

Table 2.7-21 Toul Champey Rehabilitation Project

(1) Project description:

Item	Description				
1.1 Location	District	Commune	Village	UTM Reference	
	Teuk Phos	Chorng Mornng	Khset	448882	1326116
1.2 River basin	Boribo river basin/ Small stream				
1.3 Target group	1) Number of household = 468 (Wet season medium- paddy) 2) Staff of PDOWRAM and PDA				
1.4 Objective of the project	Enhancement of rice production through rehabilitation of existing irrigation system				
1.5 Type of project	Rehabilitation of existing irrigation system				
1.6 Objective area	360Ha				
1.7 Necessity of project	<p>The proposed project is a typical irrigation pond system in undulated hilly area.</p> <p>The system was constructed in the late 1970's. Immediately after completion of construction work, the system lost the function.</p> <p>In order to recover the function, rehabilitation of the dyke system by construction of a new spillway and re-construction of intake structures would be a key issue. In addition, rehabilitation and additional construction of canals would be required because of insufficient canals in paddy fields.</p>				

(2) Agriculture

Present/Without-project & With-project Land Use of the Project Area

Land Use Sub-category	I. Present Area		II. With Project Area		Increment (II - I) Area (ha)
	(ha)	(%)	(ha)	(%)	
1. Irrigation Area	360	86	360	86	0
Normal Irrigation Paddy Field			360	86	360
Supplemental Irrigation Paddy Field	36	9			-36
Field under Rainfed Condition	324	77			-324
2. Rainfed Paddy Field					
3. Right-of-ways	60	14	60	14	0
Total	420	100	420	100	0

Agricultural Support Programs Planned

- Field Programs
- Demonstration plot
- Seed Multiplication etc.
- Farmer/Farmer group Training Programs
- Training Course
- Mass guidance/Workshop
- Support Fund for Extension Staff
- Provision of Transportation Means

Present/Without-project & With-project Crop Production in the Project Area

Land Use Sub-category/ Crops	Present/Without-project					With-project					Increment			
	Area (ha)	Cropped Area (ha)	Cropping Intensity (%)	Yield (ton/ha)	Production (ton)	Area (ha)	Cropped Area (ha)	Cropping Intensity (%)	Yield (ton/ha)	Production (ton)	Area (ha)	Cropped Area (ha)	Cropping Intensity (%)	Production (ton)
Normal Irrigation Field						360					360			
Early Wet/Dry Season														
Wet Season Rice							360	100	3.5	1,260		360		1,260
Upland Crops							20	5.6	0.5	10		20		10
Supplemental Irr. Field	36										-36			
Wet Season Rice		36	10	2.0	72							-36		-72
Rainfed Paddy Field	324										-324			
Wet Season Rice		324	90	1.5	486							-324		-486
Annual														
Annual Rice		360	100	1.6	558		360	100	3.5	1,260		0	0	702
Upland Crops							20	6		10		20	-	10
Total	360	360	100		558	360	380	106		1,270	0	20	6	712

As shown in the tables; overall yield increase of 1.9 ton/ha and paddy production increase of 700 ton are expected under the project.

(3) Project scope:

Item	Description
1. Direct Construction	
1.1 Canal work including structures - Canal rehabilitation - Canal construction	Secondary = 3.6 km, Tertiary = 7.2 km Drainage = 5.4 km
1.2 Water harvesting dyke work - Dyke rehabilitation - Construction of structure	1 no. 800 m 1 intake
2. Other Components	
2.1 FWUC level training	Training by FWUC support team through PDOWRAM and MOWRAM
2.2 Agricultural support services	Field extension & training program by PDA/MAFF

(4) Implementation Schedule

- (a) Survey, investigation, design, and tender; 12 months, (Tender; 3 months)
(c) Construction; 1 year
(d) Establishment of FWUC and training; 5 years (2 year for establishment, 3 years for training)
(e) Agriculture extension service; 3 years

(5) Cost Estimate Total Investment Costs: 685 (1,000USD)

Project Name	Total Construction Costs (1,000 USD)	Other Costs			Total Investment Costs (1,000 USD)
		FWUC level training & mobilization (1,000 USD)	Agricultural & other support (1,000 USD)	Land Acquisition Cost (1,000 USD)	
Toul Champey Rehab.Project	633	25	8	19	685

(6) Evaluation

No.	Criteria	Full point	Point obtained
1.	Resources factor	30	26
2.	Economic factor	20	14
3.	Social factor	20	8
4.	Environmental factor	10	10
5.	Ease of implementation	10	2
6.	Maturity factor	10	2
	Total	100	62.00

Table 2.7-22 Chan Keak Rehabilitation Project

(1) Project description:

Item	Description										
1.1 Location	<table border="1"> <tr> <td>District</td> <td>Commune</td> <td>Village</td> <td colspan="2">UTM Reference</td> </tr> <tr> <td>Kampong TraLach</td> <td>O russey</td> <td>KraLagn</td> <td>471184</td> <td>1317474</td> </tr> </table>	District	Commune	Village	UTM Reference		Kampong TraLach	O russey	KraLagn	471184	1317474
	District	Commune	Village	UTM Reference							
Kampong TraLach	O russey	KraLagn	471184	1317474							
1.2 River basin	Boribo river basin										
1.3 Target group	1) Number of household = 151 (Wet season medium- paddy) 2) Staff of PDOWRAM and PDA										
1.4 Objective of the project	Enhancement of rice production through rehabilitation of existing irrigation system										
1.5 Type of project	Rehabilitation of existing irrigation system										
1.6 Objective area	110Ha										
1.7 Necessity of project	The proposed Chan Keak project is a typical irrigation pond system in recession area. The system was constructed in the late 1970's. After few years operation, system lost the function. The system requires rehabilitation of dyke and canals, construction of spillway, installation of intake gates.										

(2) Agriculture

Present/Without-project & With-project Land Use of the Project Area

Land Use Sub-category	I. Present Area		II. With Project Area		Increment (II - I) Area (ha)
	(ha)	(%)	(ha)	(%)	
	1. Irrigation Area	110	95	110	95
Normal Irrigation Paddy Field			110	95	110
Supplemental Irrigation Paddy Field	27	23			-27
Field under Rainfed Condition	83	72			-83
2. Rainfed Paddy Field					
3. Right-of-ways	6	5	6	5	0
Total	116	100	116	100	0

Agricultural Support Programs Planned

- Field Programs
- Demonstration plot
- Seed Multiplication etc.
- Farmer/Farmer group Training Programs
- Training Course
- Mass guidance/Workshop
- Support Fund for Extension Staff
- Provision of Transportation Means

Present/Without-project & With-project Crop Production in the Project Area

Land Use Sub-category/ Crops	Present/Without-project					With-project					Increment			
	Area (ha)	Cropped Area (ha)	Cropping Intensity (%)	Yield (ton/ha)	Production (ton)	Area (ha)	Cropped Area (ha)	Cropping Intensity (%)	Yield (ton/ha)	Production (ton)	Area (ha)	Cropped Area (ha)	Cropping Intensity (%)	Production (ton)
Normal Irrigation Field						110					110			
Early Wet/Dry Season												0		0
Wet Season Rice							110	100	3.5	385		110		385
Upland Crops							10	9.1	0.5	5		10		5
Supplemental Irr. Field	28										-28			
Dry Season		28	25	2.0	56							-28		-56
Wet Season Rice														
Rainfed Paddy Field	82										-82			
Dry Season														
Wet Season Rice		82	75	1.5	123							-82		-123
Annual														
Annual Rice		110	100	1.6	179		110	100	3.5	385		0	0	206
Upland Crops							10	9		5		10	-	5
Total	110	110	100	1.6	179	110	120	109		390	0	10	9	211

As shown in the tables; overall yield increase of 1.9 ton/ha and paddy production increase of 210 ton are expected under the project.

(3) Project scope:

Item	Description
1. Direct Construction	
1.1 Canal work including structures - Canal rehabilitation - Canal construction	Main = 1 km, Secondary = - km Main = - km, Secondary = 1.1 km, Tertiary = 2.2 km Drainage = 1.7 km
1.2 Irrigation Pond rehabilitation - Dyke rehabilitation - Construction of structure	1 no. 550 m spillway, intake gate installation
2. Other Components	
2.1 FWUC level training	Training by FWUC support team through PDOWRAM and MOWRAM
2.2 Agricultural support services	Field extension & training program by PDA/MAFF

(4) Implementation Schedule

- (a) Survey, investigation, design, and tender; 12 months, (Tender; 3 months)
(c) Construction; 1 year
(d) Establishment of FWUC and training; 5 years (2 years for establishment, 3 years for training)
(e) Agriculture extension service; 3 years

(5) Cost Estimate Total Investment Costs: 355 (1,000USD)

Project Name	Total Construction Costs	Other Costs			Total Investment Costs
		FWUC level training & mobilization	Agricultural & other support	Land Acquisition Cost	
		(1,000 USD)	(1,000 USD)	(1,000 USD)	
Chan Keak Rehab.Project	326	13	6	10	355

(6) Evaluation

No.	Criteria	Full point	Point obtained
1.	Resources factor	30	24.5
2.	Economic factor	20	10
3.	Social factor	20	8
4.	Environmental factor	10	10
5.	Ease of implementation	10	10
6.	Maturity factor	10	2
	Total	100	64.50

Table 2.9-1 Environment Related Law and Regulation (1/2)

Title	Issued in	Provisions
Basic Law		
Law on Environmental Protection and Natural Resource Management (LEPNRM)	1996	<ul style="list-style-type: none"> • It is the supreme legal instruments under the Constitution controlling environmental protection and natural resource management of the country which includes: <ul style="list-style-type: none"> ➤ To protect and promote environmental quality and public health through prevention, reduction, and control of point sources and non-point source of pollution (Environmental Protection), ➤ To assess the environmental impact of all proposed projects prior to the issuance of the decision by the Government (Environmental Impact Assessment), ➤ To encourage and enable the public to participate in environmental protection, and natural resource management (Public Participation and Information Disclosure), and ➤ To suppress any act that cause harm to the environment (Management and Penalty). • LEPMRM consists of 11 chapters, 6 of which are the key to environmental protection, an important part of sustainable development in environmental friendly manner. Those chapters cover: (i) national environmental action planning and regional environmental planning, (ii) protected area management, (iii) environmental impact assessment, (iv) pollution control, (v) an environmental endowment fund, and (vi) penalties for violation of the law.
Environmental Management Institution		
Sub-Decree on the Organization and Functions of the Ministry of Environment	1997	<ul style="list-style-type: none"> • Structures of MOE and its functions including tasks of six line departments are defined • Provincial and/or Municipal Department of Environment are established in each Province and/or Municipality responsible for coordinating and implementing MOE activities at respective Provinces and/or Municipalities.
Environmental Impact Assessment		
Sub-Decree on Environmental Impact Assessment Process	1999	<ul style="list-style-type: none"> • Project Owners, including private or public, shall prepare Environmental Impact Assessment (EIA) or Initial Environmental Impact Assessment (IEIA) reports prior to the projects. • The sub-decree also fosters public participation in the environmental impact assessment process so as to empower communities in decision-making.
Declaration on Guidelines for Conducting Environmental Impact Assessment Report	2000	<ul style="list-style-type: none"> • The Guideline defines the format of EIA report consisting of: (i) Project Summary, (ii) Introduction, (iii) Purpose of the Project, (iv) Project Description, (v) Description of Environmental Resources, (vi) Public Participation, (vii) Environmental Impact Analysis, (viii) Environmental Impact Mitigation Measures, (ix) Economic Analysis and Environmental Value, (x) Environmental Management Plan, (xi) Institutional Capacity, (xii) Conclusion and Suggestion and (xiii) References.
Protected Areas Management		
Royal Decree on the Protection of Protected Areas	1993	<ul style="list-style-type: none"> • The Decree consists of six chapters defining protected areas classified into four categories corresponding to international classifications as follows: (i) National Parks, (ii) Wildlife Sanctuaries, (iii) Protected Landscapes and (iv) Multiple Use Areas in the country.
Royal Decree on the Establishment and Management of Tonle	1994	<ul style="list-style-type: none"> • The Tonle Sap Biosphere Reserve shall fulfill three complementary functions: (i) a conservation function to contribute to the conservation of biological diversity, (ii) a development function to foster sustainable development of ecology,

Table 2.9-1 Environment Related Law and Regulation (2/2)

Title	Issued in	Provisions
Sap Biosphere Reserve		<p>environment, society, and culture, and (iii) a logistic function to provide support for demonstration projects, environmental education and training.</p> <ul style="list-style-type: none"> • The Tonle Sap consists of three zones: (i) Core Zone, totaling 42,257 ha (Prek Toal: 21,342 ha, Boeng Tonle Chhmar: 14,560 ha and Stoeng Sen: 6,355 ha), (ii) Buffer Zone, totaling 541,482 ha and (iii) Transitional Zone amounting to 899,600 ha each of which are defined as follows: <ul style="list-style-type: none"> ➤ Core Zone: Defined likewise national park or wildlife sanctuary devoted to long term protection and conservation of natural resources and ecosystem ➤ Buffer Zone: Managed to be consistent to the protection and conservation plan of the core areas ➤ Transitional Zone: The integrated economic zone managed for the sustainable agriculture, human settlement and land uses without having adverse effects on the flooded forest, water quality and soils around the Tonle Sap Lake
Declaration No. 1033 on Protected Area	1994	<ul style="list-style-type: none"> • It is the declaration dealing with activities prohibited within protected areas such as hunting, deforestation, exploitation of minerals, and water pollution
Draft Decree on the Establishment and Management of Protected Areas	Draft	<ul style="list-style-type: none"> • It is to provide a regulatory framework for the classification, establishment, amendment, management and financial support of all classes of protected areas in the country in order to contribute to biodiversity, national socio-economic development and local community livelihood.
Pollution Control		
Sub-Decree on Water Pollution Control	1999	<ul style="list-style-type: none"> • Standard on effluent discharge and water quality is defined. • Type of pollution sources are categorized which requires permission from MOE. • MOE has responsibilities for monitoring the pollution sources and the situation of the water pollution in public water bodies.
Sub-Decree on Solid Waste Management	1999	<ul style="list-style-type: none"> • This sub-decree is to regulate solid waste management with proper technical manner and safe way in order to ensure the protection of human health and the conservation of biodiversity. • Type of the hazardous waste are defined which may cause the danger to human health and animal or damage plants, public property and the environment. • MOE shall establish guidelines on household waste management and hazardous waste management. • The Provincial and/or Cities' Authorities shall establish the waste management plan and have the responsibilities for the collection, transport, storage, recycling, minimizing and dumping of waste.
Sub-Decree on Air Pollution and Noise Disturbance	2000	<ul style="list-style-type: none"> • The sub-decree has a purpose to protect the environmental quality and public health from air pollutants and noise pollution through monitoring and curing activities.
Land		
Land Law	2001	<ul style="list-style-type: none"> • There are some provisions including land ownership and property rights, land acquisition for public works, resettlement aspects and legal requirement for compensation for the loss of land.

Source: Asian Development Bank (2003), Compendium on Environment Statistics 2003 Cambodia

Sok Sphana and Sarin Denora, Laws & Regulations on Environment Biodiversity & Protected Areas

Table 3.2-1 List of Temporary Bench Marks

Sub-project	No.	UTM	Northing (m)	Easting (m)	Elevation ² (m)	Remarks
Ream Kon	TBM.06	Ind1954 ^{*1}	1412839	333212	19.594	On the curb of bridge of existing weir (upstream, right side of the river)
		WGS84	1413159	332787		
Por Canal	TBM.05	Ind1954 ^{*1}	1412595	332465	17.840	Near existing intake, existing main canal right side
		WGS84	1412914	332041		
Darnak Ampil	HW	Ind1954 ^{*1}	1380405	370838	20.15 ^{*3}	On the curb of bridge of existing weir (upstream, left side of the river)
		WGS84	1380724	370415	23.673	
Wat Loung	TBM.07	Ind1954 ^{*1}	1382468	375489	20.94 ^{*4}	Near the bridge of rural road
		WGS84	1382787	375065		
Wat Chrey	TBM.09	Ind1954 ^{*1}	1398492	361557	14.047	Near the bridge of rural road
		WGS84	1398811	361133		
Lum Hach	TBM.10	Ind1954 ^{*1}	1362350	425890	39.782	Proposed headwork site (left side of the river)
		WGS84	1362669	425467		

*1 UTM Zone48N Ellipsoid-Everest1830 Datum-Indian1954

*2 EGM96 Geoid model except for Darnak Ampil and Wat Loung

*3 El. 20.15m derives from elevation data in the drawing of the Project Proposal for Rehabilitation of Darnak Ampil Irrigation Project, MOWRAM December 2004. EL.23.673m is observed by connecting to the National Bench Mark system.

The former number is used in the present study in order to consistently compare elevation of Darnak Ampil Sub-project and Wat Loung sub-project. Accordingly, the elevation data of the two sub-projects in the present study is lower than national bench mark network by 3.523m.

*4 Connected with Darnak Ampil HW

TBM points above were surveyed by Static Dual Frequency GPS receivers to connect with the National Bench Mark network using base stations in Battambang (N2) and, Pursat (N15) and Kampong Chhnang (N4) provinces, with results computed in WGS84 datum and then converted to Indian 1954 datum (the datum of existing topomap with a scale of 1 to 100,000).

The elevation of the TBM was determined in the GPS Post Processing software by using EGM96 (Global) Geoid model which is used for determining elevation in recent ortho-photo mapping in Cambodia.

Reference points

GPS base station	UTM	Northing	Easting	Elevation ² (m)	
Battambang	N2	WGS84	1447871	305875	13.8857
Pursat	N15	WGS84	1386934	381847	17.3062
Kompong Chr	N4	WGS84	1362669	463852	15.1214

Table 3.2-2 Flood Information from Villagers

No.	rb	Place	Interviewee	Largest	Flood scale	Frequency	Month	Flood source/route	Flood speed	Water depth/level	Inundation duration	Paddy	Other crop	House etc	Damage Level	Comment/Episode
1		Battambang WL St	PDWRAM	17 Aug. 2006						H=13.71m						
2	M	Basak Reservoir	villager			rain only										
3	M	Prek Chik (River) St	observer			6Y ago	Aug. s-Sep. b			0.5 m	3 days		corn			
4	M	Moung Russey Town	restaurant	after 1979	3-4 big floods	1999				0.5 m	1 week		corn, soybean			
5	M	Moung Russey WL St	observer			usually				near road						
6	M	Left bank near Por Canal	villager			2007		river through canal		no over bank	half month					
7	M	Near the weir	villager			1/3-4Y		never overbank		0.3 m	2-3 days					
8	M	Left bank d/s of weir	villager			1/5-6Y		overflow		0.1-0.5 m						
9		Koh Chhom WL St	villager	about 6Y before		most of the year				0.2 m	1 day					no damage
10		Svay Don Keo WL St	key farmer				Aug/Sep/ beg. Oct	thru simple pipe intake		0.5 m to 1.2 m	<10 days to 1 month (paddy)			serious		
11	P	Wat Chre near the wat	villager			every year	Aug e/Sep	from stream/canal		0.2 m: house	15 days					
12	P	Wat Chre	villager			No flood in 2005, 2006 and 2007		no overbank flow after repair of canal		0.3 m on road	half-1 month					
13	P	south of NH5	villager			Before, every year		river, the lake upper land		0.5-0.6 m	1 week					
14	B	Bomnak	commune chief	50Y ago		1987, 1992 L. fld/20Y every year normal scale	Oct.e			1 m	15 days					
15	P	Veal Veang WL St	villager	10-20Y ago		2004 or 2005		no overbank flow		0.2-1.2 m	3-7 days					evacuation system
16	B	Boribo WL St	observer's daughter			1/10Y	Aug/Sep			1.2 m	1 day					new bridge constructed
17	P	Wat Loung near the wat	villager	1996		until 2000 after 2001	Sep-Nov Oct/Nov			H=approx. 10m middle of valley	3 days					
18	P	Wat Loung 2.5 km north (Dangkiab Kdam?)	villager	1996		every year		no flood		0.5-1.0 m	3-4 days					
19	P	Dammak Ampil MC 2.1 km (South bank)	villager	Once		no other flood		west of pagoda & canal		1.5-1.7 m	2-3 days					
20	P	Dammak Ampil MC 4.2 km (North bank)	villager (39Y)	1996		Before, every Y last 2Y, no flood, probably because of MC		from the river		1.5-1.6 m (PF)	half month					
21	P	Krabau Chrum	villager	1996		nearly every Y	Aug/Sep?	river overbank		0.6-1.0 m	3-4 days					rise 2m/1.5 day
22	P	Samrong Muoy	villager	1996**		nearly every Y		lowland only		2 m house	1 week					heavy rain in upstream basin
23	P	near Bac Trakoun	villager	1996		rise-to max/3 days		only 1 overbank flood		1.6-1.7 m road	1 week					
24	P	Pursat Town	PDWRAM (1979-to date)	1996		some flood in some places, usually		river overbank		2 m house	1 week					
25	B	Sathi Hep village Ou Rum Chek village	villager			every Y, partly never flooded		1 km upward from the pond in Lum Hach		0.5-2 m	1 day only					
26	B	Khmar village	villagers (stay 20Y)	2000		some floods before break of dyke		dyke		0.5-1.0 m	3 days					Boribo river shifted.
27	B	Tang Trapeang (probably)	villager (64Y woman)	1950s (She was 8Y)		no flood after break of dyke	Oct e-Nov b	from mountain		0.5 m	3 days					the river was small
28	B	Left bank	villagers (m39Y, w47Y)	1950s		only 1 flood in 70Y		from small rivers including Prek Chik river		1.5 m	4-5 days					the river was small
29	B	Prek Koul village	villagers (w66Y)	1950± (Y15)		1983 from small rivers* and Boribo river	Sep	Boribo river		1.7-1.8m	1 week					
30	B	Kampong Chhnang Town	PDWRAM	50-60Y ago		1983 or 84		travel by boat		0.6 m	1 week, inundation 45 days					
31		January 7 Canal	PDWRAM	2000		2000		Tonle Sap near the river bank		0.3-0.5 m NHS	15-20 days					1st infrastructure
32		Svay Chek river	PDWRAM			medium flood small flood 2001, 2002		no overroad		0.1 m land	10 days					
33		Krang Pontley river	PDWRAM			nearly every Y		Takab/Chi Brong river*		1.0 m	1 week					

Prepared by JICA Study Team
 Y = year
 rb = river basin
 * Flood might come from other basin.
 M = Moung Russey
 P = Pursat
 ** correction from mis-remembered 1993
 B = Boribo
 NHS = National Highway No.5

Table 3.2-3 Five-day Discharge at Basak Reservoir and from Residual Area

Basak Reservoir on Moug Russey river						Residual Area in Moug Russey river basin					
CA = 598 km ² (m ³ /s)						CA = 187 km ² (m ³ /s)					
Month 5-day	Year					Month 5-day	Year				
	2001	2002	2003	2004	2005		2001	2002	2003	2004	2005
Jan 1	3.18	0.26	1.37	1.32	1.73	Jan 1	0.99	0.08	0.42	0.41	0.54
2	2.63	0.25	1.11	1.28	1.45	2	0.82	0.08	0.34	0.40	0.45
3	2.45	0.25	1.05	1.23	1.25	3	0.76	0.08	0.33	0.38	0.39
4	2.43	0.25	0.99	1.15	1.07	4	0.75	0.08	0.31	0.36	0.33
5	2.19	0.23	0.94	1.02	0.96	5	0.68	0.07	0.29	0.32	0.30
6	2.02	0.23	0.88	0.85	0.94	6	0.63	0.07	0.27	0.26	0.29
Feb 1	1.92	1.62	0.85	0.74	0.90	Feb 1	0.60	0.50	0.26	0.23	0.28
2	1.75	1.56	0.81	0.71	0.86	2	0.54	0.48	0.25	0.22	0.27
3	1.61	1.53	0.77	0.70	0.86	3	0.50	0.47	0.24	0.22	0.27
4	1.52	1.50	0.72	0.68	0.83	4	0.47	0.47	0.22	0.21	0.26
5	1.44	1.45	0.70	0.68	0.83	5	0.45	0.45	0.22	0.21	0.26
6	1.39	1.40	0.68	0.67	0.81	6	0.43	0.43	0.21	0.21	0.25
Mar 1	1.29	1.43	0.68	0.66	0.80	Mar 1	0.40	0.44	0.21	0.20	0.25
2	1.22	1.36	0.66	0.65	0.78	2	0.38	0.42	0.20	0.20	0.24
3	1.25	1.33	0.66	0.64	0.77	3	0.39	0.41	0.20	0.20	0.24
4	1.34	1.32	0.66	0.62	0.75	4	0.42	0.41	0.20	0.19	0.23
5	1.70	1.32	0.64	0.61	0.73	5	0.53	0.41	0.20	0.19	0.23
6	3.24	1.33	0.63	0.61	0.72	6	1.00	0.41	0.20	0.19	0.22
Apr 1	2.83	2.04	0.62	0.60	0.73	Apr 1	0.88	0.63	0.19	0.19	0.23
2	1.89	2.01	0.62	0.60	0.72	2	0.59	0.62	0.19	0.19	0.22
3	1.54	1.97	0.61	0.60	0.74	3	0.48	0.61	0.19	0.19	0.23
4	1.43	1.93	0.60	0.62	0.86	4	0.44	0.60	0.19	0.19	0.27
5	1.33	1.93	0.60	0.77	1.13	5	0.41	0.60	0.19	0.24	0.35
6	1.22	3.73	0.60	0.74	1.85	6	0.38	1.16	0.19	0.23	0.57
May 1	1.31	6.64	0.79	1.52	2.41	May 1	0.41	2.06	0.24	0.47	0.75
2	1.31	4.43	1.19	2.26	2.58	2	0.41	1.37	0.37	0.70	0.80
3	1.39	3.88	1.34	2.68	3.21	3	0.43	1.20	0.42	0.83	1.00
4	1.96	3.38	2.46	3.03	3.38	4	0.61	1.05	0.76	0.94	1.05
5	1.85	3.65	2.38	2.09	2.59	5	0.57	1.13	0.74	0.65	0.80
6	1.61	2.86	1.96	1.43	1.97	6	0.50	0.89	0.61	0.44	0.61
Jun 1	0.36	1.22	1.56	3.26	3.98	Jun 1	0.11	0.38	0.48	1.01	1.23
2	0.47	1.10	1.18	4.84	5.41	2	0.15	0.34	0.37	1.50	1.68
3	0.56	1.14	1.10	4.71	5.11	3	0.17	0.35	0.34	1.46	1.58
4	0.46	1.20	1.05	4.79	5.15	4	0.14	0.37	0.33	1.48	1.60
5	0.38	1.07	1.06	5.42	5.87	5	0.12	0.33	0.33	1.68	1.82
6	0.34	1.03	1.04	5.99	5.68	6	0.11	0.32	0.32	1.86	1.76
Jul 1	1.14	0.47	1.10	6.00	6.80	Jul 1	0.35	0.15	0.34	1.86	2.11
2	1.12	0.49	1.25	7.06	8.11	2	0.35	0.15	0.39	2.19	2.51
3	1.06	0.42	1.64	5.65	7.18	3	0.33	0.13	0.51	1.75	2.23
4	1.03	0.38	2.10	4.69	6.20	4	0.32	0.12	0.65	1.45	1.92
5	1.08	0.34	2.19	4.21	5.16	5	0.33	0.11	0.68	1.31	1.60
6	1.33	0.32	2.24	3.49	4.36	6	0.41	0.10	0.69	1.08	1.35
Aug 1	0.42	4.56	3.34	2.61	3.34	Aug 1	0.13	1.41	1.04	0.81	1.04
2	0.54	4.46	4.83	2.98	3.68	2	0.17	1.38	1.50	0.92	1.14
3	0.67	4.45	4.96	4.16	4.88	3	0.21	1.38	1.54	1.29	1.51
4	0.76	4.59	4.76	3.97	4.62	4	0.24	1.42	1.48	1.23	1.43
5	0.91	4.71	4.07	3.43	3.95	5	0.28	1.46	1.26	1.06	1.22
6	1.12	6.04	3.01	3.76	4.71	6	0.35	1.87	0.93	1.17	1.46
Sep 1	1.17	1.16	1.86	3.82	4.46	Sep 1	0.36	0.36	0.58	1.18	1.38
2	1.65	1.61	1.27	4.39	5.01	2	0.51	0.50	0.39	1.36	1.55
3	1.88	2.00	1.19	5.53	5.92	3	0.58	0.62	0.37	1.71	1.84
4	2.13	2.43	1.32	6.76	7.70	4	0.66	0.75	0.41	2.10	2.39
5	2.36	3.01	1.78	7.97	8.78	5	0.73	0.93	0.55	2.47	2.72
6	2.46	3.41	2.52	8.38	9.60	6	0.76	1.06	0.78	2.60	2.98
Oct 1	13.14	4.69	4.83	8.31	9.82	Oct 1	4.07	1.45	1.50	2.58	3.04
2	13.27	4.83	7.25	7.86	9.17	2	4.11	1.50	2.25	2.44	2.84
3	14.01	4.25	7.69	9.53	9.19	3	4.34	1.32	2.38	2.95	2.85
4	14.06	3.85	9.30	10.08	11.35	4	4.36	1.19	2.88	3.12	3.52
5	12.84	3.43	10.90	8.21	11.87	5	3.98	1.06	3.38	2.55	3.68
6	12.07	5.09	11.78	7.45	9.96	6	3.74	1.58	3.65	2.31	3.09
Nov 1	9.38	12.46	8.79	6.71	11.18	Nov 1	2.91	3.86	2.72	2.08	3.46
2	9.09	11.11	6.75	5.57	9.38	2	2.82	3.44	2.09	1.73	2.91
3	8.40	9.50	5.63	4.60	8.31	3	2.60	2.95	1.75	1.43	2.58
4	7.47	8.47	4.98	4.26	10.13	4	2.32	2.63	1.54	1.32	3.14
5	6.46	8.67	4.23	3.84	12.69	5	2.00	2.69	1.31	1.19	3.93
6	5.02	8.85	3.57	3.57	6.90	6	1.56	2.74	1.11	1.11	2.14
Dec 1	1.85	3.82	2.66	3.45	5.24	Dec 1	0.57	1.18	0.82	1.07	1.62
2	1.38	3.32	1.95	3.29	4.76	2	0.43	1.03	0.60	1.02	1.48
3	1.07	2.77	1.66	2.80	4.12	3	0.33	0.86	0.51	0.87	1.28
4	1.00	2.05	1.61	2.39	3.65	4	0.31	0.64	0.50	0.74	1.13
5	0.95	1.50	1.53	2.26	3.23	5	0.29	0.47	0.47	0.70	1.00
6	0.84	1.27	1.51	2.10	2.79	6	0.26	0.39	0.47	0.65	0.87
Annual	2.94	2.90	2.47	3.42	4.43	Annual	0.91	0.90	0.76	1.06	1.37

Prepared by JICA Study Team
Original data source: MOWRAM

Note: Residual Area is between Basak Reservoir and Moug Russey

Table 3.2-4 Five-day Discharge at Damnak Ampil Weir

	CA=	4,480 km ²		Pursat river							(m ³ /s)	
		1995	1996	1997	1998	1999	2000	2001	2002	2003		2004
Jan	1	8.2	26.2	34.0	7.1	14.5	30.7	25.6	11.9	17.3	6.2	6.8
	2	6.0	23.1	26.5	6.5	13.6	26.6	21.5	11.2	15.0	5.3	6.8
	3	5.1	14.6	21.5	5.8	13.1	24.8	19.2	10.8	14.0	4.9	6.6
	4	5.1	12.1	18.6	5.5	12.8	23.3	19.1	10.3	13.4	4.8	6.2
	5	5.1	11.5	17.1	5.1	12.0	22.1	16.8	9.9	12.8	4.7	5.6
	6	5.1	11.0	15.9	4.7	11.4	20.8	14.7	10.5	11.7	4.7	5.4
Feb	1	5.1	11.4	15.3	4.3	10.9	19.0	13.1	10.0	10.8	4.7	5.1
	2	5.1	9.7	15.4	4.1	10.7	20.1	11.9	9.0	10.5	3.8	4.9
	3	5.1	9.1	15.4	3.7	10.1	19.3	11.0	8.7	21.6	3.2	4.9
	4	5.1	8.3	13.8	3.5	9.6	14.5	10.3	8.5	21.9	3.1	4.9
	5	4.9	8.6	10.9	3.3	9.1	11.5	9.8	8.3	9.1	3.4	4.9
	6	4.9	9.0	10.4	3.1	8.8	13.9	9.5	8.2	9.0	4.0	4.9
Mar	1	4.9	9.0	-	2.8	8.4	13.2	31.2	7.9	8.9	3.2	4.7
	2	4.9	8.8	-	2.8	8.3	16.5	30.9	8.1	11.5	3.2	4.7
	3	4.9	7.6	-	2.8	8.3	20.9	32.8	7.6	11.3	3.2	4.7
	4	4.9	7.1	-	2.7	8.2	17.9	20.3	7.5	10.5	3.2	4.6
	5	4.9	7.3	-	2.5	8.0	14.5	38.6	8.1	13.1	3.1	4.1
	6	4.9	6.6	-	2.4	8.6	11.2	23.9	8.1	18.7	3.0	4.1
Apr	1	8.4	4.7	-	2.2	13.2	11.5	21.3	7.9	16.9	2.5	4.9
	2	8.1	9.5	-	2.1	72.5	11.8	18.0	8.4	12.2	2.3	4.9
	3	6.2	10.7	-	2.1	43.9	12.9	13.1	10.5	10.1	2.3	8.3
	4	6.2	14.2	-	2.2	34.2	91.6	11.6	11.1	10.0	2.8	7.9
	5	8.1	18.7	-	2.5	46.4	118.8	10.8	15.1	9.6	4.6	7.7
	6	8.3	12.2	-	3.5	39.4	88.2	10.8	13.2	19.6	3.7	9.4
May	1	9.7	20.3	-	7.4	169.5	48.5	13.1	12.1	21.6	4.1	8.4
	2	9.0	19.5	-	7.4	97.3	106.3	13.7	13.0	18.2	3.2	8.4
	3	10.7	19.3	-	8.0	95.1	124.1	13.8	16.8	14.7	2.4	7.1
	4	7.1	56.1	-	9.5	220.5	58.3	22.9	13.0	18.7	3.8	8.2
	5	6.9	68.5	-	9.8	269.7	53.9	20.4	12.3	24.6	6.5	34.7
	6	4.8	34.8	-	8.9	134.7	53.1	14.9	13.7	20.5	5.1	19.3
Jun	1	9.5	90.3	-	8.0	113.5	78.9	15.3	10.8	20.4	11.8	12.5
	2	13.0	93.2	-	8.4	205.0	155.1	31.6	10.6	21.0	17.1	10.1
	3	11.6	152.1	-	9.0	113.9	69.0	23.8	14.3	38.8	35.4	32.7
	4	15.6	165.2	-	10.8	156.8	42.7	22.3	14.9	41.5	156.7	15.5
	5	16.3	103.2	-	10.8	70.3	66.4	17.3	13.4	58.0	117.3	10.8
	6	21.9	57.4	-	11.3	73.8	103.7	77.3	19.3	63.9	62.9	10.9
Jul	1	15.6	85.8	-	12.5	191.7	161.2	100.9	16.2	60.6	27.9	15.7
	2	34.5	92.3	-	16.5	102.4	218.0	175.2	19.8	96.8	38.8	29.1
	3	34.3	141.2	-	17.4	70.7	174.6	36.3	19.7	87.8	40.9	22.8
	4	37.0	201.8	-	20.4	65.6	311.3	20.2	15.1	84.3	118.7	16.3
	5	77.2	85.3	-	19.4	48.5	125.3	19.3	15.0	120.4	115.2	36.8
	6	40.8	294.0	-	25.4	185.9	146.6	17.0	23.6	257.0	78.6	98.5
Aug	1	275.8	211.7	-	26.5	245.5	111.0	15.3	19.4	93.0	40.6	282.2
	2	133.6	116.1	-	37.4	155.0	140.6	35.3	57.9	161.7	69.8	87.5
	3	87.1	160.5	-	44.2	53.5	106.5	157.3	26.9	36.2	162.8	153.4
	4	109.5	80.5	-	55.9	40.1	170.0	162.8	58.2	42.2	99.8	59.6
	5	113.3	121.8	-	56.1	97.0	191.0	59.4	69.5	94.3	86.3	19.3
	6	333.3	130.0	-	42.7	164.9	148.9	40.3	81.0	70.2	102.3	20.9
Sep	1	446.0	121.3	-	99.1	382.2	117.0	58.2	83.3	33.6	62.4	17.8
	2	145.8	270.0	-	127.8	253.1	106.6	55.1	48.6	61.3	70.9	29.4
	3	158.5	399.4	-	82.2	127.3	106.9	39.1	72.5	73.1	60.2	58.0
	4	319.5	306.3	-	138.8	77.5	82.3	34.3	42.1	80.8	73.2	151.5
	5	288.8	137.9	-	115.4	100.8	219.0	113.6	98.8	93.3	178.2	124.0
	6	304.0	370.4	-	218.1	186.2	259.1	217.2	114.5	231.0	58.0	55.9
Oct	1	393.4	534.4	-	251.7	399.6	347.0	244.4	82.1	344.7	139.7	24.0
	2	523.8	340.6	-	230.3	218.3	218.6	398.8	96.4	438.1	301.4	40.0
	3	569.4	326.8	-	299.2	259.0	578.5	293.5	53.7	201.6	158.3	99.2
	4	260.6	363.7	-	179.2	429.4	562.6	221.3	26.7	491.6	67.1	151.4
	5	117.1	562.7	-	120.0	279.5	477.1	268.4	34.0	433.6	52.9	192.6
	6	174.7	641.1	-	84.1	502.2	390.6	234.0	250.3	230.0	48.6	337.4
Nov	1	232.3	388.5	-	48.6	672.1	340.4	155.6	134.5	82.0	43.9	88.6
	2	115.7	293.9	-	62.2	561.0	220.6	78.9	58.0	40.4	41.4	211.5
	3	260.0	261.1	-	49.8	312.4	178.6	45.8	54.6	34.0	37.3	112.1
	4	91.0	263.8	-	103.5	198.4	286.2	38.5	53.4	30.4	33.2	73.2
	5	58.7	247.4	-	83.2	109.2	263.5	30.0	49.2	25.0	30.1	71.6
	6	45.1	172.7	-	65.4	83.8	205.2	24.2	35.3	21.9	27.6	24.3
Dec	1	28.2	383.5	-	56.3	80.2	120.0	20.2	31.2	20.3	25.1	20.0
	2	23.3	177.7	-	37.4	220.2	68.9	17.6	24.9	18.7	22.5	20.5
	3	18.8	89.8	-	28.4	88.4	54.5	16.3	25.1	26.3	20.1	18.3
	4	42.5	56.0	-	23.6	58.1	67.9	16.0	18.8	14.3	15.7	16.7
	5	38.3	43.5	-	19.8	43.9	51.4	15.0	20.8	12.4	13.6	15.8
	6	30.7	33.0	-	16.6	35.4	37.2	13.8	20.1	10.7	9.0	14.8
Annual	86.8	134.1	-	43.2	128.5	125.0	58.6	32.6	68.5	42.9	43.4	

Prepared by JICA Study Team

Annual average

Original data source: MOWRAM, ADB and PWRI (Public Works Research Institute, Japan)

76.4 m³/s

Table 3.2-5 Five-day Discharge at Lum Hach Headworks (Case 2)

CA =	735 km2		Boribo river							(m3/s)	
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	
Jan	1	-	1.25	8.85	8.42	2.73	9.67	12.95	5.94	-	1.59
	2	-	1.21	6.34	7.00	2.66	9.77	12.95	5.94	-	1.79
	3	-	1.25	6.18	7.96	2.23	9.23	11.82	5.94	-	1.61
	4	-	1.68	5.94	8.62	1.57	8.41	10.80	5.75	-	1.41
	5	-	3.37	4.97	6.10	9.76	8.61	6.69	5.01	-	1.25
	6	-	10.95	3.97	5.04	10.61	9.64	4.63	5.01	-	1.21
Feb	1	-	8.99	6.62	4.55	8.37	10.90	4.05	4.31	-	1.05
	2	-	7.05	7.26	4.00	8.89	9.52	3.78	4.62	-	1.05
	3	-	5.88	7.00	3.35	7.96	9.53	3.49	4.25	-	1.00
	4	-	3.23	3.73	2.98	9.25	9.67	3.38	4.28	-	0.95
	5	-	2.44	2.84	2.51	9.82	9.77	3.31	4.31	-	0.83
	6	-	1.81	2.27	2.43	9.64	9.97	3.18	4.26	-	0.73
Mar	1	-	2.17	2.28	2.40	5.26	10.90	4.95	4.29	-	0.78
	2	-	2.18	2.14	2.50	4.85	9.52	5.19	3.77	-	0.72
	3	-	1.93	2.27	5.82	9.18	9.53	4.69	4.05	-	0.91
	4	-	1.72	2.43	6.72	9.82	9.67	3.83	3.86	-	0.94
	5	-	1.76	2.38	9.04	10.33	9.82	3.53	3.80	-	0.85
	6	-	2.60	2.79	5.63	9.60	10.33	3.28	4.10	-	0.92
Apr	1	-	1.61	2.25	4.01	7.19	8.42	3.86	30.42	-	0.97
	2	-	1.82	3.57	3.74	4.38	9.58	5.33	18.22	-	0.87
	3	-	2.95	4.73	3.80	4.95	8.67	5.38	14.78	-	0.77
	4	-	2.59	5.18	3.05	6.48	9.15	4.94	9.21	-	0.90
	5	-	5.51	7.13	3.59	7.22	9.72	4.87	7.74	-	0.85
	6	-	4.15	5.96	8.85	6.55	9.05	4.35	6.55	-	0.85
May	1	-	16.22	5.22	3.87	6.92	5.82	3.50	3.37	-	1.27
	2	-	13.59	4.97	3.10	6.60	2.63	3.09	3.37	-	1.96
	3	-	13.61	4.31	2.30	9.02	2.55	3.74	4.42	-	3.05
	4	-	51.18	4.15	2.08	9.97	3.58	3.62	6.96	-	3.95
	5	-	92.76	4.15	2.06	10.43	4.73	4.09	9.88	-	4.20
	6	-	30.46	3.86	2.06	6.49	3.69	4.68	8.53	-	4.55
Jun	1	1.40	14.19	7.62	8.13	8.12	3.52	4.65	13.57	-	4.48
	2	3.82	22.01	10.61	9.63	10.22	4.23	7.82	8.59	-	4.78
	3	4.60	37.95	17.83	9.58	9.58	3.20	10.82	5.79	-	5.76
	4	3.75	61.93	22.12	9.38	9.62	3.31	10.98	5.01	-	6.32
	5	2.44	42.08	26.17	9.28	2.93	5.16	11.18	5.85	-	12.89
	6	1.36	45.42	22.73	8.70	6.52	6.46	6.80	12.78	-	18.76
Jul	1	3.19	20.67	44.29	6.53	5.16	6.44	6.02	15.14	-	9.06
	2	3.66	16.78	59.15	4.49	9.35	5.64	5.98	19.74	-	9.45
	3	3.87	20.30	14.15	6.34	6.64	6.55	6.86	22.67	-	13.40
	4	4.11	19.35	25.70	8.00	7.26	5.52	5.98	22.67	-	11.80
	5	4.93	26.29	44.46	5.79	5.69	8.52	14.84	17.08	-	13.95
	6	10.61	18.31	64.62	5.09	7.54	11.46	13.31	9.66	-	11.48
Aug	1	9.81	16.71	23.21	9.24	10.61	12.03	12.28	6.96	-	10.10
	2	13.81	10.83	71.81	16.41	14.92	5.99	11.82	6.96	-	5.26
	3	14.04	8.29	52.98	18.11	18.11	4.25	10.03	6.96	-	4.37
	4	16.70	10.34	40.73	20.33	25.41	3.72	12.11	6.96	-	14.31
	5	12.49	16.31	26.77	13.31	21.93	2.79	30.34	7.87	-	33.76
	6	14.18	27.09	20.25	16.29	18.39	2.74	26.50	10.53	-	69.62
Sep	1	40.47	89.58	19.47	42.56	20.70	2.45	54.35	13.57	-	63.74
	2	25.75	43.96	32.82	61.56	20.53	3.17	74.03	16.09	-	29.90
	3	25.01	29.49	19.68	44.52	32.82	5.62	22.29	23.84	-	35.17
	4	47.48	20.48	18.72	74.80	56.06	16.49	32.98	37.73	-	77.02
	5	43.63	40.30	18.72	38.16	85.21	33.01	26.64	53.66	-	42.30
	6	80.21	58.63	28.64	36.40	54.73	88.34	11.68	97.88	-	35.00
Oct	1	46.70	73.21	34.29	72.30	18.73	74.60	33.29	13.05	-	37.82
	2	28.16	28.59	48.08	62.10	24.36	38.28	85.70	17.96	-	62.85
	3	23.21	53.20	134.99	47.27	11.76	33.51	53.28	6.96	-	79.15
	4	39.30	33.47	93.58	29.08	10.64	32.80	25.54	8.84	-	103.37
	5	22.58	19.37	75.34	25.55	26.18	32.05	16.67	12.19	-	48.52
	6	23.50	46.86	52.19	21.28	101.51	19.85	11.84	20.93	-	26.60
Nov	1	23.83	122.18	40.15	20.31	21.88	16.71	6.37	7.93	-	20.66
	2	25.40	104.65	23.16	16.51	13.68	13.37	5.01	6.96	-	16.07
	3	30.88	37.24	16.83	15.29	29.71	9.32	5.01	6.96	-	11.98
	4	34.51	30.12	20.05	13.07	14.10	6.47	5.01	8.78	-	14.84
	5	29.09	18.74	24.73	12.04	10.93	5.08	4.42	7.18	-	14.91
	6	24.73	17.28	18.19	9.04	6.75	4.97	9.76	6.96	-	10.86
Dec	1	-	16.83	8.85	6.50	7.86	4.20	9.56	6.96	2.43	9.29
	2	-	50.51	6.34	5.26	5.99	3.86	8.09	6.96	2.43	7.99
	3	-	18.30	6.18	4.32	4.94	15.74	7.61	6.96	2.43	7.19
	4	-	16.12	5.94	3.09	4.65	13.64	6.96	6.96	2.43	6.21
	5	-	13.59	4.97	2.55	4.55	12.72	6.96	8.78	2.25	4.60
	6	-	9.80	3.97	2.09	4.45	12.71	6.96	9.23	1.86	3.80
Annual	-	23.96	20.65	13.72	14.02	11.84	12.45	11.46	-	14.91	

Prepared by JICA Study Team

Annual average 15.38 m3/s

Original data at Boribo station: 1998-2005 MOWRAM & ADB, 2007 MOWRAM and the Study Team