case)	(1.21)	(2.37)	(0.81)	(2.47)	(4.25)	0.85	5.88	5.52	5.17	0.45	4.83	4.83
Sensitivity Tests:												
Case 1 - Increase in Capital Costs	(1.32)	(2.60)	(1.05)	(3.05)	(5.07)	0.51	5.88	5.52	5.17	0.45	4.83	4.83
Case 2 - Increase in O&M Costs	(1.21)	(2.37)	(0.84)	(2.49)	(4.28)	0.83	5.85	5.50	5.15	0.42	4.80	4.80
Case 3 - Decrease in overall benefit	(1.21)	(2.37)	(0.99)	(2.83)	(4.67)	0.39	5.26	4.94	4.63	(0.06)	4.32	4.32
Case 4 - Decrease in command area	(1.21)	(2.37)	(0.81)	(2.59)	(4.37)	0.73	5.76	5.40	5.05	0.33	4.71	4.71
Case 5 - Decrease in cropping intensity	(1.21)	(2.37)	(1.12)	(2.95)	(4.78)	0.29	5.17	4.86	4.56	(0.12)	4.26	4.26
Case 6 - Decrease in yield increment	(1.21)	(2.37)	(0.81)	(2.89)	(4.68)	0.43	4.87	4.56	4.26	(0.42)	3.55	3.55
Case 7 - Decrease in price of rice	(1.20)	(2.36)	(1.02)	(2.96)	(4.83)	0.20	4.96	4.64	4.33	(0.36)	4.02	4.02
Case 8 - Decrease in cultivated area	(1.21)	(2.37)	(0.99)	(2.83)	(4.67)	0.39	5.26	4.94	4.63	(0.06)	4.32	4.32
Case 9 - Decrease in project life (no. of years)	(1.21)	(2.37)	(0.81)	(2.47)	(4.25)	0.85	5.88	5.52	5.17	0.45		
Case 10 - Combination of cases 8 & 9	(1.21)	(2.37)	(0.99)	(2.83)	(4.67)	0.39	5.26	4.94	4.63	(0.06)		
Case 11 - Benefits delay by 2 years	(1.21)	(2.37)	(2.63)	(6.12)	(6.63)	(0.14)	3.90	4.35	5.88	1.14	4.83	4.83

Results of Evaluation	Change	NPV	EIRR	Sensitivity Indicator	Switching Value
Base Case		9.5	24.0%		
Sensitivity Scenarios					
Case 1 - Increase in Capital Costs	10%	8.0	21.2%	1.5	65%
Case 2 - Increase in O&M Costs	10%	9.3	23.8%	0.2	586%
Case 3 - Decrease in overall benefit	-10%	6.6	20.4%	-3.0	-33%
Case 4 - Decrease in command area	-10%	8.8	23.2%	-0.7	-144%
Case 5 - Decrease in cropping intensity	-10%	6.1	19.7%	-3.5	-28%
Case 6 - Decrease in yield increment	-10%	4.6	18.5%	-5.1	-19%
Case 7 - Decrease in price of rice	-10%	5.3	18.8%	-4.5	-22%
Case 8 - Decrease in cultivated area	-10%	6.6	20.4%	-3.0	-34%
Case 9 - Decrease in project life (no. of years)	5	(0.2)	11.4%		
Case 10 - Combination of cases 8 & 9		(1.9)	5.4%		
Case 11 - Benefits delay by 2 years		3.2	14.9%		

SI = sensitivity indicator (ratio of percentage change in IRR above 12% to percentage change in selected variable).
SV = switching value (percentage change in selected variable to reduce the IRR to cut-off rate).
Source: PPTA Consultant.

Table 9: Result of Economic Evaluation: Taing Krasaing, Kampong Thom Province ($ million)

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2030	2040
Costs												
Investment cost	1.59	3.17	3.17	7.93	11.11	4.76	-	-	-	-	-	-
Regular O&M cost	-	-	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
Periodic maintenance cost	-	-	-	-	-	-	-	-	-	6.97	-	-
Opportunity cost of land	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Total Costs	1.59	3.19	3.66	8.42	11.59	5.25	0.49	0.49	0.49	7.46	0.49	0.49
Benefits												
Increased production from farmlands	0.02	0.02	0.45	3.45	6.40	7.23	9.22	8.95	8.11	7.29	7.29	7.29
Savings from flood damages	-	-	0.09	0.09	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.07
Total Benefits	0.02	0.02	0.54	3.54	6.49	7.31	9.30	9.02	8.19	7.36	7.36	7.36
Net Cash Flow (Base Case)	(1.57)	(3.17)	(3.12)	(4.89)	(5.11)	2.06	8.81	8.54	7.70	(0.10)	6.88	6.88
Sensitivity Tests:												
Case 1 - Increase in Capital Costs	(1.73)	(3.48)	(3.44)	(5.68)	(6.22)	1.58	8.81	8.54	7.70	(0.10)	6.88	6.88
Case 2 - Increase in O&M Costs	(1.57)	(3.17)	(3.17)	(4.93)	(5.16)	2.01	8.77	8.49	7.65	(0.15)	6.83	6.83
Case 3 - Decrease in overall benefit	(1.57)	(3.17)	(3.18)	(5.24)	(5.76)	1.33	7.88	7.63	6.88	(0.83)	6.14	6.14
Case 4 - Decrease in command area	(1.57)	(3.17)	(3.05)	(4.83)	(5.14)	1.95	8.62	7.94	7.15	(0.60)	6.37	6.37
Case 5 - Decrease in cropping intensity	(1.57)	(3.17)	(3.39)	(5.45)	(5.96)	1.13	7.69	7.44	6.70	(1.02)	5.69	5.69
Case 6 - Decrease in yield increment	(1.57)	(3.17)	(3.12)	(5.04)	(5.35)	1.74	8.41	8.14	7.30	(0.50)	5.96	5.96
Case 7 - Decrease in price of rice	(1.57)	(3.16)	(3.28)	(5.80)	(6.78)	0.15	6.28	5.91	5.16	(2.55)	4.42	4.42
Case 8 - Decrease in cultivated area	(1.57)	(3.17)	(3.25)	(5.30)	(5.82)	1.27	8.23	8.38	7.58	(0.18)	6.80	6.80
Case 9 - Decrease in project life (no. of years)	(1.57)	(3.17)	(3.12)	(4.89)	(5.11)	2.06	8.81	8.54	7.70	(0.10)		
Case 10 - Combination of cases 8 & 9	(1.57)	(3.17)	(3.25)	(5.30)	(5.82)	1.27	8.23	8.38	7.58	(0.18)		
Case 11 - Benefits delay by 2 years	(1.59)	(3.19)	(3.66)	(8.42)	(11.06)	(1.71)	6.00	6.82	8.81	1.56	6.88	6.88

Results of Evaluation	Change	NPV	EIRR	Sensitivity Indicator	Switching Value
Base Case		12.7	22.7%		
Sensitivity Scenarios					
Case 1 - Increase in Capital Costs	10%	10.7	20.2%	1.6	63%
Case 2 - Increase in O&M Costs	10%	12.4	22.4%	0.2	434%
Case 3 - Decrease in overall benefit	-10%	8.7	19.5%	-3.1	-32%
Case 4 - Decrease in command area	-10%	10.9	21.5%	-1.4	-71%
Case 5 - Decrease in cropping intensity	-10%	7.0	18.1%	-4.4	-23%
Case 6 - Decrease in yield increment	-10%	9.8	20.7%	-2.3	-44%
Case 7 - Decrease in price of rice	-10%	0.8	12.7%	-9.4	-11%
Case 8 - Decrease in cultivated area	-10%	10.9	20.9%	-1.4	-73%
Case 9 - Decrease in project life (no. of years)	5	(0.9)	10.0%		
Case 10 - Combination of cases 8 & 9		(2.5)	6.7%		
Case 11 - Benefits delay by 2 years		3.9	14.5%		

SI = sensitivity indicator (ratio of % change in IRR above the cut-off rate to percentage change in selected variable).
SV = switching value (percentage change in selected variable to reduce the IRR to cut-off rate).

Appendix 9: DETAILED ECONOMIC AND FINANCIAL ANALYSIS (PREK CHIK AND TAING KRASAING IRRIGATION SYSTEMS)

I. PREK CHIK SUBPROJECT

A. Introduction

1. The Uplands Irrigation and Water Resources Management Sector Project will enhance agricultural and rural economic productivity through increased efficiency of irrigation systems and improved management of water resources in uplands, areas away from the Tonle Sap Lake, in Battambang and Battambang provinces.

2. Water is the key input to agricultural production, productivity increase and economic growth. Rainfall distribution and river discharges have significant seasonal variability in Cambodia thus adversely affecting sustained agriculture production and increasing vulnerability. Climate change is likely to further exacerbate the situation. Timely availability of water and its efficient management is of prime importance to agriculture productivity and for diversifying agriculture and rural economy. Improving agricultural productivity, diversification, and managing irrigation systems and water resources are among major thrusts of the Government's National Strategy: Rectangular Strategy on Growth, Employment, Equity and Efficiency, Phase 3. The ADB's Country Partnership Strategy also focuses on inclusive economic growth through physical infrastructure, agriculture and irrigation, among others.

B. Methodology

3. This report presents the economic analysis undertaken for the subproject. The economic analysis of the subproject investment was undertaken in accordance with the principles and procedures set out in the ADB guidelines[1].All benefits and costs are examined in order to assess the viability of the subproject as well as to identify its expected impact on various sectors of the local society, including the poor. For this analysis the costs and benefits within the Prek Chik irrigation command area are calculated for two alternative situations: “with” the project and “without” the project. In the “without” project scenario part of the command area is not irrigated. The analysis took account of what may be grown on the land “without” the irrigation system. The intent is to identify the incremental value of production attributable to the project (over its expected useful life) and compare this value to the incremental cost of implementing the project and of operating and maintaining the rehabilitated and new infrastructure over time.

4. To develop a model for the analysis, certain assumptions were made regarding future practice (both “with” and “without” the Project) and about the valuation of inputs and outputs. These include:

(i) Project life is assumed at 25 years. Assuming adequate maintenance, the irrigation system should be able to maintain its expected benefits for 25 years before another major renovation may be required.

[1] Include the *Cost-Benefit Analysis for Development – A Practical Guide (2013);* Guidelines for the Economic Analysis of Projects (1997); *ADB Handbook for the Economic Analysis of Water Supply Projects (1999);* and *Framework for the Economic and Financial Appraisal of Urban Development Sector Projects (1994)*.

(ii) "Without" the project assumes present cultivation patterns and technology are expected to continue for the life of the project.
(iii) "With" the project, the full command area is expected to continue to be adequately irrigated throughout the life of the project, allowing farmers to adopt appropriate cropping patterns and technology. [2]
(iv) Some agricultural outputs may be consumed by the farm households, but are valued as if sold.
(v) Some agricultural inputs such as farm labor are provided by the farm household but are valued at the market rate as if hired.
(vi) Values are expressed in constant 2015 prices so as to exclude inflation.
(vii) The US dollar ($) is the unit of account. The exchange rate used is KHR4,040 per U.S. dollar which is the average rate for the last six months prior to the time of this study.

5. Financial prices used in this analysis were determined through field visits conducted by the PPTA team. These prices have been cross-checked with prices identified in other projects and in some secondary sources.

6. In order to assess the Project's contributions (and costs) to the economy of Cambodia it is necessary to convert financial values into their economic equivalents. Economic valuations exclude transfers from one part of society to another (i.e. taxes and subsidies) and compares project benefits and real opportunity costs to the economy by translating all prices into a common, undistorted value Additional basic assumption used in the economic analysis include:
(i) The analysis uses the domestic price numeraire and for traded goods a shadow exchange rate factor (SERF) of 1.1 is applied.
(ii) For rural labor, a shadow wage rate factor (SWRF) of 0.9 is applied. The SWRF reflects the productivity of rural labor in the area.
(iii) Transfer payments such as taxes and subsidies are excluded in the calculation of economic values.
(iv) To calculate the economic net present value (ENPV) of the subproject, a discount rate of 12% is used as representing the opportunity cost of the capital invested.

C. "Without Project" and "With Project" Situation

7. **"Without Project" Situation**. The Prek Chik system is located some 72 km. from the city of Battambang and 297 km. from Phnom Penh.

8. Construction of the Prek Chik canal was started in 1977. It was still unfinished when construction work ceased in the latter part of 1978. After the country was liberated in 1979, the partly finished canal was left unutilized until some minor repairs were made in 2003. Major rehabilitation work was done in 2010 with funding from the Japanese Government to bring the canal into operation. This construction was completed in 2012. Current rehabilitation work is focused on the main canal and its irrigation structures. The reported potential command area is about 20,000 hectares. However, the current area of wet season rice grown with supplemental irrigation is just about 2,500 hectares while the current dry season paddy cultivation is only

[2] It is assumed that whatever changes that will occur in the future (to the economy, climate, etc.) are expected to affect the "with" and "without" project scenarios roughly equally --- maintaining the incremental differences in benefits and costs associated with the project's implementation.

about 30 hectares. Currently, all dry season irrigation is in ‘Prek Chik commune which is on the upstream reach of the irrigation system.

9. Water availability from Bassac Reservoir which has been undergoing gate repairs is a major issue. Flood problems from local run-off require cross-drainage solution. Over the whole right side of the main canal, the lack of drainage facilities passing under the canal has resulted to the main canal being used as drainage through inlets constructed specifically to allow flood and drainage waters during medium to high intensity storms to enter the canal. The main canal becomes in fat the major relief drain to discharge flood waters downstream through off-takes.

10. The system has no water measuring device, inflow records, cropping season duration and no budget allocation from the Government.

11. **“With Project” Situation.** The proposed improvement is expected to provide water to four communes covering a total area of 10,432 ha. Command area includes the following communes:

Table 1: Prek Chik Subproject Command Area

Commune	**Land Ownership**	**Total Area** (hectare)
Prey Svay	Farmer land	2,766
Kear	Farmer land	4,418
Preak Chik	Farmer land	1,048
Prey Trolach	Farmer land	2,200
Total		10,432

Source: PPTA Consultant.

12. Proposed physical improvements to the system are as follows:
   (i) Rehabilitation of headworks (including raising of spillway by 1.5 meters)
   (ii) Rehabilitation of 28 km Main Canal and installation of all structures for water control and distribution, and provision of all drainage works
   (iii) Secondary and Tertiary Canals for a length of 70.2 km, to be able to cover 10,400 ha of net irrigated lands.

13. Other components of the subproject include the following:
   (i) Installation of Hydro-Met stations in the watersheds for water resources monitoring (to be installed with collaboration of ongoing ADB funded Flood and Drought Risk Management and Mitigation Project).
   (ii) Provision of training to the PDWRAMs, farmer water user communes (FWUCs) and the appropriate government agencies.
   (iii) Organization, mobilization and training of FWUCs in the command area.
   (iv) Involving FWUCs in the subprojects design and supervision of works, and operation and maintenance as per their role and responsibilities defined in the recently approved law – Sub-decree on the Procedures for the Establishment, Dissolution, Role and Duties of FWUC, Royal Government of Cambodia, 12 March 2015.
   (v) Design joint reservoir operations for Dauntri and Bassac reservoirs in Battambang province.

D. Subproject Cost

14. It is estimated that the civil works will cost $16.0 million. Total cost including project management, construction supervision and design, on-farm preparation and physical

contingency will amount to $25.4 million. In economic prices the total cost is $23.3 million. Details are shown in the following table:

Table 2: Investment Cost – Prek Chik ($)

	Expenditure Category	Total Basic Financial Cost ($) [1]	Breakdown of Total Basic Cost ($)				Total Economic Cost [b]
			Foreign Component	Local Component			
				Materials	Labor		
					Skilled	Unskilled	
1	Main canal and headworks	3,843,512	614,962	2,575,153	192,176	461,221	3,508,078
2	Secondary and Tertiary Canals	12,161,040	1,945,766	8,147,897	608,052	1,459,325	11,099,713
	SUBTOTAL	16,004,552	2,560,728	10,723,050	800,228	1,920,546	14,607,791
3	Project Management	3,775,000	1,510,000	1,132,500	1,132,500	0	3,569,091
4	Onfarm preparation cost	3,129,600	500,736	2,096,832	156,480	375,552	2,856,471
5	Physical Contingency [c]	2,470,000	395,200	1,654,900	123,500	296,400	2,254,436
	T O T A L	25,379,152	4,966,664	15,607,282	2,212,708	2,592,498	23,287,790

Notes: [a] Based on May 2015 prices.

[b] Conversion of financial to economic costs was based on the following shadow pricing:

Shadow exchange rate factor (SERF)	=	1.1
Shadow wage rate factor (SWRF)	=	0.9
Taxes and Duties	=	10%
[c] Physical Contingency	=	10%

Souce: PPTA Consultant.

15. Based on the technical study, annual operation and maintenance (O&M) expenditure for the rehabilitated system is expected to amount to $25 per hectare. After seven years there will be a need for substantial periodic maintenance expenditures --- amounting to roughly 30% of the construction cost or about $4.38 million in economic cost. This amount needs to be allocated every seven years thereafter. Both kinds of maintenance will be conducted during non-crop periods in order to minimize disruption to crop production while repairs are being done.

16. This irrigation subproject will involve land acquisition of about 81 hectares for the construction of the secondary and tertiary irrigation canals. Whether the required land will be purchased or donated for the use of the project, it has an economic cost due to change in land use. This change will in turn result to loss in agricultural production. For this subproject, the net rice production per hectare in the without project situation was used as parameter to compute for the economic cost of land. This was included in the subproject resource outflow. Details of the annual computation are shown in Table 14.

E. Subproject Benefits

17. The following economic benefits were considered in evaluating the economic viability of the proposed irrigation investments:

18. **Economic value of incremental increase in crop production**. This was determined based on the increased crop production from “without project” to “with project” situations. Two crops were considered: paddy rice as the main crop covering about 70% of the command area and 10% allocated for other crops such as cassava, corn, pineapple, mungbean and water melon. The economic value was computed by multiplying the following factors: area of land used in planting (in hectare); cropping intensity (in percentage); average yield (in ton/hectare); and farm gate price of crop (in $/ton). Crop production cost is deducted from the gross

production value to derive the net benefit.[3] Incremental benefit is then calculated by deducting the without project situation from the "with project" situation.

19. As discussed, the main economic incremental benefit is the producer surplus. As such, the farmers' willingness to pay (WTP) serves as an enabling condition for the producer surplus to materialize. The WTP was established based on a series of focus group discussions conducted during the PPTA study. Because there is not yet functional farmer's water user community in both proposed subproject sites, the PPTA team interviewed the farmers' groups in another functional irrigation scheme, Stung Chinit[4], financed by ADB, with similar pre-project situation to that of the proposed subprojects. The focus group discussions observed that the current irrigation service fee in Stung Chinit is currently KHR60,000 per hectare per crop. This service fee level can be assumed to be the WTP of irrigation water users since the actual collection having reportedly been 90%. Based on ADB's experienced in irrigation sector in Cambodia, this fee level together with 90% collection efficiency, operation and maintenance can be carried out reasonably to support the producer surplus to be achieved.

20. **Avoided flood crop damages.** As reported by the farmers and recorded by the District Agriculture Office, severe flood occurrences happen in the area at least once in five years affecting about 70% of crops in 256 hectares. Avoided crop damages due to flooding were computed by multiplying the total area affected by flood (in hectare); average rice production (in ton/hectare); economic price of rice ($/ton); number of flooding incidence in five years (number); percentage of crops damaged during flooding incidence (in percentage).

21. Other benefits that were not quantified and valued in the analysis include the following: improved health and nutrition of project beneficiaries; increased water availability for agricultural activities; training of PDWRAMs, FWUC members and other relevant agencies; and more efficient management and monitoring of water resources. Furthermore, the design of a joint reservoir operation for Dauntri and Bassac reservoirs will further provide reliable supply of water in the command area.

22. Summary of data and parameters used in the valuation of economic benefits are shown in the following table while detailed annual computation of benefits is presented in Tables 7 to 13.

Table 3: Summary of Factors and Parameters Used

Parameter	Value
Total Command Area	10,432 ha
Without project (2015)	
Cultivated land in wet season (rice)	7,302 ha
Cultivated land in dry season (other crops)	522 ha
Areas affected by severe flooding	256 ha
With project (year 7 - 2022)	
Cultivated land in wet season (rice)	7,302 ha
Cultivated land in dry season (other crops)	1,043 ha
Incremental Subproject Output – Rice	

[3] This cash flow stream of benefits does change over time in line with the World Bank commodity price projections for rice and major inputs such as fertilizer.

[4] Stung Chinit Irrigation System (SCIS FWUC) is located at Kampong Thom province with coverage area of 2,803 ha. It was established in 2002 and received financial and technical support from ADB and Agence Française de Developpement (AFD). The Stung Chinit project was completed in 2008. Thereafter, it received the strong support from the Irrigation Service Center (ISC), a non-government organization.

Parameter	Value
Without project (2015)	
Yield	1.8 t/ha
Cropping intensity	70%
Farm gate price	$300/t
Production cost	$122/t
With project (year 7 - 2022)	
Yield	5 t/ha
Cropping intensity	70%
Farm gate price	$395/t
Production cost	$132/t
Incremental Subproject Output – Other Crops	
Without project (2015)	
Yield	15 t/ha
Cropping intensity	10%
Farm gate price	$324/t
Production cost	$130/t
With project (year 7 - 2022)	
Yield	21 t/ha
Cropping intensity	10%
Farm gate price	$324/t
Production cost	$127/t

Sources: UIWRMSP PPTA, Engineering and Irrigation Report (Supplementary Appendix No. 1) and Agriculture Report (Supplementary Appendix No. 3).

F. Economic Analysis

23. **Economic Returns.** The main quantifiable benefit of the subproject is the net incremental value of crop production and avoided crop damages due to flooding. Annual cost stream is determined to calculate the economic returns of the subproject. Costs are similarly projected with investment costs falling in the first three years followed by annual maintenance expenditures in each subsequent year and periodic maintenance cost every eighth year of operation. To calculate the cash flow of net project economic benefits, the cost cash flow is subtracted from the benefit cash flow.

24. The Prek Chik irrigation subproject is expected to be economically viable in that the calculated economic internal rate of return (EIRR) is 24% and the economic net present value (ENPV) of the investment is $9.5 million (when applying a discount rate of 12%). These strong economic results are due to the substantial size of the economic benefit stream relative to the economic basic construction cost of $14.6 million or $2,000 per hectare of planted area.

25. **Sensitivity Analysis.** The reported economic returns of the subproject are based upon the assumption that costs and benefits over the life of the project will be as calculated. The future, of course, may be affected by a number of unforeseen events which can adversely change the expected result. It is useful to examine particular risks and check the impact they may make to the economic returns of the project. Some of these risks include the following:

26. <u>Increase in Investment Cost</u>**:** Care has been taken to accurately estimate the cost of the Prek Chik irrigation system. One of the sensitivity tests undertaken involves the possibility of actual cost being higher than the estimated cost. To determine the vulnerability of economic returns to higher construction costs, a 10% increase in costs was included in the estimation. This cost increase causes the EIRR to decline to 21.2%, lower by 2.8% from the base EIRR. The sensitivity indicator for this level of cost increase is 1.5, indicating that the returns are

sensitive to this variable. The level of increase at which the EIRR would fall below the acceptable 12% level (the switching value)[5] is at a 65% increase in cost.

27. Increased O&M cost: Similar to investment costs, the possibility of O&M costs increasing than what was estimated may occur in the future. A test of the impact of a 10% increase in costs was done to determine how vulnerable the resulting EIRR to such an increase. The cost increase causes very insignificant change in EIRR at 23.8%.

28. Decrease in Overall Benefits: An overall decline in total benefits by 10% was also tested defining no particular factor. With this general assumption, EIRR would fall to 20.4% and the sensitivity factor is -3.0 and switching value is -33%.

29. Decrease in Command Area: If the benefitted area of the Prek Chik system were not to reach its anticipated level of 7,302 ha the economic returns can be expected to decrease from the base-case level. A 10% decrease in the command area drops the EIRR to 23.2%. The sensitivity factor is at -0.7 while the switching value is at -144% of the incremental command area improvement.

30. Decrease in Cropping Intensity: With available irrigation water, cropping intensity is expected to increase in the "with project" situation. However, in case this decreases by 10%, EIRR would decrease to 19.7%, the sensitivity factor is -3.5 and switching value is -28%.

31. Decrease in Yield Increment: The yield increment when moving from rainfed to irrigation water has been assumed to average about 5 tons per ha. If this increment were to decrease by 10%, the EIRR would drop to 18.5%. The sensitivity factor is only -5.1 and the switching value is at -19%.

32. Decrease in Price of Rice: Rice prices are assumed to change over time along the lines predicted by the World Bank commodity price projections. Any drop in prices can affect future cash flow and project returns can be expected to fall. A 10% drop in rice prices causes the EIRR to fall to 18.8%. The sensitivity factor is -4.5 and the switching value is at -22%.

33. Decrease in cultivated area: If the cultivated area were to decrease by 10% from the base-case level, EIRR will decrease to 20.4%. The sensitivity factor is at -3.0 while the switching value is at -34%.

34. Decrease in project life: The project is originally assumed at 25 years but if this will decrease to say 5 years, then EIRR drops to 11.4%.

35. Decrease in cultivated area and project life: A simultaneous change in cultivated area and project life will adversely affect the result, dropping the EIRR to 5.4% which is below the assumed opportunity cost of 12%.

36. Benefits delayed by 2 years: Any delay in implementation schedule can impact on the benefits materializing for target beneficiaries. An assumed two-year delay will decrease EIRR and ENPV to 14.9% and $3.2 million, respectively.

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[5] The switching value is the percent change in the risk variable that will make the EIRR fall to the level of the opportunity cost of capital (which is assumed to be 12%).

37. The level of economic returns, along with the results of the sensitivity analysis of various risks, indicates that the Prek Chik subproject investment is likely to pay for itself but is highly sensitive to a decrease in assumed project life. This particular risk puts the EIRR of falling below 12%, more especially if combined with other risks.

Table 4: Summary Results of Base Case and Sensitivity Tests

Results of Evaluation	Change	NPV	EIRR	Sensitivity Indicator	Switching Value
Base Case		9.5	24.0%		
Sensitivity Scenarios					
Case 1 - Increase in Capital Costs	10%	8.0	21.2%	1.5	65%
Case 2 - Increase in O&M Costs	10%	9.3	23.8%	0.2	586%
Case 3 - Decrease in overall benefit	-10%	6.6	20.4%	-3.0	-33%
Case 4 - Decrease in command area	-10%	8.8	23.2%	-0.7	-144%
Case 5 - Decrease in cropping intensity	-10%	6.1	19.7%	-3.5	-28%
Case 6 - Decrease in yield increment	-10%	4.6	18.5%	-5.1	-19%
Case 7 - Decrease in price of rice	-10%	5.3	18.8%	-4.5	-22%
Case 8 - Decrease in cultivated area	-10%	6.6	20.4%	-3.0	-34%
Case 9 - Decrease in project life (no. of years)	5	(0.2)	11.4%		
Case 10 - Combination of cases 8 & 9		(1.9)	5.4%		
Case 11 - Benefits delay by 2 years		3.2	14.9%		

SI = sensitivity indicator (ratio of percentage change in IRR above 12% to percentage change in selected variable).
SV = switching value (percentage change in selected variable to reduce the IRR to cut-off rate).
Source: PPTA Consultant.

G. Financial Household Returns

38. As an impact of the project, it was estimated that farmer households in Prek Chik will gain a significant increase in their net revenue from paddy rice production of about $2,812/farmer household/year based on an average landholding of 2 hectares.

39. Without the project, the farmer households are getting a yield of 1.8 tons/hectare at average farm gate price of $300/ton. This gives a farmer household an average net annual revenue of $610 or $51 per month.[6] With the implementation of the Project, the yield is projected to increase to 5 tons/ha. Average farm gate price of paddy rice is likewise expected to increase to $500/ton with the use of good quality seeds. Based on the average landholding, the projected average net annual revenue of farmer households is $3,422 or $285 per month.

40. Furthermore, starting at year seven of the subproject, an estimated 116,525 incremental labor days valued at $0.58 million will be required annually in the production of paddy rice and other crops.

H. Benefit Distribution and Poverty Impact

41. In Prek Chik, around 80% of the total population of the four Communes are farmers. Main source of income is derived from agriculture (91%). Poverty finds its roots on this source of income because of its dependence on a lot of factors (irrigation, agriculture inputs and technology, efficient water management, sufficiency of water at the source, type of soil, weather condition) thus providing insufficient opportunity for farmers to have sufficient and stable income

[6] UIWRMSP PPTA Report on Poverty and Socio-Economic Condition (Supplementary Appendix 16).

to meet their needs. The main factors that cause poverty which are identified by the people in the Project areas are the poor soil condition, lack of water in the canal for irrigation of crops during the dry season, people do not use the appropriate agriculture technologies, and lack of job opportunities in the locality.[7]

42. The implementation of the project will try to tackle these factors that cause poverty by enhancing agricultural and rural economic productivity through increased efficiency of irrigation systems and improved management of water resources. When completed, the Project will directly benefit the 6,663 farmers in Prek Chik and the total population in the four communes. The Project will help decrease the poverty rates in the four communes covered within the project area which ranges from 23.5% to 34.5% in Prek Chik.

43. Project sustainability is strongly affected by who benefits, and by how much, relative to who pays. Main beneficiary groups or stakeholders for this subproject are identified as the government, local economy, labor sector and the farmers. The distribution of the economic benefits and costs over and above financial revenues and expenses are estimated to determine the extent to which public investment policy can affect the share that the various sectors derive from the project. The following table on Benefit Distribution shows the result of this analysis:

Table 5: Distribution of Economic Benefits

	Financial Present Value	Economic Present Value	Economic minus Financial	Government	Economy	Labor	Farmers
Total Project Benefits	0.47	31.40	30.93				30.93
Project Costs							
Traded	2.28	2.00	(0.28)		0.28		
Unskilled labor	2.21	1.07	(1.14)			1.14	
Non-traded	13.91	6.59	(7.32)		7.32		
Total Project Costs	18.40	9.66					
Net Benefits (Losses)	(17.93)	21.74	39.66	(17.93)			
Benefits (Losses)				(17.93)	7.60	1.14	30.93

44. Another analysis was undertaken to determine the distribution of net benefits among beneficiary groups according to income level. The particular focus on net benefits that go to the poor is pertinent in this agricultural project. Computed poverty impact ratio (PIR) for this subproject is 30.8%. Details are presented in the following table:

Table 6: Poverty Impact

Particulars	Gov't. / Economy	Labor	Community	Total
Benefits (Losses)	7.60	1.14	30.93	39.66
Financial Return to Governme	(17.93)			(17.93)
Total Benefits (Losses)	(10.33)	1.14	30.93	21.74
Proportion of Poor (%)	0.29	0.67	0.29	
Benefits to Poor	(2.98)	0.76	8.92	6.70
Poverty Impact Ratio (%)				30.8%

[7] Focus Group Discussion (FGD) conducted in Taining Krasaing and Preaek Chik.

I. Conclusion

45. The proposed Prek Chik irrigation system is expected to make important contributions to the local economy, increasing paddy production and household income significantly. The scheme is economically viable. It will also play a role in the commercialization of rice production. Its expected 19,508 tons per year of incremental paddy production will almost certainly all be marketed given that the local population already has more than enough for its own consumption. Similarly, crop diversification has high potentials for other crops such as cassava, corn, mungbean, pineapple and watermelon have high potentials and will provide good production value to the farmers.

Table 7: Economic Price Estimates for Internationally Traded Outputs (Rice)

		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Rice Paddy												
Thailand (current $) [a]	$/t	415	411	408	404	401	397	394	390	387	383	380
Thailand (constant 2010 $) [a]	$/t	393	382	373	364	355	346	338	329	321	313	305
MUV (2010 = 1.0) [b]	2010	1.06	1.08	1.09	1.11	1.13	1.15	1.17	1.19	1.21	1.23	1.25
MUV (2015 = 1.0) [b]	2015	1.00	1.02	1.04	1.05	1.07	1.09	1.10	1.12	1.14	1.16	1.18
Rice FOB Bangkok (constant 2015 $)	$/t	415	404	394	384	375	366	357	348	339	330	322
Quality Adjustment [c]	$/t	332	323	315	307	300	293	285	278	271	264	258
Freight, insurance, etc.	$/t	80	80	80	80	80	80	80	80	80	80	80
CIF Sihanoukville	$/t	252	243	235	227	220	213	205	198	191	184	178
Freight & handling Sihanoukville to project area	$/t	48	48	48	48	48	48	48	48	48	48	48
Conversion to paddy [d]	$/t	123	117	113	108	103	99	95	90	86	82	78
Milling charge net of bran and husks	$/t	0	0	0	0	0	0	0	0	0	0	0
Handling and transport farm to mill [e]	$/t	6	6	6	6	6	6	6	6	6	6	6
Economic farmgate price per ton	$/t	117	112	107	102	98	93	89	85	81	76	72
Economic farmgate price per kg	$/kg	0.12	0.11	0.11	0.10	0.10	0.09	0.09	0.08	0.08	0.08	0.07
Financial - Non-fragrant variety	$/t	300	286	274	262	250	239	228	217	207	196	186
Economic - Non-fragrant variety	$/t	330	315	301	288	276	263	251	239	227	216	204
Financial - Fragrant variety	$/t	500	477	456	437	417	399	380	362	344	327	309
Economic - Fragrant variety	$/t	550	525	502	480	459	439	418	398	379	359	340

[a] WB Commodity Price Projections prepared January 22, 2015 for 2013 through 2025. (Thailand, 5% broken, white rice, milled, fob Bangkok)

[b] Manufacturing Unit Value Index

[c] Adjustment for quality relative to the standard of Thai white rice, 5% broken = 20%

[d] Standard conversion factor (SCF) applied on half the amount of handling, transportation and milling = 0.9

[e] Conversion factor of paddy to rice = 60%

Table 8a: Economic Price Estimates for Internationally Traded Inputs (Urea)

		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Urea												
Eastern Europe (current $) [a]	$/t	300	298	296	294	292	290	288	286	284	282	280
Eastern Europe (constant 2010 $) [a]	$/t	284	277	270	264	258	253	247	241	236	230	225
MUV (2010 = 1.0) [b]	2010	1.06	1.08	1.09	1.11	1.13	1.15	1.17	1.19	1.21	1.23	1.25
MUV (2015 = 1.0) [b]	2015	1.00	1.02	1.04	1.05	1.07	1.09	1.10	1.12	1.14	1.16	1.18
Urea FOB Eastern Europe (constant 2015 $)	$/t	300	292	286	279	273	267	261	255	249	243	237
Freight, insurance, etc.	$/t	80	80	80	80	80	80	80	80	80	80	80
CIF Sihanoukville	$/t	380	372	366	359	353	347	341	335	329	323	317
Freight & handling Sihanoukville to project area	$/t	48	48	48	48	48	48	48	48	48	48	48
Handling and transport to farmgate [c]	$/t	6	6	6	6	6	6	6	6	6	6	6
Economic farmgate price per ton	$/t	433	426	419	412	406	400	394	388	382	376	370
Economic farmgate price per kg	$/t	0.43	0.43	0.42	0.41	0.41	0.40	0.39	0.39	0.38	0.38	0.37

[a] WB Commodity Price Projections prepared January 22, 2015 for 2013 through 2025. (Bagged, f.o.b. Eastern Europe (varying origins)

[b] Manufacturing Unit Value Index

[c] Standard conversion factor (SCF) applied on half the amount of handling & transportation = 0.9

Table 8b: Economic Price Estimates for Internationally Traded Inputs (DAP)

		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
DAP (diammonium phosphate)												
US (current $) [a]	$/t	450	449	448	447	446	445	444	443	442	441	440
US (constant 2010 $) [a]	$/t	426	417	409	402	395	388	381	374	367	360	353
MUV (2010 = 1.0) [b]	2010	1.06	1.08	1.09	1.11	1.13	1.15	1.17	1.19	1.21	1.23	1.25
MUV (2015 = 1.0) [b]	2015	1.00	1.02	1.04	1.05	1.07	1.09	1.10	1.12	1.14	1.16	1.18
DAP FOB US Gulf (constant 2015 $)	$/t	450	441	433	425	417	410	402	395	388	380	373
Freight, insurance, etc.	$/t	80	80	80	80	80	80	80	80	80	80	80
CIF Sihanoukville	$/t	530	521	513	505	497	490	482	475	468	460	453
Freight & handling Sihanoukville to project area	$/t	48	48	48	48	48	48	48	48	48	48	48
Handling and transport to farmgate [c]	$/t	6	6	6	6	6	6	6	6	6	6	6
Economic farmgate price per ton	$/t	583	574	566	558	550	543	536	528	521	513	506
Economic farmgate price per kg	$/t	0.58	0.57	0.57	0.56	0.55	0.54	0.54	0.53	0.52	0.51	0.51

[a] WB Commodity Price Projections prepared January 22, 2015 for 2013 through 2025. (Standard size, bulk, spot, f.o.b. US Gulf)

[b] Manufacturing Unit Value Index

[c] Standard conversion factor (SCF) applied on half the amount of handling & transportation = 0.9

Table 9: Command Area Land Use With and Without the Project: Prek Chik, Battambang Province

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2040
Land Area (has.)											
By Commune											
Prey Svay	2,766	2,766	2,766	2,766	2,766	2,766	2,766	2,766	2,766	2,766	2,766
Kear	4,418	4,418	4,418	4,418	4,418	4,418	4,418	4,418	4,418	4,418	4,418
Preak Chik	1,048	1,048	1,048	1,048	1,048	1,048	1,048	1,048	1,048	1,048	1,048
Prey Trolach	2,200	2,200	2,200	2,200	2,200	2,200	2,200	2,200	2,200	2,200	2,200
Subtotal	10,432	10,432	10,432	10,432	10,432	10,432	10,432	10,432	10,432	10,432	10,432
By Cultivated Crop											
Other crops (vegetables, etc.)	1,043	1,043	1,043	1,043	1,043	1,043	1,043	1,043	1,043	1,043	1,043
Paddy rice	9,389	9,389	9,389	9,389	9,389	9,389	9,389	9,389	9,389	9,389	9,389
Subtotal	10,432	10,432	10,432	10,432	10,432	10,432	10,432	10,432	10,432	10,432	10,432
Command Area Land Use (has.)											
Without project											
Wet Season											
Paddy Rice	7,302	7,302	7,302	7,302	7,302	7,302	7,302	7,302	7,302	7,302	7,302
Other Crops	-	-	-	-	-	-	-	-	-	-	-
Fallow	3,130	3,130	3,130	3,130	3,130	3,130	3,130	3,130	3,130	3,130	3,130
Subtotal	10,432	10,432	10,432	10,432	10,432	10,432	10,432	10,432	10,432	10,432	10,432
Dry Season											
Paddy Rice	-	-	-	-	-	-	-	-	-	-	-
Other Crops	1,043	1,043	1,043	1,043	1,043	1,043	1,043	1,043	1,043	1,043	1,043
Fallow	9,389	9,389	9,389	9,389	9,389	9,389	9,389	9,389	9,389	9,389	9,389
Subtotal	10,432	10,432	10,432	10,432	10,432	10,432	10,432	10,432	10,432	10,432	10,432
With project											
Wet Season											
Paddy Rice	7,302	7,302	7,302	7,302	7,302	7,302	7,302	7,302	7,302	7,302	7,302
Other Crops	-	-	-	-	-	-	-	-	-	-	-
Fallow	3,130	3,130	3,130	3,130	3,130	3,130	3,130	3,130	3,130	3,130	3,130
Subtotal	10,432	10,432	10,432	10,432	10,432	10,432	10,432	10,432	10,432	10,432	10,432
Dry Season											
Paddy Rice	-	-	-	-	-	-	-	-	-	-	-
Other Crops	1,043	1,043	1,043	1,043	1,043	1,043	1,043	1,043	1,043	1,043	1,043
Fallow	9,389	9,389	9,389	9,389	9,389	9,389	9,389	9,389	9,389	9,389	9,389
Subtotal	10,432	10,432	10,432	10,432	10,432	10,432	10,432	10,432	10,432	10,432	10,432

Table 10: Crop Yield and Intensity – With and Without the Project: Prek Chik, Battambang Province

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2040
Crop Yield (t/ha)											
Without project											
Wet Season											
Paddy Rice	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Other Crops	-	-	-	-	-	-	-	-	-	-	-
Dry Season											
Paddy Rice	-	-	-	-	-	-	-	-	-	-	-
Other Crops	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9
With project											
Wet Season											
Paddy Rice	1.8	1.8	2.0	2.5	3.0	3.5	5.0	5.0	5.0	5.0	5.0
Other Crops	-	-	-	-	-	-	-	-	-	-	-
Dry Season											
Paddy Rice	-	-	2.0	2.5	3.0	3.5	5.0	5.0	5.0	5.0	5.0
Other Crops	14.9	14.9	14.9	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5
Cropping Intensity (%)											
Without project											
Wet Season											
Paddy Rice	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%
Dry Season											
Paddy Rice	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Other Crops	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
With project											
Wet Season											
Paddy Rice	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%
Dry Season											
Paddy Rice				0%	0%	0%	0%	0%	0%	0%	0%
Other Crops	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table 11: Crop Production Volume (in ton) and Value ($ million) With and Without Project: Prek Chik, Battambang Province

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2040
Total Crop Production (tons)											
Without project											
Wet Season											
Paddy Rice	9,201	9,201	9,201	9,201	9,201	9,201	9,201	9,201	9,201	9,201	9,201
Dry Season											
Paddy Rice	-	-	-	-	-	-	-	-	-	-	-
Other Crops	15,502	15,502	15,502	15,502	15,502	15,502	15,502	15,502	15,502	15,502	15,502
With project											
Wet Season											
Paddy Rice	9,201	9,201	10,223	12,779	15,335	17,891	25,558	25,558	25,558	25,558	25,558
Dry Season											
Paddy Rice	-	-	-	-	-	-	-	-	-	-	-
Other Crops	15,502	15,502	15,502	21,386	21,386	21,386	21,386	21,386	21,386	21,386	21,386
Economic Farmgate Price ($/ton)											
Rice											
Without project	286	274	262	250	239	228	217	207	196	186	186
With project	477	456	437	417	399	380	362	344	327	309	309
Other crops	324	324	324	324	324	324	324	324	324	324	324
Gross Crop Production ($ mil)											
Without project											
Wet Season											
Paddy Rice	2.63	2.52	2.41	2.30	2.20	2.10	2.00	1.90	1.80	1.71	1.71
Dry Season											
Paddy Rice	-	-	-	-	-	-	-	-	-	-	-
Other Crops	5.02	5.02	5.02	5.02	5.02	5.02	5.02	5.02	5.02	5.02	5.02
With project											
Wet Season											
Paddy Rice	2.63	2.52	4.46	5.33	6.12	6.81	9.26	8.80	8.35	7.90	7.90
Dry Season											
Paddy Rice	-	-	-	-	-	-	-	-	-	-	-
Other Crops	5.02	5.02	5.02	6.93	6.93	6.93	6.93	6.93	6.93	6.93	6.93

Table 12: Incremental Crop Production – With and Without the Project: Prek Chik, Battambang Province

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2040
Production Cost ($ mil)											
Without project											
Wet Season											
Paddy Rice	1.13	1.13	1.12	1.12	1.11	1.11	1.11	1.10	1.10	1.10	1.10
Dry Season											
Paddy Rice	-	-	-	-	-	-	-	-	-	-	-
Other Crops	2.01	2.01	2.01	2.01	2.01	2.01	2.01	2.01	2.01	2.01	2.01
With project											
Wet Season											
Paddy Rice	1.13	1.13	1.38	1.72	2.06	2.39	3.41	3.41	3.40	3.39	3.39
Dry Season											
Paddy Rice	-	-	-	-	-	-	-	-	-	-	-
Other Crops	2.01	2.01	2.01	2.71	2.71	2.71	2.71	2.71	2.71	2.71	2.71
Net Value of Crop Production ($ mil)											
Without project											
Wet Season											
Paddy Rice	1.50	1.39	1.29	1.19	1.09	0.99	0.89	0.80	0.70	0.61	0.61
Dry Season											
Paddy Rice	-	-	-	-	-	-	-	-	-	-	-
Other Crops	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01
With project											
Wet Season											
Paddy Rice	1.50	1.39	3.09	3.62	4.06	4.41	5.84	5.39	4.95	4.51	4.51
Dry Season											
Paddy Rice	-	-	-	-	-	-	-	-	-	-	-
Other Crops	3.01	3.01	3.01	4.21	4.21	4.21	4.21	4.21	4.21	4.21	4.21
Incremental Value of Crop Production ($ mil)											
Wet Season											
Paddy Rice	-	-	1.80	2.43	2.97	3.42	4.95	4.60	4.25	3.90	3.90
Dry Season											
Paddy Rice	-	-	-	-	-	-	-	-	-	-	-
Other Crops	-	-	-	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21
Total	-	-	1.80	3.64	4.18	4.63	6.16	5.80	5.45	5.11	5.11

Table 13: Economic Opportunity Cost of Land: Prek Chik, Battambang Province

		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2040
Economic opportunity cost of land												
Total area required (has.)	81.1	81.1	81.1	81.1	81.1	81.1	81.1	81.1	81.1	81.1	81.1	81.1
Ave. rice production without project (t/ha)	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Economic price of rice per ton ($/t)		286	274	262	250	239	228	217	207	196	186	186
Economic price of rice per hectare ($/ha)		515	493	472	451	431	411	391	372	353	334	334
Total crop production lost ($ mil)		0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03

Table 14: Benefit from Flood Savings: Prek Chik, Battambang Province

				2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2040
Flooded Area														
Flooding incidence -	once in	5	years	5	5	5	5	5	5	5	5	5	5	5
Area affected (has.)		256		256	256	256	256	256	256	256	256	256	256	256
Ave. rice production per hectare (t/ha)		1.8		1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Economic price of rice per ton ($/t)				286	274	262	250	239	228	217	207	196	186	186
Economic price of rice per hectare ($/ha)				515	493	472	451	431	411	391	372	353	334	334
Percentage of rice damaged by flood		70%		70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%
Total crop production lost ($)				92,322	88,337	84,521	80,788	77,180	73,615	70,092	66,611	63,213	59,858	59,858
Annual crop production lost ($ mil)				0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01

Table 15: Result of Economic Evaluation: Prek Chik, Battambang Province

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2030	2040
Costs												
Investment Costs	1.16	2.33	2.33	5.82	8.15	3.49	-	-	-	-	-	-
O&M Costs	-	-	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
Periodic Maintenance	-	-	-	-	-	-	-	-	-	4.38	-	-
Opportunity cost of land	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Total Costs	1.21	2.37	2.63	6.12	8.45	3.79	0.29	0.29	0.29	4.67	0.29	0.29
Benefits												
Increased production from farmlands	-	-	1.80	3.64	4.18	4.63	6.16	5.80	5.45	5.11	5.11	5.11
Savings from flood damages	-	-	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Total Benefits	-	-	1.82	3.65	4.19	4.64	6.17	5.81	5.47	5.12	5.12	5.12
Net Cash Flow (Base Case)	(1.21)	(2.37)	(0.81)	(2.47)	(4.25)	0.85	5.88	5.52	5.17	0.45	4.83	4.83
Sensitivity Tests:												
Case 1 - Increase in Capital Costs	(1.32)	(2.60)	(1.05)	(3.05)	(5.07)	0.51	5.88	5.52	5.17	0.45	4.83	4.83
Case 2 - Increase in O&M Costs	(1.21)	(2.37)	(0.84)	(2.49)	(4.28)	0.83	5.85	5.50	5.15	0.42	4.80	4.80
Case 3 - Decrease in overall benefit	(1.21)	(2.37)	(0.99)	(2.83)	(4.67)	0.39	5.26	4.94	4.63	(0.06)	4.32	4.32
Case 4 - Decrease in command area	(1.21)	(2.37)	(0.81)	(2.59)	(4.37)	0.73	5.76	5.40	5.05	0.33	4.71	4.71
Case 5 - Decrease in cropping intensity	(1.21)	(2.37)	(1.12)	(2.95)	(4.78)	0.29	5.17	4.86	4.56	(0.12)	4.26	4.26
Case 6 - Decrease in yield increment	(1.21)	(2.37)	(0.81)	(2.89)	(4.68)	0.43	4.87	4.56	4.26	(0.42)	3.55	3.55
Case 7 - Decrease in price of rice	(1.20)	(2.36)	(1.02)	(2.96)	(4.83)	0.20	4.96	4.64	4.33	(0.36)	4.02	4.02
Case 8 - Decrease in cultivated area	(1.21)	(2.37)	(0.99)	(2.83)	(4.67)	0.39	5.26	4.94	4.63	(0.06)	4.32	4.32
Case 9 - Decrease in project life (no. of years)	(1.21)	(2.37)	(0.81)	(2.47)	(4.25)	0.85	5.88	5.52	5.17	0.45		
Case 10 - Combination of cases 8 & 9	(1.21)	(2.37)	(0.99)	(2.83)	(4.67)	0.39	5.26	4.94	4.63	(0.06)		
Case 11 - Benefits delay by 2 years	(1.21)	(2.37)	(2.63)	(6.12)	(6.63)	(0.14)	3.90	4.35	5.88	1.14	4.83	4.83

Results of Evaluation	**Change**	**NPV**	**EIRR**	**Sensitivity Indicator**	**Switching Value**
Base Case		9.5	24.0%		
Sensitivity Scenarios					
Case 1 - Increase in Capital Costs	10%	8.0	21.2%	1.5	65%
Case 2 - Increase in O&M Costs	10%	9.3	23.8%	0.2	586%
Case 3 - Decrease in overall benefit	-10%	6.6	20.4%	-3.0	-33%
Case 4 - Decrease in command area	-10%	8.8	23.2%	-0.7	-144%
Case 5 - Decrease in cropping intensity	-10%	6.1	19.7%	-3.5	-28%
Case 6 - Decrease in yield increment	-10%	4.6	18.5%	-5.1	-19%
Case 7 - Decrease in price of rice	-10%	5.3	18.8%	-4.5	-22%
Case 8 - Decrease in cultivated area	-10%	6.6	20.4%	-3.0	-34%
Case 9 - Decrease in project life (no. of years)	5	(0.2)	11.4%		
Case 10 - Combination of cases 8 & 9		(1.9)	5.4%		
Case 11 - Benefits delay by 2 years		3.2	14.9%		

SI = sensitivity indicator (ratio of percentage change in IRR above 12% to percentage change in selected variable).
SV = switching value (percentage change in selected variable to reduce the IRR to cut-off rate).
Source: PPTA Consultant.

II. TAING KRASAING SUBPROJECT

A. Introduction

46. The Uplands Irrigation and Water Resources Management Sector Project will enhance agricultural and rural economic productivity through increased efficiency of irrigation systems and improved management of water resources in uplands, areas away from the Tonle Sap Lake, including Kampong Thom province.

47. Water is the key input to agricultural production, productivity increase and economic growth. Rainfall distribution and river discharges have significant seasonal variability in Cambodia thus adversely affecting sustained agriculture production and increasing vulnerability. Climate change is likely to further exacerbate the situation. Timely availability of water and its efficient management is of prime importance to agriculture productivity and for diversifying agriculture and rural economy. Improving agricultural productivity, diversification, and managing irrigation systems and water resources are among major thrusts of the Government's National Strategy: Rectangular Strategy on Growth, Employment, Equity and Efficiency.[8] The ADB's Country Partnership Strategy also focuses on inclusive economic growth through physical infrastructure, agriculture and irrigation, among others.[9]

B. Methodology

48. This report presents the economic analysis undertaken for the subproject. The economic analysis of the subproject investment was undertaken in accordance with the principles and procedures set out in the ADB guidelines.[10] All benefits and costs are examined in order to assess the viability of the subproject as well as to identify its expected impact on various sectors of the local society, including the poor.

49. For this analysis, the costs and benefits within the Taing Krasaing irrigation command area are calculated for two alternative situations: "with the project" and "without the project". In the "without project' scenario, most parts of the command area are not irrigated. The analysis took account of what may be grown on the land without the irrigation system. The intent is to identify the incremental value of production attributable to the project (over its expected useful life) and compare this value to the incremental cost of implementing the subproject and of operating and maintaining the rehabilitated and new infrastructure over time.

50. To develop a model for the analysis, certain assumptions were made regarding future practice (both "with" and "without" the project) and about the valuation of inputs and outputs. These include:

(i) Project life is assumed at 25 years. Assuming adequate maintenance, the irrigation system should be able to maintain its expected benefits for 25 years before another major renovation may be required.

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[8] Royal Government of Cambodia Ministry of Planning. 2014. *National Strategic Development Plan 2014-2018*. Phnom Penh.

[9] Asian Development Bank. 2013. *Country Partnership Strategy for Cambodia, 2014-2018.* Manila.

[10] Include the *Cost-Benefit Analysis for Development – A Practical Guide (2013);* Guidelines for the Economic Analysis of Projects (1997); *ADB Handbook for the Economic Analysis of Water Supply Projects (1999);* and *Framework for the Economic and Financial Appraisal of Urban Development Sector Projects (1994)*.

(ii) "Without" the project assumes present cultivation patterns and technology are expected to continue for the life of the project.
(iii) "With" the project, the full command area is expected to continue to be adequately irrigated throughout the life of the project, allowing farmers to adopt appropriate cropping patterns and technology.[11]
(iv) Some agricultural outputs may be consumed by the farm households, but are valued as if sold.
(v) Some agricultural inputs such as farm labor are provided by the farm household but are valued at the market rate as if hired.
(vi) Values are expressed in constant 2015 prices so as to exclude inflation.
(vii) The U.S. dollar ($) is the unit of account. The exchange rate used is KHR4,040 per U.S. dollar which is the average rate for the last six months prior to the time of this study.

51. Financial prices used in this analysis were determined through field visits conducted by the PPTA team. These prices have been cross-checked with prices identified in other projects and in some secondary sources.

52. In order to assess the Project's contributions (and costs) to the economy of Cambodia it is necessary to convert financial values into their economic equivalents. Economic valuations exclude transfers from one part of society to another (i.e. taxes and subsidies) and compares project benefits and real opportunity costs to the economy by translating all prices into a common, undistorted value. Additional basic assumptions[12] used in the economic analysis include:
(i) The analysis uses the domestic price numeraire and for traded goods a shadow exchange rate factor (SERF) of 1.1 is applied.
(ii) For rural labor, a shadow wage rate factor (SWRF) of 0.9 is applied. The SWRF reflects the productivity of rural labor in the area.
(iii) Transfer payments such as taxes and subsidies are excluded in the calculation of economic values.
(iv) To calculate the economic net present value (ENPV) of the subproject, a discount rate of 12% is used as representing the opportunity cost of the capital invested.

C. "Without Project" and "With Project" Situation

53. **"Without Project" Situation**. The Taing Krasaing system is located some 25 km southeast of the city of Kampong Thom and 185 km from Phnom Penh. It was constructed during the period 1975–1978, underwent rehabilitation in 2000 and had some sections improved and modernized in 2005 and 2012. The irrigation system is supplied by a single reservoir from the Taing Krasaing river with levee-type protection on one side only and with non-functional outlet-control gates. The watershed upstream is estimated at some 1,100 km^2. It is linked through a 7-km canal to another system called Stung Chinit located south of the Taing Krasaing system. Stung Chinit, which has a proportionately larger watershed, has more water and thus can be used as supplementary source of water for Taing Krasaing.

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[11] It is assumed that whatever changes that will occur in the future (to the economy, climate, etc.) are expected to affect both the "with" and "without" project scenarios equally and maintaining the incremental differences in benefits and costs associated with the project's implementation.
[12] ADB. 2013. *Report and Recommendation of the President to the Board of Directors: Cambodia Climate Resilient Rice Commercialization Sector Development Program, Linked Document on Economic Analysis*. Manila.

54. The main canal of Taing Krasaing runs alongside a wide maintenance road which is relatively in good condition. The road/canal combination runs for some 3 km then makes a 90^{o} degrees left turn (at a tri-furcation), and runs for another 17 km in a straight line. There are 12 gates/regulators constructed on the main canal, however, no secondary canals are attached to these.

55. Further downstream at approximately 9 km from headworks, there are three primary left off-take gates constructed in 2012, with fully constructed secondary canals attached including flow control structures and tertiary outlets to fields in level condition. Thus, after a considerable stretch of apparent non-irrigation and undeveloped lands, irrigation actually commences and covers about 10,000 ha.

56. Technical verification confirms that the Taing Krasaing system has never really functioned as an irrigation system much served the adjacent communes. Only Taing Krasaing, Kokaoh and part of Chrob are currently planted with paddy rice during wet season. During dry season, only about 400 hectares are planted with other crops such as cassava, corn, water melon, mungbean and pineapple. Flooding problems are experienced in the area caused by local run-off floods and requires cross drainage solutions. Two major breaches with lengths of about 1 to 2 km located on the right embankment need to be resolved. Furthermore, the system has no water-measuring device, no inflow and cropping season records and no budget for operations and maintenance (O&M).

57. **"With Project" Situation.** The proposed improvement is expected to provide water to four communes covering a total area of 9,869 ha. Command area includes the following communes:

Table 26: Taing Krasaing Subproject Command Area

Commune	**Land Ownership**	**Total Area** (hectare)
Tipo (Section 1)	Private companies	2,664
Tipo (Section 2)	Farmer land	2,989
Taing Krasaing	Farmer land	1,370
Chrob	Farmer land	855
Korkoah	Farmer land	1,991
Total		9,869

Source: PPTA Consultant

58. Proposed physical improvements to the system are as follows:
   - (i) Rehabilitation of headworks (including undersluice and spillway);
   - (ii) Rehabilitation of 22 km main canal and installation of all structures for water control and distribution;
   - (iii) Provision of all drainage works to resolve flooding and existing breaches in right embankment of 3 km;
   - (iv) Construction of 48 km secondary and tertiary canals;
   - (v) Installation of a pump system and associated distribution channels to lift water by a maximum of 3 meters for area of 2,960 ha of developed rain-fed land.
   - (vi) Laser land levelling of 2,000 ha land (from ADB financed Rice Commercialization Program).

59. Other components of the subproject includes the following:
   - (i) Installation of Hydro-Met stations in the watersheds for water resources monitoring (to be installed with collaboration of ongoing ADB funded Flood and Drought Risk Management and Mitigation Project)

(ii) Provision of training to the PDWRAMs, FWUCs and the appropriate government agencies.
(iii) Organization, mobilization and training of FWUCs in the command area.
(iv) Involving FWUCs in the subprojects design and supervision of works, and operation and maintenance as per their role and responsibilities defined in the recently approved law – Sub-decree on the Procedures for the Establishment, Dissolution, Role and Duties of FWUC, Royal Government of Cambodia, 12 March 2015.
(v) Design joint reservoir operations for Stung Chinit and Taing Krasang Reservoir.

D. Economic Costs

60. It is estimated that these civil works will have a base cost of $25.5 million. Total cost including project management, construction supervision and detailed engineering design, on-farm preparation and physical contingency will reach $34.6 million. In economic prices the total cost is $31.7 million. Details are shown in the following table:

Table 17: Investment Cost – Taing Krasaing ($)

	Expenditure Category	Total Basic Financial Cost ($) [a]	Breakdown of Total Basic Cost ($)				Total Economic Cost [b]
			Foreign Component	Local Component			
				Materials	Labor		
					Skilled	Unskilled	
1	Main canal and headworks	10,800,172	1,728,028	7,236,115	540,009	1,296,021	9,857,612
2	Section 1 - Tipou 1	-	0	0	0	0	0
3	Section 2 - Tipou 2	5,000,000	800,000	3,350,000	250,000	600,000	4,563,636
4	Section 3 - Cavac TK	-	0	0	0	0	0
5	Section 4 - Chroab	1,297,547	207,608	869,356	64,877	155,706	1,184,307
6	Section 5 - Karkoah	8,372,332	1,339,573	5,609,462	418,617	1,004,680	7,641,656
	SUBTOTAL	25,470,051	4,075,208	17,064,934	1,273,503	3,056,406	23,247,210
7	Project Management/Consulting Services	3,775,000	1,510,000	1,132,500	1,132,500	0	3,569,091
8	Onfarm preparation cost	2,917,500	466,800	1,954,725	145,875	350,100	2,662,882
9	Physical Contingency [c]	2,470,000	395,200	1,654,900	123,500	296,400	2,254,436
	T O T A L	34,632,551	6,447,208	21,807,059	2,675,378	3,702,906	31,733,619

Note [a] Based on May 2015 prices.
[b] Conversion of financial to economic costs was based on the following shadow pricing:
Shadow exchange rate factor (SERF) = *1.1*
Shadow wage rate factor (SWRF) = *0.9*
Taxes and Duties = *10%*
[c] Physical Contingency = *10%*
Source: PPTA Consultant.

61. Based on the technical study, annual routine operation and maintenance (O&M) expenditure for the rehabilitated system is expected to amount to $25 per hectare plus an additional $75 per hectare for the Tipou areas that need pumping. After seven years there will be a need for substantial periodic maintenance expenditures amounting to roughly 30% of the construction cost or about $6.97 million in economic cost. This amount needs to be allocated every seven years thereafter. Both routine and periodic maintenance will be conducted during non-crop periods in order to minimize disruption to crop production while repairs are being done.

62. This irrigation subproject will involve land acquisition of about 34.2 has for the construction of the secondary and tertiary irrigation canals. Whether the required land will be

purchased or donated for the use of the project, it has an economic cost due to change in land use. This change is expected to result to loss in agricultural production. For this subproject, the net rice production per hectare for the next 25 years in the without project situation was used as parameter to compute for the economic cost of land. This was included in the subproject resource outflow.

E. Economic Benefits

63. The following economic benefits were considered in evaluating the economic viability of the proposed irrigation investments:

64. **Economic value of incremental increase in crop production**. This was determined based on the increased crop production from “without project” to “with project” situations. Two crops were considered: paddy rice as the main crop covering about 90% of the command area and the other 10% allocated for other crops such as cassava, corn, pineapple, mungbean and water melon. The economic value was computed by multiplying the following factors: area of land used in planting (in hectare); cropping intensity (in percentage); average yield (in ton/hectare); and farm gate price of crop (in $/ton). Crop production cost is deducted from the gross production value to derive the net benefit.[13] Incremental benefit is then calculated by deducting the without project situation from the “with project” situation.

65. As discussed, the main economic incremental benefit is the producer surplus. As such, the farmers’ willingness to pay (WTP) serves as an enabling condition for the producer surplus to materialize. The WTP was established based on a series of focus group discussions conducted during the PPTA study. Because there is not yet functional farmer’s water user community in both proposed subproject sites, the PPTA team interviewed the farmers’ groups in another functional irrigation scheme, Stung Chinit[14], financed by ADB, with similar pre-project situation to that of the proposed subprojects. The focus group discussions observed that the current irrigation service fee in Stung Chinit is currently KHR60,000 per hectare per crop. This service fee level can be assumed to be the WTP of irrigation water users since the actual collection having reportedly been 90%. Based on ADB’s experienced in irrigation sector in Cambodia, this fee level together with 90% collection efficiency, operation and maintenance can be carried out reasonably to support the producer surplus to be achieved.

66. **Avoided crop damages due to flooding.** As reported by the farmers and recorded by the District Agriculture Office, severe flood occurrences happen in the area at least once in five years affecting about 70% of crops in 1,590 hectares. Avoided crop damages due to flooding were computed by multiplying the total area affected by flood (in hectares); average rice production (in ton/hectare); economic price of rice ($/ton); number of flooding incidence in five years (number); percentage of crops damaged during flooding incidence (in percentage).

67. Other benefits that were not quantified and valued in the analysis include the following: improved health and nutrition of project beneficiaries; increased water availability for agricultural activities; training of PDWRAMs, FWUC members and other relevant agencies; and more

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[13] This cash flow stream of benefits does change over time in line with the World Bank commodity price projections for rice and major inputs such as fertilizer.

[14] Stung Chinit Irrigation System (SCIS FWUC) is located at Kampong Thom province with coverage area of 2,803 ha. It was established in 2002 and received financial and technical support from ADB and Agence Française de Developpement (AFD). The Stung Chinit project was completed in 2008. Thereafter, it received the strong support from the Irrigation Service Center (ISC), a non-government organization.

efficient management and monitoring of water resources. Furthermore, the design of a joint reservoir operation for Taing Krasaing and Stung Chinit reservoirs will further provide sustainable supply of water in the command area.

68. Summary of data and parameters used in the valuation of economic benefits are shown in the following table while detailed annual estimates are shown in Tables 23 to 29.

Table 18: Summary of Factors and Parameters Used

Parameter	Value
Command Area	9.869 ha
Without project (2015)	
Cultivated land in wet season (paddy rice)	3,618 ha
Cultivated land in dry season (other crops)	493 ha
Areas affected by severe flooding	1,590 ha
With project, Year 7 (2022)	
Cultivated land in wet season (paddy rice)	9.869 ha
Cultivated land in dry season (rice & other crops)	9.869 ha
Incremental Subproject Output – Paddy Rice	
Without project (2015)	
Yield	1.5 t/ha
Cropping intensity	100%
Farm gate price	$300/t
Production cost	$122/t
With project, Year 7 (2022)	
Yield	3 – 4 t/ha
Cropping intensity	200%
Farm gate price	$387/t
Production cost	$261/t
Incremental Subproject Output – Other Crops	
Without project (2015)	
Yield	14.9 t/ha
Cropping intensity	100%
Farm gate price	$324/t
Production cost	$130/t
With project (year 7 - 2022)	
Yield	20.5 t/ha
Cropping intensity	100%
Farm gate price	$324/t
Production cost	$127/t

Sources: UIWRMSP PPTA, Engineering and Irrigation Report (Supplementary Appendix No. 1) and Agriculture Report (Supplementary Appendix No. 3).

F. Results of Economic Analysis

69. **Economic Returns.** The main quantifiable benefits of the subproject are the net incremental value of crop production and avoided crop damages due to flooding. Costs are similarly projected with investment costs falling in the first three years followed by annual maintenance expenditures in each subsequent year and periodic maintenance cost every seventh year of operation. To calculate the cash flow of net project economic benefits, the cost cash flow is subtracted from the benefit cash flow. This annual cost and benefit stream is determined to calculate the economic returns of the subproject.

70. The Taing Krasaing irrigation subproject is expected to be economically viable in that the calculated economic internal rate of return (EIRR) is 24.7% and the economic net present value

(ENPV) of the investment is $16.4 million (when applying a discount rate of 12%). These strong economic results are due to the substantial size of the economic benefit stream relative to the economic construction cost of $34.6 million or $3,215 per hectare of command area.

71. Variations in the base case scenario were likewise tested to determine the best possible project package and how changes in the technical scope will affect the economic returns. The results indicate that the exclusion of Tipou 1 and Tipou 2 will give a lower EIRR which means that more benefits will be given up with the non-implementation of these two sections. Significantly, the exclusion of Kokaoh shows a higher EIRR indicating that the possible exclusion of this section is actually more beneficial to the area in general. The reasons for the possible variation in technical scope are based on the following circumstances that may possibly happen during implementation:

Table 19: Possible Variations to the Technical Scope of the Base Scenario

Variation	Possible Issues in Implementation	EIRR	NPV
Base Case – inclusion of all sections		22.7%	12.7
Variation 1 – exclusion of Tipou 1	The land in this section is owned by private companies so the Government might decide to bypass this area and prioritize the farmer lands.	13.7%	1.9
Variation 2 – exclusion of Tipou 2	The elevation of this section is higher ranging from 2.5 to 5 meters. There is a need to pump the water to a reservoir in order to bring water to the farmers by gravity. Annual O&M costs are expected to be higher due to pumping costs.	14.3%	2.36
Variation 3 – exclusion of Kokaoh	There is a resettlement issue in the area. However, the technical proposal is to construct an underground freeflow piped canal to avoid the existing structures in the canal alignment.	24.4%	10.9
Variation 4 – exclusion of Tipou 2 and Kokaoh	Refer to variations 2 and 3.	12.8%	0.5

EIRR = Economic Internal Rate of Return, NPV = Net Present Value
Source: PPTA Consultant.

72. **Sensitivity Analysis.** The reported economic returns of the subproject are based upon the assumption that costs and benefits over the life of the project will be as calculated. The future, of course, may be affected by a number of unforeseen events which can adversely change the expected result. It is useful to examine particular risks and check the impact they may make to the economic returns of the project. Some of these risks include the following:

73. Increase in Investment Cost**:** Care has been taken to accurately estimate the cost of the Taing Krasaing irrigation system. One of the sensitivity tests undertaken involves the possibility of actual cost being higher than the estimated cost. To determine the vulnerability of economic returns to higher construction costs, a 10% increase in costs was included in the estimation. This cost increase causes the EIRR to fall to 20.2%, a decline of 2.5% from the base EIRR. The sensitivity indicator for this level of cost increase is 1.58, while the level of increase at which the EIRR would fall below the acceptable 12% level (the switching value)[15] is at 63%.

74. Increase in O&M cost**:** Similar to investment costs, the possibility of O&M costs increasing than what was estimated may occur in the future. A test of the impact of a 10% increase in costs was done to determine how vulnerable the resulting EIRR to such an increase. The cost increase causes a very insignificant change in EIRR with a sensitivity factor of 0.23 and switching value of 434%.

[15] The switching value is the percent change in the risk variable that will make the EIRR fall to the level of the opportunity cost of capital (which is assumed to be 12%).

75. Decrease in Overall Benefits**:** An overall decline in total benefits by 10% was also tested defining no particular factor. With this general assumption, EIRR would fall to 19.5%, still above the required 12% threshold level. Sensitivity factor is -3.11 and switching value is -32%.

76. Decrease in Command Area**:** If the benefitted area of the Taing Krasaing system were not to reach its anticipated level of 9,869 ha, the economic returns can be expected to decrease from the base-case level. A 10% decrease in the command area drops the EIRR to 21.5% and ENPV to $10.9 million.

77. Decrease in Cropping Intensity**:** With available irrigation water, cropping intensity is expected to increase in the “with project” situation. However, in case this decreases by 10%, EIRR would decrease to 18.1% and ENPV to $7.0 million.

78. Decrease in Yield Increment: The average paddy rice yield when progressing from rainfed to irrigation water has been assumed to increase from 1.5 t/ha to 4 t/ha. If this increment were to decrease by 10%, the EIRR would drop to 20.7% and ENPV to $9.8 million.

79. Increase in Price of Crops: Rice prices are assumed to change over time along the lines predicted by the World Bank commodity price projections. Any drop in prices can affect future cash flow and project returns can be expected to fall. A 10% drop in price of paddy rice and other crops causes the EIRR to fall to 12.7% and ENPV to $0.8 million.

80. Benefits delayed by two years: Any delay in implementation schedule can impact on the benefits materializing for target beneficiaries. An assumed two-year delay will decrease EIRR and ENPV to 14.5% and $3.9 million, respectively.

81. Decrease in cultivated area: If the cultivated area were to decrease by 10% from the base-case level, EIRR will decrease to 20.9%. The sensitivity factor is at -1.4 while the switching value is at -73%.

82. Decrease in project life: The project is originally assumed at 25 years but if this will decrease to say 5 years, then EIRR drops to 10.0% which is below the assumed opportunity cost of 12%..

83. Decrease in cultivated area and project life: A simultaneous change in cultivated area and project life will adversely affect the result, dropping the EIRR to 6.7% which is below the assumed opportunity cost of 12%.

84. The level of economic returns, along with the results of the sensitivity analysis of various risks, indicates that the Taing Krasaing subproject investment is likely to pay for itself. However, a decrease in the project life puts EIRR below 12%, more so if this will be combined with other risks mentioned above.

Table 20: Summary Results of Base Case and Sensitivity Tests

Results of Evaluation	Change	NPV	EIRR	Sensitivity Indicator	Switching Value
Base Case		12.7	22.7%		
Sensitivity Scenarios					
Case 1 - Increase in Capital Costs	10%	10.7	20.2%	1.6	63%
Case 2 - Increase in O&M Costs	10%	12.4	22.4%	0.2	434%
Case 3 - Decrease in overall benefit	-10%	8.7	19.5%	-3.1	-32%
Case 4 - Decrease in command area	-10%	10.9	21.5%	-1.4	-71%
Case 5 - Decrease in cropping intensity	-10%	7.0	18.1%	-4.4	-23%
Case 6 - Decrease in yield increment	-10%	9.8	20.7%	-2.3	-44%
Case 7 - Decrease in price of rice	-10%	0.8	12.7%	-9.4	-11%
Case 8 - Decrease in cultivated area	-10%	10.9	20.9%	-1.4	-73%
Case 9 - Decrease in project life (no. of years)	5	(0.9)	10.0%		
Case 10 - Combination of cases 8 & 9		(2.5)	6.7%		
Case 11 - Benefits delay by 2 years		3.9	14.5%		

SI = sensitivity indicator (ratio of % change in IRR above the cut-off rate to percentage change in selected variable)
SV = switching value (percentage change in selected variable to reduce the IRR to cut-off rate).
Source: PPTA Consultant.

G. G. Financial Household Returns

85. As an impact of the project, it was estimated that farmer households in Taing Krasaing will gain a significant increase in their net revenue from paddy rice production of about $658/farmer household/year based on an average landholding of 1.5 hectares.

86. Without the project, the farmer households are getting a yield of 1.5 tons/hectare at average farm gate price of $300/ton. This gives a farmer household an average net annual revenue of $360 or $30 per month.[16] With the implementation of the project, the yield is projected to increase to 3 tons/ha. Average farm gate price of paddy rice is likewise expected to increase to $500/ton with the use of good quality seeds. Based on the average landholding, the projected average net annual revenue of farmer households is $1.018 or $85 per month.

87. Furthermore, starting at year seven of the subproject, an estimated 181,870 incremental labor days valued at $0.91 million will be required annually in the production of paddy rice and other crops.

H. Benefit Distribution and Poverty Impacts

88. The subproject will directly benefit 11,686 farmers in four communes in Santuk District where the Taing Krasaing irrigation system is located. It will directly affect 91% of the population that derive their main income from rice and vegetable crops. Poverty finds its roots on this source of income because of its dependence on a lot of factors (irrigation, agriculture inputs and technology, efficient water management, sufficiency of water at the source, type of soil, weather condition) thus providing insufficient opportunity for farmers to have sufficient and stable income to meet their needs. The main factors that cause poverty which are identified by the people in the project areas are the poor soil condition, lack of water in the canal for irrigation of crops

[16] UIWRMSP PPTA Report on Poverty and Socio-Economic Condition (Supplementary Document 16).

during the dry season, people do not use the appropriate agriculture technologies, and lack of job opportunities in the locality.[17]

89. The implementation of the project will try to tackle these factors that cause poverty by enhancing agricultural and rural economic productivity through increased efficiency of irrigation systems and improved management of water resources. The subproject will help decrease the poverty rates in the four communes which range from 24% to 39%.[18]

90. Project sustainability is strongly affected by who benefits, and by how much, relative to who pays. Main beneficiary groups or stakeholders for this subproject are identified as the government, local economy, labor sector and the farmers. The distribution of the economic benefits and costs over and above financial revenues and expenses are estimated to determine the extent to which public investment policy can affect the share that the various sectors derive from the project. The following table on benefit distribution shows the result of this analysis:

[17] Focus Group Discussion (FGD) conducted in Taing Krasaing and Prek Chik

[18] Ministry of Planning. 2012. Poverty Reduction by Capital, Provinces, Municipalities, Districts, Khans and Communes, Sangkat. Phnom Penh.

Table 21: Distribution of Economic Benefits

	Financial Present Value	Economic Present Value	Economic minus Financial	Government	Economy	Labor	Farmers
Total Project Benefits	1.5	43.6	42.1				42.1
Project Costs							
Traded	2.0	2.7	0.8		(0.8)		
Unskilled labor	1.8	1.6	(0.2)			0.2	
Non-traded	11.5	9.5	(1.9)		1.9		
Total Project Costs	15.2	13.9					
Net Benefits (Losses)	(13.7)	29.7	43.4	(13.7)			
Benefits (Losses)				(13.7)	1.1	0.2	42.1

Source: PPTA Consultant.

91. Another analysis was undertaken to determine the impact of the subproject to the poor sector of the community. The particular focus on net benefits that go to the poor is pertinent in this agricultural project. Computed poverty impact ratio (PIR) for this subproject is 30%. Details are presented in the following table:

Table 22: Poverty Impact

Particulars	Gov't. / Economy	Labor	Community	Total
Benefits (Losses)	1.13	0.24	42.06	43.43
Financial Return to Governmen	(13.72)			(13.72)
Total Benefits (Losses)	(12.58)	0.24	42.06	29.71
Proportion of Poor (%)	0.30	0.67	0.30	
Benefits to Poor	(3.73)	0.16	12.48	8.90
Poverty Impact Ratio (%)				30.0%

I. Conclusion

92. The proposed Taing Krasaing irrigation system is expected to make important contributions to the local economy, increasing paddy production and household income significantly. The scheme is economically viable. It will also play a role in the commercialization of rice production. Its expected 52,166 tons per year of incremental paddy production will almost certainly all be marketed given that the local population already has more than enough for its own consumption. Similarly, crop diversification has high potentials for other crops such as cassava, corn, mungbean, pineapple and watermelon have high potentials and will provide good production value to the farmers.

Table 23: Economic Price Estimates for Internationally Traded Outputs (Rice)

		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Rice Paddy												
Thailand (current $) [a]	$/t	415	411	408	404	401	397	394	390	387	383	380
Thailand (constant 2010 $) [a]	$/t	393	382	373	364	355	346	338	329	321	313	305
MUV (2010 = 1.0) [b]	2010	1.06	1.08	1.09	1.11	1.13	1.15	1.17	1.19	1.21	1.23	1.25
MUV (2015 = 1.0) [b]	2015	1.00	1.02	1.04	1.05	1.07	1.09	1.10	1.12	1.14	1.16	1.18
Rice FOB Bangkok (constant 2015 $)	$/t	415	404	394	384	375	366	357	348	339	330	322
Quality Adjustment [c]	$/t	332	323	315	307	300	293	285	278	271	264	258
Freight, insurance, etc.	$/t	60	60	60	60	60	60	60	60	60	60	60
CIF Sihanoukville	$/t	272	263	255	247	240	233	225	218	211	204	198
Freight & handling Sihanoukville to project area	$/t	24	24	24	24	24	24	24	24	24	24	24
Conversion to paddy [d]	$/t	149	144	139	134	130	125	121	117	112	108	104
Milling charge net of bran and husks	$/t	0	0	0	0	0	0	0	0	0	0	0
Handling and transport farm to mill [e]	$/t	6	6	6	6	6	6	6	6	6	6	6
Economic farmgate price per ton	$/t	143	138	133	128	124	120	115	111	107	103	99
Economic farmgate price per kg	$/kg	0.14	0.14	0.13	0.13	0.12	0.12	0.12	0.11	0.11	0.10	0.10
Financial - Non-fragrant variety	$/t	300	289	279	269	260	250	241	232	224	215	207
Economic - Non-fragrant variety	$/t	330	318	307	296	285	275	266	256	246	237	227
Financial - Fragrant variety	$/t	500	481	464	448	433	417	402	387	373	358	344
Economic - Fragrant variety	$/t	550	529	511	493	476	459	443	426	410	394	379

[a] WB Commodity Price Projections prepared January 22, 2015 for 2013 through 2025. (Thailand, 5% broken, white rice, milled, fob Bangkok)

[b] Manufacturing Unit Value Index

[c] Adjustment for quality relative to the standard of Thai white rice, 5% broken = 20%

[d] Standard conversion factor (SCF) applied on half the amount of handling, transportation and milling = 0.9

[e] Conversion factor of paddy to rice = 60%

Table 24a: Economic Price Estimates for Internationally Traded Inputs (Urea)

		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Urea												
Eastern Europe (current $) [a]	$/t	300	298	296	294	292	290	288	286	284	282	280
Eastern Europe (constant 2010 $) [a]	$/t	284	277	270	264	258	253	247	241	236	230	225
MUV (2010 = 1.0) [b]	2010	1.06	1.08	1.09	1.11	1.13	1.15	1.17	1.19	1.21	1.23	1.25
MUV (2015 = 1.0) [b]	2015	1.00	1.02	1.04	1.05	1.07	1.09	1.10	1.12	1.14	1.16	1.18
Urea FOB Eastern Europe (constant 2015 $)	$/t	300	292	286	279	273	267	261	255	249	243	237
Freight, insurance, etc.	$/t	60	60	60	60	60	60	60	60	60	60	60
CIF Sihanoukville	$/t	360	352	346	339	333	327	321	315	309	303	297
Freight & handling Sihanoukville to project area	$/t	24	24	24	24	24	24	24	24	24	24	24
Handling and transport to farmgate [c]	$/t	6	6	6	6	6	6	6	6	6	6	6
Economic farmgate price per ton	$/t	389	382	375	369	362	356	350	344	338	332	327
Economic farmgate price per kg	$/t	0.39	0.38	0.38	0.37	0.36	0.36	0.35	0.34	0.34	0.33	0.33

[a] WB Commodity Price Projections prepared January 22, 2015 for 2013 through 2025. (Bagged, f.o.b. Eastern Europe (varying origins)

[b] Manufacturing Unit Value Index

[c] Standard conversion factor (SCF) applied on half of handling and transportation cost = 0.9

Table 24b: Economic Price Estimates for Internationally Traded Inputs (DAP)

		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
DAP (diammonium phosphate)												
US (current $) [a]	$/t	450	449	448	447	446	445	444	443	442	441	440
US (constant 2010 $) [a]	$/t	426	417	409	402	395	388	381	374	367	360	353
MUV (2010 = 1.0) [b]	2010	1.06	1.08	1.09	1.11	1.13	1.15	1.17	1.19	1.21	1.23	1.25
MUV (2015 = 1.0) [b]	2015	1.00	1.02	1.04	1.05	1.07	1.09	1.10	1.12	1.14	1.16	1.18
DAP FOB US Gulf (constant 2015 $)	$/t	450	441	433	425	417	410	402	395	388	380	373
Freight, insurance, etc.	$/t	60	60	60	60	60	60	60	60	60	60	60
CIF Sihanoukville	$/t	510	501	493	485	477	470	462	455	448	440	433
Freight & handling Sihanoukville to project area	$/t	24	24	24	24	24	24	24	24	24	24	24
Handling and transport to farmgate [c]	$/t	6	6	6	6	6	6	6	6	6	6	6
Economic farmgate price per ton	$/t	539	530	522	514	507	499	492	484	477	470	462
Economic farmgate price per kg	$/t	0.54	0.53	0.52	0.51	0.51	0.50	0.49	0.48	0.48	0.47	0.46

[a] WB Commodity Price Projections prepared January 22, 2015 for 2013 through 2025. (Standard size, bulk, spot, f.o.b. US Gulf)

[b] Manufacturing Unit Value Index

[c] Standard conversion factor (SCF) applied on half the amount of handling & transportation = 0.9

Table 25: Command Area Land Use With and Without the Project: Taing Krasaing, Kampong Thom Province

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2030	2040
Land Area (has.)												
By Commune												
Tipou 1	2,664	2,664	2,664	2,664	2,664	2,664	2,664	2,664	2,664	2,664	2,664	2,664
Tipou 2	2,989	2,989	2,989	2,989	2,989	2,989	2,989	2,989	2,989	2,989	2,989	2,989
Cavac Taing Krasaing	1,370	1,370	1,370	1,370	1,370	1,370	1,370	1,370	1,370	1,370	1,370	1,370
Chroab	855	855	855	855	855	855	855	855	855	855	855	855
Korkoah	1,991	1,991	1,991	1,991	1,991	1,991	1,991	1,991	1,991	1,991	1,991	1,991
Subtotal	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869
By Cultivated Crop												
Paddy Rice	8,882	8,882	8,882	8,882	8,882	8,882	8,882	8,882	8,882	8,882	8,882	8,882
Other Crops	987	987	987	987	987	987	987	987	987	987	987	987
Subtotal	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869
Command Area Land Use (has.)												
Without project												
Wet Season												
Paddy Rice	3,618	3,618	3,618	3,618	3,618	3,618	3,618	3,618	3,618	3,618	3,618	3,618
Fallow	6,252	6,252	6,252	6,252	6,252	6,252	6,252	6,252	6,252	6,252	6,252	6,252
Subtotal	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869
Dry Season												
Paddy Rice	-	-	-	-	-	-	-	-	-	-	-	-
Other Crops	493	493	493	493	493	493	493	493	493	493	493	493
Fallow	9,376	9,376	9,376	9,376	9,376	9,376	9,376	9,376	9,376	9,376	9,376	9,376
Subtotal	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869
With project												
Wet Season												
Paddy Rice	3,618	3,618	3,618	8,882	8,882	8,882	8,882	8,882	8,882	8,882	8,882	8,882
Fallow	6,252	6,252	6,252	987	987	987	987	987	987	987	987	987
Subtotal	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869
Dry Season												
Paddy Rice	-	-	-	1,962	5,651	6,899	8,403	8,882	8,882	8,882	8,882	8,882
Other Crops	493	493	493	395	592	790	987	987	987	987	987	987
Fallow	9,376	9,376	9,376	7,513	3,626	2,181	480	-	-	-	-	-
Subtotal	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869

Table 26: Crop Yield and Intensity – With and Without the Project: Taing Krasaing, Kampong Thom Province

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2030	2040
Crop Yield (t/ha)												
Without project												
Wet Season												
Paddy Rice	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Dry Season												
Paddy Rice	-	-	-	-	-	-	-	-	-	-	-	-
Other Crops	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9
With project												
Wet Season												
Paddy Rice	1.5	1.5	1.8	2.1	2.4	2.4	2.7	3.0	3.0	3.0	3.0	3.0
Dry Season												
Paddy Rice	-	-	2.5	2.5	3.2	3.2	4.0	4.0	4.0	4.0	4.0	4.0
Other Crops	14.9	14.9	14.9	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5
Cropping Intensity (%)												
Without project												
Wet Season												
Paddy Rice	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Dry Season												
Paddy Rice	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Other Crops	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
With project												
Wet Season												
Paddy Rice	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Dry Season												
Paddy Rice			100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Other Crops	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table 27: Crop Production Volume (in ton) and Value ($ million) Without and With Project: Taing Krasaing, Kampong Thom Province

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2030	2040
Total Crop Production (tons)												
Without project												
Wet Season												
Paddy Rice	5,426	5,426	5,426	5,426	5,426	5,426	5,426	5,426	5,426	5,426	5,426	5,426
Dry Season												
Paddy Rice	-	-	-	-	-	-	-	-	-	-	-	-
Other Crops	7,333	7,333	7,333	7,333	7,333	7,333	7,333	7,333	7,333	7,333	7,333	7,333
With project												
Wet Season												
Paddy Rice	5,426	5,426	6,512	18,652	21,317	21,317	23,982	26,646	26,646	26,646	26,646	26,646
Dry Season												
Paddy Rice	-	-	-	4,904	18,082	22,075	33,610	35,528	35,528	35,528	35,528	35,528
Other Crops	7,333	7,333	7,333	8,093	12,139	16,185	20,231	20,231	20,231	20,231	20,231	20,231
Economic Farmgate Price ($/ton)												
Rice												
Without project	289	279	269	260	250	241	232	224	215	207	207	207
With project	481	464	448	433	417	402	387	373	358	344	344	344
Other crops	324	324	324	324	324	324	324	324	324	324	324	324
Gross Crop Production ($ mil)												
Without project												
Wet Season												
Paddy Rice	1.57	1.51	1.46	1.41	1.36	1.31	1.26	1.21	1.17	1.12	1.12	1.12
Dry Season												
Paddy Rice	-	-	-	-	-	-	-	-	-	-	-	-
Other Crops	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38
With project												
Wet Season												
Paddy Rice	1.57	1.51	2.92	8.07	8.90	8.58	9.29	9.93	9.55	9.17	9.17	9.17
Dry Season												
Paddy Rice	-	-	-	2.12	7.55	8.88	13.02	13.24	12.73	12.23	12.23	12.23
Other Crops	2.38	2.38	2.38	2.62	3.93	5.24	6.55	6.55	6.55	6.55	6.55	6.55

Table 28: Incremental Crop Production – With and Without the Project: Taing Krasaing, Kampong Thom Province

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2030	2040
Production Cost ($ mil)												
Without project												
Wet Season												
Paddy Rice	0.68	0.68	0.68	0.67	0.67	0.67	0.67	0.66	0.66	0.66	0.66	0.66
Dry Season												
Paddy Rice	-	-	-	-	-	-	-	-	-	-	-	-
Other Crops	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
With project												
Wet Season												
Paddy Rice	0.68	0.68	1.71	4.89	5.58	5.58	6.27	6.96	6.95	6.95	6.95	6.95
Dry Season												
Paddy Rice	-	-	-	1.29	4.74	5.78	8.79	9.28	9.27	9.26	9.26	9.26
Other Crops	0.93	0.93	0.93	1.03	1.54	2.05	2.57	2.57	2.57	2.57	2.57	2.57
Net Value of Crop Production ($ mil)												
Without project												
Wet Season												
Paddy Rice	0.89	0.83	0.78	0.74	0.69	0.64	0.60	0.55	0.51	0.46	0.46	0.46
Dry Season												
Paddy Rice	-	-	-	-	-	-	-	-	-	-	-	-
Other Crops	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42
With project												
Wet Season												
Paddy Rice	0.89	0.83	1.21	3.18	3.31	3.00	3.02	2.97	2.60	2.22	2.22	2.22
Dry Season												
Paddy Rice	-	-	-	0.84	2.81	3.10	4.23	3.96	3.46	2.97	2.97	2.97
Other Crops	1.45	1.45	1.45	1.59	2.39	3.19	3.99	3.99	3.99	3.99	3.99	3.99
Incremental Value of Net Crop Production ($ mil)												
Wet Season												
Paddy Rice	-	-	0.43	2.44	2.62	2.35	2.42	2.42	2.09	1.76	1.76	1.76
Dry Season												
Paddy Rice	-	-	-	0.84	2.81	3.10	4.23	3.96	3.46	2.97	2.97	2.97
Other Crops	0.02	0.02	0.02	0.17	0.97	1.77	2.56	2.56	2.56	2.56	2.56	2.56
Total	0.02	0.02	0.45	3.45	6.40	7.23	9.22	8.95	8.11	7.29	7.29	7.29

Table 29: Benefit Savings from Avoided Flood Damages: Taing Krasaing, Kampong Thom Province

				2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2040
Flooded Area														
Flooding incidence -	once in	5	years	5	5	5	5	5	5	5	5	5	5	5
Area affected (has.)		1,590		1,590	1590	1590	1590	1590	1590	1590	1590	1590	1590	1590
Ave. rice production per hectare (t/ha)		1.5		1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Economic price of rice per ton ($/t)				289	279	269	260	250	241	232	224	215	207	207
Economic price of rice per hectare ($/ha)				433	418	403	389	376	362	349	335	323	310	310
Percentage of rice damaged by flood		70%		70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%
Total crop production lost ($)				482,055	465,211	449,076	433,295	418,047	402,975	388,081	373,365	359,003	344,818	344,818
Annual crop production lost ($ mil)				0.10	0.09	0.09	0.09	0.08	0.08	0.08	0.07	0.07	0.07	0.07

Table 30: Economic Opportunity Cost of Land: Taing Krasaing, Kampong Thom Province

		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2040
Economic opportunity cost of land												
Total area required (has.)	34.2	14.3	34.2	34.2	34.2	34.2	34.2	34.2	34.2	34.2	34.2	34.2
Ave. rice production without project (t/ha)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Economic price of rice per ton ($/t)		289	279	269	260	250	241	232	224	215	207	207
Economic price of rice per hectare ($/ha)		433	418	403	389	376	362	349	335	323	310	310
Total crop production lost ($ mil)		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Table 31: Result of Economic Evaluation: Taing Krasaing, Kampong Thom Province ($ million)

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2030	2040
Costs												
Investment cost	1.59	3.17	3.17	7.93	11.11	4.76	-	-	-	-	-	-
Regular O&M cost	-	-	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
Periodic maintenance cost	-	-	-	-	-	-	-	-	-	6.97	-	-
Opportunity cost of land	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Total Costs	1.59	3.19	3.66	8.42	11.59	5.25	0.49	0.49	0.49	7.46	0.49	0.49
Benefits												
Increased production from farmlands	0.02	0.02	0.45	3.45	6.40	7.23	9.22	8.95	8.11	7.29	7.29	7.29
Savings from flood damages	-	-	0.09	0.09	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.07
Total Benefits	0.02	0.02	0.54	3.54	6.49	7.31	9.30	9.02	8.19	7.36	7.36	7.36
Net Cash Flow (Base Case)	(1.57)	(3.17)	(3.12)	(4.89)	(5.11)	2.06	8.81	8.54	7.70	(0.10)	6.88	6.88
Sensitivity Tests:												
Case 1 - Increase in Capital Costs	(1.73)	(3.48)	(3.44)	(5.68)	(6.22)	1.58	8.81	8.54	7.70	(0.10)	6.88	6.88
Case 2 - Increase in O&M Costs	(1.57)	(3.17)	(3.17)	(4.93)	(5.16)	2.01	8.77	8.49	7.65	(0.15)	6.83	6.83
Case 3 - Decrease in overall benefit	(1.57)	(3.17)	(3.18)	(5.24)	(5.76)	1.33	7.88	7.63	6.88	(0.83)	6.14	6.14
Case 4 - Decrease in command area	(1.57)	(3.17)	(3.05)	(4.83)	(5.14)	1.95	8.62	7.94	7.15	(0.60)	6.37	6.37
Case 5 - Decrease in cropping intensity	(1.57)	(3.17)	(3.39)	(5.45)	(5.96)	1.13	7.69	7.44	6.70	(1.02)	5.69	5.69
Case 6 - Decrease in yield increment	(1.57)	(3.17)	(3.12)	(5.04)	(5.35)	1.74	8.41	8.14	7.30	(0.50)	5.96	5.96
Case 7 - Decrease in price of rice	(1.57)	(3.16)	(3.28)	(5.80)	(6.78)	0.15	6.28	5.91	5.16	(2.55)	4.42	4.42
Case 8 - Decrease in cultivated area	(1.57)	(3.17)	(3.25)	(5.30)	(5.82)	1.27	8.23	8.38	7.58	(0.18)	6.80	6.80
Case 9 - Decrease in project life (no. of years)	(1.57)	(3.17)	(3.12)	(4.89)	(5.11)	2.06	8.81	8.54	7.70	(0.10)		
Case 10 - Combination of cases 8 & 9	(1.57)	(3.17)	(3.25)	(5.30)	(5.82)	1.27	8.23	8.38	7.58	(0.18)		
Case 11 - Benefits delay by 2 years	(1.59)	(3.19)	(3.66)	(8.42)	(11.06)	(1.71)	6.00	6.82	8.81	1.56	6.88	6.88

Results of Evaluation	Change	NPV	EIRR	Sensitivity Indicator	Switching Value
Base Case		12.7	22.7%		
Sensitivity Scenarios					
Case 1 - Increase in Capital Costs	10%	10.7	20.2%	1.6	63%
Case 2 - Increase in O&M Costs	10%	12.4	22.4%	0.2	434%
Case 3 - Decrease in overall benefit	-10%	8.7	19.5%	-3.1	-32%
Case 4 - Decrease in command area	-10%	10.9	21.5%	-1.4	-71%
Case 5 - Decrease in cropping intensity	-10%	7.0	18.1%	-4.4	-23%
Case 6 - Decrease in yield increment	-10%	9.8	20.7%	-2.3	-44%
Case 7 - Decrease in price of rice	-10%	0.8	12.7%	-9.4	-11%
Case 8 - Decrease in cultivated area	-10%	10.9	20.9%	-1.4	-73%
Case 9 - Decrease in project life (no. of years)	5	(0.9)	10.0%		
Case 10 - Combination of cases 8 & 9		(2.5)	6.7%		
Case 11 - Benefits delay by 2 years		3.9	14.5%		

SI = sensitivity indicator (ratio of % change in IRR above the cut-off rate to percentage change in selected variable).
SV = switching value (percentage change in selected variable to reduce the IRR to cut-off rate).

Appendix 10:
FINANCIAL MANAGEMENT ASSESSMENT

I. INTRODUCTION

1. This financial management assessment (FMA) report was prepared in accordance with the technical guidance note for FMA (ADB, 2015). This FMA incorporates the financial management internal control and risk management assessment required by the ADB guidelines. It may need to be amended further to reflect subsequent developments and agreements during the project implementation. The FMA preparatory activities included reviewing documents, interviewing staff of government agencies, consultants, beneficiaries and other stakeholders, and completed with inputs from other references through desk studies.

2. The purpose of this FMA was to determine the robustness of the accounting, financial controls and internal audit arrangements, and the capability of the executing and implementing agencies to meet all the fiduciary requirements which will be set out in the loan agreement, and other project documents. The FMA has assessed executing and implementing agencies and financial arrangements, financial responsibilities and perceived financial risks and risk management. This FMA also provides guidance to the executing and implementing agencies for mitigation measures to ensure the effective project performance, following country laws and regulations as well as ADB's requirements.

3. This FMA report updates the FMA done on the Ministry of Water Resources and Meteorology (MOWRAM) in 2014.[1] To complete the FMA, the executing and implementing agencies have refilled out the ADB's standard FMA questionnaires (FMAQs) and the updated FMAQs are in Annex 1.

II. BRIEF PROJECT DESCRIPTION

4. The proposed Uplands Irrigation and Water Resources Management Sector Project in Cambodia is designed to assist MOWRAM to (i) rehabilitate, upgrade, modernize and provide climate proofing to selected irrigation systems and deliver improved irrigation services, with the systems (referred to as subprojects) selected from a longlist developed with MOWRAM, and (ii) support capacity development. The project is included in ADB's Country Operations Business Plan for Cambodia, 2015–2018.

5. The project's outcome will be enhanced water and agricultural productivity, with increased irrigation efficiency and increased water productivity. Its outputs will be (i) enhanced efficiency and climate resilience of irrigation systems, and (ii) improved water resource management.

6. The project will be implemented from January 2016 to March 2021.

[1] The 2014 update of the financial management assessment (FMA) on Ministry of Water Resources and Meteorology (MOWRAM) and two other agencies was done to support ADB's loan for the Flood Damage Emergency Reconstruction Project (Additional Financing) (Project No. 46009-003). This was conducted during the fact-finding mission held from 20 to 30 January 2014, based on the FMA of the ongoing project. The agencies included the MOWRAM which is managing component 3: Irrigation and Flood Control.

7. The project cost is estimated at $66.12 million with ADB financing of $60.0 million equivalent and about $6.12 million by the government, as given in the following tables. Further details of the cost and financing plan are given in the project administration manual (PAM).

Table 1: Financing Plan ($ million)

Source	**Amount**	**Share of Total** (%)
Asian Development Bank (ADF)	60.00	90.7%
Government	6.12	9.3%
Total	**66.12**	**100.0%**

Source: Asian Development Bank estimates.

Table 2: Project Investment Plan ($ million)

Item	**Amount**[a]
A. Base Cost[b]	
1. Efficiency and climate resilience of irrigation systems	50.80
2. Water resource management	1.31
3. Project management	1.15
Subtotal (A)	53.26
B. Contingencies[c]	11.24
C. Financing Charges During Implementation[d]	1.62
Total (A+B)	66.12

[a] Includes taxes and duties of about $4.53 million to be financed from the government resources for civil works and $2.32 million from ADB loan resources for the following expenditures: consulting services, equipment, furniture, vehicle and incremental operational cost.

[b] In mid-2015 prices.

[c] Physical contingencies computed at 10% for civil works (since sector approach); and 5% for vehicle, equipment and consulting services. Price contingencies computed at average 1.48% on foreign exchange costs and 3.5% on local currency costs; includes provision for potential exchange rate fluctuation under the assumption of a purchasing power parity exchange rate.

[d] Includes interest. Interest during construction for ADB loan that has been computed at the 1% per annum during the grace/five year implementation period.

Source: Asian Development Bank estimates.

Table 3: Cost by Expenditures ($ million)

			Total	**ADB**	**Government**
A.	**Base Costs**				
	1	Civil Works	45.14	41.02	4.11
	2	Hydro-meteorological Equipment	1.20	1.20	-
	3	Office Equipment/Vehicles/Furniture	1.00	1.00	-
	4	Consulting Services	4.85	4.85	-
	5	Incremental Operating Cost	0.50	0.25	0.25
	6	Land acquisition/Resettlement	0.58	-	0.58
		Subtotal (A)	**53.26**	**48.32**	**4.94**
B.	**Contingencies**				
	1	Physical Contingencies	4.94	4.38	0.55
	2	Price Contingencies	6.30	5.67	0.63
		Subtotal (B)	**11.24**	**10.06**	**1.18**
C.		**Interests During Implementation**	**1.62**	**1.62**	**-**
		Subtotal (C)	**1.62**	**1.62**	**-**
Total Cost (A+B+C)			**66.12**	**60.00**	**6.12**

Source: Asian Development Bank estimates.

III. COUNTRY AND SECTOR FINANCIAL MANAGEMENT ISSUES

8. **Public Financial Management (PFM) and Procurement Risks and Mitigation.** As in ADB's Country Partnership Strategy (2014–2018), to mitigate PFM and oversight capacity risks, ADB will extend its support to the PFM reform program by improving the financial accountability of rural development ministries and other selected ministries in areas of ADB engagement, and the PFM capacity of subnational administrations. ADB measures to mitigate procurement and corruption risks in its operations include (i) identifying risks and implementing targeted mitigation measures for all projects to ensure transparency and accountability through governance and risk assessment and risk management plans; (ii) tightening project procurement and applying measures to ensure a well-functioning monitoring and evaluation system; (iii) conducting joint investigations of irregularities in ADB-financed projects; and (iv) supporting the further development of the government's updated *Standard Operating Procedures*, *Procurement Manual*, and *Financial Management Manual* for all externally assisted projects and programs in Cambodia, and training government officials to apply them effectively.

9. **Public Expenditure and Financial Accountability (PEFA) Assessment.** The overall ratings of the PEFA assessment conducted in 2010[2] indicate a mixed assessment for Cambodia. Of the 29 items rated, two (6.9%) were rated A; four were rated B (13.8%); 15 were rated C or C+ (51.7%); while eight were rated D (27.6%). While single, system wide ratings are not recommended under the PEFA methodology since both mean and median ratings tend towards Cambodia being a C-level country as far as PFM is concerned.

10. **PFM Reform Strategy**. The importance of PFM is reflected in the Rectangular Strategy Phase 3 (2013–2018)[2] and the National Strategic Development Plan (NSDP, 2014–2018).[3] The government has been implementing a number of reforms to promote governance and public sector efficiency and improved service delivery and has made significant progress in reforming public expenditure policy in the past decade since the Public Financial Management Reform Program (PFMRP) was launched in 2004. The PFMRP aims at mobilizing resources and improving efficiency and accountability in public expenditures that would lead to achieve high rates of economic growth and poverty reduction. The PFMRP is a multi-platform approach, with each platform meant to build on previous achievements.

11. A PFMRP progress report was recently published and this assessment draws on its findings.[4] The report concludes that variable progress has been achieved since 2012. In three objectives good progress has been achieved and in eleven objectives moderate progress has been achieved. Of the 32 recommendations made in the 2012 External Advisory Panel Report,[5] 25 have either been, or are in the process of being, addressed, four are either superseded or no longer valid; and three have yet to be fully addressed. The main recommendations concern a more comprehensive analysis and communication strategy to stakeholders and the need for the National Audit Authority (NAA), the country supreme audit institution, to participate more fully in the PFMRP reforms.

[2] Royal Government of Cambodia. Ministry of Economy and Finance. 2010. *Final Report. Public Financial Management Assessment Cambodia - Based on the Public Expenditure Financial Accountability Framework (PEFA)*. Public Financial Management Reform Program, February.

[2] Royal Government of Cambodia. 2013. *Rectangular Strategy Phase III, SamdechTechno Hun Sen*.

[3] Royal Government of Cambodia. 2014. *National Strategic Development Plan 2014–2018*. .

[4] Royal Government of Cambodia. 2013. *Cambodian Budget System Reform 2013–2020*. Phnom Penh.

[5] External Advisory Panel. 2015. Public Financial Management Reform Program – Final External Advisory Panel Report. Phnom Penh. p. vii.

12. **Legislative and Policy Framework.** The Law on the Public Finance System (2008) is basically modern and provides an adequate basis for progressive implementation of the PFMRP. The Audit Law (2000) regulates external and internal audit matters. The revised Constitution (1999) and the Law on Administrative Management of the Capital, Provinces, Municipalities, Districts and Khans (Organic Law 2008) provide the core foundations for the decentralization and de-concentration reforms. The Law on Subnational Fiscal Regime and Property Management for Subnational Administrations (2012) regulates public financial management at the subnational level. Important legislative developments for corruption mitigation include penalty provisions in the Public Finance Law (2008), strengthening the Penal Code for Corrupt Offenses (2009), and passing the Anti-Corruption Law (2010).

13. **Institutional Capacities.** The Ministry of Economy and Finance (MEF) exercises strong central control over public finance matters, including the PFMRP. A dual budget system has emerged with MEF in charge of preparing and managing the recurrent budget, while the Ministry of Planning ostensibly has powers to prepare and manage a public investment program. Most externally financed investments involve development partners dealing with line ministries, the Council for the Development of Cambodia and MEF's Department of Investment Cooperation. MEF's Department of Investment Cooperation prepares and manages both the government-operated externally and domestically-financed capital/development budgets. The MEF's Financial Affairs Department (FAD), the General Department of Treasury, the Public Procurement Department, and the Cash Management Units are all closely involved with budget execution. FAD has financial controllers located in 21 key ministries. A PFM Reform Steering Committee, established through Sub-decree 23 dated 17 January 2014, is responsible for leading, preparing, facilitating, monitoring and inspecting the government's PFMRP implementation in cooperation with development partners. The committee is chaired by MEF and supported by the PFM Reform Secretariat. A technical working group, comprising representatives of government institutions and development partners, meets every six months to discuss progress and constraints of the PFM reform.

14. **Program Budgeting**. Government capacity for budget preparation (strategic planning, program budgeting, and budget execution) is being gradually improved. At the start of each budget cycle, the government produces a Macroeconomic Policy Framework and then develops a Public Financial Policy Framework using a Medium-Term Expenditure Framework (MTEF). The MTEF, which forecasts on the basis of economic and functional classifications, is updated annually to provide forward budget planning from a "top-down" perspective. Based on the MTEF, line ministries prepare annual and medium-term 3-year rolling budget strategic plans, inclusive of the public investment program, which link budgets to sector policies and priority strategies. The budget strategic plans and program budgets are prepared annually using a "bottom-up" approach with inputs from line ministries within fixed timelines.

15. **Expenditure Management, Accounting and Financial Management**. Capacities in budget preparation and execution, financial management and accounting, procurement, internal and external audit, and monitoring and evaluation are still limited but are being strengthened. The Cash Management Unit at MEF monitors budget execution and cash management of all line ministries. This is augmented by a comprehensive and very complex set of internal controls (commitment and payment order processes) which are now in place, though further improvements are needed. The National Treasury has rationalized government accounts held at commercial banks, and transferred balances to the Treasury Single Account. In addition, government payments, including salary administration through the banking system, have increased, reducing the number of cash-based transactions.

16. **Financial Reporting.** The accuracy and comprehensiveness of financial reporting are being systematically improved through the implementation of international standard budget classifications, charts of accounts, and integration of capital spending. The National Treasury controls the government bank accounts at the National Bank of Cambodia. The National Treasury reconciles these accounts with corresponding cash books monthly, within 4 weeks from the end of the month. In addition, cash forecasting models and approaches are expected to be further strengthened under the upcoming Financial Management Information System (FMIS). Areas for improvements in accounting include: (i) adopting IT accounting, and promoting a harmonized treasury and line ministry accounting system in line with the upcoming FMIS; and (ii) implementing robust and computerized asset management systems.

IV. PROJECT FINANCIAL MANAGEMENT SYSTEM

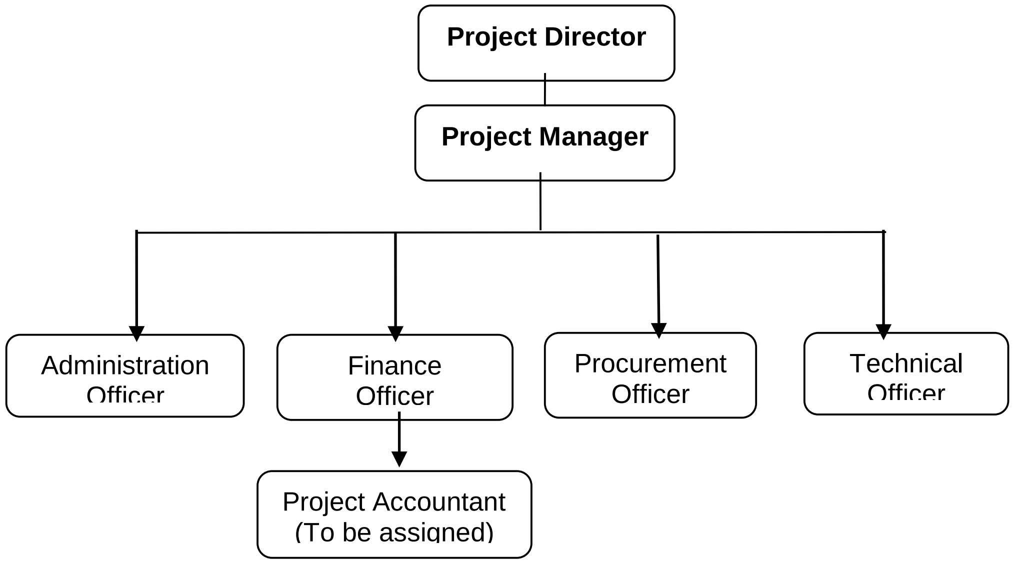
A. Overview

17. **Executing and Implementing Agencies**. The Ministry of Water Resources and Meteorology (MOWRAM) and its Department of Farmer Water User Communes (DFWUC), both public sector stakeholder agencies, are the executing agency and the implementing agency of the proposed project, respectively. MOWRAM is responsible for identifying policy and strategy development of water resources to serve business operation and development and to preserve water resources according to national and international sustainable features in accordance with policy context of the Government.

18. The project will be daily managed through a project management unit (PMU) that has been established at DFWUC, the implementing agency of the project. The PMU follows two key documents: (i) the government's May 2012 Standard Operating Procedures (SOP), and (ii) the Financial Management Manual (FMM) for the Externally Financed Projects/Programs (2012, as updated from time to time).[3]

19. **Organization and Staff Capacity**. The assessment reveals that both the executing and implementing agencies have experience to deal with projects funded by the development partners (DPs) including ADB. Their experiences include program loans, investment loans and various technical assistance projects. They have adequate internal control systems and financial reporting arrangements, not only for their regular budget and expenditure management, but also for other DP-funded projects. Additional capacity development support particularly on financial management, and procurement to properly implement comply with ADB procedures will further improve their capacity in these areas. Figure 1 shows the organizational structure of the project.

[3] Ministry of Economy and Finance (MEF): Standard Operating Procedures, Financial Management Manual and Procurement Manual Volume I and II- May 2012 for the Externally Financial Projects/Program issued the Sub-Decree no. 74ANK.BK of Cambodia on 22 May 2012



Source: MOWRAM. 2015.

Figure 1: Organizational Structure

20. **Information Management**. The PMU will be reporting to the Directorate General of Technical Affairs (DGTA), the unit in charge of managing business operations of control, promoting, and coordinating all tasks related to water including the ground, water, underground water. MOWRAM/DGTA has implemented various projects financed by ADB, Agence Francaise de Developpement (AFD), World Bank, Japanese International Cooperation Agency (JICA), and Korean International Cooperation Agency. ADB-funded projects include (i) Supporting Policy and Institutional Reforms and Capacity Development in the Water Sector,[4] (ii) Climate-Resilient Rice Commercialization Sector Development Program,[5] (iii) Water Resources Management Sector Development Program,[6] (iv) Flood Damage Emergency Reconstruction Project (FDERP),[7] and (v) Community-Based Disaster Risk Reduction.[8]

21. **Budgeting and Funds Flow Arrangements**. In recent years, MOWRAM has been undergoing intensive capacity development to improve its public financial management. It is one of three ministries[9] implementing ADB's Public Financial Management for Rural Development Program, Subprogram 2 (PFMRDP 2).[10] Under subprogram 2 of the project, the capacity building of these rural development ministries have been supported in budget preparation and

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[4] ADB. 2010. *Technical Assistance to Cambodia for Supporting Policy and Institutional Reforms and Capacity Development in the Water Sector.* Manila.

[5] ADB. 2013. *Report and Recommendation of the President to the Board of Directors: Proposed Loans and Administration of Grants and Loan to Cambodia for the Climate-Resilient Rice Commercialization Sector Development Program*. Manila.

[6] ADB. 2010. *Report and Recommendation of the President to the Board of Directors: Proposed Loans, Grant, Technical Assistance Grant, and Administration of Loan and Technical Assistance Grants to Cambodia for Water Resources Management Sector Development Program.* Manila.

[7] ADB. 2012. *Report and Recommendation of the President to the Board of Directors: Proposed Loan and Administration of Grant to Cambodia for Flood Damage Emergency Reconstruction Project.* Manila.

[8] ADB. 2014. *Proposed Grant Assistance to Cambodia Community-Based Disaster Risk Reduction.* Manila.

[9] The three rural development ministries are MAFF, MRD, and MOWRAM.

[10] ADB. 2010. *Report and Recommendation of the President to the Board of Directors: Proposed Loan and Grant for Subprogram 2, and Grant Assistance to Cambodia for Public Financial Management for Rural Development Program.* Manila. Grant agreement was signed on 22 October 2010.

execution, financial management and accounting, procurement, internal audit development, and in monitoring and evaluation. As a result, a number of capacity building training on PFM for MOWRAM staff have been implemented including (i) 3-year rolling Public Investment Plan, (ii) Preparation and Monitoring of Entity Budget and Program Budgets, (ii) SOP, (iii) FMM, (iv) IT programs, i.e. Microsoft Outlook, Microsoft Project, and Advance Excel, (v) Accounting Program of Government (Chart of Accounts), (vi) Audit of DP programs, (vii) Internal Audit, (viii) Audit Management and Accounting Software of Sage 50.

22. The MOWRAM Finance Department has installed Sage 50 in a new server supported by ADB's PFMRDP and has successfully recorded all accounting transactions of entity budget and expenditure of and produced the required financial reports of the government in 2014. It is also going to implement recording of both entity budgets and program budgets and expenditure of MOWRAM to produce the required financial reports of the government in 2015.[11] Moreover, three accounting staff of the Finance Department were trained as trainers in the Training of Trainers on Financial Management, Government Accounting Program, Accounting Software of Sage 50 so that they can further train accounting and finance staff of MOWRAM at the national and provincial levels.

B. Strengths and Weaknesses

23. **Strengths.** The following are the main strengths in the project's financial management system:

- (i) The government has adequate accounting and finance policies and guidelines which are implemented for all externally financed projects and programs. These are discussed in the SOP and FMM.
- (ii) The government launched a comprehensive PFMRP[12] in 2004, supported by ADB's PFMRDP 2 (footnote 11). This ADB grant supports MOWRAM in budget preparation and execution, financial management and accounting, procurement, internal audit development, and in monitoring and evaluation. This support includes:
  - (a) system development (including program budgeting, budget entities, new budget classification, new chart of accounts, and computerized financial management with the successful introduction of the Sage Accounting System in March–April 2014)
  - (b) substantial capacity development of the staff of the Finance Department
- (iii) The PFMRP is also strengthening capacity in audit of externally funded projects. The National Audit Authority (NAA) has been progressively improving external audit scrutiny of government expenditures and revenues, borrowings, and assets.
- (iv) The PFMRP is strengthening internal audit through the following outputs:
  - (a) Operationalized Audit Manual developed under the Public Financial Management for Rural Development Program, Subprogram 1[13] with key staff from internal audit departments trained in using the audit manual developed;
  - (b) strengthened governance/internal control framework;

[11] Based on discussion with Director of Finance and his staff on 4 May 2015.

[12] Royal Government of Cambodia. *Public Financial Management Reform Program–Strengthening Governance Through Enhanced Public Financial Management*. Phnom Penh. 2004.

[13] ADB. 2008. *Report and Recommendation of the President to the Board of Directors: Proposed Program Cluster, Grant for Subprogram 1, and Grant Assistance to Cambodia for the Public Financial Management for Rural Development Program, Subprogram 1*. Manila (G0133).

  (c) internal audit management systems implemented with appropriate manuals;
  (d) manual on auditing computerized accounting systems; and
  (e) manual on auditing externally funded projects
(v) The PMU Finance Officer is currently also the Finance Officer of the project implementing unit (PIU) of the FDERP (footnote 7) where she is gaining significant experience in project management finance.

C. Weaknesses

26. The following are the major weaknesses of the project's financial management system:

(i) The PMU staff has limited capacity in project financial management. Although the Finance Officer is gaining experience from her current capacity as PIU Finance Officer of FDERP, she is only slightly familiar with the FMM for the externally financed projects/program and ADB's Loan Disbursement Handbook.

(ii) The PMU has limited capacity to prepare the Financial Management Reports (FMRs) as required by project management, executing agency, and MEF. The current project accounting system is semi-manual with the limited use of excel spreadsheets. A computerized accounting software is one of the key internal controls as stated in the Financial Management Manual – May 2012 of MEF for the externally financed projects/programs. It should be noted that although there has been significant improvements in accounting and budgeting in MOWRAM, so far, these improvements are in the Finance Department and have yet to be passed on to the provincial offices and to the projects. So currently, the computerized accounting system using Sage has not been introduced to the MOWRAM PMU and PIUs. The accounting software still needs to be installed in the PMU finance unit and the PMU staff trained in this. Moreover, existing reporting systems do not have capacity to show financial information and physical progress in one report as shown in the FMM.

(iii) Capacity in internal audit is limited based on the assessment of the Finance Director as well as the Deputy Director of the Internal Audit Department (IAD). IAD staff comprises many staff assigned from other MOWRAM departments since 2007 but without the necessary educational background and a few new young staff with accounting degrees but lacking experience in internal audit. In addition, the IAD claims it does not have enough equipment to perform their respective duties effectively and efficiently.

(iv) Quality of external audit remains a concern, particularly the need to raise awareness of the required standard of audits of projects, need to strengthen terms of reference for external auditors and the need to review the practice of audit bundling to create large contracts in the light of inadequate capacity of auditors and experience.

D. Personnel, Accounting Policies and Procedures, Internal and External Audit

27. **Personnel**. The proposed PMU is currently administering ADB Loan: Flood Damage Emergency Reconstruction Project (Additional Financing) (FDERP-AF).[14] The PMU is composed of a project team nominated from the Department of Farmers Water Use Community

[14] ADB. 2014. *Report and Recommendation of the President to the Board of Directors: Proposed Loan for Additional Financing and Administration of Grant for Additional Financing to Cambodia: Flood Damage Emergency Reconstruction Project.* Manila.

(DFWUC) of the Directorate General of Technical Affairs. For implementing the proposed project, more staff will be assigned from the Provincial Department of Water Resources and Meteorology (PDWRAM) from Kampong Thom and Battambang provinces and from MAFF.[15]

28. The PMU Finance Officer has relevant experience in the financial management for the projects being also the PIU Finance Director of the FDERP-AF (footnote 16). However, capacity in the financial management needs further improvement. The PMU is slightly familiar with the FMM and ADB's Loan Disbursement Handbook, has lack of knowledge of computerized accounting software such as Peachtree/Sage 50 which was installed in MOWRAM's Finance Department, and has only a basic knowledge in preparing accounting reports using Excel. Further trainings on project financial management, ADB's Loan Disbursement Handbook and computerized accounting system and government procedures will be very necessary for the PMU staff.

29. The PMU will assign a Project Accountant to assist the Finance Officer in financial management as part of effort to segregate Finance Officer's duties during the project implementation. It is suggested that this Project Accountant be nominated from the Finance Department of MOWRAM. As a result of PFMRD, the capacity of the Finance Department staff has been greatly improved in handling in financial management, accounting, and Sage 50.

30. **Accounting Policies**. MOWRAM has received substantial capacity building under ADB PFMRDP (footnote 11). Key results of this program include extending and improving the budget classification and chart of accounts, to enable more effective record keeping and budgetary control and introducing the FMIS into the central and provincial treasuries.

31. It should be noted that although there has been significant improvements in accounting and budgeting in MOWRAM, so far, these improvements are in the Finance Department and have yet to be passed on to the provincial offices and to the projects. So currently, the computerized accounting system using Sage has not been introduced to the projects and the PMU and PIUs continue to use semi manual systems aided by simple excel spreadsheets.

32. **Internal Auditing**. The IAD of MOWRAM was established by the a sub-decree[16] in accordance with the Sub-Decree No. 40 ANKR/BK dated 15 February 2005 on the organization and functions of the internal department within ministries and public enterprises. The qualifications and work experience of the staff working for the internal department are limited. Based on Sub-Decree No. 54 ANKR/BK dated 29 May 2006, the IAD has its mandate to conduct the internal audit of 11 departments of MOWRAM and 25 PDWRAMs based on the 3-year rolling plan and annual plan to be approved by the minister of MOWRAM. In addition, all the audit programs of the internal audit are subject to the approval of the minister of MOWRAM. The selection of which departments of MOWRAM and PDWRAM for the internal audit is based on the approved plan.

33. The IAD has 4 offices, namely, (i) Administration and Finance Office, (ii) Internal Audit Office 1, (iii) Internal Audit Office 2, and (iv) Internal Audit Office 3; and employs a total of 25 staff. The department has received capacity building on the internal audit supported by ADB PFMRDP 2 (footnote 11). Ten staff from IAD involved in the program of the capacity building on the internal audit has been trained successfully. Five of ten staff of IAD has improved their

[15] ADB. 2015. *Aide Memoire. TA 8702-CAM: Uplands Irrigation and Water Resources Management Sector Project.* Unpublished.
[16] The Anukrit/Sub-decree no. 54ANK/BK issued by the Royal Government of Cambodia on 29 May 2006

capacity in the internal audit after the trainings were completed. However, overall qualifications and work experience of the staff working for the internal department is still limited. It is essential that the department be provided with continuous capacity building in the form of on-the-job trainings on the internal audit and advanced excel and necessary equipment such as laptop computer, printer, and vehicle.

34. Recently, the IAD of MOWRAM conducted the internal audit of three departments (Finance Department, Department of Irrigated Agriculture, and Department of Engineering), 25 provinces and capital of PDWRAM, and one of ADB funded projects in the MOWRAM. A few minor weaknesses have been found and have been successfully implemented after the recommendations have been issued.

35. **External Auditing**. MOWRAM/PMU will initiate the detailed consolidated project accounts to be audited in accordance with the international standards on auditing and/or in accordance with the government's audit regulations by an auditor acceptable to ADB. The audited accounts will be submitted in the English language to ADB within 6 months of the end of the fiscal year by the executing agency. The annual audit report will include a separate audit opinion on the use of the imprest accounts, sub-accounts, and the SOE procedures (as applicable and financial loan covenants). The government and MOWRAM have been made aware of ADB's policy on delayed submission, and the requirements for satisfactory and acceptable quality of the audited accounts. ADB reserves the right to verify the project's financial accounts to confirm that the share of ADB's financing is used in accordance with ADB's policies and procedures. The audited project accounts must be disclosed in the ADB and the executing agency's website. Currently, KPMG, is the external auditor for the FDERP-AF (footnote 16) of MOWRAM under a bundled audit arrangement.

36. The project accounts of the past and ongoing projects implemented by MOWRAM/PMU and financed by ADB and other development partners are required as stipulated in the loan/credit agreement to be annual audited by external auditor such as KPMG, EY, PWC, or BDO firms. These external audit firms are selected under the bundled audit arrangement of MEF and with agreement from ADB. In addition, these project accounts can further be audited by NAA of and Ministry of National Assembly and Senate Relation and Inspection (MONASRI) of the Royal Government of Cambodia if the circumstances are required or they wish to do so.

37. The August 2014 Joint Country Portfolio Performance Review[17] reported that the quality of audit reports remains a concern. ADB together with World Bank and JICA conducted the Financial Management Seminar on 4 December 2013 to raising awareness of the required standard of audits of projects under all three portfolios. Also, strengthened terms of reference for external auditors have been prepared and submitted to the General Department of Budget (GDB) and/or Department of Cooperation and Debt Management (DCDM) of MEF for concurrence. The practice of audit bundling to create large contracts will be reviewed in the light of inadequate capacity of auditors and experience. Recent discussions with MEF reveal that bundled audits continue to be the preferred agreement although this is agreed with ADB for each project. Contract performance will need to be closely monitored to ensure that auditing firms have assigned staff with qualification and experience as agreed in the contract. PFMRDP 2 (footnote 11) which has also supported the NAA to strengthen its capacity in audit of externally funded projects. The NAA has been progressively improving external audit scrutiny of government expenditures and revenues, borrowings, and assets.

[17] Cambodia Joint Country Performance Review (JCPPR) August 2014.

38. The annual audit report will include an audit management letter and audited financial statements which cover (i) whether the project financial statements are presented in all material respects or in accordance with the applicable financial reporting framework; (ii) whether loan proceeds were used only for the purposes of the project or not; (iii) the level of compliance for each financial covenant contained in the legal agreements for the project; (iv) compliance with the imprest fund procedure; and (v) compliance with use of the SOE procedure certifying (a) to the eligibility of those expenditures claimed under SOE procedures, and (b) proper use of the procedure in accordance with ADB's Loan Disbursement Handbook and the project documents.

E. Financial Reporting Systems, including Use of Information Technology

39. MOWRAM is required to prepare quarterly FMRs in accordance with the FMM – May 2012 issued by MEF for the externally financed projects/programs. The FMRs shall be submitted to ADB within 45 days after the end of each quarter as stipulated in the loan agreement. The FMRs usually consists of the following statements: statement of receipts and disbursement detailing sources of fund received and all expenditures incurred for a particular period and fund balance; summary of accumulated expenditure report by categories and by project activities providing information about the analysis of the fund received and spent and fund balance; project balance sheet/imprest account reconciliation; and loan disbursement summary by categories and its balance.

40. Although finance staff working for the proposed PMU of the DGTA has some work experience with ADB funded projects, they have quite limited capacity in preparing the FMRs of the projects for ADB and other development partners. The PMU does not have accounting software for the financial management system to record financial transactions and to produce FMRs for existing projects. As a result, these are recorded and reported are prepared by using separate Excel spreadsheets.

41. MOWRAM has been cited as being excellent in Output 2 of the PFMRDP on functioning computerized accounting systems. Training has been completed in MOWRAM for the computerized accounting system Sage 50 with the holding of coaching clinics in February, March, August, November 2013 and March 2014. The hardware and software have been delivered and installed and the system is now running live with 2014 data. However, implementing the improved budgeting and accounting systems in the projects and the provinces still need to be done in the coming months. Project reports should be produced by the computerized project accounting system/software. Consequently, the staff should be trained on how to generate FMRs from the accounting software.

42. Hence, the PIU of ADB FDERP (footnote 7) is trying to purchase an accounting software of Sage 50 with five users for the existing project and for the proposed project. As the computerized accounting software is one of the key internal controls as stated in the FMM – May 2012 of MEF for the externally financed projects/programs, it is recommended the computerized accounting system be procured and utilized for the proposed the project.

43. Even though most offices of MOWRAM have equipped information technology equipment, they do not function effectively and efficiently as they are rather old. In general, MOWRAM, and in particular PMU offices, do not have enough equipment such as such desktop computer, laptop computer, printer and copier. Also, most staff have found to possess basic skills to operate computer. However, some others have high skills for special applications such as Advanced Excel, Access, Outlook, Microsoft Project, AutoCad, and Peachtree/Sage 50.

F. Disbursement Arrangements, Fund Flow Mechanism

44. **Disbursement Arrangements for ADB Loan**. The Loan proceeds will be disbursed in accordance with ADB's *Loan Disbursement Handbook* (2015, as amended from time to time)[18] and detailed arrangements agreed upon between the government and ADB. Pursuant to ADB's Safeguard Policy Statement (SPS, 2009),[19] ADB funds may not be applied to the activities described on the ADB Prohibited Investment Activities List set forth at Appendix 5 of the SPS

45. MOWRAM will be responsible for preparing the annual contract awards and disbursement projections, including in (i) requesting budgetary allocations for counterpart funds, (ii) preparing withdrawal applications, and (iii) sending the withdrawal applications to ADB; and (iv) collecting supporting documents for the project expenditures they have incurred.

46. Immediately after loan effectiveness, the government, through MEF, will open a US dollar imprest account at the National Bank of Cambodia or a commercial bank acceptable to ADB for the project loan. The imprest account will be opened and managed by MOWRAM. MEF will be the account holder, and delegates the authority to MOWRAM, the authorized party. The maximum ceiling of the imprest account will not at any time exceed the estimated ADB expenditures to be paid from the imprest account for the next 6 months.

47. The request for initial advance to the imprest account should be accompanied by an Estimate of Expenditure Sheet[20] setting out the estimated expenditures for the first 6 months of project implementation, and submission of evidence satisfactory to ADB that the imprest account has been duly opened. For every liquidation and replenishment request of the imprest account, the borrower will furnish to ADB (a) the Statement of Account (Bank Statement) where the imprest account is maintained, and (b) the Imprest Account Reconciliation Statement (IARS) reconciling the above mentioned bank statement against the executing agency's records.[21]

48. Before the submission of the first withdrawal application, the borrower should submit to ADB sufficient evidence of the authority of the person(s) who will sign the withdrawal application on behalf of the borrower and the authenticated specimen signatures of each authorized person. The minimum value per withdrawal application is $100,000, unless otherwise approved by ADB. The borrower is to consolidate claims to meet this limit for reimbursement and imprest account claims. Withdrawal applications and supporting documents will demonstrate, among other things that the goods, and/or services were produced in or from ADB members, and are eligible for ADB financing.

49. **The Statement of Expenditure (SOE) Procedure**. The SOE procedure will be used for reimbursement and to liquidate and replenish the imprest accounts for eligible expenditures. Any individual payment to be reimbursed or liquidated under this procedure shall not exceed the equivalent of $50,000 for the implementing agency. SOE records should be maintained and made readily available for review by ADB's disbursement and review mission or upon ADB's request for submission of supporting documents on a sampling basis, and for independent external audit.[22]

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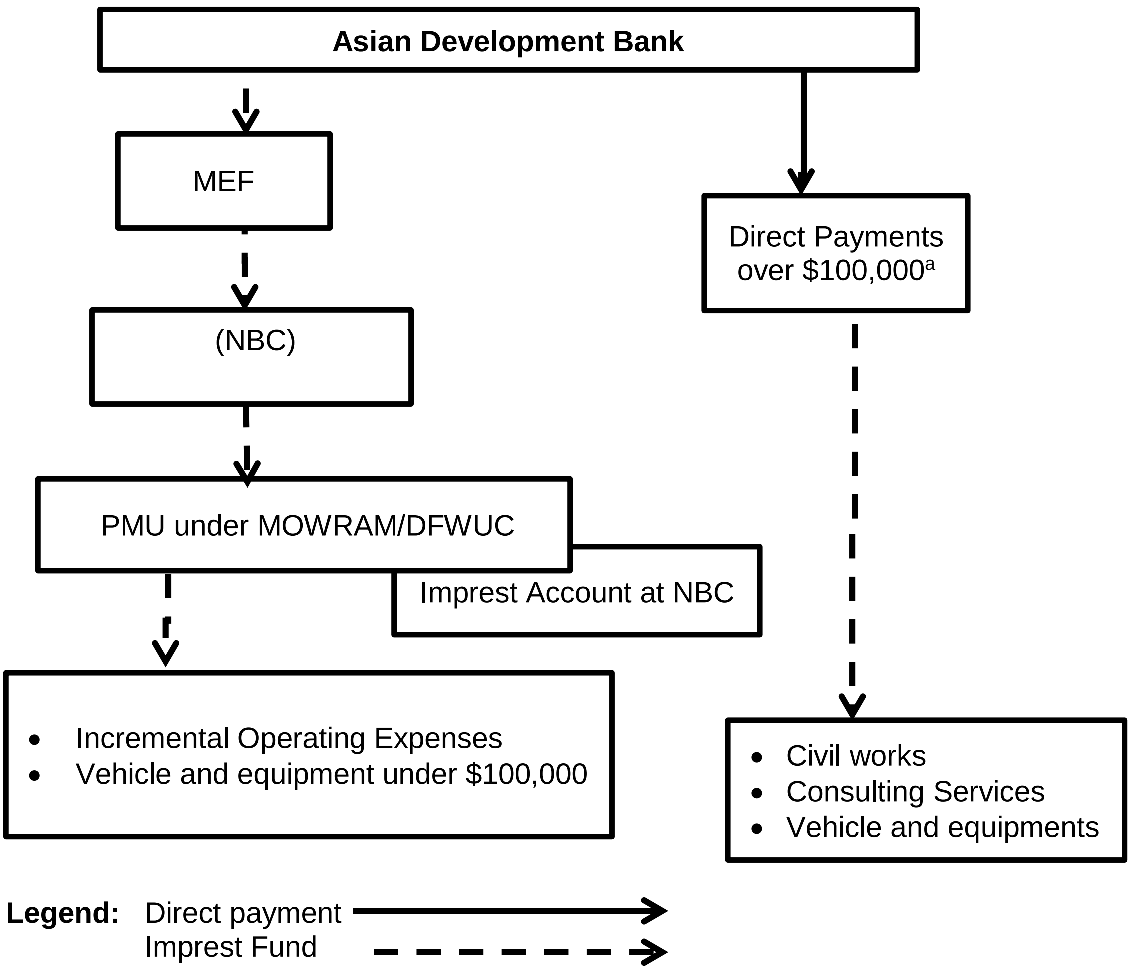
[18] Available at: http://www.adb.org/sites/default/files/loan-disbursement-handbook.pdf
[19] Available at: http://www.adb.org/Documents/Policies/Safeguards/Safeguard-Policy-Statement-June2009.pdf
[20] Available in Appendix 29 of the *Loan Disbursement Handbook.*
[21] Follow the format provided in Appendix 30 of the *Loan Disbursement Handbook.*
[22] Checklist for SOE procedures and formats are available at:
http://www.adb.org/documents/handbooks/loan_disbursement/chap-09.pdf
http://www.adb.org/documents/handbooks/loan_disbursement/SOE-Contracts-100-Below.xls

Figure 2: Fund Flow Arrangement



DFWUC = Department of Farmer Water User Communities; MEF = Ministry of Economy and Finance, MOWRAM= Ministry of Water Resources and Meteorogy; NBC = National Bank of Cambodia
[a] If necessary, payments less than $100,000 may also be made by direct payment.
Source: Asian Development Bank and the Government

50. **Disbursement and Liquidation Procedures for Government Funds**. Withdrawal of government counterpart funds must be carried out in accordance with the government policies and procedures, through its regular budget for cash and through taxes exemption, issued by MEF, for civil works. MOWRAM will be responsible for submitting withdrawal applications to MEF. Counterpart funds withdrawal applications should be made in accordance with the budget plan agreed between MOWRAM and MEF. Counterpart funds may only be withdrawn for expenditures of the project which are specified in the project loan agreements.

51. **Key Internal Controls.** Withdrawal applications must be signed by an authorized signatory or signatories. Withdrawal applications must be sequentially numbered starting with

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http://www.adb.org/documents/handbooks/loan_disbursement/SOE-Contracts-Over-100.xls
http://www.adb.org/documents/handbooks/loan_disbursement/SOE-Operating-Costs.xlshttp://www.adb.org/documents/handbooks/loan_disbursement/SOE-Free-Format.xls

the number one. For the counterpart Funds Initial Advance, the PMU completes the Government Withdrawal Application form for the initial advance of counterpart funds and submits to the Department of Cooperation and Debt Management (DCDM) in MEF. The maximum amount of the advance of counterpart funds will be agreed between MOWRAM/project team and MEF. The Government Withdrawal Application Form must be signed by the authorized signatories of MOWRAM/project team and submitted to the DCDM. The government withdrawal application must be recorded in the Project Counterpart Funds WA Register. The following figure show fund flow arrangement of the project.

52. **Counterpart Funds Replenishment**. The project team completes the Government Withdrawal Application Form and attaches a statement of actual expenditure. Supporting expenditure documentation must be maintained by the project team for subsequent review by MEF or audit. The Government Withdrawal Application Form must be signed by the authorized signatories of the MOWRAM/project team and submitted to DCDM. The government withdrawal application must be recorded in the Project Counterpart Funds WA Register.

53. The DCDM will review the completed forms and in conjunction with the Finance and Administration Department transfers the funds to the project's counterpart funds account, and advises MOWRAM of the transfer. On receipt of advice from the National Bank of Cambodia (NBC) that the funds have been deposited into the counterpart funds account, the receipt of the funds should be recorded in the General Ledger and the Government WA Register must be up-dated.

V. RISK DESCRIPTION AND RATING

54. For inherent risks, the assessment focuses on risks posed by the overall environment in which the executing and/or implementing agencies operates, before considering the impact of the executing and implementing agencies' financial management system and control such as country rules and regulations and the entity working environment (assuming the absence of any counter checks or internal controls).

Table 4: The Inherent Risks

Risk Description	**Risk Assessment**	**Mitigation Measures or Risk Management Plan**
Inherent Risk		
I. Country Specific		
A. PFM (i) Transfer of responsibilities for budget management from the MEF to line ministries, including the rolling out of the Financial Management Information System. The continuation of excessive centralization of budget management will maintain low accountability for public expenditure and service delivery, and continue to negatively affect the management of DP-funded projects; (ii) Transfer of functions and resources to SNAs. Uncertainty, delays in the delegation of functions, and inadequate delegation will postpone the build-up of capacity in SNAs. This delay will undermine the accountability of SNAs for expenditure and service	Moderate	(i) Building on earlier achievements in improving budget responsibility and accountability in rural development ministries (as discussed in para. 3 of the above text), ADB will expand technical assistance under the CPS to additional priority ministries. (ii) ADB will continue to support decentralization and de-concentration and PFM reforms for SNAs , and ensure that new ADB-financed projects are aligned with and supportive of emerging functions and capacity of SNAs; (iii) Building on earlier capacity building for

Risk Description	Risk Assessment	Mitigation Measures or Risk Management Plan
delivery, and increase risks for management of DP funded projects that have been assigned to SNAs. (iii) Internal audit and internal controls are improving, but remain weak. This increases fiduciary risks and leads to less effective and transparent business processes and practices, including for procurement. (iv) External audit capacity is improving, but remains weak. The NAA's capacity has been gradually strengthened, but is still inadequate to provide effective oversight of public expenditures.		internal audit, ADB will extend support to additional priority ministries. (iv) ADB will consider additional support to the NAA for auditing of externally financed projects, particularly in major sectors and projects of relevance for ADB. In addition, ADB will continue to support the NAA in engaging with the National Assembly to discuss audit findings and follow up on recommendations.
B. Procurement Further capacity development in procurement for line ministries and SNAs are required. Without better systems, including e-procurement, complaint handling mechanisms, and stronger institutions and human capacity, there are risks of inefficiencies and irregularities	Moderate	ADB-financed projects are managed under the government's standard operating procedures, procurement manual, and financial management manual for externally financed projects. Building on previous support for public procurement, ADB will undertake a procurement risk assessment, strengthen procurement capacities in additional ministries (particularly ministries responsible for priority sectors under the CPS 2014–2018) and SNAs (districts and municipalities), and (in cooperation with the Operations Services and Financial Management Department) deliver training on ADB's guidelines and procurement procedures. At the project level, ADB will continue to identify procurement risks and implement mitigation measures.
C. Corruption (i) The ACU faces significant challenges to effectively implement the Anti-Corruption Law and systemically address corruption. (ii) Related legal and law enforcement institutions, especially police officials, prosecutors, and judges, remain weak and vulnerable to poor governance practices. (iii) Personnel management, patronage, and public sector pay policies (salary levels in the public sector are very low) provide disincentive for rules-based and good governance practices, including in oversight and regulation of the private sector.	Substantial	(i) The ACU has been supported by ADB to implement the Anti-Corruption Action Plan for Asia and the Pacific, which is being coordinated by the ADB–OECD Anti-Corruption Initiative. In coordination with other DPs and NGOs, ADB will continue to explore entry points to support the ACU in fulfilling its mandate. (ii) Although ADB is not engaged in legal and judicial reform, which is being supported by other DPs, ADB will continue to strengthen the capacity of selected line ministries in regulatory impact assessments. (iii) Civil service salary reform is regarded as a priority by the government and development partners. Accordingly, the government is working on new salary and compensation packages and is beginning to implement a revenue mobilization strategy

Risk Description	Risk Assessment	Mitigation Measures or Risk Management Plan
		to increase the country's tax effort. ADB will closely monitor related developments.
II. Entity Specific		
Lack of control in budget execution; accounting and reporting, and budget credibility.[a]	Moderate	ADB CARM/MEF/MOWRAM to continue to monitor the progress and results of ADB: Public Financial Management for Rural Development Program[b] covering three ministries including MOWRAM. These rural development ministries are being supported in budget preparation and execution, financial management and accounting, procurement, internal audit development, and in monitoring and evaluation.
Overall Inherent Risk	Moderate	

ACU = Anti-Corruption Unit, ADB = Asian Development Bank, CARM = Cambodia Resident Mission, CPS = country partnership strategy DP = development partners, MEF = Ministry of Economy and Finance, NAA = National Audit Authority, NGOs = nongovernmental organizations, OECD = Organization for Economic Co-operation and Development, PFM = public financial management, SNAs = subnational authorities,

[a] Financial Management Assessment of Flood Damage Emergency Reconstruction Project. 2014 – ongoing improvement.

[b] ADB. ADB. 2010. *Report and Recommendation of the President to the Board of Directors: Proposed Loan and Grant for Subprogram 2, and Grant Assistance to Cambodia for Public Financial Management for Rural Development Program.* Manila.

Source: Asian Development Bank.

55. For the project or specific control risk, the assessment focuses on risks arising from the failure of the specific project's financial management and internal control arrangement to ensure that the project funds will be used economically and efficiently and for the intended purpose. The following table presents the risk summary.

Table 5: The Project/Control Risks

Risk Description	Risk Assessment	Mitigation Measures or Risk Management Plan
Executing/Implementing entity: Governance/Anti-corruption. Corruption remains a major issue and poses significant constraints for development effectiveness in Cambodia including potential risks in this specific project[a]	Moderate	ADB to ensure that ADB's Anticorruption Policy (1998, as amended to date) are explained to and discussed with the executing/implementing agencies. The specific policy requirements and anticorruption measures are described in the project administration manual. MOWRAM will (i) require all contractors/bidders, suppliers and consultants (firms or individual/national or international) to sign declarations of ethical conduct; (ii) strengthen transparency through posting project information on the executing agency's websites; develop complaint handling mechanisms; (iii) strict monitoring and enforcement of procurement procedures and contracts; and (iv) joint investigation by the NAA and the ADB's Office of

Risk Description	Risk Assessment	Mitigation Measures or Risk Management Plan
		Anticorruption and Integrity on irregularities.
External Audit: Quality of audit reports remains a concern, particularly: • Need to raise awareness of the required standard of audits of projects • Need to strengthen terms of reference for external auditors (these have been prepared and submitted to General Department of Budget/Department of Cooperation and Debt Management of MEF for concurrence) • Need to review the practice of audit bundling to create large contracts in the light of inadequate capacity of auditors and experience.	Moderate	MOWRAM to coordinate with MEF to update the terms of reference for auditors and explore potential participation of NAA or independent private auditor to further improve quality of audit report. MEF to provide oversight and MOWRAM to closely monitor contract performance of external auditors to ensure that auditing firms have assigned staff with qualification and experience as agreed in the contract.
Fund Flows. The PMU Finance Officer is familiar with FMM, but she has not yet received training on ADB's Loan Disbursement Handbook.	Moderate	Provide training on ADB's Loan Disbursement Handbook for the Finance Officer and her staff as part of the PMU consultancy package; Most funds will flow through ADB direct payments
Staffing Lack of capacity (number and skills) of staff for finance unit	Moderate	The PMU to start the selection process for the PMU Project Accountant, preferably from Finance Department of MOWRAM, Loan consultants will be engaged to assist with project management, including project financial management.
Accounting Policies and Procedures The duties of finance officer are not segregated between preparing orders and making payments.	Moderate	Once assigned to the PMU, the Project Accountant can handle preparing orders leaving the Finance Officer to be responsible only for making payments.
Internal Audit Limited capacity in internal audit	Moderate	MOWRAM will include the Project to be subject to internal audit to ensure that the organization's Internal Audit Unit carries out regular reviews of the internal control processes,
External Audit Lack of analysis in reviewing transactions and interpreting the project financial statements.[a]	Moderate	PMU will work with MEF to update the terms of reference and to engage external auditors who can provide qualified staff to audit the project accounts
Reporting and Monitoring Finance Officer has limited capacity to prepare FMRs and The current project reporting does not have the capacity to link the financial information with the project's physical progress.	Moderate	The PMU Finance Office's capacity to prepare FMRs can be improved by on the job training conducted by the finance consultant to be provided by the Loan consultancy package.
Information System (i) PMU has no accounting software to record accounting transactions and	Moderate	PMU to coordinate with the Finance Department for installation of this software at the PMU and operated using double

Risk Description	Risk Assessment	Mitigation Measures or Risk Management Plan
generate FMRs automatically (ii) There have been major improvements in the information system as a result of the Public Financial Management for Rural Development Program.[b] This includes a new chart of accounts and implementation of a computerized system.		entry accounting procedures will allow transactions to be traced and followed during audit
Overall Control Risk	Moderate	
Overall (Combined) Risk	Moderate	The implementation of mitigation actions as proposed will reduce to risk to low.

ADB = Asian Development Bank, FMR = financial management report, MEF = Ministry of Economy and Finance, MOWRAM = Ministry of Water Resources and Meteorology, NAA = National Audit Authority, PMU = project management unit

[a] Financial Management Assessment of Flood Damage Emergency Reconstruction Project. 2014 – ongoing improvement.

[b] ADB. ADB. 2010. *Report and Recommendation of the President to the Board of Directors: Proposed Loan and Grant for Subprogram 2, and Grant Assistance to Cambodia for Public Financial Management for Rural Development Program.* Manila.

Source: Asian Development Bank.

56. As detailed in FMA report, risk management actions include measures to support fund flow arrangement including procurement oversight and strengthen financial management skills have been prepared to avoid potential problems. These include (i) strengthen sector governance and FM through comprehensive reforms to develop sector-wide national programs and support for FM and accountability - based bottom up planning and good governance at all levels; (ii) will develop accounting and monitoring systems to a standard format; Reform of the assets registration and management; and (iii) will introduce a computerized accounting at all levels; Financial records will be coupled with physical records for management and preparation of annual performance assessments of the delivery of health services. Support will be provided to facilitate the secure storage and retrieval system for records. The implementation of the risk management measures identified above will ensure that financial management arrangements are adequate for the overall program, especially for the investments funded by the project.

VI. ACTION PLAN

58. The project will prepare the terms of reference and allocate adequate budget to provide appropriate training and capacity building to accounting department staff to establish robust financial management arrangements, including for record-keeping, internal controls, payables, receivables, budgeting, accounting, project management, and bank account management and the preparation of loan withdrawal applications and statement of expenditure. Independent out-sourced accounting support will be continued to ensure, among other things, timely and rigorous reconciliations, orderly record keeping, financial reporting and strict adherence to financial management policies and internal controls, and to ensure an orderly and timely year-end process for the preparation and audit of annual project accounts. The following are proposed actions for supporting financial management by the project.

Table 6: Time-Bound Action Plan

Weakness	Mitigation Action	Responsibility	Timeframe
The PMU staff has limited capacity in project FM. Although the Finance Officer is gaining experience from her current capacity as PIU Finance Officer of Flood Damage Emergency Reconstruction Project,[a] she is only slightly familiar with the FMM for the externally financed projects/program and the ADB's Loan Disbursement Handbook.	Monitor the progress and results of the Public Financial Management for Rural Development Program[b] as supported by an ADB grant. This covers 3 ministries including MOWRAM, which are being supported in budget preparation and execution, financial management and accounting, procurement, internal audit monitoring and evaluation.	ADB CARM/ MEF/ MOWRAM	Immediately
	Assign a Project Accountant to the PMU to assist the Finance Officer. The Project Accountant to be nominated from the Finance Department of MOWRAM.	MOWRAM	Upon start of loan implementation
	. Engage project management and implementation consultants including financial management consultants to build capacity in project financial management. Including training on standard operating procedures and FMM, ADB's Loan Disbursement Handbook, and provisions of the project administration manual be provided to the PMU staff.	MOWRAM, PMU	Upon start of loan implementation
The PMU has limited capacity to prepare FMRs[c] and does not have capacity to show financial information and physical progress in one report as shown in the FMM. The current project accounting system is semi-manual with the limited use of excel spreadsheets. A computerized accounting software is one of the key internal controls as stated in the FMM – May 2012 of MEF for the externally financed projects /programs. The accounting software still needs to be installed in the PMU finance unit and the PMU staff trained in this. Moreover, existing reporting systems	. System Improvement in project accounting to link the installed Sage 50 software in the Finance Department with the project accounts. . Support for PMU's plans to purchase an accounting software of sage 50 with 5 users for the existing project and for the proposed project. Staff Training for PMU on how to generate FMRs from the accounting software.	MOWRAM/FD project management and implementation consultants	Immediately Upon start of loan implementation

Weakness	Mitigation Action	Responsibility	Timeframe
Capacity in internal audit is limited.[d] IAD staff comprises many staff assigned from other MOWRAM departments since 2007 but without the necessary educational background and a few new young staff with accounting degrees but lacking experience in internal audit. In addition, the IAD claims it does not have enough equipment to perform their respective duties effectively and efficiently.	Monitor capacity building of the internal audit department under the Public Financial Management for Rural Development Program.[b] It is essential that the IAD be provided with continuous capacity building in the form of on-the-job trainings on the internal audit and advanced excel. Provide the necessary support and equipment such as laptop computer, printer, and vehicle.	MOWRAM	Immediately
Quality of external audit remains a concern, particularly the need to raise awareness of the required standard of audits of projects, need to strengthen terms of reference for external auditors and the need to review the practice of audit bundling to create large contracts in the light of inadequate capacity of auditors and experience	Update the terms of reference for auditors and explore potential participation of supreme audit institution to further improve quality. Closely monitor contract performance of external auditors to ensure that auditing firms have assigned staff with qualification and experience as agreed in the contract.	MOWRAM/ MEF	Immediately

ADB = Asian Development Bank, CARM = Cambodia Resident Mission, FMM = financial management manual, FMR = financial management report, IAD = Internal Audit Department, MEF = Ministry of Economy and Finance, MOWRAM = Ministry of Water Resources and Meteorology, NAA = National Audit Authority, PIU = project implementation unit, PMU = project management unit

[a] ADB. 2012. *Report and Recommendation of the President to the Board of Directors: Proposed Loan and Administration of Grant to Cambodia for Flood Damage Emergency Reconstruction Project.* Manila.

[b] ADB. ADB. 2010. *Report and Recommendation of the President to the Board of Directors: Proposed Loan and Grant for Subprogram 2, and Grant Assistance to Cambodia for Public Financial Management for Rural Development Program.* Manila.

[c] As required by project management, executing agency, and MEF.

[d] PPTA meeting with the Finance Director and Deputy Director of IAD.

VII. SUGGESTED COVENANTS

59. **Right to audit.** The government will ensure that contracts financed from the project will include provisions specifying the right of ADB to audit and examine the records and accounts of the project and all contractors, suppliers, consultants, and other service providers as they relate to the project.

60. **Governance and anti-corruption**. The government will ensure that (i) the program is carried out in compliance with all applicable Cambodia anti-corruption regulations, and ADB's Anticorruption Policy (1998, as amended to date); (ii) all project staff actively participate in the training in Cambodia's anti-corruption regulations and ADB's Anticorruption Policy; and (iii) a website is maintained to disclose the audited annual project accounts, project progress, and procurement activities.

VIII. CONCLUSION

61. Overall risk rating for Project FMA is “Moderate”. General environment for public financial management in Cambodia/MOWRAM is generally satisfactory and to large extent strengthened by standardized policies and guidelines which are implemented for all externally financed projects and programs. These are discussed in the SOP and in the FMM which have recently been upgraded last May 2012. Although capacity is still limited and needs improvement in project financial management and internal auditing, this is expected to improve significantly as a result of the government’s ongoing comprehensive Public Financial Management Reform Program as supported by the PFMRDP 2 (footnote 11).

62. The FMA results prepared for the project are summarized below. This is compiled from the responses and information obtained from the executing and implementing agencies as detailed in the Appendix. The summary include proper mitigation measures and other management actions that have been prepared to address the identified key issues:

Key Issues of the national financial management system	Mitigation Measures/Management Actions
Planning and Budgeting Processes: (i) Disconnect in the planning process between province and central level: (ii) lack of oordination of the annual budgeting with lack of guidance from central level: (iii) Disconnect between capital and recurrent budgets and national and development assistance	The Project has been designed to strengthen the sector governance and management through technical assistance that has simple FM, planning, budgeting and reporting. Most investment activities are for consultants, training, workshop
Funds Flow Mechanisms and Disbursement Process: (i) Anomalies and differences in FM differs between provinces: (ii) Delay in quarterly budget applications from DHOs to PHOs; (iii) Delays in the release of funds; (iv) Constraints on the availability of cash in the provincial treasury.	The funds flow process will be clearly defined and training and support to be provided to the implementing agency and project staff to develop appropriate withdrawal application and disbursement procedures where needed.
Personnel: (i) staff lack skills and capacity in budgeting and accounting; (ii) lack of job description and segregation of duties; and (iii) Skills and capacity gap to handle increases financial management resulting from the project	A comprehensive support will be provided by the project to provincial staff, especially those at district level, through reform to financial management, development of computerized accounting systems and training and human resource capacity; human resource development will support clearly defined duties and responsibilities in job descriptions.
Accounting Policies and Procedures: (i) Lack of detail in recording expenditure following the state accounting system and verification; (ii) Lack of monitoring and internal control and performance measures; (iii) Limited ability to integrate financial and physical information in financial reporting; (iv) Lack of reporting on funds received from other donors and integration into provincial health plans; and (v) Assets register are not adequately maintained and updated.	Reform of the budgeting, financial management and reporting systems will be addressed by the project and computerized accounting systems expanded to the district level, supported by ongoing training and follow up support.

63. Engagement of a team of international and domestic implementation consultants to build project management capacity during the project implementation is recommended. The finance consultant will assist to (i) provide training including on the job training for the PMU Finance Unit

and to (ii) coordinate with the Finance Department on ongoing budgeting and accounting systems improvements including computerization of the accounting system using Sage 50.

64. Overall, the project arrangements are considered satisfactory since appropriate mitigation measures/management actions have been prepared to address the key issues.

Financial Management Assessment Questionnaire
Ministry of Water Resources and Meteorology (MOWRAM) and
Department of FWUC (DFWUC)
Upland Irrigation Water Resource Management Sector Project (UIWRMSP)

Topic	**Response**		**Potential Risk Event**
1. Executing/Implementing Agency			
	Executing Agency	Implementing Agency	
1.1 What is the entity's legal status /registration?	The Ministry of Water Resources and Meteorology (MOWRAM) was established by the Royal Krom NS/RKM/0699/04 dated 23 June 1999. Under sub-decree no. 58ANKR/BK dated 30 June1999, the Ministry of Water Resources and Meteorology now has twelve departments. The duties and responsibilities of each department were set up and revised to strengthen agricultural production to contribute to reducing poverty in accordance with Cambodian government's policy.	The Department of Farmer Water User Community (DFWUC) was established by the sub-decree no.73ANKR/BK dated 30 June 2018. DFWUC has its mandate to cover policy and legal documents, FWUC policy and strategy, irrigation system information, standards for O&M, support to establish FWUC and their operation, training and technology development.	
1.2 How much equity (shareholding) is owned by the Government?	NA		
1.3 Obtain the list of beneficial owners of major blocks of shares (non-governmental portion), if any.	NA		
1.4 Has the entity implemented an externally-financed project in the past (if so, please provide details)?	Yes, it has implemented externally financed projects of ADB, AFD, WB, JICA, and KOICA. Recent and ongoing ADB projects include (i) Supporting Policy, and Institution Reforms and Capacity Development in Water Sector, (ii) Resilience Rice Commercialization Sector Development Program,	As the assigned PMU for the proposed project, DFWUC is implementing only one externally financed project namely Flood Damage Emergency Reconstruction Project-Additional Financing (FDERP-AF) financed by ADB.	

Topic	Response		Potential Risk Event
	Executing Agency	Implementing Agency	
	(iii) Water Resource Management Sector Development Program, (iv) Flood Damage Emergency Reconstruction Project; and (v) Community-Based Risk Deduction.		
1.5 Briefly describe the statutory reporting requirements for the entity.	Financial reports of the MOWRAM are reported to the Minister, the MEF and to the RGC while project financial reports of projects are reported to MEF, to development partners (DPs) and to RGC as necessary.		
1.6 Describe the regulatory or supervisory agency of the entity.	The entity is to report to the Prime Minister		
1.7 What is the governing body for the project? Is the governing body for the project independent?	Senior Management of the Ministry. Yes, it is.	General Department of Technical Affairs (GDTA). Yes, it is	
1.8 Obtain current organizational structure and describe key management personnel. Is the organizational structure and governance appropriate for the needs of the project?	The PMU was established by decision No. 034 SSR.Th.TO dated 8 January 2014 which appointed 6 staff members. The PMU comprises (i) Project Director, (ii) Project Manager, (iii) Technical Officer, (iv) Finance Officer, (v) Administrative Office, (vi) Procurement Officer, and (vii) FWUC Officer. The above mentioned officers are from DFWUC except Project Director who is from GDTA. The additional staff members will be appointed when the loan project is implemented. (See Annex 1a) Based on the Aide Memoire[23] it was agreed that 2 staff members from MAFF and Directors of PDWRAMs of Kampong Thom and Battambang will also be members of the PMU. Yes, the organizational structure is appropriate.		
1.9 Does the entity have a Code of Ethics in place?	Yes, it does. It follows the Statute for Civil Servants. Project staff will be required to sign the Code of Conduct during project implementation in accordance with ADB's Risk Assessment and Risk Management Plan (RARMP).		

[23] Aide Memoire, TA 8702- CAM: Project Preparatory Technical Assistance for Uplands Irrigation and Water Resources Management Project, Mid-term Review Mission 28 March-3 April 2015,

Topic	Response	Potential Risk Event
1.10 Describe (if any) any historical issues reports of ethics violations involving the entity and management. How were they addressed?	There are no issues of ethics violations.	
2. Funds Flow Arrangement		
2.1 Describe (proposed) project funds flow arrangements, including a funds flow diagram and explanation of the flow of funds from ADB, government and other financiers, to the government, EA, IA, suppliers, contractors, ultimate beneficiaries, etc. as applicable.	The proposed funds flow arrangements is shown in Annex 1b.	
2.2 Are the (proposed) arrangements to transfer the proceeds of the loan (from the government / Finance Ministry) to the entity satisfactory?	Yes, they are. MOWRAM normally follows the procedures based on the Financial Management Manual (FMM) for externally financed projects/programs which is accepted by MEF and ADB.	
2.3 Are the disbursement methods appropriate?	Yes they are.	
2.4 What have been the major problems in the past in receipt, accounting and/or administration of funds by the entity?	There have not been any major problems yet.	
2.5 In which bank will the Imprest Account (if applicable) be establish?	National Bank of Cambodia (NBC) or Foreign Trade Bank (FTB) , subject to acceptance by MEF and ADB	

Topic	Response	Potential Risk Event
2.6 Is the bank in which the impress account is established capable of - • Executing foreign exchange and local currency transactions? • Issuing and administering letters of credit (LC)? • Handling a large volume of transactions? • Issuing detailed monthly bank statements promptly?	Yes, it is. Yes, it is. Yes, it is. Yes, it is.	
2.7 Is the ceiling for disbursements from the imprest account and SOE appropriate/required?	Yes	
2.6 If the executing or implementing agency has used imprest funds earlier, has it experienced any difficulty in obtaining 100% of the imprest funds disbursed by ADB?	There were some initial difficulties, but these were resolved with guidance and assistance from the consultant and from MEF.	
2.8 Does the (proposed) project implementing unit (PIU) have experience in the management of disbursements from ADB?	The PMU/PIU is currently implementing the Flood Emergency Reconstruction Project-Additional Financing (FDERP-AF) financed by ADB. In spite of this, the PIU's capacity is still limited since many tasks in the other projects are being done by consultants.	PMU/PIU may experience difficulties in performing their tasks without consultant support

Topic	Response	Potential Risk Event
2.9 Does the PIU have adequate administrative and accounting capacity to manage the imprest fund and statement of expenditure (SOE) procedures in accordance with ADB's Loan Disbursement Handbook (LDH)? Identify any concern or uncertainty about the PIU's administrative and accounting capability which would support the establishment of a ceiling on the use of the SOE procedure.	Yes, but capacity is limited. No concern nor uncertainty as PIU follows ADB's LDH and FMM.	
2.10 Is the entity exposed to foreign exchange risk? If yes, describe the entity's policy and arrangements for managing foreign exchange risk.	No, it isn't as all transactions are in US Dollars.	
2.11 How are the counterpart funds accessed?	The counterpart funds for the projects are accessed through an imprest account (See Annex 1b: Funds Flow)	
2.12 How are payments made from the counterpart funds?	Immediately after loan effectiveness, the Government, through MEF, will open US dollar imprest accounts at the National Bank of Cambodia or a commercial bank acceptable to ADB for the RGC counterpart funds. Withdrawal of government counterpart funds are being carried out in accordance with the Government Policies and Procedures. MOWRAM will be responsible for submitting Withdrawal Applications to MEF. Counterpart funds withdrawal applications should be made in accordance with the budget plan agreed between MOWRAM and MEF. Counterpart funds may only be withdrawn for expenditures of the project which are specified in the project loan agreements.	
2.13 If project funds will flow to communities or NGOs, does the PIU have the necessary reporting and monitoring arrangements and features built into its systems to track the use of the project proceeds by such entities?	NA	

Topic	Response	Potential Risk Event
2.14 Are the beneficiaries required to contribute to project costs? If beneficiaries have an option to contribute in kind (in the form of labour), are proper guidelines formulated to record and value the labour contribution?	NA	
3. Staffing		
3.1 What is the (proposed) organizational structure of the accounting department? Attach an organization chart.	See Annex 1c for the organization chart of the Finance Unit of the PMU.	
3.2 Will existing staff be assigned to the project, or will new staff be recruited?	Most of the staff are assigned from the current project, Flood Damage Reconstruction Project Additional Financing (FDERP-AF)	
3.3 Describe the existing or proposed accounting staff, including job title, responsibilities, educational background and professional experience. Attach job descriptions and CVs of key accounting staff.	Only the Finance Officer has been assigned. See Annex 1d for job description and requirements which are as stated in Standard Operating Procedures (SOP) for Externally Financed Projects/Programs.	
3.4 Is the project finance and accounting function staffed adequately?	It will be staffed adequately once loan implementation starts. Staffing is based on the Financial Management Manual (FMM) for the externally financed projects/programs.	
3.5 Are the project finance and accounting adequately qualified and experienced?	The quality and experience of staff are still limited.	PMU/PIU may experience difficulties in performing their tasks without consultant support
3.6 Is the project accounting and finance staff trained in ADB procedures including the disbursement guidelines (i.e., LDH)?	Yes, but training is not yet adequate.	Staff may not be able to fully discharge their responsibility

Topic	Response	Potential Risk Event
3.7 What is the duration of the contract with the finance and accounts staff?	They are assigned to work for the entire duration of the project.	
3.8 Identify key positions of project finance and accounting staff not contracted or filled yet, and the estimated date of appointment.	A Project Accountant will be assigned at the start of project implementation.	
3.9 For new staff, describe the proposed project finance and accounting staff, including job title, responsibilities, educational background and professional experience. Attach job descriptions.	New staff (Project Accountant) will be determined upon loan implementation. Job Description is shown in Annex 1f.	
3.10 Does the project have written position descriptions that clearly define duties, responsibilities, lines of supervision, and limits of authority for all of the officers, managers, and staff?	Yes, it does. This is clearly stated in the SOP for Externally Financed Projects/Programs.	
3.11 What is the turnover rate for finance and accounting personnel (including terminations, resignations, transfers, etc.)?	Very low.	
3.12 What is training policy for the finance and accounting staff?	Staff are encouraged to attend the training/workshops on Project Management, Financial Management, and Procurement Procedures conducted by MEF, ADB or WB.	
3.13 Describe the list of training programs attended by finance and accounting staff in the last 3 years.	Standard Operating Procedures (SOP), Financial Management Manual (FMM), and basic Procurement Manual (PM) for externally financed projects/programs	

Topic	Response	Potential Risk Event
4. Accounting Policies and Procedures		
4.1 Does the entity have an accounting system that allows for the proper recording of project financial transactions, including the allocation of expenditures in accordance with the respective components, disbursement categories, and sources of funds (in particular, the legal agreements with ADB)? Will the project use the entity accounting system?	A functioning computerized accounting system in MOWRAM is one of the outputs of the comprehensive Public Financial Management Reform Program (PFMRP) which is partially funded by ADB Grant 0222-CAM. The June 2014 Progress Report mentioned excellent progress for MOWRAM for this Output. Peachtree/sage 50 is available for other projects and at the Department of Finance (DF) of MOWRAM, but there is no such accounting software for the existing PMU yet. PMU needs to coordinate with DF to be guided in the new software that DF is implementing.	
4.2 Are controls in place concerning the preparation and approval of transactions, ensuring that all transactions are correctly made and adequately explained?	Yes, there are. These procedures are clearly stated in the FMM.	
4.3 Is the chart of accounts adequate to properly account for and report on project activities and disbursement categories? Obtain a copy of the chart of accounts.	Yes, the chart of accounts has been revised/updated (one of the outputs of the PFMRD) to properly account for and report on activities. These procedures are also clearly stated in FMM, but the finance staff of the PMU/PIU have limited capacity to use the new COA to produce the required reports. PMU needs to coordinate with DF to be guided in using the new COA.	Entity and Project reports will not be consistent
4.4 Are cost allocations to the various funding sources made accurately and in accordance with established agreements?	Yes, they are.	
4.5 Are the General Ledger and subsidiary ledgers reconciled regularly and in balance?	Yes, they are.	

Topic	Response	Potential Risk Event
4.6 Describe the EA's policy for retention of accounting records including supporting documents (e.g. ADB's policy requires that all documents should be retained at least for 1 year after ADB receives the audited project financial statements, or 2 years after the loan closing date, whichever is later). Are all accounting and supporting documents retained in a defined system that allows authorized users easy access?	All accounting and supporting documents are retained on a permanent basis in a defined system that allows authorized users for easy access. They need to be kept for a period of minimum 10 years according to FMM.	
4.7 Describe any previous audit findings that have not been addressed.	All the previous audit findings have been implemented.	
Segregation of Duties		
4.8 Are the following functional responsibilities performed by different units or persons: (i) authorization to execute a transaction; (ii) recording of the transaction; and (iii) custody of assets involved in the transaction?	Yes, they are as stated in (i), (ii), and (iii).	
4.9 Are the functions of ordering, receiving, accounting for, and paying for goods and services appropriately segregated?	The users prepare a request to be endorsed by Project Manager and to be approved by Project Director. The Finance Officer prepares an order and makes payments, and the Administrative Officer is to receive the ordered items. Some functions were combined due to limited number of PMU staff. Once the accounting staff is assigned to the PMU, she can handle order preparation and the Finance Officer can make payment.	Lack of internal control
Budgeting System		
4.10 Do budgets include physical and financial targets?	Yes, they do.	

Topic	Response	Potential Risk Event
4.11 Are budgets prepared for all significant activities in sufficient detail to provide a meaningful tool with which to monitor subsequent performance?	Yes, they are.	
4.12 Are actual expenditures compared to the budget with reasonable frequency, and explanations required for significant variations from the budget?	Yes, they are according to the FMM.	
4.13 Are approvals for variations from the budget required (i) in advance or (ii) after the fact?	Variations from the budget normally require approvals in advance, however in some cases (only operating costs) approvals are after the fact.	Unauthorized budget variations
4.14 Is there a ceiling, up to which variations from the budget may be incurred without obtaining prior approval?	There is no specific ceiling for the variation, but any budget variation from the original allocations, requires approval from MEF and DPs.	
4.15 Who is responsible for preparation and approval of budgets?	For the approval of the budget within the budget allocation, PMU Finance Officer is responsible for preparing the budget and the PMU Project Manager and Director will check and approve it.	
4.16. Describe the budget process. Are procedures in place to plan project activities, collect information from the units in charge of the different components, and prepare the budgets?	The budget are processed according to SOP and FMM	

Topic	Response	Potential Risk Event
4.17 Are the project plans and budgets of project activities realistic, based on valid assumptions, and developed by knowledgeable individuals? Is there evidence of significant mid-year revisions, inadequate fund releases against allocations or inability of the EA to absorb/ spend released funds? Is there evidence that government counterpart funding is not made available adequately or on a timely basis in prior projects? What is the extent of over- or under-budgeting of major heads over the last 3 years? Is there a consistent trend either way?	Yes. Yes this happens. They are dealt with based on the FMM. No, there is not No, as it is processed with the consultation of MEF and DP.	
Payments		
4.18 Do invoice-processing procedures require: (i) Copies of purchase orders and receiving reports to be obtained directly from issuing departments? (ii) Comparison of invoice quantities, prices and terms, with those indicated on the purchase order and with records of goods actually received? (iii) Comparison of invoice quantities with those indicated on the receiving reports? (iv) Checking the accuracy of calculations? (v) Checking authenticity of invoices and supporting	Yes, these procedures are followed as stated.	

Topic	Response	Potential Risk Event
documents?		
4.19 Are all invoices stamped PAID, dated, reviewed and approved, and clearly marked for account code assignment?	Yes, they are	
4.20 Do controls exist for the preparation of the payroll and are changes to the payroll properly authorized?	Yes, controls exist because the payroll is based on (i) the number of project staff and job descriptions follow the MOWRAM Decision No. 034 SSR.Th.TO dated January 2014 which was also based on the SOP, and (ii) the salary supplement is based on MEF's decision.	
Policies and Procedures		
4.21 What is the basis of accounting (e.g., cash, accrual) by the entity and by project?	Modified cash accounting. All transactions are on a cash-basis except for advances. Advances are treated as expenditure upon liquidation.	
4.22 What accounting standards are followed (International Financial Reporting Standards, International Public Sector Accounting Standards – cash or accrual, or National Accounting Standards (specify) or other?	Cambodian Accounting Standard, based on International Accounting Standards and International Financial Reporting Standards.	
4.23 Does the project have an adequate policies and procedures manual to guide activities and ensure staff accountability?	Yes, it does. The SOP, FMM and PM for the externally financed projects/program were developed by MEF, ADB and WB.	
4.24 Is the accounting policy and procedure manual updated for the project activities?	Yes, it is.	
4.25 Do procedures exist to ensure that only authorized persons can alter or establish a new accounting principle, policy or procedure to be used by the entity?	Yes, they do.	
4.26 Are there written policies and procedures covering all routine financial management and related administrative activities?	Yes, there are written policies and procedures such as SOP, FMM and PM.	

Topic	Response	Potential Risk Event
4.27 Do policies and procedures clearly define conflict of interest and related party transactions (real and apparent) and provide safeguards to protect the organization from them?	Yes, they do.	
4.28 Are manuals distributed to appropriate personnel?	Yes, they are.	
4.29 Describe how compliance with policies and procedures are verified and monitored.	The compliance with policies and procedures are verified and monitored in accordance with FMM.	
Cash and Bank		
4.30 Indicate names and positions of authorized signatories for bank accounts. Include those persons who have custody over bank passwords, USB keys, or equivalent for online transactions.	The Minister of MOWRAM is the authorized signatory of the bank account. According to the FMM, the Project Director can also be authorized	Possible delays in processing payments due to the expected busy schedule of the Minister.
4.31 Does the organization maintain an adequate, up-to-date cashbook, recording receipts and payments?	Yes, it does.	
4.32 Describe the collection process and cash handling procedures. Do controls exist for the collection, timely deposit and recording of receipts at each collection location?	The cash is counted and recorded as per FMM and kept in the safe. Yes, they do	
4.33 Are bank accounts reconciled on a monthly basis? Or more often? Is cash on hand physically verified, and reconciled with the cash books? With what frequency is this done?	Yes, they are reconciled on a monthly basis. Yes, it is daily or weekly basis depending on the movement of cash.	
4.34 Are all reconciling items approved and recorded?	Yes, they are	

Topic	Response	Potential Risk Event
4.35 Are all unusual items on the bank reconciliation reviewed and approved by a responsible official?	Yes, they are	
4.36 Are there any persistent/non-moving reconciling items?	Not, there aren't.	
4.37 Are there appropriate controls in safekeeping of unused cheques, USB keys and passwords, official receipts and invoices?	Yes, the unused cheques are kept in the safe with key and passwords.	
4.38 Are any large cash balances maintained at the head office or field offices? If so, for what purpose?	No, they aren't.	
4.39 For online transactions, how many persons possess USB keys (or equivalent), and passwords? Describe the security rules on password and access controls.	NA	
Safeguard Over Assets		
4.40 What policies and procedures are in place to adequately safeguard or protect assets from fraud, waste and abuse? Is there a system of adequate safeguards to protect assets from fraud, waste and abuse?	Policies and procedures are discussed in the FMM. Yes, there is a system.	
4.41 Does the entity maintain a Fixed Assets Register? Is the register updated monthly? Does the register record ownership of assets, any assets under lien or encumbered, or have been pledged?	Yes, they are.	
4.42 Are subsidiary records of fixed assets and stocks kept up to date and reconciled with control accounts?	Yes, they are	

Topic	Response	Potential Risk Event
4.43 Are there periodic physical inventories of fixed assets, inventories and stocks? Are fixed assets, inventories and stocks appropriately labelled?	Yes, there are and they are	
4.38 Is the disposition of each asset appropriately recorded, and immediate steps taken to locate lost, or repair broken, assets?	Yes, it is.	
4.46 Are assets sufficiently covered by insurance policies?	This will depend on the discussion between the PMU/PIU and MEF.	
4.47 Describe the policies and procedures in identifying and maintaining fully depreciated assets from active assets.	NA	
Other Offices and Implementing Entities		
4.48 Describe other regional offices or executing entities participating in implementation	NA	
4.49 Describe the staff, their roles and responsibilities in performing accounting and financial management functions of such offices as they relate to the project.	NA	
4.50 Has the project established controls and procedures for flow of funds, financial information, accountability, and audits in relation to the other offices or entities?	NA	

Topic	Response	Potential Risk Event
4.51 Does information among the different offices/ implementing agencies flow in an accurate and timely fashion? In particular, do the offices other than the head office use the same accounting and reporting system?	NA	
4.52 Are periodic reconciliations performed among the different offices/implementing agencies? Describe the project reporting and auditing arrangements between these offices and the main executing/implementing agencies.	NA	

Topic	Response	Potential Risk Event
4.53 If any sub-accounts (under the Imprest Account) will be maintained, describe the results of the assessment of the financial management capacity of the administrator of such sub-accounts.	*NA*	
Contract Management and Accounting		
4.54 Does the agency maintain contract-wise accounting records to indicate gross value of contract, and any amendments, variations and escalations, payments made, and undisbursed balances? Are the records consistent with physical outputs/deliverables of the contract?	Yes, it does. Yes, they are.	
4.55 If contract records are maintained, does the agency reconcile	Yes, the agency reconciles.	
Other		
4.56 Describe project arrangements for reporting fraud, corruption, waste and misuse of project resources. Has the project advised employees, beneficiaries and other recipients to whom to report if they suspect fraud, waste or misuse of project resources or property?	The fraud, corruption, waste and misuse of project resources can be reported to the project director or head of the EA. Yes, it has.	
5. Internal Audit		
5.1 Is there an internal audit (IA) department in the entity?	Yes, there is. It was established by Sub-decree no. 54/ANKR/BK dated 29 May 2006 by the Royal Government of Cambodia.	

Topic	Response	Potential Risk Event
5.2 What are the qualifications and experience of the IA staff?	They have limited capacity based on the assessment of the Finance Director as well as the Deputy Director of the Internal Audit Department (IAD). IAD staff comprises a few young staff with accounting degrees but lacking experience in internal audit.	PMU/PIU may experience difficulties in performing their tasks without consultant support
5.3 To whom does the internal auditor report?	The Internal Auditor reports to the Minister.	
5.4 Will the internal audit department include the project in its work program?	Selection of the projects for internal audit is based on the risk identified during the preparation of the three year rolling plan and annual plan. It is proposed that the UIWRMSP project be included in the internal audit plan.	
5.5 Are actions taken on the internal audit findings?	Yes, they are.	
5.6 What is the internal audit program? How was it developed?	The internal audit program is to check the compliances, effectiveness, efficiency, and economy of the entity. It is developed based on the Public Auditing Standard for Cambodia	
5.7 Is the IA department sufficiently independent?	Yes, it is.	
5.8 Do they perform pre-audit of transactions?	No they don't	
5.9 Who approves the internal audit program?	Minister	
5.10 What standards guide the internal audit program?	Public Auditing Standard for Cambodia	
5.11 How are audit deficiencies tracked?	The deficiencies are stated in the Internal Audit Report and they will be checked if they have been implemented in the succeeding year.	
5.12 How long have the internal audit staff members been with the organization?	Most of IAD staffs have been working for the IAD since 2007. Most of them came from other departments of MOWRAM and do not have the appropriated qualifications to work as Internal Auditors. Five young staff that joined IAD in 2010 have appropriate qualifications and have been trained through the PFMRD program. However, they lack experience in internal audit work.	
5.13 Does any of the internal audit staff have an IT background?	Yes, but limited	
5.14 How frequently does the internal auditor meet with the audit committee without the presence of management?	They meet the audit committee headed by the Minister any time they deem it necessary.	

Topic	Response	Potential Risk Event
5.15 Has the internal auditor identified/reported any issue with reference to retention or availability of records?	Yes, it has.	
5.16 Does the internal auditor have sufficient knowledge and understanding of ADB's guidelines and procedures, including the disbursement guidelines and procedures (i.e., LDH)?	No, they don't and they need more training.	Cannot fully discharge their duties
6. External Audit- entity level		
6.1 Is the entity financial statement audited regularly by an independent auditor? Who is the auditor?	Yes, it is audited once a year. The National Audit Authority (NAA) of the Royal Government of Cambodia is the auditor.	
6.2 Are there any delays in audit of the entity? When are the audit reports issued?	The audit reports will be issued within 3 months of starting the field work. There is no deadline as to when the audit report will be completed after the end of the year.	
6.3 Is the audit of the entity conducted in accordance with the International Standards on Auditing, or the International Standards for Supreme Audit Institutions, or national auditing standards?	It is conducted according to the Public Auditing Standard for Cambodia and ISSAI - International Standards of Supreme Audit Institutions	
6.4 Were there any major accountability issues brought out in the audit report of the past three years?	No, there weren't.	
6.5 Does the external auditor meet with the audit committee without the presence of management?	Yes, it does.	

Topic	Response	Potential Risk Event
6.6 Has the entity engaged the external audit firm for any non-audit engagements (e.g., consulting)? If yes, what is the total value of non-audit engagements, relative to the value of audit services?	No, they aren't.	
6.7 Has the external auditor expressed any issues on the availability of complete records and supporting documents?	No, it hasn't.	
6.8 Does the external auditor have sufficient knowledge and understanding of ADB's guidelines and procedures, including the disbursement guidelines and procedures (i.e., LDH)?	Yes, but on average	
6.9 Are there any material issues noted during the review of the audited entity financial statements that were not reported in the external audit report?	No, there aren't.	
External Audit- project level		
6.10 Will the entity auditor audit the project accounts or will another auditor be appointed to audit the project financial statements?	Yes, another auditor (such as PWC, KPMG, EY or BDO) will be appointed by the project or MEF under a bundled audit arrangement.	
6.11 Are there any recommendations made by the auditors in prior project audit reports or management letters that have not yet been implemented?	No, for example, the recommendation to improve the slow approval process for payment in Flood Damage Emergency Reconstruction Project funded by ADB, has not yet been implemented.	

Topic	Response	Potential Risk Event
6.12 Is the project subject to any kind of audit from an independent governmental entity (e.g. the supreme audit institution) in addition to the external audit?	Yes, the project is also subject to an audit by the National Audit Authority (NAA) or the Ministry of National Assembly and Senate Relation and Inspection (MONASRI) of the Royal Government of Cambodia can audit the project if necessary.	
6.13 Has the project prepared acceptable terms of reference for an annual project audit? Have these been agreed and discussed with the EA and the auditor?	Yes, it has. Terms of Reference needs to be discussed with MEF and to be submitted to ADB's to obtain prior approval	
6.14 Has the project auditor identified any issues with the availability and completeness of records and supporting documents?	Current project auditors have not identified such issues.	
6.15 Does the external auditor have sufficient knowledge and understanding of ADB's guidelines and procedures, including the disbursement guidelines and procedures (i.e., LDH)?	External auditors have sufficient knowledge.	
6.16 Are there any recommendations made by the auditors in prior audit reports or management letters that have not yet been implemented?	The auditor's recommendation to resolve the issue of slow approval process in question 6.10 has not been implemented.	

Topic	Response	Potential Risk Event
[For second or subsequent projects] 6.17 Were past audit reports complete, and did they fully address the obligations under the loan agreements? Were there any material issues noted during the review of the audited project financial statements and related audit report that have remained unaddressed?	Yes, they were. No, there weren't.	
7. Reporting and Monitoring		
7.1 Are financial statements prepared for the entity?	Yes, they are.	
7.2 Are financial statements prepared for the implementing unit (s)?	Yes, they are.	
7.3 What is the frequency of preparation of financial statements? Are the reports prepared in a timely fashion so as to useful to management for decision making?	The financial statements have to be prepared in monthly, quarterly and annual basis according FMM.	
7.4 Does the reporting system need to be adapted to report on the project components?	Yes, it does.	
7.5 Has the project established financial management reporting responsibilities that specify the types of reports to be prepared, the report content, and purpose of the reports?	Yes, it has according to FMM.	
7.6 Are financial management reports used by management?	Yes, they are used by both the project manager and director and the MEF.	
7.7 Do the financial reports compare actual expenditures with budgeted and programmed allocations?	Yes, they do this based on FMM, but this is done using individual worksheets and not a computerized accounting system.	Lack of control

Topic	Response	Potential Risk Event
7.8 How are financial reports prepared? Are financial reports prepared directly by the automated accounting system or are they prepared by spreadsheets or some other means?	The financial reports prepared directly by spreadsheets since there is no computerized accounting system	Delays in reporting
7.9 Does the reporting system have the capacity to link the financial information with the project's physical progress? If separate systems are used to gather and compile physical data, what controls are in place to reduce the risk that the physical data may not synchronize with the financial data?	No, the system does not have this capacity. It is recommended the PMU adopt a format to show the financial information and physical progress in one report as shown in the FMM.	Physical data may not synchronize with the financial data
7.10 Does the entity have experience in implementing projects of any other donors, co-financiers, or development partners?	Yes, it does.	
8. Information System		
8.1 Is the financial management system computerized?	Yes, the financial management system used by the Finance Department of MOWRAM is computerized. But the computerized system is not yet used by the PMU.	Lack of control since two systems are being used.
8.2 If computerized, is the software off-the-shelf, or customized?	It is the off-the-self software.	
8.3 Is the computerized software standalone, or integrated and used by all departments in the headquarters and field units using modules?	It is a standalone software managed by the Finance Department of MOWRAM.	

Topic	Response	Potential Risk Event
8.4 How are the project financial data integrated with the entity financial data? Is it done through a module in the enterprise financial system with automatic data transfer, or does it entail manual entry?	It is integrated manually for the counterpart funds but not DPs funds.	Lack of control
8.5 Is the computerized software used for directly generating periodic financial statements, or does it require manual intervention and use of Excel or similar spreadsheet software?	No, it isn't, so Excel is used to generate the financial reports.	
8.6 Can the system produce the necessary project financial reports?	Yes, but the system is not efficient as required by DPs due to the lack of computerized systems.	Lack of efficiency
8.7 Is the staff adequately trained to maintain the system?	No, they are not adequately trained to maintain the new FMIS.	Staff cannot fully discharge their duties
8.8 Does the management organization and processing system safeguard the confidentiality, integrity and availability of the data?	Yes, it does as stated in FMM	
8.9 Are there back-up procedures in place?	Yes, they are as stated in FMM	
8.10 Describe the backup procedures – online storage, offsite storage, offshore storage, fire, earthquake and calamity protection for backups.	Back up Procedures • All IT systems/Accounting Software will be regularly (daily if possible) backed up and procedures established to restore data and or software following any operational disruption; • Emergency procedures will be available to provide business continuity following loss of IT systems • All IT systems will be backed up to external media (e.g. tape, disk) on at least a daily basis; and • Daily printouts of daily transactions will be made checked and signed by the Project Financial Officer and filed for future reference. However, there is no online back-up	

Appendix 11:
SUMMARY POVERTY REDUCTION AND SOCIAL STRATEGY

Country:	Cambodia	Project Title:	Uplands Irrigation and Water Resources Management Sector Project
Lending/Financing Modality:	Sector Loan	Department/ Division:	Southeast Asia Department Environment, Natural Resources and Agriculture Division

I. POVERTY AND SOCIAL ANALYSIS AND STRATEGY

Poverty targeting: general intervention

A. Links to the National Poverty Reduction and Inclusive Growth Strategy and Country Partnership Strategy

In the last decade, a sharp decline in Cambodia's poverty incidence was achieved with population below the poverty line decreasing from 47.8% in 2007 to 19.2% in 2011. Phase 3 of the Rectangular Strategy on Growth, Employment, Equity, and Efficiency (RS-Phase 3) aims to reduce poverty further to around 15% by 2018. RS-Phase 3 provides guidance to ensure equitable and sustainable growth especially in the rural areas where 9 of 10 poor people can be found. One of its main thrusts is agriculture development, which calls for improving agricultural productivity, diversification, and commercialization.[a] ADB's Country Partnership Strategy (CPS) is aligned with the RS-Phase III thrust on agriculture by supporting interventions that will shift agricultural value chains from being supply-driven to market-driven.

The proposed Project will support RS-Phase 3 and ADB's CPS by enhancing agricultural and rural economic productivity through improved management of water resources and increased efficiency of irrigation systems in the uplands of Battambang and Kampong Thom Provinces. Both of these provinces are also supported by the ongoing Climate-Resilient Rice Commercialization Sector Development Project. The proposed project will complement the Rice Commercialization Project's output on developing climate-resilient rice value chain infrastructure in these major rice-producing provinces. The combined and cumulative effects of the two projects will contribute more to improving the productivity of agriculture sector, which accounts for 34% of national GDP (2012)[b] and will have greater impact in reducing rural poverty.

B. Results from the Poverty and Social Analysis during PPTA or Due Diligence

1. Key poverty and social issues. Based on field consultations, poverty is perceived to be the result of lack of water in the canal for irrigation of crops during the dry season, poor soil condition, people not using appropriate agriculture technologies, and lack of income opportunities in the locality.[c] Since 2004 to 2012, poverty rates in Battambang and Kampong Thom have been steadily decreasing as shown in the able below:

	Poverty Rate (%)[d]		
Name of Province	**2004**	**2008**	**2012**
Battambang	37.8	31.7	24.8
Kampong Thom	41.1	36.5	29.1

The proposed Project aims to contribute to this trend of declining poverty in the two provinces by increasing incomes of farmers through improved irrigation systems and bringing cropping times from one to two per year. The project is also expected to decrease male outmigration, as greater livelihood opportunities in agriculture will encourage men to seek a living within the Project area.

2. Beneficiaries. In Kampong Thom's Taing Krasaing irrigation system alone, 93.5%[e] of families are engaged in rice production. The proposed Project will benefit 11,686[f] farmers and water users from the rehabilitation of the system's main canal and construction of secondary and tertiary canals located in 4 communes. Yield is expected to increase from 1.5 to 3.0 tons/ha and the net value per ha from $215 to $953.[g]

In Prek Chik irrigation system in Battambang, 85.6%[h] of families are engaged in rice production. Beneficiaries include 6,663[i] farmers and water users. Increase in yield is expected at 5 from 1.8 tons/ha and the net value per ha at 1,829 from 295.[j]

3. Impact channels. Size and ownership of landholding will not be used as criteria for membership in farmer and water users committees (FWUCs). Instead, the proposed Project will ensure that vulnerable farmers have sufficient opportunities to participate in determining (i) locations of secondary and tertiary canals to better serve their farmlands, (ii) water distribution frequencies and schedules, and (iii) water fees and other charges that have impacts on their paying capacities.

The average landholding in Taing Krasing is 1.5 ha and 2.0 ha in Prek Chik.[k] In Taing Krasaing, 522 farmers own less than 1 ha of land and 170 farmers do not own rice land. In Prek Chik, 1,337 farmers own less than 1 ha of land and

1,152 farmers do not own rice land.[l] Vulnerable farmers in both Provinces expect to fully benefit from and participate in the project.

4. Other social and poverty issues. Farmers complain of poor road access to markets and high credit interest rates. The Royal Government of Cambodia's public works and regulatory services can address these issues.

5. Design features. In the DMF, the outcome indicator says that crop production will be increased by 180% in 2021. Indicators for Output 1: Enhanced Efficiency and Climate resilience of Irrigation Systems pertain to rehabilitation/upgrading/modernization of irrigation systems for about 21,000 ha by 2021 and 100% increase in efficiency of the irrigation systems. Output 2: Improved Water Resource Management includes indicators for establishing FWUCs, training FWUCs and women in water management, joint reservoir operations, sustaining irrigation operations through sound O&M plans and allocating resources for O&M.

II. PARTICIPATION AND EMPOWERING THE POOR

1. Participatory approaches and project activities. The Project will establish and strengthen FWUCs where all farmers and water users will be eligible for membership. FWUCs will be involved during project planning and construction especially during O&M. Poor farmers and female-headed households will be provided equal access in project activities including training and civil works. Creation of FWUCs and hiring of unskilled women labor are among the DMF indicators.

2. Civil society organizations. CSOs can be considered as service providers for training and other assistance to FWUCs and training for Project implementers.

3. The following forms of civil society organization participation are envisaged during project implementation, rated as high (H), medium (M), low (L), or not applicable (NA):

[L] Information gathering and sharing [M] Consultation [L] Collaboration [L] Partnership

4. Participation plan. ☐ Yes. ☒ No.

The institutional analysis includes the procedures and the responsible entities for establishing FWUCs. It also includes key duties of government agencies and FWUCs throughout project implementation.

III. GENDER AND DEVELOPMENT

Gender mainstreaming category: effective gender mainstreaming

A. Key issues. Women's participation in project activities is a key concern. As the men seek employment outside the provinces, women are burdened with housework and farming duties leaving them without time to join meetings and consultations, which are crucial for establishing FWUCs. Social norms and lack of education also hinder them from occupying leadership roles in FWUCs and fully engaging in making decisions related to water use, distribution, and fees that can have significant effects on their lives.

B. Key actions. ☒ Gender action plan ☐ Other actions or measures ☐ No action or measure

The gender action plan (GAP) emphasizes the need to encourage women's participation throughout project implementation and in most project activities including trainings. Key indicators in the GAP are also reflected in the DMF to ensure that women's voices are heard and that project benefits and interventions cater to women's needs. Half of FWUCs membership is expected to be women and 30% of FWUC management is targeted to be women. Women will comprise at least 30% of unskilled labor during civil works. MOWRAM will be in charge of monitoring the GAP through the gender focal point and the assistance of a gender specialist in the team of PMIC.

IV. ADDRESSING SOCIAL SAFEGUARD ISSUES

A. Involuntary Resettlement **Safeguard Category:** ☐ A ☒ B ☐ C ☐ FI

1. Key impacts. Small strips of land may be affected temporarily or permanently during rehabilitation and/or construction of irrigation canals, drainage canals, and related infrastructure. Loss of crops and partial losses of structure may also be encountered.

2. Strategy to address the impacts. A Resettlement Framework has been developed for the Project to address involuntary resettlement impacts. It sets out screening of subprojects, procedures for resettlement planning including consultations, provision of entitlements, implementation arrangements, grievance redress mechanisms, etc. It is closely patterned after the Rice Commercialization Project to ensure consistency in the application of safeguards in same provinces.

3. Plan or other Actions.

☐ Resettlement plan
☒ Resettlement framework
☐ Environmental and social management system arrangement
☐ No action
☐ Combined resettlement and indigenous peoples plan
☐ Combined resettlement framework and indigenous peoples planning framework
☐ Social impact matrix

B. Indigenous Peoples **Safeguard Category:** ☐ A ☐ B ☒ C ☐ FI

1. Key impacts. The population in the Project area is almost exclusively composed of Buddhist Khmer farmers. There are a small number of Vietnamese and Muslim Chaam residents who are fully integrated into the wider society. As such, by definition there are no Indigenous Peoples in the Project area.

Is broad community support triggered? ☐ Yes ☒ No

2. Strategy to address the impacts. N.A.	
3. Plan or other actions. ☐ Indigenous peoples plan ☐ Indigenous peoples planning framework ☐ Environmental and social management system arrangement ☐ Social impact matrix ☒ No action	☐ Combined resettlement plan and indigenous peoples plan ☐ Combined resettlement framework and indigenous peoples planning framework ☐ Indigenous peoples plan elements integrated in project with a summary
V. ADDRESSING OTHER SOCIAL RISKS	
A. Risks in the Labor Market 1. Relevance of the project for the country's or region's or sector's labor market, indicated as high (H), medium (M), and low or not significant (L). L unemployment L underemployment L retrenchment M core labor standards 2. Labor market impact. The project will ensure that child laborers will not be employed, that men and women receive equal work for equal pay, and forced labor will not be allowed.	
B. Affordability Water fees, distribution charges, and other tariffs may be unaffordable to poor farmers and women users. The project will ensure that vulnerable beneficiaries are duly consulted in setting up these fees. It will also consider alternative forms of payment such as labor for operation and maintenance in exchange for water consumption, etc.	
C. Communicable Diseases and Other Social Risks 1. The impact of the following risks are rated as high (H), medium (M), low (L), or not applicable (NA): L Communicable diseases NA Human trafficking ☐ Others (please specify) ______________ 2. Risks to people in project area. Some of construction workers may transmit communicable diseases. The project advocates hiring of labor within the project area including poor farmers and women.	
VI. MONITORING AND EVALUATION	
1. Targets and indicators. As mentioned above, DMF indicators for the project outcome and two project outputs include poverty reduction and inclusive social development. Data sources are MOWRAM's progress reports and the project performance monitoring system (PPMS). 2. Required human resources. Project implementation consultants will include gender, social safeguards, and social development specialists. Government counterparts for gender and social safeguards will also be assigned. ADB experts on gender and social safeguards will supervise the Project. 3. Information in the project administration manual (PAM). The PAM provides for the establishment of the PPMS, progress reports and completion reports for the project, gender monitoring, and quarterly progress reports for involuntary resettlement. 4. Monitoring tools. The PAM indicates the PPMS as the main monitoring tool to measure indicators related to poverty, gender, and the creation of FWUCs.	

Source: Asian Development Bank.

[a] Asian Development Bank. Country Partnership Strategy for Cambodia (2014-2018).
[b] Ibid.
[c] Poverty and Social Assessment Report for CAM: UIWRMSP, 2015.
[d] Poverty Reduction by Capital, Provinces, Municipalities, Districts, Khans and Communes, Sangkats Based on Commune Database (CDB), 2004-2012, Ministry of Planning, July 2012.
[e] Commune Database 2012, National Institute of Statistics.
[f] Commune Database 2012 and Provincial Data Book 2009.
[g] Farm Survey Report of Agronomist, Preparing the Uplands Irrigation and Water Resources Management Sector project, ADB-PPTA 8702-CAM, March 2015 and from District Agriculture Office and Commune Meetings from 2 and 7 May 2015.
[h] Commune Database 2012, National Institute of Statistics.
[i] Commune Database 2012 and Provincial Data Book 2009.
[j] Farm Survey Report of Agronomist, Preparing the Uplands Irrigation and Water Resources Management Sector project, ADB-PPTA 8702-CAM, March 2015 and from District Agriculture Office and Commune Meetings from 2 and 7 May 2015.
[k] Ibid.
[l] Commune data provided during meeting of PPTA Team with Commune Officials on 2 May and 7 May 2015.

Appendix 12: POVERTY AND SOCIO-ECONOMIC CONDITION

A. Introduction

1. This report presents the socio-economic and poverty situation in the project areas of the Uplands Irrigation and Water Resources Management Sector Project. The project areas are located in the provinces of Battambang and Kampong Thom. The proposed project is planned to enhance agricultural and rural economic productivity through increased efficiency of irrigation systems and improved management of water resources. It will be implemented in two irrigation schemes, namely, Preaek Chik Irrigation Scheme located in Battambang Province and Taing Krasaing Irrigation Scheme located in Kampong Thom Province. Figure 1 shows the project areas. The social and poverty assessment of the project examines the socio-economic conditions in the project areas and identifies the population that will be impacted. It identifies the existing irrigation and agriculture situation in relation to poverty condition of the existing population within the proposed irrigation schemes. It presents the poverty situation in terms of the poverty rate and identifies the vulnerable population which may be impacted by the project.

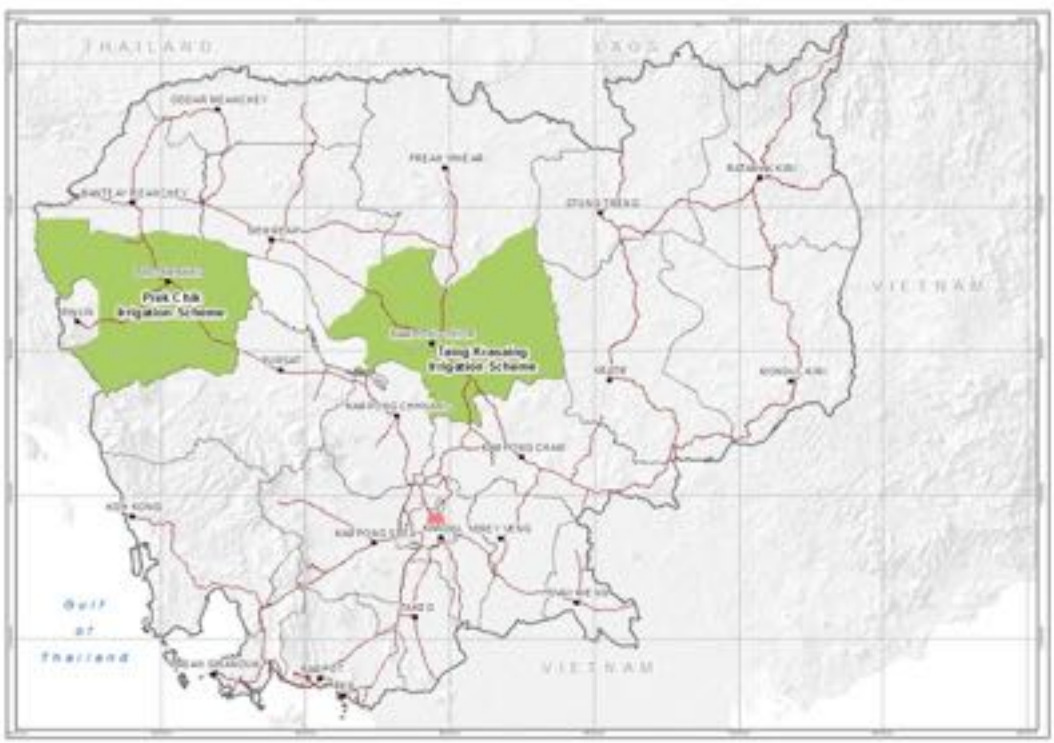

Figure 1: Location Map of the Core Sub-Projects

B. Development Scenario and Socio-Economic Development Policies and Plans

2. Over the last decade, Cambodia has been experiencing economic development with a growth rate of 10.2% for the period of 2004–2008. Though the gross domestic product (GDP) decreased to 0.1 in 2009, it recovered in 2010 and 2011 with a growth rate of 6.0. Agriculture,

fisheries and forestry have shown tremendous growth in 2005 with 15.7% compared to other sectors such as industry with 12.7% and services with 13.1%. It had however decreased to 4.0% in 2010 compared to the high increase in industry of 13.6% and services of 3.3%.[1]

3. The Government of Cambodia outlined its long-term vision for development in the national program to rehabilitate and develop Cambodia in 1994. This initiated the process of rebuilding and rehabilitating the social, physical, and institutional infrastructure. Based on this vision, the first five-year Socio-Economic Development Plan (SEDP I, 1996–2000) was formulated focusing on the establishment of macro-economic fundamentals, social development contours, and poverty alleviation strategies. In the second SEDP 2001–2005, the focus was on economic growth and poverty reduction.

4. Towards the end of 2000, countries around the world agreed on a set of common goals known as the Millennium Development Goals (MDG). On the basis of which, the Cambodian Millennium Development Goals (CMDG) was formulated focusing on poverty alleviation and human development. The National Poverty Reduction Strategy (NPRS) was adopted in December 2002 to define the country's strategy in achieving the CMDGs.

5. The CMDG focused on tackling extreme poverty and these are focused on eight Goals:

- (i) MDG 1 is the eradication of extreme hunger and poverty.
- (ii) MDG 2 is to achieve universal primary education for all people of school age.
- (iii) MDG 3 is the promotion of gender equality.
- (iv) MDG 4 is the reduction of child mortality.
- (v) MDG 5 is the improvement of maternal health.
- (vi) MDG 6 is to combat HIV/AIDs, malaria and other diseases.
- (vii) MDG 7 is on environmental sustainability.
- (viii) MDG 8 is to develop global partnership for development.

6. In 2012, an assessment was made by the Ministry of Planning on the achievements made in relation to the progress of the 194 districts and 24 provinces in achieving the MDG. Presented in

[1] Asian Development Bank. 2011. *Key Indicators for Asia and the Pacific 2011.* Manila.

8. **Table 1** is the rating and ranking of the districts and provinces where the Preaek Chik and Taing Krasaing irrigation schemes are located. The Preaek Chik irrigation scheme which is located in Battambang province has land in the districts of Moung Ruissei and Rukk Kiri covering four communes, while Taing Krasaing, located in Kampong Thom has land located in Santuk District covering four communes. The assessment shows that Battambang Province has a rating of 58[2] and ranks number 10 out of 24 provinces. It has higher achievement and ranking compared to Kampong Thom, which is ranked number 15 among 24 provinces. Among the three districts covered by the project, Moung Ruessei has the highest achievement rating of 69 with a ranking of 104 out of 194 districts. Santuk District has the lowest rating of 61 and with a ranking of 156. It shows that the MDG 1 on complete eradication of extreme hunger and poverty indicates low rating in the three districts and two provinces. MDG 3 on gender equality and MDG 5 on improve maternal health show high rating in the three districts.

[2] Rating is made on a 100% scale.

Table 1: Assessment of Achievements in the Millennium Development Goals

Millennium Development Goal	Preaek Chik Irrigation Scheme			Taing Krasaing Irrigation Scheme	
	Battambang Province	Moung Ruessei	Rukh Kiri	Kampong Thom Province	Santuk District
MDG 1	42	55	42	35	41
MDG 2	64	71	62	47	62
MDG 3	67	72	68	58	64
MDG 4	76	87	86	58	72
MDG 5	79	76	77	49	70
MDG 6	52	75	86	56	85
MDG 7	34	33	30	35	44
MDG 8	43	85	85	46	47
Total Rating (100 highest score)	58	69	66	48	61
Ranking	10 (out of 24 provinces)	104 (out of 194 dDistricts)	124 (out of 194 districts)	15 (out of 24 provinces)	156 (out of 194 districts)

Source: PPTA Consultant.

9. The Rectangular Strategy[3] selects the key elements from the MDGs, the NPRS 2003–2005 and the various policies, plans and reform program. It provides a 5-year development framework. It is envisaged that the program will be implemented and managed within the existing organizational and management structures of the Ministry of Agriculture, Forestry and Fisheries (MAFF) and the Ministry of Water Resources and Meteorology (MOWRAM). One of the key pillars of the Rectangular Strategy is the agriculture policy, which addresses the improvement of agricultural productivity and diversification. This is intended to enable the agriculture sector to serve as the dynamic driving force for economic growth and poverty reduction. In the rural areas, land and water are the two fundamental natural resources that serve as the basis for socio-economic development and poverty reduction. Through the agriculture policy, the government will develop and expand irrigated lands and effective water resources management by improving the efficiency of the existing irrigation system, further developing and enhancing the effectiveness of water communities and reducing the vulnerability of the population to natural disasters and its total dependence on natural conditions.

10. The National Strategic Development Plan 2013–2018 carries forward the agenda laid out in Rectangular Strategy Phase III, which was unfolded in September 2013 and in achieving the MDGs.

C. Socio-economic Condition

1. Land Area and Agriculture Situation

11. Cambodia has a total land area of 181,035 km^2 with a total estimated population of 15 million people of which 48.9% is male and 51.1% is female. There are 2.6 million households, out of which 1.876 million households are engaged in agriculture. The percentage

[3] Government of Cambodia. 2008. "*Rectangular Strategy" for Growth, Employment, Equity and Efficiency Phase II, First Cabinet Meeting of the Fourth Legislature of the National Assembly*. Phnom Penh.

of people living below the poverty line was 35.1% in 2004, decreasing to 29.3% in 2008, and further decreased to 22.9% in 2012. The total land area for arable and permanent crops is estimated at 4.5 million ha in 2013, of which 3.99 million ha are arable land and 0.51 million ha are planted with permanent crops such as fruit trees.[4] The country is divided into four regions with the following number of land holdings as indicated in Table 2.

Table 2: Regions and Number of Agricultural Landholdings[5]

Regions	**Number of Agricultural Holdings** (km^2)	**Proportion** (%)
Cambodia	1,876,712	100%
Plain	869,305	46.35
Tonle Sap Lake	614,369	32.75
Coastal	139,433	7.43
Plateau and Mountainous	252,605	13.47

Source: PPTA Consultant.

12. The project area is located in two provinces, namely Battambang and Kampong Thom, which belong to the Tonle Sap Lake Region as shown in Figure 1. Battambang has 26% of the total agricultural landholdings in the Tonle Sap Lake Region with an average of 3.118 ha per landholding. Kampong Thom has 13% of the agricultural landholding with an average of 1.75 ha per landholding. Tonle Sap Lake Region has 47% of the total agricultural landholding in Cambodia with an average landholding of 2.35 ha.

Table 3: Agricultural Landholdings in Project Areas

Region/Province	**Total Agricultural Landholding Area** (Ha)	**Average Area per Holding** (Ha)
Cambodia	3,071,383.83	1.637
Tonle Sap Lake Region	1,447,620.55 (47%)	2.356
Battambang Province	374,558.50 (26%)	3.118
Kampong Thom	195,057.65 (13%)	1.754

Source: PPTA Consultant.

[4] Census of Agriculture in Cambodia. 2013. National Institute of Statistics, Ministry of Planning in collaboration with Ministry of Agriculture, Forestry and Fisheries.
[5] *Ibid*, p.8

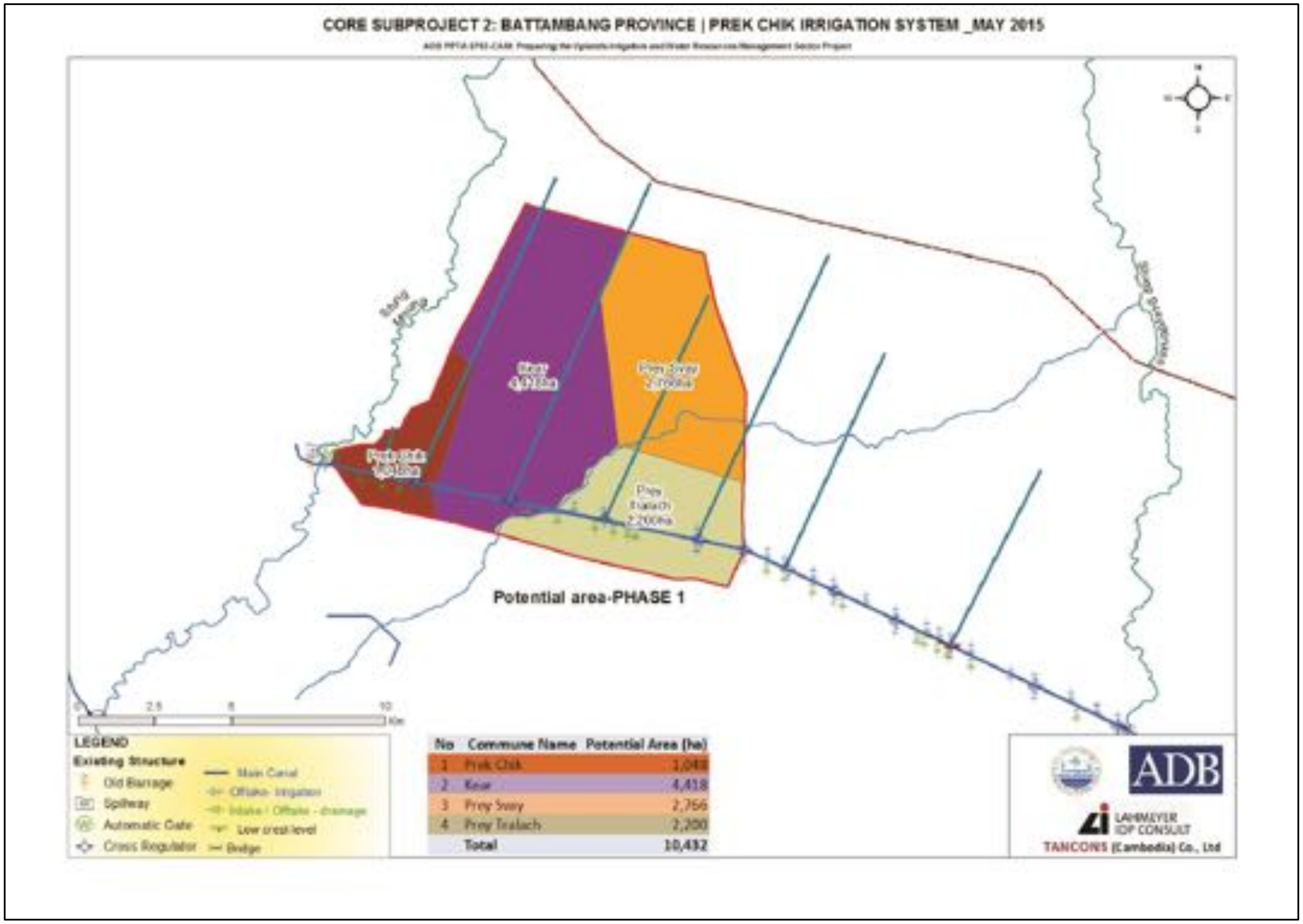

Figure 2: Lay-Out Map of Prek Chik Irrigation System, Battambang Province

13. Land tenure arrangement shows that majority of the land are owned with 94.57% in Battambang and 98.55% in Kampong Thom.

Table 4: Land Tenure Arrangement[6]

Region / Province	% of Parcels by Land Tenure				Total No. of Parcels
	Owned	Rented with payment (Money or Harvest)	Rented Free	Other Land Tenure	
Cambodia	97.91	1.53	0.36	0.21	3,731,551
Tonle Sap Lake Region	97.58	1.77	0.50	0.15	1,148
Battambang Province	94.57	4.41	0.83	0.19	191,176
Kampong Thom	98.55	1.18	0.18	0.10	230,841

Source: PPTA Consultant.

14. The total landholdings that use irrigation is estimated at 32% for the whole country. In Battambang and Kampong Thom, 20% of the landholdings use irrigation, but only 4% in Battambang and 5.5% in Kampong Thom use government irrigation facilities and 4% use other sources of irrigation.

Table 5: Landholding that Use Irrigation[7]

Region/Province	Landholding that used Irrigation (%)	Landholding that use Government Irrigation Facilities (%)
Cambodia	32%	
Tonle Sap Lake Region	23%	
Battambang Province	20%	4%
Kampong Thom	20%	5.5%

Source: PPTA Consultant.

2. Location of Project Area

15. The core sub-project areas are Preaek Chik Irrigation Scheme located in Battambang province and Taing Krasaing Irrigation Scheme located in Kampong Thom province.

16. Preaek Chik Irrigation Scheme is located 297 km from the capital city of Phnom Penh. It is accessible by land with travel time of 5 to 6 hours through National Road No. 5. The province of Battambang is bounded on the north by the Bateay Meanchey Province, on the east by Pursat Province, on the northeast by Siem Reap and on the west by Pallin. Its western boundary forms part of the international border with Thailand.

17. Taing Krassaing Irrigation Scheme is located 168 km from Phnom Penh. It is accessible by land with travel time of 3 to 4 hours passing through the National Road No. 6. Kampong Thom is bounded on the west by Kampong Chhnang and Siem Reap provinces, on the north by Preah Vihear and Siem Reap, on the south by Kampong Cham and Kampong Chhnang provinces.

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[6] *Ibid*, p.11
[7] Ibid, p.14

3. Project Administrative Scope and Coverage

18.

19. Table **6** summarizes the land area of Preaek Chik Irrigation Scheme, which is spread throughout the four communes namely: (i) Kear, (ii) Prey Svay, (iii) Preaek Chik and (iv) Prey Trolach. Within the four communes are the 13 villages where the land area of the project is located.

20. The land area of Taing Krasaing Irrigation Scheme is in four communes namely: (i) Taing Krasaing, (ii) Tipou, (iii) Chroab and (iv) Kokoah. Within the four communes are 19 villages where the land area of the project is located as shown in

21. Figure **2**.

Table 6: Administrative Scope and Coverage

Irrigation Schemes	**Location and Coverage**			
	Province	**District**	**Communes**	**Villages**
Preaek Chik	Battambang	Moung Ruessei	(1) Kear	(1) Roka Chhmol (2) Run (3) Koh Thkov (4) Ta Ok
			(2) Prey Svay	(1) Cham Ro A
		Rukh Kiri	(3) Prek Chik	(1) Prek Chik (2) Preaek Taven (3) Chhker Kham Pres (4) Khnach Ampor (5) Thnam (6) Siem
			(4) Prey Tralach	(1) Chong Por (2) Prey Khlot
		2 Districts	4 Communes	13 Villages
Taing Krasaing	Kampong Thom	Santuk	(1) Taing Krasaing	(1) Veang Cheung (2) Thomm Neath (3) Sangkom Thmei
			(2) Chroab	(1) Ou Kohkir (2) Sdok Sdam (3) Chey Mongkol (4) Tuol Vihear
			(3) Ti Pou	(1) Phlong (2) Kbal Bei (3) Trapeang Trom (4) Samraong (5) Choam Thnanh (6) Chouk Rumdoul (7) Thmei (8) Nimith
			(4) Korkoah/ (5) Kakaoh	(1) Sala Santouk (2) Chimeak (3) Santuk Krau (4) Santuk Knong
		1 District	4 Communes	19 Villages
Total	**2 Provinces**	**3 Districts**	**8 Communes**	**32 Villages**

Source: PPTA Consultant.

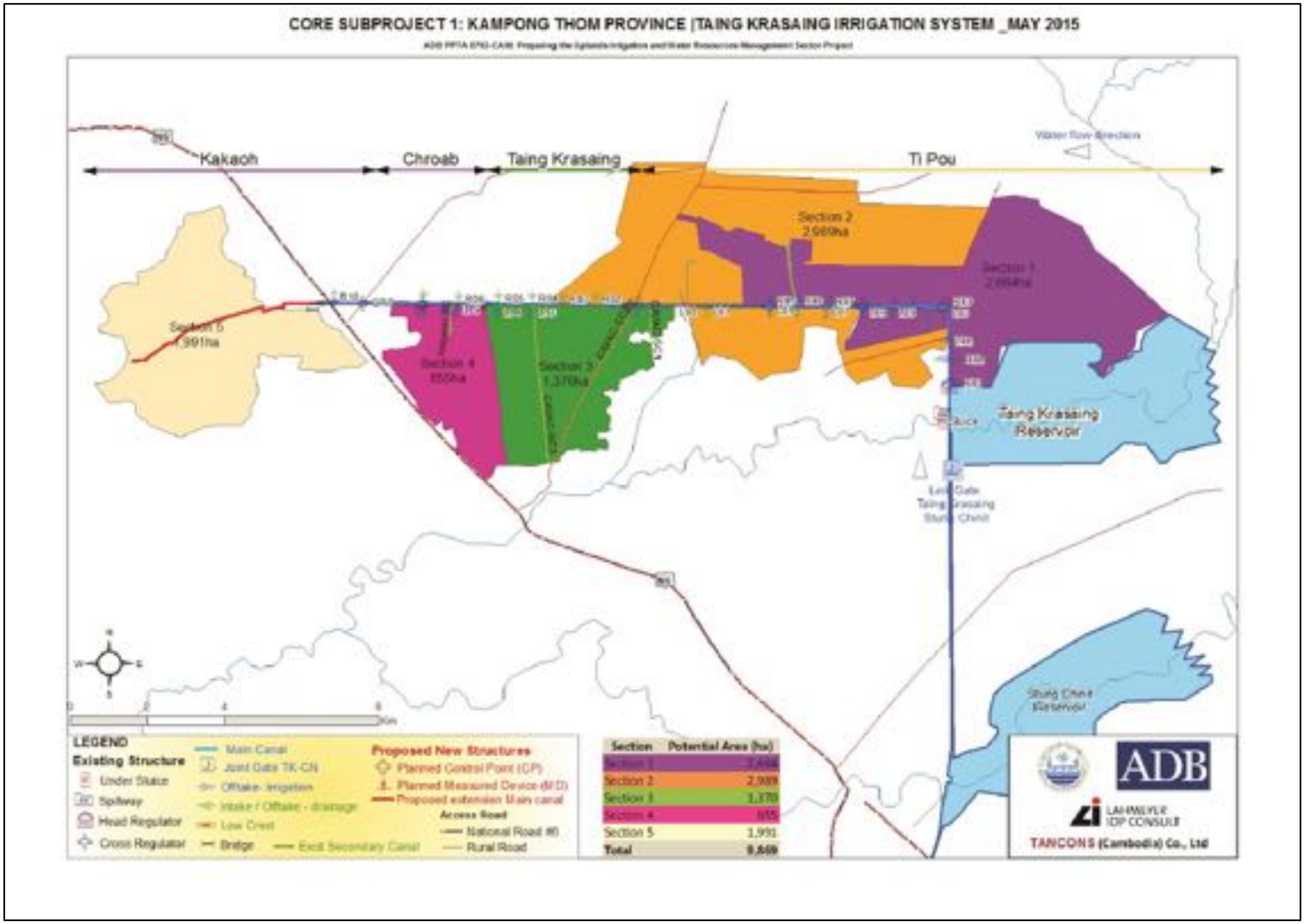


Figure 2: Lay-Out Map of Taing Krasaing Irrigation System, Kampong Thom Province

4. Project Land Area

22. The total land area of the eight communes within Prek Chik and Taing Krasaing Irrigation Schemes is 62,672 ha. Combined gross command area of the project is 20,301 ha with only 1,200 ha presently irrigated. For the cropping period 2014-2015, there are 15,525 ha planted area during the wet season crop and 110 ha planted in the dry season as summarized in

23. Table **7**.

24. In Prek Chik Irrigation Scheme, the total land area of the four communes is 19, 372 ha. Gross command area of the project is 10,432 ha which is 54% of the total land area of the communes. In 2014–2015 cropping season, the area irrigated is zero and cropped area for the wet season is 3,899 ha and 110 ha for the dry season.

25. In Taing Krasaing Irrigation Scheme the total land area of the four communes is 43,300 ha. When constructed, the project will benefit 9,869 ha of riceland, which is 23% of the total land area of the communes. In 2014–2015 cropping season, 11,686 ha of land have been planted during the wet season and no area planted during the dry season. There is 1,200 ha presently irrigated in Taing Krasaing Commune.

Table 7: Project Land Area

Irrigation Schemes	District And Communes	Total Land Area (Ha)[8]	Project Area (Ha)			
			Gross Command Project Area[9]	Existing Area Irrigated	Cropped Area (2014-2015)	
					Wet	Dry
Preaek Chik Irrigation Scheme	**Moung Ruissey District**					
	Prey Svay	6,764	2,766	0	1,371	0
	Kear	5,924	4,418	0	1,646	0
	Rukh Kiri District					
	Preaek Chik	1,298	1,048	0	675	70
	Prey Trolach	5,386	2,200	0	207	40
Sub-Total	4 Communes	19,372	10,432 (54%)	0	3,899	110
Taing Krasaing	**Santuk District**					
	Taing Krasaing	6,700	1,370	1,200[10]	1,575	0
	Tipou	21,900	5,653	0	6,529	0
	Chraob	5,700	855	0	1,948	0
	Kokoah	9,000	1,991	0	1,634	0
Sub-Total	4 communes	43,300	9,869 (23%)	1,200 (12% of Command Area)	11,686	0
Total	**8 communes**	**62,672**	**20,301 (32%)**	**1,200 (6%)**	**15,525 (77%)**	**110 (0.5%)**

[8] District Agriculture Office. 2015.
[9] Based on project design.
[10] Cambodian Agricultural Value Chain Program (CAVAC) Area with existing FWUC.

Source: PPTA Consultant.

5. Population

26. The total population in Prek Chik Irrigation Scheme is 48,890 with 51% comprising the female population. There are 10,367 households, 14% of which are female-headed. The total number of farmers in the project area is 6,663 which is 11% of the total commune population as summarized in

27. Table **8**.

28. In the Taing Krasaing Irrigation Scheme, the total population of the four communes is 39,357 with 52% comprising the female population. There are 7,939 households, 13% of which are female-headed households (FHH). There are 11,686 farmers, which comprise 30% of population in four communes.

29. The total combined population of the project area is 88,247, with 51% female. Total number of households is 18,306 with 14% FHH. There will be 18,349 potential farmer beneficiaries of the project.

Table 8: Population

Irrigation Schemes	District And Communes	Population			Households			Farmer Beneficiaries
		Total	Male	Female	Total	FHH	MHH	
Preaek Chik Irrigation Scheme	**Moung Ruisssey District**							
	Prey Svay	14,561	7,156	7,405	3,103	443	2,660	2,367
	Kear	17,159	8,140	9,019	3,509	616	2,893	2,621
	Rurak Kiri District							
	Preaek Chik	9,833	4,863	4,970	2,009	258	1,751	1,250
	Prey Trolach	7,337	3,690	3,647	1,746	169	1,577	425
Sub-Total		48,890	23,849 (49%)	25,041 (51%)	10,367	1,486 (14%)	8,881 (86%)	6,663
Taing Krasaing	**Santuk District**							
	Taing Krasaing	13,343	6,577	6,766	2,647	387	2,260	3,330
	Tipou	9,728	4,698	5,030	1,929	215	1,714	7,062
	Chroab	4,861	2,264	2,597	991	107	884	4,940
	Kokoah	11,425	5,479	5,946	2,372	347	2,025	3,846
Sub-Total		39,357	19,018 (48%)	20,339 (52%)	7,939	1,056 (13%)	6,883	11,686
Total		**88,247**	**42,867 (49%)**	**45,380 (51%)**	**18,306**	**2,542 (14%)**	**15,764 (86%)**	**18,349**

Sources: PPTA Consultant; Commune Database. National Institute of Statistics. 2013; District Agriculture, Forestry and Fisheries Office.

30. In the Prek Chik Irrigation Scheme, the age distribution of the population is 15.7% for ages 0-5 years old, 29.2% for 6-17 years old, 49.2% for 18-60 years and 5.8% for those 61 years old and above as shown in

32. **Table 9**. This means that almost 50% of the population is in productive age.

33. In the Taing Krasaing Irrigation Scheme, the age distribution is 12.5% in ages 0-5 years old, 29.5% in ages 6-17 years old and 51% in ages 18-60 years old, with 6.5% of those 61 years and above. This means that 51% of the population is in productive age.

Table 9: Age Distribution of Population

Irrigation Schemes	District And Communes	Population	Age Distribution (%)			
			0 – 5 years old	6-17 years old	18-60 years old	61 and above
Preaek Chik Irrigation Scheme	**Moung Ruisssey District**					
	Prey Svay	17,143	11.9	29.8	52.4	5.8
	Kear	20,228	18.9	25.4	49.6	6.1
	Rurak Kiri District					
	Preaek Chik	9,806	16.7	32.1	46.8	4.5
	Prey Trolach	7,337	15.5	29.5	48.1	6.9
Sub-Total		48,890	15.7	29.2	49.2	5.8
Taing Krasaing	**Santuk District**					
	Taing Krasaing	13,343	13.1	30.3	48.8	7.9
	Tipou	9,728	14.6	29.9	50.3	5.2
	Chroab	4,861	11.2	27.8	55.7	5.3
	Kokoah	11,425	11.4	30.2	50.9	7.6
Sub-Total		39,357	12.6	29.6	51.4	6.5
Total		88,247	14.2	29.5	50.2	6.0

Source: PPTA Consultant.

6. Landholding and Ownership

34. The average size of a farmer's landholding is from 1 to 3 ha. Prek Chik has 1,337 farmers with landownership of less than 1 ha of farmland. This is 20% of the farmers. There are 1,152 farmers who do not own their farm. In Taing Krasaing, there are 522 farmers who own less than 1 ha of land. This is 2.7% of the total farmers. There are 170 farmers who do not own their farmland. The total farmers who own less than 1 ha of land is 1,859 while 1,322 farmers do not own their land as summarized in Table 10.

Table 10: Size of Landholding and Ownership

Irrigation Schemes	District And Communes	Farmers		Farmers Owning Less than 1 ha		Farmers who do not own rice land	
		Total	Average Size of Land-holding	No.	%	No.	%
Preaek Chik Irrigation Scheme	**Moung Ruisssey District**						
	Prey Svay	2,367	1	195	8	270	11
	Kear	2,621	1	590	23	484	18
	Rurak Kiri District						
	Preaek Chik	1,250	3	529	42	352	28
	Prey Trolach	425	3	23	5	46	11
Sub-Total		6,663	2	1,337	20	1,152	17
Taing Krasaing	**Santuk District**						
	Taing Krasaing	3,330	1.5	509	15.40	159	5
	Tipou	7,062	1.5	0	0	0	0
	Chroab	4,940	1.5	0	0	0	0
	Kokoah	3,846	1.5	13	0.34	11	0.29
Sub-Total		11,686	1.5	522	4.5	170	1.5

Irrigation Schemes	District And Communes	Farmers		Farmers Owning Less than 1 ha		Farmers who do not own rice land	
		Total	Average Size of Land-holding	No.	%	No.	%
Total		**18,349**		**1,859**	**10**	**1,322**	**7.2**

Sources: PPTA Consultants; Commune Database 2012 and Provincial Data Book 2009; Commune data provided during meetings of PPTA Team with Commune Officials on 2 May and 7 May 2015.

7. Sources of Income

35. The main sources of income of people in the Project areas are from agriculture, craftwork and service as summarized in

36. Table **11**. Agriculture includes rice farming, planting of short and long term crops and vegetables, from fishing and livestock. Craftwork includes woodcraft and furniture making, metal and aluminum works, cooking of foodstuff, production of tire, plastics and rubber goods, textile and clothing production. Service work includes trading, repair works and transport services. In the project areas, majority of the population derive their income from agriculture, with 90% from rice production and the remaining involved in vegetable production and fishing. Only 3.7% derive their income form service and 0.10% from craftwork.

37. In the Prek Chik Irrigation Scheme, 87% of the population derives their income from rice production and 0.55% on vegetable production. On craftwork, 0.17% are involved and 5.09% are on service.

38. In the Taing Krasaing Irrigation Scheme, 93.5% are in rice production, 0.04% on vegetable and 0.84% on fishing. Only 0.035% is on craftwork and 2.23% from service work.

Table 11: Sources of Income or Occupation of Families

Irrigation Schemes	District And Communes	Agriculture (%)			Craft Work (%)	Service (%)	Others (%)
		Rice	Vegetable	Fish			
Preaek Chik Irrigation Scheme	**Moung Ruisssey District**						
	Prey Svay	94.8	0	0	0	4.7	0.5
	Kear	82.6	1.4	0	0.7	11.7	4.8
	Rurak Kiri District						
	Preaek Chik	69.13	1.08	0	0.09	5.48	5.45
	Prey Trolach	95.9	0	0	0.05	1.85	0.61
Sub-Total Average		85.60	0.62	0	0.21	5.93	2.44
Taing Krasaing	**Santuk District**						
	Taing Krasaing	88.33	0.08	3.1	0	6.54	0.72
	Tipou	99.33	0	0.26	0	0.41	0
	Chroab	92.53	0	0	0.1	1.01	5.95
	Kokoah	93.8	0.08	0	0.04	0.97	4.09
Sub-Total Average		93.50	0.04	0.84	0.035	2.23	2.70
Total Average		**90.30**	**0.30**	**0.40**	**0.10**	**3.70**	**2.60**

Source: PPTA Consultant.

8. Agriculture Situation in the Project Areas (2014-2015)

39. The agriculture situation in the project areas is based on the 2014–2015 cropping season. It describes the irrigated, rain-fed and flooded area, the rice varieties planted, agriculture method used from land preparation to harvesting, drying and marketing. It also presents the average yield/ha and the gross and net market value. It presents the credit practices of the farmers and their major problems encountered by the farmers. Presented in

40. Table **12** is the agriculture situation in Prek Chik and Taing Krasaing Irrigation Schemes.

Table 12: Agriculture Situation (2014–2015)

Agriculture Data	Prek Chik	Taing Krasaing
Irrigated Rice Area	• No area irrigated • No water in canal	• 1,200 ha (CAVAC Area) • Remaining Command area not irrigated
Rainfed Rice Area (ha) • Rice Crop • Fruit Trees and Vegetables	 • 3,899 ha • 600 ha	 • 11,686 ha • No data
Flooded Area (ha)	• Around 600 ha = 200 ha in Kear and Prey Svay Communes + 400 ha in Prey Trolach Commune where water stays around 7-10 days • Damage to crops in 2013 wet season rice crop to around 256 ha in Kear and Prey Svay Communes affecting 577 households	• Around 1,000 ha in Tipou Commune (water-logged area) • Damage to crops in 2011 to around 1,590 ha (Veang Chung, Thomm Neath, Sangkom Thmei in Taing Krasaing Commune; Ou Kohkir, Sdok Sdam, Chey Mongkol, Tuol Vihear in Charaob; and Sala Santouk, Chimeak, Santuk Krau and Santuk Knong in Kokoh Commune)
Farmers Affected by Flood	• Around 200-600	• Around 500 farmers (estimate based on average land holding of 2 ha)
Rice Varieties Planted • Early Variety • Medium Variety • Late growing Variety • Floating Rice Variety	 15% of farmers 60% of farmers 25% of farmers ---	 15% 43% 33% 9%
Agriculture Method Used • Land Preparation ○ By Cow/Buffalo ○ By hand tractor ○ By big Tractor	 10% of farmers 75% of farmers 15% of farmers	 0% farmers 95% farmers 5% farmers
• Land Leveling	10% of farmers rent tractors	1% rent tractor
• Transplanting or	0%	20%

Agriculture Data	Prek Chik	Taing Krasaing
• Broadcasting	100%	80%
Agro Inputs used • Fertilizer • Seeds • Herbicides and Mechanical control (plowing the rice field again 20 days after sowing to destroy weeds)	Most farmers use chemical fertilizer (DAP 18-46-0; NPK 16-20-0; Urea 46-0-0) 90% use their own seeds and 10% buy from Seed Station/ Provincial Agriculture Department 100% use chemical for weed control (dry season)	Most farmers use chemical fertilizer (DAP 18-46-0, NPK 16-20-0, Urea 46-0-0) 90% use their own seeds from previous crop and 10% buy seeds from station/Provincial Agriculture Department 100% use herbicide for weed control and re-plowing after 20 days of seed sowing.
Harvesting • Manual Labor • Machine	0% 100% Farmers used Combine Harvester Machine	80% used manual labor 20% by combine harvester machine
• Drying	Most farmers use sunlight for drying in 2-3 days to reduce moisture by 14% for better storage	Most farmers use sunlight for drying in 2-3 days to reduce moisture by 14% for better storage
• Post-harvest Losses	10-15% during harvest and 15% post-harvest	10-15% during harvest and 15% post-harvest
• Marketing of product	Extra rice not consumed by family are sold to private buyers at farm gate price of 900-1,200 Riels/kg	Extra rice not consumed are sold to private rice buyer at farm gate price of 720-1,300 Riels/kg
• Average Yield (tons/ha) • Kg/ha	tons/ha (1,800 kg/ha) = Range of 600 kg to 2,000 kg/ha (according to soil type and fertility)	1.5 tons/ha (1,500 kg/ha) = Range from 800 kg/ha to 1,500 kg/ha
• Gross and Net Market Value of Rice Produce (USD)	$540 (Gross Value) $295 (Net Value after production cost)	$450 (Gross Value) $215 (Net Value after production cost)
Livestock • Cows for selling • Buffalo • Pigs • Chicken	100% of farmers 20% of farmers 20% 100%	90% 10% 20% 100%
Credit • Micro Finance/Credit Institutions (2-3%/month interest rate) • Money Lenders (5-6%/month)	80% of farmers 20% of farmers	80% of farmers 20% of farmers
	• No water in canals • Lack of irrigation canals • Poor soil quality (not fertile)	• No water • Lack of irrigation canals • Poor soil quality

Agriculture Data	Prek Chik	Taing Krasaing
Major Problems of Farmers	• Lack of commercial seeds • Poor methods for land preparation and transplanting where 100% use broadcasting • Poor weed and pest control • High prices of agro-inputs • Low prices of agriculture produce • Lack of agriculture training • Poor conditions of and inadequate access roads from farm fields to markets • Limited knowledge of farmers on agriculture production and livestock rearing • High credit interest rates	• Some farmlands are of high elevation • Farmers do not use commercial seeds but from their previous seed stock which give lower yield • Seeds are not available in market • Farmers use huge quantity of seeds for broadcasting (150-200 kg/ha) • Poor technical know-how for rice planting, weed and pest control • Prices of agro inputs are high and agro-produce are low • Poor conditions of and inadequate access roads from farm fields to markets • Limited training on improved agriculture methods (farmer-field schools and demonstration plots) and livestock rearing • High credit interest rates

Sources: PPTA Consultant; Farm Survey Report of Agronomist under TA 8702-CAM: Preparing the Uplands Irrigation and Water Resources Management Sector Project. March 2015; District Agriculture Office and Commune Meetings from 2 and 7 May 2015; Mr. Nov Ra, Chief Office of Agriculture of Santuk District in Taing Krasaing and District Agriculture, Forestry and Fisheries Office, Moung Ruesei. 2013.

9. Access of Communes to Village Centers

41. Access of communes to village centers show that in Prek Chik the average distance of the communes to the village office is 6.09 km, to the district office it is 18.56 km, to the provincial office it is 72 km, to nearest school it is 3.10 km, to the nearest health center it is 6.6 km and to the nearest road it is 3.45 km as shown in

42. Table **13**.

43. In Taing Krasaing, the average distance of the communes to the village office is 2.95 km, to the district office it is 8.19 km, to nearest market it is 11.64 km, to the nearest school it is 2.24 km, to nearest health center it is 2.41 km and to nearest road it is 1.14 km.

Table 13: Access of Commune to Village Centers

Irrigation Schemes	District And Communes	Distance of Commune to Village Center (km)						
		Village Office	District Office	Provincial Office	Nearest Market	Nearest School	Health Center	Nearest Road
Preaek Chik	**Moung Ruisssey District**							
	Prey Svay	3.63	11.3	59.61	3.63	1.8	3.8	1.78

Irrigation Schemes	District And Communes	Distance of Commune to Village Center (km)						
		Village Office	District Office	Provincial Office	Nearest Market	Nearest School	Health Center	Nearest Road
Irrigation Scheme	Kear	5.25	5.38	50.92	4.42	2.3	6.4	1.16
	Rurak Kiri District							
	Preaek Chik	6.27	23.41	68.5	12.5	6.1	6.1	3.14
	Prey Trolach	10.4	46.4	94.65	11.14	2.7	11	8.98
Sub-Total		6.09	18.56	72.26	7.40	3.10	6.6	3.45
Taing Krasaing	**Santuk District**							
	Taing Krasaing	1.35	1.11	27.18	1.16	1.16	1.6	0.5
	Tipou	6.91	15,36	38.55	15.18	4.6	4.8	3.55
	Chroab	1.75	5.88	21.24	18.75	1.8	1.75	0.5
	Kokoah	1.8	10.4	16.05	11.45	1.4	1.5	0
Sub-Total		2.95	8.19	25.76	11.64	2.24	2.41	1.14
Total		**4.52**	**13.37**	**49.01**	**9.52**	**2.67**	**4.51**	**2.29**

Source: PPTA Consultant; Government of Cambodia, Ministry of Interior. 2010. Commune Database.

D. Poverty Situation in the Project Area

44. Cambodia's poverty rate had decreased by 12.2% from 35.1% in 2004 to 22.9% in 2012. The capital city of Phnom Penh had a 6.8% poverty rate in 2004 and went down to 0.1% in 2012. Poverty rate in rural areas is higher than the urban area with 13.5% in 2013 compared to 19% for urban areas in the same year.

1. Poverty Line

45. The poverty lines have been recalculated in 2009 showing new poverty lines on food and non-food. Poverty lines had been calculated for Phnom Penh, other urban areas and rural areas showing the following:

Table 14: Poverty Line

Particulars	Phnom Penh		Other Urban Area		Rural Area	
	Riels / Month / Capita	Kilo-calories	Riels / Month / Capita	Kilo-calories	Riels / Month / Capita	Kilo-calories
Food Poverty Line	94,945	2,200	79,293	2,200	69,963	2,200
Non-Food allowance	98,106	-	53,032	-	35,350	-
Water	-	-	61	-	1,247	-
Total	193,052 / month 6,347 / day	2,200	132,386 / month 4,352 / day	2,200	106,560 / month (27 USD / month) (3,503 / day= 0.87 USD / day)	2,200

Source: PPTA Consultant; Government of Cambodia, Ministry of Planning. 2013. *Poverty in Cambodia – a New Approach.*

2. Poverty Rates in the Project Area

46. In 2012, poverty rate in Battambang province is 24.8% and in Kampong Thom is 29.1%. Poverty rates have decreased from 2004 compared to 2012 with 13% in Battambang and 12% in Kampong Thom as shown in

47. and

49. **Table 15**.

50. The poverty rate of communes that are within the project area shows that Rukh Kiri District in Battambang Province has the highest concentration of poor population with 32.5% compared to 26.6% in Moung Ruessei and 30.5% in Santuk District in Kampong Thom. However, the poorest commune is Ti Pou with 39% poverty rate, located in Santuk District, Kampong Thom province located in the Taing Krasaing Irrigation Scheme.

51. Poverty rate computation is based on Commune Database using 13 indicators reflective of the standard of living which measures the ratio of families with: (i) latrine; (ii) television; (iii) motorcycle; (iv) bikes; (v) size of family; (vi) concrete homes; (vii) thatched roof; (viii) literacy rate of women aged 16-60 years old; (ix) ratio of men from 18-60 years old to total population; (x) women delivery by traditional midwife; (xi) out-of school children from 6-14 years old; and (xii) with water source with a distance of 150 meters from home.

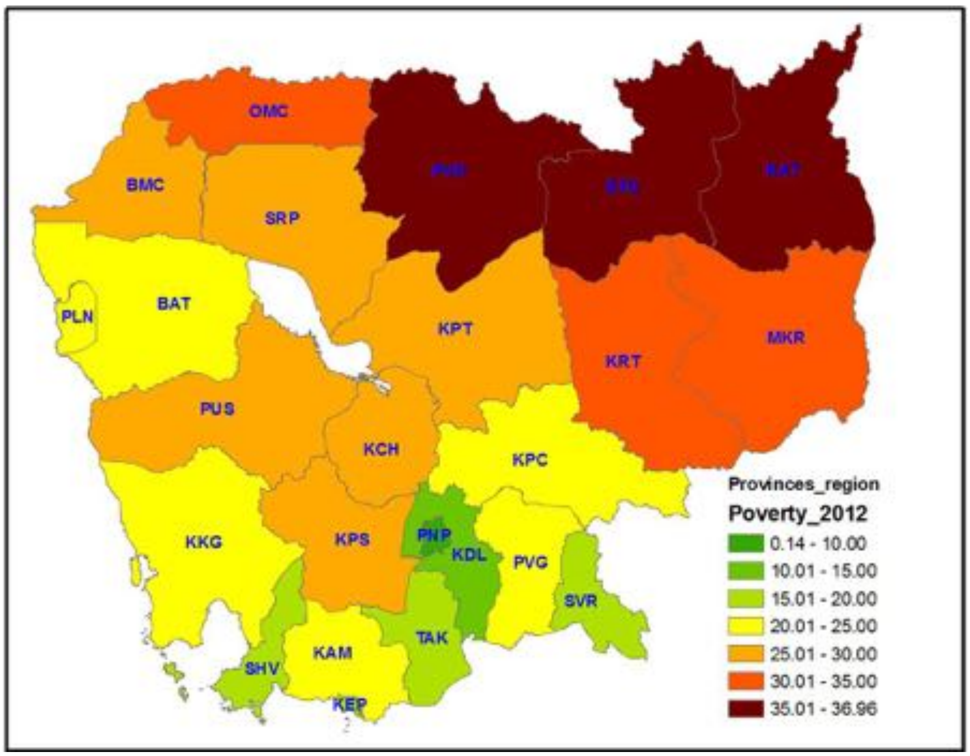


Figure 3: Location Map of Project Area and Poverty Rate, 2012

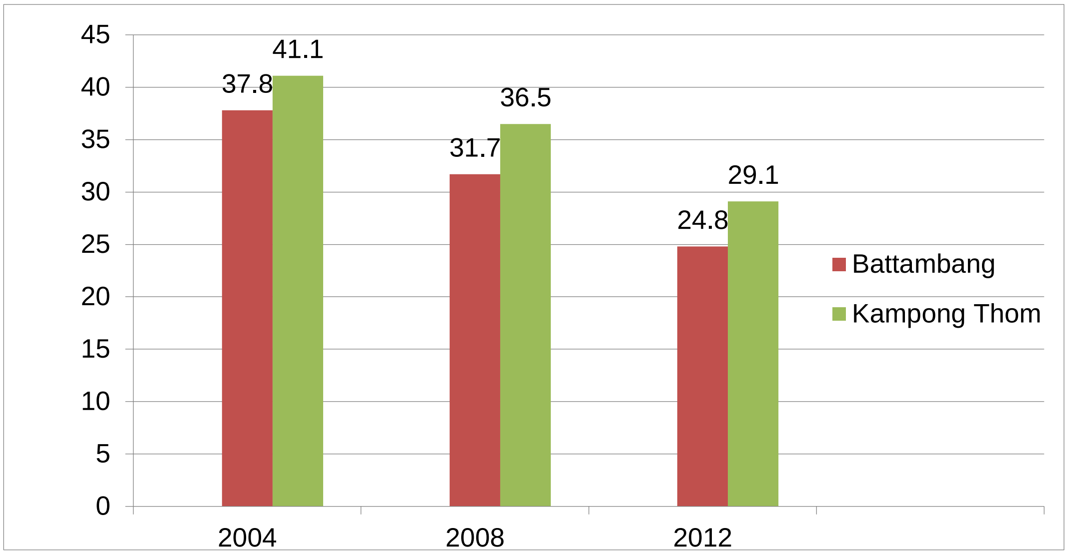
52. Poverty rates in Battambang province have decreased from 37.8% in 2004 to 24.8% in 2012 while in Kampong Thom it decreased by 12% from 41.1% in 2004 to 29.1% in 2012. In Prek Chik Irrigation Scheme, the lowest poverty rate is in Kear Commune at 23.5% in 2012 while the highest is in Prey Tralach at 34.5%. In Taing Krasaing, the lowest poverty rate is in Taing Krasaing Commune at 24.3% while the highest is in Tipou Commune at 39%. Poverty rates in Battambang are lower than in Kampong Thom from 2004 to 2012. There are more poor population in Kampong Thom at 29.1% compared to 24.8% in Battambang as of 2012 as seen in

53. .

Table 15: Poverty Rate in the Project Area

Sub-Projects (Irrigation Schemes)	Location and Coverage	Poverty Rate (%)			
		2004	2008	2012	Trend 2004-2012
	Cambodia	35.1	29.3	22.9	Decreased By 12.2%
	Phnom Penh	6.8	0.3	0.1	Decreased by 6.7%
	Other Urban Area			13.5 (2013)	
	Rural Area			19.0 (2013)	
Preaek Chik	**Battambang Province**	37.8	31.7	24.8	Decreased by 13%
	Moung Ruessei District	40.2	35.4	26.6	
	Communes:				
	• Kear Commune	34.0	29.2	23.5	
	• Prey Svay	39.8	36.1	28.9	
	Rukh Kiri District	-	37.4 (2011)	32.5	Decreased by 4.9% from 2011 data
	Communes:				
	• Prek Chik	46.0	41.3	33.2	
	• Prey Tralach	44.6	39.2	34.5	
Taing Krasaing	**Kampong Thom Province**	41.1	36.5	29.1	Decreased by 12%
	Santuk District	41.1	36.8	30.5	
	• Taing Krasaing	34.3	29.0	24.3	
	• Chroab	40.5	37.3	26.7	
	• Ti Pou	47.2	44.7	39.0	
	• Korkoah	43.8	38.1	29.3	

Source: PPTA Consultant; Poverty Reduction by Capital, Provinces, Municipalities, Districts, Khans and Communes, Sangkats Based on Commune Database (CDB), 2004-2012, Ministry of Planning, July 2012



Source: PPTA Consultant.

Figure 5: Comparative Poverty Rate

3. Poverty Assessment and Project Impact

54. In both core subprojects, around 21% of the total population of the eight communes are farmers. Main source of income is derived from agriculture (91%). Poverty finds its roots on this source of income because of its dependence on several factors (i.e. irrigation, agriculture inputs and technology, efficient water management, sufficiency of water at the source, type of soil, weather condition) thus providing insufficient opportunity for farmers to have sufficient and stable income to meet their needs.

55. The main factors that cause poverty as identified by the people in the project areas are (i) poor soil condition, (ii) lack of water in the canals for crop irrigation during the dry season, non-use of appropriate agriculture technologies, and (iii) lack of job opportunities in the localities.[11]

56. The project is designed to help address these factors that cause poverty by enhancing agricultural and rural economic productivity through increased efficiency of irrigation systems and improved management of water resources. When completed, the project will directly benefit the 18,349 farmers (6,663 in Prek Chik and 11,686 in Taing Krasaing) and the total population of 88,247 in the 8 communes. It will directly affect the 91% of the population that derive their main income from rice and vegetable crops. The project will help decrease the poverty rates in communes covered within the project area which ranges from 23.5% to 34.5% in Prek Chik and 24.3% to 39% in Taing Krasaing (Table 14). Through the implementation of the project, the farmers (men and women) shall be involved in planning and decision making, in construction activities and in the formulation of an efficient operation and maintenance plan.

[11] Focus Group Discussion (FGD) conducted in Taining Krasaing and Preaek Chik.

57. Without the project, the farmers in the two core subprojects are getting a yield of 1.8 tons/ha in Prek Chik and 1.5 tons/ha in Taing Krasaing. They get a net value for their crops of $295/ha in Prek Chik and $215/ha in Taing Krasaing. The average landholding per farmer is 2 ha in Preak Chik and 1.5 ha in Taing Krasaing. This gives an average income based on average landholding of $590 ($49/month) in Prek Chik and $323 ($27/month) in Taing Krasaing (Table 16).

58. The official government poverty line based on 2013 data is $27/month based on food poverty and non-food allowance. Based on the official poverty line, Prek Chik's average income of $49/month would be above the poverty line while Taing Krasaing's average income of $27/month would be in the border line which would mean that farmers are considered in poorer condition (Table 14).

59. With the implementation of the project, the yield is projected to increase to 5 tons/ha in Prek Chik and 3 tons/ha in Taing Krasaing. This means a net value per ha of $1,829 for Prek Chik and $953 for Taing Krasaing. With the average landholding of 2 ha in Prek Chik, the projected average income is $3,658. While in Taing Krasaing, the average landholding is 1.5 ha with a projected average income of $1,429. This means that if the irrigation system that will be improved will be functioning efficiently and the farmers will use the recommended agriculture inputs and techniques, they will be able to attain the projected increase in production.

Table 16: Average Production Cost, Yield, and Income With and Without Project

Particulars	Unit	Prek Chik	Taing Krasaing
Without Project			
• Production Cost	USD/Ha	245	235
Land Preparation		(40)	(30)
Seeds		(38)	(38)
Machine Harvesting		(100)	(100)
Urea 46%		(30)	(30)
DAP 18-46-0		(38)	(38)
• Yield per ha	Tons/Ha	1.8	1.5
• Gross Value per Ha	USD	540	450
• Net Value per Ha	USD	295	215
Average Landholding	Ha	2	1.5
Average Income based on Average Landholding	USD	590	323
With Project			
• Production Cost	USD/Ha	671	547
Land Preparation		(40)	(40)
Seeds		(40)	(35)
Sowing		(15)	(15)
Machine Harvesting		(100)	(100)
Urea 46%		(110)	(30)
KCL 60%		-	(54)
DAP 18-46-0		(56)	(19)
Compost Fertilizer		(175)	(175)
Second plowing		(40)	-
Herbicide		(10)	(5)
Insecticide		(10)	(5)
Fungicide		(10)	(5)
Water Cost		(15)	(15)
Other costs (pest control, etc.)		(50)	(50)
• Yield per ha	Tons/Ha	5	3

Particulars	Unit	Prek Chik	Taing Krasaing
• Gross Value per Ha 5,000 kg (5 tons) x 0.5 USD/kg 3,000 kg (3 tons) x 0.5 USD/kg	USD	2,500	1,500
• Net Value per Ha 2,500 USD - 671 = 1,829 1,500 USD – 547 = 953	USD	1,829	953
• Average Landholding	Ha	2	1.5
• Average Income based on Average Landholding	USD	3,658	1,429.5

Source: PPTA Consultant.

60. Within the project command area, there are 1,859 farmers who own less than one ha of land and 1,322 farmers who are tenants and do not own any land (Table 10). With irrigation provided, these farmers can have 2 crops a year and can increase their yield from 1.5 tons/ha to 3 tons/ha in Taing Krasaing and from 1.8 tons/ha to 5 tons/ha in Prek Chik with the use of appropriate agricultural production technologies and inputs (Table 10 and

61. Table **12**).

62. There are also areas that are water-logged and are prone to floods. It is estimated that around 1,600 ha (600 in Prek Chik and 1,000 ha in Taing Krasaing) are affected by floods. (

63. Table **12**). In 2013, it is estimated that around 256 ha with 577 households in Preaek Chik and 1,590 ha in Taing Krasaing have crops damaged by floods during the wet season. The project will be able to address the flooding problem by providing proper drainage and improved water management practices (

64. Table **12**).

65. Based on available data. 51% of the population are female and around 2,542 households are female-headed which comprise 14% of the population. It has also been determined that the lack of employment opportunities in the project areas and the low productivity of the land brought about by poor soil, lack of water and infrastructure for irrigation has exacerbated the condition of women. Men find work outside the communes, leaving the women to take care of their children and their farms and to attend to community activities such as meetings. The women are the most vulnerable group in the project area. With the Project, crop production is expected to improve. This may encourage the men to return and resume farming again. With the project, the women will be given equal access to benefits and opportunities, such as participation as leaders and members in the Farmer Water Users Community (FWUC), access to training, equal access to irrigation infrastructure and water and equal opportunities for employment during construction period. Their voices will be heard during planning and decision making through their active participation which will be enhanced through leadership training. They will be encouraged to participate in construction work as hired labor wherein, 40% of the workforce will be reserved for women. In the FWUC that will be organized, the membership will be open to both men and women in the farming household. The women will be encouraged to run for elections as candidates in their Farmer Water User Groups (FWUG).

The participatory approach which will be used in the implementation of the Project will put emphasis on the active participation of both men and women. (

66. Table **8** and Gender Assessment Report)

67. Employment generation during the construction period will provide work opportunities for the local people, with 40% provided to women workers. This will encourage those who have sought work outside the project area to come back and rejoin their families. This will also provide income to women who will be employed during the construction.

68. Provision of secondary and tertiary canals will require land and the farmers whose lands will be traversed with the construction of these canals will be adversely affected and should be considered in the resettlement plan. However, the project will exercise all means to minimize impact on the small farmers through design and use of existing channels. Dialogue and negotiation with the affected farmers will be done to consider the interest of the farmers and minimize the adverse effects.

69. The private companies engaged in farming and other agriculture production activities within the project areas can cause both positive and negative impacts to the farming communities. To enable their farms to be productive, private companies use some of the most efficient production technologies and inputs. The farms of private companies can be viewed as demonstration farms within the area thus possibly encourage the farmers to abandon the use of inefficient traditional farming methods. However, there’s also the possibility that these private companies can take control of the water and be an obstacle to efficient water management, thus depriving the small farmers as the main beneficiaries from the use of the irrigation system. To avoid this situation, it is important that an agreement is done before the start of O&M, among PDWRAM, the private companies and the FWUCs on the timing of delivery and the value of water. The private companies should not be given any control in the management of water in the main canal but will be provided with the necessary information as part of the water users.

CAM: Preparing the Uplands Irrigation and Water Resources Management Sector Project

Appendix 13:

Gender Assessment Report

July 10, 2015

Table of Contents

ACRONYMS

ADB	Asian Development Bank
CCA	Climate Change Adaptation
CC	Commune Council
CAVAC	Cambodia Agricultural Value Chain Program
CWCC	Commune Women and Children Committee
FWUC	Farmer Water User Communities
FGD	Focus Group Discussion
FHH	Female Headed Household
GAP	Gender Action Plan
GFP	Gender Focal Point
GMAG	Gender Mainstreaming Action Group
GMAP	Gender Mainstreaming Action Plan
GMSAP	Gender Mainstreaming Strategy and Action Plan
HH	Household
JICA	Japan International Cooperation Agency
MOWA	Ministry of Women's Affairs
MOWRAM	Ministry of Water Resources and Meteorology
O&M	Operation and Maintenance
PDWRAM	Provincial Department of Water Resource and Meteorology
PPTA	Project Preparation Technical Assistance
RGCRSP III	Royal Government of Cambodia Rectangular Strategy Phase III
RGC	Royal Government of Cambodia
TWG-G	Technical Working Group on Gender
UNDP	United Nation Development Program
UN	United Nations
WRM	Water Resource Management
WR	Water Resource

I. INTRODUCTION

1. In Cambodia, the socio-economic growth have seen rapid growth, however there is still an imbalance on the economic side and social development. It reflects the development challenges and constraint and impact on gender relation, especially on women who are the most vulnerable group.[1] According to literacy data of 2011, 69% of women are literate while 85% for men.[2] Similar to other developing countries in the Asian region, agriculture sector is recognized as the economic backbone of Cambodia with 1.4 million landholding owned and managed by (73%) male holders and 0.5 million (27%) female holder. This shows that the agricultural holding management is male dominated.[3] Most female farmers are turning towards commercial agricultural production and agro-enterprise in order to supplement household income. Based on the Farm Survey Report conducted[4], around 80% of farmers still use broadcasting method for planting, 90% use their own seeds from previous crops, instead of quality seeds and 80% of harvesting is done by manual labor. However, land preparation is done by using hand tractors and farm inputs like fertilizer and herbicides are used.

2. Most Cambodian households depend on agriculture and its related subsectors of livestock rearing, fisheries and forest exploitation for their living. Crops account for about 60% of agricultural output with rice contributing 40%, livestock 27%, fisheries 10% and forestry 3%.[5] In The Project area, around 91% derive their income from agriculture, with 90% involved in rice production, 0.30% in vegetable production and 0.40% in fish culture.[6]

3. Cambodian women are the most economically active in Asia, and while gender attitudes are changing, significant gender inequalities continue to persist.[7] Based on the Gender Study conducted in the Project area, the main gender issue in water resources management (WRM) is low women participation. This is due to the cultural belief that agriculture and WRM are the responsibilities of men. This hindered women to participate actively in decision-making and functions in this sector. Other reasons for women's lack of participation include: (1) attitude of men (husbands) towards women (wives) working with other men, (2) women's domestic role, which includes taking care of the children, cooking, cleaning the house, and (3) farm management only when their husbands or parents migrate to Thailand or Phnom Penh to look for work.[8]

4. The Royal Government of Cambodia (RGC) developed and approved the Rectangular Strategy-Phase III (RSP), wherein Goal 3 specifically promotes gender equality and women empowerment, through the implementation of population policy and gender equity. The strategic objective of the RGC of the Fourth Legislature is to strengthen the quality of people, and improve the status of women who are considered the backbone of national economy and

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[1] Cambodian Climate Change Resilient Rice Commercialization, Project Preparation Technical Assistance on Socio-Economic Assessment and Gender Analysis June 2012

[2] Project Preparation Technical Assistance on Socio-Economic Assessment and Gender Analysis June 2012

[3] Census of Agriculture in Cambodia 2013, National Institute of Statistics, Ministry of Planning and Ministry of Agriculture, Forestry and Fisheries;

[4] Farm Survey Report of Agronomist, preparing the Uplands Irrigation and Water Resource Management Sector Project, ADB-PPTA 8702-CAM, March 2015 and from District Agriculture Office and Commune Meetings from 2 and 7 May 2015

[5] Cambodian Climate Change Resilient Rice Commercialization, Socio-economic Assessment and Gender Analysis, June 2012

[6] Commune Database 2012, National Institute of Statistics, Ministry of Planning.

[7] UN-DAF, 2010, and UNDP, 2010, Gender and Climate Change: Oxfam America, 2010;

[8] Result of FGD conducted in May, 2015 at the target communes of Taing Krasaing and Prek Chik irrigation schemes;

society. Women elected as member of commune/district councils doubled in number from 8% in 2002 to 18% in 2012. To prevent violence against women, the RGC implemented a law on domestic violence and victim prevention. In addition, a first National Action Plan for 2014-2018 on preventing violence against women has been developed and approved on February 2015, as part of implementing the Strategy.[9]

5. Based on the RSP, the Ministry of Women's Affairs (MOWA) developed a Gender Mainstreaming Action Plan (Neary Ratanak, 2014-2018). Neary Ratanak has recognized women in decision-making, gender mainstreaming, climate change, disaster risk management and vulnerable groups as critical crosscutting issues. The needs of vulnerable group of women and girls are integrated and addressed in all key strategic areas. MOWA established a Technical Working Group on Gender (TWG-G) in 2004. The TWG-G is chaired by MOWA with the United Nations Development Programme (UNDP) and Japan International Cooperation Agency (JICA) as co-facilitators. It includes representatives from 31 government agencies, 14 development partners, and 15 civil society organizations.[10]

6. The Uplands Irrigation and Water Resources Management Sector Project will enhance agricultural and rural economic productivity through increased efficiency of irrigation system and improve management of water resources in uplands areas. It will rehabilitate, modernize and climate proof irrigation systems and improve their performance and management, it will also enhance land and water productivity through watershed management and land improvement, and improve management of water resources through participatory irrigation and water resources management. The extent of women's involvement in the project preparation, planning and implementation had been assessed, gender analysis had been carried and Gender Action Plan had been developed as part of the Project Preparation Technical Assistance. The Project area is located in Kampong Thom and Battambang provinces. MOWRAM will be the executing agency (the EA) and DFWUC will be the implementing agency (the IA).

7. The Ministry of Water Resources and Meteorology (MOWRAM) is one of MOWA's partner agencies. Since its formulation, the TWG-G has provided a forum for discussion and inputs into the formulation of gender related policies and strategies. In responding to gender mainstreaming in all sectors as well as women empowerment and promotion of gender equality, MOWRAM developed and approved the Gender Mainstreaming Strategy and Action Plan for 2014-2018. The strategy and action plan were prepared by the MOWRAM Gender Mainstreaming Action Group. It includes four objectives namely to: (i) strengthen the capacity of MOWRAM on gender at all levels; (ii) continue to provide opportunities for women officials in MOWRAM to be promoted into decision making position; (iii) enhance gender mainstreaming in human resources management; and (4) ensure that all services in the water resources and meteorology sector bring more benefits to women in the communities.[11]

8. Based on the above issues on gender inequality in WRM, the Upland Irrigation and Water Resources Management Sector Project in Cambodia (ADB PPTA 8702-CAM) does not only focus on rehabilitation of existing irrigation scheme, but also on social and gender issues. The Gender and Social Team (GST) conducted a study (through the conduct of interviews and focus group discussion) at the national level and in the communities of the subproject areas to find out the real issues and needs of women in their participation in WRM and in the agriculture sector. The Project applies gender integration in addressing the gender issues

[9] Royal Government of Cambodia Rectangular Strategy-phase III.
[10] Gender Mainstreaming Action Plan (Neary Ratanak, 2014-2018.
[11] Objectives of MOWRAWM Gender Mainstreaming Strategy and Action Plan 2014-2018,

identified during the survey, which became the basis in preparing the Gender Action Plan (GAP). The proposed GAP includes (i) the integration of gender awareness and gender mainstreaming within the implementing agencies, MOWRAM and Provincial Department of Water Resources and Meteorology (PDWRAM), at the national, provincial, district and field levels; (ii) increasing participation, specifically in decision making of women as member in the Farmer Water User Communities (FWUCs), (iii) developing women's leadership skill, and in occupying leadership positions in the FWUC in the subproject areas, and (iv) strengthening the capacity of MOWRAM national and sub-national staff as well as local authorities to support FWUCs. The GAP supports MOWRAM's Gender Mainstreaming Strategy and Action Plan for 2014-2018, specifically objective four, which ensures that all services in the water resources and meteorology sector bring more benefits to women in the communities.[12]

[12] Objective 4 of MOWRAWM Gender Mainstreaming Strategy and Action Plan 2014-2018, page 9;

II. GENDER ANALYSIS

9. Even though the Cambodian government recognizes both men and women as equal beneficiaries from any project, there remains a gender gap in society. It is because of the cultural attitude that affects women's control over resources resulting to their low participation in planning, decision-making, and leadership roles. Economic issues contribute to increasing women's vulnerability in many provinces of Cambodia. This is due to the migration tendency of men who fail to acquire a job from their immediate community. This leaves women to shoulder the domestic (household work), productive (farm work) and community roles (FWUC activities).[13]

10. Although women representatives in FWUCs increased to 16% in 2011, it remains low, and this requires more attention from the Ministry. On the other hand sex-disaggregated data on the leadership position of men and women in the FWUC are not available, which makes it difficult to say whether women have played significant roles in water resources management.[14]

A. Study Objectives

11. The objectives of the study are to establish the relevant baseline information on gender issues in WRM and in the agriculture sector. Specific objectives of the study conducted are the following:

- (i) To carry out gender analysis in the following:
  - (a) Gender division of labor;
  - (b) Women's access and control on agricultural production and WRM;
  - (c) Constraints faced by women's lack of participation in agriculture and WRM;
  - (d) Women's skills to participate in skilled labor/construction;
  - (e) Identify training needs of female/male members and leaders in existing FWUCs to encourage active participation of men and women in FWUC organization and in the O&M of the irrigation system;
- (ii) Identify scope for gender mainstreaming in the proposed subprojects and prepare a GAP based on the findings;
- (iii) Propose capacity building measures for the executing and implementing agencies for developing gender inclusive subprojects in the agriculture and irrigation sectors.

12. This report will present the gender division of labor in agricultural and WRM, the obstacles or issues women face in actively participating in construction and operation and maintenance (O&M) activities of the Project. It also presents the impact of climate change on livelihood and economic activities. The GAP was prepared on the basis of the findings of the study to address gender gaps and issues during project implementation.

B. Methodology

13. The study utilized both primary and secondary data sources. For primary data collection, the team conducted interviews and focus group discussions (FGD) in the subproject areas in Taing Krasaing Irrigation Scheme located in the province of Kampong Thom, and in Prek Chik

[13] Report on Gender issues in Climate Change Adaptation project preparation in Banteay Meanchey and Kampong Thom, 2012

[14] MOWRAM Gender Mainstreaming Action Plan Updated in Water Resources sector for 2014-2018;

Irrigation Scheme located in the province of Battambang. Interviews were conducted in the existing FWUC in Stung Chinit Irrigation Scheme, which is adjacent to Taing Krasaing, and with a member of Gender Mainstreaming Action Group of MOWRAM. The FGDs focused on gender division of labor in agriculture and irrigation, constraints in women's participation, issues of gender in FWUC, and women's access and control over WRM as well as agricultural production. The team also conducted site visits and familiarization on the irrigation infrastructure and the command area of the irrigation schemes. Interviews were conducted with the commune council (CC) members, gender focal points (GFPs) in communes, as well as village chiefs. For secondary data collection, the team collected relevant documents from MOWA, MOWRAM, National Institute of Statistic and reports from the Water Resources Management Sector Development Program (WRMSDP), an on-going ADB-funded project.

14. Gender analysis is a basic requirement in the formulation of the GAP, which addressed the issues and needs of both men and women in terms of access and control on WRM and in agricultural production for the improvement of their livelihood. Furthermore, the gender analysis will identify the required development in women's leadership and participation in FWUCs. Presented below are the key questions that were asked during the data gathering:

- (i) MOWRAM (Gender Mainstreaming Action Group)
  - (a) Existing activities conducted to support FWUC, and farmers in irrigation schemes.
  - (b) Gender activities conducted
  - (c) Training needs
- (ii) Interview with Commune Women and Children Committee focal point and Village Chiefs
  - (a) What are the issues of women and men in agriculture, irrigation?
  - (b) What are your experiences with regards to gender issues?
  - (c) What are your suggestions?
- (iii) FGD with Men and Women's group (FWUC members)
  - (a) What is the division of labor between women and men in agriculture and water resources?
  - (b) What is women's access and control to agricultural productivity and WRM?
  - (c) What constraints do women face in agricultural work and WRM?
  - (d) What skills do women need in order to participate actively in skilled construction work?
  - (e) What training do women need to encourage active participation in WRM and agriculture activities?
  - (f) What skill do women need to become leaders in FWUCs? What are the constraints?
  - (g) What will encourage women to participate in FWUC activities?
  - (h) How can training be modified to fit some limitations (i.e. illiteracy) of women participants?
  - (i) What support do you need to be able to manage the FWUC?

C. Cambodia Demographics

15. The total land area of Cambodia is 181,035 km^2 with a total agricultural landholding area of 3,071,383 ha with an average landholding of 1.6 ha.[15] Ninety percent (90%) of Cambodia's population is of Khmer origin, speaking the Khmer language. The population of Cambodia in

[15] Census of Agriculture in Cambodia 2013, National Institute of Statistics, Ministry of Planning

2014 is fairly homogeneous with other ethnic groups being Vietnamese (5%) and Chinese (1%), and others (4%). Over 96.9% of the population practices Theravada Buddhism, 1.9% Islam, 0.4% Christian and 0.8% other religion. Islam is the main religion of the majority of Malay and Chams minorities in the country.[16]

I. Cambodia Population 2015

16. Cambodia has a total population of about 15 Million in 2015. It is estimated to reach 15.8 Million at the beginning of 2016. The natural increase is expected to be positive, as the number of births will exceed the number of deaths by 270,959.[17] The median age of agricultural women in Cambodia is from 42-52 while by men is from 39 to 48.

II. Project Areas

17. The project areas are located in the provinces of Battambang and Kampong Thom. There will be two Irrigation Schemes that will be rehabilitated under the Project: Prek Chik (PC) Irrigation Scheme is located in Battambang province, and Taing Krasaing (TK) Irrigation Scheme in Kampong Thom province.

18. Prek Chik Irrigation Scheme will cover four Communes namely: Kear and Prey Svay located in Moung Ruessei District, and Preaek Chik and Prey Tralach located in Rukh Kiri District. Taing Krasaing Irrigation Scheme will cover four Communes namely: Taing Krasaing, Chroab, Ti Pou, and Korkoah, which are all located in Santuk District.

19. According to Table 1, the total population in the target eight communes is 88,247 with 42,867 (49%) males and 45,380 (51%) females. The total household is 18,306, with 2,542 (14%) female-headed households. The female-headed households are widows, single or those that take care of handicapped husbands. The table also shows that the potential Farm Families Beneficiaries from the project are 11,795.

Table 1: Population in the Target Communities[18]

Irrigation scheme	Communes	Population			Households			Farm Families Beneficiaries Total	Ave. Size of land-holding
		Total	Male	Female	Total	FHH	MHH		
Preaek Chik Irrigation scheme	**Moung Ruessei District**								
	1. Prey Svay	14,561	7,156	7,405	3,103	443	2,660	1,383	1
	2. Kear	17,159	8,140	9,019	3,509	616	2,893	2,209	1
	Rurak Kiri District								
	3.Preaek Chik	9,833	4,863	4,970	2,009	258	1,751	1,100	3
	4.Prey Traolach	7,337	3,690	3,647	1,746	169	1,577	524	3
Sub-total		48,890	23,849 (49.9%)	25,041 (51%)	10,367	1,486 (14%)	8,881 (86%)	5,216 (50% of HH)	2
Tang Krasaing irrigation scheme	**Santuk District**								
	5. Taing Krasaing	13,343	6,577	6,766	2,647	387	2,260	913	1.5
	6. Tipou	9,728	4,698	5,030	1,929	215	1,714	3,769	1.5
	7. Chroab	4,861	2,264	2,597	991	107	884	570	1.5

[16] CIA World Factbook, August 23, 2014;
[17] Cambodia tour report; Map of the world by sex radio;
[18] Commune Database, National Institute of Statistics, 2013, and from District Agriculture Offices, Chief Office, May 2015

Irrigation scheme	Communes	Population			Households			Farm Families Beneficiaries Total	Ave. Size of land-holding
		Total	Male	Female	Total	FHH	MHH		
	8. Kokoah	11,425	5,479	5,946	2,372	347	2,025	1,327	1.5
Sub-total		39,357	19,018 (48%)	20,339 (50%)	7,939	1,056 (13%)	6,883 (87%)	6,579 (87% of HH)	1.5
Total		**88,247**	**42,867 (49%)**	**45,380 (51%)**	**18,306**	**2,542 (14%)**	**15,764 (86%)**	**11,795**	

Source: PPTA Consultant.
Note: FHH: female-headed households; MHH: male-headed households.

20. Age distribution of total population is 14.2% from 0-5 years old, is 29.48% from 6-17 years old, 50.24% from 18-60 years old, and is 6.0% from 61 years old and above as summarized in **Table 2**. The age distribution shows that the population is relatively young with about 43.7% below 17 years old, and around 49% within the working age from 18-60 years old.[19]

Table 2: Age Distribution of Population

Irrigation Schemes	District and Commune	Population	Age Distribution (%)			
			0-5 years old	6-17 years old	18-60 years old	61 and above
Preaek Chik Irrigation scheme	**Moung Ruissey District**					
	Prey Svay	14,561	11.9	29.8	52.4	5.8
	Kear	17,156	18.9	25.4	49.6	6.1
	Rurak Kiri District					
	Prek Chik	9,806	16.7	32.1	46.8	4.5
	Prey Trolach	7,337	15.5	29.5	48.1	6.9
Sub-Total		48,890	15.7	29.2	49.2	5.8
Taing Krasaing Irrigation Scheme	**Santuk District**					
	Taing Krasaing	13,343	13.1	30.3	48.8	7.9
	Tipou	9,728	14.6	29.9	50.3	5.2
	Chroab	4,861	11.2	27.8	55.7	5.3
	Kokoah	11,425	11.4	30.2	50.9	7.6
Sub-total		39,357	12.5	29.5	51.47	6.5
Total		88,247	14.1	29.48	50.24	6.00

Source: PPTA Consultant.

a. Description of Battambang Province

i. Geography

21. The provincial capital of Battambang is the second largest city in Cambodia (2007 estimated population is around 1/4 million people). It is located in one of the biggest rice-growing areas in Southeast Asia. The average altitude of the province is around 50 m.[20] The province is bordering to the North with Banteay Meanchey, to the West with Thailand, to the East and South with Pursat and the great lake Tonle Sap. The country's total surface is about 11,702 km^2 with around 67.7 in/km^2.[21]

[19] Agriculture Rice Cambodian Climate Change Resilient Socio-Economic Assessment and Gender Analysis June, 2012
[20] Statistic Commune from Commune Data Base 2013
[21] Cambodia tour report;

ii. Demography

22. The total population of Battambang province is 1,155,038 person or 7.7% of the total population of Cambodia. Population consists of 569,947(49%) male and 585,091(51%) female.[22]

23. The project will be implemented in Prek Chik Irrigation Scheme. Lands within the Prek Chik Irrigation Scheme are located in the four Communes namely: Kear and Prey Svay located in Moung Ruessei District, and Prek Chik and Prey Tralach, which are in the Rukh Kiri District. Total land area of the four communes is 19,372 ha. Gross command area of the Project is estimated at 10,432 ha. In 2014-2015 cropping season, the area irrigated is zero and cropped area for the wet season is 3,899 ha and 110 ha for the dry season.

24. The combined population of the four Communes in Prek Chik is 48,890 with 23,849 (49.9%) male, and 25,041 (51%) female. Total households are 10,367 with 14% female-headed households. There are 5,216 farm families, which comprise 50% of total households.[23]

Table 3: Socio-Economic Condition of Target Communes in Prek Chik Irrigation Scheme

Particular	Prey Svay	Kear	Prek Chik	Prey Tralach	Total
Total Female Headed Household	443	616	258	169	1,486 (14%)
Total Number of Farm Families	1,383	2,209	1,100	524	5,216
Average Size of Landholding (Ha)	1	1	3	3	2
Total Farmers owning less than 1 ha	195 (6.9%)	590 (21.9%	529 (23.6%)	23 (26.1%)	1,337 (20.0%)
Sources of income From Agriculture:					
• Rice	94.8	82.6	69.13	95.9	85.60
• Vegetable	0	1.4	1.08	0	0.62
• Fish	0	0	0	0	0
• From Craft work	0	0.7	0.09	0.05	0.23
• From Service	4.7	11.7	5.48	1.85	5.93
• From Others	0.5	4.8	5.45	0.61	2.44

Source: PPTA Consultant.

b. Description of Kampong Thom Province

i. Geography

25. Kampong Thom is a province of Cambodia. It borders the provinces of Siem Reap to the Northwest, Preh Vihea to the North, Stung Treng to the Northeast, Kratie to the east, Kampong Cham, Kampong Chhnang to the South, and the Tonle Sap to the west. The province capital is

[22] Commune Database, CDB, National Institute of Statistic, 2013
[23] Commune Database, National Institute of Statistics, 2013

Kampong Thom City, a town of approximately 30,000 people on the banks of the Stung Sen River.

ii. Demography

26. The total population of Kampong Thom is 708,398 or 4.5% of the total population of Cambodia. Population consists of 343,478 (48.3%) male and 363,920 (51.7%) female.[24]

27. The project will be implemented in Taing Krasaing Irrigation Scheme. Lands within the Taing Krasaing are located in the four Communes namely Taing Krasaing, Tipou, Chraob and Kokoah which all belong to the Santuk District. Total land area of the four communes is 43,300 ha. Gross command area of the Project is estimated at 9,869 ha. Existing area irrigated is the 1,200 ha located in Taing Krasaing Commune, which was assisted under the Cambodia Agricultural Value Chain Program (CAVAC).

28. The combined population of the four Communes in Taing Krasaing is 39,357 with 19,018 (48%) male and 20,321 (52%) female. Total households are 7,939 with 13% female-headed households. There are 6,579 farm families, which comprise 83% of total households.[25]

Table 4: Socio-Economic Condition of Target Communes in Taing Krasaing Irrigation Scheme

Particular	Taing Krasaing	Tipou	Chraob	Kokoah	Total
Total Female Headed Household	387	215	107	347	1,056
Total number of Farm Families	913	3,769	570	1,327	6,579
Average Size of Landholding (ha)	1.5	1.5	1.5	1.5	1.5
Total Farmers owning less than 1 ha	509 (15%)	0 (0%)	0 (0%)	13 (0.34%)	522 (30%)
Sources of income Agriculture					
• Rice	88.33 %	99.33%	92.53%	93.8%	93.50%
• Vegetable	0.08 %	0%	0%	0.08%	0.04%
• Fish	3.1%	0.26%	0%	0%	0.84%
• Craft work	0 %	0%	0.1%	0.04%	0.035%
• Service	6.54%	0.41%	1.01%	0.97%	2.23%
• Other	0.72%	0%	5.95%	4.09%	2.70%

[24] Commune Database, CDB, 2013
[25] Commune Database, National Institute of Statistics, 2013

III. FINDINGS

29. Focus Group Discussions (FGD) and interviews were conducted in six communes in the project area to establish the relevant baseline information on gender issues. The following tables show the number of participants of the FGDs and interviews conducted:

Table 5: Participants in the Focus Group Discussion Conducted (Taing Krasaing)

	Male	Female	Gender not stated
Taing Krasaing Commune			
Farmers	2	1	-
FWUC	15	1	-
CC	1	-	-
Kokoh Commune			
CC	6	-	-
CWCC	-	1	-
Total	**24**	**3**	-

Source: PPTA Consultant.
Note: FWUC: farmer water user communities; CC: commune council; CWCC: Commune Women and Children Committee.

Table 6: Participants in the Interview Conducted (Taing Krasaing)

	Male	Female	Gender not stated
Tipou Commune			
CWCC	-	1	-
Assistant of Village Chief	-	1	-
Total	**-**	**2**	**-**

Source: PPTA Consultant.
Note: CWCC: Commune Women and Children Committee

Table 7: Participants in the Focus Group Discussion Conducted (Prek Chik)

	Male	Female	Gender not stated
Prey Svay Commune			
Farmers	12	28	-
Vice Village Chiefs	3	1	-
Member of Village	-	2	-
Deputy District Governor	-	1	-
Village Chiefs	2	-	-
CC	-	1	-
Prek Chik Commune			
District Governor	1	-	-
Deputy District Governor	-	1	-
CC	4	2	-
Sdok Pravoeuk Commune			
Deputy district governor	-	1	-
Commune chief	1	-	-
CCs	1	1	-
Village volunteer	1	-	-

	Male	Female	Gender not stated
Teacher	-	1	-
Farmers	5	-	8
Village members	-	-	2
Total	**30**	**39**	**10**

Source: PPTA Consultant.
Note: CC: commune council

A. Water Resource Management: Constraints Faced by Women

30. In the gender analysis study conducted in the Project area, the gender mainstreaming constraints faced by women in participating in agriculture and Water Resources Management (WRM) are the cultural belief that water resource management is the responsibility of men, the low capacity of women due to their low literacy, discrimination of women by men and community, most agricultural facilitators are men thus discouraging women to participate and lack of economic resource to support their families. These are the constraints in attaining the Project outputs such as: 40% participation of women as unskilled laborers in civil works; 50% of FWUC members will be women and 30% of FWUC Management Committee members will be women. The following presents the findings of the study conducted:

(j) Cultural Constraint
  (a) Cultural belief that WRM are the responsibility of men, women do not participate in WRM and agricultural work;
  (b) Women are busy both domestic and productive work, so it is difficult for women to fully participate in WRM as well as agricultural production;
  (c) Women cannot fully participate in trainings or meetings since they bring along their small children;
  (d) Most women have small children so they cannot participate with men to see the canal, which is far from their house.

(ii) Low Capacity of Women. Women farmers have very low literacy or have difficulty in reading and writing. It is difficult for women to absorb training lectures using visual aids with written words rather than using illustrations, pictures or drawing.

(iii) Discrimination and Lack of Participation
  (a) Some husbands are jealous if women work together with other men in FWUC activities. This makes it difficult to get women to join the FWUC. Only single women are able to join the FWUCs;
  (b) Women suffer from domestic violence caused by husbands drinking alcohol;
  (c) Communities lack understanding on gender role;
  (d) Most men are involved in productive work while most women are engaged more in domestic work. Women's participation in community activities such as FWUC is limited. They have low participation and lack the confidence to participate in discussions during meetings. They lack the confidence to express their views and opinion.

(iv) Most of agricultural facilitators are men. Women have difficulty to express themselves openly. Most facilitators are men, so it is difficult for women to share their concerns and needs.

(v) Lack of Resource. Some women have no land for agricultural production including rice and vegetable production, so they face difficulty to find income in supporting their family, especially their small children to go to school.

B. Other Related Issues Raised by Men and Women

31. Other related issues raised by men and women include:

(i) Lack of water to irrigate their farmlands;
(ii) No canal to provide water in the dry season;
(iii) Flood during wet season and drought during dry season, which lead to low yield of rice and crop production;
(iv) Debt increased. Farmers borrow money from private businessmen for agricultural production with high interest (20% or 50% for one year), and they are expected to pay back after harvesting. However, their rice yield production is low, and cannot pay back and lead to increasing debt. This debt becomes the burden of women who are left by their husbands to find work outside the community.

C. FWUC Concerns

32. The following presents the summary of the FWUC concerns in Taing Krasaing commune:

(i) FWUC encountered difficulties on water fee collection. Some farmers complain that their rice field did not get enough water for their crops.
(ii) FWUC have limited budget to repair canals.
(iii) FWUC has not received training on water fee collection or irrigation.
(iv) Women participate more in meetings in terms of attendance. Around 70% of participants are women. However, they lack interest to participate in decision-making. This is because they lack the confidence in expressing their views and opinion openly.
(v) FWUC lacks the experience and knowledge with regards to WRM.
(vi) It is difficult to get women to join FWUC.
(vii) There are few women in FWUC. There are only six out of 32 members who are women.
(viii) There is no clear delineation of responsibilities between the District Water Resources Management and Meteorology Office and FWUC in relation to the irrigation system O&M.
(ix) Women candidates to stand for FWUCs are not valued or voted by communities.
(x) Most people in communities do not understand gender relations and how men and women can share in the responsibilities at home, in the farm and in the FWUC.

1. Main Role of Commune Councils and Village Chiefs in FWUC

33. The main role of commune councils and village chiefs in FWUC includes:

(i) Assist FWUC to organize meeting with farmers.
(ii) Assist FWUC to disseminate information related to water fee collection.

2. FWUC Suggestion

34. FWUC suggested that:

(i) The PDWRAM at the district should coordinate with FWUCs in WRM.
(ii) FWUC need training on gender issues in WRM.
(iii) Provide gender awareness to farmers in the communes.

(iv) Enhance leadership skills of women to develop their skills in communication and decision-making. If a community can see more women actively participating in discussions, then more women can be voted as representatives in the Village to the FWUC.

(v) Address domestic violence.

35. Based on the interviews conducted on the Commune Women and Children Focal Point the following are the tasks they perform:

(i) Provide awareness on health service to women and children
(ii) Provide awareness on water and sanitation
(iii) Address domestic violence
(iv) Mediate land conflict
(v) Protect women and children trafficking
(vi) Help and protect victim from rape

36. Based on the above mentioned, it appears that awareness raising on domestic violence, trafficking, and protection of rape victims are already being addressed in the Communes. There is also a need to educate FWUCs with regards to gender issues in WRM and agriculture.

D. Labor work of men and women in communities

37. The tables below are the result of group discussion with communities and FWUCs in target communes in Kampong Thom and Battambang provinces.

E. Gender Division of Labor in Agriculture Activities

38. Based on the FGD results conducted, **Table 8** explains the gender division of labor and the access and control over these agriculture activities. The (X) mark for each activity shows the involvement of men and women in the various agriculture activities.

39. Based on **Table 8** it shows that women have more involvement in agriculture production (F=12, M=11), however women have less control on production than men (F=4 while M=12). This is because women stay more in the community, while the men are out looking for other job opportunities outside the commune. Women are also involved in home gardening, fish culture and chicken raising. However, men have more control over the means of production because of cultural beliefs that men are head of family and should be in control of decision-making. Men are the main income earners and they mainly decide on the use of money. Women cannot decide on their own regarding contribution to be paid on water fee. They have to wait for the men to make the decision on amount the can contribute.

40. Women share control with men on the following activities: buying of seeds, transplanting, harvesting, and rice seed selection. As shown in **Table 8**, women work more in agriculture production. They are also involved more in reproductive work such as taking care of children, grandchildren and old people with disabilities, taking care of housework, gardening, washing and they are also involved in small income generating activities (e.g. chicken and pig raising, handicraft, cooking of cakes for selling, making roofing material made of leaves). Women have less access to agricultural training on better agriculture techniques and practices. This is because the men are usually invited to attend the training. However after the training, the men go out of the commune to work outside leaving the women to look after the farm. The women are not able to apply the new agricultural techniques from the training because the men did not transfer the knowledge to them.

Table 8: Gender Distribution of Work, Access, and Control in Agriculture Sector

Agriculture	Access		Level of Participation	Control		Level of Participation
Rice Production	**Women**	**Men**		**Women**	**Men**	
1. Buying of rice seed	XX	X	Women more than men	X	X	Both men and women
2. Land Clearing		X	Only men		X	Only men
3. Transplanting	X	X	Both men and women	X	X	Both men and women
4. Spread fertilizer in rice land and maintenance of rice	X	X	Both men and women		X	Only men
5. Upgrade dike	X	X	Both men and women		X	Only men
6. Harvesting	X	X	Both men and women	X	X	Both men and women
7. Taking care of Cow and Buffalo	X	X	Both men and women		XX	More men
8. Taking care of Ox cart	X	X	Both men and women		X	Only men
9. Money use for agricultural production	X	X	Both men and women		X	Only men
10. Rice seed 11. Selection	X	X	Both men and women	X	X	Both men and women
12. Buying fertilizer	X	X	Both men and women		X	Only men
Total	**12**	**11**		**4**	**12**	

Source: PPTA Consultant.
Note: X = 1 score, XX = 2 scores

41. In conclusion, there are two main reasons why women have less control in agriculture activities than men: (1) cultural belief that women are able to do reproductive work but not productive work; (2) Males are able to earn money to support family and they do not get involved in reproductive work, so women have multiple tasks to perform when the men go outside the commune to look work, women then take over the farming activities and attend village and FWUC meetings.

1. Gender Division of Labor in Irrigation

42. The total scores of women's participation in irrigation activities are very low. Access to irrigation activities show that women participate in the payment of irrigation fee and in complaining to the FWUC regarding complaints on irrigation. Men participate in all irrigation activities. Control over irrigation shows men to be fully in control while women only jointly have on communicating complaints to the FWUC. The above table shows that women have less access and control in water resource management. This is primarily because of cultural belief that this is the main responsibility of men.

43. However it is evident that women in reality have the capacity to participate in all irrigation activities. They are inhibited from doing so because of cultural beliefs and pressure from society. Women who are left to work on the farm because their husbands are away, have to

learn how to conduct farming activities. Women are better Irrigation fee collectors because they are more persuasive than men.

Table 9: Gender Distribution of Work in Irrigation

Irrigation Structures	Access		Control	
	Women	Men	Women	Men
1. Measure the size of canal		X		X
2. Identify location for building canal		X		X
3. Maintenance		X		X
4. Irrigate water into their rice land		X		X
5. Pay water fee	X	X		X
6. Farmers communicate complaints to FWUC	X	XX	X	XX
Total	**2**	**7**	**1**	**7**

Source: PPTA Consultant.

44. It can be concluded that women have low participation in irrigation work because of cultural beliefs. However, they already attend meetings (with higher attendance as compared to men) but do not participate in decision-making. They can also perform irrigation activities that are considered as men's work.

2. Women's skills to participate in skilled labor in construction

45. According to the FGD with both men and women's groups, women lacks skill in labor / construction. It is due to cultural belief that this skill is only for men. Following the result of the FGD and interviews, women are willing to receive training on construction for future employment.

F. Training needs of female/male members and leaders in existing FWUC

46. According to the findings of the study, the training needs of female and male are the following:

(i) Training on gender issues in WRM.
(ii) Training on gender awareness for farmers in the community.
(iii) Training on domestic violence.
(iv) O&M training.
(v) Training on Women leadership.
(vi) Training on FWUC regulation explained with illustration and pictures rather than just the written visual aids.

G. Economic Role of Men and Women

47. During the FGD, the team tried to ask questions related to gender role in economic activities within their communities. The results are presented in the table below:

Table 10: Economic Activities

Men's Activities	Women's Activities
• Selling labor to cut cassava • Selling labor to plough rice land • Go to forest to find forest product • Selling labor through migration to Thailand or Phnom Penh • Selling labor for home construction	• Run a small business • Raise pigs and chicken • Selling labor for cutting cassava • Selling labor for clearing lands

Source: PPTA Consultant.

H. Existing Gender Activities of MOWRAM in FWUCs

48. MOWRAM established the FWUC Department in 2008 and developed and approved a Policy and Implementation Guideline for Sustainable FWUCs. Only few sentences relate to gender issues in the guideline as shown in page 11 point 3.2.4 *"WG7 and the MOWRAM technical working group on gender (WG2) shall coordinate activities on MOWRAM gender mainstream targets; FWUCs shall include an article in their statue that husband and wife are equal members and FWUCs shall be required to issue meeting invitations jointly to husbands and wife; PDWRAM will encourage the nomination of women to stand for FWUC committee".*

49. According to the survey findings, women want to volunteer as candidate for election in the FWUC. However, in terms of acquiring a position, women fail to secure a government position since the community lacks gender awareness, specifically on the important role that women can contribute in irrigation development.

50. The team also interviewed a member of the GMAG of the MOWRAM to understand their roles and existing activities with regards to FWUCs. GMAG used to provide gender training to provincial GFPs, but not on gender responsiveness to WRM. Their role is to oversee all gender mainstreaming in MOWRAM. There is budget limitation in implementing the Gender Mainstreaming Strategy and Action Plan.

IV. CONCLUSION

51. Based on the findings of the study, the following conclusions can be stated:

(i) The gender division of labor in WRM shows that women have less access and control but have greater participation in agriculture activities. Because of cultural constraints and belief, women's participation is limited.

(ii) Women lack the confidence and belief that they are capable of participating actively and equally as men in WRM, even though they are already actually doing the work in the field. But their participation is not given any value so it remains invisible.

(iii) According to socio-economic data in Prek Chik and Taing Krasaing Irrigation schemes, women constitute 51% of the population with 14% female-headed households. They are the most vulnerable in the farming communities because they have to remain in the commune to take care of the children, handicapped and older people, their farm and to participate in community and FWUC activities as their husbands look for work outside the commune and go to neighboring country. The women are left with the multiple tasks of domestic, productive, and community activities. They need to look for daily support to feed their families.

(iv) The impact of climate change the farmland lack water leads to low production. The women headed households are most vulnerable to this.

(v) Though women participate in meetings with their attendance higher than men, they do not participate in decision-making. They lack the confidence to share their opinion and views. Because of this, there are very few women leaders in the FWUC. The gender guideline of MOWRAM on FWUC does not provide in developing the leadership skills of women farmers. It only states that women should be encouraged to participate in the election. It does not prepare and enabling environment for women to be able to do so.

(vi) According to the findings of the study, almost all women farmers want to work in construction work as unskilled labor. And they also want to receive training on construction, if possible.

(vii) Both men and women have equal access to agricultural production including livestock, crops and rice production; however, women have less control in agricultural production. This is because of the cultural belief that women cannot do as men do. Women are not supported and encouraged by their husbands as well as community to participate in water resource management and apply modern agriculture techniques.

(viii) Training needs expressed by women to improve their participation in agriculture, irrigation and water resources management are: appropriate agriculture technology, gender awareness, leadership training, water resource management and better technology in pig and chicken raising.

(ix) The capacity of GMAG is still limited. Lack of budget to implement the Gender Mainstreaming Action Plan is also a constraint.

52. Presented in

54. **Table 11** is the summary of the key gender issues that are relevant to the project, including those identified in the gender analysis carried out during the project preparation with the proposed mitigation measures:

Table 11: Key Gender Issues and Mitigation Measures

Key Gender Issues	Mitigation Measures
1. Low participation of women in water management activities due to cultural belief that this is men's role.	• Provide awareness raising on gender concept and gender role in water management for communities in the target communes.
2. Low literacy of women. Most women cannot read and write thus prohibiting them from occupying leadership post in the FWUC.	• Provide a leadership and effective communication training for the women.
3. Lack of confidence to participate in discussion and decision making because they are shy and not able to verbalize their opinion.	• FWUC development should encourage participation of men and women farmer water users. Women should be encouraged to participate in discussions during meeting. • Provide training on leadership for women FWUC members.
4. Very few women occupy leadership position. In Taing Krasaing Irrigation scheme, there is an existing FWUC organized by Cambodia Agricultural Value Chain program (CAVAC) of the Australian Department of Foreign Affairs and Trade. Only one out of five board members is a woman and out of 53 Committee members only 4% are women.	• Disseminate gender awareness raising for communities before FWUC election to increase community belief that women are able to work for Water Management as well as be FWUC leaders.
5. Women are busy with domestic (housekeeping, taking care of children, washing, cooking, home gardening and poultry raising and with productive work in the farm, thus giving them limited time to participate in FWUC activities. This is caused by the high migration of men to look for work opportunities outside the village and the attitude of men who do not want their wives to be exposed to other men.	• Meeting/training schedule should consider women's schedule. • Awareness raising of both men and women on Gender Concept and importance of women's participation in water resources management. When men become gender sensitive, they can share in the domestic burden of women and will allow women to participate in the FWUC. The community will be supportive of women's involvement and participation in FWUC activities.
6. Lack of skill of women to participate in skilled and unskilled work for construction.	• Potential women skilled or unskilled workers should be provided with training or orientation for construction. Contractors should be oriented to recruit women workers and include this in the Contract stipulation. The PMU and PDWRAM Gender Focal Point should ensure that construction work arrangements will hire women as local workers in the construction works. Skilled work to be done by women can be as record keepers or on Administration work while unskilled work can be on planting of grass on canal embankment, carrying of soil and compaction work. Alternative work arrangement such as working on part-time basis, work rotation or contracting items of work as a group of women can be planned and used as options. The group will be awarded a specific item of work to do and they will plan how they can complete the

Key Gender Issues	Mitigation Measures
	work.[26]
7. Construction companies usually use labor from outside the communities preferring to hire men for skilled and unskilled labor. They do not also pay equally for the same work done for men and women.	• Gender equality and equity including (1) at least 40% of women participate in unskilled work for construction; (2) equal pay for equal work for both men and women. This condition will be included in the TOR of construction companies.
8. Training materials used for FWUC are mostly in written form and not easily understandable to women who cannot read and write.	• Produce more pictures to include in the training materials ensuring that training will be easy for women to understand, especially for women who cannot read and write. • Training method should avoid the lecture type but more on structured learning exercises and group dynamics exercises.
9. FWUC has very low women membership. Example is in Taing Krasaing where only one woman is a member of the Board and out of 53 Committee members only 4% are women.	• Disseminate gender awareness raising for communities before FWUC election to change community belief that women are able to work for Water Management as well as be FWUC member, in order to increase number of women elected.
10. GMAG of MOWRAM and GFP in the province have limited capacity to support the FWUC gender issues and concerns.	• Strengthen capacity of GMAG and GFP on gender role, gender issues and concern in WRM as well as gender issues in the project.

Source: PPTA Consultant.

[26] Labor Contracting Societies (LCS) composed of women laborers in the construction of irrigation canals, embankments and roads are being implemented in Bangladesh by the Bangladesh Water Development Board and by CARE International. This can be introduced as a work modality in the construction work.

V. PROPOSED GENDER ACTION PLAN

55. The Gender Action Plan (GAP) was developed in accordance with the project activities and based on the findings of the study conducted in the Project area. In implementing the proposed GAP, the mitigation measures on the issues identified in the study conducted are addressed. The GAP proposes to include gender issues in almost all project activities and training ensuring that both men and women get benefit from the project equally. It also provides opportunity for women farmers to have access and control over water resource as well as agriculture production for the improvement of their livelihoods. The GAP also pays attention to the project management, monitoring and reporting. Sex-disaggregated data should be included in project progress report. The estimated cost for implementing GAP is about $60,000.

Table 12: Gender Action Plan

Outputs	Gender Design Features/Activities	**Person / Institution responsible**
1. Enhanced efficiency and climate resilience of irrigation systems	1.1 At least 30% of unskilled labor will be given to local women during construction at equal wages;	PMU, PMIC and Civil Contractors
2. Improved water resource management	2.1. 50% of the FWUC members are women 2.2. 30% of FWUC management committee member are women 2.3. Women as FWUC are given equal opportunity with men to participate in Project training. 2.4. Ensure that women will take part in the O&M activity. 2.5. Gender specialist is included in the PMIC 2.6. Provide coaching on gender awareness and leadership for gender staff in the EA/IA and to Women in FWUCs.	PMU, PMIC and PDWRAM

A. Implementation mechanism for the Gender Action Plan

56. The Project Management Unit (PMU) will be responsible for the over-all implementation of the Project. Gender officer has been appointed within the PMU. She will be responsible for the implementation and monitoring of the GAP in coordination with the PMIC. Within the PMIC, there is a Gender Specialist who will work closely with the Gender officer in the PMU. The Gender Specialist will conduct monitoring and produce GAP progress reports in close coordination with the Gender officer at PMU. This will ensure that GAP implementation will be on track. Adequate resources (human and financial) have been allocated to implement, monitor and report on gap.

Appendix 14:
GENDER ACTION PLAN

1. The gender action plan (GAP) was developed in accordance with the project activities and based on the findings of the gender study conducted in the project areas. In implementing the proposed GAP, the mitigation measures on the issues identified in the study are addressed. The GAP proposes to include gender issues in almost all project activities and trainings to ensure that both men and women benefit from the project equally. It also provides opportunity for women farmers to have access and control over water resource as well as agriculture production for the improvement of their livelihood. The GAP also pays attention to the project management, monitoring and reporting. Sex-disaggregated data should be included in project progress reports. The estimated cost for implementing GAP is about $60,000.

Gender Action Plan

Outputs	**Gender Design Features/Activities**	**Person/Institution Responsible**
1. Enhanced efficiency and climate resilience of irrigation systems	1.1 At least 30% of unskilled labor will be given to local women during construction at equal wages	PMU, PMIC and civil contractors
2. Improved water resource management	2.1. 50% of the FWUC members are women 2.2. 30% of FWUC management committee member are women 2.3. Women as FWUC members are given equal opportunity with men to participate in Project training 2.4. Ensure that women will take part in the O&M activity 2.5. Gender specialist is included in the PMIC 2.6. Provide coaching on gender awareness and leadership for gender staff in the executing/implementing agencies and to women in FWUCs	PMU, PMIC and PDWRAM

FWUC = farmer and water users committee, PDWRAM = Provincial Departments of Water Resources and Metrology, PMIC = project management and implementation consultants, PMU = project management unit

2. **Implementation mechanism for the Gender Action Plan**. The project management unit (PMU) will be responsible for the over-all implementation of the project. Gender officer has been appointed within the PMU. She will be responsible for the implementation and monitoring of the GAP in coordination with the project management and implementation consultants (PMIC). Within the PMIC, is a gender specialist who will work closely with the gender officer in the PMU. The gender specialist will conduct monitoring and produce GAP progress reports in close coordination with the gender officer of the PMU, to ensure that GAP implementation is on track. Adequate resources (human and financial) have been allocated to implement, monitor and report on GAP.

Appendix 15:
RISK ASSESSMENT AND RISK MANAGEMENT PLAN

1. Major risks and mitigating measures are described in detail in the risk assessment and risk management plan given in the table below. The overall benefits and impacts are expected to outweigh the risks and costs.

Risk Description	Risk Assessment	Mitigation Measures or Risk Management Plan
1. Adverse effects of climate change	Medium	The project design includes improvement of drainage facilities to protect agricultural land and canals from potential flooding that may be caused by high intensity-long duration rain. For reducing impacts of droughts on water availability, irrigation scheduling will be done and water flow measurement instruments will be installed in the canals for controlled supplies to meet crop water requirements during dry spells. Farmers will also be trained on growing low delta-high value crops.
2. Inadequate planning and funding of O&M	Medium	O&M cost will be estimated and maintenance plans will be prepared by PDWRAM with support of PMIC and involvement of FWUCs at the time of design and cost estimate of subprojects. Based on that average annual irrigation service fee per hectare will be determined. FWUCs will be made responsible for collecting this and using for O&M of distribution canals. For main canals, Government will allocate O&M funds in the annual budget and PDWRAM will carry out O&M. FWUCs will oversee O&M of the main canals.
3. Weak communication between MOWRAM, PDWRAM and FWUCs	Medium	The Department of Farmer Water User Commune in MOWRAM is the implementing agency and PDWRAM is the part of the PMU.
4. Start-up actions delayed	Low	PMU is already established and staffed. Following will be completed before loan effectiveness: (a) evaluation of technical and financial proposals of PMIC and draft contract, (b) evaluation of bids for main canal international competitive bidding works, and (c) evaluation of bids for procurement of goods, equipment and vehicles. Project performance monitoring system has been developed and shall be established immediately after mobilization of PMIC.
5. Poor capacity for MOWRAM-PMU and PDWRAMs to implement	Medium	Capacity of the PMU and PDWRAM staff involved in the Project will be strengthened by providing support from the PMIC and on-the-job training on project implementation.

Risk Description	Risk Assessment	Mitigation Measures or Risk Management Plan
6. Poor construction of civil works and weak adherence to the construction schedule	Medium	PMU and PDWRAM with help of PMIC will follow competitive qualification criteria to select construction contractor(s). Quality control engineers from the PMIC will regularly verify quality of construction through in-situ test and laboratory tests of the construction material. Site engineers and construction management engineers from the PMIC will ensure adherence to design specification and construction schedule.
Overall	Medium	

FWUC = farmer and water users committee, MOWRAM = Ministry of Water Resources and Metrology, O&M = operations and maintenance, PDWRAM = Provincial Departments of Water Resources and Metrology, PMIC = project management and implementation consultants, PMU = project management unit
Source: Asian Development Bank.