Technical Assistance Consultant's Report

Project Number: 44328-012
July 2015

Kingdom of Cambodia: Uplands Irrigation and Water Resources Management Sector Project
(Financed by ADB's Technical Assistance Special Fund)

Prepared by

Lahmeyer IDP Consult Inc. in Association with TANCONS (Cambodia) Co., Ltd.

Metro Manila, Philippines

For Ministry of Water Resources and Meteorology (Executing Agency)
Department of Farmer Water User Communes (Implementing Agency)

Asian Development Bank

LAHMEYER IDP CONSULT

FINAL REPORT: ADB PPTA-8702 CAM
MAIN REPORT & APPENDICES

Proposed Loan
Kingdom of Cambodia: Uplands Irrigation and Water Resources Management Sector Project

JULY 2015

ADB

LAHMEYER IDP CONSULT

Lahmeyer IDP Consult Inc.
In Association with
TANCONS (Cambodia) Co., Ltd

Cover Photographs

Main Canal, Taing Krasaing	Main Canal, Prek Chik

This Report consists of One Volume containing the following:

Main Report

Appendices

CURRENCY EQUIVALENTS
(as of 1 July 2015)

Currency unit	–	Riel (KR)
KR1.00	=	$0.00024
$1.00	=	KR4,099.95

ABBREVIATIONS

ADB	–	Asian Development Bank
ADF	–	Asian Development Fund
DFWUC	–	Department of Farmer Water User Communes
DHRW	–	Department of Hydrology and River Work
EA	–	Executing Agency
EARF	–	Environmental Assessment and Review Framework
EIRR	–	Economic Internal Rate of Return
EMP	–	Environmental Management Plan
FWUCs	–	Farmer Water User Communes
GDP	–	Gross Domestic Product
Ha	–	Hectares
IA	–	Implementing Agency
IEE	–	Initial Environmental Examination
IP	–	Indigenous people
IRC	–	Inter-Ministerial Resettlement Committee
MAFF	–	Ministry of Agriculture, Forest and Fisheries
MEF	–	Ministry of Economy and Financial
MOE	–	Ministry of Environment
MOWRAM	–	Ministry of Water Resources and Meteorology
O&M	–	Operation and Maintenance
PAM	–	Project Administration Manual
PDWRAMs	–	Provincial Departments of Water Resources and Meteorology
PMIC	–	Project Management and Implementation Consultants
PMU	–	Project Management Unit
PPMS	–	Project Performance Monitoring System
PPTA	–	Project Preparatory Technical Assistance
RP	–	Resettlement Plans
WRMSDP	–	Water Resources Management Sector Development Program

NOTES

In this report, “$” refers to US dollars.

TABLE OF CONTENTS

Page

List of Tables

I. THE PROJECT

A. Rationale

1. Improved macroeconomic stability and public financial management reforms have helped Cambodia's economy grow over the past decade. Gross domestic product (GDP) was 7% in 2014 and is expected to remain at 6.9% during 2015 to 2016.[1]Agriculture sector is among the main contributors with 29% share in the national GDP. The sector employs 72.3% of country's workforce or an estimated five million people. Livelihoods of 80% Cambodians are dependent on agriculture.[2]

2. The farming systems in Cambodia are largely subsistence oriented. Agriculture is mostly based on rainfed production systems focused on paddy rice production. Even though Cambodia has become self-sufficient in rice and has an exportable surplus, still rice-based farming systems have low income. Despite the annual surplus of 3.3 million tons of paddy, nearly one-quarter of the provinces face food deficit. 11% of households are considered food insecure with many facing a deficit for 1–2 months each year.[3]

3. Rainfall distribution and river discharges have significant seasonal variability in Cambodia, affecting sustained agriculture production and increasing vulnerability. Timely availability of water and its efficient management is of prime importance to enhance agriculture productivity and for diversification of agriculture and rural economy. Deteriorating irrigation infrastructure is seriously compromising this. Climate change may further affect water availability, particularly during peak requirement, thus further reducing agriculture productivity.

4. Improving agricultural productivity, crop diversification, irrigation and water resources management, and water storage capacity are among the major thrusts of the Government's National Strategy. Irrigated agriculture is given high priority to ensure food security and to further develop the rural economy. Out of the 3.98 million hectares (ha) of agricultural land in Cambodia, about 1.3 million hectares is in command area of 2,730 irrigation systems.[4] Most of the irrigation systems are either dysfunctional or under-performing due to deteriorated infrastructure, lack of resources for rehabilitation, and inadequate operation and maintenance (O&M). The two core irrigation systems selected by the project have total command area of 20,200 ha but only 1,015 ha is cultivate during dry season and about 11,000 ha in wet season due to water unavailability. The project will increase the cultivated area to about 28,000 ha during wet and dry seasons by ensuring irrigation supplies.

5. Irrigation consumes about 70% of the Cambodia's water. Efficient, effective and sustainable management of country's water resources largely depends upon how smartly irrigation systems are managed by optimizing the utilization of water commensurate with seasonal water requirements of the crops, with minimum conveyance and field application losses. Increased public investments in irrigation infrastructure along with introduction of modernized operational management will ensure increased efficiency and productivity of the irrigation systems. The project's proposed interventions will enhance agricultural and rural economic productivity through increased efficiency of irrigation systems and improved management of water resources in uplands of Kampong Thom and Battambang provinces.

6. The Project will capitalize on the policy and legal reforms and institutional strengthening done under the ADB financed Water Resources Management Sector

[1] The World Bank. Cambodia Data. http://www.worldbank.org/en/country/cambodia/overview (accessed 1 July 2015).
[2] ADB. 2014. *Agriculture, Natural Resources and Rural Development Sector Assessment, Strategy and Road Map: Cambodia, 2014–2018*. Manila.
[3] World Food Program. 2008. Comprehensive Food Security and Vulnerability Analysis—Cambodia. Phnom Penh.
[4] Cambodia Irrigation Schemes Information System, MOWRAM.

Development Program (WRMSDP).[5] The law on farmers' participation in the O&M of irrigation systems,[6] approved in March 2015, will be used as the basis for forming FWUCs and involving them in the design, implementation and subsequent O&M of the subprojects. This will ensure sustainability of Project investments.

7. The project will also develop synergies with the ongoing Climate Resilient Rice Commercialization Sector Development Program (Rice-SDP)[7] and the Greater Mekong Subregion (GMS) Flood and Drought Risk Management and Mitigation Project[8]to complement outcomes of all three projects. Improved seed supplies, land levelling, and agriculture value chain facilities of the Rice-SDP will be extended to the Project beneficiaries. For improved water resources management, installation of the hydro-meteorological stations in the project area will be done in collaboration with GMS Flood and Drought Risk Management and Mitigation Project.

B. Impact and Outcome

8. The impact is aligned with inclusive economic growth through agriculture and irrigation, (Rectangular Strategy on Growth, Employment, Equity and Efficiency, Phase III, *2014 to 2018, RGC*). The outcome will be water and agriculture productivity enhanced in the Project area.

C. Outputs

9. The project will have the following two outputs.

10. **Output 1: Enhanced efficiency and climate resilience of irrigation systems.** The project will support rehabilitation, modernization, and climate proofing of irrigation systems for increasing cultivated area to 29,500 hectares in the project area in Kampong Thom and Battambang provinces. It shall (i) improve main and distribution canals and appurtenant structures, (ii) install water measurement gauges at all inlets and outlets of canals, (iii) upgrade drainage facilities to protect agricultural land and canals from potential flooding that may be caused by high intensity-long duration rains due to climate change, (iv) rehabilitate drainage facilities for 1,800 ha, and (iv) laser leveling of 2,000 hectares.

11. **Output 2: Improved water resource management.** The project will (i) organize FWUCs and provide gender inclusive trainings to FWUCs' members in the O&M of canals, management of FWUCs, water management, and involve them in design and implementation of subprojects; (ii)install hydro-meteorological stations in the watersheds; (iii)establish canals flow measurement system, (iv) train staff of Ministry of Water Resources and Meteorology (MOWRAM), Department of Farmer Water User Communes (DFWUC), Provincial Departments of Water Resources and Meteorology (PDWRAMs), FWUCs and Ministry of Agriculture, Forestry and Fisheries (MAFF) on modern canal operation techniques, irrigation scheduling, watershed management, and water management; (v) modernize canal operations; and (vi) design joint reservoir operation of Stung Chinit and Taing Krasaing reservoirs in Kampong Thom province, and Bassac and Dauntri reservoirs in Battambang province to improve water sharing arrangements between linked systems.

---

[5] ADB. 2010. *Report and Recommendation of the President to the Board of Directors: Proposed Loan and Grant for the Water Resources Management Sector Development Program in Cambodia.* Manila.

[6] Government of Cambodia. 2015. *Sub-decree on the Procedures for the Establishment, Dissolution, Role and Duties of FWUC*. Phnom Penh.

[7] ADB. 2013. *Report and Recommendation of the President to the Board of Directors: Proposed Loan for the Climate Resilient Rice Commercialization Sector Development Program in Cambodia.* Manila.

[8] ADB. 2012. *Report and Recommendation of the President to the Board of Directors: Proposed Loan for the Greater Mekong Subregion Flood and Drought Risk Management and Mitigation Project in Cambodia.* Manila.

D. Investment and Financing Plans

12. The project is estimated to cost $66.12 million with ADB financing of $60.00 million equivalent and about $6.12 million by the government. Details are provided in Table 1.

Table 1: 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+C)	**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[9] 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/six year implementation period.
Source: Asian Development Bank estimates.

13. The government has requested a loan of $60.0 million equivalent from ADB's Asian Development Fund (ADF) to help finance the Project. The financing plan is in Table 2.

Table 2: Financing Plan

Source	**Amount** ($ million)	**Share of Total** (%)
Asian Development Fund	60.00	90.70
Government	6.12	9.30
Total	**66.12**	**100.00**

Source: Asian Development Bank estimates.

[9] The following principles will be used to determine the amount of taxes and duties to be financed by ADB in a project: (i) the amount will be within the reasonable threshold identified during the CPS preparation process, (ii) the amount will not represent an excessive share of the project investment plan, (iii) the taxes and duties apply only to ADB-financed expenditures, and (iv) the financing of the taxes and duties is material and relevant to the success of the project.

E. Implementation Arrangements

14. MOWRAM will be the executing agency and DFWUC will be the implementing agency. A PMU has been established in DFWUC before commencement of the project preparatory technical assistance. The PMU is headed by a Project Director who is the Deputy Director General for Technical Affairs in DFWUC and a Project Manager who is the Director of the DFWUC. The PMU was fully involved in the preparation of the project. For implementation of the Project, the PMU will be composed of 24 designated personnel from MOWRAM, DFWUC, MAFF, Department of Hydrology and River Work (DHRW), and (PDWRAMs) of Kampong Thom and Battambang provinces. MAFF staff will coordinate the land levelling and other supporting activities to be provided from Rice-SDP including access to quality seed and agriculture value chain facilities and services. PDWRAMs will be responsible for coordinating all field activities with FWUCs and DFWUC. DHRW will coordinate installation, operation, and data collection of hydro-meteorological stations.

15. A steering committee, chaired by H.E. Minister, MOWRAM and comprising senior officials from MOWRAM, MAFF, Ministry of Economy and Finance (MEF) and Provincial Governor's Office of the two provinces, will oversee the Project implementation and management and provide policy guidance. Resettlement and land acquisition will be implemented by and under the management of the Inter-Ministerial Resettlement Committee (IRC) chaired by MEF with membership from the representatives of relevant line ministries in close cooperation with the Kampong Thom and Battambang Provincial Resettlement Sub-committees. The PMU will be responsible for implementation, planning, organization, monitoring and reporting of the Project and will be supported by the project management and implementation consultants (PMIC).The PMIC will comprise 64 person-months of international and 610 person-months of national experts to provide technical support to the PMU to efficiently manage and implement the Project. ADB's Guidelines on the Use of Consultants (2013, as amended from time to time) will be used for recruiting the consulting firms. The anticipated procurements include small and large works contracts and goods, which will be procured by using ADB's national and international competitive bidding and shopping methods. An imprest account will be maintained at the PMU level for ADB loan funds. The implementation arrangements are summarized in Table 3 and detailed in the project administration manual (PAM), attached as Appendix 5 in this report.

Table 3: Implementation Arrangements

Aspects	**Arrangements**
Implementation period	January 2016–March 2021
Estimated completion date	31 March 2021
Management	
(i) Oversight body	**Project Steering Committee (PSC)** Chair: H.E. Mr. Lim Kean Hor, Minister, MOWRAM Secretary: H.E.ChannSinath, Deputy Director General, DFWUC/Project Director Members: H.E. Vongsey Vissoth, Secretary of State, MEF H.E. Bun Hean, Secretary of State, MOWRAM H.E. Hem Vanndy, Under Secretary of State, MEF H.E. Kong Chan, Under Secretary State, MAFF H.E. Chan Sothy, Director General, MEF Mr. Chhoun Samrith, Director of Department of Cooperation and Debt Management, MEF Mr. Yi Sokthearith, Chief, Office of Multilateral Cooperation 1, MEF Mrs. Veng Youim, Deputy Chief, Office of Multilateral Cooperation 1, MEF
(ii) Executing agency	MOWRAM

Aspects	Arrangements		
(iii) Key implementing agencies	DFWUC		
(iv) Implementation unit	The PMU has been established in DFWUCcomprising staff from MOWRAM, MAFF, DHRW and PDWRAMs.		
Procurement	International competitive bidding	7 contracts	$42.80 million
	National competitive bidding	4 contracts	$4.35 million
	Shopping	3 contracts	$0.14 million
Consulting services	PMIC, QCBS	674 person-months	$4.65 million
	External Monitoring Agency-Safeguards (QBS)	Lump-sum contract	$0.20 million
Advance contracting	Consulting services for the PMIC, ICB works contract of Taing Krasang main canal, and procurement of goods, equipment and vehicles have been proposed for advance contracting.		
Disbursement	The loan proceeds will be disbursed in accordance with ADB's *Loan Disbursement Handbook* (2015, as amended from time to time) and detailed arrangements agreed upon between government and ADB.		

DFWUC = Department of Farmer Water User Communes; DHRW = Department of Hydrology and River Works; MAFF = Ministry of Agriculture, Forestry and Fisheries; MOWRAM = Ministry of Water Resource and Meteorology; PDWRAM = Provincial Department of Water Resource and Meteorology; PMU = Project Management Unit; QCBS = quality- and cost-based selection; QBS = quality based selection.
Source: Asian Development Bank.

II. DUE DILIGENCE

A. Technical

16. Technical due diligence included comprehensive review of hydrological and hydraulic conditions, water availability and water requirements, irrigation and drainage engineering aspects, agronomy and soil analysis. Topographic and geotechnical surveys were conducted to complete the feasibility study of the two core subprojects, Taing Krasaing irrigation system with command area of about 9,800 ha in Kampong Thom province and Prek Chik irrigation system in Battambang province having command area of about 20,800 ha, of which 10,400 ha will initially be provided with secondary and tertiary facilities under the Project. The Project preparation considered (i) various technical options and their economic viability; (ii) rationale for the proposed design, outcome and outputs; (iii) maximizing the irrigated area and beneficiary farmers; (iv) minimizing adverse environmental and social impacts, and prepare for climate change; and (v) robust project implementation arrangements. The Project is designed on participatory development approach wherein the beneficiary farmers will be organized in the form of FWUCs and will participate in the final design and implementation of subprojects. FWUCs will also take full responsibility of O&M of the secondary and tertiary canals.

B. Economic and Financial

17. Economic and financial analysis of the two core subprojects was carried out. The economic internal rate of return (EIRR) of Taing Krasaing irrigation system is estimated at 22.7% and Prek Chik irrigation system at 24.0%, higher than the assumed cut-off rate for economic viability of 12%. Sensitivity analysis indicates that the economic viability of the subprojects is highly robust with respect to adverse movements in the value of key variables and assumptions relating to asset values.

C. Governance

18. All procurement to be financed by ADB loan funds will be carried out in accordance with ADB's Procurement Guidelines (2015, as amended from time to time). Project implementation, procurement, and financial management will be aligned with the Government's standard operating procedures. The overall procurement classification for the project is assessed as Medium Risk (Category Medium). A financial management assessment concluded that the pre-mitigation financial management risk level for the project as moderate as existing organizational structures of the executing and implementing agencies are generally suitable for the implementation of the project and fund flow arrangements are clear. The executing agency has sufficient experience of implementing ADB financed projects. At present the executing agency is implementing four projects. The experience gained from implementing these projects will help in financial management of the project. Support of a financial management specialist from the PMIC will be provided to further ensure this.

19. ADB's Anticorruption Policy (1998, as amended to date) and ADB's Integrity Principles and Guidelines (2015, as amended to date) were explained to and discussed with the government and MOWRAM. The specific policy requirements and supplementary measures are described in the PAM.

D. Poverty and Social

20. Improved irrigation systems and secured supply of irrigation water to the farms will substantially increase farm productivity and incomes and enhance livelihoods of beneficiaries. Currently, one rice crop is grown during wet season because the canal water does not reach farms. The project will ensure water supplies for cultivating a second crop i.e. rice, vegetables and fruits in dry season. That will increase the agricultural production and household farm incomes by almost twofold.

21. The project is classified as effective gender mainstreaming. The key gender impacts of the Project include: (i) 50% women membership in FWUCs; (ii) 30% women representation in FWUC management committees; (iii) 30% of unskilled labor employed in civil works construction at equal wages will be women; and (iv) capacity building of women in management of FWUC affairs, O&M, and water management. According to project information, 51% of the beneficiaries of the project are women and 14% of the beneficiary households are headed by women.

22. Please refer to Appendix 12 for the full report on Poverty and Socio Economic Condition.

E. Safeguards

23. **Environment.** The project is classified as category B for environment. Details about the procedures to ensure that potential environmental impacts are mitigated are provided in the environmental assessment and review framework (EARF). Potential adverse environmental impacts of the Project are assessed to be temporary, insignificant and can be

readily mitigated. The EARF and the Initial Environmental Examination (IEE) for the two core subprojects have been disclosed on ADB's website. An Environmental Management Plan (EMP) has also been prepared for the core subprojects to mitigate the impacts during construction and shall be made part of the civil works contract. For other subprojects to be prepared during the Project's implementation, the EARF will be followed for environmental assessment and an IEE of each subproject will be prepared to ensure consistency with ADB's SPS 2009, and respective EMPs will be included in the IEEs and civil works contracts. Adequate resources have been allocated for environmental safeguards preparation, implementation, monitoring and reporting.

24. **Involuntary resettlement.** 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.

25. **Indigenous peoples.** The project is categorized as C as there are no indigenous people living in the project area and there are no impacts on indigenous peoples.

F. Risks and Mitigating Measures

26. Major risks and mitigating measures are summarized in Table 4 and described in detail in the risk assessment and risk management plan (refer to appendix 15).[10] The overall benefits and impacts of the project are expected to outweigh the risks and costs.

Table 4: Summary of Risks and Mitigating Measures

Risks	Mitigation Measures or Risk Management Plan
Adverse effects of climate change.	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.
Inadequate planning and funding of O&M.	O&M cost will be estimated and maintenance plans will be prepared by the IA 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 take responsibility collecting this and will use this 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.
Weak communication between MOWRAM, PDWRAMs and FWUCs.	Department of FWUC in MOWRAM has been assigned the role of IA. Central and provincial departments (MOWRAM and PDWRMs) have been made part of the PMU.
Start-up actions delayed.	PMU is already established and staffed. Following advance actions will be completed before loan effectiveness: (i) evaluation of technical and financial proposals of PMIC and draft contract,(ii) evaluation of bids for Taing Krasaing main canal ICB works, and (iii) evaluation of bids for procurement of goods, equipment and vehicles. Project Performance Monitoring System (PPMS) has also been developed and shall be established immediately after mobilization of PMIC.

[10] Risk Assessment and Risk Management Plan (accessible from the list of linked documents in Appendix 2).

III. SUMMARY FEASIBILITY STUDY OF CORE SUBPROJECTS

A. Summary of Prek Chik Core Subproject

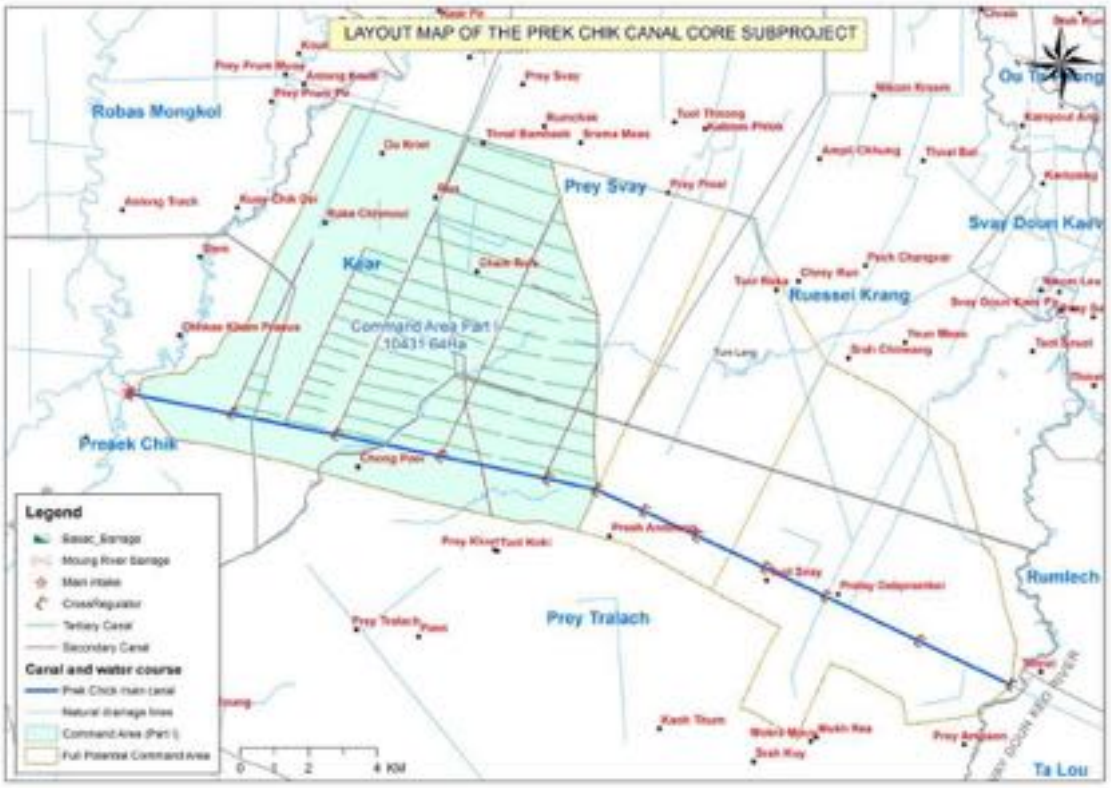
27. The system Prek Chik in Battambang province is located some 250 km from the capital city of Phnom Penh, south of the provincial capital Battambang. It is accessible through National Road No. 5. Between Pursat and Battambang at the municipality of Muong. The distance from Battambang city to Prek Chik headworks is some 50 km.

28. The total irrigable area of Prek Chik is 20,800 ha. The system is supplied from Bassac reservoir – 14 km away to south-west – at present empty and whose dam at present is undergoing repair to replace 3 missing gates out of 7. This repair is to be completed by March 2016. The Secondaries and Tertiaries system is basically non-existing. All area is rainfed, with 90% on left side, and only some 10% on right side, as system slope right-to-left from main canal flow viewpoint.

29. The main canal of 28 km length, with a 15 m drop over this length, is in stable yet unmaintained condition; all its structures are in need of repair and upgrading. The canal serves often only as drain to relief flashflood water from its right side; some 18 drain-inlets have been constructed in its right side embankment to discharge these flood drainage waters into the main canal, to be transported and released in left side drain escapes into old streams, now blocked since canal construction.

30. Prek Chik depends on Bassac reservoir, with an approximate storage of 7 to 8 MCM live storage. The plans for constructing the multi-purpose power and water supply dam at Dauntri – some 6 km upstream of Bassac - has been confirmed by MOWRAM in June 2015; therefore the initial inclusion of constructing as part of the Prek Chik project a single-purpose irrigation supply reservoir embankment for an additional 12 MCM storage has been excluded. However, in case the upstream located Dauntri Multi-purpose dam (6 km upstream – south-south-west of Bassac) is indeed constructed in the near future (over next 4 years), a reassessment of water supply and impact on water available for Prek Chik is required as significant additional water through the storage added of 132 MCM may become available for the four systems linked to Bassac, with Prek Chik being the largest (70% of total area to be supplied from Bassac). Future Dauntri Reservoir water release for power and municipal supply will need to be considered and irrigation release will need to be integrated.

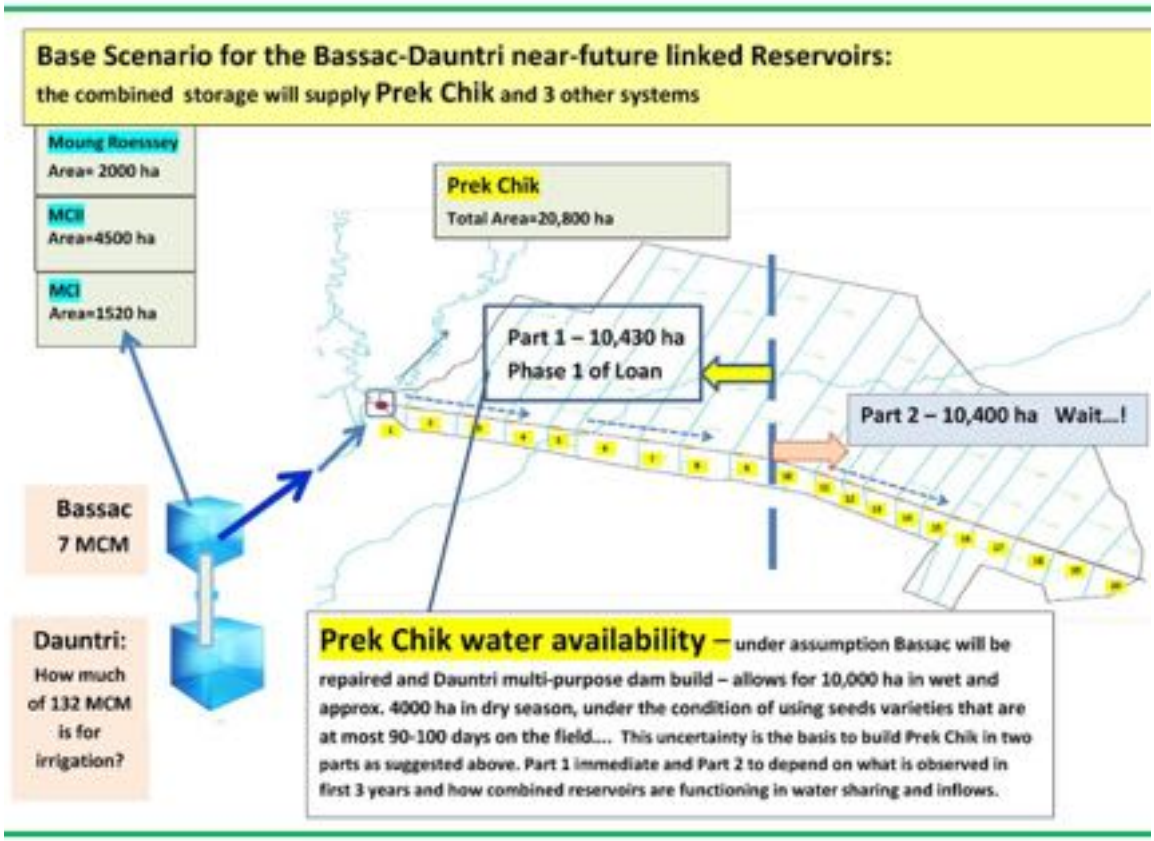
31. Approach for Prek Chik project has been on the cautionary side to first prepare only approximately half (50%) of command area for water delivery and, in view of uncertainties on completion of Dauntri, water sharing with other three systems supplied by Bassac reservoir, and overall limited data to predict to a degree of certainty of the water supplies available for wet season irrigation and area to be planted at beginning of dry season. The main canal of Prek Chik will however be prepared in full, both for all needed drainage relief works and irrigation off-takes. For Part 1, all Secondaries and Tertiaries are included. Part 2 may be undertaken pending experience with the combined reservoirs Bassac-Dauntri.



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

Cost estimate for Prek Chik Core Subproject as planned

No.	Description	Estimated Cost (USD)	Gross Command (Ha)	Land Acquisition (Ha)	O&M Costs Yearly (USD)	Remarks
1	Main Canal and Headwork	3,843,512	0	N.A.	N.A.	Full length
2	Secondary and Tertiaries system, Part 1	12,801,095	10,431	162.32	125,373	For 10,400 ha as first part – Phase 1
	Total	**16,644,607**	**10,431**	**162.32**	**125,373**	



33. **Water Availability is** a significant issue in Prek Chik as hydrological assessment showed insufficient water at Bassac Reservoir to irrigate over the full command, certainly if traditional seed varieties are used for a lengthy 140-150 days on field. The 4 systems linked (see Map) have never been supplied by Bassac in a joint manner; this needs to be recorded in an agreement between the four systems and their reservoirs, in which PDWRAM is to join the respective FWUCs and supervise both formulation and implementation of the Joint-Reservoir-Operation plans for water delivery and supply, and associated agreement, yearly verified and updated. A most important consideration is to assess the outcome of constructing the Dauntri Multi-Purpose Dam in detail and must be part of any planned joint reservoir operation. Without this key information on what Dauntri dam can supply for irrigation pur[pose, Prek Chik can only irrigate during Mid-June, and will be under water supply pressure as early as the start of January of almost every year.

34. Rehabilitation and improvement of **Prek Chik** include:

- Rehabilitation of headworks (including raising of spillway by 1.5 meters)
- Rehabilitation of 28 kms Main Canal and installation of all structures for water control and distribution, and provision of all drainage works
- 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.
- Increased focus and associated training in Joint Reservoir Operations for Bassac reservoir, to improve on water sharing and water scheduling arrangements between linked systems.
- 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 Water Management, including planning for implementation.
- Organization, mobilization and training of FWUCs in the command area.
- 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.

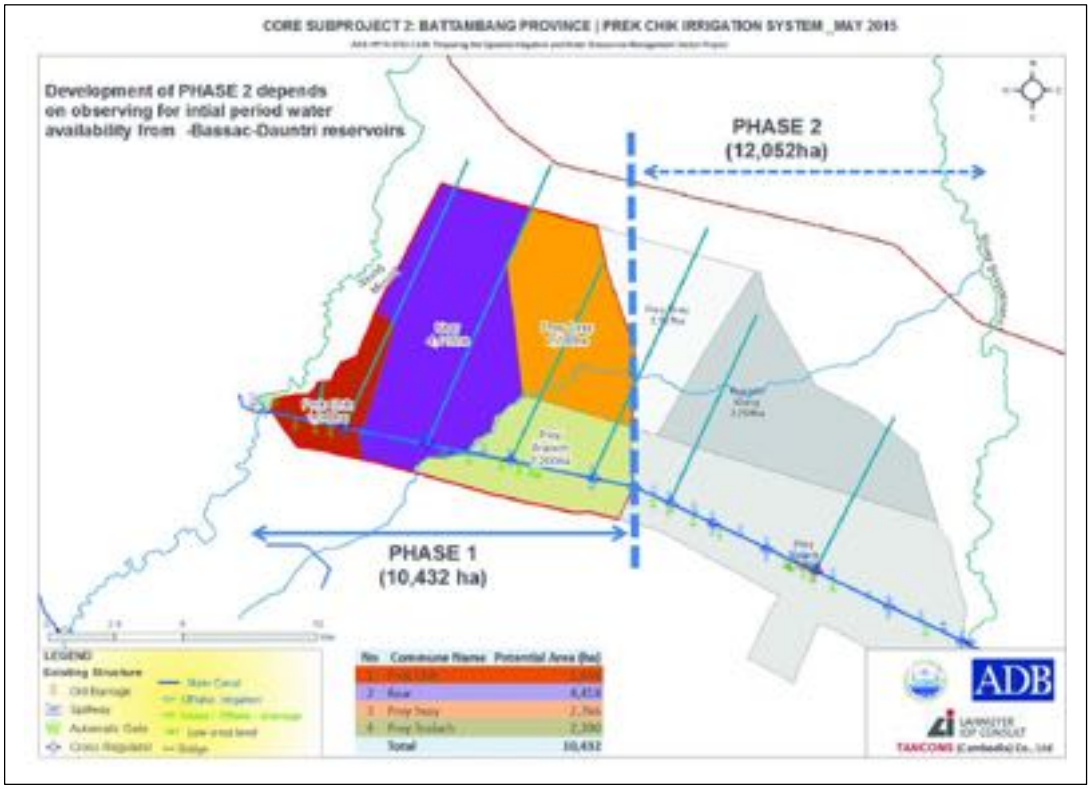
35. Other important aspects of the full upgrading of Prek Chik include:

1. **Strict Construction Quality Monitoring on Specifications** for all structures and canals and drainage concrete and earth works to be improved or provided is required from Day 1.
2. **Careful and agreed Joint Reservoir Operation** in a detailed agreed and recorded agreement with linked systems to Bassac Reservoir on water sharing is required and so is discipline in executing agreed timing of planting and irrigation scheduling for all sections in all systems.
3. **Focus on combining Water and on Non-Water Agro-Inputs** in crop production process, with support of District Agriculture, is required, in view of reaching not just increased cropping intensities, but also significant increased yields. **Use of Early Seed varieties (90-100 days)** is key – essential to be made available and to be used.
4. **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 the system.
5. **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. 30-35% in next 35 years).

36. On-Farm Facilities Development is estimated at USD 200-300/hectare, where it concerns rain-fed lands already level and in such used for many years. A total of 2000 hectares may require land clearing and shrub/small tree removal and this may cost up to USD400-500/hectare.

37. **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. However the need for this may be limited as many of the rain-fed fields to be brought under irrigation are already considerably level, having been tilled over many decades.

Additional Key Summary Maps of Prek Chik:



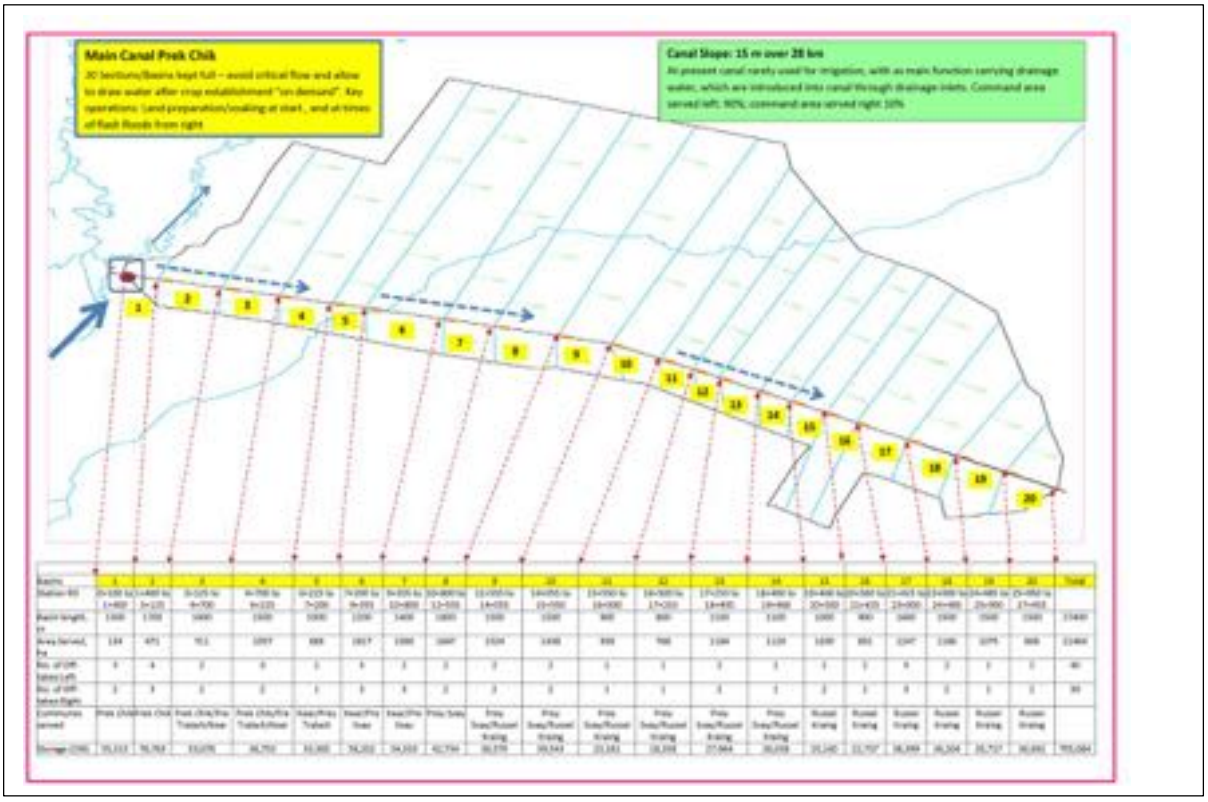


Figure 1: Drainage Pressure Points for Prek Chik System

Source: Google Earth

Inflow in Reservoir of Bassac Reservoir for Prek Chik

Table:1 The Dry Year Monthly, Averages Flow in m3/s and MCM in Bassac in Prek Chik

Watershed	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bassac Reservoir	m3/s	0.69	0.50	0.37	0.31	1.20	1.64	1.96	2.97	2.98	3.49	2.06	1.05
Bassac Reservoir	MCM	1.84	1.21	0.99	0.80	3.21	4.26	5.25	7.96	7.73	9.35	5.34	2.81
Total	MCM	1.84	1.21	0.99	0.80	3.21	4.26	5.25	7.96	7.73	9.35	5.34	2.81
						rainfall period							

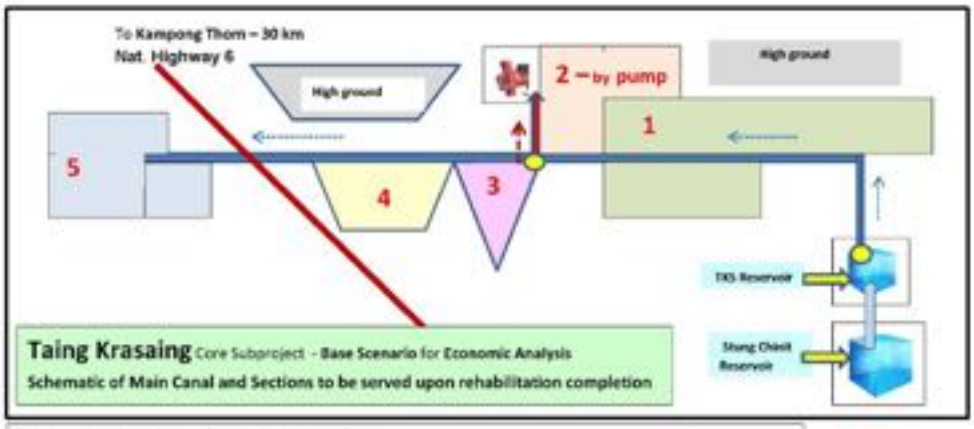
Table:2 The Normal Year Monthly, Averages Flow in m3/s and MCM in Bassac in Prek Chik

Watershed	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bassac Reservoir	m3/s	1.18	0.64	0.60	0.71	0.81	1.87	6.27	15.36	21.33	23.13	15.45	5.11
Bassac Reservoir	MCM	3.15	1.54	1.62	1.85	2.16	4.86	16.78	41.14	55.29	61.95	40.05	13.70
Total	MCM	3.15	1.54	1.62	1.85	2.16	4.86	16.78	41.14	55.29	61.95	40.05	13.70
						rainfall period							

38. Please refer to Appendix 6 for the full feasibility study report.

B. Summary of Taing Krasaing (TKS) Core Subproject

39. The core subproject of Taing Krasaing irrigation system in Kampong Thom province is located some 30 km south-east of the Kampong Thom city (provincial capital), along National Highway No.6, and is accessible from this highway through 3 secondary roads which lead to respectively head works, middle section and tail end. The system was constructed during1975-1978 Khmer Rouge era and shows many deficiencies in design. Its main canal is located it in considerable sandy soils, and is initially very wide (40 m plus), subject to considerable erosion over the last 50%.of its length. The drop over the main canal length of 22 km is a mere 20 cm. system is incomplete, and lacks secondary and on-farm irrigation facilities over 70% of its command area of 9869 ha. It has never functioned as two large breaches of resp. 2 km and 1 km length on right side of a main canal, between RD 7+000 and RD 10+000 make it unusable. Several past efforts to repair these breaches have failed; and water introduced beyond RD 7+000 will result in large flooding of lands on right side. Many minor drainage issues also exist, and over its last 5 km the canal is in extreme poor condition. These two breaches prevent irrigation of the recently upgraded area in the Commune of Taing Krasaing, known as the Section of CAVAC developed by AusAid.



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

40. The system can be divided into 5 distinct sections (see Map):

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		

41. 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. Section 4 is incomplete and Section 5 also, and will need to be attached (this is planned), as the main canal stops after some 400 m after it crosses the main National Highway No.6. The new irrigation service area this will be 9869 ha (of which 2664 ha with Private Firms).

42. 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.

43. 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.

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

45. Taing Krasaing (as linked to Stung Chinit) can be considered "water rich", meaning enough water for 2 crops per year in 4-out-ot-5 years during the key months of June through January. Trying to grow crops during February-May is not advisable and can be viewed as considerable risk. Taing Krasaing may need to be provided with water from the more water-endowed Stung Chinit reservoir a few times in 4-out-of 5 years for periods of 10-20 days as a supplementary source, at start of wets season, during dry spells, and at end of dry season crop (end-of-January to early February).

46. The complete rehabilitation works are based on topographical survey over main canal length, as well as geo-technical surveys of soils and stability factors at key locations. Modernizing and upgrading the system under the planned CAM-ADB Uplands Irrigation

planned loan foresees many new facilities required, both in irrigation and drainage, and in stabilizing the main canal at tail end. This includes lining over 2.5 km. New regulators and gates/off-takes are foreseen, and the canal will operate through the creation of 7 smaller basins (of different length), from which water can be drawn; these basis will keep the canal stable and in low flow condition, and will prevent main alteration of present canal width. 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 of the Commune of Kokoah is essential.

47. Details of the improvements foreseen for Taing Krasaing in order to make it climate-change resilient and efficient in water use include:

- 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 between RD 7+000 and 10+000.
- 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.
- 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).

48. 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

49. Other factors of importance in the full-scale upgrading include:

a) 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.
b) Strict Construction Quality Monitoring on Specifications is required.

c) 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.

d) Focus on combining Water and on Non-Water Agro-Inputs in crop production process. Use of Early maturing seed varieties (90-100 days) – to be made available and to be used.

e) 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.

f) Agreement with Private Firms on water delivery and ISF/Water Charge is essential

g) 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.

h) 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.

i) 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. Some 1000 ha may require this.

50. Please refer to Appendix 7 for the full feasibility study report.

IV. SUMMARY ECONOMIC AND FINANCIAL ANALYSIS

51. Economic analyses of the subproject investments were undertaken in accordance with the principles and procedures set out in ADB guidelines. All benefits and costs were examined in order to assess the viability of the subprojects as well as to identify their expected impacts on various sectors of the local society, including the poor.

52. The following economic benefits were considered: (i) Economic value of incremental increase in crop production which was determined based on the increased crop production from "without project" to "with project" situations. As the main economic incremental benefit is the producer surplus, 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. (ii) Avoided flood crop damages based on the reports by the farmers that severe flood occurrences happen in the area at least once in five years and result to crop damages.

53. Other benefits 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.

54. Subproject costs include civil works costing $16.0 million for Prek Chik and $25.5 million for Taing Krasaing. Total costs include project management, construction supervision

and design, on-farm preparation and physical contingency. In economic prices the total costs are $23.3 million and $31.7 million for Prek Chik and Taing Krasaing, respectively. Based on the technical study, annual operation and maintenance expenditures for the rehabilitated system are 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 costs. Both 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. The net rice production per hectare in the "without project" situation was used as parameter to compute for the economic costs of land.

55. The Prey 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%. The Taing Krasaing subproject is likewise expected to be economically viable with EIRR of 22.7% and ENPV of $12.7 million.

56. For both subprojects, sensitivity tests for EIRR suggested that the economic analyses are overall highly robust, i.e., all EIRRs 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. Two extreme cases were 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 tests 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.

57. The subprojects will directly affect 91% of the population in Prek Chik and 83% in Taing Krasaing that derive their main income from rice and vegetable crops. The subprojects will help decrease poverty rates in communes covered within the project areas which range from 23.5% to 34.5%. Computed poverty impact ratios (PIRs) for the subprojects are 30.8% for Prek chik and 30.0% for Taing Krasaing.

58. Please refer to Appendix 8 for the full Economic and Financial Analysis, Appendix 9 for the Detailed Economic and Financial Analysis and Appendix 10 for the Financial Management Assessment.

V. 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.

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.

59. The Summary Poverty Reduction and Social Strategy is attached to the report as Appendix 11, the Gender Assessment as Appendix 12 and Gender Action Plan as Appendix 14.

ANNEX 1 DESIGN AND MONITORING FRAMEWORK

Impact the Project is Aligned with: Inclusive economic growth through agriculture and irrigation (Rectangular Strategy on Growth, Employment, Equity and Efficiency, Phase III, *2014 to 2018*)			
Project Results Chain	**Performance Indicators with Targets and Baselines**	**Data Sources or Reporting Mechanisms**	**Risks**
Outcome Water and agriculture productivity enhanced in the project area	Average annual crop production increased to 4.25 ton per ha by September 2021 (baseline 2015: 1.65 ton per ha)	PPMS Project completion report	Adverse effects of climate change
Outputs 1. Enhanced efficiency and climate resilience of irrigation systems in the project area	1a. Irrigation infrastructure improved/modernized and climate proofed for increasing dry and wet season cultivated area to 29,500 ha by March 2021 (baseline 2015: 13,500 ha) 1b. Irrigation efficiency of three irrigation systems increased by 100% by March 2021 (baseline 2015: 20%) 1c. Drainage facilities rehabilitated for 1,800 ha (baseline 2015, 0 ha) 1d. 2,000 ha land leveled by laser leveling by March 2021 (baseline 2015: 0 ha) 1e. 30% unskilled labor in civil works is women	1a.QPRs of the executing agency, PPMS, LRM reports 1b. PPMS 1c. PPMS 1d-e. QPRs, PPMS	Inadequate planning and funding of O&M
2. Improved water resource management	2a. Three FWUCs formed and trained by September 2020 (baseline 2015: 0) 2b. 50% of FWUC members are women (baseline 2015, 0) 2c. 30% of FWUC management committee members are women (baseline 2015: 0) 2d. Annual O&M plan prepared at design of each irrigation system	2a-d.QPRs, LRM reports	Weak coordination between MOWRAM, PDWRAM and FWUCs
	2e. O&M funds allocated by the government for main canals and reservoirs by September 2020	2e. MEF budget documents, QPRs, LRM reports	

Project Results Chain	Performance Indicators with Targets and Baselines	Data Sources or Reporting Mechanisms	Risks
	2f. Eight hydro-meteorological stations installed in the watersheds by September 2020 (baseline 2015: 0)	2f. QPRs, LRM reports, PPMS	

Key Activities with Milestones

1. Enhanced efficiency and climate resilience of irrigation systems in the project area

1.1 Contract for Taing Krasaing main canal awarded by 30 June 2016 and works completed by 31 December 2017.

1.2 Detailed design, cost estimates and bidding documents of all subprojects completed by September 2018.

1.3 All works contracts awarded by 31 March 2019 and works completed by 30 September 2020; defect liability period ends by 31 March 2021.

2. Improved water resource management

2.1 FWUCs formed by 30June 2017.

2.2 FWUCs trainings completed by 31 December 2017.

2.3 Meteorological stations and river flow gauging stations installed by 31 December 2018.

2.4 Joint reservoir operation of Stung Chinit and Taing Krasaing reservoirs designed by 30 June 2018; and MOWRAM, PDWRAMS, FWUCS and provincial authorities adopt it by June 2019 through a formal agreement.

Project Management Activities

Project management and implementation consultants mobilized by 30 June 2016.
Goods procured by 30 June 2016.
PPMS established by September 2016.

Inputs

ADB: $60,000,000
Government:$6,120,000

Assumptions for Partner Financing

Not Applicable

ADB = Asian Development Bank; FWUC = farmers water user communes; LRM = loan review mission; MAFF = Ministry of Agriculture, Forest and Fisheries; MEF = Ministry of Economy and Finance; MOWRAM = Ministry of Water Resources and Meteorology; O&M = operation and maintenance; PCR = project completion report; PMU = project management unit; PPMS = project performance monitoring system; QPR = quarterly progress report.
Source: Asian Development Bank.

ANNEX 2 LIST OF APPENDICES

1. Sector Assessment (Summary): Agriculture and Natural Resources
2. Contribution to the ADB Results Framework
3. Country Economic Indicators
4. Development Coordination
5. CAM- Uplands Irrigation and WRM Project: Project Administration Manual
6. Feasibility Study of Prek Chik Irrigation System
7. Feasibility Study of Taing Krasaing Irrigation System
8. Economic and Financial Analysis
9. Detailed Economic and Financial Analysis
10. Financial Management Assessment
11. Summary Poverty Reduction and Social Strategy
12. Poverty and Socio Economic Condition
13. Gender Assessment
14. Gender Action Plan
15. Risk Assessment and Risk Management Plan

Appendix 1:
SECTOR ASSESSMENT (SUMMARY): AGRICULTURE, NATURAL RESOURCES AND RURAL DEVELOPMENT[1]

Sector Road Map

1. Sector Performance, Problems, and Opportunities

1. **Key sector achievements**. Agriculture remains the dominant sector in the Cambodian economy. Agriculture has, on average, grown at the rate of 4.5% per annum in 2008–2013 and contributed about 29% to the national GDP during the same period. According to the National Institute of Statistics (NIS), in 2012 the sector employed around 72.3% of Cambodia's workforce or an estimate of 5 million people, mainly organized in small farms while over 80% of the population depends on the sector for their livelihoods. Within agriculture, rice accounts for over 90% of the cropped area, the production from which is mostly consumed domestically. The rice subsector accounts for about 50% of the agriculture sector output. With government support to increase areas, aggregate national rice production rose from around 1 million tons in the mid-1990s to 8.8 million tons in 2013 (wet and dry season crops combined). As of December 2013, Cambodia has been able to export 0.6 million tons of milled rice.

2. Non-rice crops have been growing in their importance. Fruits and vegetables cultivation is increasingly widespread in an effort to meet domestic demand due to better communications and localized road improvements especially near urban and tourist areas. Other non-rice developments in recent years include the growth of maize and cassava in upland areas.

3. **Key sector problems**. Despite impressive growth, the sector development has been narrowly based and volatile. The rural population (of 10.8 million people as of December 2012) is estimated to increase by 0.34% annually. Naturally people approaching the labor age for the first time will join the agricultural sector to secure livelihoods. However, most employment is informal and remains unskilled, and as the sector is narrowly based, it is hard to increase rural income further while absorbing more rural labor into agriculture.

4. The sector currently operates with a traditional supply chain "system", whereby (i) production is chiefly producer-pushed; (ii) productivity enhancement is not a high priority and crop yield/productivity remains limited; and (iii) little diversification is observed since the sector is dominated with fragmented production units and products are yet differentiated. There is no intra and inter-sectoral linkages – neither horizontal nor vertical; and the market infrastructure development and logistics are limited. The current system focuses on distributive functions, has minimal product grading, minimal value addition, and predominates with wholesalers rather than retailers. *By nature, the current sector operation is producer-pushed, and lacks commercial orientation, diversification and connectivity in both physical and market information terms*.

5. Cambodia's agriculture is at risk since its underlying natural resource base is observed to be under serious pressure, exacerbated by climate change. Land management faces a number of problems including: (i) consequences of unregulated use of agriculture input; (ii) the alienation of large areas of state lands for economic land concessions and associated logging and land clearing; and (iii) generally unclear definition and demarcation of different types of land. Forests are under pressure from both illegal logging and also large-scale agriculture/tree

[1] This summary is based on the full version of Agriculture, Natural Resources, and Rural Development Sector Assessment, Strategy and Road Map 2014–2018 (available on request).

mono-crop concessions. About 55% of all Cambodia's forests (and 45% of its protected forests) have been degraded. Cambodia's MDG indicators for forest cover are currently below targets and will not be met by 2015, despite reclassification of 'forest' land to include plantations and abandoned areas, and thus does not reflect biodiversity level. Real deforestation is continuing at 1%–2% per year and the loss of inundated forests is particularly dramatic. It is estimated that actual harvesting rates are five times the sustainable levels. Fisheries resources: (i) are threatened by water pollution and hydropower development; (ii) evidence exists on declining average catch sizes and a fishing down the food web; and (iii) are increasingly competed for by commercial and community interests. Water resources: (i) are increasingly subject to waste discharges, agriculture inputs and other chemicals' pollution and (ii) major watershed deterioration. Coastal zone natural resources are threatened by population growth, illegal extraction of sand, and unregulated fishing. Climate change has started adding to existing pressures on these resources.

6. **Opportunities and the "desired" shift**. Cambodia's agriculture has a good chance to be transformed and create a broader base contribution to the national economic development and poverty reduction. A practical solution is to create more non-farming jobs that are closely tied into the agricultural value chains. Cambodia can achieve this if it starts putting in place an enabling environment for agro-enterprises to develop, since it is this "missing" middle that will help Cambodia to embark on the transformation from the current sector status quo of being production-pushed to a commercially-oriented, diversified, integrated, and consumer-pulled system. This shift will need to incorporate the following characteristics: being consumer oriented, addressing yield/productivity enhancement, conservation of underlying agro-ecosystems along the product value chains, focusing on processes, grading and labeling, having an integrated structure of physical, information, and control, product differentiation, predominance of retailers, global outsourcing, value creation, using logistics as a backbone, and ICT as an enabler. Such sector operation modality will help stimulate the growth of competitive farms and rural enterprises in general, promote effective rural-urban linkages, and improve food security and climate resilience in agricultural production. In effect, this development orientation will help broaden the base of the sector contribution to the national economy and trickle down more benefits to more smallholder farmers and ensure poverty reduction.

2. Government's Sector Strategy

7. The Rectangular Strategy for Growth, Employment, Equity, and Efficiency (RS) is the government's overarching development policy statement. Having been implemented since 2004, the RS has now been in its third phase and built on a diagnosis of the causes of poverty and places governance at the heart of attempts to bring about economic development. Based on platforms of good governance, peace, political stability, social order, macroeconomic stability, environmental sustainability, partnership and economic integration, the RS continues to focus on critical development issues in four priority areas. These include (i) enhancement of the agricultural sector (diversification, value-added, productivity), (ii) development of physical infrastructure, (iii) private sector development and employment generation, and (iv) capacity development and human resource development.

8. With regard to agriculture sector development, the RS emphasizes that Cambodia's agriculture sector shall continue to play an important role in supporting economic growth, ensuring equity, securing food security, and promoting development of the rural economy. The Government's vision is to modernize Cambodia's agriculture, based on a new approach and with changed scope and pace, to transform the sector from extensive stage of development i.e. primarily depending on expanded use of available resources (such as land and other natural

resources) and traditional agricultural inputs, into an intensive stage of development that primarily depends on the application of techniques, new technologies, research and development, mechanization and increased capacity of irrigation to improve productivity, and diversify into high value crops and other agricultural products including livestock farming and aquaculture while taking into account the need to ensure efficient management of land and sustainability of environment and natural resources. Moreover, further promotion of commercialization and agro-industry development will increase added-value of agricultural products and income of people.

3. ADB Sector Experience and Assistance Program

9. ADB support to agriculture has been both multi-layered and multi-faceted. ADB has engaged with policy and institutional reform processes, as well as with individual investment projects on the ground (many focused on the Tonle Sap basin provinces). It has worked on various rural livelihood dimensions (including rural infrastructure provision) and through several ministries within individual projects in often innovative (if sometimes complex) structures. The major lessons learned include: (i) regulatory and policy reforms in the sector have been significant and sustained, (ii) institutional issues have affected both the adoption of new sector practices (e.g., O&M on irrigation schemes) and projects' implementation (i.e., through procurement, consultant recruitment, covenant compliance delays, etc.), (iii) pursuit of basin-wide objectives for resource management has been compromised by institutional performance; and (iv) sector policy and management reform has been a necessary but (so far) insufficient step to promote growth and diversification, and (v) further substantial downstream activities are necessary to provide technical training for farmers and government staff, to build social capital, and to promote value chain formation.

10. **ADB's Future Strategy and Assistance Program.** ADB's sector strategy supports productivity enhancement, diversification, commercialization and connectivity, and sustainable natural resources management, without compromising the natural resource base upon which long-term sustainability depends. ADB's strategy is therefore deliberately selective in pursuit of these ends. ADB's proposed support will be in four key areas: (i) enhancing agriculture productivity, (ii) promoting diversification, (iii) supporting commercialization and connectivity (value chains and linkages), and (iv) supporting sustainable natural resources management.

11. **Enhancing Agriculture Productivity**. Enhancing agriculture sector productivity in the first instance involves measures to make on-farm practices more efficient, based on improved use of natural resources (i.e., soils and water) and non-exploitation of ecologically sensitive areas. Given that the government regards rice development as a flagship priority, ADB's approach will be to replicate some of the productivity-oriented components of the Tonle Sap Poverty Reduction and Smallholder Development Project (e.g., improved access to good quality seeds, access to agriculture market and agriculture extension through innovative rural ICT, etc.) and the Climate Resilient Rice Commercialization Sector Development Program (e.g., land use zoning and planning, ecosystem mapping and soil classification, improved land management, seeds production and distribution, technical extension materials production) activities, and also to extend geographical coverage into other provinces around the Tonle Sap basin. This theme will include some irrigation systems' enhancement, mainly to improve the efficiency of water management through land leveling (and to accommodate increasing peak flows) and to maintain operational sustainability (e.g., through farmer water user committees). This theme will also include basic research and extension capacity development within MAFF.

12. **Promoting Diversification**. Ensuring there is scope for future productivity growth in the agriculture sector requires a greater orientation towards potentially much higher-value outputs (including and especially non-commodity outputs capable of value added transformation). Promoting diversification involves better rationalization of the production resource base to allow more specialization within rice cultivation. This includes higher value and internationally competitive rice varieties, and higher-value non-rice crops. Higher-value rice includes glutinous rice, aromatics (many of which have historically been quite area-specific in their cultivation), and organic production systems. Non-rice crops are typically fruits and vegetables in lowland and irrigated areas, but can also include flowers, bamboo etc., and pulses, maize, cassava and tree crops in upland areas, as well as livestock (in the east) and aquaculture (almost anywhere). Although many crops and primary outputs with such value adding potential are already known in Cambodia, areas are small, cultivation and management history is short, and agronomic and economic data is largely absent. Accordingly, ADB will support research and development of some rice varieties having market potential and also the non-rice crops. This will specifically include the development of input regimes and management practices designed to be environmentally friendly (e.g., by better managing inputs applications) rather than potentially damaging to soils, water and wider ecosystems – including system of rice intensification, 'drought escape', precision/drip irrigation, small-scale intercropping, zero/minimum tillage, bare and degraded lands planting, etc.

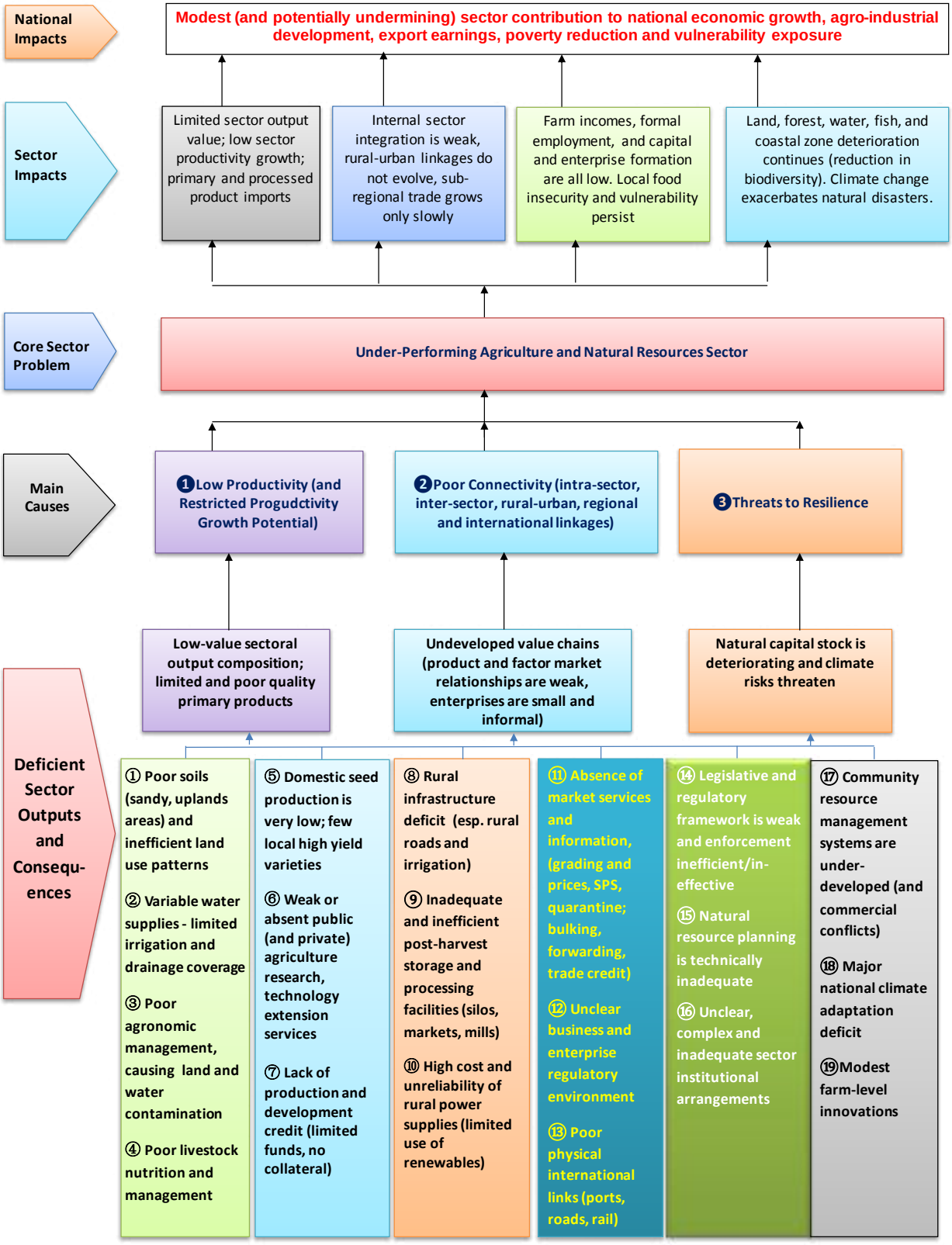
13. **Supporting Commercialization and Connectivity (value chains and linkages)**. Supporting commercialization includes a range of national and regional measures which make agriculture more market-oriented and which better link primary producers to product markets, to Cambodia's urban areas, and to regional demand. This theme will incorporate support for the filling critical parts of the country's rural infrastructure deficit through the physical expansion of post-harvest facilities (i.e., for transport, cleaning, drying, grading and storage), for rice milling efficiency improvement (i.e., for credit access and technical capacity building to reduce Cambodia's current relatively high milling costs), for access to farm development credit, market information, technology transfer, and other farm business services (including weather-related crop insurance, soils testing, equipment provision and servicing). Improvements in rice marketing, support will also be selectively focused on those non-rice crops that realistically have market potential and investment designs will particularly explore innovative ways of working in partnership with the private sector (based on experiences gained in Cambodia and elsewhere.) Options for private sector to supply/manage services on behalf of government will be explored.

14. **Supporting Sustainable Natural Resources Management**. Supporting sustainable natural resources management includes; (i) mapping of ecosystem functions and assessment of ecosystem services as input into land-use planning processes; (ii) strengthening of and support for natural resource institutions/processes; (iii) improvement of biodiversity monitoring system to maintain ecosystem integrity; (iv) strengthening of community organizations in forestry and fisheries' protected areas to manage common property resources; (v) support to innovations in developing communities' livelihoods based on conservation; and (vi) support for forest and fisheries' resources policing (i.e., training and increasing numbers of rangers, forest patrollers).

15. **Gender Development.** A large number of women are active in the sector but presently under-remunerated for their efforts being mainly engaged in subsistence production. In the proposed pipeline, gender mainstreaming shall continue to be emphasized to help the Government achieve gender targets stated in the NSDP. Specifically, ADB projects/programs will (i) support women's participation in local planning and decision making forums related to irrigation infrastructure investments, water user groups, etc.; (ii) improve women's access to training and new technologies to increase productivity and support women to shift to higher

value and market oriented production; and (iii) increase women's access to markets and financial services.

Problem Tree for Agriculture, Natural Resources and Rural Development Sector



Sector Results Framework (Agriculture, Natural Resources and Rural Development, 2014-2018)

Country Sector Outcomes		Country Sector Outputs		ADB Sector Operations	
Sector Outcomes with ADB Contribution	**Indicators with Targets & Baselines**	**Sector Outputs with ADB contribution**	**Indicators with Incremental Targets**	**Planned and Ongoing ADB Interventions**	**Main Outputs Expected from ADB Interventions**
Enhanced agriculture productivity **Diversification promoted** **Commercialization (value chains and linkages) supported**	Paddy production increases to 9.5 million tons by 2018 (2013 baseline: 8.2 million tons) Milled rice exports rise to 1.5 million tons by 2018 (2013 baseline: 600,000 tons) Domestic fruits and vegetables production accounts for 50% of Cambodia's consumption by 2018 (2013 baseline: 30%) Increased formal employment in ANR to 15% by 2018 (2013 baseline: 9.5%), of which 30% of new formal jobs annually created by 2018 are for women (2013 baseline: 20%)	Agricultural infrastructure and system expanded, improved, and well managed	Robust frameworks governing seeds, land-use planning, farmer organizations, rice standards and trade facilitation in place by 2018 Information/ICT and other extension services reach 20% of farming population by 2018 (2012 baseline: 10%) 70,000 ha of diversified rice and non-rice cropping based on planned land use and zoning practices, improved seeds by 2018 (2012 baseline: 10,000 ha) 30,000 tons of storage and drying facilities in 8 provinces installed by 2018 (2012 base line: 5,000 tons) Proportion of farming households selling commercially rises to 25% by 2018 (2012 baseline: 5%) Numbers of agribusiness service providers increases 20% by 2018 (2012 baseline: 10%) 200,000 smallholders access to improved seed varieties and new technologies (40% females) by 2018 (2012 baseline: 10,000)	**Key Support Areas** Enhancing agriculture productivity, promoting diversification, supporting commercialization and connectivity, and supporting sustainable natural resources management **Pipeline Projects:** Uplands Irrigation and Water Resources Management Sector Project Climate Resilient Rice Commercialization Project (additional financing) Quality and Safety Enhancement Project for Cambodian High Value Crops GMS Biodiversity Conservation Corridors Project (additional financing) Climate-Friendly Agribusiness Value Chain Sector Project **On-going Operations:** WRMSDP, Rice-SDP, TSHP, GMS Flood and Drought, Tonle Sap Lowlands, EFAP, GMS BCC	Legal and regulatory framework for rice and non-rice cropping improved Improved research and development capacity on rice and non-rice cropping 50,000 ha of climate resilient irrigation infrastructure rehabilitated 15,000 ha of new non-rice crops; 5,000 ha of new rice varieties 10 seed and storage facilities constructed 50 rice mills efficiency improved Coordination of water resources (IWRM) Increased formal employment in ANR rises by 15% by 2018 (sex-segregated data) Increased participation of women in irrigation management and water user associations

ANR = agriculture, natural resources and rural development, GMS BCC = Greater Mekong Subregion, ha = hectares, TSHP = Tonle Sap Poverty Reduction and Smallholder Development Project

Source: Asian Development Bank.

Appendix 2:
CONTRIBUTION TO THE ADB RESULTS FRAMEWORK

No.	Level 2 Results Framework Indicators (Outputs and Outcomes)	Targets	Methods / Comments
1	Land improved through irrigation, drainage and/or flood protections	21,000 ha	Estimated for the subprojects selected during preparation

ha = hectares.
Source: ADB estimates.

Appendix 3:
COUNTRY ECONOMIC INDICATORS

Item	Fiscal Year 2011	2012	2013	2014	2015
A. Income and Growth					
1. GDP per capita ($, current prices)	902	969	1,043	1,110	1,186
2. GDP growth (%, constant prices)	7.1	7.3	7.4	7.0	7.3
a. Agriculture	3.1	4.3	4.0	4.0	2.5
b. Industry	14.5	9.3	10.5	12.9	9.7
c. Services	5.0	8.1	7.0	6.3	8.1
B. Saving and Investment (% of GDP, current prices)[1]					
1. Gross fixed investment	22.0	23.5	23.5	21.5	…
2. Gross national saving	13.9	14.8	14.9	13.1	…
C. Money and Inflation (annual % change)					
1. Consumer price index (average)	5.5	2.9	2.9	3.9	1.6
2. Liquidity (M2)	21.4	20.9	14.6	29.9	…
D. Government Finance (% of GDP)					
1. Revenue and grants	13.2	15.2	15.0	16.0	16.7
2. Expenditure and onlending	20.7	21.6	20.8	20.2	21.3
3. Overall fiscal surplus (deficit)	(7.5)	(6.3)	(5.8)	(4.2)	(4.6)
E. Balance of Payments					
1. Merchandise trade balance (% of GDP)	(16.7)	(17.8)	(21.1)	(20.2)	(19.8)
2. Current account balance[2] (% of GDP)	(8.9)	(9.6)	(14.2)	(12.5)	(12.2)
3. Merchandise export ($) growth (annual % change)	29.0	11.8	16.0	13.4	16.0
4. Merchandise import ($) growth (annual % change)	24.7	13.4	19.7	10.1	13.0
F. External Payments Indicators					
1. Total public external debt ($, million)	3,645	4,274	4,828	5,264	…
2. External Debt Service (% of exports of goods and services)	1.0	1.0	1.1	1.2	…
3. Total External debt (% of GDP)	28.5	30.4	31.7	32.0	…
4. Gross International Reserves ($, million)	3,032	3,463	3,643	4,391	4,820
5. Import covers (months)	4.4	4.4	3.9	4.2	4.8
G. Memorandum Items					
1. GDP (current prices, KR billion)	52,069	56,682	61,390	66,363	72,036
2. Exchange rate (KR/$, average)	4,066	4,033	4,027	4,038	4,050
3. Population (million)	12.8	14.1	15.2	16.4	17.8

GDP = gross domestic product, KR = Khmer riel.
[1] = based on International Monetary Fund (IMF) Article IV, February 2014
[2] = excluding official transfers
Sources: Cambodian authorities; IMF; Asian Development Outlook database; and Asian Development Bank staff estimates.

Appendix 4:
DEVELOPMENT COORDINATION

1. The project will support the Kingdom of Cambodia to increase agricultural production by modernization and climate proofing of selected irrigation systems in Kampong Thom and Battambang provinces. The project will finance subprojects in these provinces to (i) enhance efficiency and climate resilience of irrigation systems, (ii) improve water resource management at the community level, (iii) increase farm incomes, and (iv) improve the capacity of the farmer water user communes and implementing agencies to better manage irrigation systems. The project will contribute to achieving targets of the Government's Rectangular Strategy on Growth, Employment, Equity and Efficiency 2014–2018, that among other reforms, focuses on development and expansion of irrigated lands and effective water resources management.

A. Major Development Partners: Strategic Foci and Key Activities

2. ADB has provided extensive support for irrigation rehabilitation through individual and sector projects, some incorporating policy development. ADB has also invested in the rural road network to improve connectivity to markets and provide access to public services such as education and health care through both dedicated rural road projects and rural development projects in which roads formed a significant part of the investment. Similarly, greater emphasis has been placed on flood and drought management and mitigation in recognition of the potential threat from climate change. ADB has provided a number of emergency loans to rehabilitate rural infrastructure damaged by extreme flooding in 2000, 2001, 2010, and 2011. ADB's priority sectors for support include (i) transport (provincial and rural roads); (ii) water supply, sanitation, and urban development; (iii) agriculture and natural resources (agriculture commercialization and irrigation support); (iv) education and training; and (v) finance (banking regulation, small and medium-sized enterprise finance, insurance, and microfinance).

3. The World Bank's involvement in agriculture and rural development has been closely linked to building the capacity of the Ministry of Agriculture, Forestry, and Fisheries (MAFF) through its Agricultural Productivity Improvement Project cofinanced by the International Fund for Agricultural Development. It has also been involved in land administration during the early development of the Land Act, 2002. Many investment projects financed by the World Bank have targeted governance issues and public sector financing. Its most recent initiative, through the International Finance Corporation, focused on the milling subsector and was implemented by a local nongovernment organization that develops the business management skills of selected millers in various areas of the country. Further investments are under consideration in this area.

4. The European Union has facilitated rural development through its Economic and Social Re-launch in the Northwest, a poverty-reduction initiative that focused at the grassroots to help local communities escape poverty. Many of the locally identified initiatives included the development of small infrastructure, in particular roads and irrigation facilities. More recently, it has supported the rice sector by cofinancing the Cambodia Rice Sector Support Program.

5. The Australian Agency for International Development has strengthened capacity in MAFF's Department of Agricultural Extension and in the Cambodia Agricultural Research and Development Institute. More recently it has been active in rice value chain initiatives to improve rice seed quality and post-harvest handling through its Agricultural Quality Improvement Project and the Cambodia Australia Value Chain Project.

6. Agence Francaise de Developpement (AFD) has committed significant resources to support the water sector as an individual development partner and under cofinancing arrangements, particularly with ADB. More recently AFD's focus has broadened to incorporate rice expansion through support for value chain interventions and the Rural Development Bank. AFD's most relevant intervention is through a €3.5 million grant to implement the Support to the Commercialization of Cambodian Rice Project, which is being implemented from 2012 to 2014. Its main components include: (i) organize the rice sector and build the capacity of all stakeholders; (ii) improve, standardize, and certify the quality of Cambodian rice; (iii) promote contract farming and enhance the involvement of farmer organizations in paddy rice collecting and processing, (iv) support the Rural Development Bank, and (v) provide institutional support.

Major Development Partner Financed Projects

Development Partner	Project Name	Duration	Amount (in millions)
Rural Infrastructure: Rural Roads, Irrigation, and Water Resources			
ADB	Emergency Flood Rehabilitation Project	2001–2003	$10.80 (irrigation and flood) $6.40
ADB/AFD	Stung Chinit Irrigation and Rural Infrastructure	2001–2006	$23.80
AFD	Rehabilitation of Prey Nup Polders	2002–2008	€3.80
ADB/AFD	Northwest Irrigation Sector Project	2004–2010	$22.60 €4.00
Japan	Project for the Rehabilitation of the Kandal Stung Irrigation System	2005–2008	¥1,740.00 grant
Republic of Korea	Krang Ponley Water Resources Development Project	2006–2010	$27.00
ADB	Cambodia Flooding 2011: Humanitarian Assistance Project	2012	$3.00
ADB	Flood Damage Emergency Reconstruction Project	2012–2014	$55.00
ADB	GMS Flood and Drought Mitigation and Management Sector Project	2012–2017	$45.00
Integrated Rural Development and Environment Projects			
ADB	Agriculture Sector Development Program	1996–2000	$30.00
ADB	Tonle Sap Environmental Management Project	2003–2008	$19.30
ADB	Northwest Rural Development Project	2003–2008	$27.20
UK (DFID)	Natural Resource Management and Livelihoods Program	2006–2010	£13.60
World Bank	Road Asset Management Project	2008–2012	$30.00
ADB	Emergency Food Assistance Project (in partnership with WFP in cash/food for work initiatives)	2008–2014	$35.00
ADB/IFAD/ Finland	Tonle Sap Poverty Reduction and Smallholder Development Project	2010–2016	$33.00
UNDP/GEF, Netherlands	Mekong River Basin Wetland Conservation and Sustainable Use Program	Ongoing	$31.50
Agricultural Development and Commercialization Project			
JICA/APS/WFP	Kamping Puoy Irrigation Rehabilitation and Rural Development	1998–2006	$5.60
AusAID	Agricultural Quality Improvement Project	2000–2006	A$19.50
ADB	Smallholder Agriculture and Social Protection Support Operation	2009–2014	$5.00
IFAD/AusAID GIZ/WFP	Community Based Rural Development Project	2001–2008	$19.80

Development Partner	Project Name	Duration	Amount (in millions)
ADB	Small and Medium-sized Enterprise Development Program	2006–2008	$20.00
ADB	Tonle Sap Lowland Stabilization Rural Development Project	2008–2013	$10.00
ADB	Climate-Resilient Rice Commercialization Sector Development Project (CAM 44321	2014–2019	$79.10
World Bank	Cambodia Agribusiness Access to Finance Project	2010–2013	$5.00
Australia	Cambodia Agriculture Value Chain Program	2010–2014	A$45.00
Policy Development Initiatives			
JICA	Technical Services Centre for Irrigation Systems, Phases I and II	2001–2005 2006–2009	$5.00
AFD	Support for the Development of Agriculture and Water Sector Policies	2006–2009	$1.50 grant
Australia	Water Resource Management Research Capacity Development Program	2006–2011	A$3.00
UNDP	Promoting Climate–Resilient Water Management and Agriculture in Rural Cambodia	2009–2013	$4.10
ADB	Water Resources Management Sector Development Program	2010–2015	$20.0

ADB = Asian Development Bank, AFD = Agence Française de Développement, APS = Associazione per la Partecipazione allo Sviluppo (Italian nongovernment organization), AusAID = Australian Agency for International Development, DFID = Department for International Development, EU = European Union, FAO = Food and Agriculture Organization of the United Nations, GEF = Global Environment Facility, IDA = International Development Association, IFAD = International Fund for Agricultural Development, IFC = International Finance Corporation, JICA = Japanese International Cooperation Agency, MOWRAM = Ministry of Water Resources and Meteorology, n.a. = not available, UNDP = United Nations Development Program, WFP = World Food Program.
Source: ADB estimates.

B. Institutional Arrangements and Processes for Development Coordination

7. The Government Donor Coordination Committee has met quarterly since December 2004. This committee comprises senior government officials representing all ministries and members of the development community. It has 19 technical working groups established under its umbrella, including the technical working group on agriculture and water (TWGAW), of which the ADB Cambodia Resident Mission is a member of. Minutes of quarterly meetings and joint monitoring reports of each technical working group are available on a website.

C. Achievements and Issues

8. The project design was discussed during preparation with the TWGAW to ensure consistency with the priorities developed in the government's strategy for agriculture and water, a key output of the TWGAW, and with programs of other development partners. The program management unit will coordinate with develop partners to avoid overlap.

D. Summary and Recommendations

9. The TWGAW supported the project concept and welcomed alignment with the government's Strategy for Agriculture and Water. It highlighted the need for all development partners to align their sector development programs with the government's ongoing programs of decentralization, de-concentration and public financial management initiatives to ensure strong

links between agriculture and water and to support strengthened linkages between producers along the value chain. These issues have been highlighted in the design of the project.

Appendix 5:

Project Administration Manual

Project Number: 44328-013
Loan Number: XXXX
July 2015 Draft

Proposed Loan
Kingdom of Cambodia: Uplands Irrigation and Water Resources Management Sector Project

Contents

Project Administration Manual Purpose and Process

The project administration manual (PAM) describes the essential administrative and management requirements to implement the project on time, within budget, and in accordance with Government and Asian Development Bank (ADB) policies and procedures. The PAM should include references to all available templates and instructions either through linkages to relevant URLs or directly incorporated in the PAM.

The Ministry of Water Resources and Meteorology, which is both the executing and implementing agencies are wholly responsible for the implementation of ADB financed projects, as agreed jointly between the borrower and ADB, and in accordance with Government and ADB's policies and procedures. ADB staff is responsible to support implementation including compliance by the MOWRAM of their obligations and responsibilities for project implementation in accordance with ADB's policies and procedures.

At loan negotiations the borrower and ADB shall agree to the PAM and ensure consistency with the Loan agreement. Such agreement shall be reflected in the minutes of the Loan Negotiations. In the event of any discrepancy or contradiction between the PAM and the Loan Agreement, the provisions of the Loan Agreement shall prevail.

After ADB Board approval of the project's report and recommendations of the President (RRP) changes in implementation arrangements are subject to agreement and approval pursuant to relevant Government and ADB administrative procedures (including the Project Administration Instructions) and upon such approval they will be subsequently incorporated in the PAM.

Abbreviations

ADB	=	Asian Development Bank
AFS	=	audited financial statements
DMF	=	design and monitoring framework
EARF	=	environmental assessment and review framework
EIA	=	environmental impact assessment
EMP	=	environmental management plan
ESMS	=	environmental and social management system
GACAP	=	governance and anticorruption action plan
GDP	=	gross domestic product
ICB	=	international competitive bidding
IEE	=	initial environmental examination
LAR	=	land acquisition and resettlement
LIBOR	=	London interbank offered rate
NCB	=	national competitive bidding
NGOs	=	nongovernment organizations
PAI	=	project administration instructions
PAM	=	project administration manual
PIU	=	project implementation unit
PMU	=	project management unit
QBS	=	quality based selection
QCBS	=	quality- and cost based selection
RRP	=	report and recommendation of the President to the Board
SBD	=	standard bidding documents
SOE	=	statement of expenditure
SPS	=	Safeguard Policy Statement
SPRSS	=	summary poverty reduction and social strategy
TOR	=	terms of reference

I. PROJECT DESCRIPTION

A. Rationale

1. The Project will support the Kingdom of Cambodia to increase agricultural production by rehabilitation, modernization and climate proofing of selected irrigation systems in Kampong Thom and Battambang provinces. The Project will finance subprojects to: (i) enhance efficiency and climate resilience of irrigation systems, (ii) improve water resource management, (iii) increase farm incomes, and (iv) improve the capacity of the farmer water user communes (FWUCs) and implementing agencies to better manage the irrigation systems. The Project will contribute to achieving targets of the Government's Rectangular Strategy on Growth, Employment, Equity and Efficiency 2014-2018, that among other reforms focuses on development and expansion of irrigated lands and effective water resources management by improving existing irrigation systems, further developing and enhancing the effectiveness of water communities and reducing the vulnerability of the population from natural disasters.

B. Impact and Outcome

2. The Project impact will be increased farm incomes. It is aligned with inclusive economic growth through agriculture and irrigation (Rectangular Strategy on Growth, Employment, Equity and Efficiency, Phase III, *2014 to 2018, RGC*). Outcome will be enhanced water and agricultural productivity.

C. Outputs

3. **Output 1: Enhanced efficiency and climate resilience of irrigation systems.** To achieve this output, the Project will support the rehabilitation and improvement of three existing irrigation systems:

- (i) **Taing Krasaing** in Kampong Thom Province
  - (a) Rehabilitation of undersluice and spillway of headworks.
  - (b) 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.
  - (c) Construction of 48 km secondary and tertiary canals.
  - (d) 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.
  - (e) Laser land levelling of 2000 ha land (from ADB financed Rice Commercialization Program).
- (ii) Prek Chik Irrigation System in Battambang Province
  - (a) Rehabilitation of headworks (including rising of spillway by 1.5 meters).
  - (b) Rehabilitation of 28 km Main Canal and installation of all structures for water control and distribution, and provision of all drainage works.
  - (c) Secondary and tertiary canals for a length of 70.2 km, to be able to cover 10,400 ha of net irrigated area.
- (iii) O Kra Nahk Irrigation System Irrigation System in Kampong Thom Province and other non-core subprojects
  - (a) Feasibility studies, scope of works and detailed design will be carried out during implementation of the Project

4. **Output 2: Improved water resource management.** To achieve this output, the Project will support the following:

- (i) Installation of Hydro-Met stations in the watersheds for water resources monitoring (with collaboration of ADB funded Flood and Drought Risk Management and Mitigation Project).

(ii) Modernize canal operations
(iii) Trainings to MOWRAM, PDWRAMs, and MAFF on modern canal operation techniques, irrigation scheduling, watershed management, and water management.
(iv) Organize FWUCs and provide gender inclusive trainings to members of the FWUCs in the O&M of canals, management of FWUCs, and water management.
(v) Involving FWUCs in the subprojects design and implementation, 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.
(vi) Design joint reservoir operations for Stung Chinit and Taing Krasaing reservoirs, and Bassac and Dauntri reservoirs.

II. IMPLEMENTATION PLANS

A. Project Readiness Activities

5. Project readiness activities and their expected completion dates are shown in Table 1.

Table 1: Project Readiness Activities

	2015							2016		
Indicative Activities	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Who isresponsible**
Fact finding mission	X									ADB/RGC
Advance contracting actions[a]			X	X	X	X	X			MOWRAM
Establish project implementation arrangements[b]	X									MOWRAM
ADB Board approval				X						ADB
Loan signing						X				ADB/RGC
Government legal opinion provided							X			MEF
Government budget inclusion								X		MEF
Loan effectiveness								X		MEF

ADB = Asian Development Bank; MEF = Ministry of Economy and Finance; MOWRAM = Ministry of Water Resources and Meteorology; RGC = Royal Government of Cambodia

[a] Bids for the core subproject have been invited and shall be evaluated before loan effectiveness. Shortlisting for project implementation and management consultants has been done and RFP issued. Proposals will be evaluated before the loan effectiveness.

[b] PMU was established before PPTA and PPMS has been developed.

B. Overall Project Implementation Plan

Activities	2016				2017				2018				2019				2020				2021			
	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. Recruitment of PMIC and procurement of office equipment and furniture																								
2. Award of Traing Krasaing Main Canal Contract																								
(iv) Construction of Traing Krasaing main canal																								
4. Detailed Engineering Design																								
5. Award of Contracts																								
6. Construction																								
7. Procurement and installation of hydro-meteorological equipment																								
8. Joint reservoir operations adopted																								
9. LARP activities																								
10. GAP Activities																								
11. Environmental Assessment and Management Activities																								
12. Formation of FWUCs																								
13. Training of FWUCs																								
14. PPMS					▼		▼		▼		▼		▼		▼		▼		▼		▼		▼	

Note: Construction works will complete on 30 September 2020, after 6 months defect liability period the physical completion of the project will be on 31 March 2021 and loan will close on 30 September 2021.

III. PROJECT MANAGEMENT ARRANGEMENTS

A. Project Implementation Organizations – Roles and Responsibilities

6. Ministry of Water Resources and Meteorology (MOWRAM) will be the executing agency (the EA) and its Department of Farmer Water User Communes (DFWUC) will be the implementing agency (the IA). A PMU has been established in DFWUC before commencement of the project preparatory technical assistance (PPTA). The PMU 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 DFWUC. The PMU was fully involved in the preparation of the Project. For implementation of the Project, the PMU will be composed of 24 designated personnel from MOWRAM, MAFF, DHRW, and PDWRAMs of Kampong Thom and Battambang provinces. MAFF staff will coordinate the land levelling and other supporting activities to be provided from Rice-SDP including access to quality seed and agriculture value chain facilities and services. PDWRAMs will be responsible for coordinating all field activities with FWUCs and DFWUC. DHRW will coordinate installation, operation, and data collection of hydro-meteorological stations. A steering committee, chaired by H.E. Minister MOWRAM and comprising senior officials from MOWRAM, MAFF, MEF and Provincial Governor's Office of Kampong Thom and Battambang, will oversee the Project implementation and management and provide policy guidance. Resettlement and land acquisition will be implemented by and under the management of the Inter-Ministerial Resettlement Committee (IRC) chaired by MEF with membership from the representatives of relevant line ministries in close cooperation with the Kampong Thom and Battambang Provincial Resettlement Sub-committees. The PMU will be responsible for implementation, planning, organization, monitoring and reporting of the Project. The PMU will be supported by the PMIC. The PMIC will comprise 64 person-months of international and 610 person-months of national experts to provide technical support to the PMU to efficiently manage and implement the Project. ADB's Guidelines on the Use of Consultants (2013, as amended from time to time) will be used for recruiting the consulting firms. The anticipated procurements include small and large works contracts, which will be procured by using ADB's national and international competitive bidding methods for ADB's financed subprojects. An imprest account will be maintained at the PMU level for ADB's loan funds.

Project Implementation Organizations	Management Roles and Responsibilities
Project Steering Committee	Oversee project and provide policy guidance. Chaired by H.E. Mr. Lim Kean Hor, Minister, MOWRAM, Secretary: H.E. Chann Sinath, Deputy Director General, DFWUC/Project Director Members: H.E. Vongsey Vissoth, Secretary of State, MEF H.E. Bun Hean, Secretary of State, MOWRAM H.E. Hem Vanndy, Under Secretary of State, MEF H.E. Kong Chan, Under Secretary State, MAFF H.E. Chan Sothy, Director General, MEF Mr. Chhoun Samrith, Director of Department of Cooperation and Debt Management, MEF Mr. Yi Sokthearith, Chief, Office of Multilateral Cooperation 1, MEF

Project Implementation Organizations	Management Roles and Responsibilities
	Mrs. Veng Youim, Deputy Chief, Office of Multilateral Cooperation 1, MEF
Ministry of Water Resources and Meteorology (MOWRAM)	**Executing Agency** Overall supervision and guidance on implementation of the project.
Department of FWUC in MOWRAM (PMU)	**Implementing Agency** • Procure civil works and goods • Supervise execution of works. • Payments to contractors. • Operate imprest account • Recruit and supervise PMIC • Maintain project accounts and accurate records of both financial and physical progress • Provide to ADB quarterly progress reports and six-monthly PPMS reports • Provide to ADB audited financial statements duly audited as per the loan agreement • Ensure compliance with social and environmental safeguards as per ADB's SPS 2009 • Implement gender action plan
Project Management and Implementation Consultants (PMIC)	• Assist PMU in preparing bid documents including design, review of design/specification • Assist PMU in contracts award/bids evaluation • Support preparation, implementation and monitoring of safeguards activities. • Support PMU in complying with LARF and EARF • Assist PMU in execution and supervision of works • Assist PDWRAM in mobilizing FWUCs • Provide trainings to FWUCs • Verify payments of works • Ensure quality of construction and adherence to design specification • Help PMU in maintaining project accounts • Prepare quarterly progress reports and PPMS • Carry out field surveys, engineering studies, detailed design, preparation of engineering drawings • Assist PMU in implementing GAP • Provide on-job capacity building to MOWRAM, PDWRAM and MAFF • Carry out hydrological studies and design joint reservoir operation of Stung Chinit and Taing Krasaing reservoirs

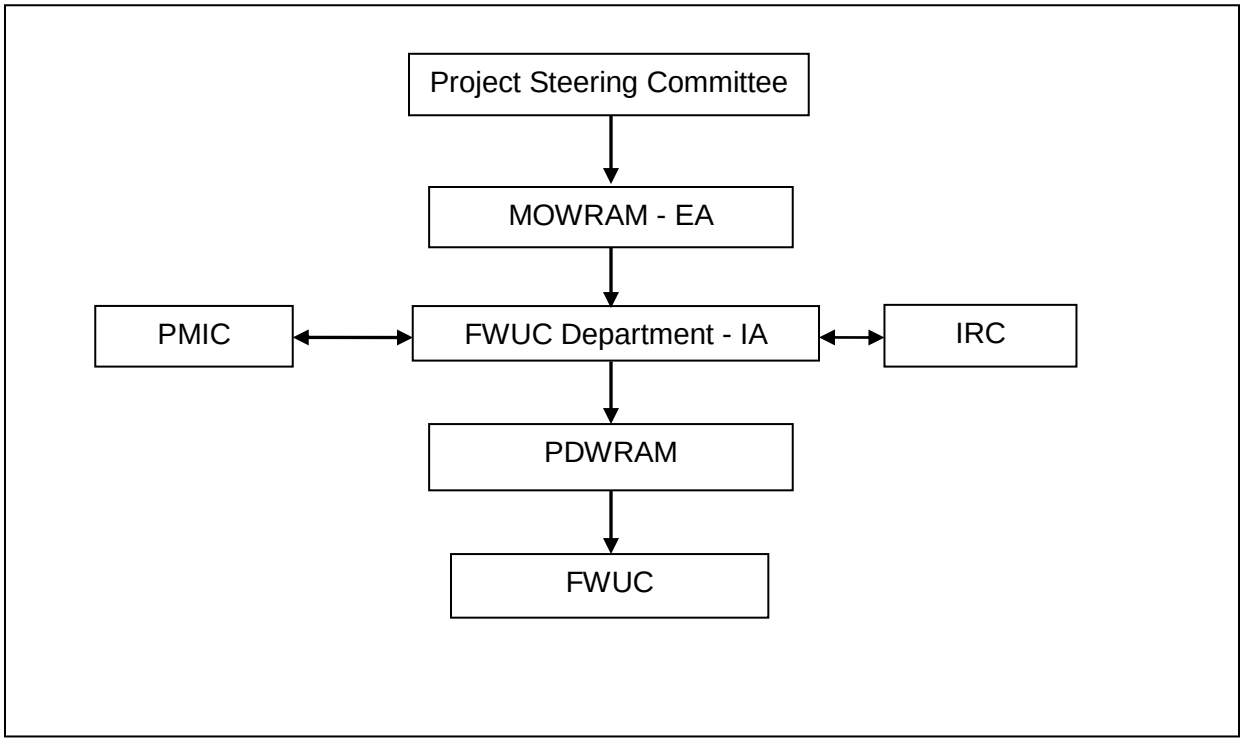
Project Implementation Organizations	Management Roles and Responsibilities
	• Design and implement modern canal operations system
Provincial Department of Water Resources and Meteorology (PDWRAMs)	Under supervision of DFWUC, MOWRAM supervise the establishment and strengthening of the FWUCs at the Irrigation system level and provide support in project implementation
Farmer Water User Communes (FWUC)	• Participate in the subprojects' design and implementation • Manage and operate distribution canals in close coordination with the PDWRAMs. • Take over the roles and responsibilities as per the Sub-decree on role and responsibilities of FWUCs • Represent the interest of the Project Beneficiaries and coordinate closely with the PDWRAM and PMU regarding project implementation at project level.
Inter-Ministerial Resettlement Committee (IRC)	• Implement land acquisition and resettlement activities • Recruit external monitoring agency for safeguards • Ensure timely payment of compensations to the affected persons • Submit internal monitoring reports

B. Key Persons Involved in Implementation

Executing/Implementing Agencies	Names of Key Personnel
Ministry of Water Resources and Meteorology (MOWRAM)	H.E. Chann Sinath Director General Technical Affairs Department of FWUC, MOWRAM Telephone: (855) 12 790035 Email address: channsinath78@gmail.com Office Address: 364 Monivong Blvd, Khan Chamkamorn Phnom Penh, Cambodia
Asian Development Bank	Jiangfeng Zhang Director Environment, Natural Resources and Agriculture Division Southeast Asia Department (SEER) Telephone No. +632-4444 local 6234 Email address: jzhang@adb.org Raza M. Farrukh Water Resources Specialist/Mission Leader (SEER) Telephone No. + (632) 632-4444 local 5270 Email address rfarrukh@adb.org

C. Project Organization Structure

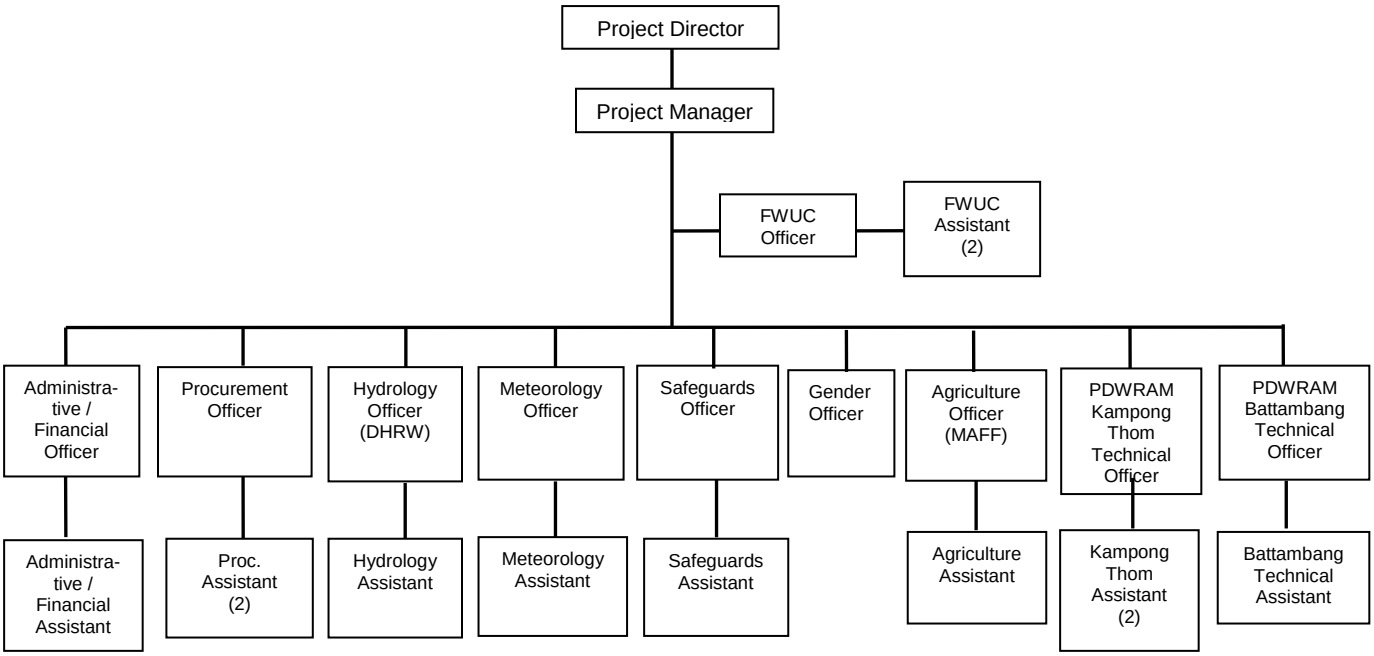
Figure 1: Project Organization Structure



D. Project Management Unit Staff at MOWRAM

SN	Name	Designation	Role
1	H.E. Chann Sinath	Deputy Director General, Technical Affair, DFWUC	Project Director
2	Mr. Huy Vantha	Director, DFWUC	Project Manager
3	Mr. Mao Hak	Deputy Director General for Technical Affair, DHRW	Hydrology Officer
4	Mr. Sreng Sotha	Officer, DHRW	Hydrology Assistant
5	Mr. Um Rina	Director of Department of Meteorology	Meteorology Officer
6	Mr. Phan Sophy	Chief, Instrument & Equipment Management Office	Meteorology Assistant
7	Mrs. Bun Sida	Vice Chief, Training and Research, DFWUC	Administrative / Financial Officer
8	Mr. Kim Vann	Officer, Training and Research, DFWUC	Administrative / Financial Assistant
9	Mr. Keo Sovathapheap	Deputy Director, DFWUC	Technical / Safeguards Officer
10	Mr. Im Soursdey	Vice Chief, DFWUC	Technical Assistant
11	Mr. Srun Sokhom	Deputy Director General, MAFF	Agriculture Officer
12	Mr. Chea Hong	Chief Office of Agricultural Irrigation, MAFF	Agriculture Assistant
13	Mrs. Im Chinda	Vice Chief, DFWUC	Gender Officer
14	Mrs. Laing Sokim	Vice Chief, Training and Research, DFWUC	Procurement Officer
15	Mr. Sran Chheav	Chief, Administrative Office	Procurement Assistant
16	Mr. Sok Boren	Officer, Administrative Office	Procurement Assistant
17	Mr. Tan Naren	Chief, DFWUC	FWUC Officer
18	Mrs. Kheth Chivy	Officer, Training and Research, DFWUC	FWUC Assistant
19	Mrs. Nhim Sophea	Officer, Training and Research, DFWUC	FWUC Assistant
20	Mr. Long Phalkun	Director, PDWRAM Battambang Province	Battambang Technical Officer
21	Mr. Peng Sophy	Irrigation Officer, PDWRAM Battambang Province	Battambang Technical Assistant
22	Mr. You La	Director, PDWRAM Kampong Thom Province	Kampong Thom Technical Officer
23	Mr. Hak Puthy	Deputy Director, PDWRAM Kampong Thom Province	Kampong Thom Technical Assistant
24	Mr. He Keun	Irrigation Officer, PWDRAM Kampong Thom Province	Kampong Thom Technical Assistant

Figure 2: Project Management Unit Organizational Chart



Source: MOWRAM, 2015

E. Implementation Procedures

7. The core subproject Taing Krasaing main canal is designed and ready for bidding. The feasibility studies of Taing Krasaing in Kampong Thom province and Prek Chik in Battambang province have been done. Detailed designs of both main canals are ready for bidding. Bidding of Taing Krasaing main canal will be started before loan effectiveness but Prek Chik main canal bids will be invited after water availability study of Bassac reservoir is completed. Detailed engineering design of distribution system of both irrigation systems will be done by the PMIC canal systems in phases. After completion of design of each phase, the contract for construction will be awarded by the PMU. FWUCs will be formed and trained and involved in the design process. Feasibility study of O Kra Nahk irrigation system in Kampong Thom province and other non-core subprojects will be carried out by the PMIC. The subprojects will be assessed on the following selection criteria before making final decision for investments.

(i) Category B or less in terms of environmental impact as defined in the SPS [do not have any significant environmental impact];
(ii) Category B or less in terms of involuntary resettlement impact as defined in the SPS [do not cause involuntary resettlement and land, if required, will be within the permissible limits for Category B;
(iii) Category C in terms of indigenous peoples impact as defined in the SPS [do not have any impact on indigenous peoples];
(iv) Irrigation system has low irrigation efficiency and water productivity, and would have scope for substantial enhancement of both irrigation efficiency and water productivity;
(v) Subproject should involve only rehabilitation of existing systems or related schemes and should not involve construction of new systems;
(vi) Subproject should be located outside the Tonle Sap basin;
(vi) Subproject should involve rehabilitation of both primary and secondary canals to ensure that water reached the farm;
(vii) Subproject should not be covered by other ongoing or proposed projects financed by ADB or any other Development Partner;
(viii) Beneficiaries should include sharecroppers, poor farmers, and women farmers; and
(ix) Subproject should be economically viable; and technically, socially and environmentally feasible. The EIRR of each subproject should be greater than 12%

8. In case a subproject is not considered eligible as per above criteria, PDWRAM and MOWRAM will propose other subprojects, that will also undergo same assessment.

9. After a subproject is assessed eligible and feasible as per the selection criteria, the feasibility study will be submitted for ADB's concurrence prior to start of bidding process.

IV. COSTS AND FINANCING

A. Detailed Cost Estimates by Expenditure Category (in million)

		Amount (USD)	% of Total Base Cost
A.	**Base Costs**		
1	Civil Works	45.14	84.7%
2	Hydrometeorology Equipment	1.20	2.3%
3	Office Equipment, Furniture and Vehicles	1.00	1.9%
4	Consulting Services	4.85	9.1%
5	Incremental Operating Cost	0.50	0.9%
6	Land acquisition and resettlement	0.58	1.1%
	Subtotal (A)	**53.26**	**100.0%**
B.	**Contingencies**		
1	Physical Contingencies	4.94	9.3%
2	Price Contingencies	6.30	11.8%
	Subtotal (B)	**11.24**	**21.1%**
C.	**Financing Charges During Implementation**		
1	Interests During Implementation	1.62	3.0%
	Subtotal (C)	**1.62**	**3.0%**
Total Cost (A+B+C)		**66.12**	**124.1%**

Some total may not sum up due to rounding off of decimals.
Source: ADB staff estimates

B. Allocation and Withdrawal of Loan Proceeds ($ Million)

No.	Category	Amount	Percentage and Basis for Withdrawal from the Loan Account
1	Civil Works	41.02	100% of total expenditure claimed*
2	Hydrometeorology Equipment	1.20	100% of total expenditure claimed**
3	Office Equipment, Furniture and Vehicle	1.00	100% of total expenditure claimed**
4	Consulting Services	4.85	100% of total expenditure claimed**
5	Incremental Operating Cost	0.25	100% of total expenditure claimed**
6	Unallocated	10.06	
6	Interests During Implementation	1.62	100% of amount due
	Total	**60.00**	

Notes:
*Exclusive of local taxes and duties, taxes paid by the Government through taxes exemption
** Inclusive of insurance and taxes and duties, paid by ADB
Source: ADB staff estimates

C. Detailed Cost Estimates by Financier (in $ million)

	Items	TOTAL	ADB		Government		Taxes and Duties
			Amount	%	Amount	%	
A.	**Base Costs**						
1	Civil Works	45.14	41.02	90.9	4.12	9.1	4.12
2	Hydrometeorology Equipment	1.20	1.20	100.0	-	-	0.27
3	Office Equipment, Furniture and Vehicles	1.00	1.00	100.0	-	-	0.44
4	Consulting Services	4.85	4.85	100.0		-	0.63
5	Incremental Operating Cost	0.50	0.25	50.0	0.25	50.0	0.02
6	Land acquisition and resettlement	0.58	-	0.0	0.58	100	-
	Subtotal (A)	**53.26**	**48.32**	**90.7**	**4.94**	**9.3**	**5.48**
B.	**Contingencies**						
1	Physical Contingencies	4.94	4.38	88.8	0.55	11.2	0.47
2	Price Contingencies	6.30	5.67	90.0	0.63	10.0	0.59
	Subtotal (B)	**11.24**	**10.06**	**89.5**	**1.18**	**10.5**	**1.06**
C.	**Financing Charges During Implementation**						
1	Interests During Implementation	1.62	1.62	100.0	-	-	-
	Subtotal (C)	**1.62**	**1.62**	100.0	-	-	-
Total Cost (A+B+C)		**66.12**	**60.00**	**90.7**	**6.12**	**9.3**	**6.54**

Some total may not sum up due to rounding off of decimals.
Source: ADB staff estimates

D. Detailed Cost Estimates by Outputs/Components (in $ million)

Item		TOTAL	OUTPUT 1		OUTPUT 2		Project Management	
			Amount	%	Amount	%	Amount	%
A. Base Costs								
1	Civil Works	45.14	45.14	84.7		0.0		0.0
2	Hydrometeorology Equipment	1.20	-	0.0	1.20	100.0		0.0
3	Office Equipment, Furniture and Vehicles	1.00	1.00	1.9	-	0.0	-	0.0
4	Consulting Services	4.85	4.09	7.7	0.11	2.4	0.64	13.3
5	Incremental Operating Cost	0.50	-	0.0	-	0.0	0.50	100.0
6	Land Acquisition and Resettlement	0.58	0.58	1.1	-	0.0	-	0.0
	Subtotal (A)	**53.26**	**50.80**	**95.4**	**1.31**	**2.5**	**1.14**	**2.1**
B. Contingencies								
1	Physical Contingencies	4.94	4.87	9.1	-	0.0	0.06	1.3
2	Price Contingencies	6.30	6.18	11.6	0.01	0.2	0.12	1.8
	Subtotal (B)	**11.24**	**11.05**	**98.3**	**0.01**	0.1	**0.18**	1.6
C. Financing Charges During Implementation								
1	Interests During Implementation	1.62	1.57	2.9	0.05	0.2	0.00	0.1
	Subtotal (C)	**1.62**	**1.57**	2.9	**0.05**	0.2	**0.00**	0.1
Total Cost (A+B+C)		**66.12**	**63.42**	**95.9**	**1.38**	**2.1**	**1.32**	**2.0**

Some total may not sum up due to rounding off of decimals.
Source: ADB staff estimates.

E. Detailed Cost Estimates by Year (in $ million)

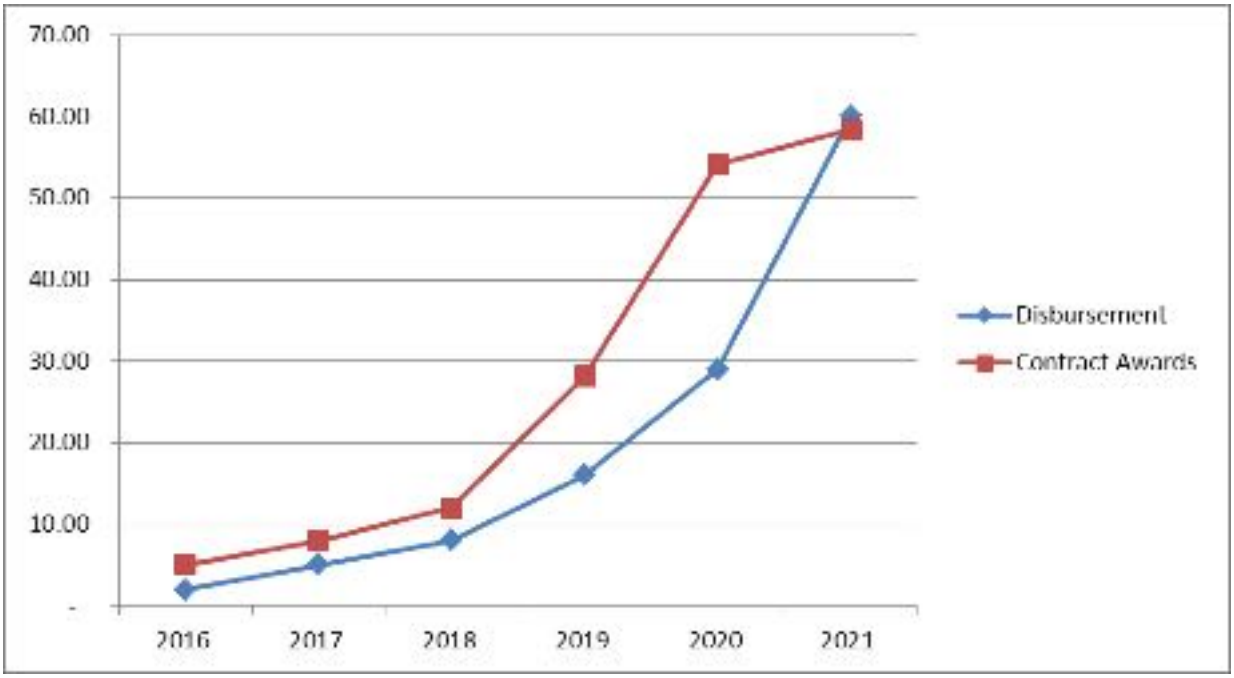
	Items	Total Cost	2016	2017	2018	2019	2020	2021
A.	**Base Costs**							
1	Civil Works	45.14	4.51	4.51	6.77	9.03	11.28	9.03
2	Hydrometeorology Equipment	1.2	1.20	-	-	-	-	-
3	Office Equipment, Furniture and Vehicle	1.00	1.00	-	-	-	-	-
4	Consulting Services	4.85	0.50	0.48	0.72	0.96	1.21	0.96
5	Incremental Operating Cost	0.50	0.08	0.08	0.08	0.08	0.08	0.08
6	Land acquisition and resettlement	0.58	0.58	-	-	-	-	-
	Subtotal (A)	**53.26**	**7.88**	**5.08**	**7.58**	**10.08**	**12.57**	**10.08**
B.	**Contingencies**							
1	Physical Contingencies	4.94	0.74	0.47	0.70	0.93	1.16	0.93
2	Price Contingencies	6.30	0.21	0.27	0.65	1.22	1.98	1.97
	Subtotal (B)	**11.24**	**0.95**	**0.74**	**1.35**	**2.15**	**3.14**	**2.90**
C.	**Financing Charges During Implementation**							
1	Interests During Implementation	1.62	0.04	0.11	0.18	0.29	0.43	0.57
	Subtotal (C)	**1.62**	**0.04**	**0.11**	**0.18**	**0.29**	**0.43**	**0.57**
Total Cost (A+B+C)		**66.12**	**8.87**	**5.93**	**9.12**	**12.52**	**16.15**	**13.54**

Some total may not sum up due to rounding off of decimals.
Source: ADB staff estimates

F. Contract and Disbursement S-curve

10. The graph below shows contract awards and disbursement over the life of the project, and annually based on the contract awards and disbursement projections.

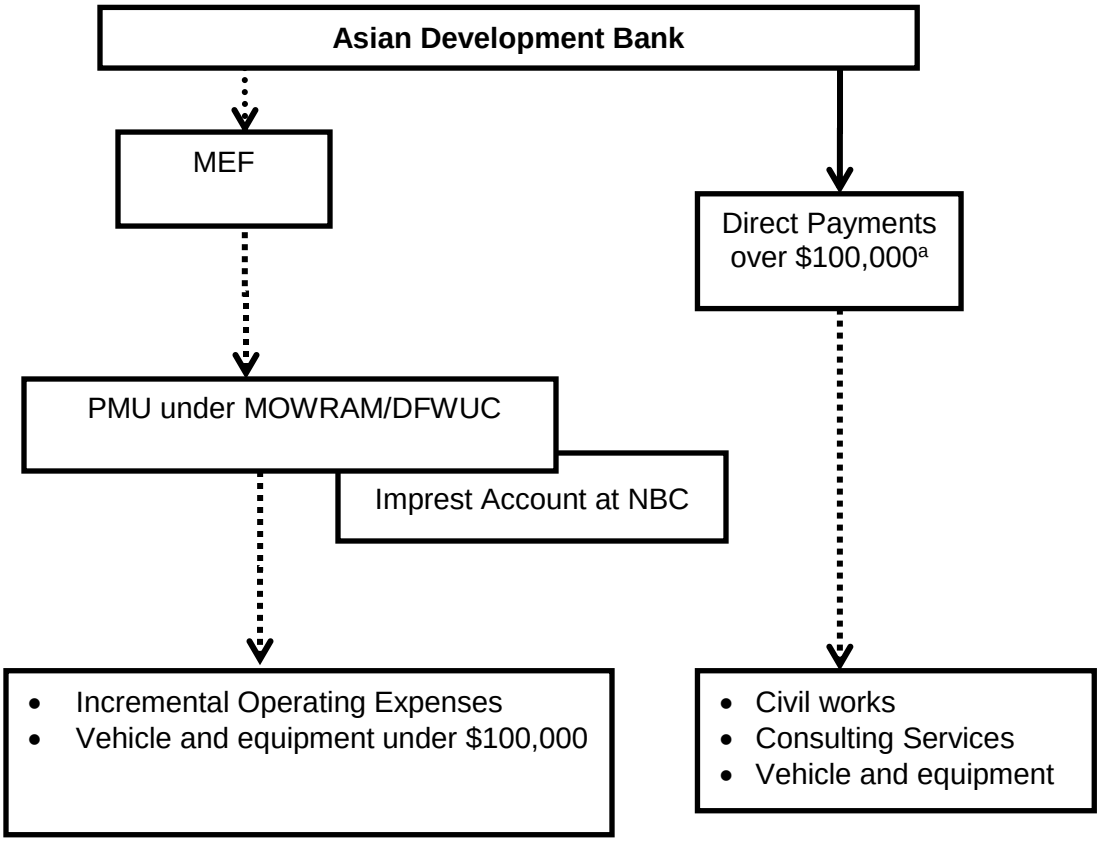
Figure 3: Contract and Disbursement S-curve



G. Fund Flow Diagram

11. The figure below shows how the funds will flow from ADB, co-financiers and the Borrower to implement project activities.

Figure 4: Fund Flow Diagram



Legend:

Imprest Fund
Direct Payment

DFWUC = Department of Farmer Water User Communes; MEF = Ministry of Economy and Finance, MOWRAM= Ministry of Water Resources and Meteorology; 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

V. FINANCIAL MANAGEMENT

A. Financial Management Assessment

12. The financial management assessment (FMA) report (Supplementary Document 17) was prepared in accordance with the FMA technical guidance note (ADB, 2015). It was initially updated by a consultant, from the FMA done by the MOWRAM in 2014[1] and finalized by the ADB's Senior Financial Management Specialist, during a fact-finding mission, from 22 to 26 June 2015. This FMA incorporates the financial management internal control and other risk assessment required by the guidance. 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.

13. The purpose of this assessment 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 are set out in the loan agreement, and other project documents. The FMA has assessed the 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. The executing and implementing agencies have worked in the past with ADB and are currently implementing several ADB funded projects. MOWRAM is also part of the government's comprehensive Public Financial Management Reform Program (PFMRP) which is being supported by an ADB Grant.[2]

14. Summary of the assessment: The FMA overall is rated as "Moderate" and is expected to become "Low" with mitigating measures. General environment for public financial management (PFM) in Cambodia is generally satisfactory due to large extent to the standardized policies and guidelines which are implemented for all externally financed projects and programs. The following tables present the risk summary for both inherent- and project risks.

Table 2: The Inherent- and Project Risks

Risk Description	Risk Assessment	Mitigation Measures or Risk Management Plan
I. Inherent Risks		
A**. Country Specific**: PFM: (i) low accountability for public expenditure and service delivery; (ii) inadequate delegation and build-up of capacity in SNAs; (iii) weak Internal audit and internal controls: (iv) External audit capacity is improving, but remains weak. Procurement: risks of inefficiencies and irregularities in procurement for line	Moderate	(i) expand technical assistance under the CPS to additional priority ministries including MOWRAM; (ii) continue to support decentralization and PFM reforms for SNAs; (iii) provide capacity building for internal audit; and (iv) support the NAA in addressing audit findings and follow up on recommendations. Improve the government's standard operating procedures, procurement manual, and FM

[2] Grant 0222-CAM: Public Financial Management for Rural Development Program, Subprogram 2.

Risk Description	Risk Assessment	Mitigation Measures or Risk Management Plan
ministries and SNAs, including e-procurement, complaint handling mechanisms, and stronger institutions and human capacity, there are Corruption: (i) The ACU faces significant challenges to effectively implement the Anti-Corruption Law and systemically address corruption.		manual; deliver training on ADB's guidelines and procurement procedures; and continue to identify procurement risks and implement mitigation measures. In coordination with other DPs and NGOs, ADB will continue to support the ACU in fulfilling its mandate.
B. **Entity Specific:** Lack of control in budget execution; accounting and reporting, and budget credibility.	Moderate	CARM/ MEF/ MOWRAM to continue to monitor the progress and results of ADB Grant no. 0222-CAM[3]: Strengthening Public Financial Management for Rural Development Program (PFMRDP) covering 3 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	
II. Project/Control Risks		
Executing/Implementing entity: Potential corruption due to weakness in internal control and external control of the Project	Moderate	MOWRAM will require all contractors /bidders, suppliers and consultants to sign declarations of ethical conduct; strengthen transparency through posting project information on the EA websites; develop complaint handling mechanisms; strict monitoring and enforcement of procurement procedures and contracts; and joint investigation by the NAA and the ADB's Office of Anticorruption and Integrity on irregularities.
Fund Flows: - The PMU Finance Officer is familiar with FMM, but she has not yet received training on ADB's LDH.	Moderate	Provide training on ADB's LDH 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	Start the selection process for the PMU Project Accountant, preferably from Department of Finance 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

[3] Grant agreement was signed on 22 October 2010

Risk Description	Risk Assessment	Mitigation Measures or Risk Management Plan
		processes.
External Audit Lack of analysis in reviewing transactions and interpreting the project financial statements.	Moderate	PMU will work with MEF to update the TOR 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 Financial Management Reports (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 generates FMRS) automatically: (ii) There have been major improvements in the information system as a result of the PFMRD. This includes a new Chart of Accounts and implementation of a computerized system.	Moderate	PMU to coordinate with the Finance Department for installation of this software at the PMU and operated using double entry accounting procedures will allow transactions to be traced and followed during audit
Overall Project/ Control Risk	Moderate	
Overall (Combined) Risk	Moderate	The implementation of mitigation actions as proposed will reduce to risk to low.

ADB = Asian Development Bank, DP = development partners, FM = financial management, FMIS = FM information system, MEF = Ministry of Economy and Finance, NAA = national audit authority, NGOs = non-governmental organizations, OECD = Organization for Economic Co-operation and Development PFM = public financial management, SNAs = sub-national authorities,
Source: Asian Development Bank

15. As details 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 FM arrangements are adequate for the overall program, especially for the investments funded by the Project.

B. Disbursement

16. The Loan proceeds will be disbursed in accordance with ADB's *Loan Disbursement Handbook* (2015, as amended from time to time),[4] and detailed arrangements agreed upon between the Government and ADB. The Loan Disbursement Handbook describes the procedures and provides standard forms for withdrawal of funds.

[4] Available at: http://www.adb.org/Documents/Handbooks/Loan_Disbursement/loan-disbursement-final.pdf

17. Pursuant to ADB's Safeguard Policy Statement (2009) (SPS) [5] 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. All financial institutions will ensure that their investments are in compliance with applicable national laws and regulations and will apply the prohibited investment activities list (Appendix 5 of SPS) to subprojects financed by ADB.

18. The following are different financing and disbursement arrangements,[6] of ADB Loan i.e. through direct payment by ADB, reimbursement, imprest fund procedures, liquidation and replenishment, and the statement of expenditures (SOEs). MOWRAM will be responsible for (i) preparing contract awards and disbursement projections, (ii) requesting budgetary allocations for counterpart funds, (iii) collecting supporting documents, and (iv) preparing and sending withdrawal applications to ADB.

19. 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 exclusive for the project loan. The imprest account will be opened and managed by MOWRAM, as follows: imprest account for ADB – MEF will be the account holder, and delegates the authority to MOWRAM, the authorized party. The EA will request initial and additional advances from ADB based on its estimate of ADB's share of eligible project expenditures for the forthcoming six months which are to be paid through the imprest account. The maximum ceiling of the imprest accounts will not at any time exceed the estimated ADB expenditures to be paid from the imprest account for the next six months.

20. The request for initial advance to the imprest account should be accompanied by an Estimate of Expenditure Sheet[7] setting out the estimated expenditures for the first six (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) 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 EA's records.[8]

21. **Statement of Expenditure (SOE) Procedure.** The SOE procedure will be used for reimbursement and to liquidate and replenish the imprest account for eligible expenditures. Any individual payment to be reimbursed or liquidated under this procedure shall not exceed the equivalent of $50,000 for the IA. 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 audit.[9]

22. 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 applications on behalf of the borrower, together with the authenticated specimen signatures of

---

[5] Available at: http://www.adb.org/Documents/Policies/Safeguards/Safeguard-Policy-Statement-June2009.pdf
[6] Available at: http://www.adb.org/documents/handbooks/loan_disbursement/chap-06.pdf
[7] Available in Appendix 29 of the *Loan Disbursement Handbook.*
[8] Follow the format provided in Appendix 30 of the *Loan Disbursement Handbook.*
[9] 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
http://www.adb.org/documents/handbooks/loan_disbursement/SOE-Contracts-Over-100.xls
http://www.adb.org/documents/handbooks/loan_disbursement/SOE-Operating-Costs.xls
http://www.adb.org/documents/handbooks/loan_disbursement/SOE-Free-Format.xls

each authorized person. The minimum value per withdrawal application is US$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.

23. **Disbursement and Liquidation Procedures for Government Funds**. Withdrawal of government counterpart funds must be 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.

24. Key Internal Controls**.** Withdrawal applications must be signed by an authorized signatory or signatories. Withdrawal applications must be sequentially numbered starting with the number one.

25. Counterpart Funds Initial Advance. The PMU completes the government withdrawal application form for the initial advance of counterpart funds and submits to the MEF – Department of Cooperation and Debt Management (DCDM). The maximum amount of the advance of counterpart funds will be agreed between MOWRAM/PMU and MEF. The government withdrawal application form must be signed by the authorized signatories of MOWRAM/PMU and submitted to the DIC. The government withdrawal application must be recorded in the project counterpart funds withdrawal application register.

26. The DCDM reviews the completed forms and in conjunction with the Finance and Administration Department transfers the funds to the Project's Counterpart Funds Imprest/Special Account and advises MOWRAM of the transfer. On receipt of advice from the NBC that the funds have been deposited into the Counterpart Funds Special Account, the receipt of the funds should be recorded in the general ledger and the government WA register must be updated.

27. Counterpart Funds Replenishment**.** The PMU completes the government WA form and attaches a statement of actual expenditure. Supporting expenditure documentation must be maintained by the PMU for subsequent review by MEF or audit. The government WA Form must be signed by the authorized signatories of the executing agency and submitted to the DIC. The government WA must be recorded in the Project Counterpart Funds WA Register.

28. The DCDM reviews the completed forms and in conjunction with the Finance and Administration Department transfers the funds to the Project's Counterpart Funds Account. On receipt of advice from the NBC that the funds have been deposited into the Counterpart Funds Special Account, the receipt of the funds should be recorded in the General Ledger and the Government WA Register must be updated.

C. Accounting

29. MOWRAM will maintain, or cause to be maintained, separate books and records by funding source for all expenditures incurred on the project. The executing agency will prepare consolidated project financial statements in accordance with the government's accounting laws and regulations which are consistent with international accounting principles and practices.

D. Auditing and Public Disclosure

30. MOWRAM will cause the detailed consolidated project financial statements to be audited in accordance with International Standards on Auditing and with the Government's audit regulations, by an independent auditor acceptable to ADB. The audited project financial statements will be submitted in the English language to ADB within six months of the end of the fiscal year by the executing agency.

31. The annual audit report for the project accounts will include an audit management letter and audit opinions which cover (i) whether the project financial statements present a true and fair view or are presented fairly, in all material respects, in accordance with the applicable financial reporting framework; (ii) whether loan and grant 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) use of the imprest fund procedure; and (v) the use of the statement of expenditure procedure certifying to the eligibility of those expenditures claimed under SOE procedures, and proper use of the SOE and imprest procedures in accordance with ADB's Loan Disbursement Handbook (2015, as amended from time to time) and the project documents.

32. Compliance with financial reporting and auditing requirements will be monitored by review missions and during normal program supervision, and followed up regularly with all concerned, including the external auditor.

33. The Government, MOWRAM and DFWUC have been made aware of ADB's policy on delayed submission, and the requirements for satisfactory and acceptable quality of the audited project financial statements.[10] ADB reserves the right to require a change in the auditor (in a manner consistent with the constitution of the borrower), or for additional support to be provided to the auditor, if the audits required are not conducted in a manner satisfactory to ADB, or if the audits are substantially delayed. 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.

34. Public disclosure of the project financial statements, including the audit report on the project financial statements, will be guided by ADB's Public Communications Policy (2011)[11]. After review, ADB will disclose the project financial statements for the project and the opinion of the auditors on the financial statements within 30 days of the date of their receipt by posting them on ADB's website. The Audit Management Letter will not be disclosed.

---

[10] ADB Policy on delayed submission of audited project financial statements:

- When audited project financial statements are not received by the due date, ADB will write to the executing agency advising that (i) the audit documents are overdue; and (ii) if they are not received within the next six months, requests for new contract awards and disbursement such as new replenishment of imprest accounts, processing of new reimbursement, and issuance of new commitment letters will not be processed.
- When audited project financial statements have not been received within 6 months after the due date, ADB will withhold processing of requests for new contract awards and disbursement such as new replenishment of imprest accounts, processing of new reimbursement and issuance of new commitment letters. ADB will (i) inform the executing agency of ADB's actions; and (ii) advise that the loan may be suspended if the audit documents are not received within the next six months.
- When audited project financial statements have not been received within 12 months after the due date, ADB may suspend the loan.

[11] Available from http://www.adb.org/documents/pcp-2011?ref=site/disclosure/publications.

VI. PROCUREMENT AND CONSULTING SERVICES

A. Advance Contracting and Retroactive Financing

35. All advance contracting and retroactive financing will be undertaken in conformity with ADB's *Procurement Guidelines* (April 2015, as amended from time to time)[12] and ADB's *Guidelines on the Use of Consultants* (March 2013, as amended from time to time)[13]. The issuance of invitations to bid under advance contracting and retroactive financing will be subject to ADB approval. The borrower, MOWRAM and DFWUC have been advised that approval of advance contracting and retroactive financing does not commit ADB to finance the Project.

36. Advance contracting. (i) tendering and bid evaluation for works contract for the core subproject, Taing Krasaing main canal; (ii) tendering and bid evaluation for procurement of office equipment, furniture and vehicles; (iii) evaluation of technical and financial proposals for recruitment of the Project Management and Implementation Consulting (PMIC) package.

B. Procurement of Goods, Works and Consulting Services

37. All procurement of goods and works will be undertaken in accordance with ADB's *Procurement Guidelines.*

38. International competitive bidding (ICB) procedures will be used for civil works contracts estimated to cost $3.0 million or more, and supply contracts valued at $1.0 million or higher. Shopping will be used for contracts for procurement of works and equipment worth less than $100,000. National competitive bidding (NCB) procedures will be used for civil works estimated to cost $100,000 or higher but less than $3.0 million, goods and equipment worth $100,000 and higher but less than $1.0 million.

39. Before the start of any procurement ADB and the Government will review the public procurement laws of the central and state governments to ensure consistency with ADB's Procurement Guidelines.

40. An 18-month procurement plan indicating threshold and review procedures, goods, works, and consulting service contract packages and national competitive bidding guidelines is in Section C.

41. All consultants will be recruited according to ADB's Guidelines on the Use of Consultants.[14] The terms of reference for all consulting services are detailed in Section D.

42. An estimated 674 person-months (64 international, 610 national) of consulting services are required to (i) facilitate project management and implementation, (ii) design and construction supervision of civil works, (iii) compliance with safeguards, (iv) implement of GAP, (v) progress and performance monitoring and reporting, and (v) strengthen the capacity of the PMU to ensure effective project implementation. The consulting firm will be engaged using the quality- and cost-based selection (QCBS) method with a ratio of 80:20.

---

[12] Available at: http://www.adb.org/Documents/Guidelines/Procurement/Guidelines-Procurement.pdf
[13] Available at: http://www.adb.org/Documents/Guidelines/Consulting/Guidelines-Consultants.pdf
[14] Checklists for actions required to contract consultants by method available in e-Handbook on Project Implementation at: http://www.adb.org/documents/handbooks/project-implementation/

C. Procurement Plan

Basic Data

Project Name: **Uplands Irrigation and Water Resources Management Sector Project**	
Project Number:	**Approval Number**:
Country: Cambodia	**Executing Agency**: Ministry of Water Resources and Meteorology
Project Financing Amount: $ 66.12 million **ADB Financing:** $60.0 million **Non-ADB Financing:** $6.12 million	**Implementing Agency:** Department of Farmer Water User Commune
Date of First Procurement Plan: 24 September 2015	**Date of this Procurement Plan**:

A. Methods, Thresholds, Review and 18-Month Procurement Plan

1. Procurement and Consulting Methods and Thresholds

43. Except as the Asian Development Bank (ADB) may otherwise agree, the following process thresholds shall apply to procurement of goods and works.

Procurement of Goods and Works		
Method	**Threshold**	**Comments**
International Competitive Bidding (ICB) for Works	$3,000,000	
International Competitive Bidding for Goods	$1,000,000	
National Competitive Bidding (NCB) for Works	Beneath that stated for ICB, Works	First NCB document subject to prior review after which post review.
National Competitive Bidding for Goods	Beneath that stated for ICB, Goods	
Shopping for Works	Below $100,000	
Shopping for Goods	Below $100,000	

Consulting Services	
Method	**Comments**
Quality and Cost Based Selection (QCBS)	80:20
Consultants Quality Selection (CQS)	

2. Goods and Works Contracts Estimated to Cost $1 Million or More

44. The following table lists goods and works contracts for which the procurement activity is either ongoing or expected to commence within the next 18 months.

Package Number	General Description	Estimated Value (USD)	Number of Contracts	Procurement Method	Review (Prior / Post)	Bidding Procedure	Advertisement Date (quarter/year)	Comments
Works								
MOWRAM-CW01	Taing Krasaing Main canal and Headwork	10,800,000	01	ICB	Prior	IS2E	Q4-2015	Large Works (prequalification of bidders and domestic preference not applicable)

Package Number	General Description	Estimated Value (USD)	Number of Contracts	Procurement Method	Review (Prior / Post)	Bidding Procedure	Advertisement Date (quarter/ year)	Comments
Goods								
PMU-HME-01	Hydro-meteorological Equipment	1,200,000	01	ICB	Prior	1S1E	Q1 2016	To be procured by PMU

3. Consulting Services Contracts Estimated to Cost $100,000 or More

45. The following table lists consulting services contracts for which the recruitment activity is either ongoing or expected to commence within the next 18 months.

Package Number	General Description	Estimated Value (USD)	Recruitment Method	Review (Prior / Post)	Advertisement Date (quarter/year)	Type of Proposal	Comments
CS-01-PMIC	Project management and implementation consultants	4,650,000	**QCBS 80:20**	Prior	Q4 2015	FTP	International/ National
CS-02-EMA	External Monitoring Agency for Safeguards	200,000	**CQS**	Prior	Q4 2016	-	National. To be recruited by IRC

4. Goods and Works Contracts Estimated to Cost Less than $1 Million and Consulting Services Contracts Less than $100,000 (Smaller Value Contracts)

46. The following table groups smaller-value goods, works and consulting services contracts for which the activity is either ongoing or expected to commence within the next 18 months.

Goods and Works								
Package Number	**General Description**	**Estimated Value (USD)**	**Number of Contracts**	**Procurement Method**	**Review** (Prior / Post)	**Bidding Procedure**	**Advertisement Date** (quarter/ year)	**Comments**
PMU-OF-01	Office Furniture	50,000	01	Shopping	Post	1S1E	Q4 2015	To be procured by PMU
PMU-OE-01	Office Equipment	300,000	01	NCB	Post	1S1E	Q4 2015	To be procured by PMU
PMU-VEH-01	Vehicle	650,000	01	NCB	Prior	1S1E	Q4 2015	To be procured by PMU
PMU-OW-1	Office Repairs	90,000	01	Shopping	Post	1S1E	Q42015	To be procured by PMU

5. Indicative List of Packages Required Under the Project

47. The following table provides an indicative list of goods, works and consulting services contracts over the life of the project, other than those mentioned in previous sections (i.e., those expected beyond the current period).

Goods and Works							
Package Number	**General Description**	**Estimated Value (USD) (cumulative)**	**Estimated Number of Contracts**	**Procurement Method**	**Review** (Prior / Post)	**Bidding Procedure**	**Comments**
MOWRAM-CW02	Tipou Distribution System	5,0000,000	01	ICB	Prior	1S2E	Large Works (prequalification of bidders and domestic preference not applicable)
MOWRAM-CW03	Chroab Distribution System	1,400,000	01	NCB	Prior	1S2E	Small Works (prequalification of bidders and domestic preference not applicable
MOWRAM-CW04	Korkoah Distribution System	8,800,000	01	ICB	Prior	1S2E	Large Works (prequalification of bidders and domestic preference not applicable
MOWRAM-CW 05	O Kro Nak Irrigation System	2,000,000	01	NCB	Prior	1S2E	Small Works (prequalification of bidders and domestic preference not applicable
MOWRAM-CW 06	Prek Chik Main Canal and Headworks	4,000,000	01	ICB	Prior	1S2E	Large Works (prequalification of bidders and domestic preference not applicable
MOWRAM-CW 07	Prek Chik Distribution System-1	7,000,000	01	ICB	Prior	1S2E	Large Works (prequalification of bidders and domestic preference not applicable
MOWRAM-CW 08	Prek Chik Distribution System-2	6,000,000	01	ICB	Prior	1S2E	Large Works (prequalification of bidders and domestic preference not applicable

E. National Competitive Bidding

1. General

48. All procurement will be undertaken in accordance with ADB's *Procurement Guidelines* (2015, as amended from time to time)[15] and ADB's *Guidelines on the Use of Consultants* (2013, as amended from time to time)[16] and the Royal Government of Cambodia's SOP Procurement Manual issued under sub-decree number 74 ANK.BK dated 22 May 2012 for externally financed Projects/Programs. If there be any discrepancy between the SOP and ADB's Guidelines, ADB's Guidelines shall prevail.

[15] Available at: http://www.adb.org/documents/procurement-guidelines-Procurement.pdf
[16] Available at: http://www.adb.org/documents/guidelines-use-consultants.pdf

2. Registration

49. Bidding shall not be restricted to pre-registered firms and such registration shall not be a condition for participation in the bidding process.

3. Prequalification

50. Post-qualification shall be used unless explicitly provided for in the loan agreement/procurement plan. Irrespective of whether post qualification or prequalification is used, eligible bidders (both national and foreign) shall be allowed to participate.

4. Bidding Period

51. The minimum bidding period is thirty- (30) days prior to the deadline for the submission of bids.

5 Bidding Documents

52. Procuring entities shall use the applicable standard bidding documents for the procurement of goods, works and services acceptable to ADB.

6. Preferences

53. No domestic preference shall be given for domestic bidders and for domestically manufactured goods.

7. Advertising

54. Invitations to bid shall be advertised in at least one widely circulated national daily newspaper or freely accessible, nationally-known website allowing a minimum of thirty (30) days for the preparation and submission of bids. NCB and ICB contracts for goods and related services and works will also be posted on ADB's website.

8. Bid Security

55. Where required, bid security shall be in the form of a bank guarantee from a reputable bank.

9. Bid Opening and Bid Evaluation

(i) Bids shall be opened in public.

(ii) Evaluation of bids shall be made in strict adherence to the criteria declared in the bidding documents and contracts shall be awarded to the lowest evaluated bidder.

(iii) Bidders shall not be eliminated from detailed evaluation on the basis of minor, non-substantial deviations.

(iv) No bidder shall be rejected on the basis of a comparison with the employer's estimate and budget ceiling without the ADB's prior concurrence.

(v) A contract shall be awarded to the technically responsive bid that offers the lowest evaluated price and no negotiations shall be permitted.

10. Rejection of all Bids and Rebidding

56. Bids shall not be rejected and new bids solicited without the ADB's prior concurrence.

11. Participation by Government-owned enterprises

57. Government-owned enterprises in the Kingdom of Cambodia shall be eligible to participate as bidders only if they can establish that they are legally and financially autonomous, operate under commercial law and are not a dependent agency of the contracting authority. Furthermore, they will be subject to the same bid and performance security requirements as other bidders.

12. ADB Member Country Restrictions

58. Bidders must be nationals of member countries of ADB, and offered goods and services must be produced in and supplied from member countries of ADB.

D. Consultant's Terms of Reference

1. Scope and Objective of the Services

59. The objective of the consulting services is to provide management and technical assistance to the EA and IA in the implementation of the Project and strengthen technical and management capacities of the participating government agencies and FWUCs.

60. The scope of work will include but not be limited to the following:

(i) Carry out detailed engineering design of the secondary and tertiary canals in the Taing Krasaing and Prek Chik irrigation systems;
(ii) Carry out feasibility study of the O Kra Nahk Irrigation system in Kampong Thom and any other system if O Kra Nahk is not found feasible;
(iii) Carry out detailed engineering design of the O Kra Nahk or other subproject that is considered feasible for financing;
(iv) Detailed planning of yearly activities in all aspects of the agreed and foreseen construction schedule;
(v) Prepare bidding documents of subprojects;
(vi) Provide assistance to PMU in procurement of works, goods, services;
(vii) Supervise construction of civil works;
(viii) Ensure timely completion, adherence to specifications, and quality of construction works;
(ix) Coordinate installation of hydro-met stations by ADB's GMS Flood and Drought Risk Management and Mitigation Project;
(x) Establish modern canal operations systems;
(xi) Form three FWUCs in the subprojects' areas, and provide them trainings. Following FWUC sub-decree approved by the Government in 2015, facilitate involvement of FWUCs in the subproject implementation, and operation & maintenance;
(xii) Estimate operation and maintenance (O&M) cost of each subproject and assist FWUCs in establishing O&M system;

(xiii) Prepare irrigation scheduling of each system and train FWUCs and PDWRAMs;
(xiv) Coordinate with ADB's Rice-SDP project and link farmers with that for introducing use of improved seeds, fertilizers, and benefiting from agriculture value chain established under Rice-SDP;
(xv) Coordinate with Rice-SDP project for laser levelling of 2,000 hectare;
(xvi) Prepare quarterly progress reports (QPRs);
(xvii) Establish Project Performance Monitoring System (PPMS), update on six monthly basis;
(xviii) Assist the PMU in the financial management of the Project such as the management of impress account, preparation of withdrawal applications, accounting, and internal audit, coordination with finance department of the MOWRAM on project finance/accounting system;
(xix) Design joint reservoir operation of Stung Chinit and Taing Krasaing reservoirs in Kampong Thom province, and Bassac and Dauntri reservoirs in Battambang province to improve water sharing arrangements between linked systems and assist MOWRAM in adopting those;
(xx) Estimate irrigation service fee (ISF) for each irrigation system based on the estimate of annual O&M requirements of the secondary and tertiary canals and prepare O&M plans;
(xxi) Estimate annual O&M cost of the main canals and prepare O&M plans to be adopted by PDWRAM/MOWRAM;
(xxii) Facilitate tripartite agreement between PDWRAM/MOWRAM, FWUCs and Private Land Owners. Estimate the amount of water to be provided to the private owners and service fee to be paid by them;
(xxiii) Carry out environmental and social due diligence of each subproject;
(xxiv) Prepare IEE of each subproject;
(xxv) Prepare Resettlement Plan of category B subprojects;
(xxvi) Ensure compliance with ADB'' Safeguards Policy Statement (SPS-2009);
(xxvii) Provide trainings to PDWRAM, PMU, MAF and Ministry of Agriculture, Forest and Fisheries (MAFF) staff in irrigation and water management, watershed management, operations of canals
(xxviii) Ensure technology and know-how transfer from the PIMC to their counterparts in the PMU;
(xxix) Establish canals flow measurement systems;
(xxx) Establish modern canal operation systems;
(xxxi) Develop and conduct Focused Information and Awareness program for the FWUCs and other stakeholders; and
(xxxii) Any other activities for delivering the envisage outputs of the Project and achieving desired outcome.

61. Consultancy services will comprise the following teams for providing assistance to the EA and the IA in the implementation and management of the Project:

(i) **The Project Management Team will be** located within PMU at Phnom Penh. The team will provide support in overall coordination and management of the project including procurement, progress and performance monitoring and reporting, financial management, safeguards compliance, organizing and training FWUCs, and training the PMU and other government staff to ensure effective project implementation.
(ii) **Feasibility and Design Team** will also be located in the PMU. This team will carry out feasibility studies of the subprojects and prepare detailed engineering design, drawings, bill of quantities, construction schedules and tender documents.
(iii) **Construction Supervision Teams** will be located at PDWRAM Kampong Thom and

PDWRAM Battambang. The teams will be responsible for supervising the construction works, progress reporting, and quality assurance.

2. Duration of Assignment and Inputs Required

62. The project implementation period of the consultant services is 60 months (1 April 2016 to 31 March 2021). A total of 674 person months including 64 person-months of the International experts and 610 person-months for the National experts would be required. The estimated staffing and expertise person-months requirements are summarized below. Detailed Terms of Reference for experts are presented in **Appendix 1**.

Table 3: Summary of Consulting Services Requirements

Positions	**Peron-Months Required**	
	International	**National**
Team Leader/Water Resources Specialist	24	-
Institutional/Training Specialist for FWUCs	4	12
Procurement Specialist & Contract Specialist	12	24
Financial and Accounting Specialist	6	54
Hydrologist	12	24
Deputy Team Leader/ Irrigation Management Specialist	-	54
Hydraulic Structural Engineer	-	24
Monitoring and Evaluation Specialist	6	24
Construction Management Engineer	-	108
Agricultural Specialist/Agronomist	-	10
Materials/Quality Control Engineer	-	24
Gender Specialist	-	18
Social Safeguards/ Resettlement Specialist	-	24
Environment Specialist	-	18
Assistant Engineers	-	192
Total	**64**	**610**

VII. SAFEGUARDS

A. Environment

63. The Project is categorized as environment category B in accordance with ADB's Safeguard Policy Statement (SPS) 2009. Details about the procedures to ensure that potential environmental impacts are avoided, reduced and mitigated in accordance with ADB SPS 2009 and regulations from the Government of Cambodia can be found in the Environmental Assessment and Review Framework (EARF) (Linked Document 11). An initial environmental examination (IEE) (Linked Document 10) report including an Environmental Management Plan (EMP) was prepared for the core subprojects core subprojects in Taing Krasaing and Prek Chik. The EMP outlines the anticipated environmental adverse impacts of the subproject, proposed mitigation and monitoring measures, and roles and responsibilities of the executing and implementing agencies, consultants, and contractors for each measure.

64. Based on the screening for potential environmental impacts and risks, the IEE concluded that the proposed core subprojects can be implemented in an environmentally acceptable manner with the corresponding EMP. For other subprojects to be prepared during the Project's implementation, the EARF will be followed for environmental assessment and an IEE of each subproject will be prepared to ensure consistency with ADB's SPS 2009, and respective EMPs will be included in the IEEs and civil works contracts. No category B subproject for environment will be selected.

65. The supervision and monitoring of environmental activities during the pre-construction, construction and operation phases are the functions of the PMU. In line with this, it is appropriate that the position of an Environmental Management Officer (EMO) be established in each PMU, responsible for supervision of environmental management and for environmental monitoring. Terms of reference for the EMO positions are at Annex C of the EARF.

B. Involuntary Resettlement

66. A Resettlement Framework (Linked Document 12) has been prepared to guide subproject screening and resettlement planning and implementation. Subprojects screened to involve significant involuntary resettlement impacts (Category A) are not eligible under the Project. Should a subproject involve insignificant involuntary resettlement impacts (Category B), the Government will prepare a draft Resettlement Plan in accordance with the Resettlement Framework. The Government will submit the draft Resettlement Plan to ADB for approval. During detailed engineering design, the Government will update the Resettlement Plan and submit the final version to ADB for approval. After approval, the Government will implement the RP. Construction can be started only in areas where compensation has been paid and an income restoration program has been put in place.

C. Indigenous Peoples

67. The Project is Category C is for Indigenous Peoples safeguards. To ensure that the Project remains in that Category, subprojects will be screened using the form in (**Appendix 2**). As per the subproject eligibility criteria, only Category C subprojects (no impact on Indigenous Peoples) are eligible for financing under the Project.

VIII. GENDER AND SOCIAL DIMENSIONS

68. The Summary Poverty Reduction and Social Strategy (Linked Document 8) identify the implementation of a Gender Action Plan (GAP), a Stakeholders Communication Strategy and measures to address identified social risks.

69. The Project's gender classification is "Effective Gender Mainstreaming" (EGM), which means that at least two of the project outputs are targeted to support women's active participation, access to project benefits and information and empowered through various skills development. A Gender Action Plan (GAP) is developed in accordance with the project activities and based on the findings of the gender assessment study (**Supplementary Document 19**) 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 livelihood. 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 4: 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

70. PMU will be responsible for the over-all implementation of the Project. A Gender officer has been appointed within the PMU. H/She will be responsible for implementation and

monitoring of the GAP in coordination with the Project Management and Implementation Consultants (PMIC). Within the PMIC, is the 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.

IX. PERFORMANCE MONITORING, EVALUATION, REPORTING AND COMMUNICATION

A. Project Design and Monitoring Framework

Impact the Project is Aligned with: Inclusive economic growth through agriculture and irrigation (Rectangular Strategy on Growth, Employment, Equity and Efficiency, Phase III, *2014 to 2018*)			
Project Results Chain	**Performance Indicators with Targets and Baselines**	**Data Sources or Reporting Mechanisms**	**Risks**
Outcome Water and agriculture productivity enhanced in the project area	Average annual crop production increased by 4.25 ton per ha by September 2021 (baseline 2015: 1.65 ton per ha)	PPMS Project completion report	Adverse effects of climate change
Outputs 1. Enhanced efficiency and climate resilience of irrigation systems in the project area	1a. Irrigation infrastructure improved/modernized and climate proofed for increasing dry and wet season cultivated area to 29,500 ha by March 2021 (baseline 2015: 13,500 ha)	1a.QPRs of the executing agency, PPMS, LRM reports	Inadequate planning and funding of O&M
	1b. Irrigation efficiency of three irrigation systems increased by 100% by March 2021 (baseline 2015: 20%)	1b. PPMS	
	1c. Drainage facilities rehabilitated for 1,800 ha (baseline 2015, 0 ha)	1c. PPMS	
	1d. 2,000 ha land leveled:by laser leveling by March 2021 (baseline 2015: 0 ha)	1d-e. QPRs, PPMS	
	1e. 30% unskilled labor in civil works is women		
2. Improved water resource management	2a. ThreeFWUCs formed and trained by September 2020 (baseline 2015: 0)	2a-d.QPRs, LRM reports	Weak coordination between MOWRAM, PDWRAM and FWUCs
	2b. 50% of FWUC members are women (baseline 2015, 0)		
	2c. 30% of FWUC management committee members are women (baseline 2015: 0)		
	2d. Annual O&M plan prepared		

Project Results Chain	Performance Indicators with Targets and Baselines	Data Sources or Reporting Mechanisms	Risks
	at design of each irrigation system		
	2e. O&M funds allocated by the government for main canals and reservoirs by September 2020 2f. Eight hydro-meteorological stations installed in the watersheds by September 2020 (baseline 2015: 0)	2e. MEF budget documents, QPRs, LRM reports 2f. QPRs, LRM reports, PPMS	

Key Activities with Milestones

1. Enhanced efficiency and climate resilience of irrigation systems in the project area

1.1 Contract for TaingKrasaing main canal awarded by 30 June 2016 and works completed by 31 December 2017.

1.2 Detailed design, cost estimates and bidding documents of all subprojects completed by September 2018.

1.3 All works contracts awarded by 31 March 2019 and works completed by 30 September 2020; defect liability period ends by 31 March 2021.

2. Improved water resource management

2.1 FWUCs formed by 30June 2017.

2.2 FWUCs trainings completed by 31 December 2017.

2.3 Meteorological stations and river flow gauging stations installed by 31 December 2018.

2.4 Joint reservoir operation of Stung Chinit and TaingKrasaing reservoirs designed by 30 June 2018; and MOWRAM, PDWRAMS, FWUCS and provincial authorities adopt it by June 2019 through a formal agreement.

Project Management Activities

Project management and implementation consultants mobilized by 30 June 2016.
Goods procured by 30 June 2016.
PPMS established by September 2016.

Inputs

ADB: $60,000,000
Government:$6,120,000

Assumptions for Partner Financing

Not Applicable

ADB = Asian Development Bank; FWUC = farmers water user communes; LRM = loan review mission; MAFF = Ministry of Agriculture, Forest and Fisheries; MEF = Ministry of Economy and Finance; MOWRAM = Ministry of Water Resources and Meteorology; O&M = operation and maintenance; PCR = project completion report; PMU = project management unit; PPMS = project performance monitoring system; QPR = quarterly progress report.
Source: Asian Development Bank.

B. Monitoring

71. **Project performance monitoring.** A project performance monitoring system (PPMS), has been developed (**Appendix 3**) based on the key indicators and targets outlined in the project design and monitoring framework (DMF). It shall be established after the IA will develop comprehensive PPMS procedures and plans in accordance with *ADB's Project Performance Monitoring System Handbook* within six months of loan effectiveness with support of PMIC. The PPMS procedures, performance indicators, and their targets will be reviewed and approved by ADB. Benchmark review mainly focusing on secondary data will be conducted. With the help of PMIC, the IA will then undertake every six months quantitative and qualitative project-performance monitoring for each project component to evaluate the delivery of planned facilities and the project benefits that accrued.

72. **Compliance monitoring.** A number of assurances have been given by the Government to ensure smooth implementation of the Project. Those are subject to the Loan covenants (Loan Agreement –schedule 5). ADB will monitor compliance with those covenants during the Project implementation through regular review missions, quarterly progress reports submitted by the PMU, and review of project accounts and procurement procedures.

73. **Social safeguards monitoring.** The Resettlement Framework details monitoring and reporting requirements for involuntary resettlement. In essence, both internal and external monitoring will be conducted. PMU will be responsible for internal monitoring while an external monitoring agency will be hired to conduct external monitoring and evaluation for involuntary resettlement. Internal and external monitoring will produce quarterly monitoring reports.

74. **Gender and social dimensions monitoring.** The progress of gender and social activities outlined in the GAP will be reported by the PMU in QPRs. Achievement of performance indicators of the GAP outlined in the DMF will be updated six monthly in the PPMS.

C. Evaluation

75. The IA, with support of the PMIC, will provide six monthly updates of the Project’s performance through PPMS. The status of achievement of performance targets/indicators of the Project’s outcome and output will be provided in the six monthly updates. ADB review missions will review the PPMS bi-annually to evaluate the Project’s performance and likelihood of delivering the desired outputs and achieving the envisaged outcome. The corrective actions will be agreed with the EA/IA and recorded in the aid memoirs/MOUs and subsequently monitored by ADB and the EA.

D. Reporting

76. The EA will provide ADB with (i) quarterly progress reports in a format consistent with ADB's project performance reporting system; (ii) consolidated annual reports including (a) progress achieved by output as measured through the indicator's/performance targets, (b) key implementation issues and solutions; (c) updated procurement plan and (d) updated implementation plan for next 12 months; and (iii) a project completion report within 6 months of physical completion of the Project. To ensure projects continue to be both viable and sustainable, project accounts and the executing agency AFSs, together with the associated auditor's report, should be adequately reviewed.

E. Stakeholder Communication Strategy

77. The main stakeholders of the Project are categorized into Government, Beneficiaries and Affected Persons/Groups, Civil Society Organizations and NGOs, the Private Sector and the Development Partners. The stakeholders communication strategy is explained as follows:

Stakeholders	Information Required	Who will provide	Strategy/Means
Government Key Stakeholders • MOWRAM, PDWRAMs • FWUC DEPARTMENT • PMU • MEF • MAFF	Full access to all information on all aspects of project planning and implementation	PMU, ADB	QPRs, PPMS, External monitoring reports of safeguards, ADB website, ADB mission aid memoirs
Beneficiaries and Project Affected Persons/Groups • Farmers • FWUC • Other Water users (private companies, domestic water supply)	Information on Project Planning, design, implementation, and expected contributions	MOWRAM, PDWRAMs, ADB	Consultations with FWUCs and beneficiaries, QPRs, PPMS, External monitoring reports of safeguards, ADB website, ADB mission aid memoirs
Civil Society Organizations and NGOs	Project plans and activities and impact on target groups	MPWRAM, PDWRAMs, ADB	Consultations with FWUCs and beneficiaries, QPRs, PPMS, External monitoring reports of safeguards, ADB website, ADB mission aid memoirs
Private Sector • Construction Companies	Procurement of contracts	PMU	MOWRAM website
International Development Partners	Project progress and performance	MOWRAM, PMIC, MEF	MOWRAM website, QPRs, PPMS

X. ANTICORRUPTION POLICY

78. ADB reserves the right to investigate, directly or through its agents, any violations of the Anticorruption Policy relating to the Project.[17] All contracts financed by ADB shall include provisions specifying the right of ADB to audit and examine the records and accounts of the executing agency and all Project contractors, suppliers, consultants and other service providers. Individuals/entities on ADB's anticorruption debarment list are ineligible to participate in ADB-financed activity and may not be awarded any contracts under the Project.[18]

79. To support these efforts, relevant provisions are included in the loan agreement, project agreement and the bidding documents for the project. In particular, all contracts financed by ADB in connection with the project will include provisions specifying the right of ADB to audit and examine the records and accounts of the executing agency and all contractors, suppliers, consultants, and other service providers as they relate to the project.

[17] Available at: http://www.adb.org/Documents/Policies/Anticorruption-Integrity/Policies-Strategies.pdf
[18] ADB's Integrity Office web site is available at: http://www.adb.org/integrity/unit.asp

XI. ACCOUNTABILITY MECHANISM

80. People who are, or may in the future be, adversely affected by the project may submit complaints to ADB's Accountability Mechanism. The Accountability Mechanism provides an independent forum and process whereby people adversely affected by ADB-assisted projects can voice, and seek a resolution of their problems, as well as report alleged violations of ADB's operational policies and procedures. Before submitting a complaint to the Accountability Mechanism, affected people should make a good faith effort to solve their problems by working with the concerned ADB operations department. Only after doing that, and if they are still dissatisfied, should they approach the Accountability Mechanism.[19]

[19] For further information see: http://www.adb.org/Accountability-Mechanism/default.asp.

XII. RECORD OF PAM CHANGES

81. All revisions/updates during the course of implementation will be retained in this Section to provide a chronological history of changes to implementation arrangements recorded in the PAM.

Annex 1
TERMS OF REFERENCE FOR CONSULTING SERVICES

I. BACKGROUND

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

A. Outputs

2. **Enhanced efficiency and climate resilience of irrigation systems.** The Project will support rehabilitation, modernization, and climate proofing of Taing Krasaing and O Kra Nahk irrigation systems in the Kampong Thom province and Prek Chik irrigation system in Battambang province. It will (i) rehabilitate main and distribution canals and appurtenant structures, (ii) install water measurement gauges at all inlets and outlets of canals, and (iii) reinstate/improve drainage facilities to protect agricultural land and canals from potential flooding that may be caused by high intensity-long duration rains due to climate change.

3. **Improved water resource management.** The Project will (i) organize farmer water user communes (FWUCs) and provide gender inclusive trainings to members of the FWUCs in operation and maintenance of canals, management of FWUCs, (ii) install hydro-meteorological stations in the watersheds, (iii) establish canals flow measurement system, (iv) train staff of PDWRAM, FWUCs and MAFF on modern canal operation techniques, irrigation scheduling, watershed management, and water management, (v) modernize canal operations; (vi) design joint reservoir operation of Stung Chinit and Taing Krasaing reservoirs in Kampong Thom province, and Bassac and Dauntri reservoirs in Battambang province to improve water sharing arrangements between linked systems.

B. Impact and Outcome

4. The Project impact will be increased farm incomes and outcome will be enhanced water and agricultural productivity.

II. PROJECT MANAGEMENT AND IMPLEMENTATION CONSULTANTS

5. The Project will construct/rehabilitate/improve/modernize the Taing Krasaing, Prek Chik and O Kra Nahk irrigation systems and other non-core subprojects, selected during the preparation period. Full feasibility studies for both Taing Krasaing and Prek Chik systems have been carried out. The detailed engineering design of the main canal and preliminary design of the distribution system have been done. The detailed engineering design of the distribution system is to be done after carrying out topographic surveys. The feasibility study and detailed design of the O Kro Nhak irrigation system in Kampong Thom will be done by PMIC, if the subproject is found feasible, otherwise another irrigation system will be selected for carrying out feasibility study and detailed design. Same approach will be adopted for other non-core subprojects.

A. Scope and Objective of the Services

6. The objective of the consulting services is to provide management and technical

assistance to the EA and IA in the implementation of the Project and strengthen technical and management capacities of the participating government agencies and FWUCs.

7. The scope of work will include but not be limited to the following:
   (i) Carry out detailed engineering design of the secondary and tertiary canals in the Taing Krasaing and Prek Chik irrigation systems;
   (ii) Carry out feasibility study of the O Kra Nahk Irrigation system in Kampong Thom and any other system if O Kra Nahk is not found feasible;
   (iii) Carry out detailed engineering design of the O Kra Nahk or other subproject that is considered feasible for financing;
   (iv) Detailed planning of yearly activities in all aspects of the agreed and foreseen construction schedule;
   (v) Prepare bidding documents of subprojects;
   (vi) Provide assistance to PMU in procurement of works, goods, services;
   (vii) Supervise construction of civil works;
   (viii) Ensure timely completion, adherence to specifications, and quality of construction works;
   (ix) Coordinate installation of hydro-met stations by ADB's GMS Flood and Drought Risk Management and Mitigation Project;
   (x) Establish modern canal operations systems;
   (xi) Form three FWUCs in the subprojects' areas, and provide them trainings. Following FWUC sub-decree approved by the Government in 2015, facilitate involvement of FWUCs in the subproject implementation, and operation & maintenance;
   (xii) Estimate operation and maintenance (O&M) cost of each subproject and assist FWUCs in establishing O&M system;
   (xiii) Prepare irrigation scheduling of each system and train FWUCs and PDWRAMs;
   (xiv) Coordinate with ADB's Rice-SDP project and link farmers with that for introducing use of improved seeds, fertilizers, and benefiting from agriculture value chain established under Rice-SDP;
   (xv) Coordinate with Rice-SDP project for laser levelling of 2,000 hectare;
   (xvi) Prepare quarterly progress reports (QPRs);
   (xvii) Establish Project Performance Monitoring System (PPMS), update on six monthly basis;
   (xviii) Assist the PMU in the financial management of the Project such as the management of impress account, preparation of withdrawal applications, accounting, and internal audit, coordination with finance department of the MOWRAM on project finance/accounting system;
   (xix) Design joint reservoir operation of Stung Chinit and Taing Krasaing reservoirs in Kampong Thom province, and Bassac and Dauntri reservoirs in Battambang province to improve water sharing arrangements between linked systems and assist MOWRAM in adopting those;
   (xx) Estimate irrigation service fee (ISF) for each irrigation system based on the estimate of annual O&M requirements of the secondary and tertiary canals and prepare O&M plans;
   (xxi) Estimate annual O&M cost of the main canals and prepare O&M plans to be adopted by PDWRAM/MOWRAM;
   (xxii) Facilitate tripartite agreement between PDWRAM/MOWRAM, FWUCs and Private Land Owners. Estimate the amount of water to be provided to the private owners and service fee to be paid by them;
   (xxiii) Carry out environmental and social due diligence of each subproject;

(xxiv) Prepare IEE of each subproject;
(xxv) Prepare Resettlement Plan of category B subprojects;
(xxvi) Ensure compliance with ADB'' Safeguards Policy Statement (SPS-2009);
(xxvii) Provide trainings to PDWRAM, PMU, MAF and Ministry of Agriculture, Forest and Fisheries (MAFF) staff in irrigation and water management, watershed management, operations of canals
(xxviii) Ensure technology and know-how transfer from the PIMC to their counterparts in the PMU;
(xxix) Establish canals flow measurement systems;
(xxx) Establish modern canal operation systems;
(xxxi) Develop and conduct Focused Information and Awareness program for the FWUCs and other stakeholders; and
(xxxii) Any other activities for delivering the envisage outputs of the Project and achieving desired outcome.

8. Consultancy services will comprise the following teams for providing assistance to the EA and the IA in the implementation and management of the Project:

(i) **The Project Management Team will be** located within PMU at Phnom Penh. The team will provide support in overall coordination and management of the project including procurement, progress and performance monitoring and reporting, financial management, safeguards compliance, organizing and training FWUCs, and training the PMU and other government staff to ensure effective project implementation.
(ii) **Feasibility and Design Team** will also be located in the PMU. This team will carry out feasibility studies of the subprojects and prepare detailed engineering design, drawings, bill of quantities, construction schedules and tender documents.
(iii) **Construction Supervision Teams** will be located at PDWRAM Kampong Thom and in PDWRAM Battambang. The teams will be responsible for supervising the construction works, progress reporting, and quality assurance.

B. Duration of Assignment and Inputs Required

9. The project implementation period of the consultant services is **60 months (1 April 2016 to 31 March 2021).** A total of **674 person months** including **64** person-months of the International experts and **610** person-months for the National experts would be required. The estimated staffing and expertise person-months requirements per component are summarized below:

Table 1: Summary of Consulting Services Requirements

Positions	Peron-Months Required	
	International	National
Team Leader/Water Resources Specialist	24	-
Institutional/Training Specialist for FWUCs	4	12
Procurement Specialist & Contract Specialist	12	24
Financial and Accounting Specialist	6	54
Hydrologist	12	24
Deputy Team Leader/ Irrigation Management Specialist	-	54
Hydraulic Structural Engineer	-	24
Monitoring and Evaluation Specialist	6	24
Construction Management Engineer	-	108
Agricultural Specialist/Agronomist	-	10
Materials/Quality Control Engineer	-	24
Gender Specialist	-	18
Social Safeguards/ Resettlement Specialist	-	24
Environment Specialist	-	18
Assistant Engineers	-	192
Total	**64**	**610**

C. Terms of Reference of Experts

1. International Experts

10. **Team Leader/Water Resources Specialist,** (24 person-months): The expert will have a Master's degree in water resources engineering/management with preferably 15 years of experience in design, implementation and management for water sector projects including dams, barrages and irrigations systems; and team leadership of preferably 2 ADB financed projects. The candidate must have demonstrated ability to lead teams composed of international and national consultants and create a strong working relationship with the EA/IA. Excellent communication (written and oral) skills and strong inter-personal skills will be considered an asset. The Team Leader will: (i) provide overall responsibility for technical support during implementation, including preparation and implementation of work plans; (ii) coordinate financial management; (iii) monitor progress against project implementation schedule and coordinate preparation and submission of periodic progress reports and technical reports; (iv) work closely with MOWRAM-PMU and advise the Project Director (PMU); (v) maintain good coordination among ADB, PMU and others stakeholders and assure links with key institutions as MAFF, MEF and Local Authorities; (vi) Provide guidance to Team to ensure that the quality of works meet a required standard; (vii) monitor work of the Civil Works Contractors; (viii) assist PMU in contracts management; (ix) monitor financial performance of the Project; (x) monitor the environment, health and safety, quality assurance & control, resettlement and social safeguards aspects to bring minimum delays to the project work; and (xi) coordination with on-going ADB-financed projects for the installation of hydro-met and telemetry, FWUC training and other support to provincial and district agencies,

11. **Institutional/Training Specialists for FWUCs,** (4 person-months): The expert will have a Master's degree in related field with preferably 10 years of experience in similar work with donor financed projects. The candidate will have demonstrated ability to work in a

multidisciplinary team and will possess excellent communication (written and oral) skills. Tasks include: (i) review of the Project related documentation to assess current capacity and capacity building objectives and implications of proposed investments under the Project; (ii) undertake need assessment at various levels of implementation (PMU and FWUCs) to determine the capacity building needs at these levels; (iii) prepare training programs for FWUCs/other stakeholders; (iv) prepare training program for PMU staff and coordinate with existing ADB-financed projects with capacity development components on sharing of resources; (v) prepare guidelines for FWUC selection, establishment, and trainings; (vi) map existing FWUCs and prepare a plan for organizing and/or strengthening FWUCs in coordination with the MOWRAM and PDWRAM; (vii) work closely with PDWRAMs to establish the important link of PDWRAMs with FWUCS; and (viii) provide trainings.

12. **Hydrologist**, (12 person-months): The expert will have a Master's degree in hydrology/water resources engineering with preferably 10 years of experience in hydrological studies, modelling and estimating flows. He /She will have demonstrated ability to work in a multidisciplinary team and excellent communication skills in spoken and written English. Tasks include: (i) design joint reservoir operation of Bassac and Dauntri reservoirs and Stung Chinit an Tain Krasaing reservoirs and facilitate MOWRAM in adopting those; (ii) carry out hydrological studies for subprojects and update the hydrological analysis and data for the purpose of determining water availability; (iii) in close coordination with the GMS Flood and Drought Project, facilitate and monitor installation of the Hydro-met stations and assure institutional operations, data collection and processing, and develop linkage with reservoir operators (PDRWAM) to use data made available for joint reservoir operations and irrigation scheduling; (iv) supervise installation of canal flow measurement gauges; (v) assist in modernizing canal operations; (vi) assist in designing discharge capacity of distribution canals based on crop water requirements in command area of each tertiary and secondary canal; and (vii) provide awareness and trainings on watershed management.

13. **Procurement and Contract Management Specialists,** (12 person-months): The expert will have a Master's degree in business administration, engineering or other related fields with preferably 10 years' experience in procurement of works and goods, preparation of tender and contract documents, evaluation of bids, and contracts managements of projects, and recruitment of consultants including at least one ADB financed project. The specialist should have demonstrated experience with developing and managing FIDIC contracts for large works. Tasks include: (i) assist the PMU in preparing bidding documents; (ii) assist the PMU in preparing RFP for external monitoring agency (EMA); (iii) assist PMU in the evaluation of bids/ proposal, prepare bid evaluation reports/submission for recruitment of EMA; (iv) assist PMU in negotiations and finalizing contract agreements for works, goods and services; (v) develop, and organize contract management capacity building and training covering FIDIC, and ADB procurement guidelines and procedures for the project implementation staff of the EA and PMU; (vi) advise Team Leader/team on the progress reporting, quality control and inspection systems to be followed during execution of civil work contracts; and (vii) advice PMU in resolving contractual issues.

13. **Financial Specialist**, (6 person-months): The expert will have Master's degree in Finance/Accounting with preferably 10 years of relevant work experience, including working with international consultants in donor funded projects. The expert will have demonstrated ability to work in a multidisciplinary team and will possess excellent communication (written and oral) skills. Tasks include: (i) assist the EA in preparing withdrawal applications to ADB and management of impress account in accordance with ADB disbursement guidelines; (ii) assist in developing procedures for financial disbursement, accounting, reporting and auditing of O&M

budget for the subprojects in accordance with procedural requirements of the Government and ADB; and (iii) assist in processing ADB loan withdrawal including certificates and reporting formats for efficient flow of funds between ADB, Government, and contractors.

14. **Monitoring and Evaluation Specialist,** (6 person-months): The expert will have a Master's degree in related field with preferably 10 years of relevant work experience. He /she will have experience working with international consultants preferably in donor funded projects. He/she will have demonstrated ability to work in a multidisciplinary team and will possess excellent communication skills in spoken and written English. The expert will: (i) establish the project performance monitoring system (PPMS) and update every six months; (ii) establish data collection, analysis and reporting mechanism for the PPMS; (iii) collet benchmark/baseline date for performance indicators in the DMF; (iv) prepare quarterly progress reports (QPRs), annual reports and Borrower's project completion report.

2. National Experts

14. **Deputy Team Leader/Irrigation Management Specialist,** (54 person-months): The expert will have a Master's degree in water resources/irrigation engineering and preferably 10 years of experience in design, implementation and management of irrigations systems. Experience of working with international consulting firms in donor funded projects and government institutes will be considered an asset. The candidate must have demonstrated ability to work in a multidisciplinary team and excellent communication skills in spoken and written English. In the absence of the Team Leader, the Deputy Team Leader will assume the management of the Project. Tasks include: (i) assist the Team Leader in management and implementation of the Project; (ii) supervise feasibility studies, detailed design and construction supervision of the subprojects; (iii) ensure effective coordination with the EA and other government agencies; (iv) prepare O&M plans for subprojects; (iv) assist M&E specialist on data collection for QPRs and PPMs; (v) assess irrigation efficiency and water productivity and incorporate measures to improve efficiency and water productivity in design of subprojects; (vi) prepare irrigation schedules based on crop water requirements; (vii) ensure timely completion of works contracts and other activities; (viii) ensure timely preparation of QPRs and PPMS.

14. **Procurement & Contract Specialists,** (24 person-months) The national procurement & contracts specialist will have a Master's degree in business administration, engineering or other related field with preferably 7 years' experience in procurement of works and goods, recruitment of consultants, preparation of tender and contract documents, evaluation of bids, and contract management including one ADB loan project. He /she will have demonstrated ability to work in a multidisciplinary team and excellent communication (written and oral) skills. The national expert will provide support to the Team Leader and International Procurement & Contract Specialists to: (i) assist the PMU in preparing bidding documents; (ii) assist the PMU in preparing RFP for external monitoring agency (EMA); (iii) assist PMU in the evaluation of bids/ proposal, prepare bid evaluation reports/submission for recruitment of EMA (iv) assist PMU in negotiations and finalizing contract agreements for works, goods and services; (v) develop, and organize contract management capacity building and training covering FIDIC, and ADB procurement guidelines and procedures for the project implementation staff of the EA and PMU (vi) advise Team Leader/team on the progress reporting, quality control and inspection systems to be followed during execution of civil work contracts; and (vii) advice PMU in resolving contractual issues.

15. **Financial and Accounting Specialist**, (54 person-months); The expert will have a Master's degree in Finance/Accounting with preferably 7 years of relevant work experience

including experience working with international consultants preferably in donor funded projects and government institutes He /she will have experience in financial management and accounting of preferably on one ADB financed project and will have excellent communication skills in spoken and written English. Tasks include: (i) assist the EA in preparing withdrawal applications to ADB, management of impress account, in accordance with ADB disbursement guidelines; (ii) assist in developing procedures for financial disbursement, accounting, reporting and auditing of O&M budget for the subprojects in accordance with procedural requirements of the Government and ADB; and (iii) assist in processing ADB loan withdrawal including certificates and reporting formats for efficient flow of funds between ADB, Government, and contractors.

16. **Institutional/Training Specialists for FWUCs,** (12 person-months): The expert will have a Bachelor's degree in related field and preferably 5 years of relevant work experience; including experience working with international consultants preferably in donor funded projects and government institutes. He /she will have demonstrated ability to work in a multidisciplinary team and excellent communication skills in spoken and written English. The National Institutional/Training Specialists will assist the International expert to: (i) review the Project related documentation, to assess current capacity and capacity building objectives and implications of proposed investments under the Project; (ii) undertake need assessment at various levels of implementation (PMU and FWUCs) to determine the capacity building needs at these levels; (iii) prepare training programs for FWUCs/other stakeholders; (iv) prepare training program for PMU staff and coordinate with existing ADB-financed projects with capacity development components on sharing of resources; (v) prepare guidelines for FWUC selection, establishment, and trainings; (vi) map existing FWUCs and prepare a plan for organizing and/or strengthening FWUCs in coordination with the MOWRAM and PDWRAM; (vii) work closely with PDWRAMs to establish the important link of PDWRAMs with FWUCS; and (viii) provide trainings.

17. **Monitoring and Evaluation Specialist,** (24 person-months): The expert will have a Master's degree in related field with preferably 5 years of relevant work experience. He /she will have experience working with international consultants preferably in donor funded projects. He/she will have demonstrated ability to work in a multidisciplinary team and will have excellent communication skills in spoken and written English. The expert will: (i) assist in establishing the project performance monitoring system (PPMS) and update every six months; (ii) establish data collection, analysis and reporting mechanism for the PPMS; (iii) collet benchmark/baseline date for performance indicators in the DMF; (iv) prepare quarterly progress reports (QPRs), annual reports and Borrower's project completion report.

18. **Hydraulic Structural Engineer,** (24 person-months): The expert will have a Master's degree in water resources engineering/hydraulics engineering with preferably 5 years of experience in design of hydraulic structures including small dams, weirs, and irrigation systems; cost estimation, preparation of BOQs, including experience working with international consultants preferably in donor funded projects. He /she will have demonstrated ability to work in a multidisciplinary team and excellent communication skills in spoken and written English. The National Hydraulic Structural Engineer will assist the International expert in: (i) review and update of hydraulic calculation of canal, drain and hydraulic structures of the Taing Krasaing and Prek Chik main canals; (ii) design canals, drains and appurtenant structures of all other subprojects; (ii) estimate cost of subprojects, prepare BOQs, tender drawings and complete all other requirements for award and construction of work contracts; (iii) supervise topographic surveys, review the results of the topographical survey and geotechnical studies and integrate these considerations in the design.

19. **Hydrologist**, (24 person-months): The expert will have a Master's degree in hydrology/water resources engineering with preferably 5 years of relevant work experience; including experience working with international consultants preferably in donor funded projects. He /She will have demonstrated ability to work in a multidisciplinary team and excellent communication skills in spoken and written English. Tasks include assisting international hydrologist to: (i) design joint reservoir operation of Bassac and Dauntri reservoirs, and Stung Chinit an Tain Krasaing reservoirs and facilitate MOWRAM in adopting those; (ii) carry out hydrological studies for subprojects and update the hydrological analysis and data for the purpose of determining water availability; (iii) In close coordination with the GMS Flood and Drought Project, facilitate and monitor installation of the Hydro-met stations and assure institutional operations, data collection and processing, and develop linkage with reservoir operators (PDRWAM) to use data made available for joint reservoir operations and irrigation scheduling; (iv) supervise installation of canal flow measurement gauges; (v) assist in modernizing canal operations; (vi) assist in designing discharge capacity of distribution canals based on crop water requirements in command area of each tertiary and secondary canal; (vii) provide awareness and trainings on watershed management.

20. **Agriculture Specialist/Agronomist,** (10 person-months): The expert will have a Master's degree in agronomy with preferably 5 years' experience in estimating crop water requirements, designing cropping patterns and cropping intensities. He /she will have demonstrated ability to work in a multidisciplinary team and excellent communication skills in spoken and written English. Tasks include: (i) work closely with hydraulics design engineer to map out the existing cropping patterns in the subprojects' command area; (ii) identify current practices of famers within the subproject area on the farming technique; (iii) identify agro input (fertilizer, pesticide, herbicide) and agro-tools which are used in the project area; (iv) propose cropping pattern and intensities to farmers by taking into account the soils quality, climatic condition, crop water requirement and water availability; (v) prepare cropping calendars for the each subproject; (vi) provide inputs in the feasibility studies and design; (vii) track yields and harvest and post-harvest issues faced by FWUCS; (viii) assess seed types used and impact on cropping calendars proposed and agreed by PDWRAMs – FWUC; and (ix) facilitate farmers access to quality seed and agriculture value chains through coordination with Rice-SDP.

21. **Materials/Quality Control Engineers,** (2 positions, 12 months each): The experts will have a Bachelor's degree in Civil Engineering with preferably 5 years' experience in quality control of construction projects preferably canals and hydraulic structures with an International/Multinational consultancy/construction firm. Their task will be to ensure the quality of construction is as per the design specifications. They will carry out on site quality tests as well as review the laboratory tests of the materials submitted by the contractors.

22. **Social Safeguards/Resettlement Specialist,** (24 person-months): The expert will have Bachelor's degree in social sciences with preferably 5 years of relevant work experience including experience working with international consultants, preferably in donor funded projects and government institutes. He/she will have experience of working on ADB financed projects and fully familiar with ADB's Safeguard Policy Statement (SPS), 2009. He/she will have demonstrated ability to work in a multidisciplinary team and excellent communication skills in spoken and written English. Tasks include: (i) screen subprojects for involuntary resettlement impacts to determine eligibility of the subproject for financing under the project; (ii) for subprojects with involuntary resettlement impacts, prepare Resettlement Plans in accordance with the Resettlement Framework; (iii) assist and supervise detailed design of subprojects to ensure involuntary resettlement impacts are minimized, if not avoided; (iv) based on detailed design, conduct detailed measurement survey and update the Resettlement Plan in accordance

with the Resettlement Framework; (v) assist in organizing and conducting consultations with affected people to ensure that the Resettlement Plan have been fully discussed and agreed; (vi) assist PMU and field staff in the implementation of Resettlement Plans in the subproject areas; (vii) develop and conduct training modules to ensure proper understanding and implementation of Resettlement Plans; (viii) monitor implementation of Resettlement Plans; and (ix) contribute to the PPMS for monitoring and reporting on resettlement by developing monitoring and evaluation indicators for involuntary resettlement and assisting in the preparation of monitoring reports for involuntary resettlement.

23. **Gender Specialist,** (18 person-months). The Gender specialist will have a Bachelor's degree with preferably 5 years of experience in gender and development. He/she will have experience of working with ADB financed projects and fully familiar with ADB's gender policy. He/she will have demonstrated ability to work in a multidisciplinary team and excellent communication skills in spoken and written English. The specialist will: (i) lead the implementation, monitoring and reporting of gender action plan (GAP); (ii) train project gender focal persons while working closely with IA/EA gender team as well as other projects Specialists; and (iii) ensure achieving the targets. The specialist will prepare periodic gender monitoring report and provide gender disaggregated data to M&E Specialist.

24. **Environment Specialist,** (18 person-months): The specialist will have: (i) an undergraduate degree or higher in environmental management or related field; (ii) at least 10 years of experience in environmental management, monitoring, and/or impact assessment; (iii) familiarity with ADB environmental safeguards requirements and national environmental management procedures; (iv) ability to communicate and work effectively with local communities, contractors, and government agencies; (v) ability to analyze data and prepare technical reports; (vi) willingness and health to regularly visit the sub-project sites; and (vii) proficiency in spoken and written English. Working closely with the PMO and the PMO Environmental Management Officer, and other relevant personnel and agencies, the specialist will assist in all aspects of the implementation of the project EARF and subproject IEEs. The specialist will: (i) Ensure that the steps of the EARF covering environmental screening and impact assessment are followed by PMUs; (ii) Deliver training in (a) EARF procedures for screening, and assessing environmental impact (IEEs); and (b) record-keeping and reporting; (iii) Assist the PMO and PMUs to establish and publicize the grievance redress mechanism (GRM) for sub-projects, ensuring that the GRM publicity is appropriate to the scale and complexity of the sub-project and includes, as a minimum, the disclosure of all contact persons for lodging complaints; and (iv) Assist the PMO to prepare quarterly (during construction) and semi-annual project monitoring progress reports (otherwise) for submission to ADB within 2 months after each reporting period.

25. **Construction Management Engineers,** (2 positions, 54 months each): The experts will be qualified Civil Engineers, with Master's degree in construction management with 7 years of experience of managing construction canals and hydraulic structures of donor financed projects. They will have demonstrated ability to work in a multidisciplinary team and excellent communication skills in spoken and written English. Their tasks include: (i) prepare construction schedules; (ii) ensure construction progress adheres to the schedules; (iii) supervise the work of assistant engineers; (iv) monitor progress and quality of construction works; (v) review measurements for completed works, and verify bills for payment; (vi) take measures to minimize contract variations; (vii) assess adequacy of contractors' input in terms of materials, equipment, construction machinery, workers, and construction approach and methodologies; (viii) monitor physical and financial progress against the milestones, for timely completion; (ix) review and approve the construction drawings of the contractor and permit the contractors to carry out

construction work effectively and efficiently and to the highest standards of quality; and (x) report progress, disputes and all the other matters to the Team Leader.

26. **Assistant Engineers**, (4 positions, 48 person-months each). Qualified Engineer, with Bachelor's degree in Civil Engineering and preferably 5 years of experience in site supervision of construction works preferably canals and hydraulic structures. They will have demonstrated ability to work in a multidisciplinary team and excellent communication skills in spoken and written English. Tasks include: (i) reporting to the Construction Management Engineer; (ii) supervise and monitor the construction of works, prepare measurements for works completed and in progress; (iii) certify contractors' bills; (iv) Check the construction schedule submitted by contractor, and assist contractor's site manager to make detailed construction plan; (v) report weekly and monthly construction progress and issues to the Construction Management Engineer; (vi) report field variations to the Construction Management Engineer and regularly monitor physical and financial progress against the milestones, according to the contracts to ensure the completion of the contracts on time; (vii) examine contractors' claims for time extension, variations, and additional compensation, etc., and recommend appropriate decisions to the Construction Management Engineer; (ix) Assist PMU in resolving contractual issues and overall contract management; and (x) ensure quality of construction as per design specifications.

D. Deliverables

27. Deliverables will include:

(i) **Inception Report** – within 3 months of mobilization – presenting approach to tasks and reporting, with details of how each task will be performed, and identifying what resources will or may be required.

(ii) **Quarterly Progress Reports (QPRs) -** summarizes the highlights per quarter, the activities undertaken and a summary of disbursements; physical and financial progress of the Project; achievements of targets for outputs and inputs defined in the DMF, to be submitted within 7 working day of the first month of the succeeding quarter.

(iii) **Project Performance Monitoring Reports (PPMS) -** shall be submitted every six months, highlighting the performance based on the DMF targets

(iv) **Borrower's Project Completion Report** (At completion of the Project).

E. Client's Input and Counterpart Personnel

28. Services, facilities and property to be made available to the Consultant by the Client:

(i) All available project reports and data. Feasibility Reports of Taing Krasaing and Prek Chik irrigation systems and detailed engineering design and drawings of main canals;

(ii) Office space with furniture and office equipment at Phnom Penh, Battambang and Kampong Thom; and

(iii) Vehicles.

III. EXTERNAL MONITORING AGENCY FOR SAFEGUARDS

A. Objectives

29. The Project requires the services of external monitoring and evaluation experts[20]/qualified non-government organizations (NGOs) to conduct an external assessment of the extent to which resettlement and rehabilitation objectives are being met. Specifically, the objectives of the monitoring program are:

(i) To verify ongoing internal monitoring information;
(ii) To verify whether the overall project and resettlement objectives are being met in accordance with the Resettlement Framework (RF), and if not to suggest corrective measures;
(iii) To assess the extent to which implementation of Resettlement Plans (RPs) complies with the RF;
(iv) To identify problems or potential problems;
(v) To identify methods of responding immediately to mitigate problems and advise MOWRAM and IRC accordingly; and
(vi) To verify if the livelihoods and the standard of living of affected persons (APs), including those of the non-titled displaced persons, are restored or improved;

B. Tasks

30. The external experts will address specific issues such as the following:

(i) Verify the detailed measurement survey (DMS) database generated by the project management unit (PMU), identify differences in inventory of loss (IOL) and/or DMS recorded in the RP, and document changes to the database;
(ii) Confirm that all APs are eligible for compensation, resettlement and rehabilitation assistance, irrespective of tenure status, social or economic standing, and any such factors that may discriminate against achieving the project objectives; Payment of compensation, allowances and other assistance are as per approved RP;
(iii) Confirm timing of disbursement of payment and assess that the level of compensation is sufficient to replace their losses;
(iv) Public consultation and awareness of key information in the resettlement plan;[21]
(v) Coordination of resettlement activities with construction schedule;
(vi) Land acquisition and transfer procedures;
(vii) Construction/rebuilding of replacement houses and structures on residual land, relocation sites (outside the residual land), and self-selected land;
(viii) Implementation of gender and/or Indigenous Peoples measures as indicated in the RP;
(ix) Level of satisfaction of APs with the provisions and implementation of the RP;
(x) Effectiveness of grievance redress mechanism (accessibility, documentation, process, resolution);
(xi) Effectiveness, sufficiency, impact, and sustainability of entitlements and income restoration programs and the need for further improvement and corrective measures, if any;

[20] External experts mean experts not involved in day-to-day project implementation or supervision.
[21] Key information in the RP include: Scope of Land Acquisition and Resettlement Impacts, Entitlement Matrix, Grievance Redress Mechanism.

(xii) Relocation site development (civic infrastructure and community services as required), identification and selection of sites in consultation with APs and host communities, equivalent or enhanced access to livelihood opportunities, process and timeliness of providing land titles/certificates;
(xiii) Capacity of APs to restore/re-establish livelihoods and living standards. Special attention will be given to severely affected APs and vulnerable APs;
(xiv) Involuntary resettlement impacts caused during construction activities;
(xv) Participation of APs in RP implementation; and
(xvi) Adequacy of budget and human resources[22] at executing agency/implementing agency level for resettlement activities, including internal monitoring.

C. Methodology

31. The methods for external monitoring activities include:
(i) Review of DMS process to be able to establish a baseline for monitoring and evaluating project benefits. The external monitoring organization (EMO) to check on a random basis[23] the DMS process with APs, from identification to agreement on DMS results. The EMO will also evaluate the DMS process to determine and assess if DMS activities are being carried out/was carried out in a participatory and transparent manner.
(ii) Resettlement audit conducted during monitoring. The EMO will carry out random checks of payments[24] disbursed to APs during monitoring. The EMO will submit a resettlement audit report upon completion of compensation payment to APs.
(iii) Review of socioeconomic data[25] prepared during the Project Preparatory Technical Assistance (PPTA). With this review, the DMS data, and additional data compiled, the EMO will provide the baseline data to be used in comparison to the post-resettlement survey. A post-resettlement survey will be carried out one year following completion of all resettlement activities, including livelihood restoration activities. Sampling will include at least 20% of severely affected and vulnerable households, as well as at least 10% of all other APs. Special attention will be paid to the inclusion of women, ethnic groups, the very poor, the landless and other vulnerable groups, with set questions for women and other target groups. The database will disaggregate information by gender, vulnerability, and ethnicity.
(iv) Participatory Rapid Appraisal (PRA), which will involve obtaining information, identifying existing or potential problems, and finding specific time-bound solutions through participatory means including: a) key informant interviews including representatives of civil society, community groups, and NGOs; b) focus group discussions (FGDs) on specific topics such as compensation payment, income restoration and relocation[26]; c) community public meetings to discuss community losses, integration of resettled households in host communities or construction work employment; d) direct field observations, for example, of resettlement site development; e) formal and informal interviews with affected households, women, ethnic minorities, and other vulnerable

[22] Assessment of human resources is in terms of both number of staff assigned, as well as capacity.
[23] Depending on number of affected households (AHs).
[24] Depending on number of AHs.
[25] Possible data sources include: census, IOL, socioeconomic survey, village records/documents.
[26] Groups that may be targeted for involvement in FGDs include AHs in general, and vulnerable AHs such as women-headed households, the poor, and ethnic minorities

groups to monitor and assess the progress the APs are making to restore their living standards, APs' perceived need for additional assistance (and type of assistance), and their individual satisfaction with current economic activities; and f) in-depth case studies of problems identified by internal or external monitoring that required special efforts to resolve. The PRA will also focus on good practices in land acquisition and involuntary resettlement objectives, approaches, and implementation strategies.

(v) Review the results of internal monitoring.

D. Timing & Team Composition

34. The external experts will conduct monitoring missions to be carried out on a quarterly basis starting from the completion of DMS for the first batch of subprojects until the completion of livelihood/income restoration activities in all subprojects. For subprojects where payment of compensation/allowances has been substantially completed, the external experts will also conduct resettlement audit mission to validate status of compensation and hand-over of plots and recommend issuance of (no-objection letter) NOL for the commencement of civil works.

35. The external monitoring and evaluation experts/qualified NGOs will be composed of one team leader with extensive experience in monitoring and evaluation of resettlement activities in the country with strong ability in preparing resettlement reports. He/she should demonstrate good communication skills and have at least a bachelor degree in a relevant field. The team leader will be assisted by at least 1 specialist with similar experience and background. All reports will be submitted in English (and in local language, if required) to the government and ADB simultaneously.

E. Deliverables

36. Inception report, including findings of review of baseline data, monitoring methodology and detailed work plan (in terms of sampling, timing, budget, other required resources)

37. Quarterly monitoring report, including (a) methods used by the EMO during the monitoring period; (b) progress of RP implementation, including any deviations from the provisions of the RP; (c) identification of problem issues and recommended corrective actions to inform implementing agencies and resolve issues in a timely manner (refer to Table 1); (d) identification of specific gender and ethnic minorities issues, as relevant; (e) report on progress of the follow-up of issues and problems identified in the previous reports; (f) lessons learned that might be useful for future activities; and, (g) resettlement audit report.

Table 1: Sample Corrective Action Plan Summary Table

No.	Survey code	Project Component	Village	Name of head of Affected Household/ Name of AP	Name or use of affected structure	Status of structures	Corrective Action	Budget (USD)	Schedule of implementation of corrective action
									By (date)

						Total			

38. Include Monitoring and Evaluation indicators (commonly a table in the RP). A set of suggested indicators are in Table 2[27], to be replaced with RP table as required:

Table 2: Indicators for Verification by External Experts

Monitoring Indicator	Basis for Indicator
Basic information on displaced persons' households (Gender disaggregated data essential for all aspects)	• Location of the project • Composition and structure, ages, educational, and skill levels • Gender of household head • Ethnic group • Access to health, education, utilities, and other social services • Housing type • Land and other resource-owning and resource-using patterns • Occupations and employment patterns • Income sources and levels • Agricultural production data (for rural households) • Participation in neighborhood or community groups • Access to cultural sites and events • Valuation of all assets
Restoration of living standards	• Were house compensation payments made free of depreciation, fees, or transfer costs to the displaced persons? • Have displaced persons adopted the housing options developed? • Have perceptions of community been restored? • Have displaced persons achieved replacement of key social and cultural elements?
Restoration of livelihoods (Disaggregate data for displaced persons moving to group resettlement sites, self-relocating displaced persons, displaced persons with enterprises affected)	• Were compensation payments free of deductions for depreciations, fees, or transfer costs to the displaced persons? • Were compensation payments sufficient to replace lost assets? • Was sufficient replacement land available of suitable standard? • Did income substitution allow for reestablishment of enterprises and production? • Have affected enterprises received sufficient assistance to reestablish themselves? • Have vulnerable groups been provided income-earning opportunities? • Are these opportunities effective and sustainable? • Do jobs provided restore pre-project income levels and living standards?
Levels of displaced persons' satisfaction	• How much do the displaced persons know about resettlement procedures and entitlements? • Do the displaced persons know their entitlements? • Do they know whether these have been met? • How do the displaced persons assess the extent to which their own living standards and livelihoods have been restored? • How much do the displaced persons know about grievance procedures and conflict resolution procedures?
Effectiveness of resettlement	• Were the displaced persons and their assets correctly enumerated?

[27] ADB. 2012. *Involuntary Resettlement Safeguards: A Planning and Implementation Good Practice Sourcebook – Draft Working Document.* Manila.

planning	• Was the time frame and budget sufficient to meet objectives, were there institutional constraints? • Were entitlements too generous? • Were vulnerable groups identified and assisted? • How did resettlement implementers deal with unforeseen problems?

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

ADB PPTA 8702: CAM

APPENDIX 6:

SUBPROJECT FEASIBILITY STUDY: PREK CHIK IRRIGATION SYSTEM

July 10, 2015

Table of Contents

Acronyms

List of Tables

List of Maps

List of Figures

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	Prek Chik 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

EXECUTIVE SUMMARY

1.1 The Project and Key Subproject Features

1. This Feasibility Report presents all elements and considerations of the Due Diligence investigations into the system **Prek Chik in Battambang province**. This system Prek Chik was selected as a core subproject for upgrading/rehabilitation/modernizing as part of the PPTA for the ADB-CAM 8702 Project Loan on Uplands Irrigation and Water Resources Management Sector project.

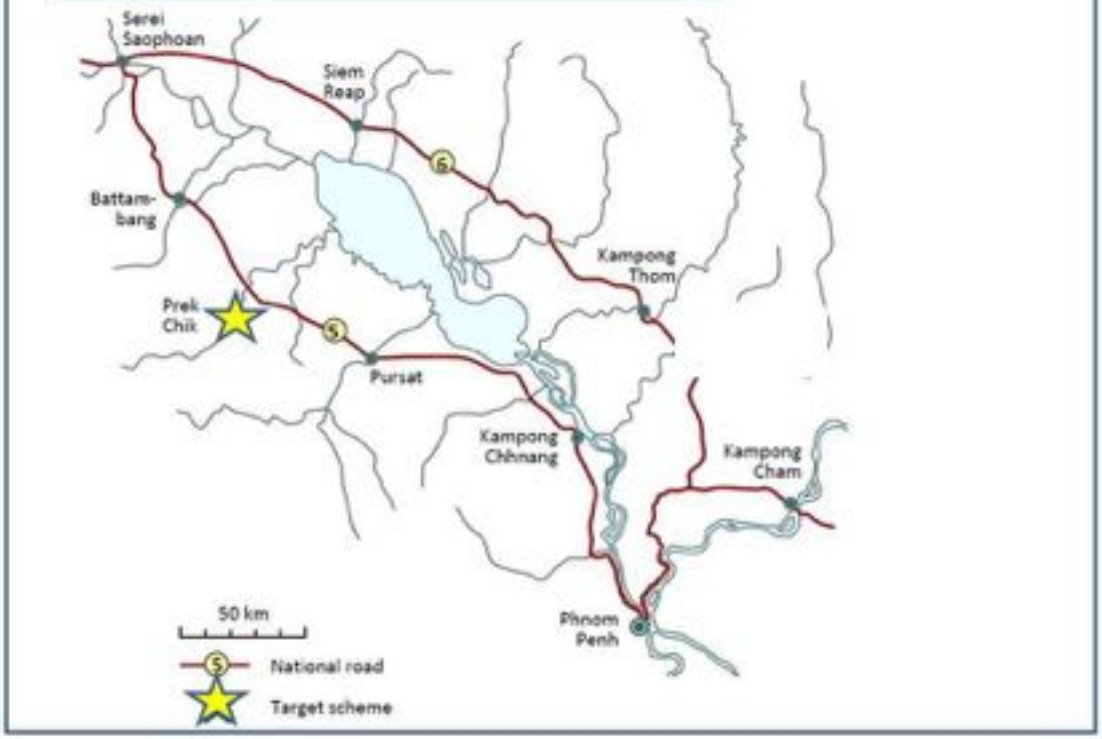
2. **The System: Size and Sections**: The total irrigable area of Prek Chik is 20,800 ha. The system is supplied from Bassac reservoir – 14 km away – at present empty and whose dam at present is undergoing to repair and replace 3 missing gates out of 7. Present information is that this repair is to be completed by March 2016 under the ADB-Flood Damage Emergency Project. Irrigation service is at present non-existing since the Bassac dam problems and has in fact never really occurred. The Secondaries and Tertiaries system is basically non-existing. All area is rainfed, with 90% on left side, and only some 10% on right side, as system slope right-to-left from main canal flow viewpoint.

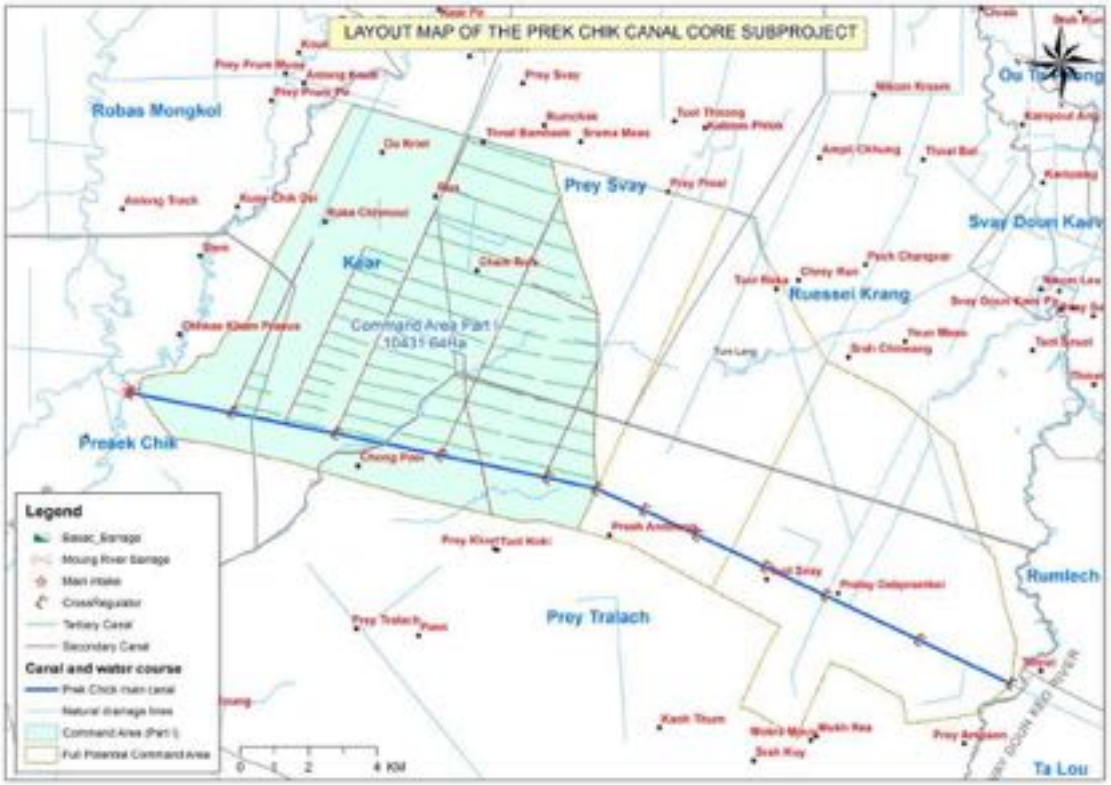
3. **The Main Canal:** The main canal of 28 km length, with a 15 m drop over this length, is in stable yet unmaintained condition; all its structures are in need of repair and upgrading. The canal serves often only as drain to relief flashflood water from its right side; some 18 drain-inlets have been constructed in its right side embankment to discharge these flood drainage waters into the main canal, to be transported and released in left side drain escapes into old streams, now blocked since canal construction.

4. **Water Supply and availability**. Prek Chik depends on Bassac reservoir, with an approximate storage of 7- 8 MCM. The plans for constructing the multi-purpose power and water supply dam at Dauntri – some 6 km upstream of Bassac - has been confirmed by MOWRAM in June 2015; therefore the initial inclusion of constructing as part of the Prek Chik project a single-purpose irrigation supply reservoir embankment for an additional 12 MCM storage has been excluded. However, in case the upstream located Dauntri Multi-purpose dam (6 km upstream of Bassac) is indeed constructed in the near future (over next 4 years), a reassessment of water supply and impact on water available for Prek Chik is required as significant additional water will become available for the 4 systems linked to Bassac, with Prek Chik being the largest (70% of total area to be supplied from Bassac).

5. **Approach for Prek Chik project** will be to first prepare only approx. half (50%) of command area for water delivery and, in view of uncertainties on completion of Dauntri, water sharing with other three systems supplied by Bassac reservoir, and overall limited data to predict to a degree of certainty of the water supplies available for wet season irrigation and area to be planted at beginning of dry season. The main canal of Prek Chik will however be prepared in full, both for all needed drainage relief works and irrigation off-takes. For Part 1, all Secondaries and Tertiaries are included. Part 2 may be undertaken pending experience with the combined reservoirs Bassac-Dauntri.

Figure 1 - Location Map of Taing Prek Chik Subproject



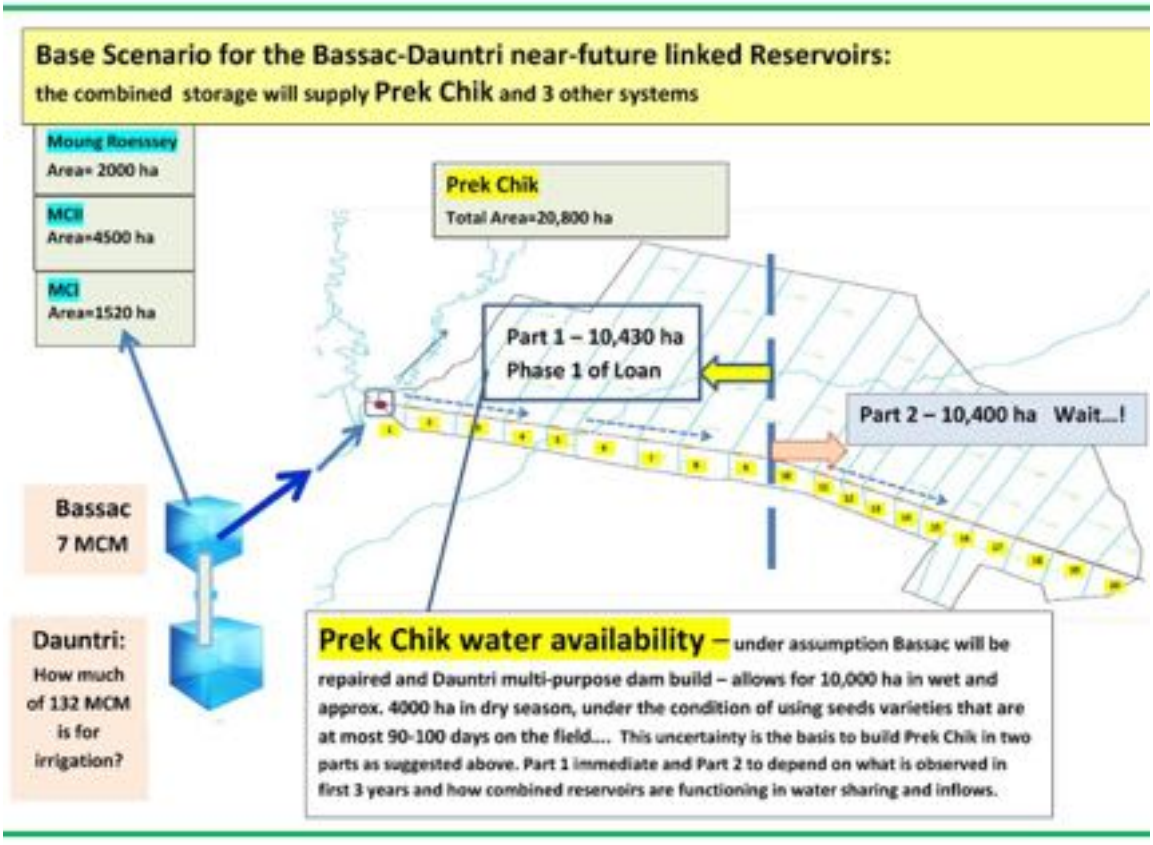


6. **Cost Estimates for full rehabilitation, upgrading and modernizing** are:

Cost estimate for Prek Chik Core Subproject as planned

No.	Description	Estimated Cost (USD)	Gross Command (Ha)	Land Acquisition (Ha)	O&M Costs Yearly (USD)	Remarks
1	Main Canal and Headwork	3,843,512	0	N.A.	N.A.	Full length
2	Secondary and Tertiaries system, Part 1	12,801,095	10,431	162.32	125,373	For 10,400 ha as first part – Phase 1
	Total	**16,644,607**	**10,431**	**162.32**	**125,373**	

Map 1: Base Scenario for Prek Chik –4 linked systems to Bassac



1.2 Conclusions, Findings and Keys to Success

i. **Water Availability is** a significant issue in Prek Chik as hydrological assessment showed insufficient water at Bassac Reservoir to irrigate over the full command, certainly if traditional seed varieties are used for a lengthy 140-150 days on filed. The 4 systems linked (see Map) have never been supplied by Bassac in a joint manner; this needs to be recorded in an agreement between the four systems and their reservoirs, in which PDWRAM is to join the respective FWUCs and supervise both formulation and implementation of the Joint-Reservoir-Operation plans for water delivery and supply, and associated agreement, yearly verified and updated.

ii. **Economic viability.** Prek Chik irrigation subproject is expected to be economically viable in that the calculated economic internal rate of return (EIRR) is 23.8% and the economic net present value (ENPV) of the investment is $9.2 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. Economic Analysis are attached as **Appendix 1**.

iii. **Water Productivity** (in USD/m3) for vegetables is approx. double to rice, pointing to the need to promote these non-rice crops as they generate more income and uses less water as compared to just rice-rice for 2 crops on 100% of the areas. However growing vegetable crops are labor intensive and farmers are required to be full time in the fields caring of the crops.

iv. **Strict Construction Quality Monitoring on Specifications** for all structures and canals and drainage concrete and earth works to be improved or provided is required from Day 1.

v. **Careful and agreed Joint Reservoir Operation** in a detailed agreed and recorded agreement with linked systems to Bassac Reservoir on water sharing is required and so is discipline in executing agreed timing of planting and irrigation scheduling for all sections in all systems.

vi. **MOWRAM-PMU as Executing Agency is to be active and present** in field during actual implementation in all aspects of works and system preparation, to support the PDWRAM and interact and guide the FWUC formation process.

vii. **Focus on combining Water and on Non-Water Agro-Inputs** in crop production process, with support of District Agriculture, is required, in view of reaching not just increased cropping intensities, but also significant increased yields. **Use of Early Seed varieties (90-100 days)** is key – essential to be made available and to be used. The varieties used today when under rain-fed are 150 days on the field. So two seasons in one year are not possible as water available may be limited in the key dry season months of February to June. If one switches to full irrigation (as will be the case in Prek Chik and Taing Krasaing), it is a pre-

condition, that the farmers water users switch (and are assisted in this) to new varieties developed by CARDI (Cambodian Agricultural Research and Development Institute) such as:

- Pkar Rumdoul - 110 days (export quality)
- Sen Pidor - 110 days (export quality)
- IR 66 - 90 days - higher yields as above but not for export
- IR 504 - 90 days -higher yields as above but not for export

The IR varieties can quickly give a yield of 5 ton/ha or more. The selling price for dry un-milled rice is today around USD 300/ton. The key observation here is: **Irrigation (based on upgraded and modernized system facilities) and better quality, short-term seed jointly, and only jointly, will be the basis for system performance, i.e. irrigation season length for two seasons should not exceed 220 days**. It will be required by District Agriculture and FWUCs to monitor seed used in all parts and sections on a seasonal basis, also to assess how farmers need assistance in this matter.

viii. **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 the system.

ix. **Fields demonstration and experiments** should be included to convince farmers to adapt with farming techniques etc., including a focus on vegetables production – these are more labor-intensive, but also with major water savings and potential for significant increase in net farmer income income.

x. **Strengthening PDWRAM and Training of FWUCs** are key issues. **FWUCs** will need to be formed still, but time remains until water will actually flow. Training Programs have been developed. Future FWUCs have been informed during the PPTA period on all plans.

xi. **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. 30-35% in next 35 years).

xii. **On-Farm Facilities Development** is estimated at USD 200-300/hectare, where it concerns rain-fed lands already level and in such used for many years. Parts of Section 2 and 3 for a total of 2000 hectares may require land clearing and shrub/small tree removal and this may cost up to USD400-500/hectare.

xiii. **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. However the

need for this may be limited as many of the rain-fed fields to be brought under irrigation are already considerably level, having been tilled over many decades.

xiv. **Coordination** among key stakeholders such as MOWRAM/PDWRAM, MAFF/PDAFF, Local Authorities and FWUC is crucial for sustainable O&M of the irrigation system and to attain improved crop production. Such coordination needs to recorded in specific procedures, roles and steps before the first irrigation on system completion, and should be officially reviewed every season, and corrected yearly with new commitments recorded. This coordination should be expressed in targets and data to be collected, for monitoring and verification, and should include budget reviews on sufficiency.

xv. **Participation of women** in the planning, construction and O&M activities is an important element of the project. To attain this, women and men within the Project area need awareness raising, training on communication and leadership, construction and O&M. Meaningful participation of women and men in Project implementation will lead to viable FWUC and sustainable O&M. It is anticipated that at least 30% of workers will be women.

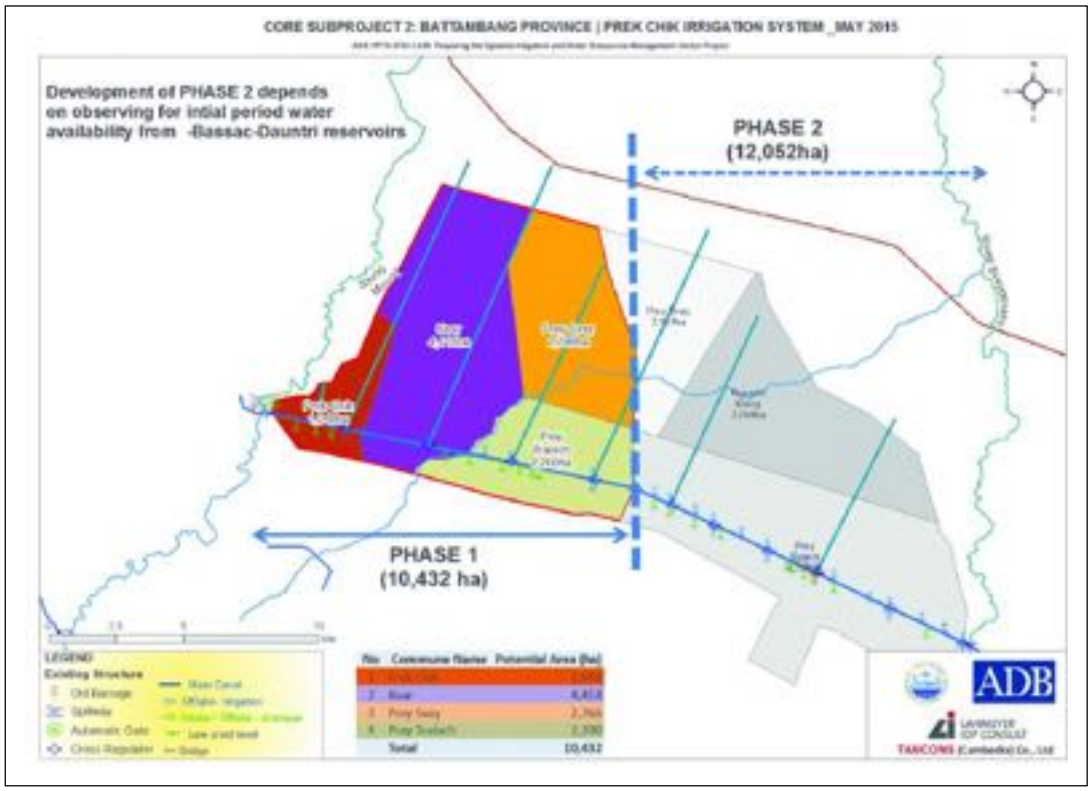
xvi. The **Financial Management Assessment (FMA**) of the proposed project financial management arrangements in MOWRAM (Executing Agency) and the DFWUC (the Implementing Agency) of the proposed project in accordance with ADB's Guidelines has resulted in an overall risk rating of "Moderate" and which is expected to become "Low" with mitigating measures. Lack of capacity in project financial management and internal auditing is currently being addressed through the government's ongoing comprehensive Public Financial Management Reform Program (PFMRP).

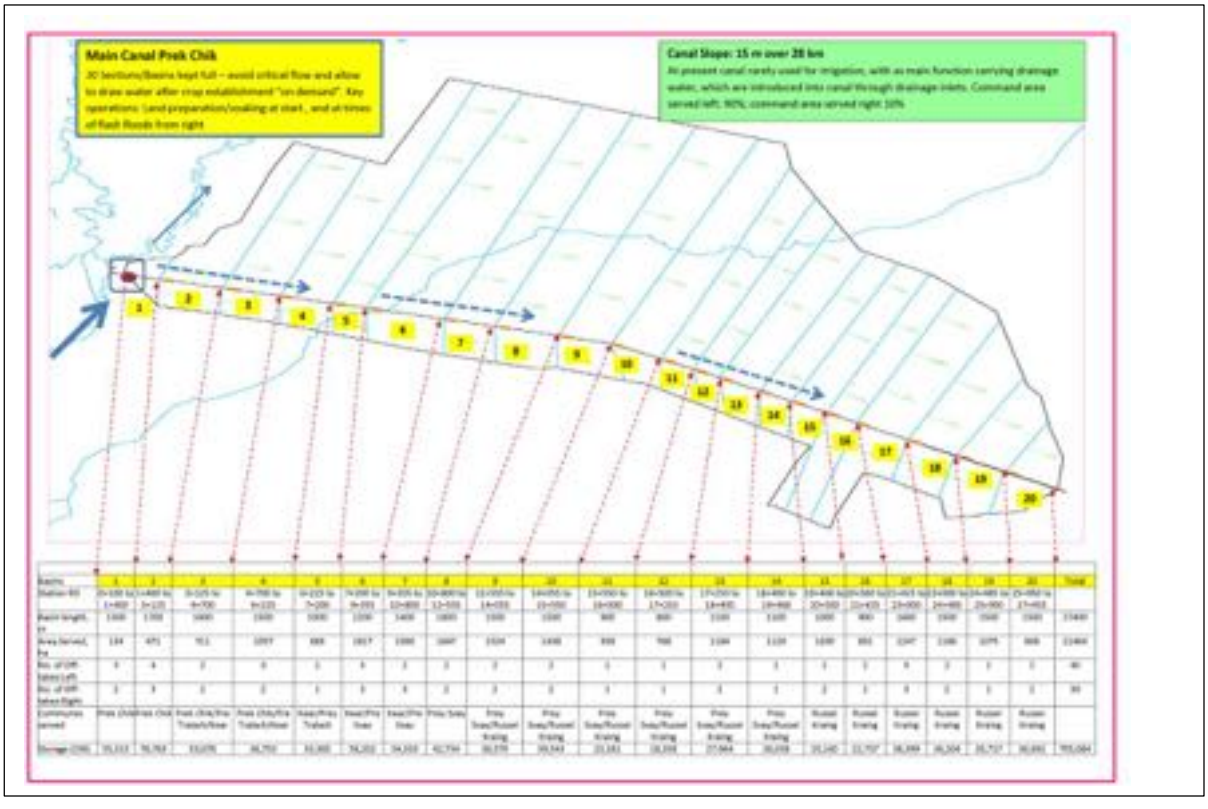
xvii. As concerns **Financial Management Systems**, the significant capacity building of recent years fin the sector covering technical and financial management of FWUCs and PDWRAMs/MOWRAM through the ongoing Water Resources Management Sector Development Program (WRMSDP) and financial management systems through a comprehensive Public Financial Management Reform Program (PFMRP) is based on two manuals: (i) Policy and Implementation Guidelines for Sustainable FWUCs and Policy and Implementation Manual for Operation and Maintenance of Irrigation Schemes for the PDWRAM; workshops were conducted to brief the FWUC and PDWRAM representatives about the manuals; (ii) under the PFMRP, capacity development in financial management was provided to MOWRAM/PDWRAM through systems improvements, manual preparation, computerization, and training.

xviii. The regular use of documents on systems and procedures for externally financed projects/programs is a prerequisite and considered of great importance: these documents are the Financial Management Manual for All Externally Financed Projects/Programs in Cambodia and the Standard Operating Procedures for All Externally Financed Projects/Programs in Cambodia will ensure that all project accounting and reporting requirements of development partners, including ADB, are complied with. Further enhancements to the system can be in the

computerization of project accounting and linking it to the computerized accounting system/software installed at the Finance Department.

Key Summary Maps:





1 SUBPROJECT RATIONALE

7. 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, 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. 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.

8. 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.

9. 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

10. 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.

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

12. Rehabilitation and improvement of **Prek Chik:**

- Rehabilitation of headworks (including raising of spillway by 1.5 meters)
- Rehabilitation of 28 kms Main Canal and installation of all structures for water control and distribution, and provision of all drainage works
- 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.
- Increased focus and associated training in Joint Reservoir Operations for Bassac reservoir, to improve on water sharing and water scheduling arrangements between linked systems.

Output 2: Improved water resource management.

13. 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 Water Management, including planning for implementation.
- Organization, mobilization and training of FWUCs in the command area

Output 3: Improved project management.

14. 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 PREK CHIK IRRIGATION SYSTEM

2.1 Description of the Project Site

2.1.1 Location

15. Prek Chik Irrigation Scheme is located 297 km from the capital city of Phnom Penh. It is accessible by land with travel time of five to six 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.

Table 1: Administrative Scope and Coverage

Irrigation Schemes	Location and Coverage			
	Province	District	Communes	Villages
Prek 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
Total		2 Districts	4 Communes	13 Villages
	2 Provinces	**3 Districts**	**8 Communes**	**32 Villages**

Source: PPTA Consultant.

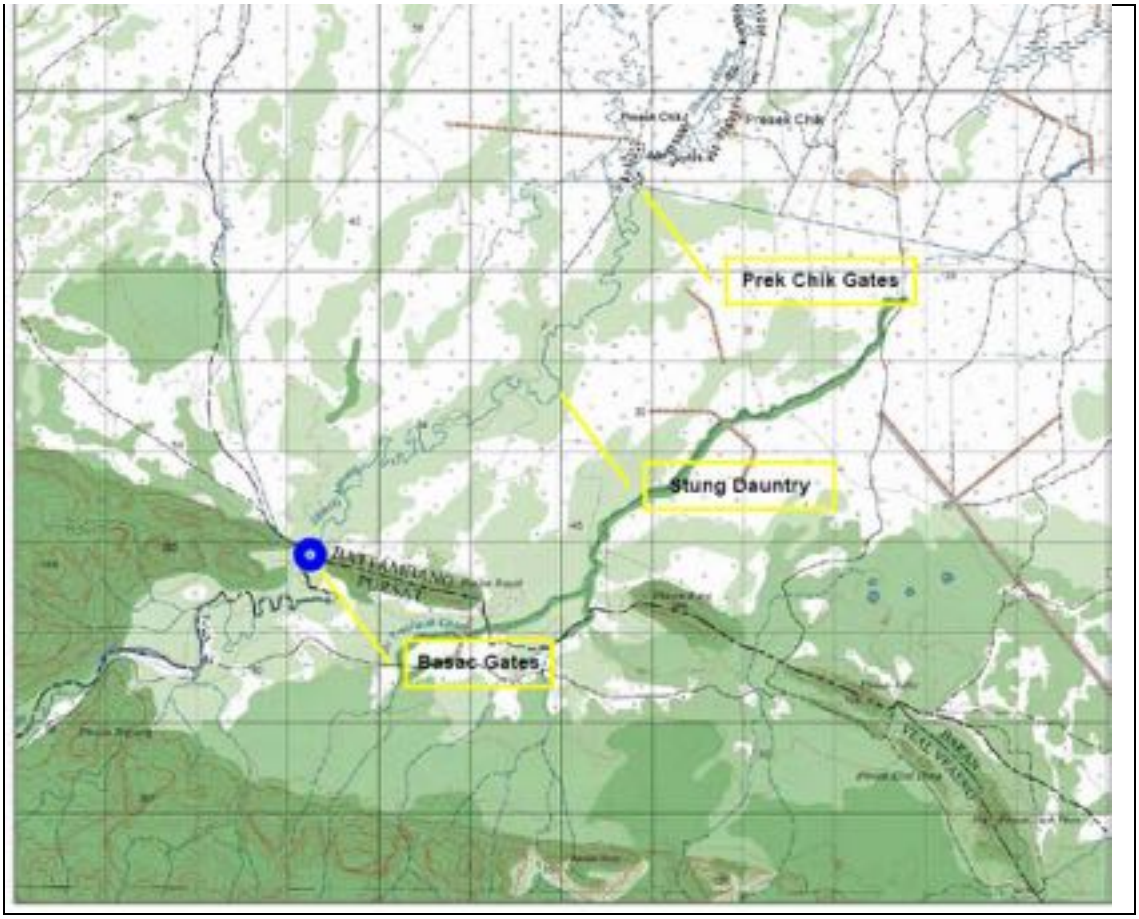
2.1.2 Profile and Current Infrastructure Condition of the Prek Chik Irrigation System

16. Between 1950 and 1970, the government constructed three diversion structures at Prek Chik, Ta Lords and Toek Chrey. These diversion structures were destroyed during the Civil War which started in 1970. During the Khmer Rouge regime (1975-1979) two reservoirs and three diversion structures were constructed along the river at new locations. The reservoirs were at Kra Peu and Phnom Bassac (Bassac Reservoir) while structures for diversion of water from Steng Moung Russey were at Preuk Chik, Anloung Kob and Ream Kun. Map 10 shows Prek Chik Gates, Prek Chik Canal and Bassac Reservoir.

17. Construction of the Prek Chik Canal (PKC) was started in 1977. PKC was still unfinished when the construction work ceased in the latter part of 1978. After the country was liberated in 1979, the partly finished canal was largely unused until some small repairs were made by the Battambang PDWRAM in 2003. Major rehabilitation work was done by MOWRAM in 2010 with funding from the Japanese government to bring the PKC into effective operation. This construction work was completed at the beginning of 2012.

The MOWRAM rehabilitation plan focused on the main canal and its irrigation structures. According to the Battambang PDWRAM, the potential wet season command area is estimated to be about 20,000ha. However, the current area of wet season rice grown with supplemental irrigation is about 2500ha, while the current dry season paddy cultivation is only about 30ha. Currently all dry season irrigation is in Prek Chik commune which is in the upstream reach of the PKC.

Map 2: Prek Chik Core Subproject Map



Source: Cambodian JICA Topomap

3 SUBPROJECT DESIGN

3.1 Engineering and Irrigation-Hydraulic Design

18. 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 Prek Chik is:

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 subproject
3. prepare bill of quantities and bidding documents for the core subproject
4. propose options for modernizing irrigation systems and incorporate those in the design of the core subproject
5. assess the irrigation efficiency of the core subproject, 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 the core subprojects.
8. assess climate change risks
9. suggest adaptation measures to climate proof infrastructures
10. design climate proofing interventions for core subprojects and estimate their cost
11. prepare a training/awareness program for Farmer Water User Community (FWUC) 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 subproject and estimate their cost

3.1.1 Engineering

19. Prek Chik main canal (PC) construction started during Pol Pot in around 1977 and 1978. At the same time construction of Bassac reservoir was started. The construction was not completed when the country was liberated in 1979, and the canal was not used until further work was carried out. Some small repair work was done by the Battambang PDWRAM during 2005 and in 2010, major rehabilitation of PC Main Canal was done by MOWRAM using funding from the Japanese government. Construction was completed in early 2012.

20. The rehabilitation plan for Main Canal focused only on the main canal and its irrigation structures. According to the Battambang PDWRAM, current wet season supplement irrigated area is of about 2,500ha and potential wet season command area is estimated about 20,800ha, however, there are no operational secondary canals and the

current area of dry season paddy in Prek Chik commune is about 30ha, at the upstream reach of Main Canal.

21. The immediate issue with Prek Chik MC is sufficient lack of water. The Bassac reservoir is the only dry season water for Prek Chi , and this reservoir is not functioning because operation of its gates caused severe flood problems and pending a solution, the gates have been removed (see Section 3.1.1.1). Farmers said if water was available, dry season paddy could be grown in a strip about 300m wide on the southern (right-hand) side of Prek Chik Main Canal making use of the natural slope. On the northern (right-hand) side, land slopes to the Tonle Sap Lake allowing a large cultivated area to be commanded which could extend to National Road No.5 should sufficient water be available.

22. Overall the Main Canal of Prek Chik is in good condition. However, there are several breaches in both the left and right canal embankments and severe scouring downstream of some cross regulators. These problems have arisen because local people used the Canal during wet season to divert flood water from the Moung River exceeding the conveyance Canal's capacity . The need to divert flood water is reported by farmers to be a result of inability of the existing automatic flapped gate weir and the duck bill weir downstream of the canal head regulator to convey the river flood. Some lateral canals have been constructed by local people but these do not have the correct shaped and slope, and lack control structures.

23. Current wet season paddy cultivation in Prek Chick area faces problems from flooding. On the right bank natural runoff from the Southern mountain range backs up against the right canal bank since there are insufficient cross drainage works. High water levels in Prek Chik Main Canal during the wet season, related to the previously mentioned problem of using the Canal for flood relief, prevent drainage into the canal. Farmers reported that this flooding lasts only 3 to 4 days, which affect yield but still allows rice to be harvested. In some years, however, when there is late wet season rain during harvest, water backs up against the right embankment causing a serious problem as it submerges the ripe paddy, preventing harvest and resulting in it being abandoned.

3.1.1.1 Bassac Reservoir issues

24. The Bassac reservoir construction was commenced during Pol Pot regime in around 1975-76. The earth dike, a sluice at the east of the existing weir and a canal leading from the left bank of the reservoir were constructed during that time. Since construction was not yet completed the reservoir was not brought into operation. The sluice was demolished by MOWRAM in 2005 during the construction of the existing weir and 7 automatic flap gates. In the same year the main left-bank canal head regulator was constructed.

25. Since installation in 2005 the automatic flap gates have never operated correctly. Rapid and uncontrolled gate operation in response to water level rise in the reservoir results in flash flooding downstream. These floods happened in 2005 and 2006 but in 2007 and 2008 floods were small. Then in the 2009 to 2013 wet seasons severe flooding resulted. In July 2014, under pressure from local farmers could who could no longer bear with annual flash flood inducing by the incorrect gate operation, Battambang PDWRAM

removed 3 of 7 flap gates and also opened the weir under-sluice. Since the removal of 3 flap gates, the river has reverted to natural flow.

26. The Bassac weir automatic flap gates were intended to gradually open to release reservoir inflow floods. Their operation is designed to be triggered by the reservoir water level rising above the crest of the gates. When water reaches this level, the weight of water over the flap gates is heavier than the gate counter weight. But the gates neither open gradually nor sequentially. Rather all seven gates open together suddenly causing severe flooding downstream similar to a dam break. This flash flooding has caused damage to property and paddy fields.

27. The flood wave propagating downstream has also caused damage at Prek Chik headworks. Here the capacity of the two automatic gates on Prek Chik diversion weir is much less than Bassac and the large inflow causes flooding at that location. Farmers have sought to minimize flooding by opening the canal head regulator gates but the consequent high flow in Prek Chik Main Canal has caused serious damage to some cross regulators.

28. The slide gate of under sluice at Bassac weir is currently jammed and cannot be opened or closed, resulting in a very small amount of water could be stored in the Bassac reservoir. While this would not provide sufficient water for irrigation, it may assist water sellers who are using small trucks to supply water for domestic purposes during the dry season.

29. In 2014, the Flood Damage Emergency Reconstruction Project - Additional Financing was approved to renovate three automatic flap gates[1] at the Bassac weir, reconstruct 10.238km of the left bank main canal to supply a command area of about 4500ha, construct a right bank main canal with length of 3.28km to supply a command area of 1,520ha and to rehabilitate 3.2km of an existing road. The left bank canal is currently under construction.

3.1.1.2 Prek Chik Canal issues

30. The issues with Prek Chik main canal are:

- Prek Chik main canal is relies on Bassac reservoir as a single source of water during the dry season
- Secondary canals are insufficient for the proposed command area
- There are too few irrigation structures along the main canal and some of the existing structures are damaged. Water levels in Prek Chik Main Canal need to be increased to allow water to gravitate through off-takes to the command areas. This will require cross-regulators at closer spacing
- Canal embankments on both sides of Prek Chik Main Canal need to be modified so that water can be held in each section between cross regulators at a sufficient level to allow gravity flow through off-takes. The existing canal embankments are

[1] Three gates are to be renovated. They are to operate in conjunction with the other 4 existing automatic gates. The renovated gates will be modified so that their counterweights hold them open (flapped down) and raised and lowered using hand cranks.

constructed to create available head at the off-takes when the cross-regulator is kept closing. By doing so gravity flow is possible through the off-take in to the secondary canals and irrigation from secondary canal is done in the downward slope parallel to the main canal.

31. Extension and improvement could be made to the Prek Chik left bank main canal by installing cross regulators and off-takes. Engineering considerations will not limit the work and extension of the canal should be limited by considerations of water availability, including the need to provide for instream requirements in the Moung River, and expected financial return from the irrigation development. Battambang PDWRAM has requested for the secondary canals to be extended to National Road No.5, if possible; The existing canal head work regulator would require upgrading as farmers report it currently has too small opening. The track along the left bank canal would require reshaping.

32. There are several breaches in the right embankment of the PKMC resulting from runoff from the Southern Mountain range. Drainage is needed which is sufficient to manage the estimated peak runoff. There are two options: (i) an inverted syphon to carry water under Prek Chik Main Canal from where it will be carried in drains across paddy fields on the left side of PKMC, and (ii) to drain into the Main Canal. Battambang PDWRAM are concerned for the first option, drainage water could damage the paddy fields. It favors drainage inlets into the main canal. When more laterals are constructed as planned this option may be feasible.

3.1.1.3 Prek Chik headworks issues

33. Battambang PDWRAM is of the view that the two diversion structures: the duckbill weir and the automatic flap gates at Prek Chik head work are able to handle a normal river flood but were insufficient for a flood created by simultaneous faulty operation of the automatic gates at Bassac Reservoir. The PDWRAM said that such an event would also cause the natural stream would flow overbank and plantations and villages would get flooded. These statements seem at odds with views of local farmers who said that even after three flap gates at the Bassac reservoir were removed, the Prek Chik weir gates could only manage a river flood if water was released into Prek Chik main canal.

34. The current status of gates at Prek Chik weir is (i) the under sluice slide gate cannot be closed or opened as required and there is severe seepage past the gate; (ii) the two automatic flap gates are in good operation but there is leakage through the side of gates.

35. PDWRAM is of the view that the crest level of the Automatic flap gates is too low, causing difficulty in diverting water into Prek Chik Main Canal. However careful study is needed using a hydraulic model to compute the backwater profile along the natural stream before raising crest level of the flap gates. PDWRAM also said (i) the current crest height of the existing duck bill weir is also low and should be raised as the flap gate (ii) recommended the automatic flap gates be replaced by installing ‘emergency’ gates, with normal releases made through the under sluice by power operating the slide gate.

3.1.1.4 Social water management

36. PDWRAM requests that the project provide support for FWUC through allocating some operations budget and providing an FWUC operation office.

3.1.2 Upgrading Prek Chick Core Subproject

37. Engineering works required to upgrade PKC and operate PKMC as irrigation canal include headwork structures, main canal and structures and a secondary and tertiary distribution system canal network.

- **Water sources (Bassac Reservoir Embankments)**

38. The Bassac reservoir embankments will play the key role as the water sources for the Prek Chik Core Subproject; Bassac is located on the Moung River about 15 kilometers upstream the headworks for Prek Chik Canal. Bassac reservoir as an existing embankment, concrete weir and gates. This structure is now being rehabilitated by the ADB funded Flood Damage Emergency Reconstruction Project. Repair works for the gates at the Bassac Reservoir will be finished early in 2016. The reservoir is expected to be in operation in the following season. The live storage for this reservoir is about 7 million cubic meters (7 MCM).

- **Headwork structures**

39. There are four main structures at the headwork of PKMC, watergate, duckbill weir, automatic flap gates, and canal head regulator.

- *The Watergate* is an old existing structure which never functioned to control water flow into Prek Chik Canal. No works are proposed for this structure excepting to clear debris and avoid obstruction to river flow.
- *The Duckbill weir is* located about 100m at the downstream of the water gate on Moung River, The weir was recently constructed to fulfil the role earlier planned for the watergate. The weir controls the flow down the Moung River, maintaining the design water level, so that water can be conveyed into Prek Chik Main Canal by gravity. However according to the result of the topographical survey the current crest elevation of the duckbill weir is insufficient to command river flow into the PKMC. The crest level of the Duckbill weir will be increased by 1m as part of the system upgrade. The higher water level will increase command area by about 2000ha in the upstream part of PKMC.
- *Automatic flap gates*: These gates are part of the Duckbill weir structure, working with it to maintain water level for diversion to PKMC. These gates do not work well, in a gradual manner, rather they stick, and the rapidly fall or rise. During a river flood, the two automatic gates drop at the same time releasing a massive amount of water from upstream of the weir to the Moung River downstream. This creates a large flood wave which damages crops and erodes the river bank. When water level in the river drops, the gates do not rise as they should, and allow water from the upstream to continue down the Moung River to the Tonle Sap Lake. Since river level drops after a flood and stays low because the gates do not rise, there

is neither water nor head to command irrigation from PKMC. The two gates will be rehabilitated as part of PKC upgrading. Each automatic gate will be equipped with a hand crank. Erosion protection works downstream of the structures will also be part of the upgrading work.

- **Main Canal and equipped structures**

40. PKMC was rehabilitated several years ago by MOWRAM and remains generally in the good shape although, there are embankment breaches at several points along its length caused by overland flow from the right hand side of the canal. On the other hand, this Canal has never functioned as an irrigation canal because it does not have an effective water supply because of its dysfunction headworks. Rather, Canal acts as a drainage canal which collects runoff water from the catchment on the right side and drains to the natural river at its tail.

41. In addition, the topographical survey shows that the current bed slope of the canal is sleep; there is an 18m difference from head to tail of canal of 27.6Km length, and there are not enough cross regulators.

42. The major works to improve PKMC will be adding new cross drainage structures, additional crossing structures and offtake structures. Canal clearing and repairing the embankments will also be important works. Six kilometers of interception drain will be constructed to improve the drainage pattern of the system, and help the Main Canal successfully perform a dual function of irrigation and drainage.

- **Distribution system**

43. The development of the secondary and tertiary distribution system over the defined command area of 20,800ha will be divided into two phases. Phase I will cover the first 10,400ha of the command area, and the construction work will be undertaken in the year following the completion of Canal improvement works. The phase II, will be considered 2 or 3 years after phase I, because of the uncertainty of the water supply which depends on actions at both Bassac and Dauntri Reservoirs.

44. Within the 10,400ha, there will be 10 secondary canals measuring in total length of 34.60km. Half of this length is on existing alignments. There will also be a considerable length of tertiary canal constructed totaling 107.65km. The tertiary canals will bring water from secondary canals and deliver into famer's rice plots. Beside these two levels of irrigation canal, 35km of drain canal will also be part of the system upgrading. These drain canal will collect the runoff from rice fields, and drain it into natural drainage lines or rivers. Both irrigation canals and drainage canals will be equipped with different types of structures in order to make the system function in a correct manner.

3.1.3 Hydraulics design of Prek Chik Main Canal

45. According to the selected cropping pattern, the computed irrigation requirement for the design of the main canal is 20m^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 the below Table 2. The design

canal bed gradient and the selected Manning roughness coefficient are also shown in the table.

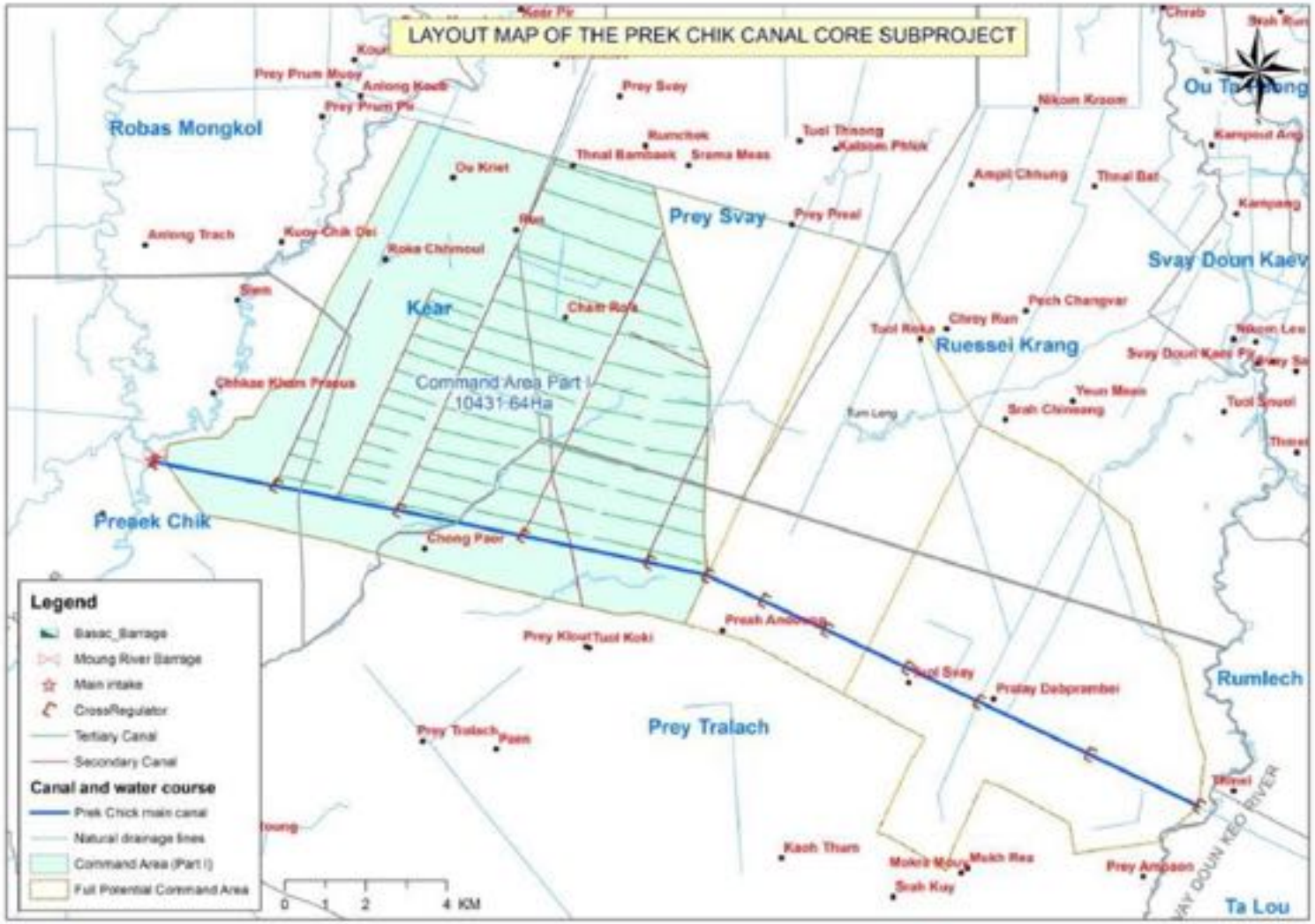
Table 2: Selected Canal Hydraulic Parameters

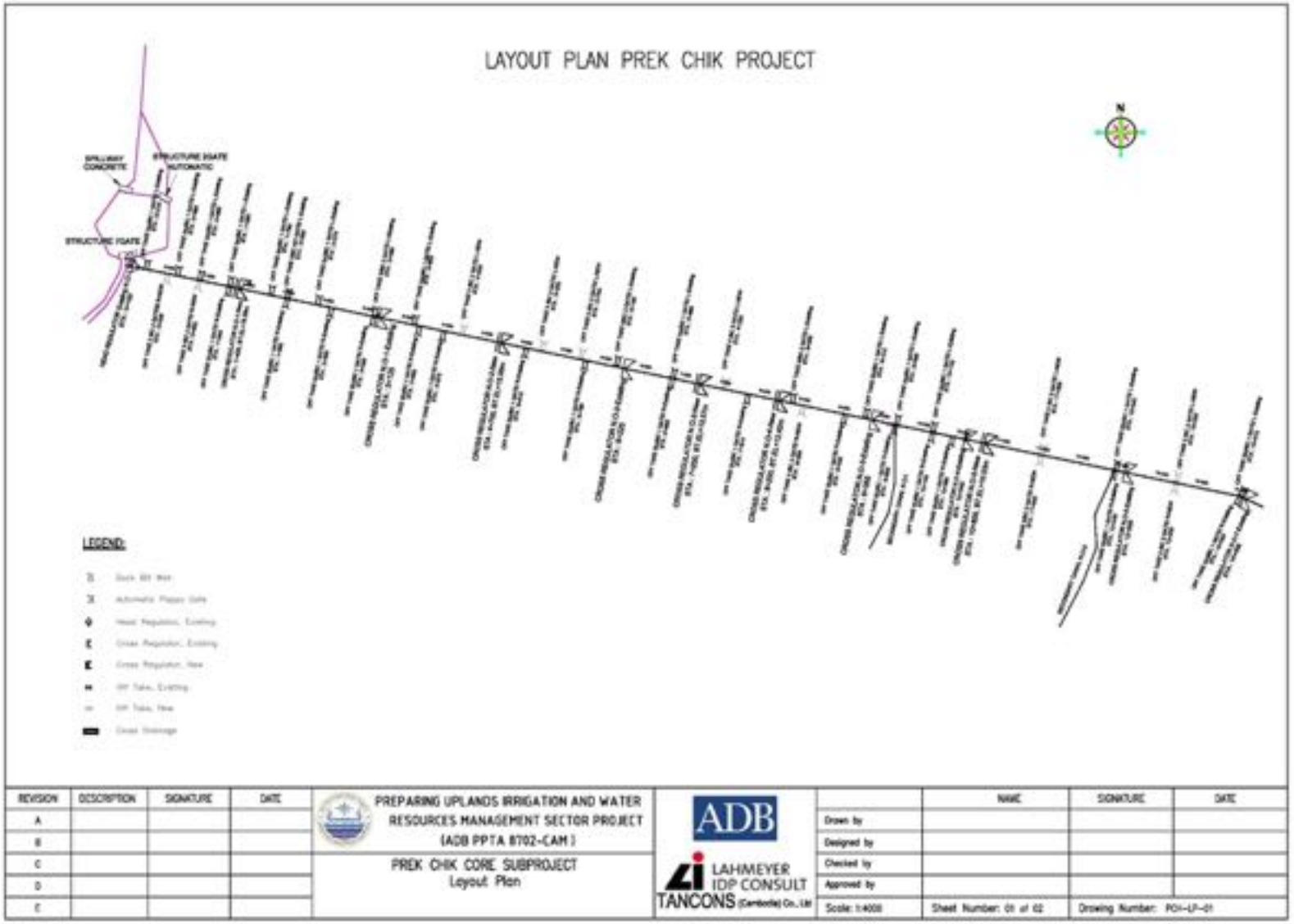
Descriptions	Hydraulic Dimensions
The canal bed width (b) =	6.0 m
Canal slide slope	2
Canal depth from existing embankment	3.3
Roughness coefficient, n	0.025
Design canal bed slope	0.00015

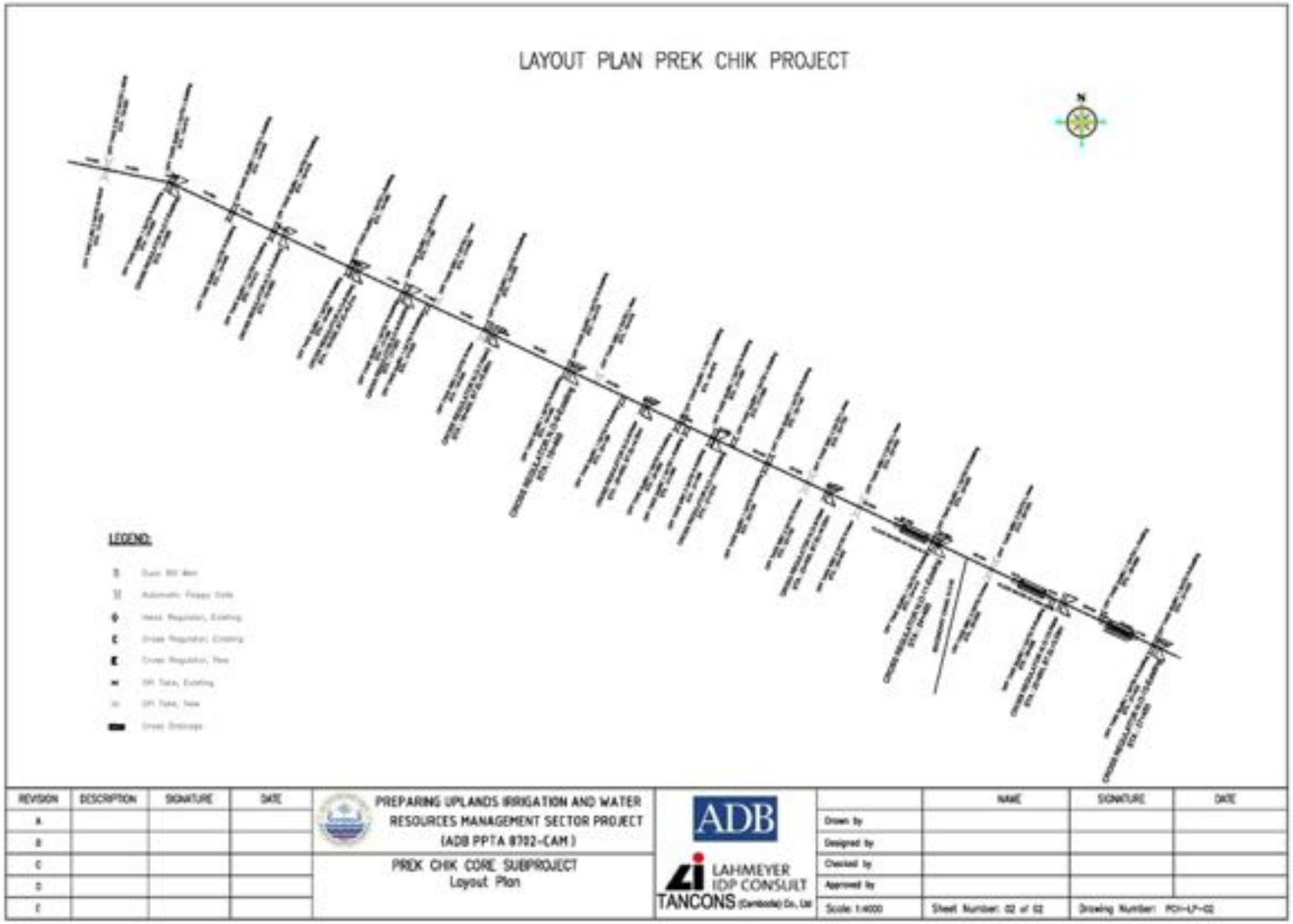
46. With the define canal hydraulic parameters the main canal capacity is computed with the use of Manning formula and the design discharge is found out about 37.4m^3/s. Hence the main canal capacity can convey the flow far more than the required flow of 20m^3/s as defined by the selected cropping pattern. The canal runs under sub critical flow condition with normal flow depth higher than the critical flow depth, the canal is safe from siltation and scouring as the design normal flow velocity is higher than the none-silting velocity and lower than or equal to the none-scouring velocity. In addition the normal flow velocity is less than the critical flow velocity and the design canal bed slope is less than the computed critical slope.

47. However during actual application, the canal will be operated as a series of 20 cascading basins from upstream to the downstream. Each will function as storage pool between cross regulators, and irrigation is done in rotation from basin to basin. Within each basin is equipped with two Cross Regulators (CR), one at the upstream end and the other one is at the downstream end. The downstream CR of each basin from the second basin to basin number nineteen will function both as an upstream CR and a downstream CR of the adjacent basin.

Map 3: Layout Map of Prek Chik Canal Core Subproject




LAYOUT PLAN PREK CHIK PROJECT
N
SPILLWAY CONCRETE
STRUCTURE GATE AUTOMATIC
STRUCTURE GATE
LEGEND:
PREPARING UPLANDS IRRIGATION AND WATER RESOURCES MANAGEMENT SECTOR PROJECT
(ADB PPTA 8702-CAM)
PREK CHIK CORE SUBPROJECT
Layout Plan
ADB
LAHMEYER IDP CONSULT
TANCONS (Cambodia) Co., Ltd
REVISION
DESCRIPTION
SIGNATURE
DATE
NAME
Drawn by
Designed by
Checked by
Approved by
Scale: 1:4000
Sheet Number: 01 of 02
Drawing Number: PCH-LP-01


LAYOUT PLAN PREK CHIK PROJECT
N
LEGEND:
REVISION
DESCRIPTION
SIGNATURE
DATE
A
B
C
D
E
PREPARING UPLANDS IRRIGATION AND WATER RESOURCES MANAGEMENT SECTOR PROJECT
(ADB PPTA 8702-CAM)
PREK CHIK CORE SUBPROJECT
Layout Plan
ADB
LAHMEYER IDP CONSULT
TANCONS (Cambodia) Co., Ltd
Drawn by
Designed by
Checked by
Approved by
Scale: 1:4000
NAME
SIGNATURE
DATE
Sheet Number: 02 of 02
Drawing Number: PCH-LP-02

3.1.4 Water Availability

48. The following tables have been developed from the hydrological data collected and applied to the base scenarios for the Prek Chik Main Canal; they form the basis for subsequent reservoir operation, irrigation scheduling in relation with cropping pattern, and determining possible cropping intensity.

Table 3: Prek Chick Core Subproject: Inflow into Bassac Reservoir

Inflow in Reservoir of Bassac Reservoir for Prek Chik

Table:1 The Dry Year Monthly, Averages Flow in m3/s and MCM in Bassac in Prek Chik

Watershed	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bassac Reservoir	m3/s	0.69	0.50	0.37	0.31	1.20	1.64	1.96	2.97	2.98	3.49	2.06	1.05
Bassac Reservoir	MCM	1.84	1.21	0.99	0.80	3.21	4.26	5.25	7.96	7.73	9.35	5.34	2.81
Total	MCM	1.84	1.21	0.99	0.80	3.21	4.26	5.25	7.96	7.73	9.35	5.34	2.81
						rainfall period							

Table:2 The Normal Year Monthly, Averages Flow in m3/s and MCM in Bassac in Prek Chik

Watershed	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bassac Reservoir	m3/s	1.18	0.64	0.60	0.71	0.81	1.87	6.27	15.36	21.33	23.13	15.45	5.11
Bassac Reservoir	MCM	3.15	1.54	1.62	1.85	2.16	4.86	16.78	41.14	55.29	61.95	40.05	13.70
Total	MCM	3.15	1.54	1.62	1.85	2.16	4.86	16.78	41.14	55.29	61.95	40.05	13.70
						rainfall period							

3.1.5 Irrigation Efficiency

49. 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. Volume 2 of the Mid-Term Report included a section on considerations on irrigation efficiencies.

50. 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 can 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
7) All stakeholders have rights, roles and responsibilities which need to be defined and known to all and recorded.

51. 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).

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

53. 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.

54. There are three physical characteristics which govern any irrigation operation, in terms of both quantity and time:

1) The evapotranspiration by the various crops cultivated and changes in it during the growing season;
2) The moisture retention of the soils between field capacity and a preselected depletion limit (the lowest acceptable moisture content that does not significantly affect yields);
3) The infiltration rate of the relevant soils.

55. Other physical factors such as rainfall distribution, topography, and canal seepage may, of course, also play a role, but the above three characteristics must be considered under all circumstances. Further, if one wishes to analyze individualistic versus collectivistic behavior trends by the farmer population, one must also have a certain minimum amount of information on the socio-organizational structure of the area. Together, all these factors must serve as a basis for defining such operational features as depth, duration, and interval of irrigation for the various crops and soils. But even with this information available, it is only possible to predict the overall irrigation efficiency within an accuracy of 15 per cent at its very best. The assumed percentage of irrigation efficiency in a new project cannot be checked until some 5 to 10 years after its construction, i.e. after farmers and operators have entirely adapted to the new conditions.

56. 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.

57. 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.

58. 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.

59. 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

60. 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.

61. 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.

62. 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 2000s.

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

Table 4: Irrigation Efficiencies in Prek Chik subproject

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

64. 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.

65. For the Prek Chik, 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).

66. 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.

67. 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.

68. 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.

69. 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

70. 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.

71. 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.

72. 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

73. 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.

3.1.6 Drainage Needs for Prek Chik

74. Drainage has been apparent as a major issue at Prek Chik since the first field visit. Even with medium rainfall there are flash floods from higher ground on the right side of the main canal. In fact, it was reported that in many occasions the main canal served as drainage relief with inlets on the right side of the main canal passing water into the main canal which is subsequently discharged through off-takes on right side, which serve a dual function of irrigation and drainage, into secondaries. This is depicted in the map below where the red arrows indicate the water pressures during major rainfalls.

Figure 1: Drainage Pressure Points for Prek Chik System

Source: Google Earth

75. Four (4) cross drainage structures are designed and will be constructed on the Prek Chick Main Canal. These structures will allow flash flood drain from right side to the left side of the Canal. In addition, existing inlet drainage which was originally built from the previous projects will be improved and will be used to drain over demand water from the farmer rice fields into the Canal.

3.1.7 Water Productivity

76. 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.

77. 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 Prek Chik core subproject under rain-fed and at times under irrigation on limited basis.

Table 5: Net Profit for Various Crops per ha in USD and Water Productivity in USD/m^3

	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

78. 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.

79. 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.

80. 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.

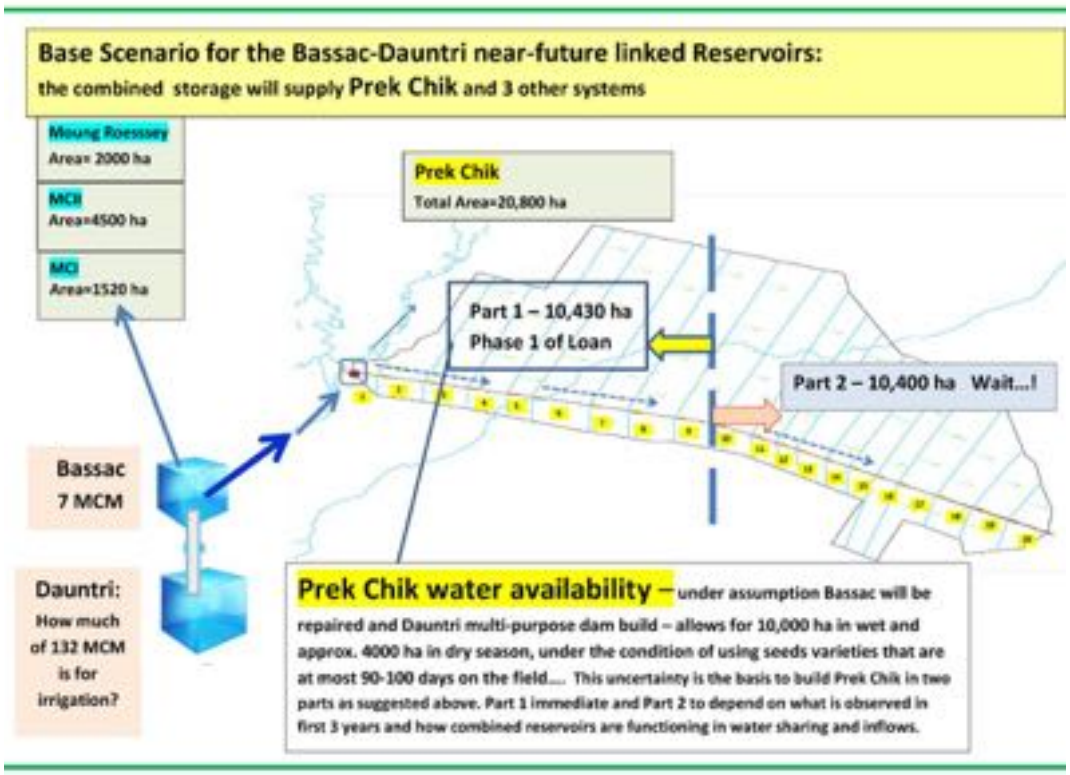
3.1.8 Joint Reservoir Operations (JOROP)

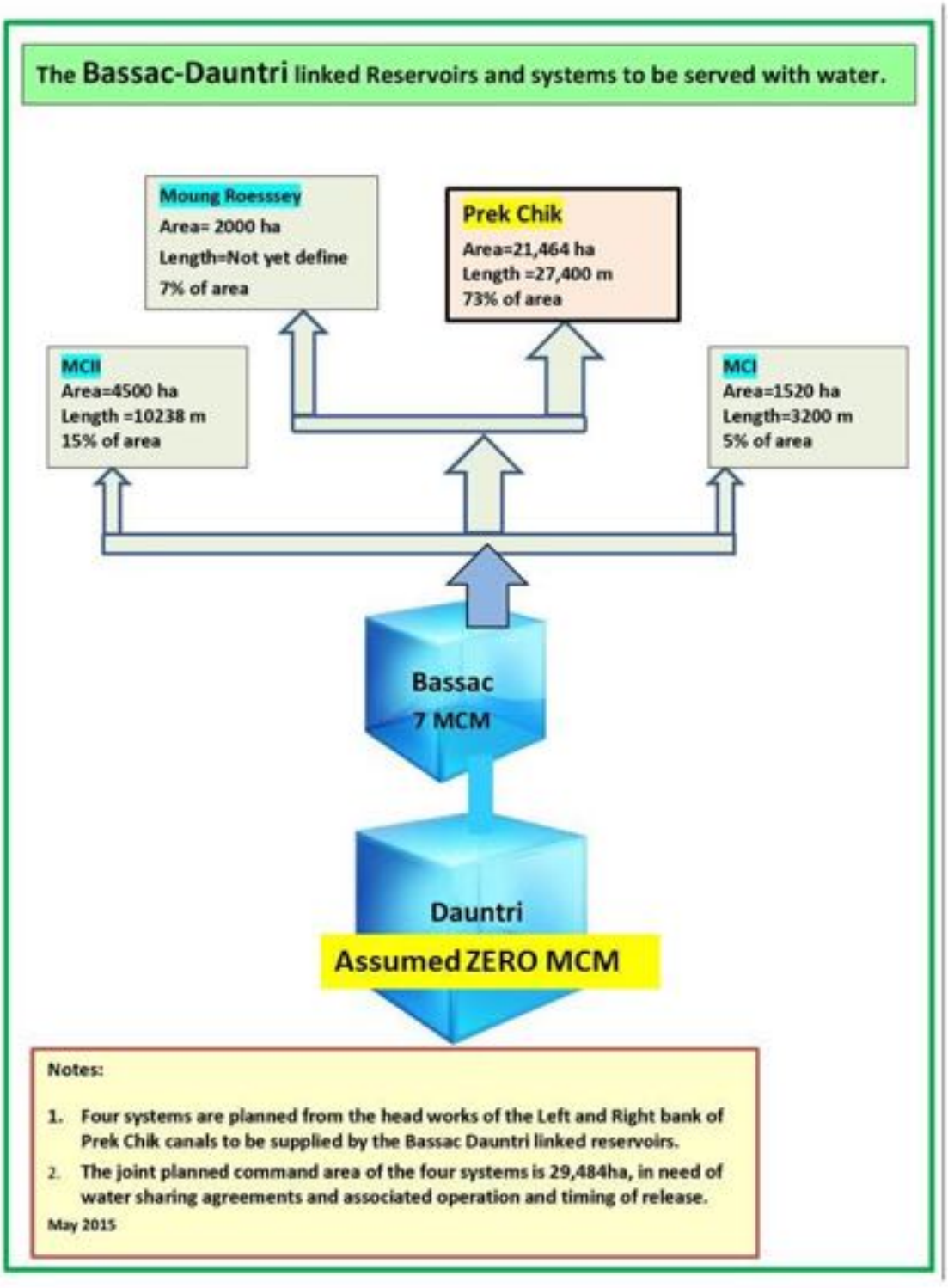
81. The Prek Chik core subproject is linked to other systems, as they are supplied by the reservoirs and depend on this water to be (proportionally) divided. In view of construction schedules and completing all irrigation facilities, the issue of how and with what agreed upon procedures to develop a **Joint Reservoir Operation (JOROP)** for Bassac-Dauntri (BD) is still not of immediate urgency (until 2018), but starting to plan for this should be of immediate concern to MOWRAM and PDWRAMs.

82. **Prek Chik,** is linked to three other systems, all obtaining water from Bassa c Reservoir. Prek Chik and the 3 other linked systems have a joint irrigated area approaching 29,000 ha, but considerable areas have been added in recent years, with more planned, and Bassac reservoir has not functioned for last several years in view of the 3 broken gates.

83. The Prek Chik planned cropping intensity for the dry season is 4,000 ha or some 40% and to obtain planting and harvesting on this area will require careful water use within the command area, but also between the linked systems. Irrigation in the dry season will be a completely new experience; therefore present expertise available in PDWRAMs on providing appropriate operations may be considerably below what will be required. These JOROP considerations are of great importance to be planned and resolved during Project implementation and associated PMIC consultancy; it is too early to formulate and decide on this at this stage.

84. What is important now is to become aware of the need (certainly for Bassac and Prek Chik) 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.


Base Scenario for the Bassac-Dauntri near-future linked Reservoirs:
the combined storage will supply Prek Chik and 3 other systems
Moung Roessey
Area= 2000 ha
MCII
Area=4500 ha
MCI
Area=1520 ha
Prek Chik
Total Area=20,800 ha
Part 1 – 10,430 ha
Phase 1 of Loan
Part 2 – 10,400 ha Wait...!
Bassac
7 MCM
Dauntri:
How much of 132 MCM is for irrigation?
Prek Chik water availability – under assumption Bassac will be repaired and Dauntri multi-purpose dam build – allows for 10,000 ha in wet and approx. 4000 ha in dry season, under the condition of using seeds varieties that are at most 90-100 days on the field.... This uncertainty is the basis to build Prek Chik in two parts as suggested above. Part 1 immediate and Part 2 to depend on what is observed in first 3 years and how combined reservoirs are functioning in water sharing and inflows.


The Bassac-Dauntri linked Reservoirs and systems to be served with water.
Moung Roesssey
Area= 2000 ha
Length=Not yet define
7% of area
Prek Chik
Area=21,464 ha
Length =27,400 m
73% of area
MCII
Area=4500 ha
Length =10238 m
15% of area
MCI
Area=1520 ha
Length=3200 m
5% of area
Bassac
7 MCM
Dauntri
Assumed ZERO MCM
Notes:
1. Four systems are planned from the head works of the Left and Right bank of Prek Chik canals to be supplied by the Bassac Dauntri linked reservoirs.
2. The joint planned command area of the four systems is 29,484ha, in need of water sharing agreements and associated operation and timing of release.
May 2015

Considerations on establishing a JOROP for Prek Chik core subproject

85. A JOROP will be something new for PDWRAM of both provinces. The investments made in both core subprojects 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.

86. 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 for both 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.

87. 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. For Prek Chik, such planning will be essential.

	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							
JL1	Wet Season Irrigation						
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 (Example for PREK CHIK)

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.

3.1.9 Main Canal Operations Prek Chik

88. During peak flood when flood magnitude reaching to 155m^3/s, the head regulator gates should be partly open allowing only the design flow of 20m^3/s entering into the canal. It should not be fully opened to relieve the pressure of a peak flood in the river. The peak flood should be evacuated through the existing duck bill weir and the flap gates.

89. The entire Canal length is divided into twenty small basins controlled by the twenty Cross Regulators (CR). Each basin will have a length of about 1.5 to 2 Kilometers. Water flows from the headwork into first basin through head regulator, and then to the following and subsequent basin through cross regulators. The drop of water level from the upstream basin to the downstream basin varies from 0.5m to 2m depending on topography along the main canal.

90. Irrigation from the main canal should be done by filling in each basin consecutively from upstream to the downstream reach with the use of the CRs, and each basin is irrigated in rotation consecutively from the first upstream basin to the last basin. While off-taking water from the main canal, the downstream gate of the basin should be close to raise enough head. And after irrigation of the upstream basin(s) is done, the downstream CR of the first basin or upstream CR of the second basin should be open to allow water to fill up the downstream adjacent basin and irrigation should be done from this basin. Continue doing this way until irrigation from the last basin is done, after which irrigation should be rotated to the first basin again.

91. Irrigation water is designed to divert from the main canal into the lateral when water level reaches Full Supply Level (FSL) or Crest level of the downstream CR gate. Water then flows by gravity from the laterals into the paddy field following the downward slope of the natural topography, see figure 10 below.

92. The peak irrigation requirement Prek Chik is of about 224 mm/month, and irrigation is to be rotated from the first basin to the last basin on a 10 day rotational period with flow being delivered from each basin for one day. Hence the required water depth for a 10 day rotation period is 75mm. The average irrigated area per basin, calculated on the aerial photo and it is about 1300 ha. With the required irrigation depth of 75mm, the volume for one 10 day rotation is of about 985,500m^3, hence the required flow per day is of about 1.14m3/s. This flow is used for design of lateral canal taking water from each basin.

3.1.10 Land Leveling

93. 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.

94. 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.

95. 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.

96. 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.

97. 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.

98. 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.

99. 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.

3.1.10.1 Components of Laser Leveling System

100. 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.

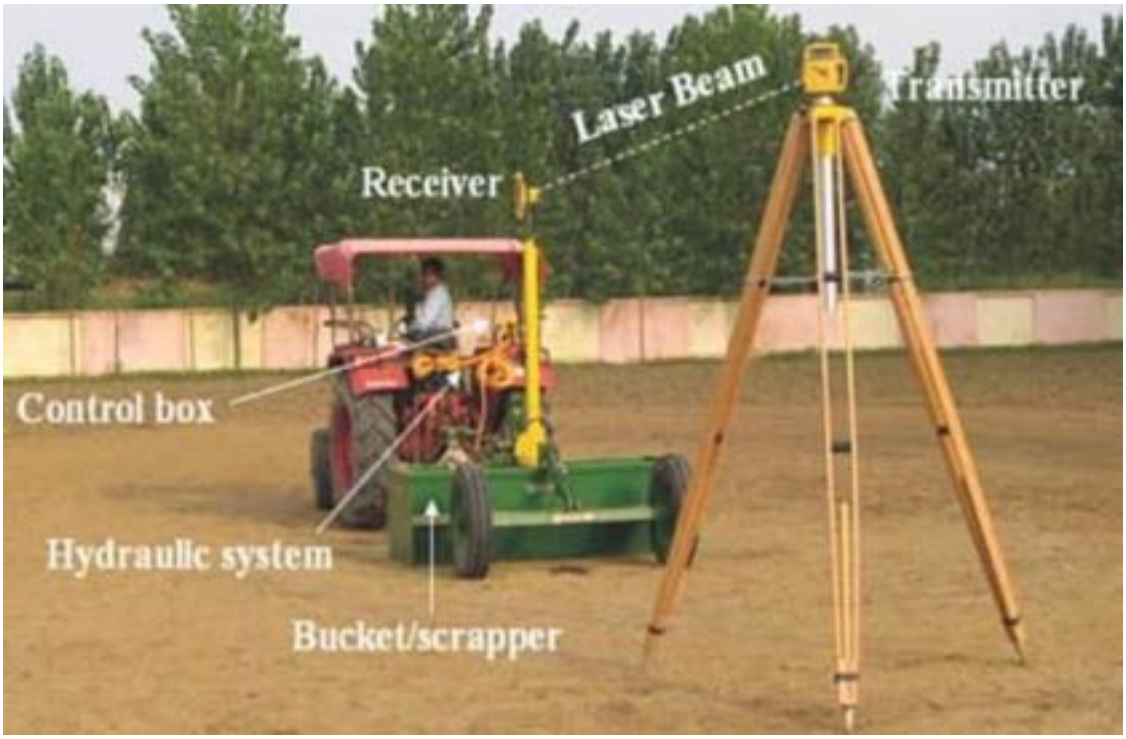
(iii) **Laser receiver:** The laser receiver is a multi-directional receiver that detects the position of the laser reference plane and transmits this signal to the control box.

(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 2: Showing different components of Laser Levelling System

Figure 3: Working mechanism of Laser Leveler



101. 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.

3.1.10.2 Approach to land leveling

102. 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.

103. 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.

104. **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.

105. **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.

106. **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 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

3.1.10.3 Benefits of land leveling

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 %

107. **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.

108. **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.

109. **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%.

3.1.10.4 Laser leveling in Prek Chik Core Subproject

110. Lands and plots in Prek Chik core subproject will benefit from land leveling. Areas in part of the Phase I areas in Prek Chik 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.

111. 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 Prek Chik Phase I where land clearing will still be required and it can be anticipated that laser leveling will be required. The areas concerned and in need for such laser land leveling may be in the range of 2000-4000 has.

3.1.10.5 Land Leveling familiarity in MAFF

112. 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.

113. 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.

114. 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.

3.1.10.6 Conclusion

115. 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.

3.1.11 Technical Drawings

116. The detail technical drawings for Main Canal and all relevant structures on the headwork and structures on the Canal of two core 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 60 drawings sheet for Prek Chik, and these drawings are converted in the PDF. Two AutoCAD operators are deployed between late February and end of May 2015 to handle this workload.

117. The first sheet of each drawing set is the "General Note" in which descriptions of technical terms, legends and symbols used in whole drawings set are given. The second 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 - 60 for Prek Chik - are available to ADB and MOWRAM on CD and USB memory stick.

List of Drawings on Prek Chik Core Subproject

All Drawings in A3 size

No.	ITEM	Number of Sheets
1	General Note	1
2	Core Subproject Location Map	1
3	Layout Plan	2
4	Headwork	
4.1	Duck Bill Weir	5
4.2	Automatic Flappy Gate	7
5	Main Canal works	
5.1	Main Canal	14
5.2.	Head Regulator/Cross Regulator, Existing	3
5.3	Cross Regulator, NEW	9
5.4	Off take I(a) (Single Box Culvert, 1gate) Existing	2
5.5	Off-take I(b) (1 Cell Box Culvert, 1gate), Existing	2
5.6	Off-take II (2 Cells Box Culvert, 2gates), Existing	2
5.7	Off-take II (2 Cells Box Culvert, 2gates), New	4
5.8	Cross drainage	4
5.9	Foot Bridge	4
	TOTAL	60

3.1.12 Surveys

3.1.12.1 Topographical survey

118. Topographical survey for the core subproject-- Prek Chik 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.

119. All headwork structures and the 27 kilometers in total length of the Prek Chik Main Canal were surveyed. Three alignments of the secondary canals of the Prek Chik core subprojects are also included in the survey works. The results of the survey have been processed using computer program AutoCAD Civil 3D 2009 Land Desktop softwares. The outcomes of the processed survey result show that the average slope of the Prek Chik main canal is 0.8m drop per 1 kilometer length. And within the whole canal length there are several drop locations with drop height in the range of about 1 to 1.5 m. For this reason, additional cross regulators are required to be equipped within the Prek Chik Main Canal between the existing ones. With more cross regulators the canal could command more area.

3.1.13 Guidelines to Contractor for Prek Chik

120. Prior to construction the contractor should start conduct the topographical survey verifying all the available Bench Mark points (BMs) and install numbers of additional BMs as needed. Water should be completely drained from the Prek Chik main canal and the storage pool at the location of the head-work.

121. After water is drained, the contractor should start construction to raise the existing sill elevation of the flap gates and the duck bill weir as specified in the Engineering design section.

122. 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 in canal reaches 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 more than 20m is recommended to prevent the BMs being disturbed during construction.

123. 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. Three new cross-drainage works are to be constructed at RD 23+900 to RD 24+400, RD 25+500 to RD 25+900 and the third location from RD 26+700 to RD 27+200. The design dimension and elevations are shown in the technical drawing.

124. The contractor should ensure construction safety and standard, identifying locations for storing of construction materials at site, site office locations/camp. He should

inform the communities about the contractor team to be presented in the area during the construction period. He should follow carefully the project Environmental Management and Mitigation Plans during construction works as specify in the project report and follow the Royal Government of Cambodia (RGC) labor laws and should not allow child labor. In addition he should follow strictly the construction technical specification as attached in the bidding document.

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

126. 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.

3.1.14 Bill-of-Quantities

127. 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 (BoQ) 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.

128. There are 12 Bills for Prek Chik core subproject. These BOQ will be used as the key part of the Bidding Documents.

3.1.15 Biddings Documents

129. 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.

3.1.16 Cost Estimates

130. 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 5 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.. The cost estimates for each unit of canal and structure for both core subprojects are generated in the same sheet of related BoQ 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.

3.1.17 Construction Specification

131. 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.

132. The Construction Specification is divided into 11 main chapters. Chapters 1 and 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.

3.1.18 System Maintenance of Prek Chik Core Subproject

133. 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.

134. 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.

135. Less maintenance, comparing with the 15-year-in-operation system Stung Chinit in Kampong Thom province, will be required in Prek Chik. The soils in Prek Chik are more resistant to erosion. Prek Chik will serve mainly for supplementary irrigation to the wet season rice crop. For these reasons, the O&M for Prek Chik is estimated at a lower rate of 12 USD per hectare per year. The annual total O&M cost for the whole command area of 20,800 hectares is then 250,000 US.

3.1.19 Link to Agriculture Support

136. 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.

137. 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.

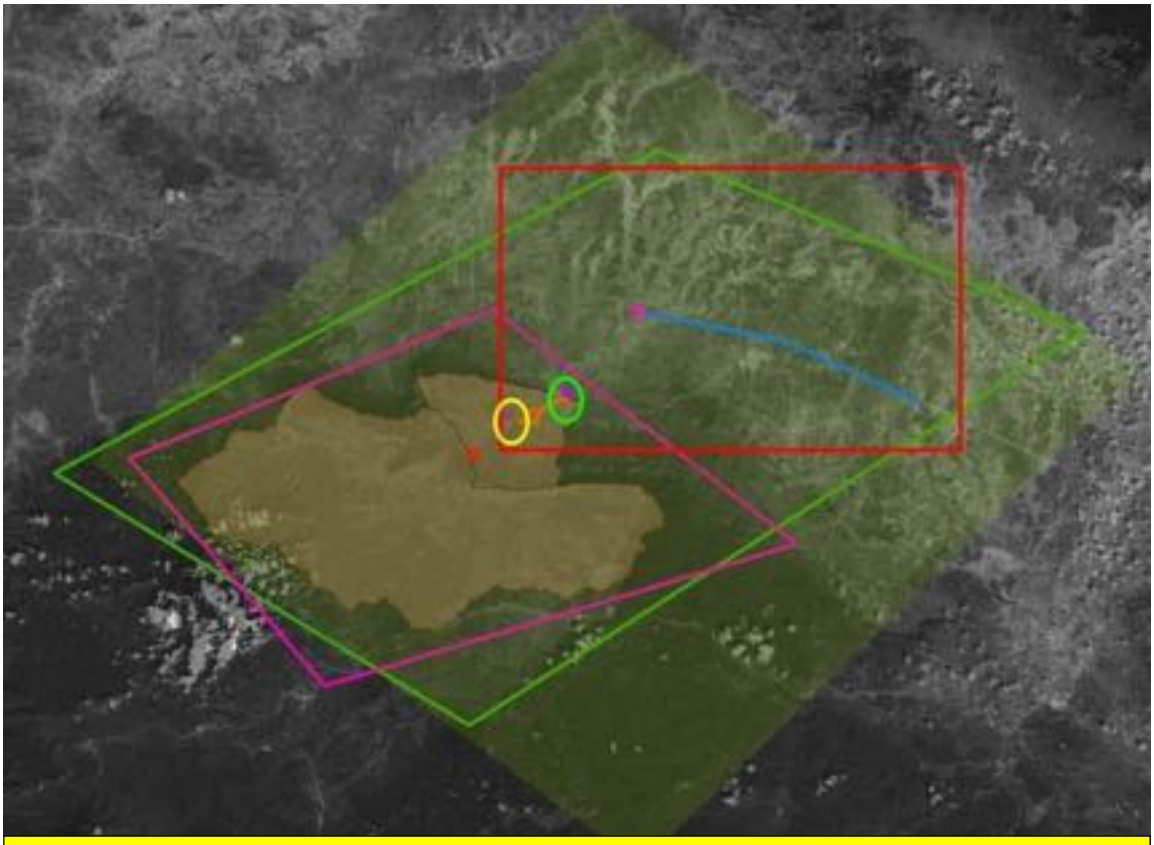
138. This point to the apparent and obvious need to review and include the use of non-water agro-inputs in the overall crop production process and associated cropping calendar. The benefits used in the Economic Analysis use this assumption of better seeds of shorter duration on the field during irrigated 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.

139. 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).

3.1.20 Use of Satellite Images (remote sensing)

140. 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 and Prek Chik. 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, and by mid-May 2015 for the areas of Prek Chik, Bassac Reservoir and Dauntri reservoir site. These images are accessible through Website Links of gisat; The website links are:

http://eotap.gisat.cz/Prek-Chik-Overview-Map-Index.html
http://eotap.gisat.cz/Prek-Chik-DetailCanal-Map-Index.html
http://eotap.gisat.cz/Prek-Chik-DetailDam-Map-Index.html

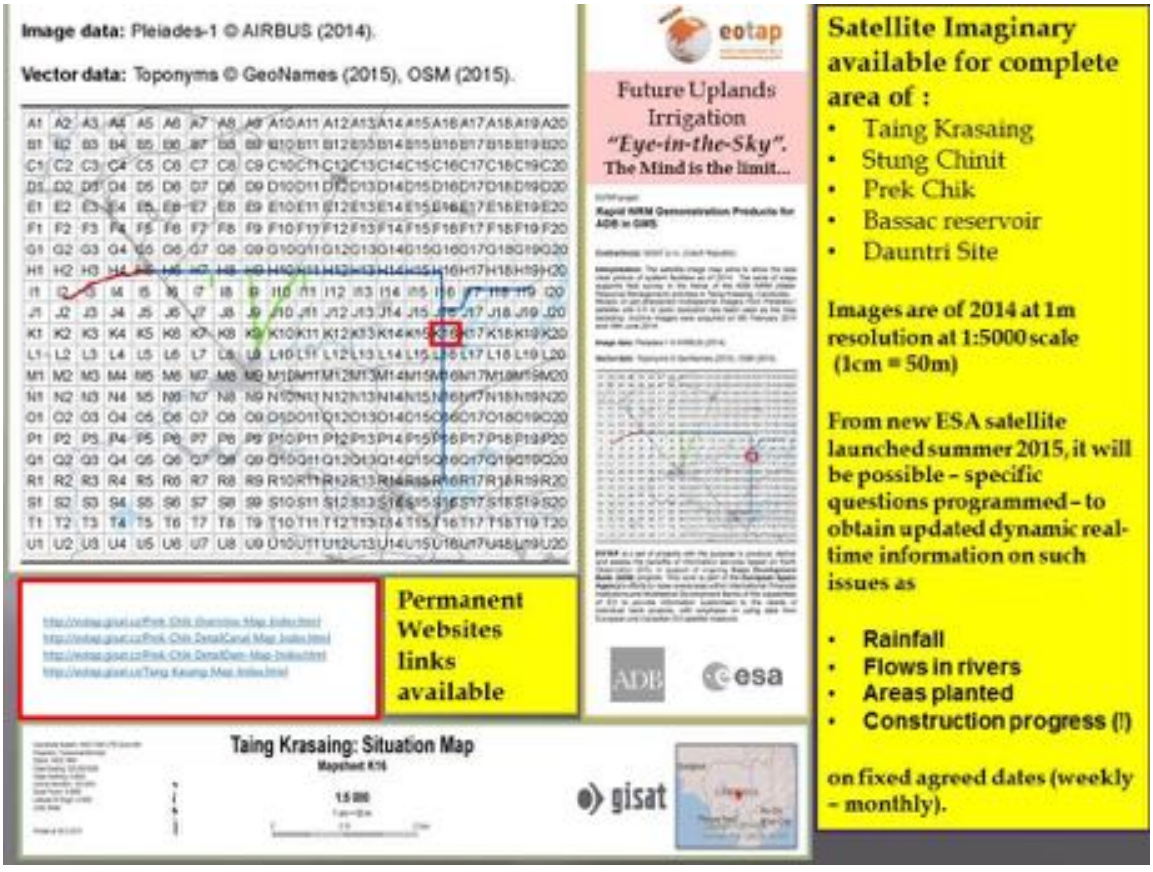


Information provided to gisat through coordinates with the green circle Bassac reservoir, yellow circle the Dauntri site and the blue line in red rectangle the Prek Chik main canal and command area.

141. 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 Prek Chik, Bassac reservoir and Dauntri Reservoir Sites. Images are of 2014 at 1m resolution at 1:5000 scale (1cm = 50m).

142. 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.

143. 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.



3.1.21 Climate Change

144. 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 farmer water user communities (FWUCs) to enhance climate resilience.

145. 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.

146. Climate change in the core subprojects will impact the systems and their performance in the following manner:

1. To anticipate drought, through increasingly prolonged period of no rainfall, both during the dry season, but also during the wet season;
2. 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;
3. 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;
4. More frequent flash floods of greater intensity and durations

147. Both core subprojects operate through reservoirs 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 requirement 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.

148. 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

149. Required drainage works have not been calculated separately as they are intertwined with irrigation related canal performance. But all measures, major in Prek Chik where the main canal often functions as the only available drain discharge option, will be corrected and improved to high standard requirements.

150. As stated in various chapters of this Link Supporting Document, the main canal of both systems 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 (Prek Chik).

151. 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.

152. 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.

153. A study of considerable relevance to the overall Stung Chinit watershed in Kampong Thom province 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.

154. His conclusion are of immediate relevance in general to Prek Chik, as climate data used and models to predict impact are valid for all areas adjacent and bordering the Tonle Sap lake.

155. 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**

156. **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.

157. **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.

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.

Note:Taing Krasaing is another reservoir which is linked with Stung Chinit by a link canal of 7Km to the north.

158. 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. This is especially important for resp. wet 10,400 ha and dry cropping area of 4000 ha in Prek Chik Phase 1, as water in Bassac-Dauntri storage will run out faster as compared to more water rich Taing Krasaing-Stung Chinit linked reservoirs. Proposed Hydro-Met and Telemetry as outlined in Hydrology are part of these measures too and installation is essential.

159. 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.

3.2 Agriculture

3.2.1 Assessment of Field and Practices in the two Core Subprojects

160. Presented below in Table 10 is the assessment of Key Agro-Inputs in both core subprojects.

Table 6: Overview Table on Agricultural Practices in the Rice-Based Core Subproject

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 Prek Chik Core Subproject.
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 Prek Chik 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	**Demonstrations**
	Demonstration plots will be established in association with a number of the FSSs in order to demonstrate on field water management, land preparation, direct seeding, fertiliser application (base dressing and top dressing), weed control, pest and disease control and harvesting & marketing.
8	**Crop nutrition**
	Based on the results of soil analysis, recommendations will be made on appropriate fertilizer regimes. Farmers will be encouraged to purchase fertilizer in bulk. In areas where soil acidity is affecting yield, correction measures will be tested and demonstrated to farmers.
9	**Credit**
	There are micro-finance institutions (MFIs) operating in the project areas and these will be encouraged to work with farmers and to provide seasonal credit for improved inputs. Farmers will be assisted to make loan applications based on realistic and achievable projections for increased yield and income.
10	**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.
11	**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.
12	**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 m^3 per hectare on a new irrigation scheme operating at 50% water use efficiency.
13	**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.
14	**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.

161. Tables 11 and 12 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 7: 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 8: 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

162. Table 13 below compares – based on above assessment details – the two core subprojects with respect to the current key agro-inputs and practices (the "without" project case) and what can be expected in the "with" project case. The cropping calendars presented in Figures 4 and 5 are quite similar as they both start the wet season around mid-May to early June. Figure 6 below presents a summary Production Profile of Prek Chik Core Subproject.

Table 9: Comparative Table of Key Agro-Inputs and Practices Activities – Current and Future – in the Prek Chik and another core subproject (Taing Krasaing)

			Tang Krasang			Preuk Chik	
	Characteristic	Season	Unit	Without TODAY	WITH - Future	Without TODAY	WITH Future
1	Cropping Intensity	WS	%	80	100	100	100
	Cropping Intensity	DS	%	Zero	30	5	40
2	Yield	WS	t/ha	1.5	2.7	1.8	3.2
		DS		Zero	3.2	2.2	3.9
3	Fertilizer	WS	% using	< 30	90	80	100
		DS		Zero	100	100	100
4	Land Preparation	Mechanized	%	80	90	80	95
5	Planting	WS	Transplant	20	20	15	25
			Broadcast	80	80	85	75
		DS	Transplant	Zero			20
			Broadcast	Zero		100	80
6	Seed type		Self-saved	100%		Self-saved	90%
7	Vegetable	See Note					
8	Other Crops	See Note					
9	Harvest	WS	Combine	70	85	90	90
		DS			85	90	90

Notes: WS= Wet Season; DS = Dry Season
Vegetables and other crops to be included pending additional information collection

163. The Climate Resilient Rice Commercialization Sector Development Program (Rice-SDP) is an important project for both core subprojects. The Rice-SDP has been carefully examined and several discussions with its consultants have occurred. Rice-SDP is planned to be implemented in Prey Veng, Kampong Thom and Battambang provinces and will focus on rehabilitation and climate proofing of selected irrigation systems; the construction of seed cleaning, drying, grading and storage facilities; and construction of paddy drying and storage facilities.

164. The Program will also finance a number of national level initiatives that can be used in the provinces to promote enhanced agricultural productivity. National initiatives in relation to the production of quality seed material, the revision of technical information packages, and the zoning of agricultural land will provide a sound basis for the provincial and district departments of agriculture to support farming activities. The pilot insurance scheme will be tested within the target provinces.

3.2.2 Other Development Projects

165. 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.

166. 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.

167. 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.

168. 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.

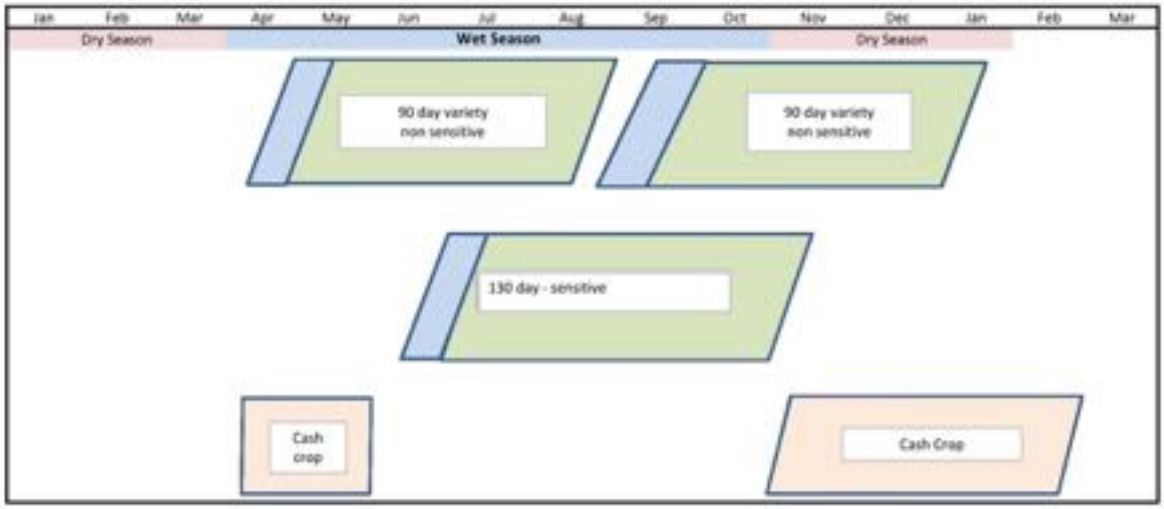
169. The JICA-funded **Agriculture Production Project** whose first phase commenced in 2003 worked with rice in Kampong Thom and Battambang. Among other technologies, it demonstrated the drum seeder for the row sowing of pre-germinated rice seed, a technique that is gaining traction in a number of Asian 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.

3.2.3 Crop Calendars

170. **Prek Chik.** If sufficient water is available, Prek Chik would have the same potential but it is most likely that may not be achievable. If not, the Prek Chik cropping calendar would be an early wet season followed by a late wet/early dry season crop in the areas that can be double cropped. Both crops would require using short season varieties. The area to be single cropped would be a wet season crop using either a short season or medium season variety.

Figure 4: Cropping Calendar for Prek Chik Core Subproject

Cropping Calendar for Irrigated Systems



Legend

= Land preparation

= crop growth and harvesting

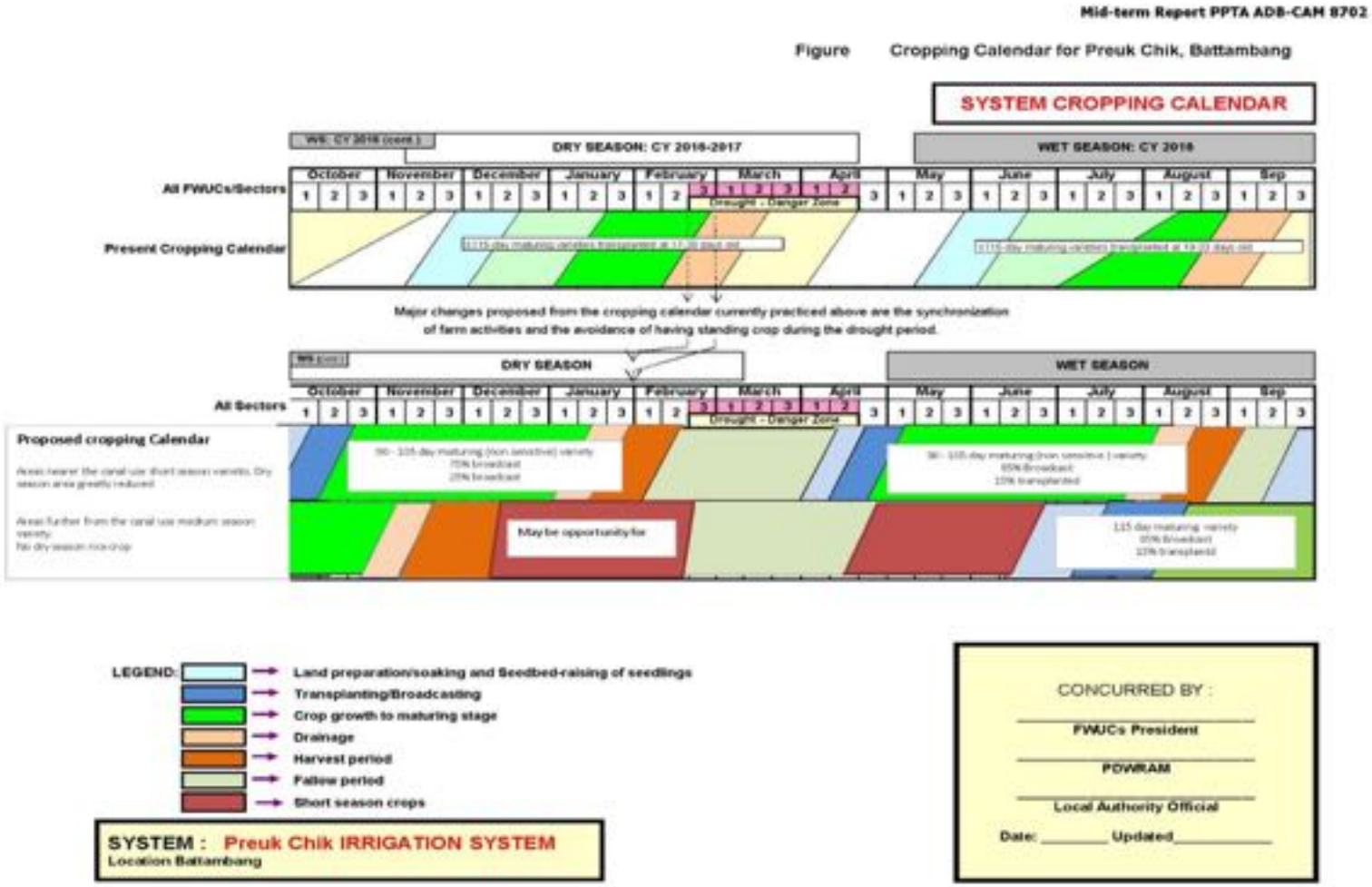
The cropping calendar is based on rice following rice rotation where there is sufficient water to grow a wet season and a dry season crop. Where a two crop programme is planned short season rice varieties will be planted.
Where there is not sufficient water for a dry season crop there is one medium season 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			Dry Season Efficiency		
		50%	40%	30%	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.

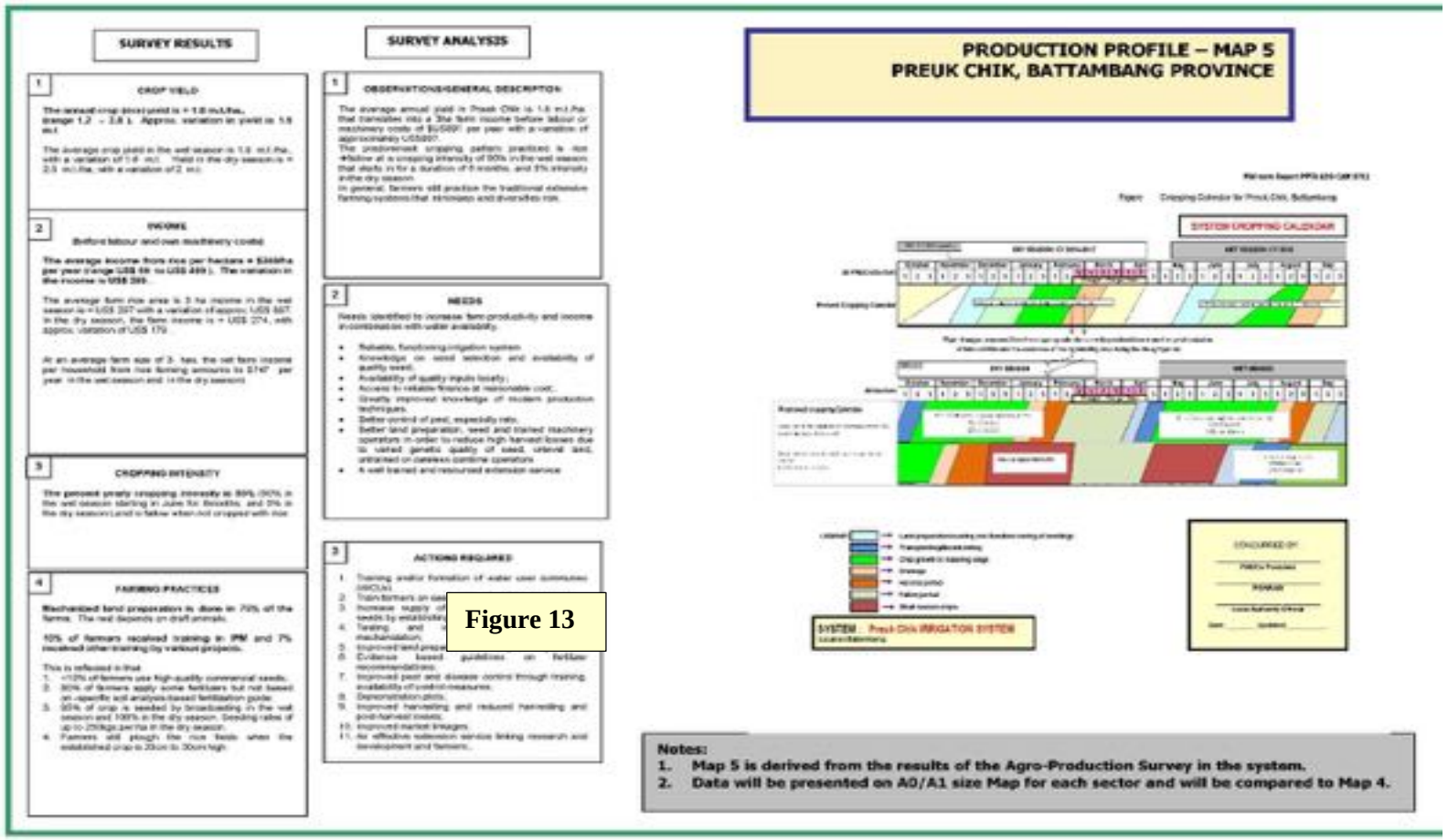
Figure 5: Cropping Calendar for Prek Chik



Source: PPTA Consultant

Figure 6: The Production Profile of Prek Chik Irrigation System

Figure MAP 5 - THE PRODUCTION PROFILE OF PRAEK CHIK IRRIGATION SYSTEM



Source: PPTA Consultant

3.3 **On-farm Water Management**

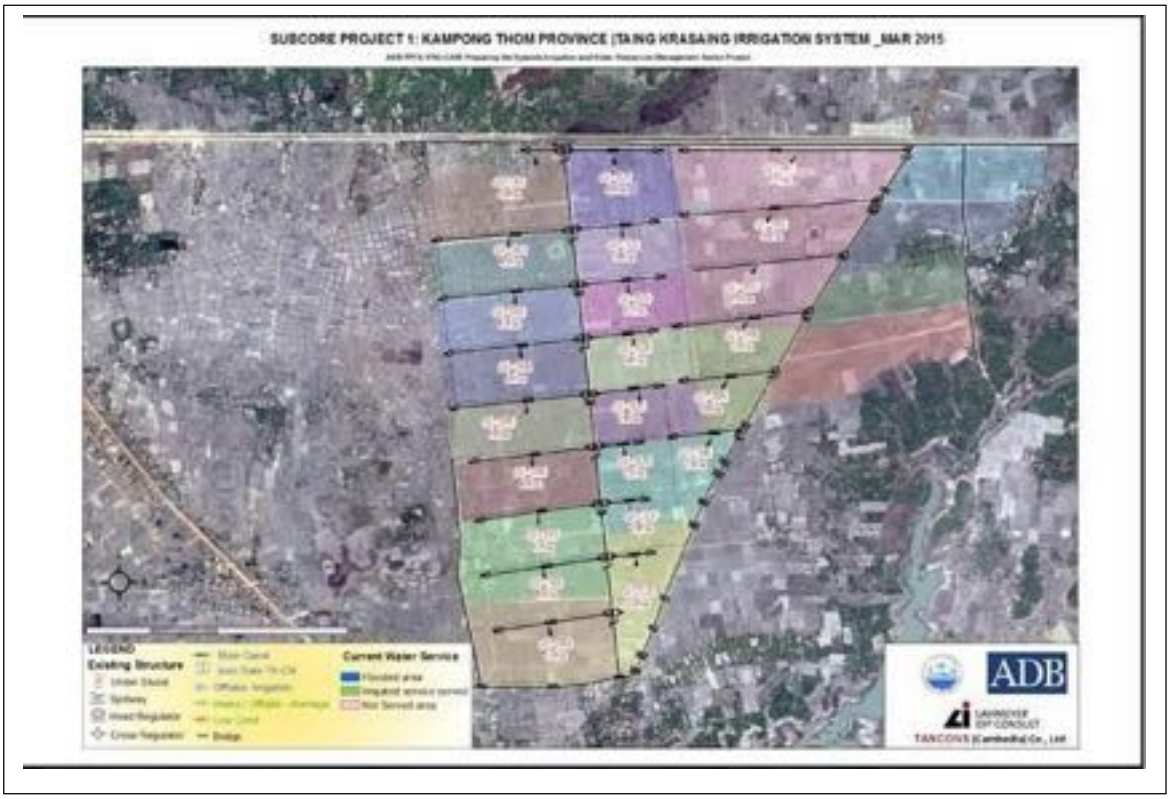
171. Within the core subproject areas, has no experiences in on farm water management, as the system has not yet developed on-farm water management facilities, such as irrigation and drainage canal distribution network equipped with control structure.

172. The OFWM layout of the CAVAC area (Section 3) shown in Figure 7 below.

173. Figure 7 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 7: Section 3, CAVAC Taing Krasaing development



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 Tertiary Canal 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

175. 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

176. 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**.

177. 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.

3.4 Watershed Management

3.4.1 Assessment of the Prek Chik-Bassac Watershed

Description

178. The Prek Chik-Bassac watershed of the Moung River is located in Battambang Province. It is a rather flat area, partly cultivated and partly idle, surrounded by a range of low mountains with somewhat degraded forest cover. Due to its elevation, the land is not well suited for rice cultivation. Apart from rice, a variety of other crops are grown such as cassava, maize, pineapple, various legumes, banana, mango and other fruit trees. Livelihoods include livestock and poultry breeding. There are no economic land concessions in this area; but it seems that people occupy a chunk of land in the watershed area and its surroundings.

Issues

179. Parts of the headwater areas in this watershed are in poor state, with degraded vegetation cover and top soils; consequentially there is high specific sediment release from these areas carried by the surface runoff every year. The limited water availability in the dry season is a visible constraint to livelihoods, agriculture and environmental health. Groundwater exists but is not widely used due to poor quality (bad smell). Still, some hand pumps are available, and shared on a community basis. Most households use jumbo jars to meet their dry season water demand, which are supplied from water harvesting and by delivery vans. There are a few household and community ponds, but these were almost dry when the Consultant Team visited in February 2015.

180. Pressures and impacts include the following:

- Forest fires occur every year in February, damaging the top soils and vegetation cover, and causing release of sediments.
- Some forest areas are being cleared for wet season cultivation and land speculation, damaging the vegetation cover and causing serious siltation in the reservoir.
- Also, there is some irregular collection of timber and firewood, adding to the pressures on vulnerable forest areas.

Governance and Institutional Arrangements

181. An FWUC was established in 2002, as well as a forest community organization. Both organizations remain inactive and are in need of being activated to ensure watershed benefits to everyone. The Bassac Reservoir is operated by Bassac Commune with guidance from PDWRAM in Battambang. Collection of water fees has been on the agenda since 2002, but is impeded by a lack of perceived benefits among the water users. The PDWRAM Director mentioned a lack of technical documentation left behind after structural rehabilitation and upgrading by external contractors. Operation and maintenance would be highly facilitated by routine provision of design documentation

along with some guidelines in Khmer. A PDWRAM site office near the main water gate was suggested as a helpful measure in support of improved dialogue about operation and maintenance.

Corrective and Preventive Measures

182. Potential technical corrective and preventive measures include the following:

- There may be a potential for sediment control structures upstream of the Bassac Reservoir.
- Discontinuation of irregular forest clearance and replacement with voluntary reforestation and fruit tree plantation.
- Re-development of idle lands (including reforestation and sustainable forest utilization) is a clear development opportunity.
- The potential for risk management and damage control related to forest fires should be considered.
- Technological support for 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

183. There is a clear scope for re-activating the FWUC and the forest community organization, with adequate technical guidance and backstopping, and adequate information flows maintained on a routine basis (predicted water allocation and availability, weather forecasts, pest attacks etc.). The capacity of these bodies must be strengthened by targeted education, facilitation of networking, and coaching and backstopping, involving the provincial departments in charge of water resources, agriculture and forestry. Positive experience from the Kamping Puoy Irrigation Scheme (elsewhere in Battambang Province) can be replicated in this irrigation scheme, especially the effective application of irrigation service fees. This could contribute to sustainability of the watershed after rehabilitation.

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

184. 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 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.[2] The country is divided into four regions with the following number of land holdings as indicated in **Table 14**:

Table 10: Regions and Number of Agricultural Landholdings[3]

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.

185. Land tenure arrangement shows that majority of the land are owned with 94.57% in Battambang.

Table 11: Land Tenure Arrangement[4]

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.

186. 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%

[2] Census of Agriculture in Cambodia 2013, National Institute of Statistics, Ministry of Planning in collaboration with Ministry of Agriculture, Forestry and Fisheries

[3] *Ibid*, p.8

[4] *Ibid*, p.11

in Battambang and 5.5% in Kampong Thom use government irrigation facilities and 4% use other sources of irrigation.

Table 12: Landholding that Use Irrigation[5]

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.

4.1.1.2 Location of Project Area

187. The Project area is located in two provinces, namely Battambang and Kampong Thom, which belong to the Tonle Sap Lake Region. 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 13: 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.

4.1.1.3 Project Land Area

188. 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.

[5] Ibid, p.14

Table 14: Project Land Area

Irrigation Schemes	District And Communes	Total Land Area (Ha)[6]	Project Area (Ha)			
			Gross Command Project Area[7]	Existing Area Irrigated	Cropped Area (2014-2015)	
					Wet	Dry
Prek 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**

Source: PPTA Consultant.

4.1.1.4 Population

189. 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 Table 19.

Table 15: Population[8]

Irrigation Schemes	District And Communes	Population			Households			Farmer Beneficiaries[9]
		Total	Male	Female	Total	FHH	MHH	
Prek 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							
	Prek 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

Source: PPTA Consultant.

190. 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 Table 20. This means that almost 50% of the population is in productive age.

.

[6] District Agriculture Office, 2015
[7] Based on Project Design
[8] Commune Database, National Institute of Statistics, 2013
[9] District Agriculture, Forestry and Fisheries Office

Table 16: 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
Prek 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					
	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

Source: PPTA Consultant.

4.1.1.5 Landholding and Ownership

191. The average size of a farmer's landholding is from one to three hectares. Prek Chik has 1,337 farmers with landownership of less than one ha of farmland. This is 20% of the farmers. There are 1,152 farmers who do not own their farm.

Table 17: Size of Landholding and Ownership[10]

Irrigation Schemes	District And Communes	Farmers		Farmers Owning Less than 1 ha[11]		Farmers who do not own rice land[12]	
		Total	Average Size of Land-holding	No.	%	No.	%
Prek 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

Source: PPTA Consultant.

4.1.1.6 Sources of Income

192. The main sources of income of people in the Project areas are from agriculture, craftwork and service as summarized in table 22.

193. 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

[10] Commune Database 2012 and Provincial Data Book 2009

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

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

production and fishing. Only 3.7% derive their income form service and 0.10% from craftwork.

194. 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.

Table 18: Sources of Income or Occupation of Families

Irrigation Schemes	District And Communes	Agriculture (%)			Craft Work (%)	Service (%)	Others (%)
		Rice	Vegetable	Fish			
Prek 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

Source: PPTA Consultant.

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

195. 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 19 is the agriculture situation in Prek Chik Irrigation Scheme.

Table 19: Agriculture Situation (2014-2015)

Agriculture Data	Prek Chik[13]
Irrigated Rice Area	• No area irrigated • No water in canal
Rain-fed Rice Area (Ha) • Rice Crop • Fruit Trees and Vegetables	 • 3,899 Ha • 600 Ha
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
Farmers Affected by Flood	• Around 200-600
Rice Varieties Planted • Early Variety • Medium Variety • Late growing Variety	 15% of Farmers 60% of Farmers 25% of Farmers

[13] Farm Survey Report of Agronomist, in 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.

Agriculture Data	Prek Chik[13]
• Floating Rice Variety	---

Agriculture Method Used
• Land Preparation
  ○ By Cow/Buffalo
  ○ By hand tractor
  ○ By big Tractor
	
	10% of Farmers
	75% of Farmers
	15% of Farmers

• Land Leveling	10% of farmers rent tractors
• Transplanting or • Broadcasting	0% 100%
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)
Harvesting • Manual Labor • Machine	 0% 100% Farmers used 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 by family are sold to private buyers at farm gate price of 900-1,200 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)
• Gross and Net Market Value of Rice Produce (USD)	540 USD (Gross Value) 295 USD (Net Value after production cost)
Livestock • Cows for selling • Buffalo • Pigs • Chicken	 100% of Farmers 20% of Farmers 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 in canals • Lack of irrigation canals • Poor soil quality (not fertile) • 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

Agriculture Data	Prek Chik[13]
	• 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

Source: PPTA Consultant.

4.1.1.8 Poverty Situation in the Project Area

196. 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

197. 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:

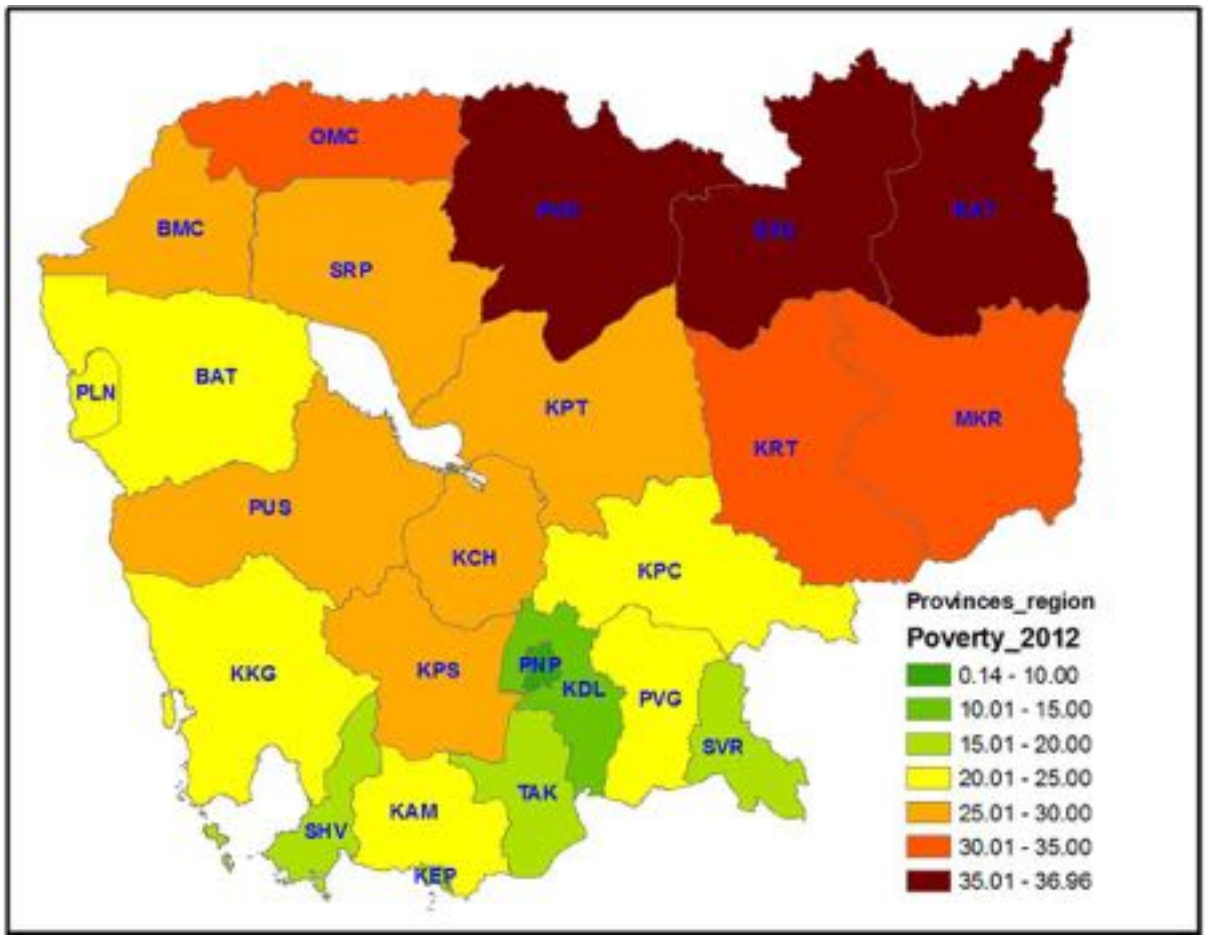
Table 20: Poverty Line[14]

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.

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

Poverty Rates in the Project Area



198. 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 Map 2 and Table 21**).**

199. 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.

200. 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 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 4: Location Map of Project Area and Poverty Rate, 2012

Table 21: Poverty Rate in the Project Area[15]

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)	
Prek 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:				
	• Preaek Chik	46.0	41.3	33.2	
	• Prey Tralach	44.6	39.2	34.5	

Source: PPTA Consultant.

201. 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.

202. 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 (ii) and lack of job opportunities in the localities.[16]

4.1.2 Gender

203. 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[17]. 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

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

[16] Focus Group Discussion (FGD) conducted in Taing Krasaing and Prek Chik

[17] UN-DAF, 2010, and UNDP, 2010, Gender and Climate Change: Oxfam America, 2010;

(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.[18]

204. 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.[19]

205. 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.
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. Because of the impact of climate change the farmland lack water, which leads to low production. The women headed households become the most vulnerable.

[18] Result of FGD conducted in May, 2015 at the target communes of Taing Krasaing and Prek Chik irrigation schemes;

[19] Objective 4 of MOWRAWM Gender Mainstreaming Strategy and Action Plan 2014-2018, page 9;

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.

206. Presented in **Table 22** 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 22: 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. • 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	• Meeting/training schedule should consider women's schedule. • Awareness raising on Gender Concept for communities in the target communes.

Key Gender Issues	Mitigation Measurable
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.	
• 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

207. 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 23: 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

Project Activities	Proposed Gender Action Plan	Person / Institution responsible
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 on gender issues.	MOWRAM, Gender Focal Point, Project Gender Specialist
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	MOWRAM, GFP, Project Gender Specialist

Project Activities	Proposed Gender Action Plan	Person / Institution responsible
	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.	
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**

208. The project is classified as category B for involuntary resettlement. No land acquisition is required for 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

209. 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 24** is the summary of the stakeholder analysis conducted:

Table 24: 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,	Represent their own interest to improve their condition

Stakeholder Group	Interest	Mandate
	improvement in water management and in crop production.	
• Water Users Groups - Famer Water User Communities (FWUC)	Functional and efficient irrigation system that will benefit its farmer members. Represent the interest and welfare of its members.	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)
- Private Companies such as the Chinese, Korean and Vietnamese Companies in Taing Krasaing Irrigation Scheme)	Maximum benefit for their farms that use water from the irrigation scheme. Better service delivery from PDWRAM with the improved irrigation scheme.	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		

Stakeholder Group	Interest	Mandate
• Asian Development Bank	Support to irrigation and agriculture improvement through Loan and Grant	Development Assistance
• 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

210. 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

211. 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[20]:

- 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.

212. 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 seven Secretaries of State and seven 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

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

625 (54 female + 571 male) are based in the Phnom Penh municipality and the 24 provinces.

5.1.2 Provincial Department of Water Resources and Meteorology (PDWRAM)

213. There are 24 Provincial offices of the PDWRAM with 625 personnel (54 female + 571 male). The functions of the PDWRAM are stated as follows:[21]

- 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.

214. The PDWRAM is headed by a Director and supported by two 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.[22]

215. 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[23], there are 27 staff with 4% women. Presented in Table 25 is the number of PDWRAM staff:

Table 25: PDWRAM Staff in the Provinces involved in the Project Implementation

Province	Number of Staff		
	Female	Male	Total
Cambodia (24 Provinces)	54 (9%)	571	625
• **Battambang Province**	8 (12%)	59	67
• **Kampong Thom Province**	1 (4%)	26	27

5.1.3 Project Management Unit

216. 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 Department of FWUC. It is composed of 13 designated personnel responsible for the over-all project implementation, planning, organization, monitoring and

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

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

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

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.

217. 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

218. 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; and,
- The PDWRAM/Municipality of Water Resources and Meteorology shall register all FWUCs in the FWUC registry, after endorsement by MOWRAM.

219. 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)

220. 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.

221. 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 three Secondary canals, three Gates – left off-takes from main canal, one 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.

222. 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

223. 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**

224. The institutional assessment and mitigation measures in project implementation is presented in **Table 26.** It focuses on MOWRAM/PDWRAM, the FWUCs, Irrigation infrastructure and the Private Companies within the Project area.

Table 26: 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, 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.	• Well defined FWUC Organizing Framework within MOWRAM/PDWRAM • 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-

PARTICULARS	RISKS	MITIGATION MEASURES
		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**

225. The social risks identified in and mitigation measures are presented in Table 27.

Table 27: Social Risks Assessment

No	Risks	Prek Chik	Mitigation Measures
1	FWUC Organizing will require an assisted process of establishment and strengthening from pre-	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	PMU should assign specific FWUC Organizers for each Irrigation System. The recommended

No	Risks	Prek Chik	Mitigation Measures
	construction, construction until O&M of the Project.	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.	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)[24]	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 and cultural belief that irrigation and water management should involve only the men. Difficulty in mobilizing 40% of women to participated in construction work.	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 importance of women's participation in Project activities and lack of confidence of women to participate and voice their views during meetings.	The Gender Action Plan considers these issues and propose specific activities to address these. (See also Table 8)

5.4 **Assessment of Training for MOWRAM, PDWRAM and PMU**

226. 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

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

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 one 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 28 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 28: 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) 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)

WRMSDP Training Plan (Approved)			UIWRMSP Training Plan (Proposed for Project)		
No.	**Training Module**	**Participants**	**No.**	**Training Module**	**Participants**
					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 Prek 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: Prek 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)
			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)

WRMSDP Training Plan (Approved)			UIWRMSP Training Plan (Proposed for Project)		
No.	**Training Module**	**Participants**	**No.**	**Training Module**	**Participants**
			12	Improved Crop Production Practices and Value Chain	2 FWUCs (2 x 10 = 20 participants)

6 FINANCIAL ASSESSMENT

227. 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.

228. 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 Prek Chik

229. To determine how much is the annual O&M budget which the government needs to provide for Prek Chik, the O&M cost was 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 48,553 as shown in Table 29.

Table 29: Prek Chik: Average O&M Cost/ha based on 50:50 cost sharing

		Cost/ha	Cost Sharing	
			PDWRAM	FWUC
Costs in 2015 Prices	$	KHR		
Secondary and Tertiaries system, Part 1	125,373	506,506,920	253,253,460	253,253,460
Total Hectares	10,432			
Average O&M per hectare (2015)	12	48,553		
Costs in Current Prices				
Project Year				
Year 1- 2019		55,716	290,614,170	290,614,170
Year 2 - 2020		57,666	300,785,666	300,785,666
Year 3 - 2021		59,684	311,313,165	311,313,165
Year 4 - 2022		61,773	322,209,125	322,209,125
Year 5 - 2023		63,935	333,486,445	333,486,445

230. 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. 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 still need to be developed. 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.

231. It is assumed that the FWUCs will be able to implement at the very least, ISFs at the current level of the ISF of the Stung Chinit FWUC which is KHR 60,000. 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 KHR90,000 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 is needed to generate an increase in the willingness to pay. This will target farmers' perceptions of the need for cost recoverable ISFs. Table 34 shows that using the Stung Chinit ISFs, the farmer rates will cover 124% of the full O&M costs and 247% of the shared cost.

Table 30: Cost Recovery of Prek Chik Irrigation System Using Current ISF of Stung Chinit

		Prek Chik Farmers
AT FULL COST (100%)		
A	O&M Cost/ha (KR)	48,553.19
B	ISF (KR)	60,000.00
	($)	14.85
	% Cost Recovery (B/A)	124%
AT SHARED COST (50%)		
A	O&M Cost/ha (KR)	24,276.60
B	ISF (KR)	60,000.00
	($)	14.85
	% Cost Recovery (B/A)	247%

232. The base scenario, considers ISF payment to start at a lower rate of KHR 50,000 (see alternative scenario for the ISF of KHR 60,000). Based on the analysis, the resulting receipts from ISF will still be adequate to cover the cost share of the FWUC at this rate. In fact, the FWUC can partially contribute to the recovery of the O&M costs share of the PDWRAM. A minimal deficiency of KHR 60 million in the first year, will need to be provided for by the government.

233. An alternative scenario was developed which shows the effect of setting the initial ISF at KHR 60,000. At this rate, the ISFs can recover full O&M costs. This level of ISF will also result in a surplus even after covering the full cost of the O&M and is higher than what is really needed to cover O&M.

Table 31: Prek Chik Calculation of O&M Budget Needed (Base Case)

		2017	2018	Year 1 2019 Year 4 of project	Year 2 2020	Year 3 2021	Year 4 2022	Year 5 2023
A	**SURPLUS/(DEFICIENCY TO BE REQUESTED FROM THE GOVERNMENT)**							
	RECEIPTS							
	ISF Farmers (KR)							
	Hectares			10,432	10,432	10,432	10,432	10,432
	ISF/ha	-	-	50,000	50,000	50,000	50,000	50,000
	Increase in fees					0%		
	Total	-	-	521,600,000	521,600,000	521,600,000	521,600,000	521,600,000
	O&M EXPENDITURES							
	Share of FWUC Assuming 50:50 cost sharing			290,614,170	300,785,666	311,313,165	322,209,125	333,486,445
	FWUC Surplus/ (Deficiency to be requested from government)			230,985,830	220,814,334	210,286,835	199,390,875	188,113,555
	BALANCE AFTER PROVIDING FWUC COST SHARE OF 50%							
	FWUC Surplus/ (Deficiency to be requested from government)			230,985,830	220,814,334	210,286,835	199,390,875	188,113,555
	Amount to be provided to PDWRAM to contribute to PDWRAM cost share			230,985,830	220,814,334	210,286,835	199,390,875	188,113,555
	Balance for FWUC			-	-	-	-	-
B	**SUMMARY OF BUDGET TO BE PROVIDED BY THE GOVERNMENT**							
	Share of PDWRAM Assuming 50:50 cost sharing			290,614,170	300,785,666	311,313,165	322,209,125	333,486,445
	FWUC budget							
	Deficiency (to be requested as subsidy, added to budget to be provided by government)			-	-	-	-	-
	Surplus from FWUC to be provided to government (deducted from budget to be requested from government)			230,985,830	220,814,334	210,286,835	199,390,875	188,113,555
	Total budget requirement			59,628,341	79,971,333	101,026,329	122,818,251	145,372,890

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

(b) Actual ISF to be implemented will be based on a review of ISF and Farmers' perception of services derived, capacity and willingness to pay.

BASE SCENARIO: INITIAL RATE OF KHR 50,000

	Year 1 2019	Year 2 2020	Year 3 2021	Year 4 2022	Year 5 2023
Farmers (a)					
Average Annual ISF/ha	50,000	50,000	50,000	50,000	50,000
Average O&M Cost//ha	55,716	57,666	59,684	61,773	63,935
% cost recovery of full costs	90%	87%	84%	81%	78%
% cost recovery of shared cost (50:50)	27,858	28,833	29,842	30,887	31,968
	179%	173%	168%	162%	156%
Total Budget Requirement (KHR Million)	59.63	79.97	101.03	122.82	145.37

ALTERNATIVE SCENARIO; INITIAL RATE OF KHR 60,000

	Year 1 2019	Year 2 2020	Year 3 2021	Year 4 2022	Year 5 2023
Farmers (a)					
Average Annual ISF/ha	60,000	60,000	60,000	60,000	60,000
Average O&M Cost//ha	55,716	57,666	59,684	61,773	63,935
% cost recovery of full costs	108%	104%	101%	97%	94%
% cost recovery of shared cost (50:50)	27,858	28,833	29,842	30,887	31,968
	215%	208%	201%	194%	188%
Total Budget Requirement (KHR Million)	0.00	0.00	0.00	0.00	0.00

6.2 **Conclusion for Prek Chik**

234. The base scenario shows that the Prek Chik irrigation systems will require a budget provision of around KHR 60 million in the first year of operation increasing to KHR 145 million in Year 5. This already considers that the ISFs collected by the FWUC will be adequate to cover the cost share of the FWUC. In fact, the FWUC can partially contribute to the recovery of the O&M costs share of the PDWRAM.

235. 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 Prek Chik irrigation system depends on this.

236. 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 Prek Chik Irrigation System.

237. In the coming years, increasing cost recovery depends 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, it is proposed that a focused information and awareness program targeting the farmers' perceptions of 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.

7 ECONOMIC ASSESSMENT

238. 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[25].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.

239. 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. [26]
(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.

[25] 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)*.

[26] 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.

240. 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.

241. 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.

7.1 "Without Project" and "With Project" Situation

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

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

244. 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.

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

246. **"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 32: Prek Chik Subproject Command Area

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

Source: PPTA Consultant.

247. 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.

248. Other components of the subproject include the following:

(iv) 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).

(v) Provision of training to the PDWRAMs, farmer water user communes (FWUCs) and the appropriate government agencies.

(vi) Organization, mobilization and training of FWUCs in the command area.

(vii) 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.

(viii) Design joint reservoir operations for Dauntri and Bassac reservoirs in Battambang province.

7.2 **Subproject Cost**

249. 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 33: 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
	TOTAL	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.

250. 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.

251. 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 lost 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 45.

7.3 Subproject Benefits

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

253. **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.[27] Incremental benefit is then calculated by deducting the without project situation from the "with project" situation.

254. 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[28], 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.

255. **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).

256. 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

[27] 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.

[28] 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.

operation for Dauntri and Bassac reservoirs will further provide reliable supply of water in the command area.

257. 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 38-47.

Table 34: 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	
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).

7.4 Economic Analysis

258. **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.

259. 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.

260. **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:

261. Increase in Investment Cost**:** 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)[29] is at a 65% increase in cost.

262. 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%.

263. 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%.

264. 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.

265. 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%.

266. 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%.

[29] 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%).

267. 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%.

268. 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%.

269. 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%.

270. 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%.

271. 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.

272. 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 35: 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.

7.5 **Financial Household Returns**

273. 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.

274. 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.[30] 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.

275. 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.

7.6 **Benefit Distribution and Poverty Impact**

276. 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)

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

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.[31]

277. 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.

278. 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 36: 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

279. 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:

[31] Focus Group Discussion (FGD) conducted in Taing Krasaing and Prek Chik.

Table 37: 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%

7.7 **Conclusion**

280. 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 38: 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 39: 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 40: 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 41: 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 42: 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 43: 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 44: 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 45: 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 46: 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 47: 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.