

Appendix-H
DESIGN AND COST ESTIMATE

**THE STUDY
ON
COMPREHENSIVE AGRICULTURAL DEVELOPMENT
OF
PREK THNOT RIVER BASIN
IN
THE KINGDOM OF CAMBODIA**

**FINAL REPORT
Volume-VI: Appendixes for Master Plan
Appendix-H
Design and Cost Estimate**

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APPENDIX-H: DESIGN AND COST ESTIMATE

Chapter H-1 Structural Design

H-1.1 Rehabilitation of Roleang Chrey Regulator

H-1.1.1 Current Problem

The existing downstream apron has a dissipater of USBR III type with length of 10.0m. In the case that the length of dissipater is 10m, the discharge of 290m³/sec for dissipater has been estimated by hydraulic calculation. This value may be too small as compared with actual flood discharge of Prek Thnot River. It means that not only the length of downstream apron but also height and width of baffle block and end sill is not enough to dissipate the flood discharge. The riprap as riverbed protection at downstream of apron may be scoured by floodwater taking into account of these condition. Beside, the slope protection has been broken. So that, the improvement of downstream apron and the rehabilitation of both the riverbed and side slope protection is necessary.

H-1.1.2 Design Flood Discharge

The flood discharge of 800m³/sec that is resulted based on the data of previous studies, such as The study on The Project for The Rehabilitation of The Kandal Stung Irrigation System, is applied to design of downstream apron. The discharge of 800m³/sec is equivalent to the discharge in about 10 years return period according to the previous studies as follows.

Studied by	year	10 years	20years	30years	50years	100years
SMHEA	1965	—	840	—	960	1,060
SMEC	1992	750	930	—	1,350	1,800
JICA	1995	860	1,100	—	1,500	1,900
MMD	2001	1,000	—	—	1,300	1,600
JICA (NK)	2002	930	1,090	1,180	1,290	1,450

Refer to "The basic design study on the project for the rehabilitation pf Kandal Stung irrigation system (December, 2004)"

H-1.1.3 Downstream Apron

The type of dissipater on downstream apron is USBR III same as existing type. The downstream apron lengthens 5.7m to downstream. The existing baffle block and end sill will be demolished.

The discharge of the gate is given by following formula.

$$Q = C \cdot B \cdot d (2g(h1 - d/2))^{0.5}$$

Where, $C = \text{flow index} = 0.65$

$B = \text{opening width of gate (m)}$

$d = \text{gate opening in meter}$

$h1 = \text{water height at upstream (m)}$

The result of hydraulic calculation is as shown in Table H1.1 and H1.2

The main features of downstream apron are as follows

- Length 15.7m
- Baffle block height =1.35m
Width =1.00m
Space =1.00m
Slope 1:1.00

- End sill height =1.25m
Slope 1:2.00

H-1.1.4 Riverbed and Side Slope Protection

The riverbed protection by riprap with thickness of 50cm shall be provided to 30m downstream from the end of apron. The slope protection will be provided as same manner. The general plan of rehabilitation of Roleang Chrey Regulator is shown in Drawing No.1

H-1.2 River Outlet Facility

The discharge capacity at Roleang Chrey Regulator shall be regulated to regulate the intake capacity at the intake of both North main canal and South Main Canal. However, the existing gate at Roleang Chrey Regulator cannot regulate the discharge less than about 10m³/sec because of gate size. The minimum discharge is about 10m³/sec when the gate opens at minimum depth of 10cm. The required range of discharge is less than 10m³/sec. The new river outlet facility that can regulate discharge be less than 10m³/sec should be provided.

H-1.2.1 Design Discharge

The peak irrigation water on “The project for the rehabilitation of the Kandal Stung irrigation system”, where is directly downstream of Kampong Speu Province, is 2.33m³/sec and maintenance flow discharge to downstream is 0.6m³/sec. Accordingly, the discharge regulated at Roleang Chrey Regulator is more than 2.93m³/sec, and it is recommended that the discharge regulated at Roleang Chrey Regulator is more than 5.0m³/sec taking into account of water requirement in future in the downstream area.

The maximum design discharge of 10m³/sec for new river outlet facility is adopted in accordance with mentioned above and the capacity of the existing gate of Roleang Chrey Regulator.

H-1.2.2 Type and Location of River Outlet Facility

Three alternatives as follows were examined on regulation of discharge, operation and maintenance, construction cost and so on

- Discharge by new structure be composed of intake, pipe culvert and outlet
- Discharge by outlet valve be set in the existing gate leaf
- Discharge by new gate constructed at existing gate with new pier (the existing gate leaf will be divided into two part, one is scraped and others is reused.)

The discharge regulation range from 0.1 to 1.0m³/sec will be required depending on above mentioned study for Kandal Stung

The Alternative a) is selected for the river outlet facility from viewpoints of regulation of discharge, operation of gate, and maintenance, though Alternative b) might has a lowest construction cost.

Item	Alternative a)	Alternative b)	Alternative c)
regulation of discharge	Discharge range from 0.1 to 10m ³ /s by two gate of width x height = 1.0x1.0	Diameter of valve is about 0.6m. Max. discharge by one valve is 2.0m ³ /s. Discharge range from 0.1 to 10m ³ /s by five valve.	Even if the width of regulation gate is 1.0m, the height of gate is 6.7m. The minimum opening of gate is 5cm, and the discharge is 0.4m ³ /s. The required regulation is difficult.
	○	○	×

operation and maintenance	Gate operation is commonly. It is easy to maintain and repair because intake has the stoplog.	○	Because operator must walk on crest of gate leaf, operator drops from crest possibly. The hoist is in water every time. The corrosion and rust generate easily. It is susceptible to damage by driftwood and others. Because the existing gates have no stoplogs, the coffering by the floating gate and so on is necessary when the maintenance or repair is carried out. It needs time, labor and cost.	×	Gate operation is commonly. Because the span of pier is narrow, the driftwood is caught in span easily. It disturbs the smooth flow. Because the existing gates have no stoplogs, the coffering by the floating gate and so on is necessary when the maintenance or repair is carried out. It needs time, labor and cost.	△
construction cost	Expensive than Alternative b). Alternative a) is almost equal as Alternative c)	△	The cost of Alternative b) is lower than others because of no civil works.	○	The cost of Alternative c) is almost equal Alternative a). (Concrete works of new pier + Modification of gate)	△
others			When the stoplog is installed to pier, the modification of pier is necessary and the equipment for transfer and elevator of stoplog is big size.	×	Additional pier reduces the flow area.	×
Evaluation	1		2		3	

The river outlet facility is located at the right side abutment based on following conditions

- The topographic condition of both sides is the same and no limitation.
- The geological condition of both sides is assumed be also same in accordance with original design drawing of Prek Thnot Diversion Weir.
- The sheet piles were constructed from the end of bridge toward each side for 25m.
- The site office locates at the right side.

The pipe culvert takes a route around the sheet piles as shown in Drawing No.1

H-1.2.3 Design Features

The river outlet facility is composed of an intake with two slide gates, a pipe culvert lined by concrete and stilling basin.

Main features of River outlet facility are presented below,

- Discharge max. 10.0m³/s
- Intake Width 2.60m
- Gate Size and Nos. 1.0 × 1.0m × 2 nos.
- Culvert Size and Nos. Diameter = 1.0m × 2 nos. (Pipe culvert)
- Length of conduit 78.5m
- Intake Sill EL. EL. 29.80m
- Outlet EL. EL. 29.50m

The hydraulic calculation result of intake gate is as Table H1-3.

The general plan of river outlet facility is shown in Drawing No.1 and No.2.

H-1.3 Main Canal and Related Structure

H-1.3.1 Main Canal

The rehabilitation of main canals in the project area is mainly to raise the crest of canal bank by additional embankment on the existing canal bank to maintain the water level so that the gravity irrigation will be possible. The excavation of bottom of existing canal shall be made partly to keep the flow depth. The embankment and excavation at side slope of existing canal should not be made, if possible, to reduce the construction volume.

The following materials will be used for the embankment.

- The excavation material at existing canal,
- The excavation material in the reservoir of pond adjacent main canal,
- The borrow material that is proper clayey soil from borrow pit.

The sod facing at both inside and outside slope is provided for slope protection from erosion by rain water.

The maintenance road with pavement of laterite is provided for the canal bank.

The main feature of main canal is as follows:

- Side slope of canal bank: 1:1.50 (vertical to horizontal),
- Top width of canal bank: 3.0m,
- Width of maintenance road: 4.0m,
- Thickness of pavement: 0.2m.

The typical cross section of main canal is shown in Figure H1.1

The design discharge of each main canal is as follows

- North main canal
 - Station No.0 to No.14+360: $Q = 10.4\text{m}^3/\text{sec}$
 - Station No.14+360 to No.31+910: $Q = 5.8\text{m}^3/\text{sec}$
 - Station No.31+910 to end of main canal: $Q = 2.3\text{m}^3/\text{sec}$
- South main canal
 - Station No.0 to No.26+544 $Q = 16.3\text{m}^3/\text{sec}$
 - Station No.26+544 to No.31+520 $Q = 6.6\text{m}^3/\text{sec}$
- Au Krang Ambel canal $Q = 4.6\text{m}^3/\text{sec}$

The profiles of North Main Canal and South Main Canal are shown in Drawing No.5 and Drawing No.6, respectively.

H-1.3.2 Check Structure

The Check structure is used to control the flow and to maintain a certain water level in the canal. The check structure is composed of a weir and several check gates. The over flow depth of weir is designed to be 20cm. The check structure to be used for this project is equipped with manually operated slide gate.

The over flow discharge of weir and the discharge through gate is given by follows.

- Over flow discharge

$$Q = C \cdot B \cdot h^{3/2}$$

Where, $C = \text{discharge coefficient} = 1.80$
 $B = \text{crest length of weir (m)}$
 $h = \text{over flow depth (m)}$

- Discharge through gate

$$Q = C \cdot B \cdot d (2g(\Delta h + h_a))^{0.5}$$

Where, $C = \text{flow index} = 0.65$

$B = \text{width of gate (m)}$

$d = \text{gate opening in meter}$

$h = \text{difference of water level between upstream and downstream of check structure (m)}$

$h_a = \text{velocity head at upstream canal} = V^2/2g$

$g = \text{gravity acceleration}$

The general plan of check structure is as shown in Drawing No.7.

H-1.3.3 Turnout

The orifice type is recommended for turnout of Main Canals due to the following advantages.

- The canal water can be regulated and measured at the same time,
- The structure has less problems with sediment,
- An operation is easy and measurement of discharge is accurate,
- The structure is structurally stable.

The box culvert type or the pipe culvert type will be applied to turnout based on the design discharge.

The discharge of the orifice type turnout is given by following formula.

$$Q = C \cdot B \cdot d (2g(h_1 - d))^{0.5}$$

Where, $C = \text{flow index} = 0.65$

$B = \text{opening width of gate (m)}$

$d = \text{gate opening in meter}$

$h_1 = \text{water height above the sill (m)}$

The plans of turnout of two types are shown in Drawing No.8-1 and No.8-2, respectively.

H-1.3.4 Drainage Culvert

The drainage culvert will be provided at the river crossing points of Main Canal. Two types of drainage culvert are shown in Figure H1.2.

H-1.4 Small Reservoirs

The existing small reservoirs in the target area are classified into three as follows.

- 1) Reservoirs of which embankment has less damage by erosion,
- 2) Reservoirs of which embankment has some erosion and deformation partly,
- 3) Reservoirs of which embankment has been eroded and deformed seriously.

The embankment of reservoirs classified as 2) and 3) will be rehabilitated. The existing intake structures of reservoirs regardless of classification above, except that have been rehabilitated recently, will be reconstructed or improved.

H-1.4.1 Embankment

The excavation material in the reservoir might be used for embankment material according to the site investigation on several reservoirs. Where the excavation material is dispersible clay, and when the dispersible clay is used for embankment material, it shall be used inside of embankment and shall be protected by the proper clayey soil that is provided from the borrow pit around the reservoir locally.

The following widths of crest of embankment are recommended taking into account both

the property of embankment material be susceptible to erosion and the existing crest width of embankment.

Height of embankment (m)	Width of crest (m)
H<4.0	5.0
4.0<H<8.0	5.0
8.0<H	6.0

The following slope of upstream and downstream sides is proposed taking into consideration stability of embankment and the soil property of material.

Height of embankment (m)	Upstream slope	Downstream slope
H<4.0	1:1.80	1:1.60
4.0<H<8.0	1:2.00	1:1.80
8.0<H	1:2.00	1:2.00

The slope protection of sod facing on both upstream and downstream slope is necessary so that the slope is hard to be eroded. The sod facing on upstream slope should be put on to 50cm below the full water level.

The freeboard shall be set to be more than 1.0m.

H-1.4.2 Intake and Spillway

The existing intake structure shall be reconstructed or be improved with adequate dimensions of structure and good operational slide gate. Because the bed elevation of existing irrigation canal from pond is lower than the elevation of paddy field directly downstream of pond, it is not possible to irrigate the paddy field at adjacent reservoir by gravity. A new intake will be provided to irrigate the paddy field at adjacent reservoir by gravity.

Almost all of reservoirs do not have a spillway because the intake structure with no gate or with no function gate is as both intake and spillway in the present condition. This condition contributes to the flush out of the embankment partly by water. The spillway shall be provided for each reservoir. The canal type spillway with no over flow weir locates on the reservoir. The chute and stilling basin is made by rock

The general plan for rehabilitation of small dams is shown in Drawing No.10.

Chapter H-2 Cost Estimate

H-2.1 Basic Conditions and Assumptions

The basic conditions and assumptions for cost estimation are as follows.

- 1) Cost estimate refers to the prices as of January 2006.
- 2) Unit prices of labor, construction materials, engineering works, etc., were collected from MOWRAM and market.
- 3) Construction is undertaken on contract basis, and bidding of contractor is done based on the work volume and technical requirements.
- 4) Project cost comprises i) direct construction cost, ii) O&M equipment cost, iii) engineering service cost, iv) agricultural support service cost v) cost of formation and strengthening FWUC/FWUG, and vi) contingencies
- 5) Administration cost is 10% of direct construction cost.
- 6) The cost of O&M equipment is 1% of direct construction cost.
- 7) Contingencies comprise physical contingency and price escalation. The physical contingency is 10% of the Project cost.
- 8) Price escalation is evaluated based upon 2.5% per annum for foreign currency portion and 7.5% per annum for local currency portion.
- 9) The institutional development cost includes the cost for training, extension, and other supporting services identified in the supporting programs.
- 10) Conversion rate is assumed at US\$ 1.0 = Riel 4,070 (as of January 2006).

H-2.2 Implementation Schedule of Projects

The implementation schedule of the proposed projects is studied for each. A detailed schedule of each project is described in the relevant Appendices. For example, Upper North Main Canal Irrigated Agriculture Improvement Project which contains mainly hardware component is described in Appendix-F Irrigation and Drainage. On the other hand, Livestock Sub-sector Development Study is described in Appendix-D Agriculture.

However, all projects have a reciprocal relationship in its necessity, urgency, a nature of the work, and so on. Therefore an overall implementation schedule is made.

A full-scale project implementation is to be started by Roleang Chrey Gates Urgent Improvement Project in middle of 2006, and will last up to 2015 as shown in Table H2.2.1.

H-2.3 Project Cost

The required costs for implementation of each project are summarized on Table H2.3.1 based on the nature of the work and implementation schedule of each project. An overall project cost amounts about US\$75.1illion as shown in the following table.

An annual disbursement of the project cost is summarized in Table H2.3.2.

Tables

Table H1.1 Hydraulic calculation of gate at Roleang Chrey Regulator

The discharge is given by the equation:

$$Q = C_d \times d \times B \times \{2g(h_1 - d/2)\}^{0.5} \dots\dots 1)$$

where: C_d = flow index = 0.65
 B = width of gate in meter
 d = gate opening in meter

$$h_0 = C_a \cdot d \dots\dots 2)$$

where: C_a = coefficient of Vena contracta (=0.61)

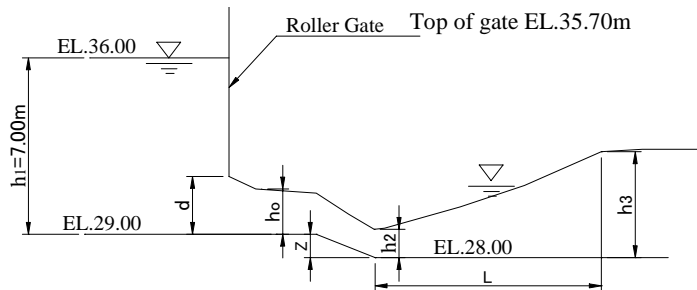
$$h_3 = 1/2 \{(1 + 8Fr^2)^{0.5} - 1\} \cdot h_2$$

where: Fr = Froude number
 $Fr = V_2 / \sqrt{g \cdot h_2}$
 V_2 = flow velocity (m/sec)

$$h_0 + hv_0 + Z = h_2 + hv_2$$

$$hv_0 = V_0^2 / 2g$$

$$hv_2 = V_2^2 / 2g$$



Numbers of gate = 5 nos.
 Width of gate = 12.5 m
 Height of gate = 6.7 m

Flood discharge (m ³ /sec)	800
Discharge per unit width in meter q_1 (m ³ /sec/m)	12.80
d (m)	1.80
q_2 by equation 1) (m ³ /sec/m)	12.80
h_1 (m)	7.00
h_0 (m)	1.10
V_0 (m/sec)	11.65
hv_0 (m)	6.93
Z (m)	1.00
h_2 (m)	1.02
V_2 (m/sec)	12.52
hv_2 (m)	8.00
Fr	3.957
h_3 (m)	5.23
Length of stilling basin = $3h_3$	15.69

(USBR Type III)

Table H1.2 Hydraulic calculation of Stilling basin at Roleang Chrey Regulator

Flood discharge	Q	=	12.8 m ³ /s
Width of gate	B	=	12.5 m
	g	=	9.8 m ² /s
Inflow Velocity	V_2		12.52 m/s
Inflow depth	h_2		1.022 m
Froude number	Fr	$= v / \sqrt{g \cdot h_2}$	3.957
Depth of hydraulic jump	h_3	$= h_2/2 \cdot (\sqrt{1+8Fr^2}-1)$	5.231 m
Length of stilling basin	L	$= 3 \cdot h_3$	15.693 15.7 m
Chute Block			
height	h_s	$= h_2$	1.022 1.05 m
width	W_s	$= h_2$	1.022 1.05 m
space between each blocks	S_s	$= h_2$	1.022 1.05 m
fractional space		$= h_2/2$	0.511 0.55 m
Baffle block			
height	h_b	$= (0.17 \cdot Fr + 0.6) \cdot h_2$	1.301 1.35 m
width	W_b	$= 0.75 \cdot h_b$	0.976 1.00 m
space	S_b	$= 0.75 \cdot h_b$	0.976 1.00 m
fractional space		$= 0.375 \cdot h_b$	0.475 0.50 m
width of crest		$= 0.2 \cdot h_b$	0.270 0.30 m
space between chute block and baffle block		$= 0.8 \cdot h_2$	4.185 4.20 m
slope		$= 1 : 1.0$	
End sill			
height	h_e	$= (0.056 \cdot Fr + 1.0) \cdot h_2$	1.249 1.25 m
width of crest	W_e	$= 0.2 \cdot h_e$	0.250 0.25 m
slope		$= 1 : 2.0$	
River bed protection			
length	L	$= 6 \cdot h_3$	31.386 31.40 m

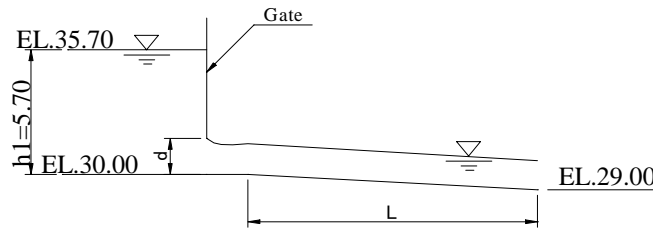
Table H1.3 Hydraulic calculation of River Outlet Structure at Roleang Chrey Regulator

1. Gate dimensions

The discharge at gate is given by the equation:

$$Q = C_d \times d \times B \times \{2g (h_1 - d/2)\}^{0.5}$$

where: Q = discharge 10.0 (m³/sec)
 C_d = flow index = 0.65
 B = width of gate in meter 1.0 m
 d = gate opening in meter.
 h₁ = 5.70 m
 Full water level = 35.70 m



Number of gate		nos.	2	2	2	2
Width of gate in meter	B	(m)	0.6	0.8	0.9	1.0
Gate opening in meter	d	(m)	0.48	0.64	0.72	0.80
Discharge	Q	(m ³ /sec)	3.87	6.83	8.62	10.60

ok

The gate B x H = 1.0 x 1.0, Number of gate is 2.

2. Hydraulic calculation of pipe culvert 2 lane

$$V = 1/n \cdot I^{1/2} R^{2/3} \quad (\text{m/sec})$$

$$Q = A \cdot V \quad (\text{m}^3/\text{sec})$$

where: V = flow velocity (m/sec)
 n = coefficient of roughness = 0.015
 I = hydraulic gradient
 R = hydraulic radius
 A = flow area (m²)

Length of pipe culvert L = 73.6 m
 EL. at entrance EL. 30.0 m
 EL. at exit EL. 29.5 m

When h is 0.938D, the maximum discharge flows.

$$D = 1.0\text{m}$$

$$h = 0.94\text{m}$$

$$A = 0.765\text{m}^2$$

$$R = 0.290$$

$$I = dh / L = (5.70 + (30.0 - 29.5)) / 73.6 = 0.084$$

$$V = 1/n \cdot I^{1/2} R^{2/3} = 8.48 \text{ m/sec}$$

$$Q = A \cdot V \cdot 2 \text{ lane} = 12.97 \text{ m}^3/\text{sec} > 10.0 \text{ ok}$$

Table H2.2.1 Implementation Plan for Short and Medium Terms

Proposed Improvement Projects/Studies		Medium Term																
		Short Term																
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015							
No. Code No.	Name of Projects/Studies	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	
Scheme-wise Improvement																		
Zone-based Approach (Zone-1)																		
1	A.1(1) Irrigated Agriculture Improvement Model Project (refer to Appendix F)																	
2	A.1(2) Upper North Main Canal Irrigated Agriculture Improvement Project (refer to Appendix F)																	
3	A.1(3) Upper South Main Canal Irrigated Agriculture Improvement Project (refer to Appendix F)																	
Zone-based Approach (Zone-2)																		
4	A.2(1) Lower North Main Canal Irrigated Agriculture Improvement Project (refer to Appendix F)																	
5	A.2(2) Lower South Main Canal Irrigated Agriculture Improvement Project (refer to Appendix F)																	
6	A.2(3) Ou Krang Ambel Irrigated Agriculture Improvement Project (refer to Appendix F)																	
Zone-based Approach (Zone-3)																		
7	A.3(1) Water Harvesting Irrigated Agriculture Improvement Project (refer to Appendix F)																	
8	A.4(1) Rainfed Agriculture Improvement Project (refer to Appendix D)																	
Zones Crosscutting Approach																		
9	B.1(1) Roleang Chey Gates Urgent Improvement Project (refer to Appendix E)																	
10	B.1(2) Roleang Chey Regulator and Intakes Improvement Project (refer to Appendix F)																	
11	B.2(1) Veterinary Services Strengthening and Livestock Raising Improvement Project (refer to Appendix D)																	
12	B.3(1) Community Inland Fisheries Development Project (refer to Appendix D)																	
13	B.4(1) Income Generation Project for Marginal Farmers (refer to Appendix D)																	
Subject-wise Improvement																		
14	C.1(1) Coordination between MOWRAM and MAFF Strengthening Project (refer to Appendix K)																	
15	C.1(2) Provincial Departments Strengthening Project (refer to Appendix K)																	
16	C.2(1) Livestock Sub-sector Development Study (refer to Appendix D)																	
17	C.3(1) Technical Guidelines Preparation Project (refer to Appendix F)																	
18	C.4(1) Environmental Management Basic Capacity Development Project (refer to Appendix I)																	
19	C.4(2) Environmental Management Applied Capacity Development Project (refer to Appendix I)																	
20	C.5(1) Irrigated Agriculture Technology Improvement Pilot Project (refer to Appendix F)																	
21	C.6(1) Irrigation Facility Maintenance Capacity Strengthening Pilot Project (refer to Appendix F)																	
22	C.7(1) Rainfed Agriculture Improvement Pilot Project (refer to Appendix K)																	
23	C.8(1) Community Inland Fisheries Development Pilot Project (refer to Appendix K)																	
24	C.9(1) River Basin Effective Water Use Awareness Raising Project (refer to Appendix F)																	
25	C.10(1) Institutional and agricultural Support Services Strengthening Project (refer to Appendix D)																	
26	C.11(1) Hydrological Observation Strengthening Project (refer to Appendix A)																	
27	C.11(2) Flood Forecast Warning Study (refer to Appendix A)																	

Tabel H2.3.1 Summary of Project Cost Estimate

(Unit : Thousand US dollar)

Item	Scheme-wise Improvement (Zone Based Projects)										Scheme-wise Improvement (Zone Based Projects)										Scheme-wise Improvement									
	A.1(1)	A.1(2)	A.1(3)	A.2(1)	A.2(2)	A.2(3)	A.3(1)	A.4(1)	B.1(1)	B.1(2)	B.2(1)	B.3(1)	B.4(1)	C.1(1)	C.1(2)	C.2(1)	C.3(1)	C.4(1)	C.4(2)	C.5(1)	C.6(1)	C.7(1)	C.8(1)	C.9(1)	C.10(1)	C.11(1)	C.11(2)	Total		
I. Direct Construction Cost																														
1) Regulator & Intakes																														
2) Main Canal	832	5,681	4,188	-	1,025	2,900	-	-																						
3) Secondary, tertiary canals	263	819	1,511	1,817	7,795	1,266	149																							
4) Water harvesting																														
II. O&M equipment	10	63	55	17	86	40	43																							
III. Engineering service cost	171	771	628	308	875	474	451																							
IV. Formation and strengthening FWUC	25	51	65	26	114	59	17																							
V. Agricultural support services	23	42	54	24	113	49	12																							
VI. Human resources cost																														
VII. Direct cost																														
Sub-total (I.-VII.)	1,324	7,860	6,812	2,192	10,607	5,040	5,232	2,479	75	3,692	314	344	566	89	300	1,410	1,500	70	400	800	790	100	110	550	2,440	53	120	55,269		
VI. Physical contingency	132	786	681	219	1,061	504	523	0	0	369	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Price Contingency	223	2,686	2,378	779	3,515	1,675	1,672	496	0	725	63	69	113	9	30	141	225	0	120	0	119	0	0	83	488	0	0	15,609		
Total	1,679	11,332	9,871	3,190	15,183	7,219	7,427	2,975	75	4,786	377	413	679	98	330	1,551	1,725	70	520	800	909	100	110	633	2,928	53	120	75,153		

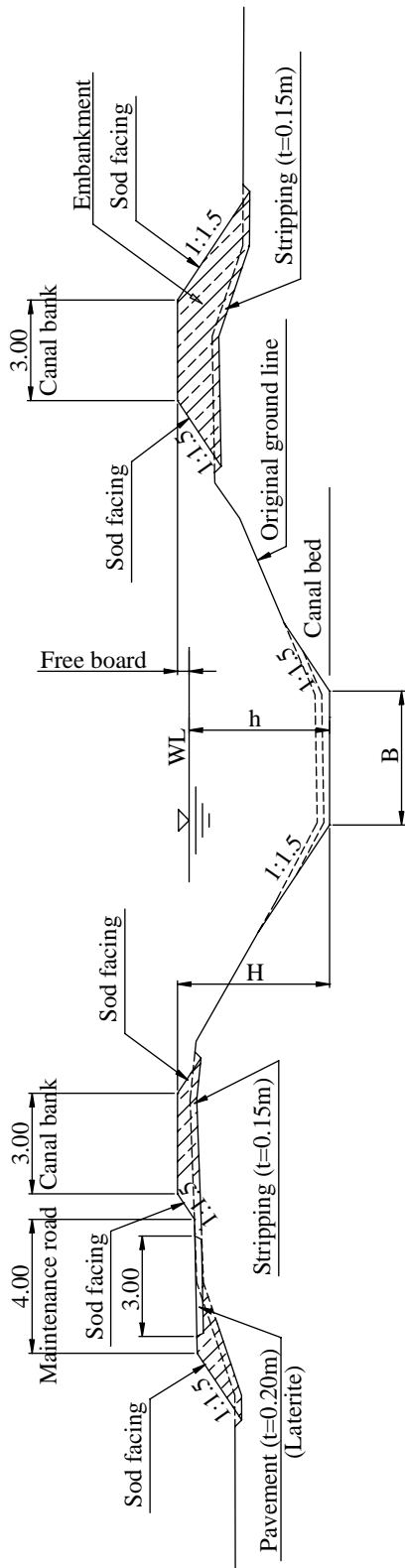
- A.1(1) Irrigated Agriculture Improvement Model Project
- A.1(2) Upper North Main Canal Irrigated Agriculture Improvement Project
- A.1(3) Upper South Main canal irrigated agricultural improvement project
- A.2(1) Lower North Main canal irrigated agricultural improvement project
- A.2(2) Lower South Main canal irrigated agricultural improvement project
- A.2(3) Ou Krang Ambel irrigated agricultural improvement project
- A.3(1) Water Harvesting irrigated agricultural improvement project
- A.4(1) Rainfed Agriculture Improvement Project
- B.1(1) Roleang Chrey Regulator Gates Urgent Project
- B.1(2) Roleang Chrey Regulator and Intakes Rehabilitation and Improvement Project
- B.2(1) Veterinary Services Strengthening and Livestock Raising Improvement Project
- B.3(1) Community Inland Fisheries Development Project
- B.4(1) Income Generation Projects for Marginal Farmers
- C.1(1) Coordination between MOWRAM and MAFF Strengthening Project
- C.1(2) Provincial Departments Strengthening Project
- C.2(1) Livestock Sub-sector Development Study
- C.3(1) Technical Guidelines Preparation Project
- C.4(1) Environmental Management Basic Capacity Development Project
- C.4(2) Environmental Management Applied Capacity Development Project
- C.5(1) Irrigated Agriculture On-Farm Technology Improvement Pilot Project
- C.6(1) Irrigation Facility Maintenance Capacity Strengthening Pilot Project
- C.7(1) Rainfed Agriculture Improvement Pilot Project
- C.8(1) Community Inland Fisheries Development Pilot Project
- C.9(1) River Basin Effective Water Use Awareness Raising Project
- C.10(1) Institutional and Agriculture Support Services Strengthening Project
- C.11(1) Hydrological Observation Strengthening Project
- C.11(2) Flood Forecast and Warning Study

Table H2.3.2 Annual Disbursement of Project Cost

(Unit: US\$000)

Projects/Studies	Total Cost	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
(1) Scheme-wise Improvement											
(a) Zone-1											
A.1(1) Irrigated Agriculture Improvement Model Project	1,679				737	917	10	11	4		
A.1(2) Upper North Main Canal Irrigated Agriculture Improvement Project	11,332						710	2,732	5,453	2,187	250
A.1(3) Upper South Main Canal Irrigated Agriculture Improvement Project	9,871						549	2,103	4,467	2,397	355
(b) Zone-2											
A.2(1) Lower North Main Canal Irrigated Agriculture Improvement Project	3,190							965	1,554	671	
A.2(2) Lower South Main Canal Irrigated Agriculture Improvement Project	15,183						3,040	4,728	3,152	2,249	2,014
A.2(3) Ou Krang Ambel Irrigated Agriculture Improvement Project	7,219							3,038	3,590	591	
(c) Zone-3											
A.3(1) Water Harvesting Irrigated Agriculture Improvement Project	7,427					129	1,447	2,160	2,117	832	742
(d) Zone-4											
A.4(1) Rainfed Agricultural Improvement Project	2,975				595	595	595	595	595		
(e) Zones Crosscutting											
B.1(1) Roleang Chrey Regulator Gates Urgent Improvement Project	75	75									
B.1(2) Roleang Chrey Regulator and Intakes Improvement Project	4,786				382	2,710	1,694				
B.2(1) Veterinary Services Strengthening and Livestock Raising Improvement Project	377				76	75	75	75	76		
B.3(1) Community Inland Fisheries Development Project	413						79	79	81	84	90
B.4(1) Income Generation Project for Marginal Farmers	679				91	108	149	166	165		
Sub-total	65,206				1,881	4,534	8,348	16,662	21,254	9,011	3,451
(2) Subject-wise Improvement											
C.1(1) Coordination between MOWRAM and MAFF Strengthening Project	98				98						
C.1(2) Provincial Departments Strengthening Project	330				330						
C.2(1) Livestock Sub-sector Development Study	1,551				1,551						
C.3(1) Technical Guidelines Preparation Project	1,725				690	863	172				
C.4(1) Environmental Management Basic Capacity Development Project	70	35	35								
C.4(2) Environmental Management Applied Capacity Development Project	520							156	104	104	156
C.5(1) Irrigated Agriculture On-farm Technology Improvement Pilot Project	800	300	400	100							
C.6(1) Irrigation Facility Maintenance Capacity Strengthening Pilot Project	909				345	460	104				
C.7(1) Rainfed Agriculture Improvement Pilot Project	100	45	45	10							
C.8(1) Community Inland Fisheries Development Pilot Project	110				50	60	64				
C.9(1) River Basin Effective Water Use Awareness Raising Project	633				253	316	64				
C.10(1) Institutional and agricultural Support Services Strengthening Project	2,928					293	586	586	586	586	291
C.11(1) Hydrological Observation Strengthening Project	53	26	27								
C.11(2) Flood Forecasting and Warning Study	120	120									
Sub-total	9,947	406	627	110	3,317	1,992	926	742	690	690	447
Total	75,153	406	627	110	5,198	6,526	9,274	17,394	21,944	9,701	3,898

Figures



h = Design water depth (m)
 H = Height of canal (m)
 B = Width of canal (m)

The sod facing on internal side slope of canal should be put on to a depth of 50cm below the design water level.

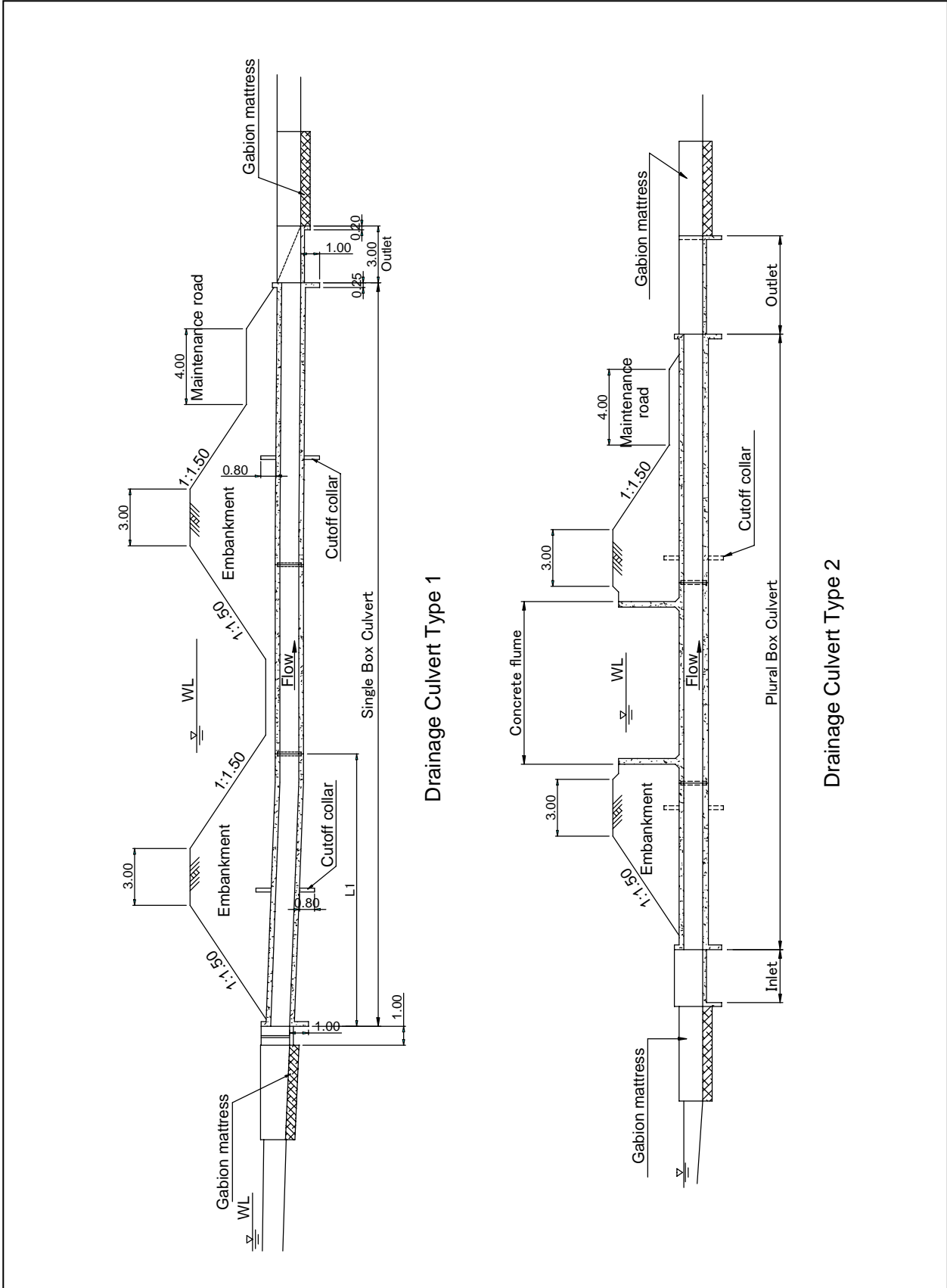
Typical Cross Section of Main Canal

The Study on Comprehensive Agricultural Development of Prek Thnot River Basin, The Kingdom of Cambodia

Japan International Cooperation Agency

Figure H1.1.

Typical cross section of Main canal



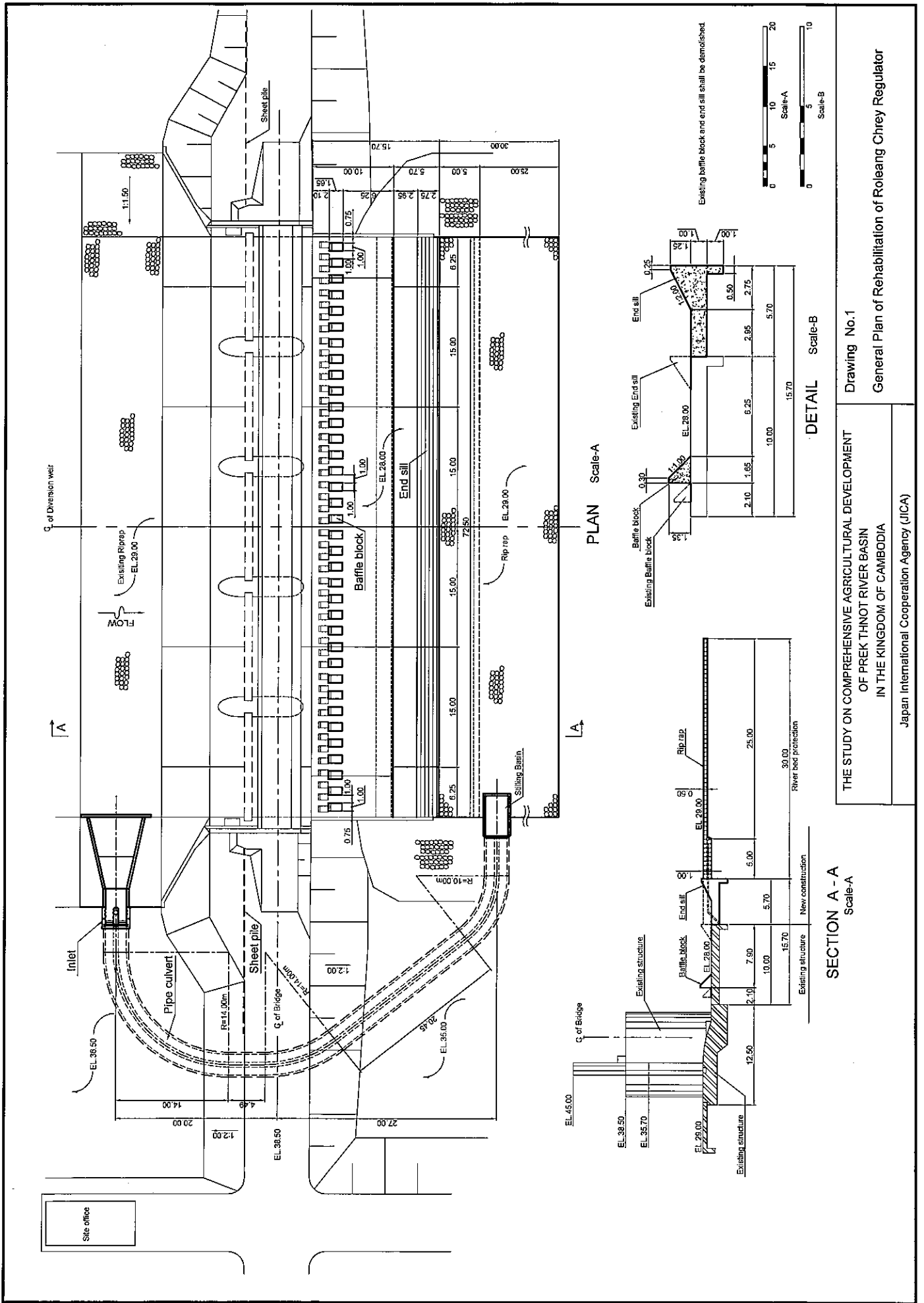
Drainage Culvert Type 1

Drainage Culvert Type 2

The Study on Comprehensive Agricultural Development of Prek Thnot River Basin, The Kingdom of Cambodia
 Japan International Cooperation Agency

Figure H1.2
Drainage culvert

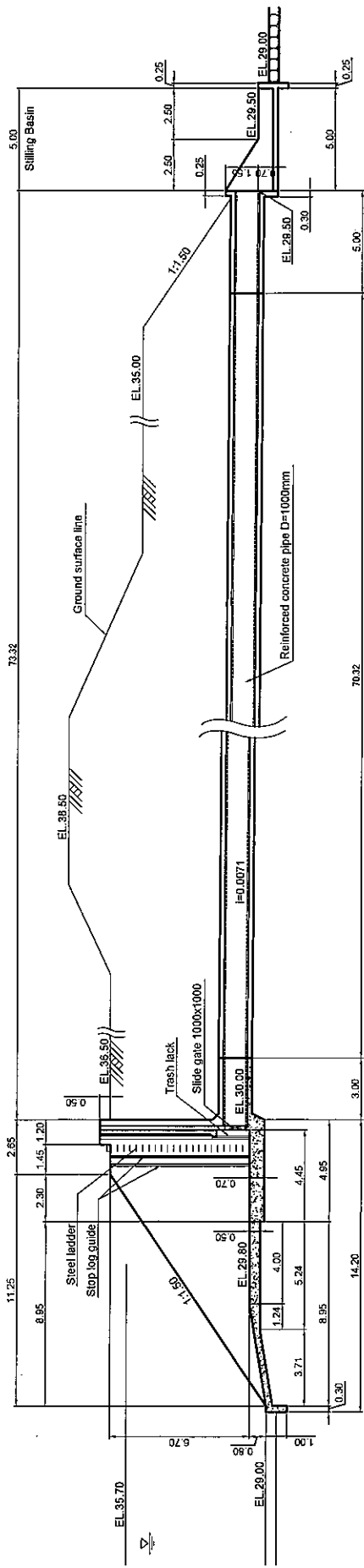
Drawings



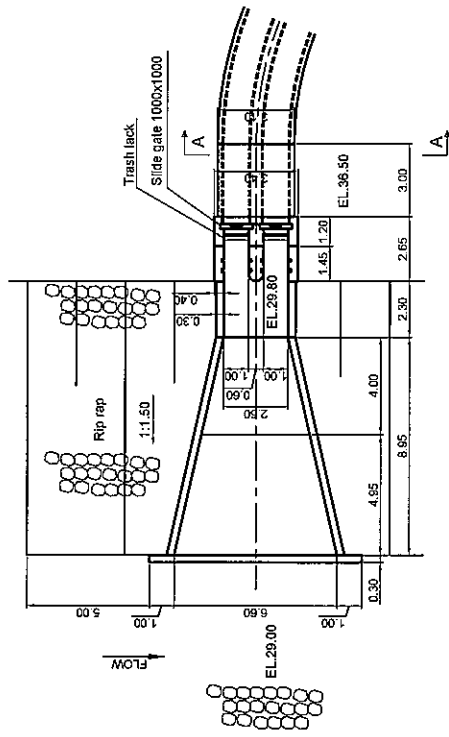
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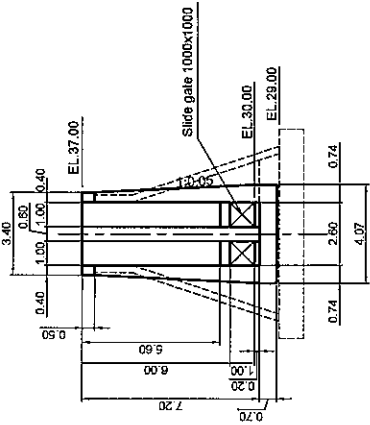
Drawing No.1
General Plan of Rehabilitation of Roleang Chrey Regulator



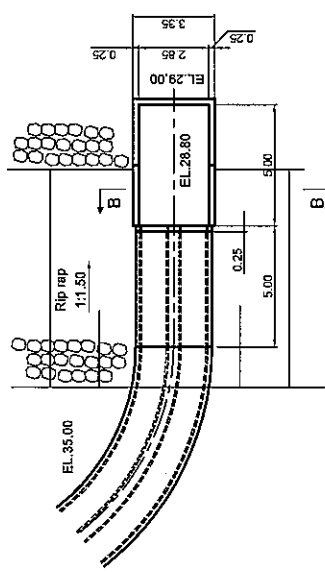
Longitudinal Section



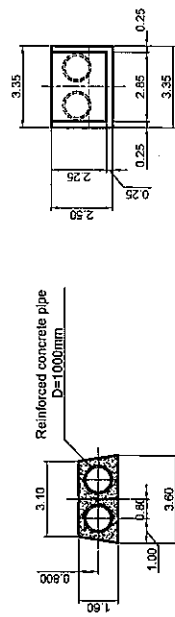
PLAN of INLET



ELEVATION of INLET

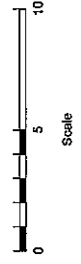


PLAN of OUTLET



SECTION A - A

SECTION B - B

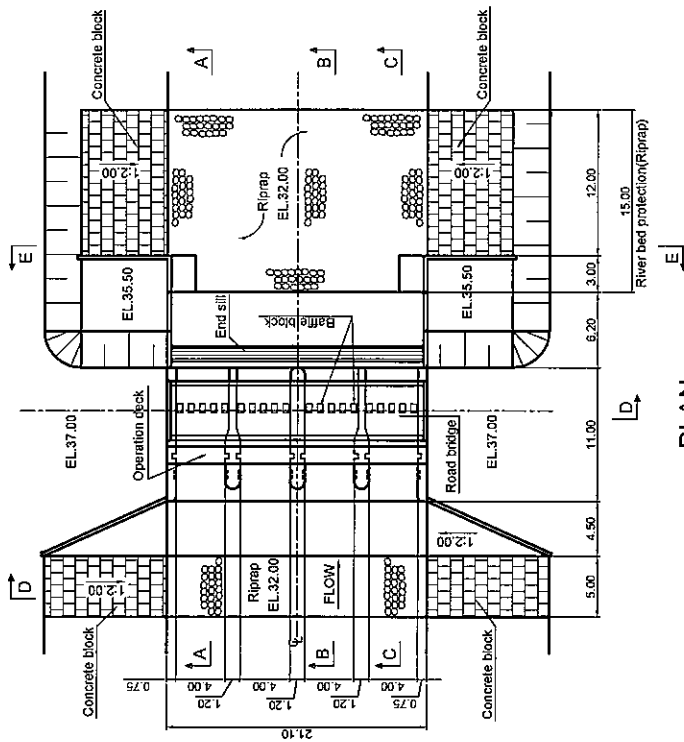


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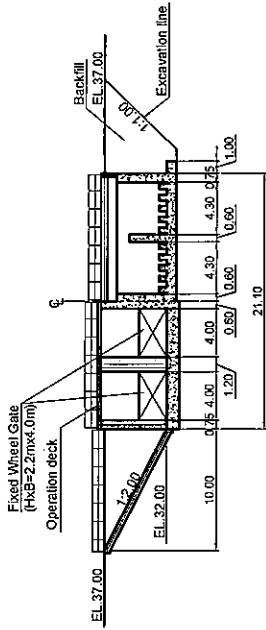
Drawing No.2

General Plan of River Outlet Facility
at Roleang Chrey Regulator

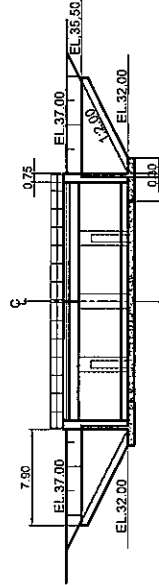
INTAKE STRUCTURE



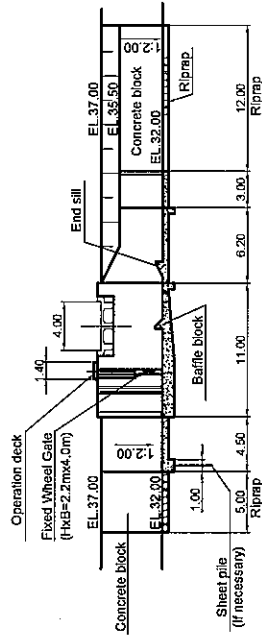
PLAN



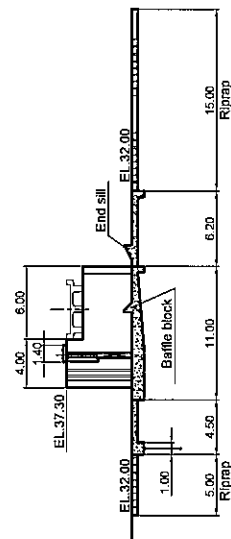
SECTION D-D



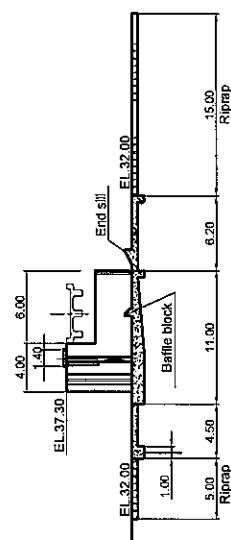
SECTION E-E



SECTION A-A



SECTION B-B



SECTION C-C

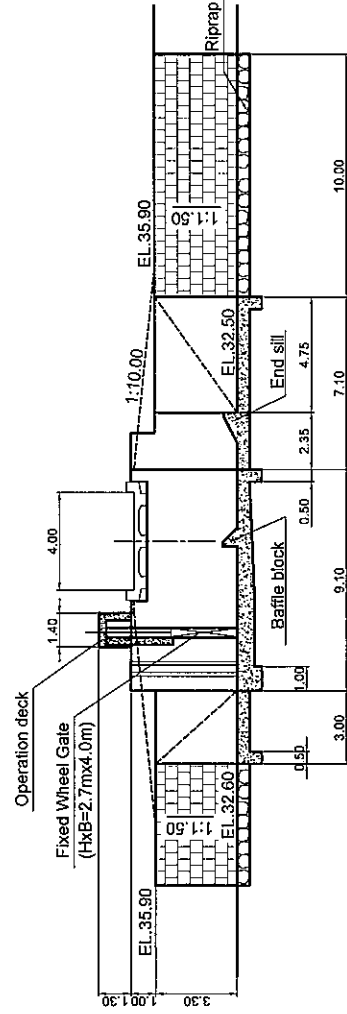
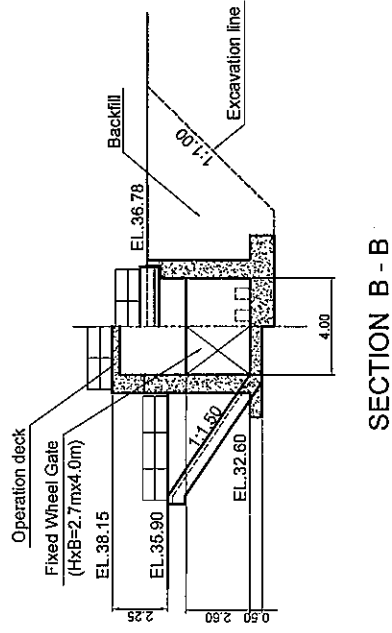
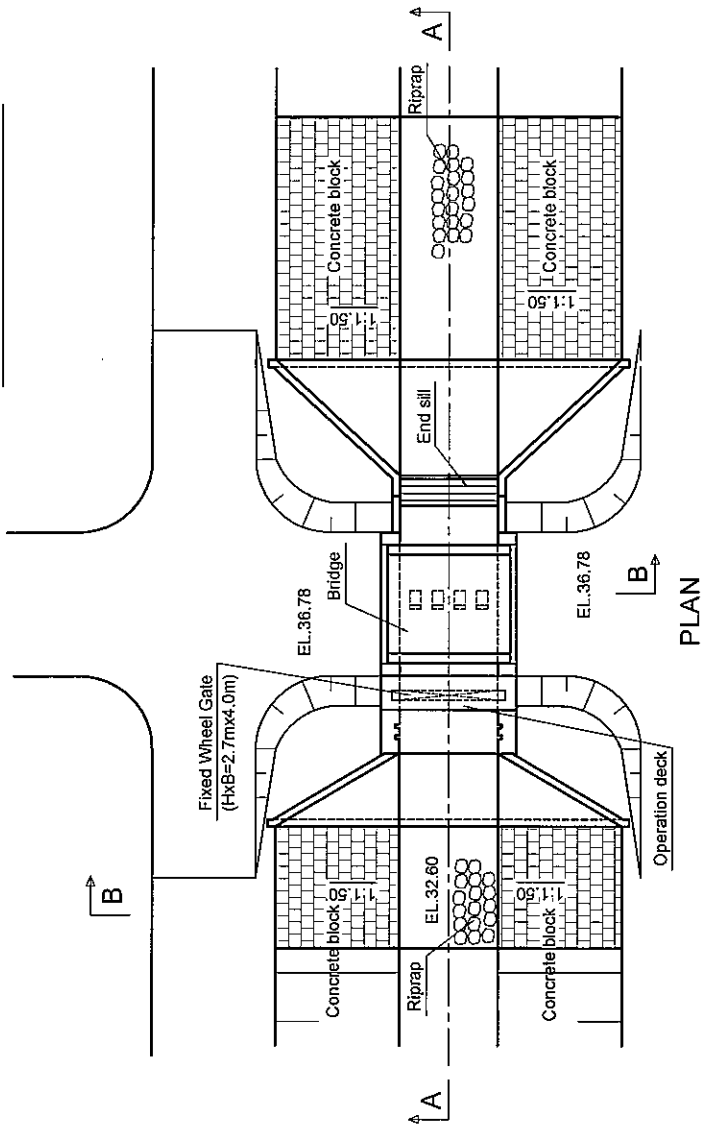


THE STUDY ON COMPREHENSIVE AGRICULTURAL DEVELOPMENT
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Japan International Cooperation Agency (JICA)

Drawing No.3
Andong Sla Intake Structure of North Main Canal

INTAKE STRUCTURE



SECTION A - A

THE STUDY ON COMPREHENSIVE AGRICULTURAL DEVELOPMENT
 OF PREK THNOT RIVER BASIN
 IN THE KINGDOM OF CAMBODIA

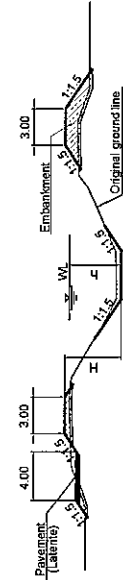
Drawing No.4

Vatkrouh Intake Structure of South Main Canal

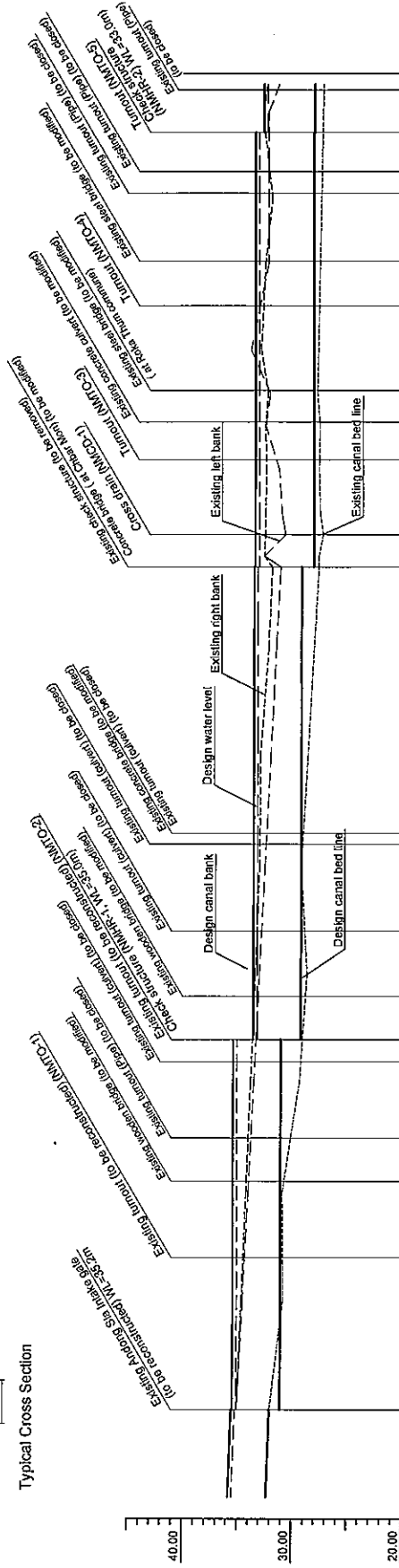
Japan International Cooperation Agency (JICA)

PROFILE (1/3)

HH=140000 V=1:400



Typical Cross Section



Upper North Main Canal Irrigated Agricultural Improvement Project

Roleang Chrey Regulator and Intake Improvement Project

Station No.	Distance (m)	Accumulated distance (m)	Existing			Design		
			Right bank elevation (m)	Left bank elevation (m)	Canal bed elevation (m)	Right bank elevation (m)	Left bank elevation (m)	Canal bed elevation (m)
No. 0	0	0	32.00	35.00	35.00	32.30	35.50	35.80
No. 1	200	1,000	32.00	35.00	35.00	31.05	35.05	35.40
No. 2	200	2,000	30.80	34.49	34.59	31.03	35.03	35.38
No. 3	200	3,000	30.85	33.97	34.17	31.02	35.02	35.37
No. 4	200	4,200	31.00	33.46	33.76	31.00	35.00	35.35
No. 5	200	5,000	29.14	32.43	33.34	29.16	33.18	33.51
No. 6	200	6,000	28.54	31.92	32.93	29.14	33.14	33.49
No. 7	200	7,000	28.12	31.52	32.96	28.12	33.12	33.47
No. 8	200	8,000	27.96	31.41	32.10	29.11	33.11	33.46
No. 9	150	9,000	27.53	31.02	31.79	29.10	33.10	33.45
No. 10	150	10,000	27.60	30.78	32.83	28.01	33.01	33.36
No. 11	200	11,000	27.44	32.14	32.43	28.01	33.01	33.36
No. 12	50	12,000	27.30	32.14	31.80	28.00	33.00	33.35
No. 13	200	13,000	27.14	32.12	32.65	27.92	32.85	32.57

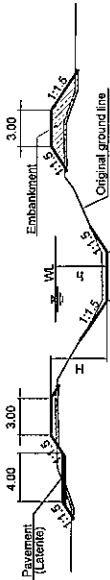
Dimensions
 Q=Design discharge (m³/sec)
 i=Canal bed gradient
 h=Design water depth (m)
 V=Flow velocity (m/sec)
 B=Width of canal bed (m)
 H=Height of canal (m)
 Canal slope (horizontal to vertical) m=1.50

Drawing No. 5-1
 Profile of North Main Canal (1/3)

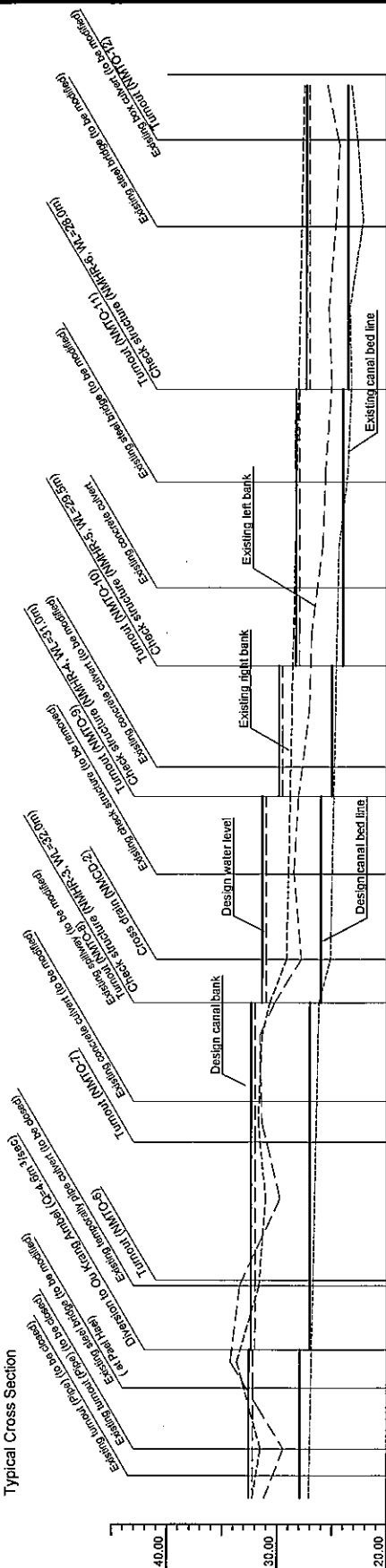
THE STUDY ON COMPREHENSIVE AGRICULTURAL DEVELOPMENT
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PROFILE (2/3)
H=1:40000 V=1:400



Typical Cross Section



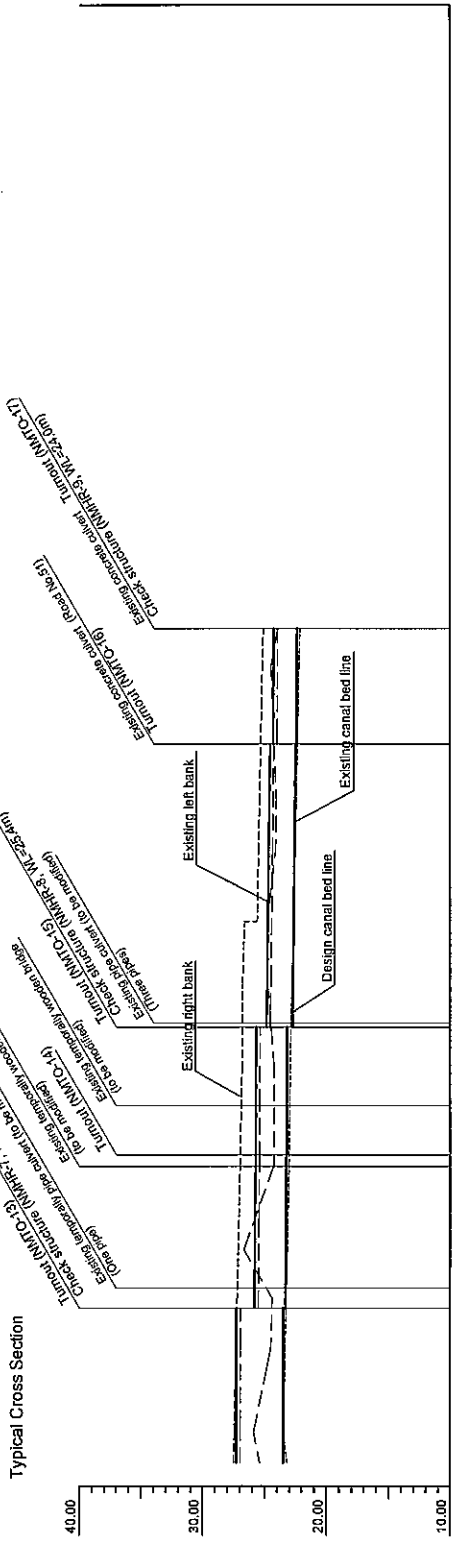
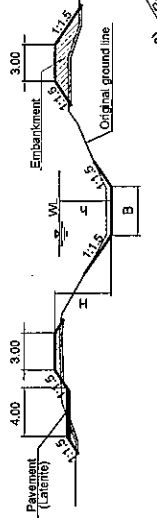
Upper North Main Canal Irrigated Agricultural Improvement Project

Station No.	Distance (m)	Accumulated distance (m)	Canal bed elevation (m)	Left bank elevation (m)	Right bank elevation (m)	Canal bed elevation (m)	Water surface (m)	Canal Bank elevation (m)	Design	
									Q=10.4m ³ /sec h=4.30m, V=0.23m/sec B=4.00m, H=4.35m	i=0.000001
+450	200	13.000	27.00	29.44	31.50	27.92	32.22	32.57	Q=5.8m ³ /sec h=5.00m, V=0.10m/sec B=4.00m, H=5.35m	i=0.000002
+450	450	13.450	27.00	29.44	31.50	27.99	32.20	32.55	Q=5.8m ³ /sec h=5.00m, V=0.10m/sec B=4.00m, H=5.35m	i=0.000002
+450	550	14.000	27.00	34.25	33.66	27.99	32.20	32.55	Q=5.8m ³ /sec h=5.00m, V=0.10m/sec B=4.00m, H=5.35m	i=0.000002
+450	650	14.250	28.84	34.25	33.66	27.99	32.20	32.55	Q=5.8m ³ /sec h=5.00m, V=0.10m/sec B=4.00m, H=5.35m	i=0.000002
+450	750	15.750	26.54	29.74	31.04	27.00	32.00	32.35	Q=5.8m ³ /sec h=5.00m, V=0.10m/sec B=4.00m, H=5.35m	i=0.000002
+450	850	16.500	26.40	31.38	31.70	27.00	32.00	32.35	Q=5.8m ³ /sec h=5.00m, V=0.10m/sec B=4.00m, H=5.35m	i=0.000002
+450	950	17.000	26.24	31.57	31.37	27.00	32.00	32.35	Q=5.8m ³ /sec h=5.00m, V=0.10m/sec B=4.00m, H=5.35m	i=0.000002
+450	1050	17.250	28.18	30.24	30.68	26.01	31.01	31.36	Q=5.8m ³ /sec h=4.50m, V=0.12m/sec B=4.00m, H=4.35m	i=0.000003
+450	1150	17.550	28.18	30.24	30.68	26.01	31.01	31.36	Q=5.8m ³ /sec h=4.50m, V=0.12m/sec B=4.00m, H=4.35m	i=0.000003
+450	1250	18.000	24.98	28.48	28.98	26.01	31.00	31.35	Q=5.8m ³ /sec h=4.50m, V=0.12m/sec B=4.00m, H=4.35m	i=0.000005
+450	1350	19.450	24.84	28.08	28.84	26.01	31.00	31.35	Q=5.8m ³ /sec h=4.50m, V=0.12m/sec B=4.00m, H=4.35m	i=0.000005
+450	1450	20.000	24.69	27.06	28.68	26.01	28.51	28.86	Q=5.8m ³ /sec h=4.00m, V=0.15m/sec B=4.00m, H=4.30m	i=0.000005
+450	1550	20.250	24.69	27.06	28.68	26.01	28.51	28.86	Q=5.8m ³ /sec h=4.00m, V=0.15m/sec B=4.00m, H=4.30m	i=0.000005
+450	1650	20.650	24.54	26.85	28.54	24.01	28.01	28.31	Q=5.8m ³ /sec h=4.00m, V=0.15m/sec B=4.00m, H=4.30m	i=0.000005
+450	1750	21.000	24.54	26.85	28.54	24.01	28.01	28.31	Q=5.8m ³ /sec h=4.00m, V=0.15m/sec B=4.00m, H=4.30m	i=0.000005
+450	1850	21.000	23.22	25.01	28.08	24.00	28.00	28.30	Q=5.8m ³ /sec h=3.50m, V=0.18m/sec B=4.00m, H=3.80m	i=0.000008
+450	1950	22.450	23.54	25.58	28.24	24.00	28.00	28.30	Q=5.8m ³ /sec h=3.50m, V=0.18m/sec B=4.00m, H=3.80m	i=0.000008
+450	2050	23.000	23.22	25.01	28.08	24.00	28.00	28.30	Q=5.8m ³ /sec h=3.50m, V=0.18m/sec B=4.00m, H=3.80m	i=0.000008
+450	2150	23.250	23.22	25.01	28.08	24.00	28.00	28.30	Q=5.8m ³ /sec h=3.50m, V=0.18m/sec B=4.00m, H=3.80m	i=0.000008
+450	2250	24.750	22.15	24.63	27.78	23.52	27.02	27.32	Q=5.8m ³ /sec h=3.50m, V=0.18m/sec B=4.00m, H=3.80m	i=0.000008
+450	2350	25.500	22.69	24.28	27.64	23.52	27.02	27.32	Q=5.8m ³ /sec h=3.50m, V=0.18m/sec B=4.00m, H=3.80m	i=0.000008
+450	2450	25.450	22.69	24.28	27.64	23.52	27.02	27.32	Q=5.8m ³ /sec h=3.50m, V=0.18m/sec B=4.00m, H=3.80m	i=0.000008
+500	2500	25.500	22.69	24.28	27.64	23.52	27.02	27.32	Q=5.8m ³ /sec h=3.50m, V=0.18m/sec B=4.00m, H=3.80m	i=0.000008
+500	26000	26.000	22.69	24.28	27.64	23.52	27.02	27.32	Q=5.8m ³ /sec h=3.50m, V=0.18m/sec B=4.00m, H=3.80m	i=0.000008

Dimensions
 Q=Design discharge (m³/sec)
 i=Canal bed gradient
 h=Design water depth (m)
 V=Flow velocity (m/sec)
 B=Width of canal bed (m)
 H=Height of canal (m)
 Canal slope (horizontal to vertical) n=1.50

PROFILE (3/3)

H=1:4000 V=1:400

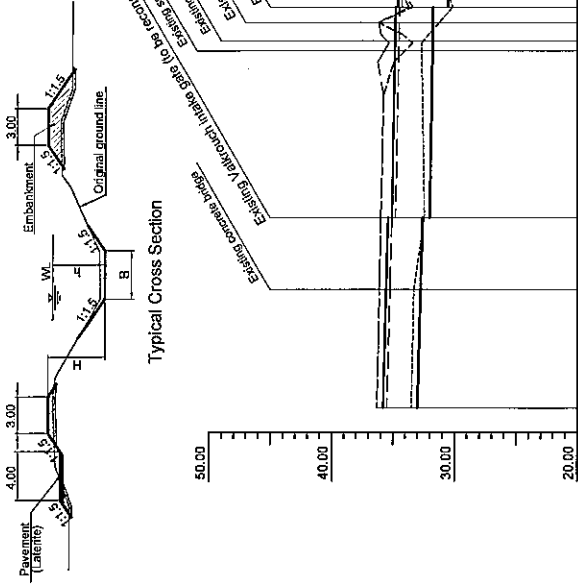


Station No.	Distance (m)	Accumulated distance (m)	Canal bed elevation (m)	Left bank elevation (m)	Right bank elevation (m)	Canal bed elevation (m)	Water surface (m)	Canal Bank elevation (m)	Upper North Main Canal Irrigated Agricultural Improvement Project		Lower North Main Canal Irrigated Agricultural Improvement Project	
									Q=5.8m³/sec h=3.50m, V=0.18m/sec B=4.00m, H=3.80m	Q=5.8m³/sec h=2.20m, V=0.36m/sec B=4.00m, H=2.50m	Q=5.8m³/sec h=1.60m, V=0.48m/sec B=4.00m, H=2.10m	Q=2.3m³/sec h=1.60m, V=0.23m/sec B=4.00m, H=1.90m
No. 25	250	26,000	27.01	27.01	27.01	27.01	27.01	27.31	27.31	27.31	24.30	
No. 26	500	26,250	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	24.00	
No. 27	750	27,000	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	22.40	
No. 28	1000	27,750	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	25.17	
No. 29	1250	28,000	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	25.23	
No. 30	1500	28,250	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	24.40	
No. 31	1750	29,000	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	24.53	
No. 32	2000	29,250	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	24.40	
No. 33	2250	29,500	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	24.40	
No. 34	2500	29,750	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	24.40	
No. 35	2750	30,000	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	24.40	
No. 36	3000	30,250	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	24.40	
No. 37	3250	30,500	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	24.40	
No. 38	3500	30,750	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	24.40	
No. 39	3750	31,000	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	24.40	
No. 40	4000	31,250	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	24.40	
No. 41	4250	31,500	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	24.40	
No. 42	4500	31,750	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	24.40	
No. 43	4750	32,000	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	24.40	
No. 44	5000	32,250	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	24.40	
No. 45	5250	32,500	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	24.40	
No. 46	5500	32,750	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	24.40	
No. 47	5750	33,000	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	24.40	
No. 48	6000	33,250	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	24.40	
No. 49	6250	33,500	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	24.40	
No. 50	6500	33,750	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	24.40	
No. 51	6750	34,000	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	24.40	
No. 52	7000	34,250	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	24.40	
No. 53	7250	34,500	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	24.40	
No. 54	7500	34,750	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	24.40	
No. 55	7750	35,000	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	24.40	
No. 56	8000	35,250	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	24.40	
No. 57	8250	35,500	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	24.40	
No. 58	8500	35,750	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	24.40	
No. 59	8750	36,000	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	24.40	
No. 60	9000	36,250	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	24.40	
No. 61	9250	36,500	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	24.40	
No. 62	9500	36,750	27.01	27.01	27.01	27.01	27.31	27.31	27.31	27.31	24.40	

Dimensions
 Q=Design discharge (m³/sec)
 i=Canal bed gradient
 h=Design water depth (m)
 V=Flow velocity (m/sec)
 B=Width of canal bed (m)
 H=Height of canal (m)
 Canal slope (horizontal to vertical) m=1.50

PROFILE (1/3)

H=1:4,000 V=1:400



Upper South Main Canal Irrigated Agricultural Improvement Project

Irrigated Agricultural Improvement Model Project

Rôleang Chrey Regulator and Intake Improvement Project

Station No.	Dimensions		Irrigated Agricultural Improvement Model Project		Upper South Main Canal Irrigated Agricultural Improvement Project	
	Q	I	h	B	Q	I
No.0	0	0.00017	3.00	4.00	16.3	0.00026
+973	973	0.00026	3.30	4.00	16.3	0.00026
+974	974	0.00026	3.30	4.00	16.3	0.00026
+975	975	0.00026	3.30	4.00	16.3	0.00026
+976	976	0.00026	3.30	4.00	16.3	0.00026
+977	977	0.00026	3.30	4.00	16.3	0.00026
+978	978	0.00026	3.30	4.00	16.3	0.00026
+979	979	0.00026	3.30	4.00	16.3	0.00026
+980	980	0.00026	3.30	4.00	16.3	0.00026
+981	981	0.00026	3.30	4.00	16.3	0.00026
+982	982	0.00026	3.30	4.00	16.3	0.00026
+983	983	0.00026	3.30	4.00	16.3	0.00026
+984	984	0.00026	3.30	4.00	16.3	0.00026
+985	985	0.00026	3.30	4.00	16.3	0.00026
+986	986	0.00026	3.30	4.00	16.3	0.00026
+987	987	0.00026	3.30	4.00	16.3	0.00026
+988	988	0.00026	3.30	4.00	16.3	0.00026
+989	989	0.00026	3.30	4.00	16.3	0.00026
+990	990	0.00026	3.30	4.00	16.3	0.00026
+991	991	0.00026	3.30	4.00	16.3	0.00026
+992	992	0.00026	3.30	4.00	16.3	0.00026
+993	993	0.00026	3.30	4.00	16.3	0.00026
+994	994	0.00026	3.30	4.00	16.3	0.00026
+995	995	0.00026	3.30	4.00	16.3	0.00026
+996	996	0.00026	3.30	4.00	16.3	0.00026
+997	997	0.00026	3.30	4.00	16.3	0.00026
+998	998	0.00026	3.30	4.00	16.3	0.00026
+999	999	0.00026	3.30	4.00	16.3	0.00026
1000	1000	0.00026	3.30	4.00	16.3	0.00026

Dimensions
 Q=Design discharge (m³/sec)
 I=Canal bed gradient
 h=Design water depth (m)
 V=Flow velocity (m/sec)
 B=Width of canal bed (m)
 H=Height of canal (m)
 Canal slope (horizontal to vertical) m=1.50

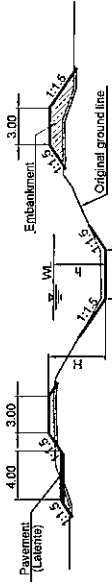
THE STUDY ON COMPREHENSIVE AGRICULTURAL DEVELOPMENT
 OF PREK THNOT RIVER BASIN
 IN THE KINGDOM OF CAMBODIA

Drawing No.6-1
 Profile of South Main Canal (1/3)

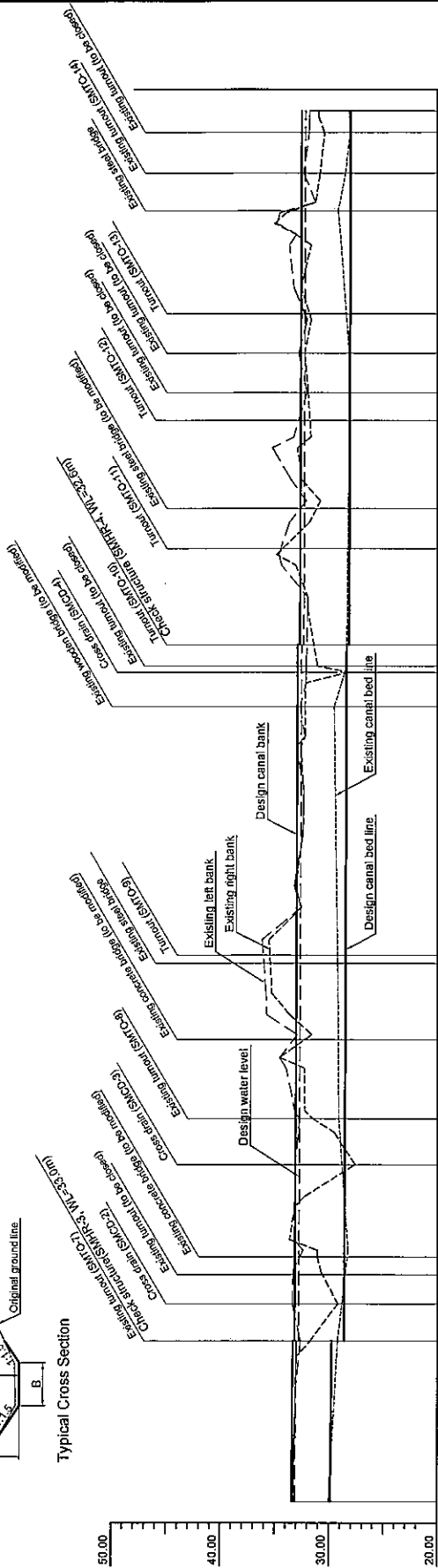
Japan International Cooperation Agency (JICA)

PROFILE (2/3)

H=1:40000 V=1:400



Typical Cross Section



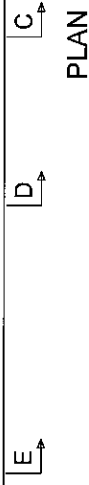
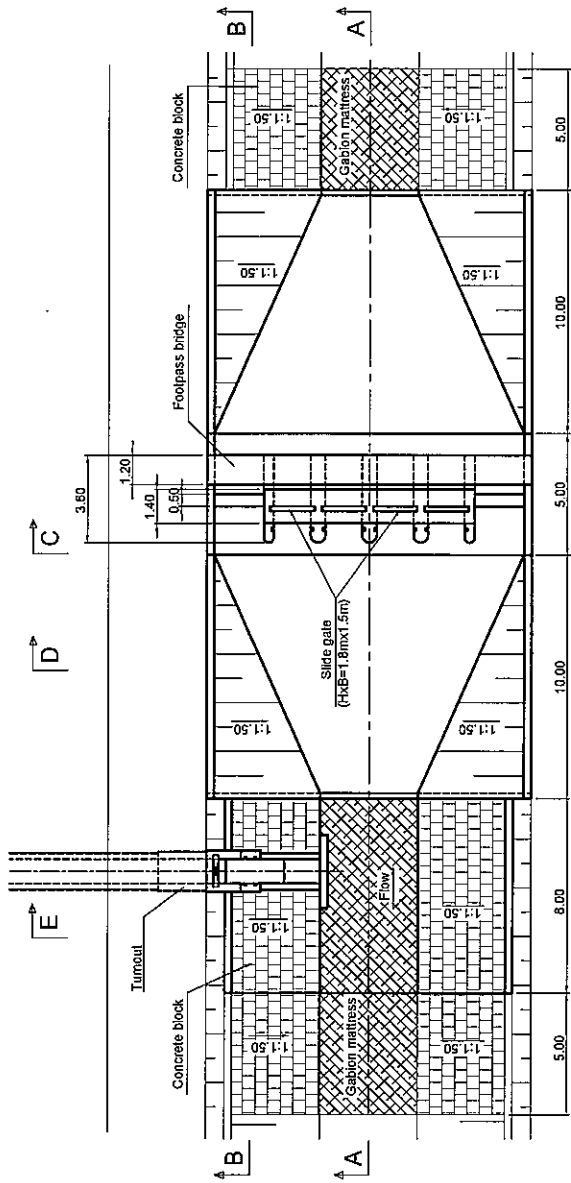
Upper South Main Canal Irrigated Agricultural Improvement Project

Station No.	Distance (m)	Accumulated distance (m)	Existing		Design	
			Canal bed elevation (m)	Left bank elevation (m)	Canal bed elevation (m)	Water surface (m)
No. 13	1,000	13,000	29.87	33.13	33.43	33.43
No. 14	1,000	14,000	29.79	33.04	33.34	33.34
No. 15	500	14,500	29.74	33.00	33.30	33.30
No. 16	194	15,344	29.58	32.78	33.13	33.13
No. 17	429	17,000	28.52	32.72	33.07	33.07
No. 18	1,000	18,000	28.49	32.68	33.02	33.02
No. 19	900	19,000	28.46	32.66	33.01	33.01
No. 20	1,000	20,000	28.43	32.63	32.98	32.98
No. 21	379	20,800	28.40	32.60	32.95	32.95
No. 22	900	21,900	28.17	32.37	32.72	32.72
No. 23	1,000	23,000	28.14	32.34	32.69	32.69
No. 24	259	23,959	28.11	32.31	32.66	32.66
No. 25	600	25,000	28.08	32.28	32.63	32.63
No. 26	352	25,415	28.07	32.27	32.62	32.62

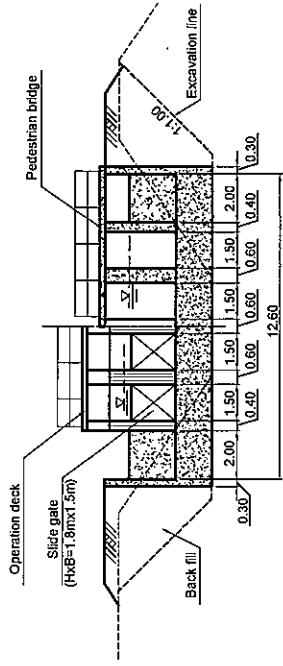
Dimensions
 Q=Design discharge (m³/sec)
 I=Canal bed gradient
 h=Design water depth (m)
 V=Flow velocity (m/sec)
 B=Width of canal bed (m)
 H=Height of canal (m)
 Canal slope (horizontal to vertical) m=1.50

THE STUDY ON COMPREHENSIVE AGRICULTURAL DEVELOPMENT OF PREK THNOT RIVER BASIN IN THE KINGDOM OF CAMBODIA
 Drawing No.6-2
 Profile of South Main Canal (2/3)
 Japan International Cooperation Agency (JICA)

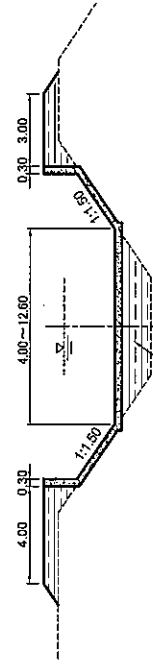
CHECK STRUCTURE



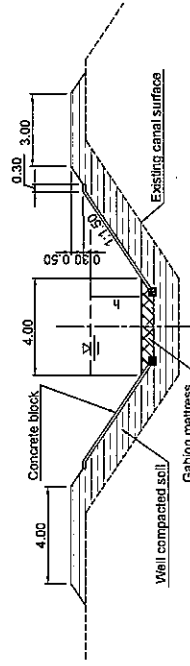
PLAN



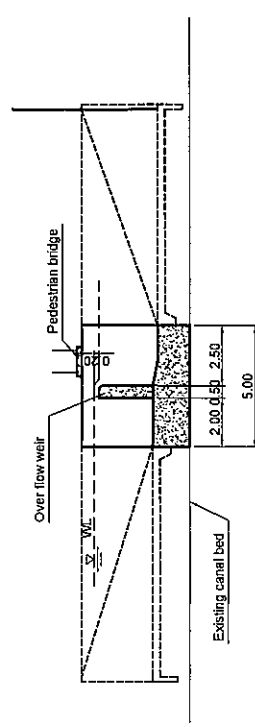
SECTION C - C



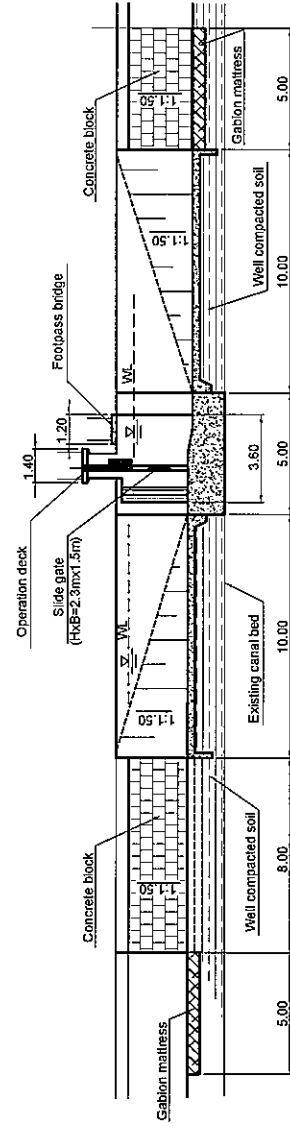
SECTION D - D



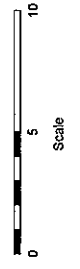
SECTION E - E



SECTION B - B



SECTION A - A



THE STUDY ON COMPREHENSIVE AGRICULTURAL DEVELOPMENT
OF PREK THNOT RIVER BASIN
IN THE KINGDOM OF CAMBODIA

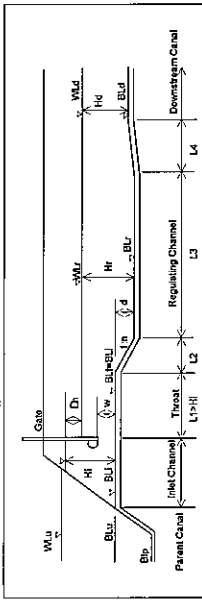
Japan International Cooperation Agency (JICA)

Drawing No.7
General Plan of Check Structure

TURNOUT Type 1

Example of Hydraulic Calculation of Turnout

Q = 0.65 by $\sqrt{2g(H-h)^{3/2}}$
 Structure Type
 Design Head Difference 0.15 m
 Head loss Allowable Range = 0.05 m

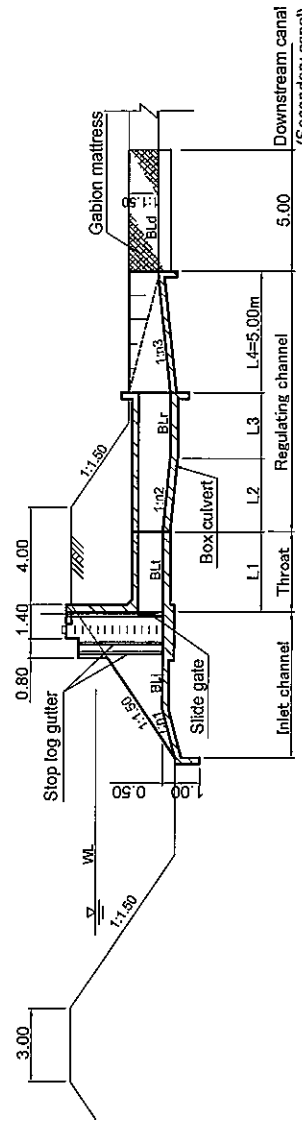


Dimension and Hydraulic Conditions
 Gate with Bgr 0.75 m
 Design Discharge Q = 0.150 m³/sec
 Min. Discharge Q_{min} = 0.05 m³/sec
 Water Depth Above Gate H = 0.50 m
 Head of Gate H_g = 1.00 m
 Parent Canal
 W Depth 1.000 m
 Floor EL 89.000 m
 BL₀-BL₀ = 0.00 m

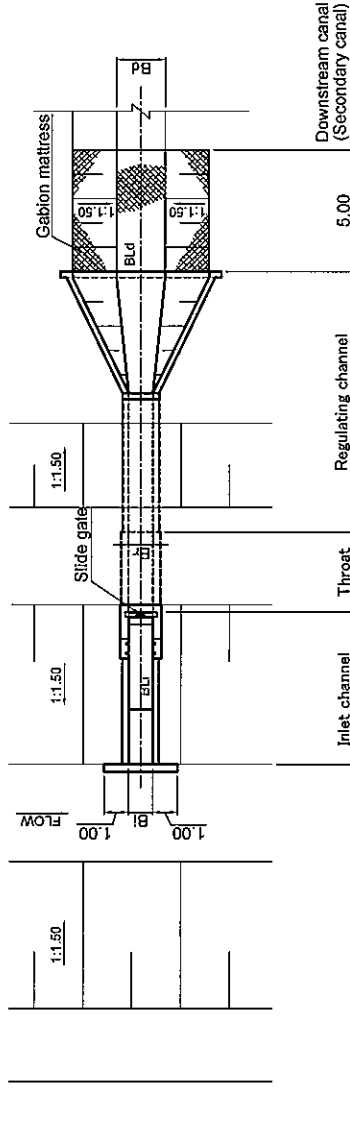
Water Surface	V ₀ = BL ₀	Q _{max} 100.000	Q _{min} 0.14	Inlet Channel		Regulating Channel		Downstream Canal	
				0.14	Q _{min}	Q _{max}	Q _{min}	Q _{max}	Q _{min}
Water Surface	BL ₀	100.000	0.14	0.14	Q _{min}	0.05	0.75	0.75	0.45
Bottom	BL ₀	99.700	0.14	0.75	BL ₀	0	0.75	0.75	0.45
Side Slope	1:m	1:1.50	1:1.50	0.300	BL ₀	0	0.300	0.300	0.45
Energy Head	H = E ₀ + V ₀ ² /2g	0.2815	0.2815	0.2815	H ₀	0.2815	0.2815	0.2815	0.2815
Water Depth	H = E ₀ + V ₀ ² /2g	0.2815	0.2815	0.2815	H ₀	0.2815	0.2815	0.2815	0.2815
Water Surface Width	B = B ₀ + V ₀ ² /gS	0.9861	0.9861	0.9861	B ₀	0.9861	0.9861	0.9861	0.9861
Velocity	V = Q/B	0.7138	0.7138	0.7138	V ₀	0.7138	0.7138	0.7138	0.7138
Energy Head	H = E ₀ + V ₀ ² /2g	0.2815	0.2815	0.2815	H ₀	0.2815	0.2815	0.2815	0.2815
Inlet Loss	E _l = K _l V ₀ ² /2g	0.0013	0.0013	0.0013	E _l	0.0013	0.0013	0.0013	0.0013
Hydraulic Radius	R = A/P	0.1541	0.1541	0.1541	R ₀	0.1541	0.1541	0.1541	0.1541
Roughness Coefficient	n	0.0143	0.0143	0.0143	n	0.0143	0.0143	0.0143	0.0143
Hydraulic Gradient	S = H/L	0.000126	0.000126	0.000126	S	0.000126	0.000126	0.000126	0.000126
Min. Throat Length	L ₃ >= 1.50 m	1.50	1.50	1.50	L ₃	1.50	1.50	1.50	1.50
L ₂ >= 1.00 m	1.00	1.00	1.00	1.00	L ₂	1.00	1.00	1.00	1.00
L ₄ >= 1.00 m	1.00	1.00	1.00	1.00	L ₄	1.00	1.00	1.00	1.00

Energy Level	Water Level	Floor Level	Inlet Channel		Regulating Channel		Downstream Canal	
			EL ₀	WL ₀	EL ₁	WL ₁	EL ₂	WL ₂
99.998	99.998	99.700	99.998	99.998	99.998	99.998	99.998	
99.998	99.998	99.700	99.998	99.998	99.998	99.998	99.998	
99.998	99.998	99.700	99.998	99.998	99.998	99.998	99.998	

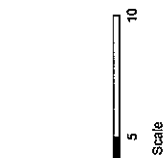
PROFILE



PLAN



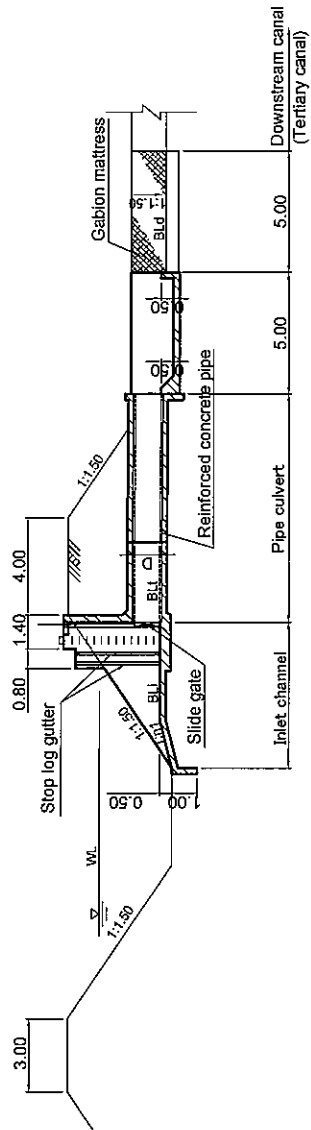
Scale



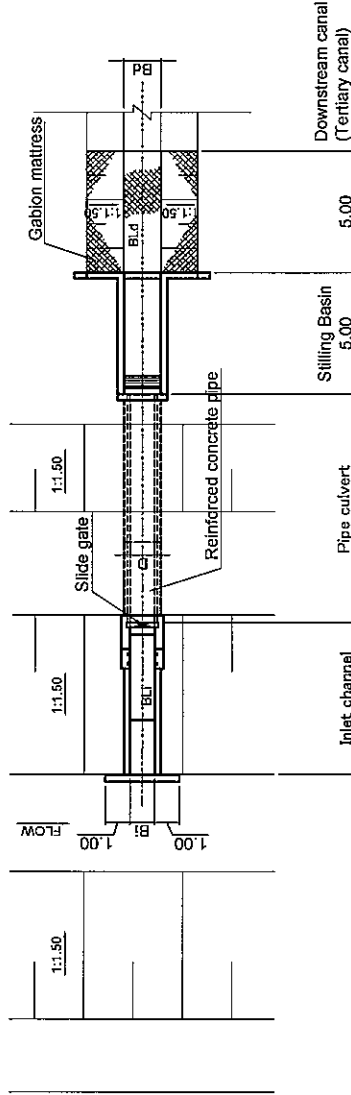
THE STUDY ON COMPREHENSIVE AGRICULTURAL DEVELOPMENT
 OF PREK THNOT RIVER BASIN
 IN THE KINGDOM OF CAMBODIA
 Japan International Cooperation Agency (JICA)

Drawing No. 8-1
 General Plan of Turnout Type 1

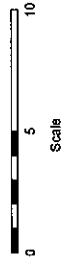
TURNOUT Type 2



PROFILE



PLAN



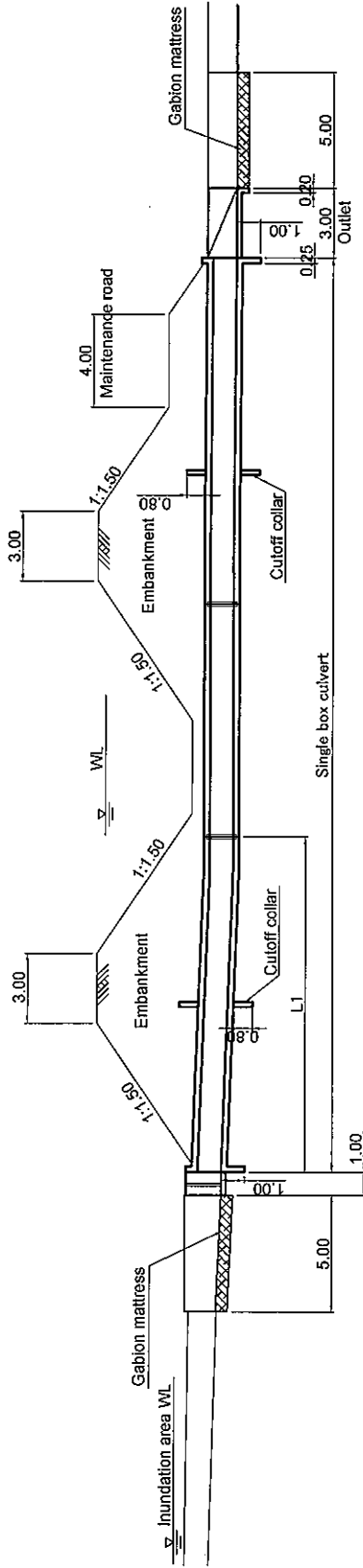
THE STUDY ON COMPREHENSIVE AGRICULTURAL DEVELOPMENT
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Japan International Cooperation Agency (JICA)

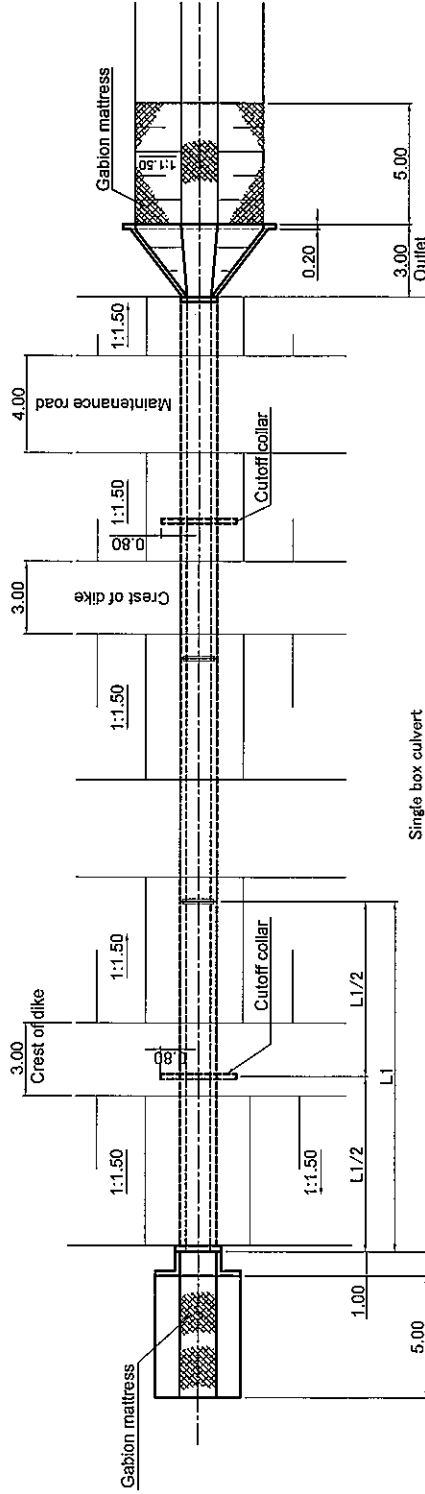
Drawing No.8-2

General Plan of Turnout Type 2

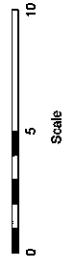
CROSS DRAIN (TYPE 1)



PROFILE



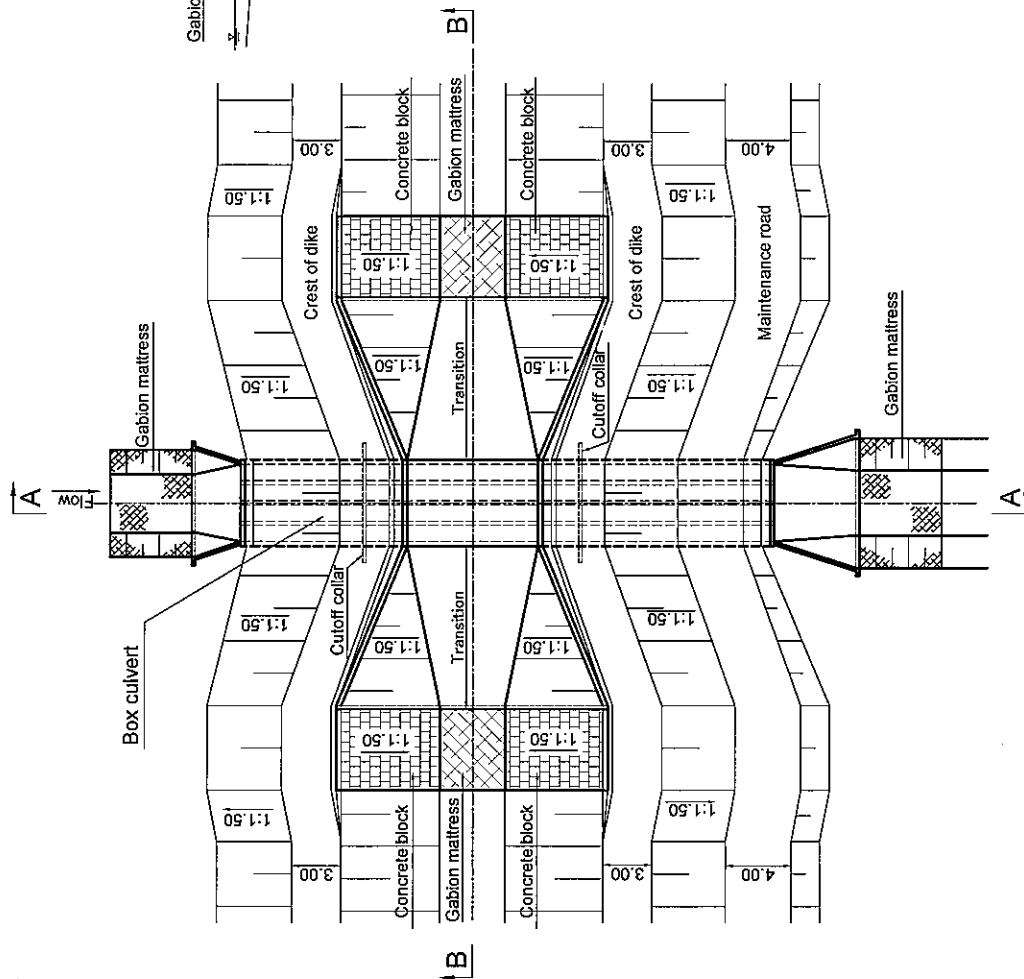
PLAN



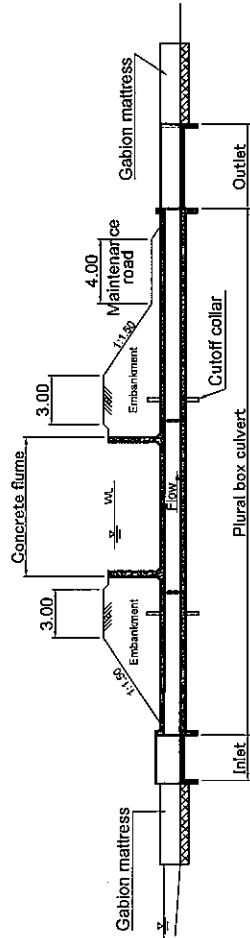
THE STUDY ON COMPREHENSIVE AGRICULTURAL DEVELOPMENT
OF PREK THNOT RIVER BASIN
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Japan International Cooperation Agency (JICA)

Drawing No.9-1
General Plan of Cross Drain (Type 1)

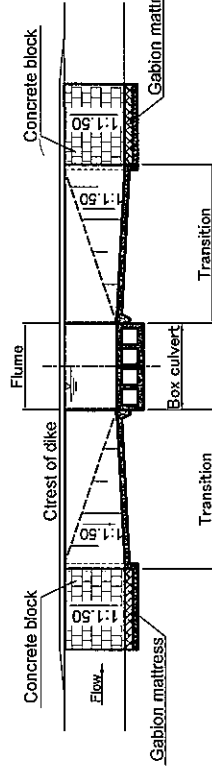
CROSS DRAIN (TYPE 2)



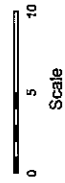
PLAN



SECTION A - A



SECTION B - B

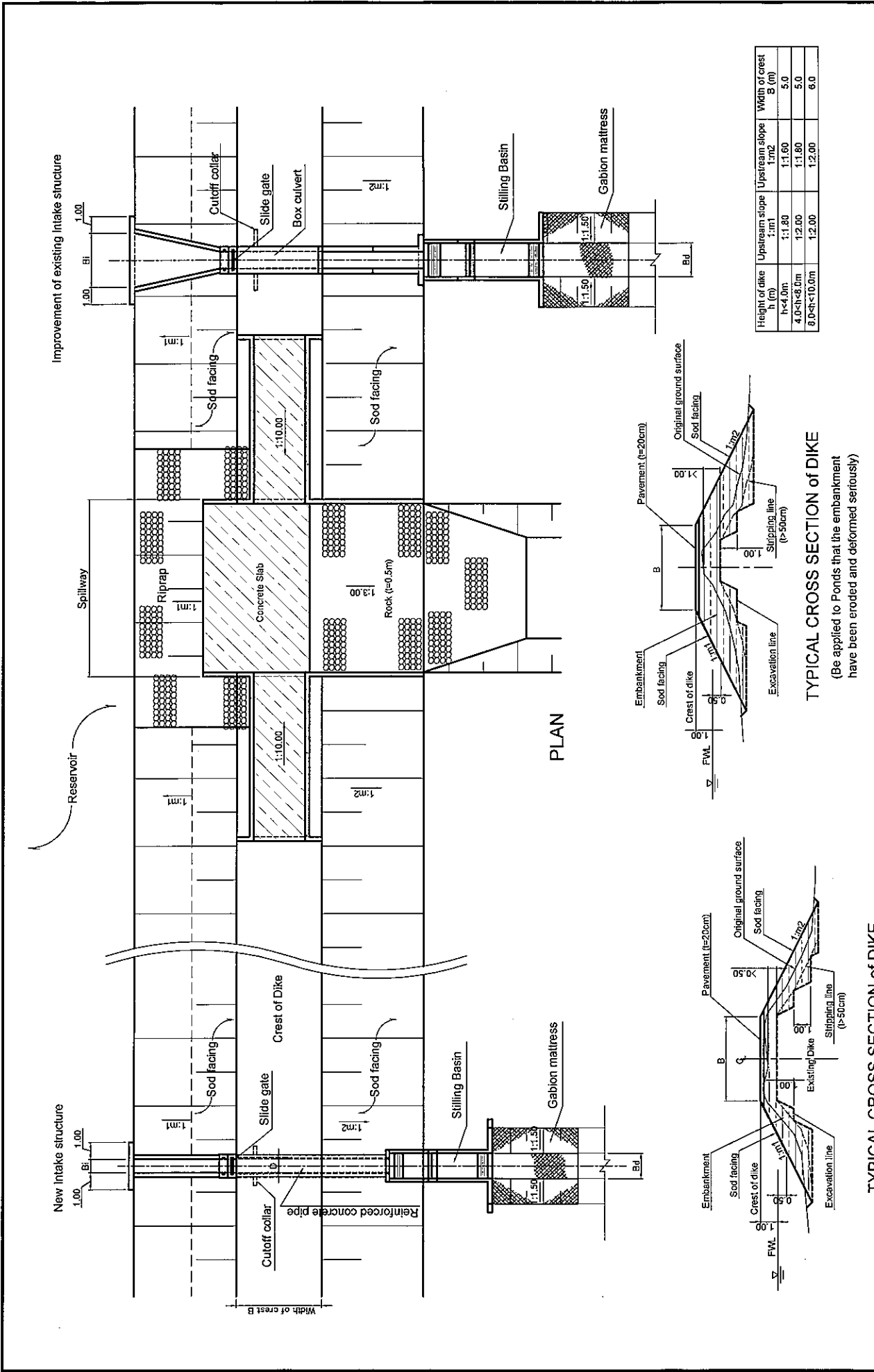


THE STUDY ON COMPREHENSIVE AGRICULTURAL DEVELOPMENT
OF PREK THNOT RIVER BASIN
IN THE KINGDOM OF CAMBODIA

Drawing No.9-2

General Plan of Cross Drain (Type 2)

Japan International Cooperation Agency (JICA)



TYPICAL CROSS SECTION of DIKE

(Be applied to Ponds that the embankment have been eroded and deformed seriously)

TYPICAL CROSS SECTION of DIKE

(Be applied to Ponds that the embankment have some erosion and deformation partly)

PLAN

Improvement of existing Intake structure

Reservoir

THE STUDY ON COMPREHENSIVE AGRICULTURAL DEVELOPMENT
OF PREK THNOT RIVER BASIN
IN THE KINGDOM OF CAMBODIA
Japan International Cooperation Agency (JICA)

Drawing No.10
General Plan of Rehabilitation of Small Pond

Appendix-I
ENVIRONMENT

**THE STUDY
ON
COMPREHENSIVE AGRICULTURAL DEVELOPMENT
OF
PREK THNOT RIVER BASIN
IN
THE KINGDOM OF CAMBODIA**

**FINAL REPORT
Volume-VI: Appendixes for Master Plan
Appendix-I
Environment**

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APPENDIX-I: ENVIRONMENT

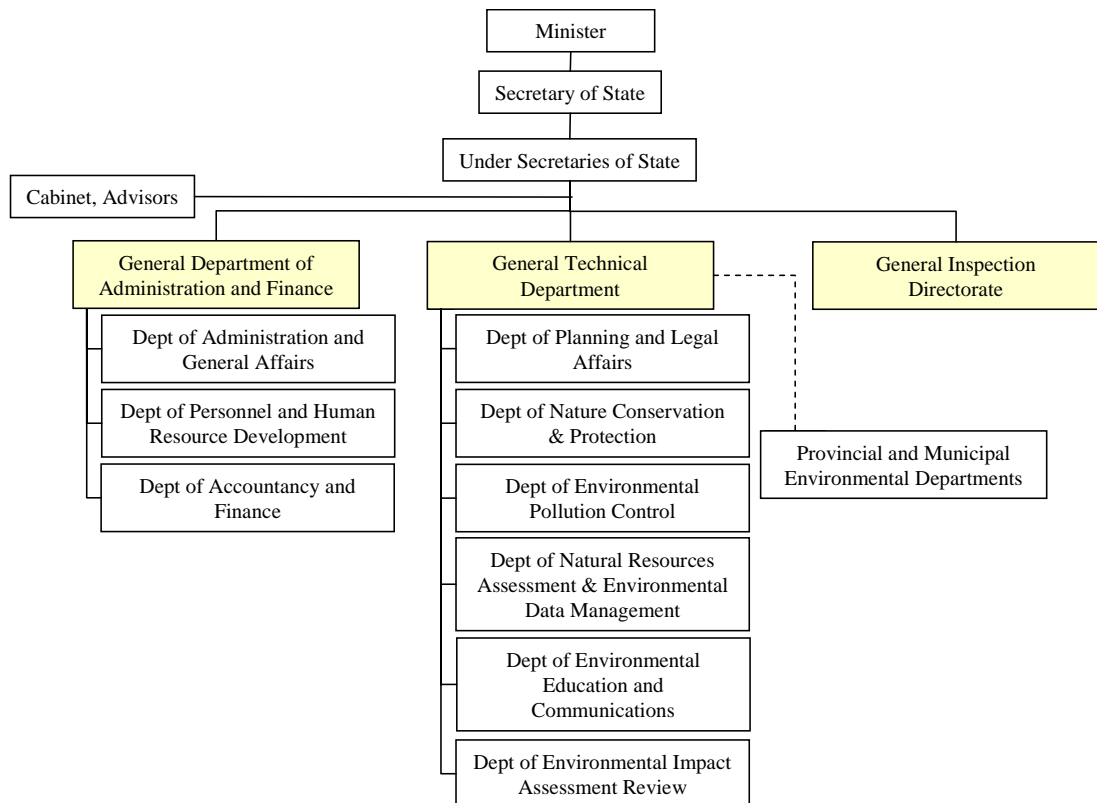
I-1 Relevant Agency of Environment

I-1.1 Ministry of Environment

(1) General

Environmental management in Cambodia is primarily overseen by the Ministry of Environment (MOE). MOE was established in 1993 and its mandate was approved under the Sub-Decree on the Organization and Functions of the Ministry of Environment in 1997. MOE is responsible for promoting environmental protection and conservation of natural resources in order to contribute environmental quality, public welfare, national culture and socio-economy.

The current structure of MOE is shown below. The organization on technical tasks consists of the six departments including Department of Environment Impact Assessment Review under its Director General. In addition, in twenty-one provinces and three municipalities, Provincial/ Municipal Environment Departments are carrying out regional environmental management under the supervision of MOE.



Organization Structure of the Ministry of Environment

Source: MOE Strategic Plan (2004-2008)

MOE developed third strategic plan for 2004-2008 in 2003 and defined nine strategic goals as follows;

- 1) Innovate institution arrangement for management natural resource at the local level.
- 2) Advance legal mechanisms for both national and local government.
- 3) Establish networking among public and private institutions on scientific, technical, legal instruments, and economic aspects of the environmental pollution, national regulation, and the implementation of international conventions.

- 4) Integrate enforcement programs in environmental protection and natural resource conservation sector.
- 5) Promote partnerships between levels of the regional, government, public and private sectors, donor's agencies and the local community.
- 6) Improve protected area zonation schemes, integrated into land use and management plans.
- 7) Manage oriented environmental pollution and monitoring programs.
- 8) Create information technology applications for local and sub-regional management situations.
- 9) Promote investment opportunities in environmental pollution management.

(2) Department of EIA

Department of Environmental Impact Assessment (EIA) is primarily responsible for EIA procedure including evaluation and review of EIA study report submitted to MOE. The responsibilities of Department of EIA also cover i) preparation of "inclusion list" of the projects for which EIA will be required, ii) preparation of the guidelines of EIA, iii) promotion of the public participation in the EIA process, and iv) monitoring of the project. According to the Department of EIA, they are planning to prepare sectoral guidelines of EIA in addition to the general guideline of EIA, which are under the line of approval.

In 2005, total 17 Initial Environmental Impact Assessment (IEIA) reports were submitted and six projects have already get approval from MOE.

I-1.2 Provincial Level

(1) General

The Sub-Decree on the Organization and Functions of the Ministry of Environment enacted in 1997 stipulates that each province or provincial municipality should establish a provincial/municipal department of environment which is responsible for coordination with MOE and implementation of the environmental management activities in their respective provinces. Following that, the 1999 Declaration on the Organization of the Provincial and Municipal Environment Department specifies provincial and municipal responsibilities in environmental management. In addition, in the case project cost is less than USD2,000,000, the responsibility of review, recommendation and approval of IEIA/EIA has been authorized Provincial Department of Environment.

(2) Provincial Department of Environment in Kampong Speu Province

Provincial Department of Environment (PDE) of Kampong Speu Province have total 37 staff. PDE's activities currently include i) management of natural resources in Kiriron Natural Park and Aural Wildlife Sanctuaries, ii) pollution control, and iii) review of EIA study. As for pollution control, PDE has monitored offensive odor from the livestock farms. PDE is also involved in environmental education about general environment and village sanitation, and school campaign of tree and flower plantation in cooperation with NGOs.(3) Provincial Department of Environment in Kandal Province

PDE of Kandal Province, at which total 30 staff is working, has one administration office and three technical offices; namely, i) pollution control, ii) natural conservation, and iii) EIA review. As same as PDE of Kampong Speu, pollution control office has monitored offensive odor from the livestock farms. Natural conservation office has promoted environmental education and has conducted a series of trainings for farmers, primary school students, and high school students.

I-1.3 MOWRAM

MOWRAM is involved in resettlement through the Resettlement Unit which has been supported by the Asian Development Bank (ADB) since it's inception in 2001 and currently they have four staff. Currently the Resettlement Unit has been engaged in the

Stung Chinit Irrigation and Rural Infrastructure Project supported by ADB and implementing resettlement together with compensation programs.

On the other hand, MOWRAM has not set up any unit or department for environmental management and/or Environmental Impact Assessment (EIA). Moreover, no staff has assigned in charge of the environment assessment. In the fact, MOWRAM has not implemented any projects which require EIA study under the Sub-decree in Cambodia yet.

According to Strategic Development Plan (2006-2010) of MOWRAM, one of the institutional development goals is to strengthen comprehensive capacity to develop and apply procedures for social and environmental impact assessment and mitigation. Under the Development Plan, they have planned to establish Social and Environmental Impact Management (S&EIM) Unit with appropriate trainings to the staff in MOWRAM and PDOWRAM.

I-1.4 MAFF

(1) General

The MAFF is involved in environmental monitoring and management through two departments and their provincial equivalents, and one office for EIA.

The former departments are the Department of Forestry and Wildlife and the Department of Fisheries. At the provincial level, these are the Forestry and Wildlife Service and the Fisheries Service of the Provincial Departments of Agriculture, Forestry and Fisheries. On the other hand, the latter one is EIA Office under the Department of Planning and Statistics.

Department of Forestry and Wildlife is responsible for managing wildlife and wildlife habitat within forested areas and for declaring and managing forestry and wildlife reserves. On the other hand, Department of Fisheries and its provincial services have legislative jurisdiction over all water bodies that are fisheries resources and covers protection of species and habitat, the management of the resources, monitoring of catch and upgrading and enhancement activities.

(2) EIA Office

EIA Office under the Department of Planning and Statistics was established in 1999 with support of ADB under the Institutional Strengthening and Expanding EIA Capacity in Cambodia Project in 1997-1999. Though there were seven staff assigned at the moment, currently, two staff, one of which is the counterpart of the Study, are working at the EIA Office. They have few experienced supervise, review or monitor EIA process so far. In addition, it is noted that there have been no relation and cooperation between EIA Office and other technical departments/ units, according to the EIA Office.

I-2 Capacity Development Activities on Environment

I-2.1 Current Capacity of staff of MOWRAM and MAFF

(1) MOWRAM

As mentioned previously, MOWRAM hasn't assigned any staff in charge of environment in MOWRAM. The counterpart of environment under the Study working at International Cooperation Office has had a few chances to examine EIA reports about irrigation projects prepared by donors.

(2) MAFF

According to the counterpart of the Study from EIA Office, EIA Office has not experienced any EIA related activities including preparation of terms of reference (TOR)

for EIA, supervision, review and monitoring of EIA study for seven years since the EIA Office was set up. They have been trained through several trainings including the 6-week training of trainers about EIA under the project of ADB (Institutional Strengthening and Expanding EIA Capacity in Cambodia Project). However they expressed insufficiency of practical experience and skill for implementation of EIA study as executing agency.

I-2.2 Capacity Development Activities in Phase I of the Study

The target of capacity development activities is environmental counterparts of the Study, i.e. one staff from EIA Office of MAFF and one staff from International Cooperation Department of MOWRAM.

In Phase I of the Study, two times of workshops about EIA and a series of meetings, field surveys of current condition were conducted by the JICA Study Team as shown in the following table. The two of counterparts participated actively in all activities.

It is noted that the relation between MOWRAM and MAFF regarding environment has been developing through the activities under the Phase I of the Study so that they would utilize their relationship in the future especially for implementation of EIA.

Capacity Development Activities on Environment in Phase I of the Study

Date	Contents	Capacity Development
Jun 23- Jun 31, 2006	Review of the current condition - Interview to MOE, Department of EIA - Interview to PDE in Kampong Speu - Interview to PDE in Kandal - Exploration of the Target Area - Interview to Resettlement Unit, MOWRAM	- Collected relevant data and information about environment and social aspects through interview of concerned organizations - Observed the Target Area to grasp the current condition of environment.
Feb 6, 2006	First Workshop - Explanation of overview of EIA by the JICA Study Team - Explanation of EIA procedure in Cambodia by the JICA Study Team - Discussion on the proposed Master Plan related to environmental management. - Discussion on next activities under the Study	- Discussed environmental items to be checked - Discussed the Master Plan related to environmental management in consideration of each organizational condition. - Discussed necessity of capacity development training
Feb 9, 2006	Second Workshop - Screening of the proposed Master Plan - Practice of initial environmental examination (IEE) toward the selected projects from the proposed Master Plan - Presentation about IEE result by each counterpart	- Implemented screening of the Master Plan - Implemented initial environmental examination toward selected projects (rehabilitation of the canal project and community inland fishery project) - Presented the result of IEE - Proposed mitigation measures toward negative impacts
Feb 14, 2006	Meeting - Practice of presentation for coming Seminar.	- Developed presentation material for coming Seminar

I-2.3 Primary Recommendation

(1) MOWRAM

Currently under the EIA sub-decree in Cambodia, MOWRAM is requested to conduct EIA study in the case of irrigation infrastructure project over 5,000 ha. In fact, one of the projects under the Master Plan, The Lower South Main Canal Irrigation Agriculture Improvement Project which covers more than 5,000 ha, requires the EIA study. As planned to build up the responsible unit of environmental and social impact management under the Strategic Development Plan (2006-2010), MOWRAM should pursue the plan for establishment of the unit. In addition to strengthening of institutional structure, in parallel, capability of environment issues toward the relevant staff should be strengthened as in the Environmental Management Basic Capacity Development Project under the Master Plan.

(2) MAFF

So far the EIA Office has not been utilized practically in MAFF. Moreover, any strategic plans related to the EIA Office and its activities cannot be found as one of the future policies of MAFF. As for individual level, staff of the EIA Office have insufficient knowledge for practical implementation of the EIA study. By measure of these current conditions of MAFF, both i) improvement of individual knowledge and ii) strengthening of institutional framework should be conducted.

As for individual level, as in the Master Plan project, the capability of preparation of terms of reference for the EIA study, supervision, monitoring of the EIA process and review of the EIA report should be strengthened. In addition to the individual level's capacity development, it would require interventions at the organizational level where appropriate processes and procedures need to be internalized by various levels of human resources. It seems essential to provide opportunities for discussion on i) implementation structure of EIA, and ii) job responsibility of the EIA Office, among management levels of staff.

I-3 Environmental Examination Application (Form) in Cambodia

Name of Project Owner :	Nationality :
Address :	
Identity card or Passport :	
Company Name :	
Phone number :	Fax number :
Is the project public, private or joint-venture?	
How much capital in your investment plan (USD)?	
Which institution who approves the project?	
Project site :	
Lot N° :	Street :
Group :	Village :
Commune/Quarter :	District/Khan :
Province/City :	
Section and type of project :	
1. Type of project :	
2. Section :	
Size of project :	
(Ex. 1. Road distance to be constructed or rehabilitated (km).	
2. Land area (ha) to be constructed or cultivated.	
3. Quantity of raw materials for productive process of the project and its productivity.	
4. Quantity of rooms and chairs for hotel and restaurant.)	
.....	
How long does the project take?	
1. For construction :	
2. For operation :	
3. For abandon or closure :	
How the transportation of raw materials and productivity in-out premises to be done?	
Estimate the quantity of the used water, liquid waste, solid waste to be discharged and CO2 to be emitted per	

day?

.....
.....

Tabulate estimation of concentration of :

1. Process of waste water discharging

- pH :
- Ammonia (NH₃) :
- Nitrate Nitrogen :
- Heavy metal :
- Phenol (C₆H₅OH) :
- Oil and Grease :
- Turbidity :
- Conductivity :
- Total of suspended solid :
- Total of sediment :

2. Radiation of carbon dioxide's particles into ambience

- Carbon mono-oxide :
- Nitrogen dioxide :
- Sulfur oxide :
- Ozone :
- Lead :

Where the solid waste, liquid waste, carbon dioxide can be disposed, discharged and emitted?

.....
.....

Which source causing high vibration and noise by the project?

.....
.....

New proposed or existing project?

.....
.....

If it's relevant to land, estimate the land area to be covered by the project (including land filling, clearing and new land encroachment).

.....
.....

How many labor powers need be used for the phase of project construction and operation?

1. For construction

- Local :
- Oversea :

2. For operation

- Local :
- Oversea :

Describe about status of staffs, workers staying in your project site :

- Water supply :
- Health and safety :
- Sanitation :
- Solid waste management :

Confirmation: On behalf of I'm representative of a project owner, I would like to ensure that all information in my application mentioned above are the real one.

Signature : Date :

Name of signatory :

Role and function of signatory :

I-4 Results of Initial Environmental Examinations

This section shows a series of results of initial environmental examinations (IEEs) for each of 9 projects under the Master Plan. The projects of the Master Plan for IEE are shown below.

S.N.	Master Plan
A.1(1)	Irrigated Agriculture Improvement Model Project
A.1(2)	Upper North Main Canal Irrigated Agriculture Improvement Project
A.1(3)	Upper South Main Canal Irrigated Agriculture Improvement Project
A.2(1)	Lower North Main Canal Irrigated Agriculture Improvement Project
A.2(2)	Lower South Main Canal Irrigated Agriculture Improvement Project
A.2(3)	Ou Krang Ambel Irrigated Agriculture Improvement Project
A.3(1)	Water Harvesting Irrigated Agriculture Improvement Project
B.1(2)	Roleang Chrey Regulator and Intakes Improvement Project
B.3(1)	Community Inland Fisheries Development Project

The result of IEE includes i) project description, ii) impact matrix, iii) figure of potential negative impacts and its causes, iv) table of potential impacts and possible mitigation measures, and v) conclusion.

	Item	Contents
i)	Project description	The brief information of the project is described in this attachment, while detail information is shown in Chapter 9 (Project Digest)
ii)	Impact matrix;	Potential impacts towards a) social environment, b) natural environment and c) pollution were studied in each separated phase, i.e. A) designing phase, B) construction phase, and C) operation phase. The mark in the table means categories of impact. Left-hand side of each cell represents a direction of impact and right-hand side represents a magnitude of impact as follows. Left side; ++: Positive impact --: Negative Impact =: Neutral Impact Right side; A: relatively significant impact, B: relatively medium-size impact, C: relative small impact, D: :unknown as of now, *: No impact or no corresponding impact
iii)	Figure of potential negative impacts and its causes	The figure shows the summarized relation and mechanism of cause and impact conceivably based on existing data and information and planning of the project.
iv)	Table of potential impacts and possible mitigation measures	The table shows that potential negative impact and possible mitigation measures in order to avoid and/or mitigate the negative environmental impact by appropriate and reasonable way as much as possible.
v)	Conclusion	Conclusion of the result of IEE

A.1(1): Irrigated Agriculture Improvement Model Project

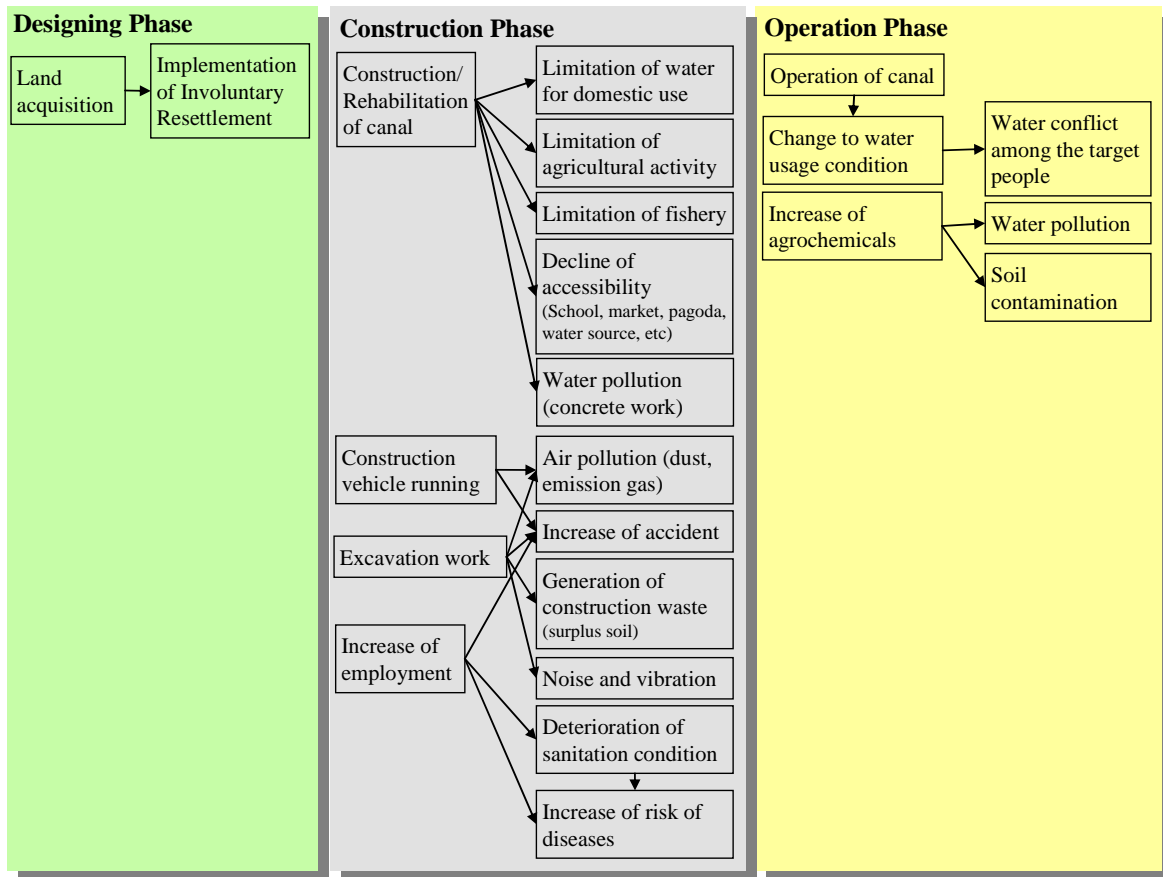
i) Project Description

Components;	Rehabilitation of the canals (total 13.1 km), rehabilitation of the ponds (total 4), new construction of the canals (total 6.1 km), agricultural support services program, formation and strengthening of FWUCs/FWUGs (The Irrigated Agriculture On-farm Technology Improvement Pilot Project is implemented simultaneously, that includes support program for on-farm level water management toward FWUCs/FWUGs)
Location/Area;	Chbar Mon District, Samraong Tong District (Zone 1, Kampong Speu Province); 570 ha
Characteristics; (to be noted)	<p>Social: Canal water is utilized as domestic water for surrounding people. In Zone 1, water source is mainly ponds (70%) in dry season and rain water (60%) in rainy season. Not all areas have set up FWUCs/ FWUGs so far.</p> <p>Natural: Local people are catching fish from the South canal and ponds mainly for domestic consumption.</p> <p>Pollution: No specific pollution</p>
Duration;	2 Years
Executing Agency;	MOWRAM, MAFF

ii) Impact Matrix

Potential Impact \ Activity		Designing	Construction	Operation	Comments
Social Environment					
1	Involuntary Resettlement	--/D	*	*	Depends on detailed design of the canals
2	Local economy (employment, etc)	*	=/C	++/C	
3	Land use and utilization of local resources	--/C	*	*	Land acquisition
4	Social institutions	*	*	++/C	Formation and strengthening of FWUGs
5	Existing social infrastructures and services	*	*	++/C	Improvement of the canals and ponds
6	The poor, indigenous and ethnic people	*	*	*	
7	Misdistribution of benefit and damage	*	*	*	
8	Cultural heritage	*	*	*	
9	Local conflict of interests	*	*	--/C	
10	Water Usage	*	--/B	++/B	
11	Sanitation	*	--/C	*	
12	Hazards (Risk), Infectious diseases	*	--/C	*	
Natural Environment					
13	Topography and Geographical features	*	*	*	
14	Soil Erosion	*	*	*	
15	Groundwater	*	*	*	
16	Hydrological Situation	*	*	*	
17	Flora, Fauna and Biodiversity	*	--/C	=/C	
18	Meteorology	*	*	*	
19	Landscape	*	*	*	
20	Global Warming	*	*	*	
Pollution					
21	Air Pollution	*	--/C	*	
22	Water Pollution	*	--/C	--/C	
23	Soil Contamination	*	*	--/C	
24	Waste	*	--/C	*	
25	Noise and Vibration	*	--/C	*	
26	Ground Subsidence	*	*	*	
27	Offensive Odor	*	*	*	
28	Bottom sediment	*	*	*	
29	Accidents	*	--/C	*	

iii) **Potential Negative Impacts and its Causes**



iv) **Potential impacts and possible mitigation measures**

Potential Impacts	Phase	Rating	Impact cause/ severity	Assumed mitigation measures/ Monitoring method	Action time for Avoid./ mitigation
Involuntary resettlement	Designing	D	Expansion of the canal width and length will lead land acquisition and/or involuntary resettlement.	- Careful attention for designing of the canals in order to mitigate land acquisition and/or involuntary resettlement as much as possible through investigation. - A series of meeting to discuss and obtain consensus with the affected people - Compensation and supportive program for the affected people	Designing (Mitigation)
Limitation of water for domestic use	Construction	B	Draining of water from the canals at construction phase will cause limitation of water usage from the canals for domestic use.	- Stakeholder meetings at designing phase in order to discuss and obtain consensus of construction schedule and methods. - Regular public meetings.	Designing, Construction (mitigation)
Limitation of agricultural activity	Construction	C	Draining of water from the canal at construction phase will cause limitation of water usage from canal for agricultural activity	- Stakeholder meetings at designing phase in order to discuss and obtain consensus of construction schedule and methods. - Construction at dry season (avoidance of rainy season because of paddy season) - Regular public meetings.	Designing, Construction (mitigation)

Potential Impacts	Phase	Rating	Impact cause/ severity	Assumed mitigation measures/ Monitoring method	Action time for Avoid./ mitigation
Limitation of fishery	Construction	C	Draining of water from the canal at construction phase will cause limitation of fishery activity	- Stakeholder meetings at designing phase in order to discuss and obtain consensus of construction schedule and methods. - Decide construction schedule in consideration of egg production of the species and fishery timing (avoidance of rainy season) - Regular public meetings.	Designing, Construction (mitigation)
Decline of accessibility (School, market, pagoda, water source, etc)	Construction,	C	Construction of the canals will decrease accessibility to school, market, pagodas and water source.	- Installment of temporary bridge based on people's request.	Designing, (mitigation)
Water pollution	Construction,	C	Low pH-water problem triggered by the concrete works at construction phase are expected to affect negatively on the aquatic-biodiversity. However minimal impacts are predicted because of construction scale.	- Installation of adequate treatment system	Construction (mitigation)
Air pollution	Construction	C	Because the most roads are unpaved, the dust are expected to be spread especially in dry season. In addition, the construction vehicle will exhaust emission gas.	- Regular sprinkling for unpaved road - Minimization of idling for construction vehicles	Construction (mitigation)
Increase of accident	Construction	C	Accidents caused by construction machinery and vehicles are expected during the construction phase.	- Appropriate maintenance of machinery and vehicles - Imposition of disciplines for safety operation. - Periodical check	Construction (mitigation)
Generation of construction waste (surplus soil)	Construction	C	Disposed soil will be generated by excavation during the construction phase.	- Effective utilization of surplus soil in and around the project area. - Establishment of soil disposal site far from residence area or river.	Construction (mitigation)
Noise and vibration	Construction	C	Noise and vibration caused by movement of heavy equipment are expected. However minimal impacts are predicted because of construction scale.	- Limitation of construction time. (e.g. at daytime only) - Public meetings to obtain consensus about the construction time with surrounding people.	Construction (mitigation)
Deterioration of sanitation condition, increase of risk of diseases	Construction	C	The negative impacts on the sanitary condition of surrounding villages caused due to the inflow of workers are expected. In addition, the spread of infection due to the inflow of workers is expected.	- Improvement of sanitary condition of workers (accommodation, installation of toilet, water supply, etc). - Implementation of educational program for workers. - Periodical patrol	Construction (mitigation)

Potential Impacts	Phase	Rating	Impact cause/ severity	Assumed mitigation measures/ Monitoring method	Action time for Avoid./ mitigation
Local conflict	Operation	C	Improper management of the water usage from the canals will lead local conflict among the FWUCs/FWUGs members.	- Support program for improvement of management capability of FWUCs/FWUGs. - Regular meeting among the FWUCs/FWUGs members. - Regular monitoring of FWUCs/FWUGs activities by MOWRAM.	Designing, Operation (mitigation)
Water Pollution and soil contamination caused by agrochemicals	Operation	C	The farmer may intend to increase the dosage of farm inputs to increase the farm production following the stabilization of the irrigation water. This might result in nutrient load or chemical contamination in drainage water, and affect the downstream aquatic-diversity. It is noted that the water management is not operated in connection with the farm input application at present. It has also the possibility to cause the contamination of fertilizer into the drainage water even under proper application of farm input.	- Support program for agricultural extension toward the target people at the same time. - Regular monitoring of agricultural activity by MAFF. - Follow up program toward the target people.	Operation (mitigation)

v) Conclusion

- Land acquisition and involuntary resettlement should be conducted very carefully from the designing phase, because of great sensitive issue. Gradual discussion with local people especially with the affected people, and proper compensation should be proposed and implemented in cooperation with Inter-ministerial Resettlement Committee (IRC).
- Because this model project component is mainly rehabilitation of the existing canals with small-scale new installment, significant negative impacts are not expected with proper management at construction phase. In addition, mitigation measure proposed will minimize negative impact much further.
- One of considerable issue is limitation of water availability at construction phase. It is important to conduct a series of public meetings periodically to announce and discuss construction schedule in consideration with people's activities including fishery and agricultural activities so as to get people's consensus and cooperation toward the project.
- It is important to train FWUCs/FWUGs members for proper management of water and proper usage of agrochemical. This can avoid water conflict among the people and mitigate negative impact toward water and land quality caused by increase of agrochemical.

A.1(2): Upper North Main Canal Irrigated Agriculture Improvement Project

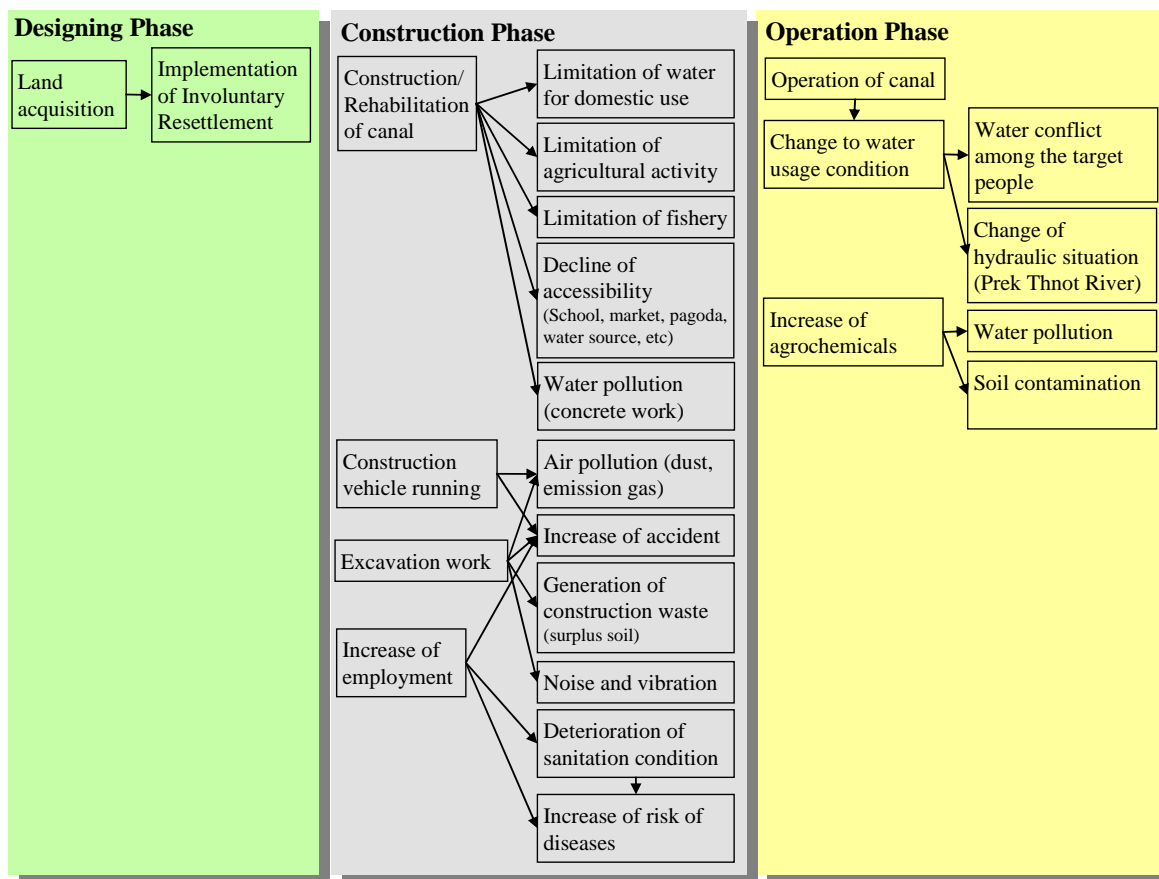
i) Project Description

Components;	Rehabilitation of main canals (total 32 km), secondary canal (4.9 km) new construction of secondary canals (5.2 km) and tertiary systems, rehabilitation of ponds (total 11), agricultural support services program, formation and strengthening of FWUCs/FWUGs
Location/Area;	Chbar Mon District, Samraong Tong District (Zone 1, Kampong Speu Province); 2,210 ha
Characteristics; (to be noted)	<p>Social: Canal water is utilized as domestic water for surrounding people. In Zone 1, water source is mainly ponds (70%) in dry season and rain water (60%) in rainy season. Not all areas have set up FWUCs/ FWUGs so far.</p> <p>Natural: Local people are catching fish from the North canal mainly for domestic consumption.</p> <p>Pollution: No specific pollution</p>
Duration;	6 Years
Executing Agency;	MOWRAM, MAFF

ii) Impact Matrix

Potential Impact		Activity	Designing	Construction	Operation	Comments
Social Environment						
1	Involuntary Resettlement	--/D	*	*		Depends on detailed design of the canals
2	Local economy (employment, etc)	*	=/B	++/B		
3	Land use and utilization of local resources	--/C	*	*		Land acquisition
4	Social institutions	*	*	++/B		Formation and strengthening of FWUCs
5	Existing social infrastructures and services	*	*	++/A		Improvement of the canals and ponds
6	The poor, indigenous and ethnic people	*	*	*		
7	Misdistribution of benefit and damage	*	*	*		
8	Cultural heritage	*	*	*		
9	Local conflict of interests	*	*	--/C		
10	Water Usage	*	--/A	++/A		
11	Sanitation	*	--/C	*		
12	Hazards (Risk), Infectious diseases	*	--/C	*		
Natural Environment						
13	Topography and Geographical features	*	*	*		
14	Soil Erosion	*	*	*		
15	Groundwater	*	*	*		
16	Hydrological Situation	*	*	=/C		Change of hydraulic situation on Prek Thnot river
17	Flora, Fauna and Biodiversity	*	--/C	=/C		Fish under the construction
18	Meteorology	*	*	*		
19	Landscape	*	*	*		
20	Global Warming	*	*	*		
Pollution						
21	Air Pollution	*	--/C	*		
22	Water Pollution	*	--/B	--/C		
23	Soil Contamination	*	*	--/C		
24	Waste	*	--/C	*		
25	Noise and Vibration	*	--/C	*		
26	Ground Subsidence	*	*	*		
27	Offensive Odor	*	*	*		
28	Bottom sediment	*	*	*		
29	Accidents	*	--/C	*		

iii) Potential Negative Impacts and its Causes



iv) Potential impacts and possible mitigation measures

Potential Impacts	Phase	Rating	Impact cause/ severity	Assumed mitigation measures/ Monitoring method	Action time for Avoid./ mitigation
Involuntary resettlement	Readjustment	D	Expansion of the canal width and length will lead land acquisition and/or involuntary resettlement.	<ul style="list-style-type: none"> - Careful attention for designing of the canals in order to mitigate land acquisition and/or involuntary resettlement as much as possible through investigation. - A series of meeting to discuss and obtain consensus with the affected people - Compensation and supportive program for the affected people 	Designing (Mitigation)
Limitation of water usage for domestic	Construction	B	Draining of water from the canals at construction phase will cause limitation of water usage from the canals for agricultural activity	<ul style="list-style-type: none"> - Stakeholder meetings at designing phase in order to discuss and obtain consensus of construction schedule and methods. - Construction at dry season (avoidance of rainy season because of paddy season) - Regular public meetings. 	Designing, Construction (mitigation)
Limitation of agricultural activity	Construction	B	Draining of water from the canals at construction phase will cause limitation of fishery activity	<ul style="list-style-type: none"> - Stakeholder meetings at designing phase in order to discuss and obtain consensus of construction schedule and methods. - Decide construction schedule in consideration of egg production of the species and fishery timing (avoidance of rainy season) - Regular public meetings. 	Designing, Construction (mitigation)

Potential Impacts	Phase	Rating	Impact cause/ severity	Assumed mitigation measures/ Monitoring method	Action time for Avoid./ mitigation
Limitation of fishery	Const- ruction	B	Draining of water from the canals at construction phase will cause limitation of water usage from the canals for agricultural activity	- Stakeholder meetings at designing phase in order to discuss and obtain consensus of construction schedule and methods. - Construction at dry season (avoidance of rainy season because of paddy season) - Regular public meetings.	Designing, Construction (mitigation)
Decline of accessibility (School, market, pagoda, water source, etc)	Const- ruction,	C	Construction of the canals will decrease accessibility to school, market, pagodas and water source.	- Installment of temporary bridge based on people's request.	Designing, (mitigation)
Water pollution	Const- ruction,	C	Low pH-water problem triggered by the concrete works at construction phase are expected to affect negatively on the aquatic-biodiversity.	- Installation of adequate treatment system	Construction (mitigation)
Air pollution	Const- ruction	C	Because the most roads are unpaved, the dust are expected to be spread especially in dry season. In addition, the construction vehicle will exhaust emission gas.	- Regular sprinkling for unpaved road - Minimization of idling for construction vehicles	Construction (mitigation)
Increase of accident	Const- ruction	C	Accidents caused by construction machinery and vehicles are expected during the construction phase.	- Appropriate maintenance of machinery and vehicles - Imposition of disciplines for safety operation. - Periodical check	Construction (mitigation)
Noise and vibration	Const- ruction	B	Noise and vibration caused by movement of heavy equipment are expected.	- Limitation of construction time. (e.g. at daytime only) - Public meetings to obtain consensus about the construction time with surrounding people.	Construction (mitigation)
Generation of construction waste (surplus soil)	Const- ruction	C	Disposed soil will be generated by excavation during the construction phase.	- Effective utilization of surplus soil in and around the project area. - Establishment of soil disposal site far from residence area or river.	Construction (mitigation)
Deterioration of sanitation condition, increase of risk of diseases	Const- ruction	C	The negative impacts on the sanitary condition of surrounding villages caused due to the inflow of workers are expected. In addition, the spread of infection due to the inflow of workers is expected.	- Improvement of sanitary condition of workers (accommodation, installation of toilet, water supply, etc). - Implementation of educational program for workers. - Periodical patrol	Construction (mitigation)
Local conflict	Opera- tion	C	Improper management of the water usage from the canals will lead local conflict among the FWUCs/FWUGs members.	- Support program for improvement of management capability of FWUCs/FWUGs. - Regular meeting among the FWUCs/FWUGs members. - Regular monitoring of FWUCs/FWUGs activities by MOWRAM.	Designing, Operation (mitigation)
Change of hydraulic situation	Opera- tion	C	Change of hydrological situation caused by rehabilitation of gate function is expected.	- Periodical patrol of water flow of Prek Thnot River at several stations including at downstream (it is noted that water flow toward north canal will not increase compared with before construction because of effective water use condition.)	Operation (mitigation)

Potential Impacts	Phase	Rating	Impact cause/ severity	Assumed mitigation measures/ Monitoring method	Action time for Avoid./ mitigation
Water Pollution and soil contamination caused by agrochemicals	Operation	C	The farmer may intend to increase the dosage of farm inputs to increase the farm production following the stabilization of the irrigation water. This might result in nutrient load or chemical contamination in drainage water, and affect the downstream aquatic diversity. It is noted that the water management is not operated in connection with the farm input application at present. It has also the possibility to cause the contamination of fertilizer into the drainage water even under proper application of farm input.	- Support program for agricultural extension toward the target people at the same time. - Regular monitoring of agricultural activity by MAFF. - Follow up program toward the target people.	Operation (mitigation)

v) Conclusion

- Land acquisition and involuntary resettlement should be conducted very carefully from the designing phase, because of great sensitive issue. Gradual discussion with local people especially with the affected people, and proper compensation should be proposed and implemented in cooperation with Inter-ministerial Resettlement Committee (IRC).
- Because the project component is mainly rehabilitation of the existing canals with new installment of secondary and tertiary level canal, significant negative impacts are not expected with proper management at construction phase. In addition, mitigation measure proposed will minimize negative impact much further.
- One of considerable issue is limitation of water availability at construction phase. It is important to conduct a series of public meetings periodically to announce and discuss construction schedule in consideration with people's activities including fishery and agricultural activities so as to get people's consensus and cooperation toward the project.
- Because the people in this project area are not familiar to take in workers from other areas, great attention toward management of workers and construction field are significant. In addition, sanitation for workers should be taken care and installment of accommodation, toilet and water supply should be maintained.
- It is important to train FWUCs/FWUGs members for proper management of water and proper usage of agrochemical. This can avoid water conflict among the people and mitigate negative impact toward water and land quality caused by increase of agrochemical.

A.1(3): Upper South Main Canal Irrigated Agriculture Improvement Project

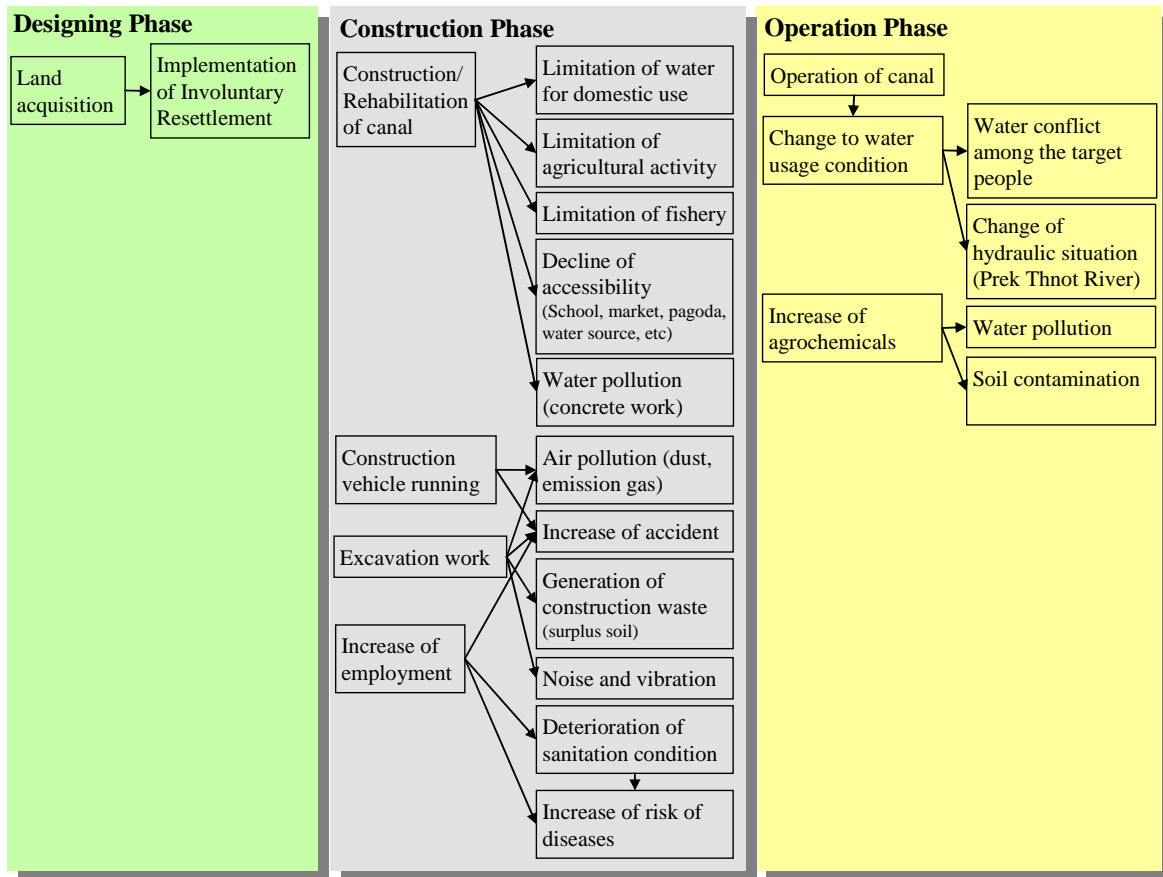
i) Project Description

Components;	Rehabilitation of main canals (total 18 km), secondary canal (9.5 km), new construction of secondary canals (21.3 km) and tertiary systems, rehabilitation of ponds (total 4), agricultural support services program, formation and strengthening of FWUCs/FWUGs
Location/Area;	Chbar Mon District, Samraong Tong District (Zone 1, Kampong Speu Province); 2,880 ha
Characteristics; (to be noted)	Social: Canal water is utilized as domestic water for surrounding people. In Zone 1, water source is mainly ponds (70%) in dry season and rain water (60%) in rainy season. Not all areas have set up FWUCs/ FWUGs so far. Natural: Local people are catching fish from the South canal mainly for domestic consumption. Pollution: No specific pollution
Duration;	6 Years
Executing Agency;	MOWRAM and PDRAM of Kampong Speu

ii) Impact Matrix

Potential Impact		Activity	Designing	Constru ction	Opera tion	Comments
Social Environment						
1	Involuntary Resettlement		--/D	*	*	Depends on detailed design of the canals
2	Local economy (employment, etc)		*	=/B	++/B	
3	Land use and utilization of local resources		--/B	*	*	Land acquisition
4	Social institutions		*	*	++/B	Formation and strengthening of FWUCs
5	Existing social infrastructures and services		*	*	++/A	Improvement of the canals and ponds
6	The poor, indigenous and ethnic people		*	*	*	
7	Misdistribution of benefit and damage		*	*	*	
8	Cultural heritage		*	*	*	
9	Local conflict of interests		*	*	--/C	
10	Water Usage		*	--/A	++/A	
11	Sanitation		*	--/C	*	
12	Hazards (Risk), Infectious diseases		*	--/C	*	
Natural Environment						
13	Topography and Geographical features		*	*	*	
14	Soil Erosion		*	*	*	
15	Groundwater		*	*	*	
16	Hydrological Situation		*	*	=/C	Change of hydraulic situation on Prek Thnot river
17	Flora, Fauna and Biodiversity		*	--/C	=/C	Fish under the construction
18	Meteorology		*	*	*	
19	Landscape		*	*	*	
20	Global Warming		*	*	*	
Pollution						
21	Air Pollution		*	--/C	*	
22	Water Pollution		*	--/B	--/C	
23	Soil Contamination		*	*	--/C	
24	Waste		*	--/C	*	
25	Noise and Vibration		*	--/C	*	
26	Ground Subsidence		*	*	*	
27	Offensive Odor		*	*	*	
28	Bottom sediment		*	*	*	
29	Accidents		*	--/C	*	

iii) Potential Negative Impacts and its Causes



iv) Potential impacts and possible mitigation measures

Potential Impacts	Phase	Rating	Impact cause/ severity	Assumed mitigation measures/ Monitoring method	Action time for Avoid./ mitigation
Involuntary resettlement	Readjustment	D	Expansion of the canal width and length will lead land acquisition and/or involuntary resettlement.	- Careful attention for designing of the canals in order to mitigate land acquisition and/or involuntary resettlement as much as possible through investigation. - A series of meeting to discuss and obtain consensus with the affected people - Compensation and supportive program for the affected people	Designing (Mitigation)
Limitation of water usage for domestic	Construction	B	Draining of water from the canals at construction phase will cause limitation of water usage from the canals for agricultural activity	- Stakeholder meetings at designing phase in order to discuss and obtain consensus of construction schedule and methods. - Construction at dry season (avoidance of rainy season because of paddy season) - Regular public meetings.	Designing, Construction (mitigation)
Limitation of agricultural activity	Construction	B	Draining of water from the canals at construction phase will cause limitation of fishery activity	- Stakeholder meetings at designing phase in order to discuss and obtain consensus of construction schedule and methods. - Decide construction schedule in consideration of egg production of the species and fishery timing (avoidance of rainy season) - Regular public meetings.	Designing, Construction (mitigation)

Potential Impacts	Phase	Rating	Impact cause/ severity	Assumed mitigation measures/ Monitoring method	Action time for Avoid./ mitigation
Limitation of fishery	Construction	B	Draining of water from the canals at construction phase will cause limitation of water usage from canals for agricultural activity	- Stakeholder meetings at designing phase in order to discuss and obtain consensus of construction schedule and methods. - Construction at dry season (avoidance of rainy season because of paddy season) - Regular public meetings.	Designing, Construction (mitigation)
Decline of accessibility (School, market, pagoda, water source, etc)	Construction,	C	Construction of the canals will decrease accessibility to school, market, pagodas and water source.	- Installment of temporary bridge based on people's request.	Designing, (mitigation)
Water pollution	Construction,	C	Low pH-water problem triggered by the concrete works at construction phase are expected to affect negatively on the aquatic-biodiversity.	- Installation of adequate treatment system	Construction (mitigation)
Air pollution	Construction	C	Because the most roads are unpaved, the dust are expected to be spread especially in dry season. In addition, the construction vehicle will exhaust emission gas.	- Regular sprinkling for unpaved road - Minimization of idling for construction vehicles	Construction (mitigation)
Increase of accident	Construction	C	Accidents caused by construction machinery and vehicles are expected during the construction phase.	- Appropriate maintenance of machinery and vehicles - Imposition of disciplines for safety operation. - Periodical check	Construction (mitigation)
Noise and vibration	Construction	B	Noise and vibration caused by movement of heavy equipment are expected.	- Limitation of construction time. (e.g. at daytime only) - Public meetings to obtain consensus about the construction time with surrounding people.	Construction (mitigation)
Generation of construction waste (surplus soil)	Construction	C	Disposed soil will be generated by excavation during the construction phase.	- Effective utilization of surplus soil in and around the project area. - Establishment of soil disposal site far from residence area or river.	Construction (mitigation)
Deterioration of sanitation condition, increase of risk of diseases	Construction	C	The negative impacts on the sanitary condition of surrounding villages caused due to the inflow of workers are expected. In addition, the spread of infection due to the inflow of workers is expected.	- Improvement of sanitary condition of workers (accommodation, installation of toilet, water supply, etc). - Implementation of educational program for workers. - Periodical patrol	Construction (mitigation)
Local conflict	Operation	C	Improper management of the water usage from the canals will lead local conflict among the FWUCs/FWUGs members.	- Support program for improvement of management capability of FWUCs/FWUGs. - Regular meeting among the FWUCs/FWUGs members. - Regular monitoring of FWUCs/FWUGs activities by MOWRAM.	Designing, Operation (mitigation)
Change of hydraulic situation	Operation	C	Change of hydrological situation caused by rehabilitation of gate function is expected.	- Periodical patrol of water flow of Prek Thnot River at several stations including at downstream (it is noted that water flow toward north canal will not increase compared with before construction because of effective water use condition.)	Operation (mitigation)

Potential Impacts	Phase	Rating	Impact cause/ severity	Assumed mitigation measures/ Monitoring method	Action time for Avoid./ mitigation
Water Pollution and soil contamination caused by agrochemicals	Operation	C	The farmer may intend to increase the dosage of farm inputs to increase the farm production following the stabilization of the irrigation water. This might result in nutrient load or chemical contamination in drainage water, and affect the downstream aquatic diversity. It is noted that the water management is not operated in connection with the farm input application at present. It has also the possibility to cause the contamination of fertilizer into the drainage water even under proper application of farm input.	- Support program for agricultural extension toward the target people at the same time. - Regular monitoring of agricultural activity by MAFF. - Follow up program toward the target people.	Operation (mitigation)

v) Conclusion

- Land acquisition and involuntary resettlement should be conducted very carefully from the designing phase, because of great sensitive issue. Gradual discussion with local people especially with the affected people, and proper compensation should be proposed and implemented in cooperation with Inter-ministerial Resettlement Committee (IRC).
- Because the project component is mainly rehabilitation of the existing canals with new installment of secondary and tertiary level canal, significant negative impacts are not expected with proper management at construction phase. In addition, mitigation measure proposed will minimize negative impact much further.
- One of considerable issue is limitation of water availability at construction phase. It is important to conduct a series of public meetings periodically to announce and discuss construction schedule in consideration with people's activities including fishery and agricultural activities so as to get people's consensus and cooperation toward the project.
- Because the people in this project area are not familiar to take in workers from other areas, great attention toward management of workers and construction field are significant. In addition, sanitation for workers should be taken care and installment of accommodation, toilet and water supply should be maintained.
- It is important to train FWUCs/FWUGs members for proper management of water and proper usage of agrochemical. This can avoid water conflict among the people and mitigate negative impact toward water and land quality caused by increase of agrochemical.

A.2(1): Lower North Main Canal Irrigated Agriculture Improvement Project

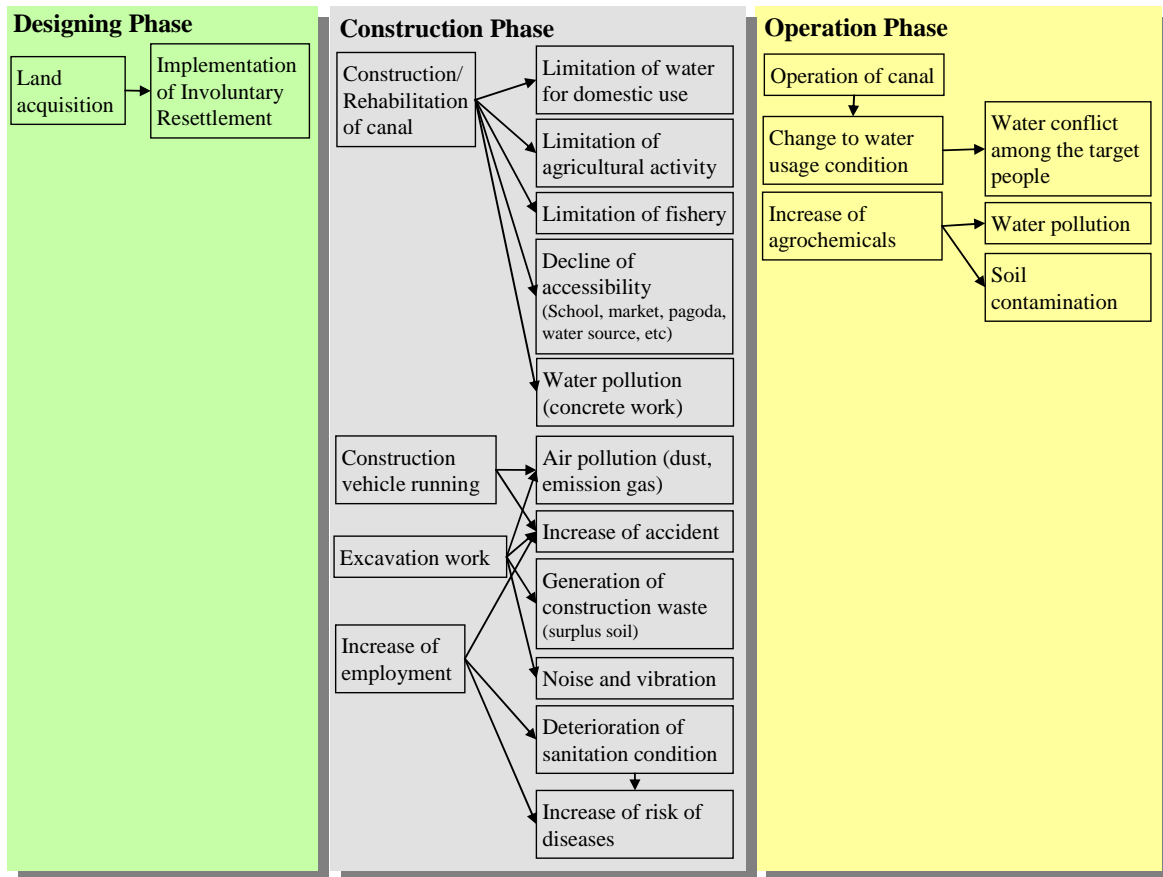
i) Project Description

Components;	Rehabilitation of secondary canals (total 8.6 km), new construction of secondary canals (10.9 km) and tertiary systems, agricultural support services program, formation and strengthening of FWUCs/FWUGs
Location/Area;	Angk Snuol District, (Zone 2, Kandal Province); 1,390 ha
Characteristics; (to be noted)	<p>Social: In Zone 2, water from well is main water source which covers approximately 90% in dry season and 50% in rainy season. 40% utilize rain water in rainy season. Not all areas have set up FWUCs/ FWUGs so far.</p> <p>Natural: Local people are catching fish from the North canal and ponds mainly for domestic consumption.</p> <p>Pollution: No specific pollution</p>
Duration;	4 Years (After the Upper North Main Canal Irrigated Agriculture Improvement Project)
Executing Agency;	MOWRAM

ii) Impact Matrix

Potential Impact		Activity	Designing	Construction	Operation	Comments
Social Environment						
1	Involuntary Resettlement		--/D	*	*	Depends on detailed design of the canals
2	Local economy (employment, etc)		*	=/C	++/C	
3	Land use and utilization of local resources		--/C	*	*	Land acquisition
4	Social institutions		*	*	++/C	Formation and strengthening of FWUGs
5	Existing social infrastructures and services		*	*	++/C	Improvement of the canals and ponds
6	The poor, indigenous and ethnic people		*	*	*	
7	Misdistribution of benefit and damage		*	*	*	
8	Cultural heritage		*	*	*	
9	Local conflict of interests		*	*	--/C	
10	Water Usage		*	--/B	++/B	
11	Sanitation		*	--/C	*	
12	Hazards (Risk), Infectious diseases		*	--/C	*	
Natural Environment						
13	Topography and Geographical features		*	*	*	
14	Soil Erosion		*	*	*	
15	Groundwater		*	*	*	
16	Hydrological Situation		*	*	*	
17	Flora, Fauna and Biodiversity		*	--/C	=/C	
18	Meteorology		*	*	*	
19	Landscape		*	*	*	
20	Global Warming		*	*	*	
Pollution						
21	Air Pollution		*	--/C	*	
22	Water Pollution		*	--/C	--/C	
23	Soil Contamination		*	*	--/C	
24	Waste		*	--/C	*	
25	Noise and Vibration		*	--/C	*	
26	Ground Subsidence		*	*	*	
27	Offensive Odor		*	*	*	
28	Bottom sediment		*	*	*	
29	Accidents		*	--/C	*	

iii) **Potential Negative Impacts and its Causes**



iv) **Potential impacts and possible mitigation measures**

Potential Impacts	Phase	Rating	Impact cause/ severity	Assumed mitigation measures/ Monitoring method	Action time for Avoid./ mitigation
Involuntary resettlement	Designing	D	Expansion of the canal width and length will lead land acquisition and/or involuntary resettlement.	- Careful attention for designing of the canals in order to mitigate land acquisition and/or involuntary resettlement as much as possible through investigation. - A series of meeting to discuss and obtain consensus with the affected people - Compensation and supportive program for the affected people	Designing (Mitigation)
Limitation of water for domestic use	Construction	C	Draining of water from the canals at construction phase will cause limitation of water usage from the canals for domestic use.	- Stakeholder meetings at designing phase in order to discuss and obtain consensus of construction schedule and methods. - Regular public meetings.	Designing, Construction (mitigation)
Limitation of agricultural activity	Construction	C	Draining of water from the canal at construction phase will cause limitation of water usage from the canals for agricultural activity	- Stakeholder meetings at designing phase in order to discuss and obtain consensus of construction schedule and methods. - Construction at dry season (avoidance of rainy season because of paddy season) - Regular public meetings.	Designing, Construction (mitigation)

Potential Impacts	Phase	Rating	Impact cause/ severity	Assumed mitigation measures/ Monitoring method	Action time for Avoid./ mitigation
Limitation of fishery	Construction	C	Draining of water from the canals at construction phase will cause limitation of fishery activity	- Stakeholder meetings at designing phase in order to discuss and obtain consensus of construction schedule and methods. - Decide construction schedule in consideration of egg production of the species and fishery timing (avoidance of rainy season) - Regular public meetings.	Designing, Construction (mitigation)
Decline of accessibility (School, market, pagoda, water source, etc)	Construction,	C	Construction of the canals will decrease accessibility to school, market, pagodas and water source.	- Installment of temporary bridge based on people's request.	Designing, (mitigation)
Water pollution	Construction,	C	Low pH-water problem triggered by the concrete works at construction phase are expected to affect negatively on the aquatic-biodiversity. However minimal impacts are predicted because of construction scale.	- Installation of adequate treatment system	Construction (mitigation)
Air pollution	Construction	C	Because the most roads are unpaved, the dust are expected to be spread especially in dry season. In addition, the construction vehicle will exhaust emission gas.	- Regular sprinkling for unpaved road - Minimization of idling for construction vehicles	Construction (mitigation)
Increase of accident	Construction	C	Accidents caused by construction machinery and vehicles are expected during the construction phase.	- Appropriate maintenance of machinery and vehicles - Imposition of disciplines for safety operation. - Periodical check	Construction (mitigation)
Generation of construction waste (surplus soil)	Construction	C	Disposed soil will be generated by excavation during the construction phase.	- Effective utilization of surplus soil in and around the project area. - Establishment of soil disposal site far from residence area or river.	Construction (mitigation)
Noise and vibration	Construction	C	Noise and vibration caused by movement of heavy equipment are expected. However minimal impacts are predicted because of construction scale.	- Limitation of construction time. (e.g. at daytime only) - Public meetings to obtain consensus about the construction time with surrounding people.	Construction (mitigation)
Deterioration of sanitation condition, increase of risk of diseases	Construction	C	The negative impacts on the sanitary condition of surrounding villages caused due to the inflow of workers are expected. In addition, the spread of infection due to the inflow of workers is expected.	- Improvement of sanitary condition of workers (accommodation, installation of toilet, water supply, etc). - Implementation of educational program for workers. - Periodical patrol	Construction (mitigation)
Local conflict	Operation	C	Improper management of the water usage from the canals will lead local conflict among the FWUCs/FWUGs members.	- Support program for improvement of management capability of FWUCs/FWUGs. - Regular meeting among the FWUCs/FWUGs members. - Regular monitoring of FWUCs/FWUGs activities by MOWRAM.	Designing, Operation (mitigation)

Potential Impacts	Phase	Rating	Impact cause/ severity	Assumed mitigation measures/ Monitoring method	Action time for Avoid./ mitigation
Water Pollution and soil contamination caused by agrochemicals	Operation	C	<p>The farmer may intend to increase the dosage of farm inputs to increase the farm production following the stabilization of the irrigation water. This might result in nutrient load or chemical contamination in drainage water, and affect the downstream aquatic diversity.</p> <p>It is noted that the water management is not operated in connection with the farm input application at present. It has also the possibility to cause the contamination of fertilizer into the drainage water even under proper application of farm input.</p>	<p>- Support program for agricultural extension toward the target people at the same time.</p> <p>- Regular monitoring of agricultural activity by MAFF.</p> <p>- Follow up program toward the target people.</p>	Operation (mitigation)

v) Conclusion

- Land acquisition and involuntary resettlement should be conducted very carefully from the designing phase, because of great sensitive issue. Gradual discussion with local people especially with the affected people, and proper compensation should be proposed and implemented in cooperation with Inter-ministerial Resettlement Committee (IRC).
- Because the project component is mainly rehabilitation of the existing canals with new installment of secondary and tertiary level canal, significant negative impacts are not expected with proper management at construction phase. In addition, mitigation measure proposed will minimize negative impact much further.
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- Because the people in this project area are not familiar to take in workers from other areas, great attention toward management of workers and construction field are significant. In addition, sanitation for workers should be taken care and installment of accommodation, toilet and water supply should be maintained.
- It is important to train FWUCs/FWUGs members for proper management of water and proper usage of agrochemical. This can avoid water conflict among the people and mitigate negative impact toward water and land quality caused by increase of agrochemical.

A.2(2): Lower South Main Canal Irrigated Agriculture Improvement Project

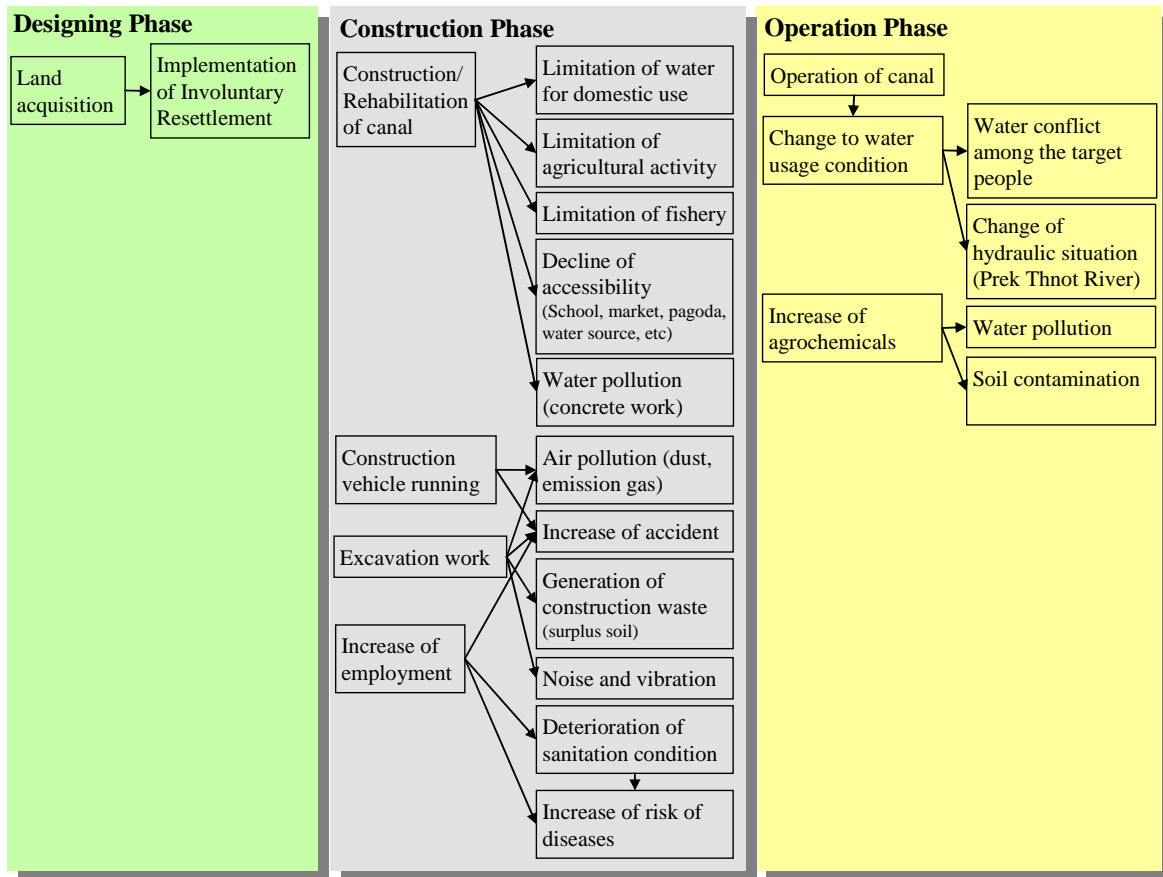
i) Project Description

Components;	Rehabilitation of main canal (total 6 km) and secondary canals (5.8 km), new construction of secondary canals (5.8 km) and tertiary systems, rehabilitation of ponds (5), agricultural support services program, formation and strengthening of FWUCs/ FWUGs. <i>*EIA procedure requires under the Sub-Decree in Cambodia</i>
Location/Area;	Kong Pisei Distict, Kandal Stung District (Zone 2, Kampong Speu and Kandal Province); 6,750 ha
Characteristics; (to be noted)	Social: In Zone 2, water from well is main water source which covers approximately 90% in dry season and 50% in rainy season. 40% utilize rain water in rainy season. Not all areas have set up FWUCs/ FWUGs so far. Natural: Local people are catching fish from the canal and ponds mainly for domestic consumption. Pollution: No specific pollution
Duration;	5 Year (After the Upper South Main Canal Irrigated Agriculture Improvement Project)
Executing Agency;	MOWRAM, MAFF

ii) Impact Matrix

Potential Impact		Activity			Comments
		Designing	Constru ction	Opera tion	
Social Environment					
1	Involuntary Resettlement	--/D	*	*	Depends on detailed design of the canals
2	Local economy (employment, etc)	*	=/B	++/A	
3	Land use and utilization of local resources	--/C	*	*	Land acquisition
4	Social institutions	*	*	++/B	Formation and strengthening of FWUCs
5	Existing social infrastructures and services	*	*	++/A	Improvement of the canals and ponds
6	The poor, indigenous and ethnic people	*	*	*	
7	Misdistribution of benefit and damage	*	*	*	
8	Cultural heritage	*	*	*	
9	Local conflict of interests	*	*	--/C	
10	Water Usage	*	--/A	++/A	
11	Sanitation	*	--/C	*	
12	Hazards (Risk), Infectious diseases	*	--/C	*	
Natural Environment					
13	Topography and Geographical features	*	*	*	
14	Soil Erosion	*	*	*	
15	Groundwater	*	*	*	
16	Hydrological Situation	*	*	=/C	Change of hydraulic situation on Prek Thnot river
17	Flora, Fauna and Biodiversity	*	--/C	=/C	Fish under the construction
18	Meteorology	*	*	*	
19	Landscape	*	*	*	
20	Global Warming	*	*	*	
Pollution					
21	Air Pollution	*	--/B	*	
22	Water Pollution	*	--/B	--/C	
23	Soil Contamination	*	*	--/C	
24	Waste	*	--/C	*	
25	Noise and Vibration	*	--/B	*	
26	Ground Subsidence	*	*	*	
27	Offensive Odor	*	*	*	
28	Bottom sediment	*	*	*	
29	Accidents	*	--/C	*	

iii) **Potential Negative Impacts and its Causes**



iv) **Potential impacts and possible mitigation measures**

Potential Impacts	Phase	Rating	Impact cause/ severity	Assumed mitigation measures/ Monitoring method	Action time for Avoid./ mitigation
Involuntary resettlement	Readjustment	D	Expansion of the canal width and length will lead land acquisition and/or involuntary resettlement.	- Careful attention for designing of the canals in order to mitigate land acquisition and/or involuntary resettlement as much as possible through investigation. - A series of meeting to discuss and obtain consensus with the affected people - Compensation and supportive program for the affected people	Designing (Mitigation)
Limitation of water usage for domestic	Construction	B	Draining of water from the canals at construction phase will cause limitation of water usage from the canals for agricultural activity	- Stakeholder meetings at designing phase in order to discuss and obtain consensus of construction schedule and methods. - Construction at dry season (avoidance of rainy season because of paddy season) - Regular public meetings.	Designing, Construction (mitigation)
Limitation of agricultural activity	Construction	B	Draining of water from the canals at construction phase will cause limitation of fishery activity	- Stakeholder meetings at designing phase in order to discuss and obtain consensus of construction schedule and methods. - Decide construction schedule in consideration of egg production of the species and fishery timing (avoidance of rainy season) - Regular public meetings.	Designing, Construction (mitigation)

Potential Impacts	Phase	Rating	Impact cause/ severity	Assumed mitigation measures/ Monitoring method	Action time for Avoid./ mitigation
Limitation of fishery	Const- ruction	B	Draining of water from the canals at construction phase will cause limitation of water usage from the canals for agricultural activity	- Stakeholder meetings at designing phase in order to discuss and obtain consensus of construction schedule and methods. - Construction at dry season (avoidance of rainy season because of paddy season) - Regular public meetings.	Designing, Construction (mitigation)
Decline of accessibility (School, market, pagoda, water source, etc)	Const- ruction,	C	Construction of the canals will decrease accessibility to school, market, pagodas and water source.	- Installment of temporary bridge based on people's request.	Designing, (mitigation)
Water pollution	Const- ruction,	B	Low pH-water problem triggered by the concrete works at construction phase are expected to affect negatively on the aquatic-biodiversity.	- Installation of adequate treatment system	Construction (mitigation)
Air pollution	Const- ruction	B	Because the most roads are unpaved, the dust are expected to be spread especially in dry season. In addition, the construction vehicle will exhaust emission gas.	- Regular sprinkling for unpaved road - Minimization of idling for construction vehicles	Construction (mitigation)
Increase of accident	Const- ruction	C	Accidents caused by construction machinery and vehicles are expected during the construction phase.	- Appropriate maintenance of machinery and vehicles - Imposition of disciplines for safety operation. - Periodical check	Construction (mitigation)
Noise and vibration	Const- ruction	B	Noise and vibration caused by movement of heavy equipment are expected.	- Limitation of construction time. (e.g. at daytime only) - Public meetings to obtain consensus about the construction time with surrounding people.	Construction (mitigation)
Generation of construction waste (surplus soil)	Const- ruction	C	Disposed soil will be generated by excavation during the construction phase.	- Effective utilization of surplus soil in and around the project area. - Establishment of soil disposal site far from residence area or river.	Construction (mitigation)
Deterioration of sanitation condition, increase of risk of diseases	Const- ruction	C	The negative impacts on the sanitary condition of surrounding villages caused due to the inflow of workers are expected. In addition, the spread of infection due to the inflow of workers is expected.	- Improvement of sanitary condition of workers (accommodation, installation of toilet, water supply, etc). - Implementation of educational program for workers. - Periodical patrol	Construction (mitigation)
Local conflict	Opera- tion	C	Improper management of the water usage from the canals will lead local conflict among the FWUCs/FWUGs members.	- Support program for improvement of management capability of FWUCs/FWUGs. - Regular meeting among the FWUCs/FWUGs members. - Regular monitoring of FWUCs/FWUGs activities by MOWRAM.	Designing, Operation (mitigation)
Change of hydraulic situation	Opera- tion	C	Change of hydrological situation caused by rehabilitation of gate function is expected.	- Periodical patrol of water flow of Prek Thnot River at several stations including at downstream (it is noted that water flow toward north canal will not increase compared with before construction because of effective water use condition.)	Operation (mitigation)

Potential Impacts	Phase	Rating	Impact cause/ severity	Assumed mitigation measures/ Monitoring method	Action time for Avoid./ mitigation
Water Pollution and soil contamination caused by agrochemicals	Operation	C	The farmer may intend to increase the dosage of farm inputs to increase the farm production following the stabilization of the irrigation water. This might result in nutrient load or chemical contamination in drainage water, and affect the downstream aquatic diversity. It is noted that the water management is not operated in connection with the farm input application at present. It has also the possibility to cause the contamination of fertilizer into the drainage water even under proper application of farm input.	- Support program for agricultural extension toward the target people at the same time. - Regular monitoring of agricultural activity by MAFF. - Follow up program toward the target people.	Operation (mitigation)

v) Conclusion

- Land acquisition and involuntary resettlement should be conducted very carefully from the designing phase, because of great sensitive issue. Gradual discussion with local people especially with the affected people, and proper compensation should be proposed and implemented in cooperation with Inter-ministerial Resettlement Committee (IRC).
- Because the project component is mainly rehabilitation of the existing canals with new installment of secondary and tertiary level canal, significant negative impacts are not expected with proper management at construction phase. In addition, mitigation measure proposed will minimize negative impact much further.
- One of considerable issue is limitation of water availability at construction phase. It is important to conduct a series of public meetings periodically to announce and discuss construction schedule in consideration with people's activities including fishery and agricultural activities so as to get people's consensus and cooperation toward the project.
- Because the people in this project area are not familiar to take in workers from other areas, great attention toward management of workers and construction field are significant. In addition, sanitation for workers should be taken care and installment of accommodation, toilet and water supply should be maintained.
- It is important to train FWUCs/FWUGs members for proper management of water and proper usage of agrochemical. This can avoid water conflict among the people and mitigate negative impact toward water and land quality caused by increase of agrochemical.

A.2(3): Ou Krang Ambel Irrigated Agriculture Improvement Project

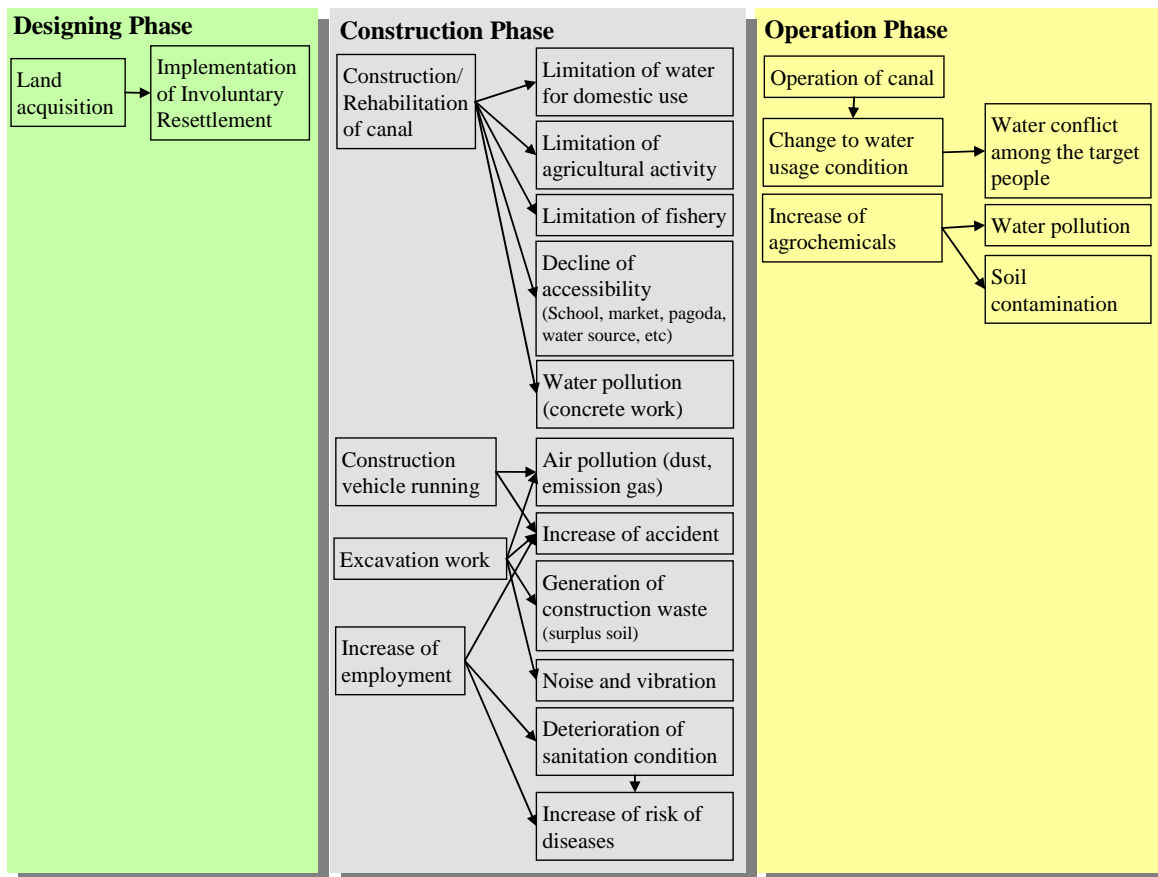
i) Project Description

Components;	Rehabilitation of check gate and intake gate, canal (total 21 km), secondary canal (11.7 km) new construction of secondary canals (8.3 km) and tertiary systems, agricultural support services program, formation and strengthening of FWUCs/FWUGs
Location/Area;	Samraong Tong District, Angk Snuol District, (Zone 2, Kampong Speu and Kandal Province); 2,900 ha
Characteristics; (to be noted)	Social: In Zone 2, water from well is main water source which covers approximately 90% in dry season and 50% in rainy season. 40% utilize rain water in rainy season. Not all areas have set up FWUCs/ FWUGs so far. Natural: Local people are catching fish from the canal and ponds mainly for domestic consumption. Pollution: No specific pollution
Duration;	4-5 Year
Executing Agency;	MOWRAM and PDRAM of Kampong Speu

ii) Impact Matrix

Potential Impact		Activity	Designing	Construction	Operation	Comments
Social Environment						
1	Involuntary Resettlement		--/D	*	*	Depends on detailed design of the canals
2	Local economy (employment, etc)		*	=/B	++/B	
3	Land use and utilization of local resources		--/C	*	*	Land acquisition
4	Social institutions		*	*	++/B	Formation and strengthening of FWUCs
5	Existing social infrastructures and services		*	*	++/B	Improvement of the canals and ponds
6	The poor, indigenous and ethnic people		*	*	*	
7	Misdistribution of benefit and damage		*	*	*	
8	Cultural heritage		*	*	*	
9	Local conflict of interests		*	*	--/C	
10	Water Usage		*	--/B	++/B	
11	Sanitation		*	--/C	*	
12	Hazards (Risk), Infectious diseases		*	--/C	*	
Natural Environment						
13	Topography and Geographical features		*	*	*	
14	Soil Erosion		*	*	*	
15	Groundwater		*	*	*	
16	Hydrological Situation		*	*	*	
17	Flora, Fauna and Biodiversity		*	--/C	=/C	
18	Meteorology		*	*	*	
19	Landscape		*	*	*	
20	Global Warming		*	*	*	
Pollution						
21	Air Pollution		*	--/C	*	
22	Water Pollution		*	--/C	--/C	
23	Soil Contamination		*	*	--/C	
24	Waste		*	--/C	*	
25	Noise and Vibration		*	--/C	*	
26	Ground Subsidence		*	*	*	
27	Offensive Odor		*	*	*	
28	Bottom sediment		*	*	*	
29	Accidents		*	--/C	*	

iii) Potential Negative Impacts and its Causes



iv) Potential impacts and possible mitigation measures

Potential Impacts	Phase	Rating	Impact cause/ severity	Assumed mitigation measures/ Monitoring method	Action time for Avoid./ mitigation
Involuntary resettlement	Designing	D	Expansion of the canal width and length will lead land acquisition and/or involuntary resettlement.	- Careful attention for designing of the canals in order to mitigate land acquisition and/or involuntary resettlement as much as possible through investigation. - A series of meeting to discuss and obtain consensus with the affected people - Compensation and supportive program for the affected people	Designing (Mitigation)
Limitation of water for domestic use	Construction	B	Draining of water from the canals at construction phase will cause limitation of water usage from the canals for domestic use.	- Stakeholder meetings at designing phase in order to discuss and obtain consensus of construction schedule and methods. - Regular public meetings.	Designing, Construction (mitigation)
Limitation of agricultural activity	Construction	B	Draining of water from the canals at construction phase will cause limitation of water usage from the canals for agricultural activity	- Stakeholder meetings at designing phase in order to discuss and obtain consensus of construction schedule and methods. - Construction at dry season (avoidance of rainy season because of paddy season) - Regular public meetings.	Designing, Construction (mitigation)

Potential Impacts	Phase	Rating	Impact cause/ severity	Assumed mitigation measures/ Monitoring method	Action time for Avoid./ mitigation
Limitation of fishery	Construction	B	Draining of water from the canals at construction phase will cause limitation of fishery activity	<ul style="list-style-type: none"> - Stakeholder meetings at designing phase in order to discuss and obtain consensus of construction schedule and methods. - Decide construction schedule in consideration of egg production of the species and fishery timing (avoidance of rainy season) - Regular public meetings. 	Designing, Construction (mitigation)
Decline of accessibility (School, market, pagoda, water source, etc)	Construction,	C	Construction of the canals will decrease accessibility to school, market, pagodas and water source.	<ul style="list-style-type: none"> - Installment of temporary bridge based on people's request. 	Designing, (mitigation)
Water pollution	Construction,	C	Low pH-water problem triggered by the concrete works at construction phase are expected to affect negatively on the aquatic-biodiversity. However minimal impacts are predicted because of construction scale.	<ul style="list-style-type: none"> - Installation of adequate treatment system 	Construction (mitigation)
Air pollution	Construction	C	Because the most roads are unpaved, the dust are expected to be spread especially in dry season. In addition, the construction vehicle will exhaust emission gas.	<ul style="list-style-type: none"> - Regular sprinkling for unpaved road - Minimization of idling for construction vehicles 	Construction (mitigation)
Increase of accident	Construction	C	Accidents caused by construction machinery and vehicles are expected during the construction phase.	<ul style="list-style-type: none"> - Appropriate maintenance of machinery and vehicles - Imposition of disciplines for safety operation. - Periodical check 	Construction (mitigation)
Generation of construction waste (surplus soil)	Construction	C	Disposed soil will be generated by excavation during the construction phase.	<ul style="list-style-type: none"> - Effective utilization of surplus soil in and around the project area. - Establishment of soil disposal site far from residence area or river. 	Construction (mitigation)
Noise and vibration	Construction	C	Noise and vibration caused by movement of heavy equipment are expected. However minimal impacts are predicted because of construction scale.	<ul style="list-style-type: none"> - Limitation of construction time. (e.g. at daytime only) - Public meetings to obtain consensus about the construction time with surrounding people. 	Construction (mitigation)
Deterioration of sanitation condition, increase of risk of diseases	Construction	C	The negative impacts on the sanitary condition of surrounding villages caused due to the inflow of workers are expected. In addition, the spread of infection due to the inflow of workers is expected.	<ul style="list-style-type: none"> - Improvement of sanitary condition of workers (accommodation, installation of toilet, water supply, etc). - Implementation of educational program for workers. - Periodical patrol 	Construction (mitigation)
Local conflict	Operation	C	Improper management of the water usage from the canals will lead local conflict among the FWUCs/FWUGs members.	<ul style="list-style-type: none"> - Support program for improvement of management capability of FWUCs/FWUGs. - Regular meeting among the FWUCs/FWUGs members. - Regular monitoring of FWUCs/FWUGs activities by MOWRAM. 	Designing, Operation (mitigation)

Potential Impacts	Phase	Rating	Impact cause/ severity	Assumed mitigation measures/ Monitoring method	Action time for Avoid./ mitigation
Water Pollution and soil contamination caused by agrochemicals	Operation	C	<p>The farmer may intend to increase the dosage of farm inputs to increase the farm production following the stabilization of the irrigation water. This might result in nutrient load or chemical contamination in drainage water, and affect the downstream aquatic diversity.</p> <p>It is noted that the water management is not operated in connection with the farm input application at present. It has also the possibility to cause the contamination of fertilizer into the drainage water even under proper application of farm input.</p>	<p>- Support program for agricultural extension toward the target people at the same time.</p> <p>- Regular monitoring of agricultural activity by MAFF.</p> <p>- Follow up program toward the target people.</p>	Operation (mitigation)

v) Conclusion

- Land acquisition and involuntary resettlement should be conducted very carefully from the designing phase, because of great sensitive issue. Gradual discussion with local people especially with the affected people, and proper compensation should be proposed and implemented in cooperation with Inter-ministerial Resettlement Committee (IRC).
- Because this project component is mainly rehabilitation of the existing canals with small-scale new installment, significant negative impacts are not expected with proper management at construction phase. In addition, mitigation measure proposed will minimize negative impact much further.
- One of considerable issue is limitation of water availability at construction phase. It is important to conduct a series of public meetings periodically to announce and discuss construction schedule in consideration with people's activities including fishery and agricultural activities so as to get people's consensus and cooperation toward the project.
- It is important to train FWUCs/FWUGs members for proper management of water and proper usage of agrochemical. This can avoid water conflict among the people and mitigate negative impact toward water and land quality caused by increase of agrochemical.

A.3(1): Water Harvesting Irrigated Agriculture Improvement Project

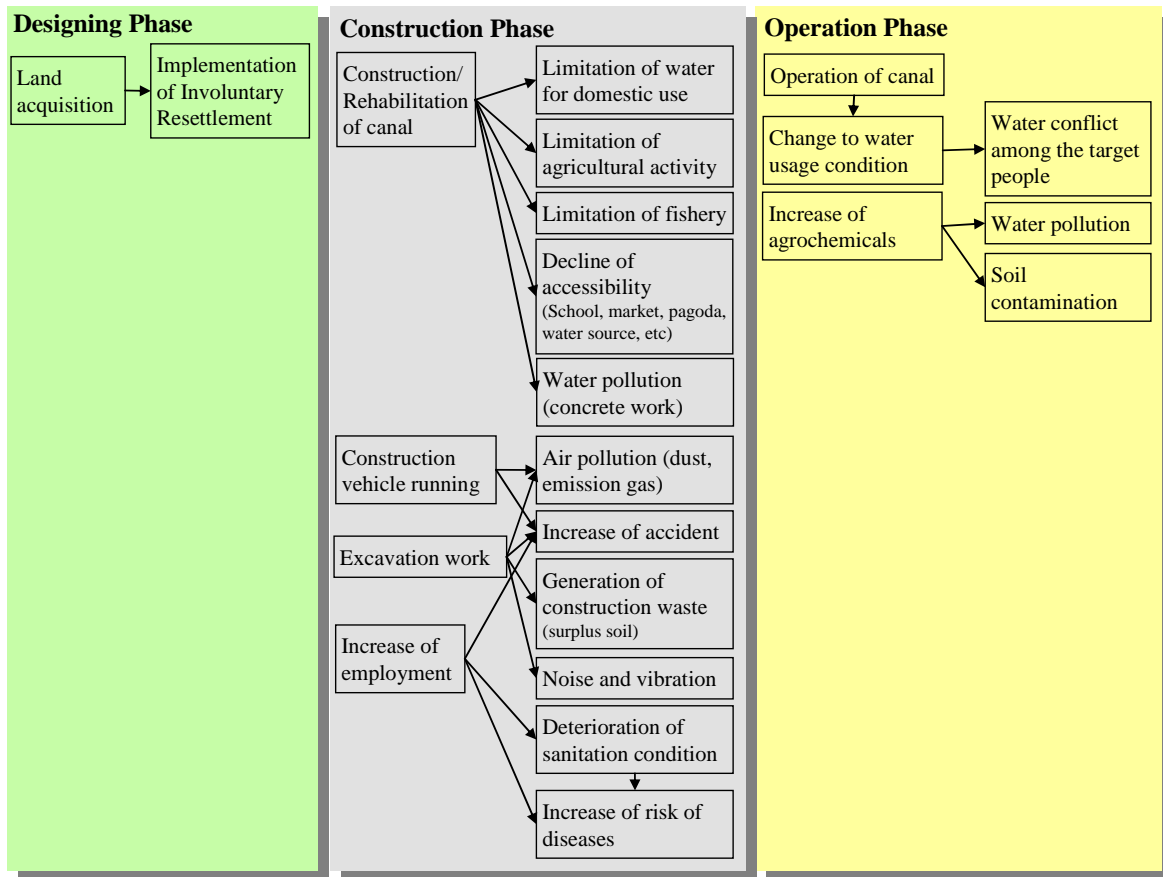
i) Project Description

Components;	Rehabilitation of ponds (49 sites), rehabilitation and new construction of secondary canals (18 km), agricultural support services program, formation and strengthening of FWUCs/FWUGs
Location/Area;	Chbar Mon District, Samraong Tong District, Kong Pisei District, Angk Snuol District (Zone 3, Kampong Speu and Kandal Province); 600 ha
Characteristics; (to be noted)	Social: In Zone 3, water from well is main water source which covers more than 90% in dry season and 55% in rainy season. 35% utilize rain water in rainy season. Not all areas have set up FWUCs/ FWUGs for ponds management so far. Natural: Local people are catching fish from the ponds for domestic consumption. Pollution: No specific pollution
Duration;	4 Year
Executing Agency;	MOWRAM and MAFF

ii) Impact Matrix

Potential Impact		Activity	Designing	Construction	Operation	Comments
Social Environment						
1	Involuntary Resettlement	--/D	*	*		Depends on detailed design of the canals
2	Local economy (employment, etc)	*	=/C	+/+C		
3	Land use and utilization of local resources	--/B	*	*		Land acquisition
4	Social institutions	*	*	+/+B		Formation and strengthening of FWUGs
5	Existing social infrastructures and services	*	*	+/+B		Improvement of the ponds and canals
6	The poor, indigenous and ethnic people	*	*	*		
7	Misdistribution of benefit and damage	*	*	*		
8	Cultural heritage	*	*	*		
9	Local conflict of interests	*	*	--/C		
10	Water Usage	*	--/B	+/+B		
11	Sanitation	*	--/C	*		
12	Hazards (Risk), Infectious diseases	*	--/C	*		
Natural Environment						
13	Topography and Geographical features	*	*	*		
14	Soil Erosion	*	*	*		
15	Groundwater	*	*	*		
16	Hydrological Situation	*	*	*		
17	Flora, Fauna and Biodiversity	*	--/C	=/C		
18	Meteorology	*	*	*		
19	Landscape	*	*	*		
20	Global Warming	*	*	*		
Pollution						
21	Air Pollution	*	--/C	*		
22	Water Pollution	*	--/C	--/C		
23	Soil Contamination	*	*	--/C		
24	Waste	*	--/C	*		
25	Noise and Vibration	*	--/C	*		
26	Ground Subsidence	*	*	*		
27	Offensive Odor	*	*	*		
28	Bottom sediment	*	*	*		
29	Accidents	*	--/C	*		

iii) **Potential Negative Impacts and its Causes**



iv) **Potential impacts and possible mitigation measures**

Potential Impacts	Phase	Rating	Impact cause/ severity	Assumed mitigation measures/ Monitoring method	Action time for Avoid./ mitigation
Involuntary resettlement	Designing	D	Expansion of the canal width and length will lead land acquisition and/or involuntary resettlement.	- Careful attention for designing of the canals in order to mitigate land acquisition and/or involuntary resettlement as much as possible through investigation. - A series of meeting to discuss and obtain consensus with the affected people - Compensation and supportive program for the affected people	Designing (Mitigation)
Limitation of water for domestic use	Construction	B	Draining of water from the canals at construction phase will cause limitation of water usage from the canals for domestic use.	- Stakeholder meetings at designing phase in order to discuss and obtain consensus of construction schedule and methods. - Regular public meetings.	Designing, Construction (mitigation)
Limitation of agricultural activity	Construction	B	Draining of water from the canals at construction phase will cause limitation of water usage from the canals for agricultural activity	- Stakeholder meetings at designing phase in order to discuss and obtain consensus of construction schedule and methods. - Construction at dry season (avoidance of rainy season because of paddy season) - Regular public meetings.	Designing, Construction (mitigation)

Potential Impacts	Phase	Rating	Impact cause/ severity	Assumed mitigation measures/ Monitoring method	Action time for Avoid./ mitigation
Limitation of fishery	Construction	B	Draining of water from the canals at construction phase will cause limitation of fishery activity	- Stakeholder meetings at designing phase in order to discuss and obtain consensus of construction schedule and methods. - Decide construction schedule in consideration of egg production of the species and fishery timing (avoidance of rainy season) - Regular public meetings.	Designing, Construction (mitigation)
Decline of accessibility (School, market, pagoda, water source, etc)	Construction,	C	Construction of the canals will decrease accessibility to school, market, pagodas and water source.	- Installment of temporary bridge based on people's request.	Designing, (mitigation)
Water pollution	Construction,	C	Low pH-water problem triggered by the concrete works at construction phase are expected to affect negatively on the aquatic-biodiversity. However minimal impacts are predicted because of construction scale.	- Installation of adequate treatment system	Construction (mitigation)
Air pollution	Construction	C	Because the most roads are unpaved, the dust are expected to be spread especially in dry season. In addition, the construction vehicle will exhaust emission gas.	- Regular sprinkling for unpaved road - Minimization of idling for construction vehicles	Construction (mitigation)
Increase of accident	Construction	C	Accidents caused by construction machinery and vehicles are expected during the construction phase.	- Appropriate maintenance of machinery and vehicles - Imposition of disciplines for safety operation. - Periodical check	Construction (mitigation)
Generation of construction waste (surplus soil)	Construction	C	Disposed soil will be generated by excavation during the construction phase.	- Effective utilization of surplus soil in and around the project area. - Establishment of soil disposal site far from residence area or river.	Construction (mitigation)
Noise and vibration	Construction	C	Noise and vibration caused by movement of heavy equipment are expected. However minimal impacts are predicted because of construction scale.	- Limitation of construction time. (e.g. at daytime only) - Public meetings to obtain consensus about the construction time with surrounding people.	Construction (mitigation)
Deterioration of sanitation condition, increase of risk of diseases	Construction	C	The negative impacts on the sanitary condition of surrounding villages caused due to the inflow of workers are expected. In addition, the spread of infection due to the inflow of workers is expected.	- Improvement of sanitary condition of workers (accommodation, installation of toilet, water supply, etc). - Implementation of educational program for workers. - Periodical patrol	Construction (mitigation)
Local conflict	Operation	C	Improper management of the water usage from the canals will lead local conflict among the FWUCs/FWUGs members.	- Support program for improvement of management capability of FWUCs/FWUGs. - Regular meeting among the FWUCs/FWUGs members. - Regular monitoring of FWUCs/FWUGs activities by MOWRAM.	Designing, Operation (mitigation)

Potential Impacts	Phase	Rating	Impact cause/ severity	Assumed mitigation measures/ Monitoring method	Action time for Avoid./ mitigation
Water Pollution and soil contamination caused by agrochemicals	Operation	C	The farmer may intend to increase the dosage of farm inputs to increase the farm production following the stabilization of the irrigation water. This might result in nutrient load or chemical contamination in drainage water, and affect the downstream aquatic diversity. It is noted that the water management is not operated in connection with the farm input application at present. It has also the possibility to cause the contamination of fertilizer into the drainage water even under proper application of farm input.	- Support program for agricultural extension toward the target people at the same time. - Regular monitoring of agricultural activity by MAFF. - Follow up program toward the target people.	Operation (mitigation)

v) Conclusion

- Land acquisition and involuntary resettlement should be conducted very carefully from the designing phase, because of great sensitive issue. Gradual discussion with local people especially with the affected people, and proper compensation should be proposed and implemented in cooperation with Inter-ministerial Resettlement Committee (IRC).
- Because this project component is mainly rehabilitation of the existing canals with small-scale new installment, significant negative impacts are not expected with proper management at construction phase. In addition, mitigation measure proposed will minimize negative impact much further.
- One of considerable issue is limitation of water availability at construction phase. It is important to conduct a series of public meetings periodically to announce and discuss construction schedule in consideration with people's activities including fishery and agricultural activities so as to get people's consensus and cooperation toward the project.
- It is important to train FWUCs/FWUGs members for proper management of water and proper usage of agrochemical. This can avoid water conflict among the people and mitigate negative impact toward water and land quality caused by increase of agrochemical.

B.1(2): Roleang Chrey Regulator and Intakes Improvement Project

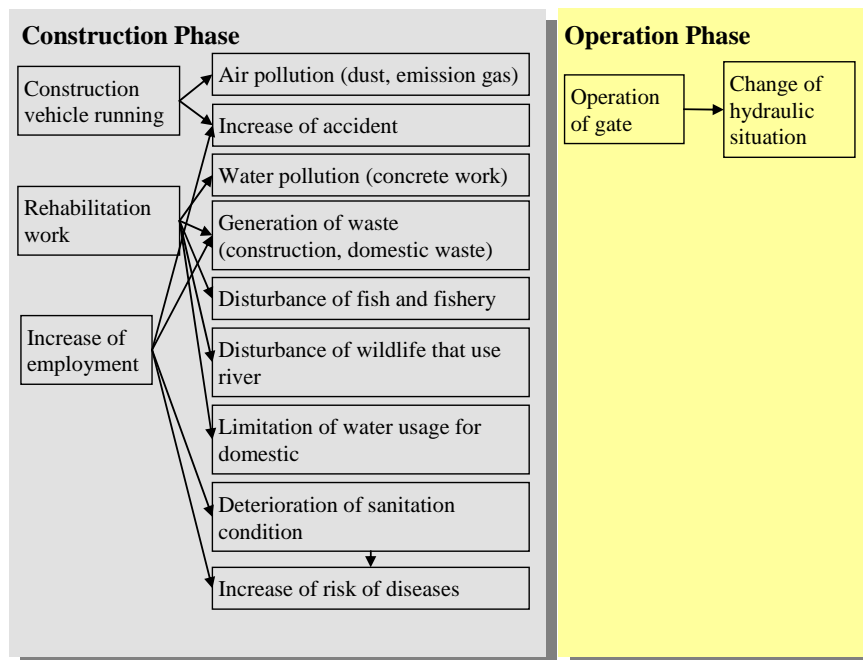
i) Project Description

Components;	Rehabilitation of Roleang Chrey Regulator, reconstruction of intake gate
Location/Area;	Roleang Chrey Regulator of Prek Thnot River, Kampong Speu Province
Target Group;	MOWRAM, PDOWRAM of Kampong Speu
Characteristics; (to be noted)	<p>Social: Most people living along the Prek Thnot River or canals connected with the River utilize river water for both domestic use and agricultural activities.</p> <p>Natural: Local people are catching fish from the Prek Thnot River mainly for domestic consumption.</p> <p>Pollution: No data of water pollution of Prek Thnot River.</p>
Duration;	2 years
Executing Agency;	MOWRAM

ii) Impact Matrix

Potential Impact		Activity	Construction	Operation	Comments
Social Environment					
1	Involuntary Resettlement		*	*	
2	Local economy (employment, livelihood etc)		*	++/A	Proper water resource usage
3	Land use and utilization of local resources		*	*	
4	Social institutions		*	*	
5	Existing social infrastructures and services		*	++/A	Proper water management
6	The poor, indigenous and ethnic people		*	*	
7	Misdistribution of benefit and damage		*	*	
8	Cultural heritage		*	*	
9	Local conflict of interests		*	*	
10	Water Usage		--/C	++/A	
11	Sanitation		--/C	*	
12	Hazards (Risk), Infectious diseases		--/C	*	
Natural Environment					
13	Topography and Geographical features		*	*	
14	Soil Erosion		*	*	
15	Groundwater		*	*	
16	Hydrological Situation		*	=/B	Change of hydraulic situation of Prek Thnot River
17	Flora, Fauna and Biodiversity		--/C	*	Change of circumstance of wildlife
18	Meteorology		*	*	
19	Landscape		*	*	
20	Global Warming		*	*	
Pollution					
21	Air Pollution		--/C	*	Dust and emission gas
22	Water Pollution		--/C	*	Very limited muddy water
23	Soil Contamination		*	*	
24	Waste		--/C	*	A small amount of construction waste and waste from employee
25	Noise and Vibration		--/C	*	Construction scale is small without excavation and compaction
26	Ground Subsidence		*	*	
27	Offensive Odor		*	*	
28	Bottom sediment		*	*	
29	Accidents		--/C	*	

iii) **Potential Negative Impacts and its Causes**



iv) **Potential impacts and possible mitigation measures**

Potential Impacts	Phase	Rating	Impact cause/ severity	Assumed mitigation measures/ Monitoring method	Action time for Avoid./ mitigation
Air pollution	Construction	C	Because the most roads are unpaved, the dust are expected to be spread especially in dry season. In addition, the construction vehicle will exhaust emission gas.	- Regular sprinkling for unpaved road - Minimization of idling for construction vehicles	Construction (mitigation)
Increase of accident	Construction	C	Accidents caused by construction machinery and vehicles are expected during the construction phase.	- Appropriate maintenance of machinery and vehicles - Imposition of disciplines for safety operation. - Regular check of the equipment	Construction (mitigation)
Water pollution	Construction	C	Low pH-water problem triggered by the concrete works at construction phase are expected to affect negatively on the aquatic-biodiversity. However minimal impacts are predicted because of construction scale.	- Installation of adequate treatment system	Construction (mitigation)
Generation of waste (construction and domestic)	Construction	C	Construction waste of old gate will be generated although those are small amount. Domestic waste from employee will also be generated.	- Demolition of construction waste and disposal of the waste at safe space far from residential area. - Collection of domestic waste and disposal at safe space far from residential area (It is noted that the no large numbers of outside workers are expected.)	Construction (mitigation)
Disturbance of fish and fishery	Construction	C	Fish habitats are expected to change by deterioration of water quality and change of water flow.	- Installation of adequate treatment system - Careful decision of construction schedule in consideration of egg production of the species and fishery timing.	Designing Construction (mitigation)

Potential Impacts	Phase	Rating	Impact cause/ severity	Assumed mitigation measures/ Monitoring method	Action time for Avoid./ mitigation
Disturbance of wildlife that use river	Const- ruction	C	The change of river circumstance is expected to affect bird and other wildlife that utilize river for living at construction phase. But to date, no information about wildlife species nor frequency of utilization.	- Investigation of bird and wildlife by interview of the people and reconnaissance during the designing phase so that any species that may be particularly disturbed by the project can be identified and mitigation measures devised. - Careful decision of construction schedule in consideration of wildlife living condition.	Designing (mitigation)
Limitation of water usage for domestic	Const- ruction	C	Construction activities will limit river water for domestic use by people.	- Public information before the construction starts and obtain consensus from the stakeholders.	Designing (mitigation)
Deterioration of sanitation condition, increase of risk of diseases	Const- ruction	C	The negative impacts on the sanitary condition of surrounding villages caused due to the inflow of workers are expected. In addition, the spread of infection due to the inflow of workers is expected.	- Improvement of sanitary condition of workers (accommodation, installation of toilet, water supply, etc). - Implementation of educational program for workers. - Periodical patrol	Construction (mitigation)
Change of hydraulic situation	Opera- tion	C	Change of hydraulic situation caused by rehabilitation of gate function is expected.	- Periodical patrol of water flow of Prek Thnot River at several stations including at downstream	Operation (mitigation)

v) Conclusion

- Because the project is rehabilitation of the existing gate and intake system with small-scale construction, significant negative impacts are not expected with proper management. In addition, mitigation measure proposed will minimize negative impact much further.
- Because the people in this project area are not familiar to take in workers from other areas, great attention toward management of workers and construction field are significant. In addition, sanitation for workers should be taken care and installment of accommodation, toilet and water supply should be maintained.

B.3(1): Community Inland Fisheries Development Project

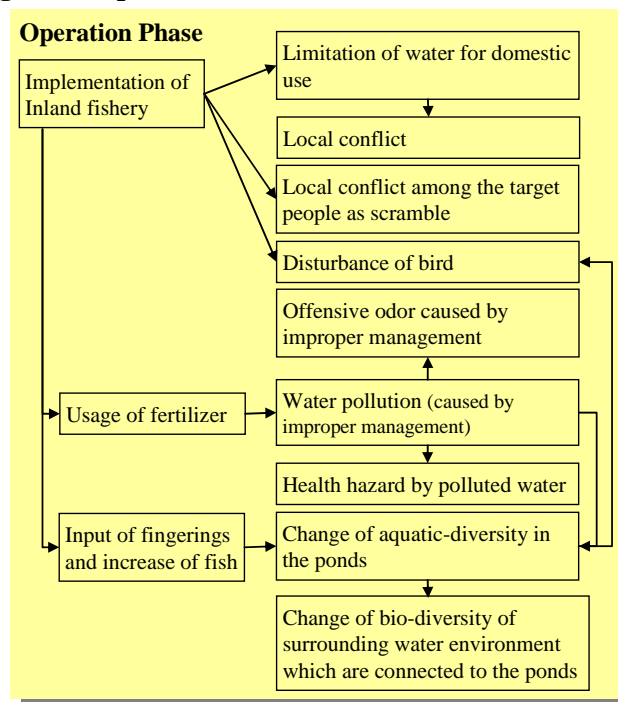
i) Project Description

Components;	Promotion of community inland fisheries in the water surfaces (ponds) through a series of training and periodic field guidance with fishing equipment.
Location/Area;	Ponds used for the Water Harvesting Irrigated Agriculture Improvement Project (Total 49 ponds in Zone 3)
Target Group;	FWUCs/FWUGs in the Water Harvesting Irrigated Agriculture Improvement Project Area
Characteristics; (to be noted)	<p>Social: Some existing ponds are already utilized as fishing points by surrounding people. Some people utilize water from ponds as domestic water.</p> <p>Natural: In existing ponds, there are fish including indigenous species and sometimes exotic species. No data about bird species and its frequency to the ponds.</p> <p>Pollution: No data of water pollution of ponds.</p>
Duration;	5 years with 1 year pilot operation
Executing Agency;	Department of Fisheries, MAFF

ii) Impact Matrix

Potential Impact	Activity	Operation	Comments
Social Environment			
1	Involuntary Resettlement	*	
2	Local economy (employment, livelihood etc)	++/C	Increase of fishery activity
3	Land use and utilization of local resources	++/C	Utilization of ponds for water harvesting
4	Social institutions	++/B	Formulation and strengthening of FWUCs/ FWUGs
5	Existing social infrastructures and services	++/B	
6	The poor, indigenous and ethnic people	*	
7	Misdistribution of benefit and damage	*	
8	Cultural heritage	*	
9	Local conflict of interests	--/C	Possibility of Income gap
10	Water Usage	=/B	Limitation of domestic use of ponds water
11	Sanitation	--/C	
12	Hazards (Risk), Infectious diseases	--/C	
Natural Environment			
13	Topography and Geographical features	*	
14	Soil Erosion	*	
15	Groundwater	*	
16	Hydrological Situation	*	
17	Flora, Fauna and Biodiversity	--/C	No specific data of birds for usage of ponds.
18	Meteorology	*	
19	Landscape	*	
20	Global Warming	*	
Pollution			
21	Air Pollution	*	
22	Water Pollution	--/C	In the case of improper management of the pond
23	Soil Contamination	--/C	
24	Waste	*	
25	Noise and Vibration	*	
26	Ground Subsidence	*	
27	Offensive Odor	--/C	
28	Bottom sediment	*	
29	Accidents	*	

iii) **Potential Negative Impacts and its Causes**



iv) **Potential impacts and possible mitigation measures**

Potential Impacts	Phase	Rating	Impact cause/ severity	Assumed mitigation measures/ Monitoring method	Action time for Avoid./ mitigation
Limitation of water for domestic use	Operation	C	Usage of ponds as fishery will limit water for domestic use by surrounding people.	- Detailed investigation of current usage condition and pick up the ponds for fishery so as to take out the ponds which are well-utilized by people. - Discussion among the relevant people who utilize the pond to gain a consensus.	Designing (mitigation)
Local conflict of interests	Operation	C	Improper management of the fishery in the ponds will lead local conflicts among the FWUCs/FWUGs members. limitation of water for domestic use will also lead local conflicts between people who earn benefit from the project and people who are limited the water usage.	- Implementation of inventory survey for the selection of target ponds carefully so as to obtain consensus from the people surroundings. - Support program for improvement of management capability of FWUCs/FWUGs. - Regular monitoring of FWUCs/FWUGs activities by MAFF.	Designing, Operation (mitigation)
Disturbance of bird (wildlife)	Operation	D	The change of ponds circumstance by increase of fishery and change of aquatic bio-diversity have possibility to affect bird (wildlife) that utilize the ponds for living. (To date, no information about the wildlife species nor frequency of utilization.)	- A reconnaissance survey and/or interviews to the local people around the project area at designing phase are effective so that any important species that may be particularly disturbed by construction can be identified and mitigation measures devised.	Designing (mitigation)

Potential Impacts	Phase	Rating	Impact cause/ severity	Assumed mitigation measures/ Monitoring method	Action time for Avoid./ mitigation
Offensive odor from the ponds	Operation	C	Offensive odor caused by improper management of the ponds by FWUCs/FWUGs are expected.	- Support program for improvement of management capability of FWUCs/FWUGs. - Regular monitoring of FWUCs/FWUGs activities by MAFF. - Regular monitoring of the ponds by MAFF.	Operation (mitigation)
Water Pollution/ Health hazard	Operation	C	Improper management of the ponds by FWUCs/FWUGs will bring improper usage of fertilizers and/or other inputs to the ponds. This might influence contamination of water quality. In addition, people utilize water of ponds for domestic use, water contamination would influence human health.	- Support program for improvement of management capability of FWUCs/FWUGs. - Description about risk of water quality and health to the guideline. - Regular monitoring of FWUCs/FWUGs activities by MAFF. - Regular monitoring of water quality of the ponds by MAFF.	Operation (mitigation)
Change of aquatic-diversity of the ponds and surrounding water environment	Operation	C	The bio-diversity of the ponds and surrounding water environment which are connected to the ponds might be changed by releasing fingerings and water pollution if any.	- Research of existing fish species in order to utilize indigenous species as fingerings. - Regular monitoring of the ponds by MAFF.	Designing (mitigation)

v) Conclusion

- At the designing phase, careful site selection should be conducted. Because people utilize the water of ponds for domestic use, consensus among the surrounding people should be obtained for implementation of this project. In addition, after the site would be selected, regular public meetings should be conducted among stakeholders for i) information disclosure, ii) taking account of public inputs in decision making, iii) increase of public confidence, and iv) reduction of conflict.
- Investigation of existing of fish species should be investigated so as to utilize indigenous species as fingerings.
- Support programs toward target group of FWUCs/FWUGs for proper management of ponds and fishery which has been included one components of the project are necessary to be examined based on their capabilities and circumstances.
- Regular monitoring of i) ponds environment, ii) water quality of the ponds, and iii) FWUCs/FWUGs activities and management condition should be conducted by Department of Fishery, MAFF.

Appendix-J
PROJECT EVALUATION

**THE STUDY
ON
COMPREHENSIVE AGRICULTURAL DEVELOPMENT
OF
PREK THNOT RIVER BASIN
IN
THE KINGDOM OF CAMBODIA**

**FINAL REPORT
Volume-VI: Appendixes for Master Plan
Appendix-J
Project Evaluation**

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APPENDIX-J: PROJECT EVALUATION

Chapter J-1 Objectives and Evaluated Projects

J-1.1 Objectives

The objectives of the master plan evaluation are to clarify the economic viability of conceived projects with using EIRR and effects on the farmers' economy applying farm budget analysis in order to assure viability of the projects selected for further detailed study, i.e. feasibility study.

J-1.2 Evaluated Projects

The analysis and discussion in this report is focusing on economic viability of the selected projects. Since project has various aspects that should be taken into consideration when comparing among each others, looking at them from all angles, including economic viability, is to be continuously carried out by the Study Team.

Based on the water resource assessment of the Study Area and Target Area, the Target Area was divided into four different zones, as follows.

Zoning of Target Area

Zones	Description	Area (ha)
Zone-1	Area irrigated by Prek Thnot River with 80% water supply dependability	5,710
Zone-2	Area irrigated by Prek Thnot River with 50% water supply dependability	11,210
Zone-3	Irrigated area by Water Harvesting with water supply less than 50% dependability	1,200
Zone-4	Rainfed area	23,380

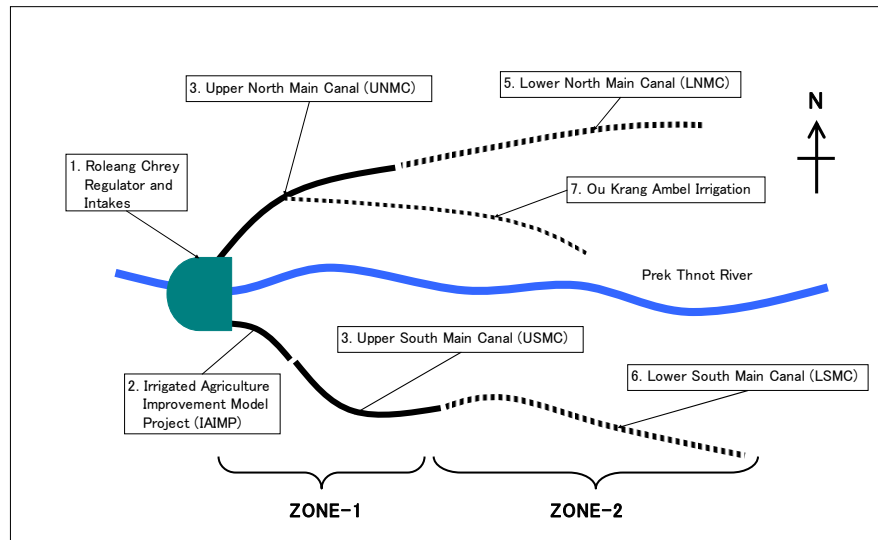
For the master plan, more than twenty different projects are conceived, consisting of (1) Scheme-wise Improvement Projects based on above zoning, coupled with zones crosscutting activities, and (2) Subject-wise Improvement Projects that addresses on particular issues, aspects and sub-sectors.

The economic analysis is conducted on total 9 selected projects from (1) Scheme-wise Improvement Project category. However, because there are close hydrological relations among them, it was considered appropriate to evaluate the set of projects where appropriate, rather than separately evaluating single project.

The list of 9 evaluated projects and the simple schematic map showing the locations and hydrological relations among them are shown in next page.

Evaluated Projects for each Zone

Zones	No.	Code	Description	Command Area (ha)
Zones Cross-cutting	1.	RC	Roleang Chrey Regulator and Intakes Improvement Project	16,700
Zone-1	2.	IAIMP	Irrigated Agriculture Improvement Model Project (IAIMP)	570
	3.	UNMC	Upper North Main Canal Irrigated Agriculture Improvement Project	2,210
	4.	USMC	Upper South Main Canal Irrigated Agriculture Improvement Project	2,880
Zone-2	5.	LNMC	Lower North Main Canal Irrigated Agriculture Improvement Project	1,390
	6.	LSMC	Lower South Main Canal Irrigated Agriculture Improvement Project	6,750
	7.	-	Ou Krang Ambel Irrigated Agriculture Improvement Project	2,900
Zone-3	8.	-	Water Harvesting Irrigated Agriculture Improvement Project	1,200
Zone-4	9.	-	Rainfed Agriculture Improvement Project	23,380



Simple Schematic Map of Evaluated Projects in Zones-1 and 2

Some explanations on the relations between above-listed projects are;

- (1) Roleang Chrey Regulator and Intakes is situated at the upper-most stream of the Prek Thnot River in the Target Zone, and is the **KEY STRUCTURE** for all connected irrigation schemes in the down stream. All these connected schemes (No. 2 to 7 in above table) are assuming the improvement of Roleang Chrey Regulator and Intakes, as the precondition for their own improvement.
- (2) Irrigated Agriculture Improvement Model Project (IAIMP) and Upper South Main Canal (USMC) Irrigated Agriculture Improvement Project in Zone-1, and Lower South Main Canal (LSMC) Irrigated Agriculture Improvement Project in Zone-2, are connected by the south main canal running through them from upstream to downstream. As it is easily be understood, improvements of the schemes situated in downstream will require the prior improvement of other scheme(s) in upstream.
- (3) Likewise, Upper North Main Canal (UNMC) in Zone-1, and Lower North Main Canal (LNMC) and Ou Krang Ambel Irrigation in Zone-2 are connected, however for Ou Krang Ambel it is connecting UNMC with the branch canal. In this set of projects, while improvement of UNMC will be the precondition for the improvement of LNMC, for Ou Krang Ambel it is not, since UNMC is functioning to the level supplying the decent level of water to Ou Krang Ambel irrigation scheme.

Taking the above situation into consideration, economic evaluation is conducted for total 9 Project Implementation Scenarios (PIS), listed in the following.

- 1) Roleang Chrey (RC) Regulator and Intakes Improvement Project

Taking the implementation of 1) RC as precondition, for North Main Canal area;

- 2) RC + UNMC,
- 3) RC + Ou Krang Ambel, and
- 4) RC + UNMC + Ou Krang Ambel + LNMC.

Likewise, for South Main Canal area;

- 5) RC + IAIMP,
- 6) RC + IAIMP + USMC, and
- 7) RC + IAIMP + USMC + LSMC.

Separately from above, two more projects for Zones-3 and 4, they are;

- 8) Water Harvesting Irrigated Agriculture Improvement Project, and
- 9) Rainfed Agriculture Improvement Project.

Chapter J-2 Economic Evaluation for Master Plan Projects

J-2.1 Economic Evaluation

J-2.1.1 Evaluation Procedures

All prices for Master Plan Evaluation were expressed in constant prices as of January 2006, applying the average monthly official exchange rate of USD 1.0 = Riel 4,070. The economic life of the project is assumed to be 50 years beginning from year 2009, the proposed commencement year for construction, except for the separate two evaluations of UNMC and USMC assumed to be started from year 2011.

Economic farm gate prices of traded agricultural inputs and outputs were based on their export and import parity prices derived from the World Bank Commodity Price Forecasts as of October 2005. The long-run projected prices in 2010 at 2005 constant price were used in the analysis. The average of export and import parity prices of farm products of rice, maize, and import parity prices of fertilizer were calculated and applied for the economic prices as shown in Table J-1.

A standard conversion factor (SCF) of 0.98 and a shadow wage rate (SWR) of 0.48 were applied for the adjustment of prices and labor costs reflecting the market distortion. Table J-2 summarizes the Economic prices applied for preparation of crop production budgets. Transfer payment such as tax, duty, subsidy, interest, etc., were excluded in estimating the economic costs and benefits. Financial construction costs were converted into economic values of using the construction conversion factors (CCFs).

J-2.1.2 Economic Benefit

Irrigation and drainage benefit will accrue from increase in cropping areas and productivity of target crops comprising paddy, upland crops such as mungbean, and vegetables. The economic benefit was estimated as the increment of net production value between future “with” and present “without” project conditions. The economic crop budgets of respective crops were prepared under the “with” and “without” project conditions, by applying requirements for farm inputs and total labor, unit crop yields, and their economic prices (See Table J-3 and J-4). The irrigation and drainage benefit (increment of net production value) of the respective projects were estimated as follows (for details, see Table J-5).

Economic Irrigation and Drainage Benefit of 9 Evaluated Projects

Zones	No.	Code	Project Area (ha)	Cropping Intensity (%)		Net Production Value (Riel, Million)		
				Without Project	With Project	Without Project	With Project	Increment
Zones Cross-cutting	1.	RC	16,700	*104	*118	7,677.2	9,271.0	1,593.8
Zone-1	2.	IAIMP	570	155	155	622.7	1019.0	375.7
	3.	UNMC	2,210	111	115	1,544.9	2,703.8	1,158.9
	4.	USMC	2,880	100	105	1,730.7	3,124.4	1,393.7
Zone-2	5.	LNMC	1,390	101	119	757.8	1,689.8	984.4
	6.	LSMC	6,750	101	120	3,200.4	8,533.7	5,333.3
	7.	Ou Krang Ambel	2,900	101	119	1,601.6	3,637.5	2,035.9
Zone-3	8.	Water Harvest	1200	101	105	680.9	1252.0	571.1
Zone-4	9.	Rainfed	23,380	100	101	10,708.0	15342.8	4,634.8

* Weighted average of Project No. 2 to 7 in above table.

In the above table, RC is assuming complete malfunctioning of the gate from 2007 which requires the urgent improvement. Its present status is judged quite serious and with very high probability, the gates will become inoperable before long. Thereby net production values for RC ‘without’ and ‘with’ in the above table mean ‘no action taken’ case for the former, and ‘action taken’ case for the latter.¹ In other words, RC as the project is aiming at maintaining the present production level in the all connected command areas and to prevent the water supply deterioration. RC as a project can be expressed as it will save the cost of no action.

Annual economic benefit flow was estimated based on the progress of the area to be developed, built-up period of increment of net production values are between 2 to 6 years, depending on the project (See Table J-6). Annual economic benefit flow was estimated based on the progress of the area to be developed, built-up period of increment of net production values are between 2 to 6 years, depending on the project (See Table J-6).

J-2.1.3 Negative Benefit

Existing farmlands will be acquired and used for the construction of irrigation and drainage facilities. The agricultural production foregone defined as the annual net production value without project was accounted for negative benefit in the evaluation as follows (See Table J-7).

Negative Project Benefit

Zones	No.	Project name/Code	Farm Land (ha)	Foregone Amount (Riel, Million/year)
Zones Crosscutting	1.	RC	0	0
Zone-1	2.	IAIMP	5	5.5
	3.	UNMC	20	13.5
	4.	USMC	25	14.6
Zone-2	5.	LNMC	10	5.4
	6.	LSMC	130	59.0
	7.	Ou Krang Ambel	30	16
Zone-3	8.	Water Harvest	0	0
Zone-4	9.	Rainfed	0	0

J-2.1.4 Economic Cost

(1) Cost for Project Investment

The economic construction cost was classified by (i) preparatory works, (ii) direct construction, (iii) O&M equipment, (iv) agricultural supporting activities, (v) formation and strengthening FWUC, (vi) administration, (vii) engineering services, and (viii) physical contingencies (See Table J-8). The economic project investment cost was estimated by applying relevant conversion factors to the components of financial foreign and local currency cost comprising equipments, materials and labor. The total economic project cost of the respective projects was estimated as follows.

¹ The net production values of “no action taken for RC case” for project number 2 to 7 are included in J-5, as (2) Present/Without Project Condition (2007 -).

Economic Investment Cost

Zones	No.	Project name/Code	Project Area (ha)	Investment Cost (Riel, Million)	Cost Per ha (Riel '000)
Zones Crosscutting	1.	RC	*16,700	14,542	871
Zone-1	2.	IAIMP	570	5,181	9,089
	3.	UNMC	2,210	30,696	13,889
	4.	USMC	2,880	26,581	9,229
Zone-2	5.	LNMC	1,390	8,598	6,185
	6.	LSMC	6,750	41,163	6,098
	7.	Ou Krang Ambel	2,900	19,665	6,781
Zone-3	8.	Water Harvest	1200	18,814	15,678
Zone-4	9.	Rainfed	23,380	10,616	454

* Project area for RC is the sum of Project No. 2 to 7 in above table.

(2) O&M Cost

The financial O&M cost was converted to economic value by applying relevant conversion factors to the components of financial foreign and local currency costs, in the way same as the project investment costs. The O&M cost of the respective projects was estimated as follows (See Table J-9).

Economic O&M Cost

Zones	No.	Project name/Code	Project Area (ha)	O & M Cost (Riel, Million/year)	Cost Per ha (Riel '000)
Zones Crosscutting	1.	RC	*16,700	51,5	3.08
Zone-1	2.	IAIMP	570	17.5	30,702
	3.	UNMC	2,210	109.3	49,457
	4.	USMC	2,880	94.9	32,951
Zone-2	5.	LNMC	1,390	28.8	20,719
	6.	LSMC	6,750	148.6	22,015
	7.	Ou Krang Ambel	2,900	69.5	23,966
Zone-3	8.	Water Harvest	600	74.1	123,500
Zone-4	9.	Rainfed	23,980	-	-

* Project area for RC is the sum of Project No. 2 to 7 in above table.

(3) Replacement Cost

The project facilities and equipments with shorter useful life than those of respective projects need to be replaced after the assumed working life is over. The replacement cost was estimated by applying the conversion factors to the respective financial cost for replacement. The useful life and replacement cost of the respective projects was estimated as follows (See Table J-10).

Economic Replacement Cost

(Riel, Million)

Zones	No.	Project name/Code	O & M Equipments (10 years)	Gates (25 years)
Zones Crosscutting	1.	RC	90	15,950
Zone-1	2.	IAIMP	32	146
	3.	UNMC	184	661
	4.	USMC	161	444
Zone-2	5.	LNMC	50	450

	6.	LSMC	251	1,798
	7.	Ou Krang Ambel	117	463
Zone-3	8.	Water Harvest	661	126
Zone-4	9.	Rainfed	-	-

J-2.1.5 Economic Evaluation Results

The economic cost and benefit stream comprising (i) the cost for project investment, O&M and replacement, and (ii) irrigation and drainage, and negative benefit was prepared for the economic life of the respective projects and sets of projects (See Table J-11).

Economic internal rate of return (EIRR) and other indicators were calculated and summarized as follows.

Economic Irrigation and Drainage Benefit of 9 Evaluated Projects Implementation Scenarios

Evaluated Projects/Sets of Projects		EIRR (%)	NPV (Riel, Million) (7% discount rate)			B/C
			Benefit	Cost	B-C	
1.	RC	13.6	21,996	15,560	6,436	1.4
2.	RC + UNMC	4.7	31,216	39,149	-7,933	0.8
3.	RC + Ou Krang Ambel	9.4	38,098	30,715	7,383	1.2
4.	RC + UNMC + Ou Krang Ambel + LNMC	6.2	55,367	60,785	-5,418	0.9
5.	RC + IAIMP	10.6	26,232	20,513	5,719	1.3
6.	RC + IAIMP + USMC	6.2	37,430	40,637	-3,207	0.9
7.	RC + IAIMP + USMC + LSMC	7.4	73,866	70,414	3,472	1.0
8.	Water Harvest	0.4	5,216	15,766	-10,550	0.3
9.	Rainfed	17.6	35,032	8,762	26,270	4.0

Some notes on the economic evaluation results shown in above table are:

- 1) The benefit achieved by RC is the benefit derived by preventing the complete malfunctioning of the regulator from occurring. In other words, benefit of preventing the impending crop losses. Most other projects (No. 2 to 7 in above table) are assuming the prior (or parallel) implementation of RC as a precondition.
- 2) Water harvesting irrigation improvement in zone-3 did not show good result. Although this is the result of evaluating 49 small pond schemes in aggregate, another evaluation conducted for 5 considerably better cost performance small pond schemes shown high figure (EIRR 15.5%). This indicates the needs for selective implementation of the small pond schemes in this group.
- 3) Rainfed agriculture improvement in zone-4 performed well in above evaluation. However, it should be noted here that this achievement is based on the assumption in which the regional level extension officers will continuously perform well in the post-project period and assuming the full-fledged adoption of the introduced technology by significant portion of farmers in the area.

J-2.2 Financial Evaluation

Farm economic analysis of typical farms on net returns from paddy field under the present and 'with'-project condition has been made for the financial analyses of the irrigated and rainfed agriculture improvement plans. The assumptions involved in the analyses are as follows;

Assumptions for Farm Economic Analyses

Typical Farms	Holding size of paddy field: 0.7 ha per farm household
Subject of Analysis	Net return from paddy field under present & with-project condition
With-project & Present Farm Net Return from Paddy Field	With-project & present crop budgets are applied for estimation

The results of the analyses are presented in Table J-12 and summarized in the following table.

Results of Farm Economic Analyses (unit: Riel)

Zone/Project	1. Present	2. With-project	Increment per Farm (2 – 1)
	Net Return from Paddy Field per Farm	Net Return from Paddy Field per Farm	
Zone-1 ^{1/}			
- Model Project	786,000	1,133,000	347,000
- UNMC	514,000	822,000	308,000
- USMC	446,000	746,000	299,000
Zone-2	385,000	830,000	445,000
Zone-3	433,000	732,000	299,000
Zone-4	234,000	470,000	236,000

^{1/}: Irrigated Agricultural Improvement Model Project

Upper North Main Canal Irrigated Agricultural Improvement Project (UNMC)

Upper South Main Canal Irrigated Agricultural Improvement Project (USMC)

As shown in above table, the anticipated incremental net return from paddy field under the with-project condition are estimated at the range of Riel 299,000 to 445,000 from the present levels in the irrigated agricultural improvement projects and the incremental net return in the rainfed agriculture improvement project in Zone-4 is estimated at Riel 236,000.

Tables

Table J-1 Economic Price Estimate for Traded Goods, MP Study (1/5)

Item	Import Parity Price			Export Parity Price		
	Operation	Unit	Price	Operation	Unit	Price
I. Rice/Paddy						
1. Projected 2010 World Price (in 1990 price) /a		US\$/ton	197		US\$/ton	197
2. Projected 2010 World Price (in 2005 price) /a		US\$/ton	215.9		US\$/ton	215.9
3. Quality Adjustment	x	%	90	x	%	90
4. CIF/FOB Price at Kompong Som Port /b	=	US\$/ton	194.3	=	US\$/ton	194.3
5. Port Charge, Handling and Warehousing	+	US\$/ton	12.9	-	US\$/ton	12.9
6. Price at Kompong Som Port	=	US\$/ton	207.2	=	Riel/kg	181.4
Equivalent in Riel / kg /c	=	Riel/kg	843	=	Riel/kg	738
7. Transportation Cost /d	+	Riel/kg	29			
(Kampong Som-Phnom Penh)						
(Kampong Speu-Kampong Som)				-	Riel/kg	25
(Kampong Speu -Phnom Penh)	-	Riel/kg	4			
8. Ex-Mill /Wholesale Price in Kampong Speu	=	Riel/kg	868	=	Riel/kg	713
9. Milling Cost and Margin /d	-	Riel/kg	22	-	Riel/kg	22
10. Processing Ratio	x	%	66	x	%	66
11. By-Products through Processing /e	+	Riel/kg	70	+	Riel/kg	70
12. Millgate Paddy Price	=	Riel/kg	628	=	Riel/kg	526
13. Transport/Handling from Farmgate /d	-	Riel/kg	15	-	Riel/kg	15
14. Farmgate Price	=	Riel/kg	613	=	Riel/kg	511
		50%		50%		
17. Weighted average economic farm gate price		Riel/kg	562			
II. Maize						
1. Projected 2010 World Price (in 1990 price) /a		US\$/ton	89.9		US\$/ton	89.9
2. Projected 2010 World Price (in 2005 price) /a		US\$/ton	98.5		US\$/ton	98.5
3. International Shipping and Handling	+	US\$/ton	40.0			
4. CIF/FOB Price at Kompong Som Port	=	US\$/ton	138.5	=	US\$/ton	98.5
5. Port Charge, Handling and Warehousing	+	US\$/ton	12.9	-	US\$/ton	12.9
6. Price at Kompong Som Port	=	US\$/ton	151.4	=	Riel/kg	85.6
Equivalent in Riel / kg /c	=	Riel/kg	616	=	Riel/kg	348
7. Transportation Cost /d	+	Riel/kg	29			
(Kampong Som-Phnom Penh)						
(Kampong Speu -Kampong Som)				-	Riel/kg	25
(Kampong Speu -Phnom Penh)	-	Riel/kg	4			
8. Price in Kampong Speu	=	Riel/kg	641	=	Riel/kg	323
9. Transport/Handling from Farmgate /d	-	Riel/kg	15	-	Riel/kg	15
10. Farmgate Price	=	Riel/kg	626	=	Riel/kg	308
		50%		50%		
17. Weighted average economic farm gate price		Riel/kg	470			

Note : /a ; Based on the World Bank, Global Commodity Forecast, Oct. 2005

The projected prices in 1990 constant US\$ were adjusted by the factor of 1.096 (MUV) to allow for price escalation between 1990 and 2005.

Paddy : Thai, milled, 5% broken, FOB Bangkok

Maize : US No.2, Yellow, FOB Gulf Ports

/b ; Assumed at the same price at Bangkok port in Thailand

/c ; Exchange rate : US\$ = Riel 4,070

/d ; Adjusted with SCF of 0.98

/e ; Rice bran : Riel 300 /kg of rice bran, 18% of paddy weight

Broken rice: Riel 320 /kg of broken rice, 5 % of paddy weight.

Table J-1 Economic Price Estimate for Traded Goods, MP Study (2/5)

Item	Import Parity Price			Export Parity Price		
	Operation	Unit	Price	Operation	Unit	Price
III. Soybean						
1. Projected 2010 World Price (in 1990 price) /a		US\$/ton	197		US\$/ton	197
2. Projected 2010 World Price (in 2005 price) /a		US\$/ton	215.9		US\$/ton	215.9
3. International Shipping and Handling	+	US\$/ton	35.0			
4. CIF/FOB Price at Kompong Som Port	=	US\$/ton	250.9	=	US\$/ton	215.9
5. Port Charge, Handling and Warehousing	+	US\$/ton	12.9	-	US\$/ton	12.9
6. Price at Kompong Som Port	=	US\$/ton	263.8	=	Riel/kg	203.0
Equivalent in Riel / kg /b	=	Riel/kg	1,074	=	Riel/kg	826
7. Transportation Cost /c (Kampong Som-Phnom Penh)	+	Riel/kg	29			
(Kampong Speu -Kampong Som)				-	Riel/kg	25
(Kampong Speu -Phnom Penh)	-	Riel/kg	4			
8. Trade Price in Kampong Speu	=	Riel/kg	1,099	=	Riel/kg	801
9. Transport/Handling from Farmgate /c	-	Riel/kg	15	-	Riel/kg	15
10. Farmgate Price	=	Riel/kg	1,084	=	Riel/kg	786
	50%			50%		
11. Weighted average economic farm gate price		Riel/kg	935			
IV. Groundnut						
1. Projected 2010 World Price (in 1990 price) /a		US\$/ton	680.8		US\$/ton	680.8
2. Projected 2010 World Price (in 2005 price) /a		US\$/ton	746.3		US\$/ton	746.3
3. Conversion to Shelled Groundnuts (50%)		US\$/ton	373.2		US\$/ton	373.2
4. International Shipping and Handling	+	US\$/ton	35.0			
5. CIF/FOB Price at Kompong Som Port	=	US\$/ton	408.2	=	US\$/ton	373.2
6. Port Charge, Handling and Warehousing	+	US\$/ton	12.9	-	US\$/ton	12.9
7. Price at Kompong Som Port	=	US\$/ton	421.1	=	Riel/kg	360.3
Equivalent in Riel / kg /b	=	Riel/kg	1,714	=	Riel/kg	1,466
8. Transportation Cost /c (Kampong Som-Phnom Penh)	+	Riel/kg	29			
(Kampong Speu-Kampong Som)				-	Riel/kg	25
(Kampong Speu -Phnom Penh)	-	Riel/kg	4			
9. Trade Price in Kampong Speu	=	Riel/kg	1,739	=	Riel/kg	1,441
10. Transport/Handling from Farmgate /c	-	Riel/kg	15	-	Riel/kg	15
11. Farmgate Price - Without Shell	=	Riel/kg	1,724	=	Riel/kg	1,426
- With Shell (80%)	=	Riel/kg	1,379	=	Riel/kg	1,141
	50%			50%		
12. Weighted average economic farm gate price		Riel/kg	1,260			
Note : /a ; Based on the World Bank, Global Commodity Forecast, Oct. 2005						
* The projected prices in 1990 constant US\$ were adjusted by the factor of <u>1.096</u> (MUV) to allow for price escalation between 1990 and 2005.						
Soybeans, Groundnut oil : CIF Rotterdam						
/b ; Exchange rate : US\$ = Riel <u>4,070</u>						
/c ; Adjusted with SCF of <u>0.98</u>						

Table J-1 Economic Price Estimate for Traded Goods, MP Study (3/5)

Item	Import Parity Price			
	Operation	Unit	Price	
V. Fertilizer				
(1) Urea				
1. Projected 2010 World Price (in 1990 price) /a		US\$/ton	137.0	
2. Projected 2010 World Price (in 2005 price) /a		US\$/ton	150.2	
3. International Shipping and Handling	+	US\$/ton	40.0	
4. CIF Price at Kompong Som Port	=	US\$/ton	190.2	
5. Port Charge, Handling and Warehousing	+	US\$/ton	12.9	
6. Price at Kompong Som Port	=	US\$/ton	203.1	
Equivalent in Riel / kg /b	=	Riel/kg	827	
7. Transportation Cost /c (Kampong Som-Kampong Speu)	+	Riel/kg	25	
8. Trade Price in Kampong Speu	=	Riel/kg	852	
9. Transport/Handling to Farmgate /c	+	Riel/kg	15	
10. Farmgate Price	=	Riel/kg	867	
		Price of Nutrient (N) /e	Riel/kg	1,885
(2) DAP (Diammonium Phosphate)				
1. Projected 2010 World Price (in 1990 price) /a		US\$/ton	154.1	
2. Projected 2010 World Price (in 2005 price) /a		US\$/ton	168.9	
3. International Shipping and Handling	+	US\$/ton	45.0	
4. CIF Price at Kompong Som Port	=	US\$/ton	213.9	
5. Port Charge, Handling, Warehousing and Bagging	+	US\$/ton	12.9	
6. Price at Kompong Som Port	=	US\$/ton	226.8	
Equivalent in Riel / kg /b	=	Riel/kg	923	
7. Transportation Cost /c (Kampong Som-Kampong Speu)	+	Riel/kg	25	
8. Trade Price in Kampong Speu	=	Riel/kg	948	
9. Transport/Handling to Farmgate /c	+	Riel/kg	15	
10. Farmgate Price	=	Riel/kg	963	
		Price of Nutrient (P) /e	Riel/kg	2,093
		Price of Nutrient (N) /e	Riel/kg	5,350
(3) Potassium Chloride (KCL) /d				
1. Projected 2010 World Price (in 1990 price) /a		US\$/ton	107.0	
2. Projected 2010 World Price (in 2005 price) /a		US\$/ton	117.3	
3. International Shipping and Handling	+	US\$/ton	40.0	
4. CIF Price at Kompong Som Port	=	US\$/ton	157.3	
5. Port Charge, Handling, Warehousing and Bagging	+	US\$/ton	12.9	
6. Price at Kompong Som Port	=	US\$/ton	170.2	
Equivalent in Riel / kg /b	=	Riel/kg	693	
7. Transportation Cost /c (Kampong Som-Takeo)	+	Riel/kg	25	
8. Trade Price in Takeo	=	Riel/kg	718	
9. Transport/Handling to Farmgate /c	+	Riel/kg	15	
10. Farmgate Price	=	Riel/kg	733	
		Price of Nutrient (K) /e	Riel/kg	1,222

Note : /a ; Based on the World Bank, Global Commodity Forecast, Oct. 2005

* The projected prices in 1990 constant US\$ were adjusted by the factor of 1.096 (MUV) to allow for price escalation between 1990 and 2001.

Urea : Bagged, FOB Black Sea

DAP : Bulk, FOB US Gulf

KCL : Bulk, FOB Black Sea

/b ; Exchange rate : US\$ = Riel 4,070

/c ; Adjusted with SCF of 0.98

/d ; Potassium Chloride (Muriate of Potash)

/e ; Nutrient content is 46%, 46%(18-46-0), and 60%, respectively for Urea, DAP and KCL.

Table J-1 Economic Price Estimate for Traded Goods, MP Study (4/5)

VI. Estimation of Standard Conversion factors

Year	Total Import Value to Cambodia (CIF)	Total Export Value from Cambodia (FOB)	Import Subsidy /a	Import Tax /b	Export Subsidy	Export Tax	Standard Conversion Factor
	(Unit ; US\$ Million)						
	I	E	Is	It	Es	Et	SCF
1998	1,262.0	802		98.7		0.7	0.955
1999	1,722.0	1,129		108.9		4.3	0.965
2000	2,100.0	1,401		96.7		4.1	0.974
2001	2,270.0	1,571		92.8		2.5	0.977
2002	2,503.0	1,836		104.0		3.7	0.977
2003	2,789.0	2,137		94.2		4.5	0.982
2004	3,288.0	2,375		122.1		4.8	0.980
2005							
Average Standard Conversion Factor (SCF)							
1998-2004							0.973
1998-2002							0.970
2000-2004							0.978

Note : $SCF = (I+E) / [(I-Is+It)+(E+Es-Et)]$

/a ; Import subsidy is accounted at the import tax exemption.

/b ; Custom duties are accounted.

Sources : Ministry of Economy and Finance, Cambodia Statistical Yearbook 2005

Table J-1 Economic Price Estimate for Traded Goods, MP Study (5/5)

VII. Estimate of Shadow Wage Factor in the Study Area

Item	Operation	Unit	2005	2010	2020
1. Total Population in the Study Area (Population growth rate)/a		Person (%)	322,706	357,658 (1.73)	441,610 (2.13)
2. Labor Force Population		Person			
Total /b	(37.6%)		121,300	134,500	166,000
For agriculture			78,800 (65.0%)	80,700 (60.0%)	91,300 (55.0%)
3. Annual Available Person-Day	236	P.day/year	18,596,800	19,045,200	21,546,800
	(P.day/person/year)				
4. Net Annual Available Person-Day for Agriculture	(50%)	P.day/year	9,298,400	<u>9,522,600</u>	<u>10,773,400</u>
5. Agricultural Labor Input /c		Distribution			
5.1 Present/Without Project Condition	(41,500ha)				
1) Wet season paddy (irrigated)	(500ha)	1.20%		49,000	49,000
2) Wet season paddy (supplement)	(5,500ha)	13.25%		533,500	533,500
3) Wet season paddy (rainfed)	(35,500ha)	85.54%		2,769,000	2,769,000
4) Diversified crop (rainfed)					
Mungbean	(1,250ha)	3.00%		62,500	62,500
Other cereals/vegetables	(1,660ha)	4.00%		149,400	149,400
(1) + 2) + 3) + 4)	(44,410ha)	107.00%		3,563,400	3,563,400
5) Other farm works	(30% of cropping)			1,069,000	1,069,000
Total (1), 2), 3), 4) and 5))				<u>4,632,400</u>	<u>4,632,400</u>
5.2 Future/With Project Condition	(17,300ha)				
A. <u>Upper North & South Main Canal (MC)</u>	(5,660ha)				
1) Wet season paddy (irrigated)	(500ha)	8.83%		52,500	52,500
2) Wet season paddy (supplement)	(5,160ha)	91.17%		567,600	567,600
3) Wet season paddy (rainfed)	(0ha)	0.00%		0	0
4) Diversified crop (irrigated/rainfed)					
Mungbean	(170ha)	3.00%		10,200	10,200
Vegetables	(230ha)	4.00%		20,700	20,700
(1) + 2) + 3) + 4)	(6,060ha)	107.00%		651,000	651,000
5) Other farm works	(30% of cropping)			195,300	195,300
Total (1, 2, 3, 4 and 5))				<u>846,300</u>	<u>846,300</u>
B. <u>Lower North & South MC and Ou Kra</u>	(11,040ha)				
1) Wet season paddy (irrigated)	(0 ha)	0.00%		0	0
2) Wet season paddy (supplement)	(11,040 ha)	100.00%		1,159,200	1,159,200
3) Wet season paddy (rainfed)	(0 ha)	0.00%		0	0
4) Diversified crop (irrigated/rainfed)					
Mungbean	(330 ha)	3.00%		19,800	19,800
Vegetables	(440 ha)	4.00%		39,600	39,600
(1) + 2) + 3) + 4)	(11,810ha)	107.00%		1,218,600	1,218,600
5) Other farm works	(30% of cropping)			365,600	365,600
Total (1), 2), 3), 4) and 5))				<u>1,584,200</u>	<u>1,584,200</u>
C. <u>Water Harvesting Irrigated Ag.</u>	(600ha)				
1) Wet season paddy (irrigated)	(0 ha)	0.00%		0	0
2) Wet season paddy (supplement)	(300 ha)	50.00%		31,500	31,500
3) Wet season paddy (rainfed)	(300 ha)	50.00%		27,000	27,000
4) Diversified crop (irrigated/rainfed)					
Mungbean	(20 ha)	3.00%		1,200	1,200
Vegetables	(20 ha)	4.00%		1,800	1,800
(1) + 2) + 3) + 4)	(640ha)	107.00%		61,500	61,500
5) Other farm works	(30% of cropping)			18,500	18,500
Total (1), 2), 3), 4) and 5))				<u>80,000</u>	<u>80,000</u>
D. <u>Rainfed Ag. Improvement</u>	(23,980ha)				
1) Wet season paddy (rainfed)	(23,980 ha)	100.00%		2,158,200	2,158,200
2) Diversified crop (rainfed)					
Mungbean	(10 ha)	1.00%		600	600
Vegetables	(10 ha)	1.00%		900	900
(1) + 2)	(24,000ha)	102.00%		2,159,700	2,159,700
3) Other farm works	(30% of cropping)			647,900	647,900
Total (1), 2), and 3))				<u>2,807,600</u>	<u>2,807,600</u>
Total (A + B + C + D)					<u>5,318,100</u>
6. Shadow Wage Factors					
Without Project Condition				0.49	0.43
With Project Condition				0.56	0.49
7. Shadow Wage Rate					
(Standard conversion factor : 0.98)					
Without Project Condition				0.48	0.42
With Project Condition				0.55	0.48

Note : /a ; Estimated by data from: Statistical Year Book 2005, NIS, Ministry of Planning, and First Revision, Population Projection for Cambodia 1998 - 2020, NIS, Ministry of Planning.

/b ; Percentage of economically active population aged 10 and over (Kampong Speu) 51.9 % (1)

Percentage of population aged 10 and over (Kampong Speu) ; 72.5 % (2)

Labor force population ratio ; (1 x 2) 37.6 %

/c ; Labor requirement per ha

Crops	Person-day/ha			
	Present	With Project		W-har
		UP-NS	LW-NS&OK	
Paddy				
Rainfed	78	0	90	90
Irrigated	98	105	0	0
Supplement	97	110	105	105
Mungbean	50	60	60	60
Vegetables	90	90	90	90

Table J-2 Summary of Financial and Economic Prices Applied, MP Study

Particulars	Unit	Financial Price Applied /a	Conversion	Economic Price Applied
1. Farm Products				
Dry Paddy	(Riel/kg)			
- High yielding varieties (Dec. 2005)		550	b	562
- Improved local varieties		600	b	562
Maize/Corn	(Riel/kg)	600	b	470
Mungbean	(Riel/kg)	1,500	c	1,470
Vegetable average	(Riel/kg)	519	c	509
2. By-Products				
Rice straw	(Riel/kg)	28	c	27
By-products of Mung B & Meiz	(Riel/kg)	30	c	29
3. Seeds				
Paddy (degraded HYV)	(Riel/kg)	630	c	617
Paddy (local variety)	(Riel/kg)	710	c	696
Paddy (improved variety)	(Riel/kg)	900	c	882
Maize	(Riel/kg)	2,000	c	1,960
Mungbean	(Riel/kg)	1,400	c	1,372
Vegetable average	(Riel/kg)	1,000	c	980
4. Fertilizer				
Urea	(Riel/kg)	1,400	b	867
DAP	(Riel/kg)	1,600	b	963
KCL	(Riel/kg)	1,400	b	733
Compost	(Riel/ton)	25,000	d	10,500
5. Chemical				
	(Riel/litre)	10,000	c	9,800
6. Tool and Equipment				
	5% of the cost for inputs and draft animals			
7. Labor, Animal Power and Machinery				
Labor	(Riel/Person-day)	6,000	d	2,520
Animal	(Riel/Animal-day)	8,000	d	3,360
8. Transportation				
Farmgate to Kampong Speu	(Riel/kg)	30	c	29

Remarks:

/a ; Dec. 2005 prices

/b ; Economic price estimate based on the WB Commodity Markets Forecast

/c ; Financial prices are converted to economic value multiplying by SC 0.98/d ; Multiplied by shadow wage rate of 0.42Based on the shadow wage rate fac 0.43) multiplied by S 0.98

Table J-3 Economic Crop Budget, Present/Without Project Condition, MP Study

Name of crops	Unit	Paddy (H.Y.V)			Paddy (Impr. Local V.)			Paddy (Local V. for Rainfed)		
		Q'ty	Price (Riel)	Value (1000Riel)	Q'ty	Price (Riel)	Value (1000Riel)	Q'ty	Price (Riel)	Value (1000Riel)
1. Gross Income	Riel			1,414			1,237			884
Main products	kg	2,400	562	1,349	2,100	562	1,180	1,500	562	843
By-product	kg	2,400	27	65	2,100	27	57	1,500	27	41
		(straw)			(straw)			(straw)		
2. Production Cost	Riel			581			567			426
2.1 Inputs	Riel			176			175			125
Seed	kg	60	617	37	80	696	56	80	696	56
Farm manure (wet)	ton	1	10,500	5	1	10,500	5	1	10,500	5
Fertilizer Urea	kg	70	867	61	60	867	52	35	867	30
DAP	kg	70	963	67	60	963	58	35	963	34
KCL	kg	0	733	0	0	733	0	0	733	0
Agro-chemicals	liter	1	9,800	6	0	9,800	4	0	9,800	0
2.2 Labor	P-d			247			244			196
Hired labor	P-d	20	2,520	50	20	2,520	50	16	2,520	40
Family labor	P-d	78	2,520	197	77	2,520	194	62	2,520	156
2.3 Draft animal	Riel			130			121			85
Land preparation	Ani-d	18.0		60	18		60	12		41
Plowing	Ani-d	15.0	3,360	50	15.0	3,360	50	10.0	3,360	34
Paddling	Ani-d	3.0	3,360	10	3.0	3,360	10	2.0	3,360	7
Transportation	Ani-d	2,400.0	29	70	2,100.0	29	61	1,500.0	29	44
2.4 Tool/Equipment	Riel			28			27			20
3. Net Return (N.Return/P. Cost Ratio)	Riel			833			670			458
				1.43			1.18			1.08

Name of crops	Unit	Mungbean			Vegetables (average)		
		Q'ty	Price (Riel)	Value (1000Riel)	Q'ty	Price (Riel)	Value (1000Riel)
1. Gross Income	Riel			675			4,708
Main products	kg	450	1,470	662	9,250	509	4,708
By-product	kg	450	29	13	9,250	0	0
		(waste bean)			(stem and waste nuts)		
2. Production Cost	Riel			264			1,546
2.1 Inputs	Riel			92			720
Seed	kg	50	1,372	69	166	980	163
Farm manure (wet)	ton	0	10,500	0	15	10,500	158
Fertilizer Urea	kg	15	867	13	177	867	153
DAP	kg	10	963	10	215	963	207
KCL	kg	0	733	0	0	733	0
Agro-chemicals	liter	0	9,800	0	4	9,800	39
2.2 Labor	P-d			126			376
Hired labor	P-d	15	2,520	38	53	2,520	132
Family labor	P-d	35	2,520	88	97	2,520	244
2.3 Draft animal	Riel			33			309
Land preparation	Ani-d			20			41
Plowing	Ani-d	5.0	3,360	17	10.0	3,360	34
Paddling	Ani-d	1.0	3,360	3	2.0	3,360	7
Transportation	Ani-d	450.0	29	13	9,250.0	29	268
2.4 Tool/Equipment	Riel			13			141
3. Net Return (N.Return/P. Cost Ratio)	Riel			411			3,162
				1.56			2.05

Table J-4 Economic Crop Budget, With Project Condition, MP Study (1/4)

Economic Crop Budget

With Project Condition

I. ZONE-1: Upper North/South Main Canal and Irrigated Agriculture Improvement Model Project Area

Name of crops	Paddy Early Wet/Wet (H.Y.V)				Paddy Wet Med. (Impr V.)		
	Unit	Q'ty	Price (Riel)	Value (1000Riel)	Q'ty	Price (Riel)	Value (1000Riel)
1. Gross Income	Riel			1,944			1,767
Main products	kg	3,300	562	1,855	3,000	562	1,686
By-product	kg	3,300 (straw)	27	89	3,000 (straw)	27	81
2. Production Cost	Riel			723			727
2.1 Inputs	Riel			248			248
Seed	kg	40	882	35	40	882	35
Farm manure (wet)	ton	1	10,500	11	1	10,500	11
Fertilizer							
Urea	kg	115	867	100	110	867	95
DAP	kg	65	963	63	55	963	53
KCL	kg	40	733	29	60	733	44
Agro-chemicals	liter	1	9,800	10	1	9,800	10
2.2 Labor	P-d			265			277
Hired labor	P-d	21	2,520	53	22	2,520	55
Family labor	P-d	84	2,520	212	88	2,520	222
2.3 Draft animal	Riel			176			167
Land preparation	Ani-d	24.0		80	24.0		80
Plowing	Ani-d	20.0	3,360	67	20.0	3,360	67
Paddling	Ani-d	4.0	3,360	13	4.0	3,360	13
Transportation	Ani-d	3,300.0	29	96	3,000.0	29	87
2.4 Tool/Equipment	Riel			34			35
3. Net Return (N.Return/P. Cost Ratio)	Riel			1,221			1,040
				1.69			1.43

Name of crops	Unit	Mungbean			Vegetables (average)		
		Q'ty	Price (Riel)	Value (1000Riel)	Q'ty	Price (Riel)	Value (1000Riel)
1. Gross Income	Riel			1,049			4,708
Main products	kg	700	1,470	1,029	9,250	509	4,708
By-product	kg	700 (waste bean)	29	20	9,250 (stem and waste nuts)	0	0
2. Production Cost	Riel			415			1,544
2.1 Inputs	Riel			204			719
Seed	kg	50	1,372	69	166	980	163
Farm manure (wet)	ton	2	10,500	21	15	10,500	158
Fertilizer							
Urea	kg	55	867	48	177	867	152
DAP	kg	50	963	48	215	963	207
KCL	kg	25	733	18	0	733	0
Agro-chemicals	liter	0	9,800	0	4	9,800	39
2.2 Labor	P-d			151			376
Hired labor	P-d	18	2,520	45	53	2,520	132
Family labor	P-d	42	2,520	106	97	2,520	244
2.3 Draft animal	Riel			40			309
Land preparation	Ani-d	6.0		20	12.0		41
Plowing	Ani-d	5.0	3,360	17	10.0	3,360	34
Paddling	Ani-d	1.0	3,360	3	2.0	3,360	7
Transportation	Ani-d	700.0	29	20	9,250.0	29	268
2.4 Tool/Equipment	Riel			20			140
3. Net Return (N.Return/P. Cost Ratio)	Riel			634			3,164
				1.53			2.05

Table J-4 Economic Crop Budget, With Project Condition, MP Study (2/4)

Economic Crop Budget

With Project Condition

II. ZONE-2: Lower North & South Main Canal and Ou krang Ambel Area

Name of crops	Unit	Paddy Wet Med. (Impr V.)		
		Q'ty	Price (Riel)	Value (1000Riel)
1. Gross Income	Riel			1,650
Main products	kg	2,800	562	1,574
By-product	kg	2,800 (straw)	27	76
2. Production Cost	Riel			659
2.1 Inputs	Riel			202
Seed	kg	40	882	35
Farm manure (wet)	ton	1	10,500	11
Fertilizer	kg	80	867	69
Urea	kg	50	963	48
DAP	kg	40	733	29
KCL	kg			
Agro-chemicals	liter	1	9,800	10
2.2 Labor	P-d			265
Hired labor	P-d	21	2,520	53
Family labor	P-d	84	2,520	212
2.3 Draft animal	Riel			161
Land preparation	Ani-d	24.0		80
Plowing	Ani-d	20.0	3,360	67
Paddling	Ani-d	4.0	3,360	13
Transportation	Ani-d	2,800.0	29	81
2.4 Tool/Equipment	Riel			31
3. Net Return (N.Return/P. Cost Ratio)	Riel			991 1.50

Name of crops	Unit	Mungbean			Vegetables (average)		
		Q'ty	Price (Riel)	Value (1000Riel)	Q'ty	Price (Riel)	Value (1000Riel)
1. Gross Income	Riel			1,049			4,708
Main products	kg	700	1,470	1,029	9,250	509	4,708
By-product	kg	700 (waste bean)	29	20	9,250 (stem and waste nuts)	0	0
2. Production Cost	Riel			415			1,544
2.1 Inputs	Riel			204			719
Seed	kg	50	1,372	69	166	980	163
Farm manure (wet)	ton	2	10,500	21	15	10,500	158
Fertilizer	kg	55	867	48	177	867	152
Urea	kg	50	963	48	215	963	207
DAP	kg	25	733	18	0	733	0
KCL	kg				4	9,800	39
Agro-chemicals	liter	0	9,800	0			
2.2 Labor	P-d			151			376
Hired labor	P-d	18	2,520	45	53	2,520	132
Family labor	P-d	42	2,520	106	97	2,520	244
2.3 Draft animal	Riel			40			309
Land preparation	Ani-d	6.0		20	12.0		41
Plowing	Ani-d	5.0	3,360	17	10.0	3,360	34
Paddling	Ani-d	1.0	3,360	3	2.0	3,360	7
Transportation	Ani-d	700.0	29	20	9,250.0	29	268
2.4 Tool/Equipment	Riel			20			140
3. Net Return (N.Return/P. Cost Ratio)	Riel			634 1.53			3,164 2.05

Table J-4 Economic Crop Budget, With Project Condition, MP Study (3/4)

Economic Crop Budget

With Project Condition

III. ZONE-3: Water Harvesting Irrigated Agricultural Project Area

Name of crops	Unit	Paddy Wet Med. (Impr V.)		
		Q'ty	Price (Riel)	Value (1000Riel)
1. Gross Income	Riel			1,650
Main products	kg	2,800	562	1,574
By-product	kg	2,800	27	76
		(straw)		
2. Production Cost	Riel			651
2.1 Inputs	Riel			202
Seed	kg	40	882	35
Farm manure (wet)	ton	1	10,500	11
Fertilizer	kg	80	867	69
Urea	kg	50	963	48
DAP	kg	40	733	29
KCL	kg	1	9,800	10
Agro-chemicals	liter			
2.2 Labor	P-d			265
Hired labor	P-d	21	2,520	53
Family labor	P-d	84	2,520	212
2.3 Draft animal	Riel			153
Land preparation	Ani-d	24.0		80
Plowing	Ani-d	20.0	3,360	67
Paddling	Ani-d	4.0	3,360	13
Transportation	Ani-d	2,500.0	29	73
2.4 Tool/Equipment	Riel			31
3. Net Return	Riel			999
(N.Return/P. Cost Ratio)				1.53

Name of crops	Unit	Mungbean			Vegetables (average)		
		Q'ty	Price (Riel)	Value (1000Riel)	Q'ty	Price (Riel)	Value (1000Riel)
1. Gross Income	Riel			1,049			4,708
Main products	kg	700	1,470	1,029	9,250	509	4,708
By-product	kg	700	29	20	9,250	0	0
		(waste bean)			(stem and waste nuts)		
2. Production Cost	Riel			415			1,544
2.1 Inputs	Riel			204			719
Seed	kg	50	1,372	69	166	980	163
Farm manure (wet)	ton	2	10,500	21	15	10,500	158
Fertilizer	kg	55	867	48	177	867	152
Urea	kg	50	963	48	215	963	207
DAP	kg	25	733	18	0	733	0
KCL	kg	0	9,800	0	4	9,800	39
Agro-chemicals	liter						
2.2 Labor	P-d			151			376
Hired labor	P-d	18	2,520	45	53	2,520	132
Family labor	P-d	42	2,520	106	97	2,520	244
2.3 Draft animal	Riel			40			309
Land preparation	Ani-d	6.0		20	12.0		41
Plowing	Ani-d	5.0	3,360	17	10.0	3,360	34
Paddling	Ani-d	1.0	3,360	3	2.0	3,360	7
Transportation	Ani-d	700.0	29	20	9,250.0	29	268
2.4 Tool/Equipment	Riel			20			140
3. Net Return	Riel			634			3,164
(N.Return/P. Cost Ratio)				1.53			2.05

Table J-4 Economic Crop Budget, With Project Condition, MP Study (4/4)

Economic Crop Budget

With Project Condition

IV. ZONE-IV: Rainfed Agriculture Improvement Area

Name of crops	Unit	Paddy Wet Med. (Impr V.)		
		Qty	Price (Riel)	Value (1000Riel)
1. Gross Income	Riel			1,178
Main products	kg	2,000	562	1,124
By-product	kg	2,000 (straw)	27	54
2. Production Cost	Riel			528
2.1 Inputs	Riel			159
Seed	kg	40	882	35
Farm manure (wet)	ton	1	10,500	11
Fertilizer	kg	50	867	43
	kg	50	963	48
	kg	30	733	22
Agro-chemicals	liter	0	9,800	0
2.2 Labor	P-d			226
Hired labor	P-d	18	2,520	45
Family labor	P-d	72	2,520	181
2.3 Draft animal	Riel			118
Land preparation	Ani-d	18.0		60
Plowing	Ani-d	15.0	3,360	50
Paddling	Ani-d	3.0	3,360	10
Transportation	Ani-d	2,000.0	29	58
2.4 Tool/Equipment	Riel			25
3. Net Return	Riel			650
(N.Return/P. Cost Ratio)				1.23

Name of crops	Unit	Mungbean			Vegetables (average)		
		Qty	Price (Riel)	Value (1000Riel)	Qty	Price (Riel)	Value (1000Riel)
1. Gross Income	Riel			1,049			4,708
Main products	kg	700	1,470	1,029	9,250	509	4,708
By-product	kg	700 (waste bean)	29	20	9,250	0	0
							(stem and waste nuts)
2. Production Cost	Riel			415			1,544
2.1 Inputs	Riel			204			719
Seed	kg	50	1,372	69	166	980	163
Farm manure (wet)	ton	2	10,500	21	15	10,500	158
Fertilizer	kg	55	867	48	177	867	152
	kg	50	963	48	215	963	207
	kg	25	733	18	0	733	0
Agro-chemicals	liter	0	9,800	0	4	9,800	39
2.2 Labor	P-d			151			376
Hired labor	P-d	18	2,520	45	53	2,520	132
Family labor	P-d	42	2,520	106	97	2,520	244
2.3 Draft animal	Riel			40			309
Land preparation	Ani-d	6.0		20	12.0		41
Plowing	Ani-d	5.0	3,360	17	10.0	3,360	34
Paddling	Ani-d	1.0	3,360	3	2.0	3,360	7
Transportation	Ani-d	700.0	29	20	9,250.0	29	268
2.4 Tool/Equipment	Riel			20			140
3. Net Return	Riel			634			3,164
(N.Return/P. Cost Ratio)				1.53			2.05

Table J-5 Economic Irrigation and Drainage Benefit, MP Study (1/8)

I. ZONE-I: Upper North Main Canal (UNMC) Area**(1) Present/Without Project Condition (2006)**

Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	2,445		1,531.2
Early Wet Season Rice			
- Early Variety (HYV)	215	833	179.1
Wet Season Rice			
- Early Variety (HYV)	0	0	0.0
- Medium Variety (irrigated)	1,560	670	1,045.2
- Medium Variety (rainfed)	670	458	306.9
Upland Crop	20		13.7
Upland Crops	18	411	7.4
Vegetables	2	3,162	6.3
Total	2,465		1,544.9
Total Physical Area	2,230	C. Intensity	111%
NPV per ha		Riel '000	US\$
		692.8	170.2
Note : Riel	4,070	/US\$	

(2) Present/Without Project Condition (2007 -)

Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	2,230		1,021.3
Early Wet Season Rice			
- Early Variety (HYV)	0	833	0.0
Wet Season Rice			
- Early Variety (HYV)	0	0	0.0
- Medium Variety (irrigated)	0	670	0.0
- Medium Variety (rainfed)	2,230	458	1,021.3
Upland Crop	20		13.7
Upland Crops	18	411	7.4
Vegetables	2	3,162	6.3
Total	2,250		1,035.0
Total Physical Area	2,230	C. Intensity	101%
NPV per ha		Riel '000	US\$
		464.1	114.0
Note : Riel	4,070	/US\$	

(3) With Project Condition

Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	2,425		2,606.2
Early Wet Season Rice			
- Early Variety (HYV)	215	1,221	262.5
Wet Season Rice			
- Early Variety (HYV)	250	1,221	305.3
- Medium Variety (irrigated)	1,960	1,040	2,038.4
- Medium Variety (rainfed)	0	0	0.0
Upland Crop	110		97.6
Upland Crops	99	634	62.8
Vegetables	11	3,164	34.8
Total	2,535		2,703.8
Total Physical Area	2,210	C. Intensity	115%
NPV per ha		Riel '000	US\$
		1,223.4	300.6
Note : Riel	4,070	/US\$	

(4) Increment (With - Without 2006)

Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	-20		1,075.0
Early Wet Season Rice			
- Early Variety (HYV)	0	1,221	83.4
Wet Season Rice			
- Early Variety (HYV)	250	1,221	305.3
- Medium Variety (irrigated)	400	1,040	993.2
- Medium Variety (rainfed)	-670	458	-306.9
Upland Crop	90		83.9
Upland Crops	81	634	55.4
Vegetables	9	3,164	28.5
Total	70		1,158.9
Total Physical Area	2,210	C. Intensity	4%
NPV per ha		Riel '000	US\$
		530.6	130.4

(5) Increment (With - Without 2007-)

Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	195		1,584.9
Early Wet Season Rice			
- Early Variety (HYV)	215	1,221	262.5
Wet Season Rice			
- Early Variety (HYV)	250	1,221	305.3
- Medium Variety (irrigated)	1,960	1,040	2,038.4
- Medium Variety (rainfed)	-2,230	458	-1,021.3
Upland Crop	90		83.9
Upland Crops	81	634	55.4
Vegetables	9	3,164	28.5
Total	285		1,668.8
Total Physical Area	2,210	C. Intensity	14%
NPV per ha		Riel '000	US\$
		759.3	186.6

Table J-5 Economic Irrigation and Drainage Benefit, MP Study (2/8)

II. ZONE-I: Upper South Main Canal (USMC) Area

(1) Present/Without Project Condition (2006)

Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	2,905		1,723.8
Early Wet Season Rice			
- Early Variety (HYV)	0	833	0.0
Wet Season Rice			
- Early Variety (HYV)	0	0	0.0
- Medium Variety (irrigated)	1,855	670	1,242.9
- Medium Variety (rainfed)	1,050	458	480.9
Upland Crop	10		6.9
Upland Crops	9	411	3.7
Vegetables	1	3,162	3.2
Total	2,915		1,730.7
Total Physical Area	2,905	C. Intensity	100%
NPV per ha		Riel '000	US\$
		595.8	146.4
Note : Riel	4,070	/US\$	

(2) Present/Without Project Condition (2007 -)

Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	2,905		1,330.5
Early Wet Season Rice			
- Early Variety (HYV)	0	833	0.0
Wet Season Rice			
- Early Variety (HYV)	0	0	0.0
- Medium Variety (irrigated)	0	670	0.0
- Medium Variety (rainfed)	2,905	458	1,330.5
Upland Crop	10		6.9
Upland Crops	9	411	3.7
Vegetables	1	3,162	3.2
Total	2,915		1,337.4
Total Physical Area	2,905	C. Intensity	100%
NPV per ha		Riel '000	US\$
		460.4	113.1
Note : Riel	4,070	/US\$	

(3) With Project Condition

Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	2,880		2,995.2
Early Wet Season Rice			
- Early Variety (HYV)	0	1,221	0.0
Wet Season Rice			
- Early Variety (HYV)	0	1,221	0.0
- Medium Variety (irrigated)	2,880	1,040	2,995.2
- Medium Variety (rainfed)	0	0	0.0
Upland Crop	140		129.2
Upland Crops	124	634	78.6
Vegetables	16	3,164	50.6
Total	3,020		3,124.4
Total Physical Area	2,880	C. Intensity	105%
NPV per ha		Riel '000	US\$
		1,084.9	266.6
Note : Riel	4,070	/US\$	

(4) Increment (With - Without 2006)

Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	-25		1,271.4
Early Wet Season Rice			
- Early Variety (HYV)	0	1,221	0.0
Wet Season Rice			
- Early Variety (HYV)	0	1,221	0.0
- Medium Variety (irrigated)	1,025	1,040	1,752.3
- Medium Variety (rainfed)	-1,050	458	-480.9
Upland Crop	130		122.3
Upland Crops	115	634	74.9
Vegetables	15	3,164	47.4
Total	105		1,393.7
Total Physical Area	2,880	C. Intensity	5%
NPV per ha		Riel '000	US\$
		489.1	120.2

(5) Increment (With - Without 2007-)

Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	-25		1,664.7
Early Wet Season Rice			
- Early Variety (HYV)	0	1,221	0.0
Wet Season Rice			
- Early Variety (HYV)	0	1,221	0.0
- Medium Variety (irrigated)	2,880	1,040	2,995.2
- Medium Variety (rainfed)	-2,905	458	-1,330.5
Upland Crop	130		122.3
Upland Crops	115	634	74.9
Vegetables	15	3,164	47.4
Total	105		1,787.0
Total Physical Area	2,880	C. Intensity	5%
NPV per ha		Riel '000	US\$
		624.5	153.5

Table J-5 Economic Irrigation and Drainage Benefit, MP Study (3/8)

III. ZONE-1: Irrigated Agriculture Improvement Model Project (IAIMP) Area**(1) Present/Without Project Condition (2006)**

Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	860		622.7
Early Wet Season Rice			
- Early Variety (HYV)	285	833	237.4
Wet Season Rice			
- Early Variety (HYV)	0	0	0.0
- Medium Variety (irrigated)	575	670	385.3
- Medium Variety (rainfed)	0	458	0.0
Upland Crop	30		20.6
Upland Crops	27	411	11.1
Vegetables	3	3,162	9.5
Total	890		643.3
Total Physical Area	575	C. Intensity	155%
NPV per ha		Riel '000	US\$
		1,118.8	274.9
Note : Riel	4,070	/US\$	

(2) Present/Without Project Condition (2007 -)

Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	575		263.4
Early Wet Season Rice			
- Early Variety (HYV)	0	833	0.0
Wet Season Rice			
- Early Variety (HYV)	0	0	0.0
- Medium Variety (irrigated)	0	670	0.0
- Medium Variety (rainfed)	575	458	263.4
Upland Crop	30		20.6
Upland Crops	27	411	11.1
Vegetables	3	3,162	9.5
Total	605		284.0
Total Physical Area	575	C. Intensity	105%
NPV per ha		Riel '000	US\$
		493.9	121.4
Note : Riel	4,070	/US\$	

(3) With Project Condition

Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	855		992.4
Early Wet Season Rice			
- Early Variety (HYV)	285	1,221	348.0
Wet Season Rice			
- Early Variety (HYV)	285	1,221	348.0
- Medium Variety (irrigated)	285	1,040	296.4
- Medium Variety (rainfed)	0	0	0.0
Upland Crop	30		26.6
Upland Crops	27	634	17.1
Vegetables	3	3,164	9.5
Total	885		1,019.0
Total Physical Area	570	C. Intensity	155%
NPV per ha		Riel '000	US\$
		1,787.7	439.2
Note : Riel	4,070	/US\$	

(4) Increment (With - Without 2006)

Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	-5		369.7
Early Wet Season Rice			
- Early Variety (HYV)	0	1,221	110.6
Wet Season Rice			
- Early Variety (HYV)	285	1,221	348.0
- Medium Variety (irrigated)	-290	1,040	-88.9
- Medium Variety (rainfed)	0	458	0.0
Upland Crop	0		6.0
Upland Crops	0	634	6.0
Vegetables	0	3,164	0.0
Total	-5		375.7
Total Physical Area	570	C. Intensity	0%
NPV per ha		Riel '000	US\$
		668.9	164.3

(5) Increment (With - Without 2007-)

Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	280		729.0
Early Wet Season Rice			
- Early Variety (HYV)	285	1,221	348.0
Wet Season Rice			
- Early Variety (HYV)	285	1,221	348.0
- Medium Variety (irrigated)	285	1,040	296.4
- Medium Variety (rainfed)	-575	458	-263.4
Upland Crop	0		6.0
Upland Crops	0	634	6.0
Vegetables	0	3,164	0.0
Total	280		735.0
Total Physical Area	570	C. Intensity	50%
NPV per ha		Riel '000	US\$
		1,293.8	317.8

Table J-5 Economic Irrigation and Drainage Benefit, MP Study (4/8)

VI. ZONE-2: Lower North Main Canal Area

(1) Present/Without Project Condition (2006)			
Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	1,400		757.8
Early Wet Season Rice			
- Early Variety (HYV)	0	833	0.0
Wet Season Rice			
- Early Variety (HYV)	0	0	0.0
- Medium Variety (irrigated)	550	670	368.5
- Medium Variety (rainfed)	850	458	389.3
Upland Crop	10		9.6
Upland Crops	8	411	3.3
Vegetables	2	3,162	6.3
Total	1,410		767.4
Total Physical Area	1,400	C. Intensity	101%
NPV per ha		Riel '000	US\$
		548.1	134.7
Note : Riel	4,070	/US\$	
(2) Present/Without Project Condition (2007 -)			
Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	1,400		641.2
Early Wet Season Rice			
- Early Variety (HYV)	0	833	0.0
Wet Season Rice			
- Early Variety (HYV)	0	0	0.0
- Medium Variety (irrigated)	0	670	0.0
- Medium Variety (rainfed)	1,400	458	641.2
Upland Crop	10		9.6
Upland Crops	8	411	3.3
Vegetables	2	3,162	6.3
Total	1,410		650.8
Total Physical Area	1,400	C. Intensity	101%
NPV per ha		Riel '000	US\$
		464.9	114.2
Note : Riel	4,070	/US\$	
(3) With Project Condition			
Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	1,590		1,689.8
Early Wet Season Rice			
- Early Variety (HYV)	0	1,221	0.0
Wet Season Rice			
- Early Variety (HYV)	200	1,221	244.2
- Medium Variety (irrigated)	1,390	1,040	1,445.6
- Medium Variety (rainfed)	0	0	0.0
Upland Crop	70		62.0
Upland Crops	63	634	39.9
Vegetables	7	3,164	22.1
Total	1,660		1,751.8
Total Physical Area	1,390	C. Intensity	119%
NPV per ha		Riel '000	US\$
		1,260.3	309.7
Note : Riel	4,070	/US\$	
(4) Increment (With - Without 2006)			
Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	190		932.0
Early Wet Season Rice			
- Early Variety (HYV)	0	1,221	0.0
Wet Season Rice			
- Early Variety (HYV)	200	1,221	244.2
- Medium Variety (irrigated)	840	1,040	1,077.1
- Medium Variety (rainfed)	-850	458	-389.3
Upland Crop	60		52.4
Upland Crops	55	634	36.6
Vegetables	5	3,164	15.8
Total	250		984.4
Total Physical Area	1,390	C. Intensity	19%
NPV per ha		Riel '000	US\$
		712.2	175.0
(5) Increment (With - Without 2007-)			
Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	190		1,048.6
Early Wet Season Rice			
- Early Variety (HYV)	0	1,221	0.0
Wet Season Rice			
- Early Variety (HYV)	200	1,221	244.2
- Medium Variety (irrigated)	1,390	1,040	1,445.6
- Medium Variety (rainfed)	-1,400	458	-641.2
Upland Crop	60		52.4
Upland Crops	55	634	36.6
Vegetables	5	3,164	15.8
Total	250		1,101.0
Total Physical Area	1,390	C. Intensity	19%
NPV per ha		Riel '000	US\$
		795.4	195.5

Table J-5 Economic Irrigation and Drainage Benefit, MP Study (5/8)

V. ZONE-2: Ou Krang Ambel Irrigation Area

(1) Present/Without Project Condition (2006)			
Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	2,930		1,587.9
Early Wet Season Rice			
- Early Variety (HYV)	0	833	0.0
Wet Season Rice			
- Early Variety (HYV)	0	0	0.0
- Medium Variety (irrigated)	1,160	670	777.2
- Medium Variety (rainfed)	1,770	458	810.7
Upland Crop	20		13.7
Upland Crops	18	411	7.4
Vegetables	2	3,162	6.3
Total	2,950		1,601.6
Total Physical Area	2,930	C. Intensity	101%
	NPV per ha	Riel '000	US\$
		546.6	134.3
Note :	Riel	4,070	/US\$
(2) Present/Without Project Condition (2007 -)			
Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	2,930		1,341.9
Early Wet Season Rice			
- Early Variety (HYV)	0	833	0.0
Wet Season Rice			
- Early Variety (HYV)	0	0	0.0
- Medium Variety (irrigated)	0	670	0.0
- Medium Variety (rainfed)	2,930	458	1,341.9
Upland Crop	20		13.7
Upland Crops	18	411	7.4
Vegetables	2	3,162	6.3
Total	2,950		1,355.6
Total Physical Area	2,930	C. Intensity	101%
	NPV per ha	Riel '000	US\$
		462.7	113.7
Note :	Riel	4,070	/US\$
(3) With Project Condition			
Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	3,300		3,504.4
Early Wet Season Rice			
- Early Variety (HYV)	0	1,221	0.0
Wet Season Rice			
- Early Variety (HYV)	400	1,221	488.4
- Medium Variety (irrigated)	2,900	1,040	3,016.0
- Medium Variety (rainfed)	0	0	0.0
Upland Crop	150		133.1
Upland Crops	135	634	85.6
Vegetables	15	3,164	47.5
Total	3,450		3,637.5
Total Physical Area	2,900	C. Intensity	119%
	NPV per ha	Riel '000	US\$
		1,254.3	308.2
Note :	Riel	4,070	/US\$
(4) Increment (With - Without 2006)			
Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	370		1,916.5
Early Wet Season Rice			
- Early Variety (HYV)	0	1,221	0.0
Wet Season Rice			
- Early Variety (HYV)	400	1,221	488.4
- Medium Variety (irrigated)	1,740	1,040	2,238.8
- Medium Variety (rainfed)	-1,770	458	-810.7
Upland Crop	130		119.4
Upland Crops	117	634	78.2
Vegetables	13	3,164	41.2
Total	500		2,035.9
Total Physical Area	2,900	C. Intensity	18%
	NPV per ha	Riel '000	US\$
		707.7	173.9
(5) Increment (With - Without 2007-)			
Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	370		2,162.5
Early Wet Season Rice			
- Early Variety (HYV)	0	1,221	0.0
Wet Season Rice			
- Early Variety (HYV)	400	1,221	488.4
- Medium Variety (irrigated)	2,900	1,040	3,016.0
- Medium Variety (rainfed)	-2,930	458	-1,341.9
Upland Crop	130		119.4
Upland Crops	117	634	78.2
Vegetables	13	3,164	41.2
Total	500		2,281.9
Total Physical Area	2,900	C. Intensity	18%
	NPV per ha	Riel '000	US\$
		791.6	194.5

Table J-5 Economic Irrigation and Drainage Benefit, MP Study (6/8)

VI. ZONE-2: Lower South Main Canal Area

(1) Present/Without Project Condition (2006)			
Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	6,880		3,151.0
Early Wet Season Rice			
- Early Variety (HYV)	0	833	0.0
Wet Season Rice			
- Early Variety (HYV)	0	0	0.0
- Medium Variety (irrigated)	0	670	0.0
- Medium Variety (rainfed)	6,880	458	3,151.0
Upland Crop	80		49.4
Upland Crops	74	411	30.4
Vegetables	6	3,162	19.0
Total	6,960		3,200.4
Total Physical Area	6,880	C. Intensity	101%
	NPV per ha	Riel '000	US\$
		465.2	114.3
Note :	Riel	4,070 /US\$	
(2) Present/Without Project Condition (2007 -)			
Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	6,880		3,151.0
Early Wet Season Rice			
- Early Variety (HYV)	0	833	0.0
Wet Season Rice			
- Early Variety (HYV)	0	0	0.0
- Medium Variety (irrigated)	0	670	0.0
- Medium Variety (rainfed)	6,880	458	3,151.0
Upland Crop	80		49.4
Upland Crops	74	411	30.4
Vegetables	6	3,162	19.0
Total	6,960		3,200.4
Total Physical Area	6,880	C. Intensity	101%
	NPV per ha	Riel '000	US\$
		465.2	114.3
Note :	Riel	4,070 /US\$	
(3) With Project Condition			
Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	7,750		8,241.0
Early Wet Season Rice			
- Early Variety (HYV)	0	1,221	0.0
Wet Season Rice			
- Early Variety (HYV)	1,000	1,221	1,221.0
- Medium Variety (irrigated)	6,750	1,040	7,020.0
- Medium Variety (rainfed)	0	0	0.0
Upland Crop	330		292.7
Upland Crops	297	634	188.3
Vegetables	33	3,164	104.4
Total	8,080		8,533.7
Total Physical Area	6,750	C. Intensity	120%
	NPV per ha	Riel '000	US\$
		1,264.3	310.6
Note :	Riel	4,070 /US\$	
(4) Increment (With - Without 2006)			
Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	870		5,090.0
Early Wet Season Rice			
- Early Variety (HYV)	0	1,221	0.0
Wet Season Rice			
- Early Variety (HYV)	1,000	1,221	1,221.0
- Medium Variety (irrigated)	6,750	1,040	7,020.0
- Medium Variety (rainfed)	-6,880	458	-3,151.0
Upland Crop	250		243.3
Upland Crops	223	634	157.9
Vegetables	27	3,164	85.4
Total	1,120		5,333.3
Total Physical Area	6,750	C. Intensity	19%
	NPV per ha	Riel '000	US\$
		799.1	196.3
(5) Increment (With - Without 2007-)			
Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	870		5,090.0
Early Wet Season Rice			
- Early Variety (HYV)	0	1,221	0.0
Wet Season Rice			
- Early Variety (HYV)	1,000	1,221	1,221.0
- Medium Variety (irrigated)	6,750	1,040	7,020.0
- Medium Variety (rainfed)	-6,880	458	-3,151.0
Upland Crop	250		243.3
Upland Crops	223	634	157.9
Vegetables	27	3,164	85.4
Total	1,120		5,333.3
Total Physical Area	6,750	C. Intensity	19%
	NPV per ha	Riel '000	US\$
		799.1	196.3

Table J-5 Economic Irrigation and Drainage Benefit, MP Study (7/8)

VIII. ZONE-3: Water Harvesting Irrigated Agricultural Improvement Area

(1) Present/Without Project Condition (2006)			
Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	1,200		676.8
Early Wet Season Rice			
- Early Variety (HYV)	0	833	0.0
Wet Season Rice			
- Early Variety (HYV)	0	0	0.0
- Medium Variety (irrigate)	600	670	402.0
- Medium Variety (rainfed)	600	458	274.8
Upland Crop	10		4.1
Upland Crops	10	411	4.1
Vegetables	0	3,162	0.0
Total	1,210		680.9
Total Physical Area	1,200	C. Intensity	101%
NPV per ha		Riel '000	US\$
		567.4	139.4
Note : Riel	4,070	/US\$	

(2) Present/Without Project Condition (2007 -)			
Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	1,200		676.8
Early Wet Season Rice			
- Early Variety (HYV)	0	833	0.0
Wet Season Rice			
- Early Variety (HYV)	0	0	0.0
- Medium Variety (irrigate)	600	670	402.0
- Medium Variety (rainfed)	600	458	274.8
Upland Crop	10		4.1
Upland Crops	10	411	4.1
Vegetables	0	3,162	0.0
Total	1,210		680.9
Total Physical Area	1,200	C. Intensity	101%
NPV per ha		Riel '000	US\$
		567.4	139.4
Note : Riel	4,070	/US\$	

(3) With Project Condition			
Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	1,200		1,198.8
Early Wet Season Rice			
- Early Variety (HYV)	0	1,221	0.0
Wet Season Rice			
- Early Variety (HYV)	0	1,221	0.0
- Medium Variety (irrigate)	1,200	999	1,198.8
- Medium Variety (rainfed)	0	0	0.0
Upland Crop	60		53.2
Upland Crops	54	634	34.2
Vegetables	6	3,164	19.0
Total	1,260		1,252.0
Total Physical Area	1,200	C. Intensity	105%
NPV per ha		Riel '000	US\$
		1,043.3	256.3
Note : Riel	4,070	/US\$	

(4) Increment (With - Without 2006)			
Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	0		522.0
Early Wet Season Rice			
- Early Variety (HYV)	0	1,221	0.0
Wet Season Rice			
- Early Variety (HYV)	0	1,221	0.0
- Medium Variety (irrigate)	600	999	796.8
- Medium Variety (rainfed)	-600	458	-274.8
Upland Crop	50		49.1
Upland Crops	44	634	30.1
Vegetables	6	3,164	19.0
Total	50		571.1
Total Physical Area	600	C. Intensity	4%
NPV per ha		Riel '000	US\$
		475.9	116.9

(5) Increment (With - Without 2007-)			
Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	0		522.0
Early Wet Season Rice			
- Early Variety (HYV)	0	1,221	0.0
Wet Season Rice			
- Early Variety (HYV)	0	1,221	0.0
- Medium Variety (irrigate)	600	999	796.8
- Medium Variety (rainfed)	-600	458	-274.8
Upland Crop	50		49.1
Upland Crops	44	634	30.1
Vegetables	6	3,164	19.0
Total	50		571.1
Total Physical Area	600	C. Intensity	4%
NPV per ha		Riel '000	US\$
		475.9	116.9

Table J-5 Economic Irrigation and Drainage Benefit, MP Study (8/8)

IX. ZONE-4: Rainfed Agriculture Improvement Area**(1) Present/Without Project Condition (2006)**

Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	23,380		10,708.0
Early Wet Season Rice			
- Early Variety (HYV)	0	833	0.0
Wet Season Rice			
- Early Variety (HYV)	0	0	0.0
- Medium Variety (irrigated)	0	670	0.0
- Medium Variety (rainfed)	23,380	458	10,708.0
Upland Crop	0		0.0
Upland Crops	0	411	0.0
Vegetables	0	3,162	0.0
Total	23,380		10,708.0
Total Physical Area	23,380	C. Intensity	100%
	NPV per ha	Riel '000	US\$
		458.0	112.5
Note :	Riel	4,070 /US\$	

(2) Present/Without Project Condition (2007 -)

Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	23,380		10,708.0
Early Wet Season Rice			
- Early Variety (HYV)	0	833	0.0
Wet Season Rice			
- Early Variety (HYV)	0	0	0.0
- Medium Variety (irrigated)	0	670	0.0
- Medium Variety (rainfed)	23,380	458	10,708.0
Upland Crop	0		0.0
Upland Crops	0	411	0.0
Vegetables	0	3,162	0.0
Total	23,380		10,708.0
Total Physical Area	23,380	C. Intensity	100%
	NPV per ha	Riel '000	US\$
		458.0	112.5
Note :	Riel	4,070 /US\$	

(3) With Project Condition

Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	23,380		15,197.0
Early Wet Season Rice			
- Early Variety (HYV)	0	1,221	0.0
Wet Season Rice			
- Early Variety (HYV)	0	1,221	0.0
- Medium Variety (irrigated)	0	1,040	0.0
- Medium Variety (rainfed)	23,380	650	15,197.0
Upland Crop	230		145.8
Upland Crops	230	634	145.8
Vegetables	0	3,164	0.0
Total	23,610		15,342.8
Total Physical Area	23,380	C. Intensity	101%
	NPV per ha	Riel '000	US\$
		656.2	161.2
Note :	Riel	4,070 /US\$	

(4) Increment (With - Without 2006)

Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	0		4,489.0
Early Wet Season Rice			
- Early Variety (HYV)	0	1,221	0.0
Wet Season Rice			
- Early Variety (HYV)	0	1,221	0.0
- Medium Variety (irrigated)	0	1,040	0.0
- Medium Variety (rainfed)	0	650	4,489.0 *
Upland Crop	230		145.8
Upland Crops	230	634	145.8
Vegetables	0	3,164	0.0
Total	230		4,634.8
Total Physical Area	23,380	C. Intensity	1%
	NPV per ha	Riel '000	US\$
		198.2	48.7

* Increment by harvest volume increase due to varietal change

(5) Increment (With - Without 2007-)

Crops	Planted Area (ha)	Net Production Value	
		Per ha (Riel '000)	Total (Riel 'Million)
Paddy	0		4,489.0
Early Wet Season Rice			
- Early Variety (HYV)	0	1,221	0.0
Wet Season Rice			
- Early Variety (HYV)	0	1,221	0.0
- Medium Variety (irrigated)	0	1,040	0.0
- Medium Variety (rainfed)	0	650	4,489.0 *
Upland Crop	230		145.8
Upland Crops	230	634	145.8
Vegetables	0	3,164	0.0
Total	230		4,634.8
Total Physical Area	23,980	C. Intensity	1%
	NPV per ha	Riel '000	US\$
		198.2	48.7

* Increment by harvest volume increase due to varietal change

Table J-6 Annual Incremental Economic Benefit Flow, MP Study (1/3)

I. ZONE-1: Upper North Main Canal Area

Year in Order	Year	Area under Irrigation (ha)	Build-Up Ratio (%)	Benefit Build-Up (Riel Million)				Total
				Year 2012 Area	Year 2013 Area	Year 2014 Area	Year 2015 Area	
1	2011		5					
2	2012		35					
3	2013	210	90	5.6				5.6
4	2014	400	100	39.0	10.6			49.6
5	2015	900		100.3	74.3	23.9		198.5
6	2016	700		<u>111.4</u>	191.0	167.1	18.6	488.1
7	2017			111.4	<u>212.2</u>	429.8	130.0	883.4
8	2018			111.4	212.2	<u>477.5</u>	334.3	1,135.4
9	2019			111.4	212.2	477.5	<u>357.8</u>	<u>1,158.9</u>
10	2020			111.4	212.2	477.5	357.8	1,158.9
11	2021			111.4	212.2	477.5	357.8	1,158.9
12	2022			111.4	212.2	477.5	357.8	1,158.9

Note : Incremental net production value (Rp.'000/ha) 530.6

II. ZONE-1: Upper South Main Canal Area

Year in Order	Year	Area under Irrigation (ha)	Build-Up Ratio (%)	Benefit Build-Up (Riel Million)				Total
				Year 2012 Area	Year 2013 Area	Year 2014 Area	Year 2015 Area	
1	2011		5					
2	2012		35					
3	2013	200	90	4.9				4.9
4	2014	650	100	34.2	15.9			50.1
5	2015	1,500		88.0	111.3	36.7		236.0
6	2016	530		<u>97.8</u>	286.1	256.8	13.0	653.7
7	2017			97.8	<u>317.9</u>	660.3	90.7	1,166.7
8	2018			97.8	317.9	<u>733.7</u>	233.3	1,382.7
9	2019			97.8	317.9	733.7	<u>244.3</u>	<u>1,393.7</u>
10	2020			97.8	317.9	733.7	244.3	1,393.7
11	2021			97.8	317.9	733.7	244.3	1,393.7
12	2022			97.8	317.9	733.7	244.3	1,393.7

Note : Incremental net production value (Rp.'000/ha) 489.1

III. ZONE-1: Irrigated Agriculture Improvement Model Project Area

Year in Order	Year	Area under Irrigation (ha)	Build-Up Ratio (%)	Benefit Build-Up (Riel Million)				Total
				Year 2012 Area	Year 2013 Area	Year 2014 Area	Year 2015 Area	
1	2009		50					
2	2010	170	100	56.9				
3	2011	200		<u>113.7</u>	66.9			180.6
4	2012	200		113.7	<u>133.8</u>	66.9		314.4
5	2013			113.7	133.8	<u>128.2</u>		<u>375.7</u>
6	2014			113.7	133.8	128.2		375.7
7	2015			113.7	133.8	128.2		375.7
8	2016			113.7	133.8	128.2		375.7
9	2017			113.7	133.8	128.2		375.7
10	2018			113.7	133.8	128.2		375.7
11	2019			113.7	133.8	128.2		375.7
12	2020			113.7	133.8	128.2		375.7

Note : Incremental net production value (Rp.'000/ha) 668.9

Table J-6 Annual Incremental Economic Benefit Flow, MP Study (2/3)

IV. ZONE-2: Lower North Main Canal Area

Year in Order	Year	Area under Irrigation (ha)	Build-Up Ratio (%)	Benefit Build-Up (Riel Million)				Total
				Year 2013 Area	Year 2014 Area	Year 2015 Area	Year 2015 Area	
1	2011							
2	2012		20					
3	2013		70					
4	2014	290	100	41.3				41.3
5	2015	500		144.6	71.2			215.8
6	2016	550		<u>206.5</u>	249.3	78.3		534.1
7	2017	50		206.5	<u>356.1</u>	274.2	7.1	843.9
8	2018			206.5	356.1	<u>391.7</u>	24.9	979.2
9	2019			206.5	356.1	391.7	<u>30.1</u>	<u>984.4</u>
10	2020			206.5	356.1	391.7	30.1	984.4
11	2021			206.5	356.1	391.7	30.1	984.4
12	2022			206.5	356.1	391.7	30.1	984.4

Note : Incremental net production value (Rp.'000/ha) 712.2

V. ZONE-2: Lower South Main Canal Area

Year in Order	Year	Area under Irrigation (ha)	Build-Up Ratio (%)	Benefit Build-Up (Riel Million)					Total
				Year 2013 Area	Year 2014 Area	Year 2015 Area	Year 2016 Area	Year 2017 Area	
1	2011								
2	2012		5						
3	2013		35						
4	2014	300	65	12.0					12.0
5	2015	600	90	83.9	24.0				107.9
6	2016	1,500	100	155.8	167.8	59.9			383.5
7	2017	2,500		215.8	311.6	419.5	99.9		1,046.8
8	2018	1,850		<u>239.7</u>	431.5	779.1	699.2	73.9	2,223.4
9	2019			239.7	<u>479.5</u>	1,078.8	1,298.5	517.4	3,613.9
10	2020			239.7	479.5	<u>1,198.7</u>	1,798.0	960.9	4,676.8
11	2021			239.7	479.5	1,198.7	<u>1,997.8</u>	1,330.5	5,246.2
12	2022			239.7	479.5	1,198.7	1,997.8	<u>1,417.6</u>	<u>5,333.3</u>
12	2023			239.7	479.5	1,198.7	1,997.8	1,417.6	5,333.3

Note : Incremental net production value (Rp.'000/ha) 799.1

VI. ZONE-2: Ou Krang Ambel Irrigation Area

Year in Order	Year	Area under Irrigation (ha)	Build-Up Ratio (%)	Benefit Build-Up (Riel Million)				Total
				Year 2013 Area	Year 2014 Area	Year 2015 Area	Year 2015 Area	
1	2011							
2	2012		20					
3	2013		70					
4	2014	400	100	56.6				56.6
5	2015	800		198.2	113.2			311.4
6	2016	1,000		<u>283.1</u>	396.3	141.5		820.9
7	2017	700		283.1	<u>566.2</u>	495.4	99.1	1,443.8
8	2018			283.1	566.2	<u>707.7</u>	346.8	1,903.8
9	2019			283.1	566.2	707.7	<u>478.9</u>	<u>2,035.9</u>
10	2020			283.1	566.2	707.7	478.9	2,035.9
11	2021			283.1	566.2	707.7	478.9	2,035.9
12	2022			283.1	566.2	707.7	478.9	2,035.9

Note : Incremental net production value (Rp.'000/ha) 707.7

Table J-6 Annual Incremental Economic Benefit Flow, MP Study (3/3)

VII. ZONE-3: Water Harvesting Agriculture Improvement Area

Year in Order	Year	Area under Irrigation (ha)	Build-Up Ratio (%)	Benefit Build-Up (Riel Million)						Total
				Year 2009 Area	Year 2010 Area	Year 2011 Area	Year 2012 Area	Year 2013 Area	Year 2014 Area	
1	2010		10							
2	2011	120	30	5.7						5.7
3	2012	240	50	17.1	11.4					28.5
4	2013	240	70	28.6	34.3	11.4				74.3
5	2014	240	90	40.0	57.1	34.3	11.4			142.8
6	2015	240	100	51.4	80.0	57.1	34.3	11.4		234.2
7	2016	120		<u>57.1</u>	102.8	80.0	57.1	34.3	5.7	337.0
8	2017			57.1	<u>114.2</u>	102.8	80.0	57.1	17.1	428.3
9	2018			57.1	114.2	<u>114.2</u>	102.8	80.0	28.6	496.9
10	2019			57.1	114.2	114.2	<u>114.2</u>	102.8	40.0	542.5
11	2020			57.1	114.2	114.2	114.2	<u>114.2</u>	51.4	565.3
12	2021			57.1	114.2	114.2	114.2	114.2	<u>57.1</u>	<u>571.1</u>
12	2022			57.1	114.2	114.2	114.2	114.2	57.1	571.0

Note : Incremental net production value (Rp.'000/ha) 475.9

VIII. ZONE-4: Rainfed Agriculture Improvement

Year in Order	Year	Area under improvement (ha)	Build-Up Ratio (%)	Benefit Build-Up (Riel Million)						
				Year 2009 Area	Year 2010 Area	Year 2011 Area	Year 2012 Area	Year 2013 Area	Year 2014 Area	Year 2015 Area
1	2008		1							
2	2009	100	16	0.2						
3	2010	300	51	3.2	0.6					
4	2011	600	85	10.1	9.5	1.2				
5	2012	1,200	100	16.8	30.3	19.0	2.4			
6	2013	3,000		<u>19.8</u>	50.5	60.6	38.1	5.9		
7	2014	7,000		19.8	<u>59.5</u>	101.1	121.3	95.1	13.9	
8	2015	11,180		19.8	59.5	<u>118.9</u>	202.2	303.2	222.0	22.2
9	2016			19.8	59.5	118.9	<u>237.8</u>	505.4	707.6	354.5
10	2017			19.8	59.5	118.9	237.8	<u>594.6</u>	1,179.3	1,130.1
11	2018			19.8	59.5	118.9	237.8	594.6	<u>1,387.4</u>	1,883.5
12	2019			19.8	59.5	118.9	237.8	594.6	1,387.4	<u>2,216.8</u>

Note : Incremental net production value (Rp.'000/ha) 198.2

Table J-7 Negative Project Benefit, MP Study
(Production Foregone)

Item	NPV Without P. Condition (Riel 000/ha)	Farm Land (ha)	Foregone Amount (Riel Million)
1. ZONE-I: Upper North Main Canal Area			
Construction of canals	692.8	20.0	<u>13.9</u>
2. ZONE-I: Upper South Main Canal Area			
Construction of canals	595.8	25.0	<u>14.9</u>
3. ZONE-I: Irrigated Agriculture Improvement Model Project Area			
Construction of canals	1,118.8	5.0	<u>5.6</u>
ZONE-I: TOTAL; Upper North & South Main Canal Areas			
Construction of canals		50.0	<u>34.4</u>
4. ZONE-II: Lower North Main Canal Area			
Construction of canals	548.1	10.0	<u>5.5</u>
5. ZONE-II: Lower South Main Canal Area			
Construction of canals	465.2	130.0	<u>60.5</u>
6. ZONE-II: Ou Krang Ambel Irrigation Area			
Construction of canals	546.6	30.0	<u>16.4</u>
ZONE-II: TOTAL; Lower North & South and Ou Krang Ambel Area			
Construction of canals		170.0	<u>82.4</u>
OVERALL TOTAL : ZONE-I & II			
Construction of canals		220.0	<u>116.8</u>

Table J-8 Economic Investment Cost, MP Study (1/3)

I. Roleing Chrey Regulator and Intakes (RC)

(Unit : Riel: Million)

Description	Financial Cost			Conversion Factors	Economic Cost									
	F/C	L/C	Total		Total	2009	2010	2011	2012	2013	2014	2015	2016	2017
1. Preparatory Works	464	199	663	0.77	510	510								
2. Direct Cost														
1)R. Chrey Reg. Rehab. and Intake	6,172	2,646	8,818	0.77	6,760	340	4,060	2,370						
2)North and South Intake Rehabilitation	3,114	1,335	4,449	0.77	3,410	170	2,050	1,190						
3. O&M Equipment	122	0	122	0.74	90			90						
4. Administration Cost	816	318	1,134	0.77	870	40	440	390						
5. Engineering Services	1,148	484	1,632	0.97	1,580	80	870	630						
Total (1 to 5)	11,837	4,981	16,818	0.79	13,220	1,140	7,420	4,670						
6. Physical Contingen (10% of 1 to 5)	1,180	500	1,680		1,322	114	742	467						
Grand Total	13,017	5,481	18,498		14,542	1,254	8,162	5,137						

II. ZONE-1: Upper North Main Canal Irrigation (UNMC)

(Unit : Riel Million)

Description	Financial Cost			Conversion Factors	Economic Cost									
	F/C	L/C	Total		Total	2011	2012	2013	2014	2015	2016	2017	2018	2019
1. Preparatory Works	987	423	1,411	0.77	1,079	270	540	270						
2. Direct Cost														
1)North Main Canal	16,185	6,937	23,122	0.77	17,693	885	6,193	10,616	0					
2)Secondary, Tertiary Canals	3,564	1,527	5,092	0.77	3,896	390	1,558	1,870	78					
3. O&M Equipment	257	0	257	0.73	188			188						
4. Agricultural Supporting Activities	51	120	171	0.79	135			61	68	7				
5. Formation and Strengthening FWUC	42	160	201	0.80	162		41	41	65	16				
6. Administration Cost	1,580	677	2,257	0.77	1,727	173	605	518	397	35				
7. Engineering Services	2,197	941	3,138	0.96	3,025	303	1,059	1,059	605					
Total (1 to 7)	24,863	10,785	35,649	0.78	27,905	1,630	8,826	14,310	3,005	135				
8. Physical Contingen (10% of 1 to 7)	2,486	1,079	3,565		2,791	163	883	1,431	301	14				
Grand Total	27,350	11,864	39,213		30,696	1,793	9,708	15,741	3,305	149				

III. ZONE-1: Upper South Main Canal Irrigation (USMC)

(Unit : Riel Million)

Description	Financial Cost			Conversion Factors	Economic Cost									
	F/C	L/C	Total		Total	2011	2012	2013	2014	2015	2016	2017	2018	2019
1. Preparatory Works	856	367	1,223	0.77	936	187	561	187						
2. Direct Cost														
1)South Main Canal	11,932	5,114	17,045	0.77	13,043	0	3,913	7,826	1,304					
2)Secondary, Tertiary Canals	5,191	2,225	7,416	0.77	5,675	284	2,554	2,554	284					
3. O&M Equipment	224	0	224	0.73	163			163						
4. Agricultural Supporting Activities	66	154	220	0.79	173			61	95	17				
5. Formation and Strengthening FWUC	53	212	265	0.81	213		21	64	107	21				
6. Administration Cost	1,370	587	1,957	0.77	1,497	150	449	524	300	75				
7. Engineering Services	1,789	767	2,556	0.96	2,464	370	986	739	370					
Total (1 to 7)	21,480	9,424	30,905	0.78	24,165	706	6,214	12,118	4,729	397				
8. Physical Contingen (10% of 1 to 7)	2,148	942	3,090		2,417	71	621	1,212	473	40				
Grand Total	23,628	10,367	33,995		26,581	777	6,836	13,330	5,202	437				

IV. ZONE-1: Irrigated Agriculture Improvement Model Project (IAIMP)

(Unit : Riel Million)

Description	Financial Cost			Conversion Factors	Economic Cost									
	F/C	L/C	Total		Total	2009	2010	2011	2012	2013	2014	2015	2016	2017
1. Preparatory Works	156	67	223	0.76	170	111	60							
2. Direct Cost														
1)South Main Canal	2,370	1,016	3,386	0.77	2,591	1,814	777							
2)Secondary, Tertiary Canals	749	321	1,070	0.77	819	287	532							
3. O&M Equipment	41	0	41	0.73	30		30							
4. Agricultural Supporting Activities	28	66	94	0.79	74	15	48	4	4	4				
5. Formation and Strengthening FWUC	20	81	102	0.81	82	41	41							
6. Administration Cost	250	107	357	0.77	273	137	134	3						
7. Engineering Services	487	209	696	0.96	671	403	268							
Total (1 to 7)	4,102	1,867	5,968	0.79	4,710	2,806	1,890	6	4	4				
8. Physical Contingen (10% of 1 to 7)	410	187	597		471	281	189	1	0	0				
Grand Total	4,512	2,053	6,565		5,181	3,087	2,079	7	4	4				

Table J-8 Economic Investment Cost, MP Study (2/3)

V. ZONE-2: Lower North Main Canal Irrigation (LNMCI)

(Unit : Riel Million)

Description	Financial Cost			Conversion Factors	Economic Cost									
	F/C	L/C	Total		Total	2011	2012	2013	2014	2015	2016	2017	2018	2019
1. Preparatory Works	259	111	370	0.77	283		156	127						
2. Direct Cost														
1)Secondary, Tertiary Canals	5,177	2,219	7,395	0.77	5,659		1,132	3,112	1,415					
3. O&M Equipment	69	0	69	0.73	51			51						
4. Agricultural Supporting Activities	29	68	98	0.79	77		27	27	23					
5. Formation and Strengthening FWUC	21	85	106	0.81	85		26	34	26					
6. Administration Cost	414	177	592	0.77	453		136	158	158					
7. Engineering Services	877	376	1,254	0.96	1,208		483	483	242					
Total (1 to 7)	6,847	3,036	9,883	0.78	7,816		1,959	3,993	1,864					
8. Physical Contingenc(10% of 1 to 7)	685	304	988		782		196	399	186					
Grand Total	7,531	3,340	10,871		8,598		2,155	4,393	2,050					

VI. ZONE-2: Ou Krang Ambel Irrigation

(Unit : Riel Million)

Description	Financial Cost			Conversion Factors	Economic Cost									
	F/C	L/C	Total		Total	2011	2012	2013	2014	2015	2016	2017	2018	2019
1. Preparatory Works	629	270	899	0.77	688		482	206						
2. Direct Cost														
1)Secondary, Tertiary Canals	11,869	5,087	16,956	0.77	12,974		6,487	5,190	1,297					
2)Water Harvest	718	308	1,026	0.77	785		471	314						
3. O&M Equipment	163	0	163	0.73	119			119						
4. Agricultural Supporting Activities	60	140	199	0.79	157		47	71	39					
5. Formation and Strengthening FWUC	48	192	240	0.81	194		77	97	19					
6. Administration Cost	1,007	432	1,439	0.77	1,101		440	550	110					
7. Engineering Services	1,350	579	1,929	0.96	1,860		930	744	186					
Total (1 to 7)	15,844	7,006	22,850	0.78	17,877		8,935	7,291	1,652					
8. Physical Contingenc(10% of 1 to 7)	1,584	701	2,285		1,788		894	729	165					
Grand Total	17,429	7,707	25,135		19,665		9,828	8,020	1,817					

VII. ZONE-2: Lower South Main Canal Irrigation (LSMC)

(Unit : Riel Million)

Description	Financial Cost			Conversion Factors	Economic Cost									
	F/C	L/C	Total		Total	2010	2011	2012	2013	2014	2015	2016	2017	2018
1. Preparatory Works	1,342	575	1,917	0.77	1,467		880	587						
2. Direct Cost														
1)South Main Canal	2,920	1,252	4,172	0.8	3,192		638	2,235	319					
2)Secondary, Tertiary Canals	22,208	9,518	31,726	0.77	24,277		3,642	9,711	3,642	3,642	3,642			
3)Water Harvest	1,702	731	2,434	0.77	1,862		186	931	372	372				
3. O&M Equipment	350	0	350	0.73	256				256					
4. Agricultural Supporting Activities	138	322	460	0.79	363		36	73	73	91	91			
5. Formation and Strengthening FWUC	93	371	464	0.81	374		37	75	75	112	75			
6. Administration Cost	2,010	862	2,872	0.77	2,198		659	440	440	330	330			
7. Engineering Services	2,493	1,068	3,561	0.96	3,433		1,030	687	687	515	515			
Total (1 to 7)	33,256	14,699	47,955	0.78	37,421		7,109	14,736	5,862	5,061	4,652			
8. Physical Contingenc(10% of 1 to 7)	3,326	1,470	4,796		3,742		711	1,474	586	506	465			
Grand Total	36,582	16,169	52,750		41,163		7,820	16,210	6,448	5,568	5,117			

Table J-8 Economic Investment Cost, MP Study (3/3)

VIII. ZONE-3: Water Harvesting Agriculture Improvement Area

(Unit : Riel Million)

Description	Financial Cost			Conversion Factors	Economic Cost									
	F/C	L/C	Total		Total	2010	2011	2012	2013	2014	2015	2016	2017	2018
1. Preparatory Works	612	262	874	0.77	669	34	268	301	67					
2. Direct Cost														
1)Secondary, Tertiary Canals	404	173	577	0.8	441		44	88	177	88	44			
2)Water Harvest	11,836	5,073	16,909	0.77	12,939		1,294	4,529	4,529	1,294	1,294			
3. O&M Equipment	175	0	175	0.73	128		26	38	38	13	13			
4. Agricultural Supporting Activities	15	34	49	0.79	38		4	8	15	8	4			
5. Formation and Strengthening FWUC	13	52	65	0.81	53		12	12	15	9	6			
6. Administration Cost	979	420	1,399	0.77	1,070	54	214	268	268	161	107			
7. Engineering Services	1,282	549	1,832	0.96	1,766	88	530	618	353	177				
Total (1 to 7)	15,316	6,563	21,880	0.78	17,104	175	2,391	5,861	5,461	1,749	1,467			
8. Physical Contingenc(10% of 1 to 7)	1,532	656	2,188		1,710	18	239	586	546	175	147			
Grand Total	16,848	7,220	24,067		18,814	193	2,630	6,447	6,007	1,924	1,614			

IX. ZONE-4: Rainfed Agriculture Improvement Area

(Unit : Riel Million)

Description	Financial Cost			Conversion Factors	Economic Cost									
	F/C	L/C	Total		Total	2008	2009	2010	2011	2012	2013	2014	2015	2016
1. Preparatory Works	16	65	81	0.78	63	19	29	16	0					
2. Direct Cost														
1)Secondary, Tertiary Canals	0	0	0	0.00	0									
2)Water Harvest	0	0	0	0.00	0									
3. O&M Equipment	0	0	0	0.00	0									
4. Agricultural Supporting Activities	325	1,301	1,626	0.78	1,269		190	444	444	190				
5. Formation and Strengthening FWUC	0	0	0	0.00	0									
6. Administration Cost	26	104	130	0.78	102	0	25	31	31	15				
7. Engineering Services	6,431	2,031	8,462	0.00	8,218	1,890	2,055	1,397	1,479	1,397				
Total (1 to 7)	6,798	3,501	10,299	0.94	9,651	1,909	2,299	1,887	1,954	1,603				
8. Physical Contingenc(10% of 1 to 7)	680	350	1,030		965	191	230	189	195	160				
Grand Total	7,478	3,851	11,329		10,616	2,100	2,529	2,076	2,149	1,763				

Table J-9 Economic Annual O&M Cost, MP Study (1/8)

I. Roleang Chrey Regulator and Intakes (RC)**(1) Economic Annual O&M Cost at Full Stage**

Item	Financial Cost (Riel Million)	Conversion Factor	Economic Cost (Riel Million)
1. Materials	6.6	0.83	5.5
2. Equipment	6.6	0.75	4.9
3. Labor	13.2	0.48	6.3
4. O&M Staff	39.5	0.88	34.8
Total (ha) 16,700	65.86		51.5
Per ha (Riel)			<u>3,084</u>

(2) Annual Disbursement of Economic O&M Cost

Year in Order	Year	Area under Irrigation (ha)	Annual O&M Cost (Riel Million)
1	2009	16700	
2	2010	16700	
3	2011	16700	51.5
4	2012	16700	51.5
5	2013	16700	51.5
6	2014	16700	51.5
7	2015	16700	51.5
8	2016	16700	51.5
9	2017	16700	51.5
10	2018	16700	51.5
11	2019	16700	51.5
12	2020	16700	51.5
13	2021	16700	51.5
14	2022	16700	51.5
15	2023	16700	51.5

Table J-9 Economic Annual O&M Cost, MP Study (2/8)

II. Upper North Main Canal Area (UNMC)**(1) Economic Annual O&M Cost at Full Stage**

Item	Financial Cost (Riel Million)	Conversion Factor	Economic Cost (Riel Million)
1. Materials	14	0.83	11.6
2. Equipment	14	0.75	10.5
3. Labor	28	0.48	13.4
4. O&M Staff	83.9	0.88	73.8
Total (ha) 2,210	139.9		109.3
Per ha (Riel)			<u>49,457</u>

(2) Annual Disbursement of Economic O&M Cost

Year in Order	Year	Area under Irrigation (ha)	Annual O&M Cost (Riel Million)
1	2011		
2	2012		
3	2013	210	10.4
4	2014	610	30.2
5	2015	1,510	74.7
6	2016	<u>2,210</u>	109.3
7	2017	2,210	109.3
8	2018	2,210	109.3
9	2019	2,210	109.3
10	2020	2,210	109.3
11	2021	2,210	109.3
12	2022	2,210	109.3
13	2023	2,210	109.3
14	2024	2,210	109.3
15	2025	2,210	109.3

Table J-9 Economic Annual O&M Cost, MP Study (3/8)

III. Upper South Main Canal Area (USMC)

(1) Economic Annual O&M Cost at Full Stage

Item	Financial Cost (Riel Million)	Conversion Factor	Economic Cost (Riel Million)
1. Materials	12.1	0.83	10
2. Equipment	12.1	0.75	9.1
3. Labor	24.3	0.48	11.7
4. O&M Staff	72.8	0.88	64.1
Total (ha) 2,880	121.3		94.9
Per ha (Riel)			<u>32,951</u>

(2) Annual Disbursement of Economic O&M Cost

Year in Order	Year	Area under Irrigation (ha)	Annual O&M Cost (Riel Million)
1	2011		
2	2012		
3	2013	200	6.6
4	2014	850	28
5	2015	2,350	77.4
6	2016	<u>2,880</u>	<u>94.9</u>
7	2017	2,880	94.9
8	2018	2,880	94.9
9	2019	2,880	94.9
10	2020	2,880	94.9
11	2021	2,880	94.9
12	2022	2,880	94.9
13	2023	2,880	94.9
14	2024	2,880	94.9
15	2025	2,880	94.9

Table J-9 Economic Annual O&M Cost, MP Study (4/8)

IV. Irrigated Agriculture Improvement Model Project Area (IAIMP)

(1) Economic Annual O&M Cost at Full Stage

Item	Financial Cost (Riel Million)	Conversion Factor	Economic Cost (Riel Million)
1. Materials	2.2	0.82	1.8
2. Equipment	2.2	0.85	1.9
3. Labor	4.4	0.48	2.1
4. O&M Staff	13.3	0.88	11.7
Total (ha) 570	22.1		17.5
Per ha (Riel)			<u>30,702</u>

(2) Annual Disbursement of Economic O&M Cost

Year in Order	Year	Area under Irrigation (ha)	Annual O&M Cost (Riel Million)
1	2009		
2	2010	70	2.1
3	2011	220	6.8
4	2012	370	11.4
5	2013	<u>570</u>	<u>17.5</u>
6	2014	570	17.5
7	2015	570	17.5
8	2016	570	17.5
9	2017	570	17.5
10	2018	570	17.5
11	2019	570	17.5
12	2020	570	17.5
13	2021	570	17.5
14	2022	570	17.5
15	2023	570	17.5

Table J-9 Economic Annual O&M Cost, MP Study (5/8)

V. Lower North Main Canal Area (LNMC)**(1) Economic Annual O&M Cost at Full Stage**

Item	Financial Cost (Riel Million)	Conversion Factor	Economic Cost (Riel Million)
1. Materials	3.7	0.83	3.1
2. Equipment	3.7	0.75	2.8
3. Labor	7.3	0.48	3.5
4. O&M Staff	22	0.88	19.4
Total (1,390 ha)	36.7		28.8
Per ha (Riel)			<u>20,719</u>

(2) Annual Disbursement of Economic O&M Cost

Year in Order	Year	Area under Irrigation (ha)	Annual O&M Cost (Riel Million)
1	2011		
2	2012		
3	2013		
4	2014	290	6.0
5	2015	790	16.4
6	2016	1,340	27.8
7	2017	<u>1,390</u>	<u>28.8</u>
8	2018	1,390	28.8
9	2019	1,390	28.8
10	2020	1,390	28.8
11	2021	1,390	28.8
12	2022	1,390	28.8
13	2023	1,390	28.8
14	2024	1,390	28.8
15	2025	1,390	28.8

Table J-9 Economic Annual O&M Cost, MP Study (6/8)

VI. Ou Krang Ambel Area**(1) Economic Annual O&M Cost at Full Stage**

Item	Financial Cost (Riel Million)	Conversion Factor	Economic Cost (Riel Million)
1. Materials	8.9	0.82	7.3
2. Equipment	8.9	0.74	6.6
3. Labor	17.8	0.48	8.5
4. O&M Staff	53.5	0.88	47.1
Total (2,900 ha)	89.1		69.5
Per ha (Riel)			<u>23,966</u>

(2) Annual Disbursement of Economic O&M Cost

Year in Order	Year	Area under Irrigation (ha)	Annual O&M Cost (Riel Million)
1	2011		
2	2012		
3	2013		
4	2014	400	9.6
5	2015	1,200	28.8
6	2016	2,200	52.7
7	2017	<u>2,900</u>	<u>69.5</u>
8	2018	2,900	69.5
9	2019	2,900	69.5
10	2020	2,900	69.5
11	2021	2,900	69.5
12	2022	2,900	69.5
13	2023	2,900	69.5
14	2024	2,900	69.5
15	2025	2,900	69.5

Table J-9 Economic Annual O&M Cost, MP Study (7/8)

VII. Lower South Main Canal Area (LSMC)

(1) Economic Annual O&M Cost at Full Stage

Item	Financial Cost (Riel Million)	Conversion Factor	Economic Cost (Riel Million)
1. Materials	19	0.83	15.8
2. Equipment	19	0.75	14.3
3. Labor	38	0.48	18.2
4. O&M Staff	114	0.88	100.3
Total (6,750 ha)	190		148.6
Per ha (Riel)			<u>22,015</u>

(2) Annual Disbursement of Economic O&M Cost

Year in Order	Year	Area under Irrigation (ha)	Annual O&M Cost (Riel Million)
1	2010		
2	2011		
3	2012		
4	2013	300	6.6
5	2014	900	19.8
6	2015	2,400	52.8
7	2016	4,900	107.9
8	2017	<u>6,750</u>	<u>148.6</u>
9	2018	6,750	148.6
10	2019	6,750	148.6
11	2020	6,750	148.6
12	2021	6,750	148.6
13	2022	6,750	148.6
14	2023	6,750	148.6
15	2024	6,750	148.6

Table J-9 Economic Annual O&M Cost, MP Study (8/8)

VIII. ZONE-3: Water Harvesting Agriculture Improvement Area

(1) Economic Annual O&M Cost at Full Stage

Item	Financial Cost (Riel Million)	Conversion Factor	Economic Cost (Riel Million)
1. Materials	9.5	0.83	7.9
2. Equipment	9.5	0.75	7.1
3. Labor	18.9	0.48	9.1
4. O&M Staff	56.8	0.88	50
Total (600 ha)	94.7		74.1
Per ha (Riel)			<u>123,500</u>

(2) Annual Disbursement of Economic O&M Cost

Year in Order	Year	Area under Irrigation (ha)	Annual O&M Cost (Riel Million)
1	2010		
2	2011	60	7.4
3	2012	180	22.2
4	2013	300	37.1
5	2014	420	51.9
6	2015	540	66.7
7	2016	<u>600</u>	<u>74.1</u>
8	2017	600	74.1
9	2018	600	74.1
10	2019	600	74.1
11	2020	600	74.1
12	2021	600	74.1
13	2022	600	74.1
14	2023	600	74.1
15	2024	600	74.1
16	2025	600	74.1

Table J-10 Economic Replacement Cost, MP Study (1/8)

I. Roleang Chrey Regulator and Intakes (RC)

(1) Economic Replacement Cost by Item

Item	Useful Life (year)	Financial Cost (Riel Million)	Conversion Factor	Economic Cost (Riel Million)
1. Project Facilities				
1) Gates of R.C Reg. and N & S Intakes				
- Gate	25	19,692.0	0.81	15,950.5
2. O&M Equipment				
	10	122.1	0.74	90.4

(2) Annual Replacement Cost

(Unit : Riel Million)											
Year in Order	Year	With 5 Years'	With 10 Years'	With 25 Years'	Total	Year in Order	Year	With 5 Years'	With 10 Years'	With 25 Years'	Total
1	2009					26	2034				
2	2010					27	2035				
3	2011					28	2036			15,950.5	15950.5
4	2012					29	2037				
5	2013					30	2038				
6	2014					31	2039				
7	2015					32	2040				
8	2016					33	2041		90.4		90.4
9	2017					34	2042				
10	2018					35	2043				
11	2019					36	2044				
12	2020					37	2045				
13	2021		90.4		90.4	38	2046				
14	2022					39	2047				
15	2023					40	2048				
16	2024					41	2049				
17	2025					42	2050				
18	2026					43	2051		90.4		90.4
19	2027					44	2052				
20	2028					45	2053				
21	2029					46	2054				
22	2030					47	2055				
23	2031		90.4		90.4	48	2056				
24	2032					49	2057				
25	2033					50	2058				

Table J-10 Economic Replacement Cost, MP Study (2/8)

II. ZONE-1: Upper North Main Canal Area (UNMC)

(1) Economic Replacement Cost by Item

Item	Useful Life (year)	Financial Cost (Riel Million)	Conversion Factor	Economic Cost (Riel Million)
1. Project Facilities				
1) North main Canal Gates	25	496	0.81	401.8
2) Secondary, Tertiary Gates	25	192.0	0.81	155.5
3) Water Harvesting Gates	25	128.0	0.81	103.7
2. O&M Equipment				
	10	257.2	0.73	187.8

(2) Annual Replacement Cost

(Unit : Riel Million)											
Year in Order	Year	With 5 Years'	With 10 Years'	With 25 Years'	Total	Year in Order	Year	With 5 Years'	With 10 Years'	With 25 Years'	Total
1	2011					26	2036				
2	2012					27	2037				
3	2013					28	2038				
4	2014					29	2039			401.8	401.8
5	2015					30	2040			155.5	155.5
6	2016					31	2041			103.7	103.7
7	2017					32	2042				
8	2018					33	2043		187.8		187.8
9	2019					34	2044				
10	2020					35	2045				
11	2021					36	2046				
12	2022					37	2047				
13	2023		187.8		187.8	38	2048				
14	2024					39	2049				
15	2025					40	2050				
16	2026					41	2051				
17	2027					42	2052				
18	2028					43	2053		187.8		187.8
19	2029					44	2054				
20	2030					45	2055				
21	2031					46	2056				
22	2032					47	2057				
23	2033		187.8		187.8	48	2058				
24	2034					49	2059				
25	2035					50	2060				

Table J-10 Economic Replacement Cost, MP Study (3/8)

III. ZONE-1: Upper South Main Canal Area (USMC)

(1) Economic Replacement Cost by Item

Item	Useful Life (year)	Financial Cost (Riel Million)	Conversion Factor	Economic Cost (Riel Million)
1. Project Facilities				
1) South main Canal Gates	25	248	0.81	200.9
2) Secondary. Tertiary Gates	25	252.0	0.81	204.1
3) Water Harvesting Gates	25	48.0	0.81	38.9
2. O&M Equipment				
	10	220.0	0.73	160.6

(2) Annual Replacement Cost

(Unit : Riel Million)											
Year in Order	Year	With 5 Years'	With 10 Years'	With 25 Years'	Total	Year in Order	Year	With 5 Years'	With 10 Years'	With 25 Years'	Total
1	2011					26	2036				
2	2012					27	2037				
3	2013					28	2038				
4	2014					29	2039			200.9	200.9
5	2015					30	2040			204.1	204.1
6	2016					31	2041			38.9	38.9
7	2017					32	2042				
8	2018					33	2043		160.6		160.6
9	2019					34	2044				
10	2020					35	2045				
11	2021					36	2046				
12	2022					37	2047				
13	2023		160.6		160.6	38	2048				
14	2024					39	2049				
15	2025					40	2050				
16	2026					41	2051				
17	2027					42	2052				
18	2028					43	2053		160.6		160.6
19	2029					44	2054				
20	2030					45	2055				
21	2031					46	2056				
22	2032					47	2057				
23	2033			160.6	160.6	48	2058				
24	2034					49	2059				
25	2035					50	2060				

Table J-10 Economic Replacement Cost, MP Study (4/8)

IV. ZONE-1: Irrigated Agriculture Improvement Model Project Area (IAIMP)

(1) Economic Replacement Cost by Item

Item	Useful Life (year)	Financial Cost (Riel Million)	Conversion Factor	Economic Cost (Riel Million)
1. Project Facilities				
1) South main Canal Gates	25	120	0.81	97.2
2) Secondary. Tertiary Gates	25	60.0	0.81	48.6
2. O&M Equipment				
	10	44.0	0.73	32.1

(2) Annual Replacement Cost

(Unit : Riel Million)											
Year in Order	Year	With 5 Years'	With 10 Years'	With 25 Years'	Total	Year in Order	Year	With 5 Years'	With 10 Years'	With 25 Years'	Total
1	2011					26	2036				
2	2012					27	2037				
3	2013					28	2038			97.2	97.2
4	2014					29	2039			48.6	48.6
5	2015					30	2040				
6	2016					31	2041				
7	2017					32	2042		32.1		32.1
8	2018					33	2043				
9	2019					34	2044				
10	2020					35	2045				
11	2021					36	2046				
12	2022					37	2047				
13	2023		32.1		32.1	38	2048				
14	2024					39	2049				
15	2025					40	2050				
16	2026					41	2051				
17	2027					42	2052		32.1		32.1
18	2028					43	2053				
19	2029					44	2054				
20	2030					45	2055				
21	2031					46	2056				
22	2032			32.1	32.1	47	2057				
23	2033					48	2058				
24	2034					49	2059				
25	2035					50	2060				

Table J-10 Economic Replacement Cost, MP Study (5/8)

V. ZONE-2: Lower North Main Canal Area (LNMC)

(1) Economic Replacement Cost by Item

Item	Useful Life (year)	Financial Cost (Riel Million)	Conversion Factor	Economic Cost (Riel Million)
1. Project Facilities				
1) Secondary, Tertiary Canal G	25	556.0	0.81	450.4
2. O&M Equipment	10	69.2	0.73	50.5

(2) Annual Replacement Cost

(Unit : Riel Million)											
Year in Order	Year	With 5 Years'	With 10 Years'	With 25 Years'	Total	Year in Order	Year	With 5 Years'	With 10 Years'	With 25 Years'	Total
1	2011					26	2036				
2	2012					27	2037				
3	2013					28	2038				
4	2014					29	2039				
5	2015					30	2040			450.4	450.4
6	2016					31	2041				
7	2017					32	2042				
8	2018					33	2043				
9	2019					34	2044		50.5		50.5
10	2020					35	2045				
11	2021					36	2046				
12	2022					37	2047				
13	2023					38	2048				
14	2024		50.5		50.5	39	2049				
15	2025					40	2050				
16	2026					41	2051				
17	2027					42	2052				
18	2028					43	2053				
19	2029					44	2054		50.5		50.5
20	2030					45	2055				
21	2031					46	2056				
22	2032					47	2057				
23	2033					48	2058				
24	2034		50.5		50.5	49	2059				
25	2035					50	2060				

Table J-10 Economic Replacement Cost, MP Study (6/8)

VI. ZONE-2: Ou Krang Ambel Irrigation Area

(1) Economic Replacement Cost by Item

Item	Useful Life (year)	Financial Cost (Riel Million)	Conversion Factor	Economic Cost (Riel Million)
1. Project Facilities				
1) Secondary, Tertiary Canal G	25	508.0	0.81	411.5
2) Water Harvesting Gates	25	64.0	0.81	51.8
2. O&M Equipment	10	162.8	0.73	118.8

(2) Annual Replacement Cost

(Unit : Riel Million)											
Year in Order	Year	With 5 Years'	With 10 Years'	With 25 Years'	Total	Year in Order	Year	With 5 Years'	With 10 Years'	With 25 Years'	Total
1	2011					26	2036				
2	2012					27	2037				
3	2013					28	2038				
4	2014					29	2039				
5	2015					30	2040			411.5	411.5
6	2016					31	2041			51.8	51.8
7	2017					32	2042				
8	2018					33	2043				
9	2019					34	2044		118.8		118.8
10	2020					35	2045				
11	2021					36	2046				
12	2022					37	2047				
13	2023					38	2048				
14	2024		118.8		118.8	39	2049				
15	2025					40	2050				
16	2026					41	2051				
17	2027					42	2052				
18	2028					43	2053				
19	2029					44	2054		118.8		118.8
20	2030					45	2055				
21	2031					46	2056				
22	2032					47	2057				
23	2033					48	2058				
24	2034		118.8		118.8	49	2059				
25	2035					50	2060				

Table J-10 Economic Replacement Cost, MP Study (7/8)

VII. ZONE-2: Lower South Main Canal Area (LSMC)

(1) Economic Replacement Cost by Item

Item	Useful Life (year)	Financial Cost (Riel Million)	Conversion Factor	Economic Cost (Riel Million)
1. Project Facilities				
1) South Main Canal	25	72.0	0.81	58.3
2) Secondary. Tertiary Canal G	25	2,036.0	0.81	1,649.2
3) Water Harvesting Gates	25	112.0	0.81	90.7
2. O&M Equipment	10	350.0	0.73	255.5

(2) Annual Replacement Cost

(Unit : Riel Million)											
Year in Order	Year	With 5 Years'	With 10 Years'	With 25 Years'	Total	Year in Order	Year	With 5 Years'	With 10 Years'	With 25 Years'	Total
1	2010					26	2035				
2	2011					27	2036		255.5		255.5
3	2012					28	2037				
4	2013					29	2038				
5	2014					30	2039				
6	2015					31	2040			58.3	58.3
7	2016					32	2041			1,649.2	1,649.2
8	2017					33	2042			90.7	90.7
9	2018					34	2043				
10	2019					35	2044				
11	2020					36	2045		255.5		255.5
12	2021					37	2046				
13	2022					38	2047				
14	2023					39	2048				
15	2024					40	2049				
16	2025		255.5		255.5	41	2050				
17	2026					42	2051				
18	2027					43	2052				
19	2028					44	2053				
20	2029					45	2054				
21	2030					46	2055		255.5		255.5
22	2031					47	2056				
23	2032					48	2057				
24	2033					49	2058				
25	2034					50	2059				

Table J-10 Economic Replacement Cost, MP Study (8/8)

VIII. ZONE-3: Water Harvest Agriculture Improvement Area

(1) Economic Replacement Cost by Item

Item	Useful Life (year)	Financial Cost (Riel Million)	Conversion Factor	Economic Cost (Riel Million)
1. Project Facilities				
1) Water Harvesting Gates	25	816.0	0.81	661.0
2. O&M Equipment	10	175.0	0.73	127.8

(2) Annual Replacement Cost

(Unit : Riel Million)											
Year in Order	Year	With 5 Years'	With 10 Years'	With 25 Years'	Total	Year in Order	Year	With 5 Years'	With 10 Years'	With 25 Years'	Total
1	2010					26	2035				
2	2011					27	2036		20.5	110.5	131.0
3	2012					28	2037			110	110.0
4	2013					29	2038			110	110.0
5	2014					30	2039			110	110.0
6	2015					31	2040		21	110	131.0
7	2016					32	2041		21		21.0
8	2017					33	2042		21		21.0
9	2018					34	2043		21		21.0
10	2019					35	2044		21		21.0
11	2020		21		21	36	2045		20.5		20.5
12	2021		21		21	37	2046				
13	2022		21		21	38	2047				
14	2023		21		21	39	2048				
15	2024		21		21	40	2049				
16	2025		20.5		20.5	41	2050		21		21
17	2026					42	2051		21		21
18	2027					43	2052		21		21
19	2028					44	2053		21		21
20	2029					45	2054		21		21
21	2030		21		21	46	2055		20.5		20.5
22	2031		21		21	47	2056				
23	2032		21		21	48	2057				
24	2033		21		21	49	2058				
25	2034		21		21	50	2059				

Table J-11 Economic Cost and Benefit Stream, MP Study (1/9)

I. Roleang Chrey Regulator with Intakes (RC)

EIRR :	13.6%	Net Present Value (Riel Million)	<i>Benefit</i>	<i>Cost</i>	<i>B/C Ratio</i>
		(7.00 % discount rate)	21,996	15,560	1.4

(Unit : Riel Million)

Year in Order	Year	Economic Cost			Economic Benefit			Net Cash Flow	
		Project Investment	O&M	Replacement	Total	Irri. & Drainage	Production Foregone		Total
1	2009	1,254.0			1,254.0	1,593.8		1,593.8	339.8
2	2010	8,162.0			8,162.0	1,593.8		1,593.8	-6,568.2
3	2011	5,137.0	51.5		5,188.5	1,593.8		1,593.8	-3,594.7
4	2012		51.5		51.5	1,593.8		1,593.8	1,542.3
5	2013		51.5		51.5	1,593.8		1,593.8	1,542.3
6	2014		51.5		51.5	1,593.8		1,593.8	1,542.3
7	2015		51.5		51.5	1,593.8		1,593.8	1,542.3
8	2016		51.5		51.5	1,593.8		1,593.8	1,542.3
9	2017		51.5		51.5	1,593.8		1,593.8	1,542.3
10	2018		51.5		51.5	1,593.8		1,593.8	1,542.3
11	2019		51.5		51.5	1,593.8		1,593.8	1,542.3
12	2020		51.5		51.5	1,593.8		1,593.8	1,542.3
13	2021		51.5	90.4	141.9	1,593.8		1,593.8	1,451.9
14	2022		51.5		51.5	1,593.8		1,593.8	1,542.3
15	2023		51.5		51.5	1,593.8		1,593.8	1,542.3
16	2024		51.5		51.5	1,593.8		1,593.8	1,542.3
17	2025		51.5		51.5	1,593.8		1,593.8	1,542.3
18	2026		51.5		51.5	1,593.8		1,593.8	1,542.3
19	2027		51.5		51.5	1,593.8		1,593.8	1,542.3
20	2028		51.5		51.5	1,593.8		1,593.8	1,542.3
21	2029		51.5		51.5	1,593.8		1,593.8	1,542.3
22	2030		51.5		51.5	1,593.8		1,593.8	1,542.3
23	2031		51.5	90.4	141.9	1,593.8		1,593.8	1,451.9
24	2032		51.5		51.5	1,593.8		1,593.8	1,542.3
25	2033		51.5		51.5	1,593.8		1,593.8	1,542.3
26	2034		51.5		51.5	1,593.8		1,593.8	1,542.3
27	2035		51.5		51.5	1,593.8		1,593.8	1,542.3
28	2036			15,950.5	15,950.5	1,593.8		1,593.8	-14,356.7
29	2037				0.0	1,593.8		1,593.8	1,593.8
30	2038				0.0	1,593.8		1,593.8	1,593.8
31	2039		51.2		51.2	1,593.8		1,593.8	1,542.6
32	2040		51.2		51.2	1,593.8		1,593.8	1,542.6
33	2041		51.2	90.4	141.6	1,593.8		1,593.8	1,452.2
34	2042		51.2		51.2	1,593.8		1,593.8	1,542.6
35	2043		51.2		51.2	1,593.8		1,593.8	1,542.6
36	2044		51.2		51.2	1,593.8		1,593.8	1,542.6
37	2045		51.2		51.2	1,593.8		1,593.8	1,542.6
38	2046		51.2		51.2	1,593.8		1,593.8	1,542.6
39	2047		51.2		51.2	1,593.8		1,593.8	1,542.6
40	2048		51.2		51.2	1,593.8		1,593.8	1,542.6
41	2049		51.2		51.2	1,593.8		1,593.8	1,542.6
42	2050		51.2		51.2	1,593.8		1,593.8	1,542.6
43	2051		51.2	90.4	141.6	1,593.8		1,593.8	1,452.2
44	2052		51.2		51.2	1,593.8		1,593.8	1,542.6
45	2053		51.2		51.2	1,593.8		1,593.8	1,542.6
46	2054		51.2		51.2	1,593.8		1,593.8	1,542.6
47	2055		51.2		51.2	1,593.8		1,593.8	1,542.6
48	2056		51.2		51.2	1,593.8		1,593.8	1,542.6
49	2057		51.2		51.2	1,593.8		1,593.8	1,542.6
50	2058		51.2		51.2	1,593.8		1,593.8	1,542.6

Table J-11 Economic Cost and Benefit Stream, MP Study (2/9)

II. Roleang Chrey Regulator with Intakes (RC) + Upper North Main Canal (UNMC)

EIRR : 4.7%		Net Present Value (Riel Million)							Benefit	Cost	B/C Ratio		
		(7.00 % discount rate)							31,216	39,149	0.8		
Year in Order	Year	Economic Cost						Economic Benefit				Net Cash Flow	
		Project Investment		O&M		Replacement		Total	Irri. & Drainage		Production		Total
		RC Reg.	UNMC	RC Reg.	UNMC	RC Reg.	UNMC		RC Reg.	UNMC	Foregone		
1	2009	1,254.0						1,254.0	1,593.8			1,593.8	339.8
2	2010	8,162.0						8,162.0	1,593.8			1,593.8	-6,568.2
3	2011	5,137.0	1,792.7	51.5				6,981.2	1,593.8		-1.1	1,592.7	-5,388.5
4	2012		9,708.2	51.5				9,759.7	1,593.8		-4.1	1,589.7	-8,170.0
5	2013		15,740.9	51.5	10.4			15,802.8	1,593.8	5.6	-8.1	1,591.3	-14,211.5
6	2014		3,305.1	51.5	30.2			3,386.8	1,593.8	49.6	-12.1	1,631.3	-1,755.5
7	2015		148.8	51.5	74.7			275.0	1,593.8	198.5	-13.1	1,779.2	1,504.2
8	2016			51.5	109.3			160.8	1,593.8	488.1	-13.1	2,068.8	1,908.0
9	2017			51.5	109.3			160.8	1,593.8	883.4	-13.1	2,464.1	2,303.3
10	2018			51.5	109.3			160.8	1,593.8	1,135.4	-13.1	2,716.1	2,555.3
11	2019			51.5	109.3			160.8	1,593.8	1,158.9	-13.1	2,739.6	2,578.8
12	2020			51.5	109.3			160.8	1,593.8	1,158.9	-13.1	2,739.6	2,578.8
13	2021			51.5	109.3	90.4		251.2	1,593.8	1,158.9	-13.1	2,739.6	2,488.4
14	2022			51.5	109.3			160.8	1,593.8	1,158.9	-13.1	2,739.6	2,578.8
15	2023			51.5	109.3		187.8	348.6	1,593.8	1,158.9	-13.1	2,739.6	2,391.0
16	2024			51.5	109.3			160.8	1,593.8	1,158.9	-13.1	2,739.6	2,578.8
17	2025			51.5	109.3			160.8	1,593.8	1,158.9	-13.1	2,739.6	2,578.8
18	2026			51.5	109.3			160.8	1,593.8	1,158.9	-13.1	2,739.6	2,578.8
19	2027			51.5	109.3			160.8	1,593.8	1,158.9	-13.1	2,739.6	2,578.8
20	2028			51.5	109.3			160.8	1,593.8	1,158.9	-13.1	2,739.6	2,578.8
21	2029			51.5	109.3			160.8	1,593.8	1,158.9	-13.1	2,739.6	2,578.8
22	2030			51.5	109.3			160.8	1,593.8	1,158.9	-13.1	2,739.6	2,578.8
23	2031			51.5	109.3	90.4		251.2	1,593.8	1,158.9	-13.1	2,739.6	2,488.4
24	2032			51.5	109.3			160.8	1,593.8	1,158.9	-13.1	2,739.6	2,578.8
25	2033			51.5	109.3		187.8	348.6	1,593.8	1,158.9	-13.1	2,739.6	2,391.0
26	2034			51.5	109.3			160.8	1,593.8	1,158.9	-13.1	2,739.6	2,578.8
27	2035			51.5	109.3			160.8	1,593.8	1,158.9	-13.1	2,739.6	2,578.8
28	2036				109.3	15,950.5		16,059.8	1,593.8	1,158.9	-13.1	2,739.6	-13,320.2
29	2037				109.3			109.3	1,593.8	1,158.9	-13.1	2,739.6	2,630.3
30	2038				109.3			109.3	1,593.8	1,158.9	-13.1	2,739.6	2,630.3
31	2039			51.2	109.3		401.8	562.3	1,593.8	1,158.9	-13.1	2,739.6	2,177.3
32	2040			51.2	109.3		155.5	316.0	1,593.8	1,158.9	-13.1	2,739.6	2,423.6
33	2041			51.2	109.3	90.4	103.7	354.6	1,593.8	1,158.9	-13.1	2,739.6	2,385.0
34	2042			51.2	109.3			160.5	1,593.8	1,158.9	-13.1	2,739.6	2,579.1
35	2043			51.2	109.3		187.8	348.3	1,593.8	1,158.9	-13.1	2,739.6	2,391.3
36	2044			51.2	109.3			160.5	1,593.8	1,158.9	-13.1	2,739.6	2,579.1
37	2045			51.2	109.3			160.5	1,593.8	1,158.9	-13.1	2,739.6	2,579.1
38	2046			51.2	109.3			160.5	1,593.8	1,158.9	-13.1	2,739.6	2,579.1
39	2047			51.2	109.3			160.5	1,593.8	1,158.9	-13.1	2,739.6	2,579.1
40	2048			51.2	109.3			160.5	1,593.8	1,158.9	-13.1	2,739.6	2,579.1
41	2049			51.2	109.3			160.5	1,593.8	1,158.9	-13.1	2,739.6	2,579.1
42	2050			51.2	109.3			160.5	1,593.8	1,158.9	-13.1	2,739.6	2,579.1
43	2051			51.2	109.3	90.4		250.9	1,593.8	1,158.9	-13.1	2,739.6	2,488.7
44	2052			51.2	109.3			160.5	1,593.8	1,158.9	-13.1	2,739.6	2,579.1
45	2053			51.2	109.3		187.8	348.3	1,593.8	1,158.9	-13.1	2,739.6	2,391.3
46	2054			51.2	109.3			160.5	1,593.8	1,158.9	-13.1	2,739.6	2,579.1
47	2055			51.2	109.3			160.5	1,593.8	1,158.9	-13.1	2,739.6	2,579.1
48	2056			51.2	109.3			160.5	1,593.8	1,158.9	-13.1	2,739.6	2,579.1
49	2057			51.2	109.3			160.5	1,593.8	1,158.9	-13.1	2,739.6	2,579.1
50	2058			51.2	109.3			160.5	1,593.8	1,158.9	-13.1	2,739.6	2,579.1

Table J-11 Economic Cost and Benefit Stream, MP Study (3/9)

III. Roleang Chrey Regulator with Intakes (RC) + Ou Krang Ambel Irrigation

EIRR :	9.4%	Net Present Value (Riel Million)			Benefit	Cost	B/C Ratio
		(7.00 % discount rate)			38,098	30,715	1.2

(Unit : Riel Million)

Year in Order	Year	Economic Cost						Economic Benefit				Net Cash Flow	
		Project Investment		O&M		Replacement		Total	Irri. & Drainage		Production		Total
		RC Reg.	Ou KA	RC Reg.	Ou KA	RC Reg.	Ou KA		RC Reg.	Ou KA	Foregone Ou KA		
1	2009	1,254.0						1,254.0	1,593.8			1,593.8	339.8
2	2010	8,162.0						8,162.0	1,593.8			1,593.8	-6,568.2
3	2011	5,137.0		51.5				5,188.5	1,593.8			1,593.8	-3,594.7
4	2012		9,828.0	51.5				9,879.5	1,593.8		-5.0	1,588.8	-8,290.7
5	2013		8,019.7	51.5				8,071.2	1,593.8		-10.0	1,583.8	-6,487.4
6	2014		1,817.4	51.5	9.6			1,878.5	1,593.8	56.6	-15.0	1,635.4	-243.1
7	2015			51.5	28.8			80.3	1,593.8	311.4	-15.2	1,890.0	1,809.7
8	2016			51.5	52.7			104.2	1,593.8	820.9	-15.2	2,399.5	2,295.3
9	2017			51.5	69.5			121.0	1,593.8	1,443.8	-15.2	3,022.4	2,901.4
10	2018			51.5	69.5			121.0	1,593.8	1,903.8	-15.2	3,482.4	3,361.4
11	2019			51.5	69.5			121.0	1,593.8	2,035.9	-15.2	3,614.5	3,493.5
12	2020			51.5	69.5			121.0	1,593.8	2,035.9	-15.2	3,614.5	3,493.5
13	2021			51.5	69.5	90.4		211.4	1,593.8	2,035.9	-15.2	3,614.5	3,403.1
14	2022			51.5	69.5			121.0	1,593.8	2,035.9	-15.2	3,614.5	3,493.5
15	2023			51.5	69.5			121.0	1,593.8	2,035.9	-15.2	3,614.5	3,493.5
16	2024			51.5	69.5	118.8		239.8	1,593.8	2,035.9	-15.2	3,614.5	3,374.7
17	2025			51.5	69.5			121.0	1,593.8	2,035.9	-15.2	3,614.5	3,493.5
18	2026			51.5	69.5			121.0	1,593.8	2,035.9	-15.2	3,614.5	3,493.5
19	2027			51.5	69.5			121.0	1,593.8	2,035.9	-15.2	3,614.5	3,493.5
20	2028			51.5	69.5			121.0	1,593.8	2,035.9	-15.2	3,614.5	3,493.5
21	2029			51.5	69.5			121.0	1,593.8	2,035.9	-15.2	3,614.5	3,493.5
22	2030			51.5	69.5			121.0	1,593.8	2,035.9	-15.2	3,614.5	3,493.5
23	2031			51.5	69.5	90.4		211.4	1,593.8	2,035.9	-15.2	3,614.5	3,403.1
24	2032			51.5	69.5			121.0	1,593.8	2,035.9	-15.2	3,614.5	3,493.5
25	2033			51.5	69.5			121.0	1,593.8	2,035.9	-15.2	3,614.5	3,493.5
26	2034			51.5	69.5	118.8		239.8	1,593.8	2,035.9	-15.2	3,614.5	3,374.7
27	2035			51.5	69.5			121.0	1,593.8	2,035.9	-15.2	3,614.5	3,493.5
28	2036				69.5	15,950.5		16,020.0	1,593.8	2,035.9	-15.2	3,614.5	-12,405.5
29	2037				69.5			69.5	1,593.8	2,035.9	-15.2	3,614.5	3,545.0
30	2038				69.5			69.5	1,593.8	2,035.9	-15.2	3,614.5	3,545.0
31	2039			51.2	69.5			120.7	1,593.8	2,035.9	-15.2	3,614.5	3,493.8
32	2040			51.2	69.5	411.5		532.2	1,593.8	2,035.9	-15.2	3,614.5	3,082.3
33	2041			51.2	69.5	90.4	51.8	262.9	1,593.8	2,035.9	-15.2	3,614.5	3,351.6
34	2042			51.2	69.5			120.7	1,593.8	2,035.9	-15.2	3,614.5	3,493.8
35	2043			51.2	69.5			120.7	1,593.8	2,035.9	-15.2	3,614.5	3,493.8
36	2044			51.2	69.5	118.8		239.5	1,593.8	2,035.9	-15.2	3,614.5	3,375.0
37	2045			51.2	69.5			120.7	1,593.8	2,035.9	-15.2	3,614.5	3,493.8
38	2046			51.2	69.5			120.7	1,593.8	2,035.9	-15.2	3,614.5	3,493.8
39	2047			51.2	69.5			120.7	1,593.8	2,035.9	-15.2	3,614.5	3,493.8
40	2048			51.2	69.5			120.7	1,593.8	2,035.9	-15.2	3,614.5	3,493.8
41	2049			51.2	69.5			120.7	1,593.8	2,035.9	-15.2	3,614.5	3,493.8
42	2050			51.2	69.5			120.7	1,593.8	2,035.9	-15.2	3,614.5	3,493.8
43	2051			51.2	69.5	90.4		211.1	1,593.8	2,035.9	-15.2	3,614.5	3,403.4
44	2052			51.2	69.5			120.7	1,593.8	2,035.9	-15.2	3,614.5	3,493.8
45	2053			51.2	69.5			120.7	1,593.8	2,035.9	-15.2	3,614.5	3,493.8
46	2054			51.2	69.5	118.8		239.5	1,593.8	2,035.9	-15.2	3,614.5	3,375.0
47	2055			51.2	69.5			120.7	1,593.8	2,035.9	-15.2	3,614.5	3,493.8
48	2056			51.2	69.5			120.7	1,593.8	2,035.9	-15.2	3,614.5	3,493.8
49	2057			51.2	69.5			120.7	1,593.8	2,035.9	-15.2	3,614.5	3,493.8
50	2058			51.2	69.5			120.7	1,593.8	2,035.9	-15.2	3,614.5	3,493.8

Table J-11 Economic Cost and Benefit Stream, MP Study (5/9)

V. Roleang Chrey Regulator with Intakes (RC) + Irrigated Agriculture Improvement Model Project (IAIMP)

EIRR :	10.6%	Net Present Value (Riel Million)				Benefit	Cost	B/C Ratio
		(7.00 % discount rate)				26,232	20,513	1.3

(Unit : Riel Million)

Year in Order	Year	Economic Cost						Economic Benefit				Net Cash Flow	
		Project Investment		O&M		Replacement		Total	Irri. & Drainage		Production		Total
		RC Reg.	IAIMP	RC Reg.	IAIMP	RC Reg.	IAIMP		RC Reg.	IAIMP	Foregone		
1	2009	1,254.0	3,086.7					4,340.7	1,593.8		-1.0	1,592.8	-2,747.9
2	2010	8,162.0	2,079.2		2.1			10,243.3	1,593.8		-3.0	1,590.8	-8,652.5
3	2011	5,137.0	7.0	51.5	6.8			5,202.3	1,593.8	180.6	-5.0	1,769.4	-3,432.9
4	2012		4.1	51.5	11.4			67.0	1,593.8	314.4	-5.0	1,903.2	1,836.2
5	2013		4.1	51.5	17.5			73.1	1,593.8	375.7	-5.0	1,964.5	1,891.4
6	2014			51.5	17.5			69.0	1,593.8	375.7	-5.0	1,964.5	1,895.5
7	2015			51.5	17.5			69.0	1,593.8	375.7	-5.0	1,964.5	1,895.5
8	2016			51.5	17.5			69.0	1,593.8	375.7	-5.0	1,964.5	1,895.5
9	2017			51.5	17.5			69.0	1,593.8	375.7	-5.0	1,964.5	1,895.5
10	2018			51.5	17.5			69.0	1,593.8	375.7	-5.0	1,964.5	1,895.5
11	2019			51.5	17.5			69.0	1,593.8	375.7	-5.0	1,964.5	1,895.5
12	2020			51.5	17.5			69.0	1,593.8	375.7	-5.0	1,964.5	1,895.5
13	2021			51.5	17.5	90.4		159.4	1,593.8	375.7	-5.0	1,964.5	1,805.1
14	2022			51.5	17.5		32.1	101.1	1,593.8	375.7	-5.0	1,964.5	1,863.4
15	2023			51.5	17.5			69.0	1,593.8	375.7	-5.0	1,964.5	1,895.5
16	2024			51.5	17.5			69.0	1,593.8	375.7	-5.0	1,964.5	1,895.5
17	2025			51.5	17.5			69.0	1,593.8	375.7	-5.0	1,964.5	1,895.5
18	2026			51.5	17.5			69.0	1,593.8	375.7	-5.0	1,964.5	1,895.5
19	2027			51.5	17.5			69.0	1,593.8	375.7	-5.0	1,964.5	1,895.5
20	2028			51.5	17.5			69.0	1,593.8	375.7	-5.0	1,964.5	1,895.5
21	2029			51.5	17.5			69.0	1,593.8	375.7	-5.0	1,964.5	1,895.5
22	2030			51.5	17.5			69.0	1,593.8	375.7	-5.0	1,964.5	1,895.5
23	2031			51.5	17.5	90.4		159.4	1,593.8	375.7	-5.0	1,964.5	1,805.1
24	2032			51.5	17.5		32.1	101.1	1,593.8	375.7	-5.0	1,964.5	1,863.4
25	2033			51.5	17.5			69.0	1,593.8	375.7	-5.0	1,964.5	1,895.5
26	2034			51.5	17.5			69.0	1,593.8	375.7	-5.0	1,964.5	1,895.5
27	2035			51.5	17.5			69.0	1,593.8	375.7	-5.0	1,964.5	1,895.5
28	2036				17.5	15,950.5		15,968.0	1,593.8	375.7	-5.0	1,964.5	-14,003.5
29	2037				17.5			17.5	1,593.8	375.7	-5.0	1,964.5	1,947.0
30	2038				17.5		97.2	114.7	1,593.8	375.7	-5.0	1,964.5	1,849.8
31	2039			51.2	17.5		48.6	117.3	1,593.8	375.7	-5.0	1,964.5	1,847.2
32	2040			51.2	17.5			68.7	1,593.8	375.7	-5.0	1,964.5	1,895.8
33	2041			51.2	17.5	90.4		159.1	1,593.8	375.7	-5.0	1,964.5	1,805.4
34	2042			51.2	17.5		32.1	100.8	1,593.8	375.7	-5.0	1,964.5	1,863.7
35	2043			51.2	17.5			68.7	1,593.8	375.7	-5.0	1,964.5	1,895.8
36	2044			51.2	17.5			68.7	1,593.8	375.7	-5.0	1,964.5	1,895.8
37	2045			51.2	17.5			68.7	1,593.8	375.7	-5.0	1,964.5	1,895.8
38	2046			51.2	17.5			68.7	1,593.8	375.7	-5.0	1,964.5	1,895.8
39	2047			51.2	17.5			68.7	1,593.8	375.7	-5.0	1,964.5	1,895.8
40	2048			51.2	17.5			68.7	1,593.8	375.7	-5.0	1,964.5	1,895.8
41	2049			51.2	17.5			68.7	1,593.8	375.7	-5.0	1,964.5	1,895.8
42	2050			51.2	17.5			68.7	1,593.8	375.7	-5.0	1,964.5	1,895.8
43	2051			51.2	17.5	90.4		159.1	1,593.8	375.7	-5.0	1,964.5	1,805.4
44	2052			51.2	17.5		32.1	100.8	1,593.8	375.7	-5.0	1,964.5	1,863.7
45	2053			51.2	17.5			68.7	1,593.8	375.7	-5.0	1,964.5	1,895.8
46	2054			51.2	17.5			68.7	1,593.8	375.7	-5.0	1,964.5	1,895.8
47	2055			51.2	17.5			68.7	1,593.8	375.7	-5.0	1,964.5	1,895.8
48	2056			51.2	17.5			68.7	1,593.8	375.7	-5.0	1,964.5	1,895.8
49	2057			51.2	17.5			68.7	1,593.8	375.7	-5.0	1,964.5	1,895.8
50	2058			51.2	17.5			68.7	1,593.8	375.7	-5.0	1,964.5	1,895.8

Table J-11 Economic Cost and Benefit Stream, MP Study (6/9)

VI. Roleang Chrey Regulator with Intakes (RC) + Irrigated Agriculture Improvement Model Project (IAIMP) + Upper South Main Canal (USMC)

EIRR : 6.2%

Net Present Value (Riel Million)
(7.00 % discount rate)

Benefit Cost B/C Ratio
37,430 40,637 0.9

(Unit : Riel Million)

Year in Order	Year	Economic Cost									Economic Benefit						Net Cash Flow		
		Project Investment			O&M			Replacement			Total	Irri. & Drainage			Production Foregone			Total	
		RC Reg.	IAIMP	USMC	RC Reg.	IAIMP	USMC	RC Reg.	IAIMP	USMC		RC Reg.	IAIMP	USMC	IAIMP	USMC			
1	2009	1,254.0	3,086.7									4,340.7	1,593.8			-1.0		1,592.8	-2,747.9
2	2010	8,162.0	2,079.2			2.1						10,243.3	1,593.8			-3.0		1,590.8	-8,652.5
3	2011	5,137.0	7.0	777.0	51.5	6.8						5,979.3	1,593.8	180.6		-5.0	-1.0	1,768.4	-4,210.9
4	2012		4.1	6,835.5	51.5	11.4						6,902.5	1,593.8	314.4		-5.0	-3.0	1,900.2	-5,002.3
5	2013		4.1	13,329.5	51.5	17.5	6.6					13,409.2	1,593.8	375.7	4.9	-5.0	-8.0	1,961.4	-11,447.8
6	2014			5,201.8	51.5	17.5	28					5,298.8	1,593.8	375.7	50.1	-5.0	-12.5	2,002.1	-3,296.7
7	2015			436.9	51.5	17.5	77.4					583.3	1,593.8	375.7	236.0	-5.0	-14.6	2,185.9	1,602.6
8	2016				51.5	17.5	94.9					163.9	1,593.8	375.7	653.7	-5.0	-14.6	2,603.6	2,439.7
9	2017				51.5	17.5	94.9					163.9	1,593.8	375.7	1,166.7	-5.0	-14.6	3,116.6	2,952.7
10	2018				51.5	17.5	94.9					163.9	1,593.8	375.7	1,382.7	-5.0	-14.6	3,332.6	3,168.7
11	2019				51.5	17.5	94.9					163.9	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,179.7
12	2020				51.5	17.5	94.9					163.9	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,179.7
13	2021				51.5	17.5	94.9	90.4				254.3	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,089.3
14	2022				51.5	17.5	94.9		32.1			196.0	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,147.6
15	2023				51.5	17.5	94.9			160.6		324.5	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,019.1
16	2024				51.5	17.5	94.9				163.9	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,179.7	
17	2025				51.5	17.5	94.9				163.9	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,179.7	
18	2026				51.5	17.5	94.9				163.9	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,179.7	
19	2027				51.5	17.5	94.9				163.9	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,179.7	
20	2028				51.5	17.5	94.9				163.9	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,179.7	
21	2029				51.5	17.5	94.9				163.9	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,179.7	
22	2030				51.5	17.5	94.9				163.9	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,179.7	
23	2031				51.5	17.5	94.9	90.4			254.3	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,089.3	
24	2032				51.5	17.5	94.9		32.1		196.0	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,147.6	
25	2033				51.5	17.5	94.9			160.6	324.5	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,019.1	
26	2034				51.5	17.5	94.9				163.9	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,179.7	
27	2035				51.5	17.5	94.9				163.9	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,179.7	
28	2036					17.5	94.9	15,950.5			16,062.9	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	-12,719.3	
29	2037					17.5	94.9				112.4	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,231.2	
30	2038					17.5	94.9		97.2		209.6	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,134.0	
31	2039				51.2	17.5	94.9		48.6	200.9	413.1	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	2,930.5	
32	2040				51.2	17.5	94.9			204.1	367.7	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	2,975.9	
33	2041				51.2	17.5	94.9	90.4		38.9	292.9	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,050.7	
34	2042				51.2	17.5	94.9		32.1		195.7	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,147.9	
35	2043				51.2	17.5	94.9			160.6	324.2	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,019.4	
36	2044				51.2	17.5	94.9				163.6	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,180.0	
37	2045				51.2	17.5	94.9				163.6	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,180.0	
38	2046				51.2	17.5	94.9				163.6	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,180.0	
39	2047				51.2	17.5	94.9				163.6	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,180.0	
40	2048				51.2	17.5	94.9				163.6	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,180.0	
41	2049				51.2	17.5	94.9				163.6	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,180.0	
42	2050				51.2	17.5	94.9				163.6	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,180.0	
43	2051				51.2	17.5	94.9	90.4			254.0	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,089.6	
44	2052				51.2	17.5	94.9		32.1		195.7	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,147.9	
45	2053				51.2	17.5	94.9			160.6	324.2	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,019.4	
46	2054				51.2	17.5	94.9				163.6	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,180.0	
47	2055				51.2	17.5	94.9				163.6	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,180.0	
48	2056				51.2	17.5	94.9				163.6	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,180.0	
49	2057				51.2	17.5	94.9				163.6	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,180.0	
50	2058				51.2	17.5	94.9				163.6	1,593.8	375.7	1,393.7	-5.0	-14.6	3,343.6	3,180.0	

Table J-11 Economic Cost and Benefit Stream, MP Study (7/9)

Year in Order	Year	Project Investment		Economic Cost				Economic Benefit				Benefit	Cost	B/C Ratio					
		Net Present Value (Real Million)		(= 7.00 % discount rate)				(Unit : Real Million)											
		RC Reg.	IAMP	USMC	LSMC	RC Reg.	IAMP	USMC	LSMC	IAMP	USMC				LSMC	Total	Net Cash Flow		
1	2009	1,254.0	3,086.7														1,592.8	-2,747.9	
2	2010	81,620.0	2,072.2															1,592.8	-8,662.5
3	2011	5,137.0	7.0	777.0														1,768.4	-4,210.9
4	2012		41	6,855.5	7,819.9													1,895.2	-12,827.2
5	2013		41	13,329.5	16,209.9													1,956.4	-27,692.7
6	2014			5,201.8	6,448.3													1,979.1	-9,774.6
7	2015			4,569	5,675													1,979.1	-9,774.6
8	2016																	1,979.1	-9,774.6
9	2017																	1,979.1	-9,774.6
10	2018																	1,979.1	-9,774.6
11	2019																	1,979.1	-9,774.6
12	2020																	1,979.1	-9,774.6
13	2021																	1,979.1	-9,774.6
14	2022																	1,979.1	-9,774.6
15	2023																	1,979.1	-9,774.6
16	2024																	1,979.1	-9,774.6
17	2025																	1,979.1	-9,774.6
18	2026																	1,979.1	-9,774.6
19	2027																	1,979.1	-9,774.6
20	2028																	1,979.1	-9,774.6
21	2029																	1,979.1	-9,774.6
22	2030																	1,979.1	-9,774.6
23	2031																	1,979.1	-9,774.6
24	2032																	1,979.1	-9,774.6
25	2033																	1,979.1	-9,774.6
26	2034																	1,979.1	-9,774.6
27	2035																	1,979.1	-9,774.6
28	2036																	1,979.1	-9,774.6
29	2037																	1,979.1	-9,774.6
30	2038																	1,979.1	-9,774.6
31	2039																	1,979.1	-9,774.6
32	2040																	1,979.1	-9,774.6
33	2041																	1,979.1	-9,774.6
34	2042																	1,979.1	-9,774.6
35	2043																	1,979.1	-9,774.6
36	2044																	1,979.1	-9,774.6
37	2045																	1,979.1	-9,774.6
38	2046																	1,979.1	-9,774.6
39	2047																	1,979.1	-9,774.6
40	2048																	1,979.1	-9,774.6
41	2049																	1,979.1	-9,774.6
42	2050																	1,979.1	-9,774.6
43	2051																	1,979.1	-9,774.6
44	2052																	1,979.1	-9,774.6
45	2053																	1,979.1	-9,774.6
46	2054																	1,979.1	-9,774.6
47	2055																	1,979.1	-9,774.6
48	2056																	1,979.1	-9,774.6
49	2057																	1,979.1	-9,774.6
50	2058																	1,979.1	-9,774.6

Table J-11 Economic Cost and Benefit Stream, MP Study (8/9)

VIII. ZONE-3: Water Harvesting Agriculture Improvement Area

EIRR :	0.4%	Net Present Value (Riel Million)	<i>Benefit</i>	<i>Cost</i>	<i>B/C</i>
		(7.00 % discount rate)	5,216	15,766	0.3

(Unit : Riel Million)

Year in Order	Year	Economic Cost				Economic Benefit			Net Cash Flow
		Project Investment	O&M	Replacement	Total	Irri. & Drainage	Production Foregone	Total	
1	2010	192.8			192.8			0.0	-192.8
2	2011	2,629.6	7.4		2,637.0	5.7		5.7	-2,631.3
3	2012	6,447.3	22.2		6,469.5	28.5		28.5	-6,441.0
4	2013	6,007.1	37.1		6,044.2	74.3		74.3	-5,969.9
5	2014	1,923.5	51.9		1,975.4	142.8		142.8	-1,832.6
6	2015	1,614.1	66.7		1,680.8	234.2		234.2	-1,446.6
7	2016		74.1		74.1	337.0		337.0	262.9
8	2017		74.1		74.1	428.3		428.3	354.2
9	2018		74.1		74.1	496.9		496.9	422.8
10	2019		74.1		74.1	542.5		542.5	468.4
11	2020		74.1	21.0	95.1	565.3		565.3	470.2
12	2021		74.1	21.0	95.1	571.1		571.1	476.0
13	2022		74.1	21.0	95.1	571.1		571.1	476.0
14	2023		74.1	21.0	95.1	571.1		571.1	476.0
15	2024		74.1	21.0	95.1	571.1		571.1	476.0
16	2025		74.1	20.5	94.6	571.1		571.1	476.5
17	2026		74.1		74.1	571.1		571.1	497.0
18	2027		74.1		74.1	571.1		571.1	497.0
19	2028		74.1		74.1	571.1		571.1	497.0
20	2029		74.1		74.1	571.1		571.1	497.0
21	2030		74.1	21.0	95.1	571.1		571.1	476.0
22	2031		74.1	21.0	95.1	571.1		571.1	476.0
23	2032		74.1	21.0	95.1	571.1		571.1	476.0
24	2033		74.1	21.0	95.1	571.1		571.1	476.0
25	2034		74.1	21.0	95.1	571.1		571.1	476.0
26	2035		74.1	131.0	205.1	571.1		571.1	366.0
27	2036		74.1	110	184.1	571.1		571.1	387.0
28	2037		74.1	110	184.1	571.1		571.1	387.0
29	2038		74.1	110.0	184.1	571.1		571.1	387.0
30	2039		74.1	110.0	184.1	571.1		571.1	387.0
31	2040		74.1	131.0	205.1	571.1		571.1	366.0
32	2041		74.1	21.0	95.1	571.1		571.1	476.0
33	2042		74.1	21.0	95.1	571.1		571.1	476.0
34	2043		74.1	21.0	95.1	571.1		571.1	476.0
35	2044		74.1	21.0	95.1	571.1		571.1	476.0
36	2045		74.1	20.5	94.6	571.1		571.1	476.5
37	2046		74.1		74.1	571.1		571.1	497.0
38	2047		74.1		74.1	571.1		571.1	497.0
39	2048		74.1		74.1	571.1		571.1	497.0
40	2049		74.1		74.1	571.1		571.1	497.0
41	2050		74.1	21.0	95.1	571.1		571.1	476.0
42	2051		74.1	21.0	95.1	571.1		571.1	476.0
43	2052		74.1	21.0	95.1	571.1		571.1	476.0
44	2053		74.1	21.0	95.1	571.1		571.1	476.0
45	2054		74.1	21.0	95.1	571.1		571.1	476.0
46	2055		74.1	20.5	94.6	571.1		571.1	476.5
47	2056		74.1		74.1	571.1		571.1	497.0
48	2057		74.1		74.1	571.1		571.1	497.0
49	2058		74.1		74.1	571.1		571.1	497.0
50	2059		74.1		74.1	571.1		571.1	497.0

Table J-11 Economic Cost and Benefit Stream, MP Study (9/9)

IX. ZONE-4: Rainfed Agriculture Improvement Area

EIRR : 17.6%	Net Present Value (Riel Million)	<i>Benefit</i>	<i>Cost</i>	<i>B/C</i>
	(7.00 % discount rate)	35,032	8,762	4.0

(Unit : Riel Million)

Year in Order	Year	Economic Cost				Economic Benefit			Net Cash Flow
		Project Investment	O&M	Replacement	Total	Irri. & Drainage	Production Foregone	Total	
1	2008	2,100.0			2,100.0			0.0	-2,100.0
2	2009	2,528.6			2,528.6	0.2		0.2	-2,528.4
3	2010	2,076.1			2,076.1	3.8		3.8	-2,072.3
4	2011	2,149.1			2,149.1	20.8		20.8	-2,128.3
5	2012	1,762.8			1,762.8	68.5		68.5	-1,694.3
6	2013				0.0	174.9		174.9	174.9
7	2014				0.0	410.7		410.7	410.7
8	2015				0.0	947.8		947.8	947.8
9	2016				0.0	2,003.5		2,003.5	2,003.5
10	2017				0.0	3,340.0		3,340.0	3,340.0
11	2018				0.0	4,301.5		4,301.5	4,301.5
12	2019				0.0	4,634.8		4,634.8	4,634.8
13	2020				0.0	4,634.8		4,634.8	4,634.8
14	2021				0.0	4,634.8		4,634.8	4,634.8
15	2022				0.0	4,634.8		4,634.8	4,634.8
16	2023				0.0	4,634.8		4,634.8	4,634.8
17	2024				0.0	4,634.8		4,634.8	4,634.8
18	2025				0.0	4,634.8		4,634.8	4,634.8
19	2026				0.0	4,634.8		4,634.8	4,634.8
20	2027				0.0	4,634.8		4,634.8	4,634.8
21	2028				0.0	4,634.8		4,634.8	4,634.8
22	2029				0.0	4,634.8		4,634.8	4,634.8
23	2030				0.0	4,634.8		4,634.8	4,634.8
24	2031				0.0	4,634.8		4,634.8	4,634.8
25	2032				0.0	4,634.8		4,634.8	4,634.8
26	2033				0.0	4,634.8		4,634.8	4,634.8
27	2034				0.0	4,634.8		4,634.8	4,634.8
28	2035				0.0	4,634.8		4,634.8	4,634.8
29	2036				0.0	4,634.8		4,634.8	4,634.8
30	2037				0.0	4,634.8		4,634.8	4,634.8
31	2038				0.0	4,634.8		4,634.8	4,634.8
32	2039				0.0	4,634.8		4,634.8	4,634.8
33	2040				0.0	4,634.8		4,634.8	4,634.8
34	2041				0.0	4,634.8		4,634.8	4,634.8
35	2042				0.0	4,634.8		4,634.8	4,634.8
36	2043				0.0	4,634.8		4,634.8	4,634.8
37	2044				0.0	4,634.8		4,634.8	4,634.8
38	2045				0.0	4,634.8		4,634.8	4,634.8
39	2046				0.0	4,634.8		4,634.8	4,634.8
40	2047				0.0	4,634.8		4,634.8	4,634.8
41	2048				0.0	4,634.8		4,634.8	4,634.8
42	2049				0.0	4,634.8		4,634.8	4,634.8
43	2050				0.0	4,634.8		4,634.8	4,634.8
44	2051				0.0	4,634.8		4,634.8	4,634.8
45	2052				0.0	4,634.8		4,634.8	4,634.8
46	2053				0.0	4,634.8		4,634.8	4,634.8
47	2054				0.0	4,634.8		4,634.8	4,634.8
48	2055				0.0	4,634.8		4,634.8	4,634.8
49	2056				0.0	4,634.8		4,634.8	4,634.8
50	2057				0.0	4,634.8		4,634.8	4,634.8

Table J-12 Farm Economic Analysis of Typical Farms

Items	Zone-1 I/																		
	Model Project			Upper North Main Canal			Upper South Main Canal			Zone-2			Zone-3			Zone-4			
	With	Present	Increment	With	Present	Increment	With	Present	Increment	With	Present	Increment	With	Present	Increment	With	Present	Increment	
Typical Farm																			
Holding Size of Paddy Field (ha)	0.70	0.35	0.35	0.07	0.07	0	0.70	0.70	0	0.70	0.70	0	0.70	0.70	0	0.70	0.70	0	0.70
- Irrigated Field			0.35																
- Supplementary Irrigated Field		0.35	-0.35	0.63	0.42	0.21	0.70	0.45	0.25	0.25	0.25	-0.25	0.70	0.11	0.59	0.70	0.35	0.35	0.35
- Rainfed Field					0.21	-0.21									-0.59				
Total	0.70	0.70	0	0.70	0.70	0	0.70	0.70	0	0.70	0.70	0	0.70	0.70	0	0.70	0.70	0	0.70
Net Return from Paddy Field																			
1. Cropped Area (ha)																			
- Early Rainy Season																			
- Early Rice	0.35	0.35	0	0.07	0.07	0	0.10						0.10						
- Rainy Season																			
- Early Rice	0.35	0.35	0.35	0.07	0.07	0.07	0.70	0.45	0.25	0.25	0.25	0.25	0.70	0.11	0.59	0.70	0.35	0.35	0.35
Medium Rice (irrigated)		0.70	-0.35	0.63	0.49	0.14	0.70	0.25	-0.25	-0.25	-0.25	0	0.70	0.59	-0.59	0.70	0.35	-0.35	0.70
Medium Rice (rainfed)					0.21	-0.21									0.10				
Total	1.05	1.05	0	0.77	0.77	0	0.70	0.70	0	0.70	0.70	0	0.80	0.70	0.10	0.70	0.70	0	0.70
- Upland Crops/Vegetable	0.04	0.04	0	0.03	0.01	0.02	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.01	0.02	0.04	0.01	0.03	0.01
2. Net Return per Ha (Riel 1,000)																			
- Early Rainy Season	1,058	754	304	1,058	754	304	1,058	709	323	323	323	304	1,001	709	292	1,001	709	292	329
- Rainy Season																			
- Early Rice	1,058	709	323	1,058	709	323	1,032	709	323	323	323	304	1,001	709	292	1,001	709	292	329
- Rainy Season																			
- Early Rice	1,032	709	323	1,032	709	323	1,032	709	323	323	323	304	1,001	709	292	1,001	709	292	329
Medium Rice (irrigated)																			
Medium Rice (rainfed)		651	127	778	651	127	778	509	127	127	127	127	778	651	127	778	651	127	334
- Upland Crops/Vegetable 1/	778	651	127	778	651	127	778	509	127	127	127	127	778	651	127	778	651	127	334
3. Net Return per Farm (Riel 1,000)																			
- Early Rainy Season	370	264	106	74	53	21	0	0	0	0	0	0	106	0	106	0	0	0	0
- Rainy Season																			
- Early Rice	370	264	106	74	53	21	0	0	0	0	0	0	106	0	106	0	0	0	0
- Rainy Season																			
- Early Rice	370	0	370	74	0	74	0	0	0	0	0	0	0	0	0	0	0	0	0
Medium Rice (irrigated)	361	496	-135	650	347	303	722	319	403	403	403	303	701	78	623	701	248	453	0
Medium Rice (rainfed)	0	0	0	0	107	-107	0	127	-127	-127	-127	0	0	300	-300	0	178	-178	230
- Upland Crops/Vegetable 1/	31	26	5	23	7	17	23	0	23	23	23	17	23	7	17	31	7	25	6
Net Return per Farm (Riel 1,000)	1,133	786	347	822	514	308	746	446	299	299	299	308	830	385	445	732	433	299	236

1/: Weighted average of upland crops & vegetables

Appendix-K

***PROJET PROPOSAL, IMPLEMENTATION SCHEDULE,
AND PDM FOR 27 PROJECTS/STUDIES***

**THE STUDY
ON
COMPREHENSIVE AGRICULTURAL DEVELOPMENT
OF
PREK THNOT RIVER BASIN
IN
THE KINGDOM OF CAMBODIA**

**FINAL REPORT
Volume-VI: Appendixes for Master Plan
Appendix-K
Project Proposal, Implementation Schedule,
and PDM for 27 Projects/Studies**

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**APPENDIX-K: PROJET PROPOSAL, IMPLEMENTATION
SCHEDULE, AND PDM FOR 27 PROJECTS/STUDIES**



1. Scheme-wise Improvement

1.1 Zone-1 Projects

1.1.1 A.1(1) Irrigated Agriculture Improvement Model Project

(1) Project Proposal

(1) Title of Project	Irrigated Agriculture Improvement Model Project
(2) Location	District: Chbar Mon, Samraong Tong, Province: Kampong Speu
(3) Objective of Project	The project aims at demonstration of proper water management and increase of rice production in the model area by good harmonization of agriculture, irrigation and drainage and institutional development.
(4) Site Description	<p>The South Main Canal (SMC) has been recently constructed by MOWRAM. However, the canal has not been well maintained due to lack of government budget. Further, related structures of secondary and tertiary canals such as turnouts, regulators, and culverts are not sufficiently constructed. Water from SMC is not efficiently delivered to paddy fields because of the above constraints. This poor condition of irrigation facilities must be one of the important reasons for the low agricultural productivity in the area.</p> <p>South Main Canal and related structures</p> <ul style="list-style-type: none"> - SMC recently constructed is about 26 km long. However, its design considerably deviates from the ordinal one. The present canal is designed to maintain the water level lower than adjacent paddy fields. A few water level regulators were constructed, but water level in the secondary or tertiary canals is still lower than the paddy fields. To struggle against this difficulty, many farmers are taking water from the main canal using portable pumps. - Permanent turnouts which divert water from the main canal to secondary and tertiary canals are rarely constructed. It makes it difficult for farmers to withdraw water. To solve this problem, some farmers broke canal embankments and buried pipes without proper backfilling. This caused collapse of the canal embankments. <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;">  <p><i>The SMC seriously eroded</i></p> </div> <div style="text-align: center;">  <p><i>A check structure severely deteriorated</i></p> </div> </div> <p>Secondary canals and related structures</p> <ul style="list-style-type: none"> - Number and length of secondary canals are insufficient. - Gravity irrigation is unable to be practiced since design water level of the canal is lower than adjacent paddy fields. - Existing turnouts and check gates are deteriorated. - Numbers of turnouts and check gates are insufficient. - Design criteria of secondary and tertiary canals are unclear. This unclear criteria cause poor water management, since some canals command too large an area.

	<p>Tertiary canal systems</p> <ul style="list-style-type: none"> - Improper layout of tertiary systems causes poor water management. <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;">  <p><i>A check structure recently constructed</i></p> </div> <div style="text-align: center;">  <p><i>An existing tertiary canal</i></p> </div> </div>																												
<p>(5) Agricultural Development Plan</p>	<p>The agriculture development plan indicated in comparison with the present condition is as follows;</p> <p style="text-align: center;">Agriculture Development Plan (Paddy Production)</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2"></th> <th colspan="3">With Project</th> <th>Present</th> <th rowspan="2">Increment</th> </tr> <tr> <th>Early Rainy</th> <th>Rainy Season</th> <th>Annual</th> <th>Annual</th> </tr> </thead> <tbody> <tr> <td>Cropped Area</td> <td>285ha</td> <td>570ha</td> <td>855ha</td> <td>860ha</td> <td>-5ha</td> </tr> <tr> <td>Yield</td> <td>3.3t/ha</td> <td>3.0~3.3t/ha</td> <td>3.0~3.3t/ha</td> <td>1.5~2.4t/ha</td> <td>-</td> </tr> <tr> <td>Production</td> <td>941t</td> <td>1,796t</td> <td>2,737t</td> <td>1,892t</td> <td>845t</td> </tr> </tbody> </table> <p>At the full development stage, an increase in the production of paddy of some 850 t/year from the present level is aimed at.</p>		With Project			Present	Increment	Early Rainy	Rainy Season	Annual	Annual	Cropped Area	285ha	570ha	855ha	860ha	-5ha	Yield	3.3t/ha	3.0~3.3t/ha	3.0~3.3t/ha	1.5~2.4t/ha	-	Production	941t	1,796t	2,737t	1,892t	845t
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	Early Rainy	Rainy Season	Annual	Annual																									
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Production	941t	1,796t	2,737t	1,892t	845t																								
<p>(6) Irrigation Development Plan</p>	<p>Water management of the irrigation system will be done by government agencies for major facilities and by FWUCs for on-farm facilities. As the first step, an on-farm level water management model is planned to be established in the “Irrigated Agriculture On-farm Technology Improvement Pilot Project”. For the second step, total irrigation system management from the main canal to on-farm facilities needs to be established by this model project. Implementation of the model project also can demonstrate actual benefits from the irrigation system.</p> <p>Taking the strong relationship with the above-mentioned pilot project into account, the model project needs to be conducted in an area surrounding the pilot project, which is in the upstream part of the SMC system. It is also necessary that the model project area has proper scale to practice and demonstrate proper water management. The proper size of the model area would be the area operated by several turnouts and a few check structures. Taking these criteria into account, the model project area was finally decided to be the most upstream command area of SMC distributed in Chbar Mon and Samraong Tong districts. Length of SMC and paddy area in the model project area is 7 km and 570 ha respectively. Complete irrigation will be achieved in the entire project area at least four years out of five (80% dependability) in the rainy season.</p> <p>To introduce river water from the Prek Thnot River to the paddy fields, all canals are proposed to be improved to be able to maintain proper water level for gravity irrigation. Related structures such as check structures and turnouts are planned to be provided at the diversion points on the main canal. To avoid the canals obstructing public transportation, culverts or bridges are planned to be provided. Of the 32 km of total length of SMC, the most upstream 7km is proposed to be rehabilitated by the project. Design discharge of SMC is 16.3 m³/sec.</p> <p>A participatory approach will be applied in the planning of the tertiary canal system and construction of watercourses. Tertiary canal and watercourse layout will be determined through workshops with farmers in the planning stage. Watercourses will be constructed by the farmers under guidance of the government. Formation and strengthening of FWUCs will also be implemented in parallel.</p>																												
<p>(7) Project Justification</p>	<p>(a) Relevance</p> <p>The project has high relevancy, since adequate irrigation water supply is one of the</p>																												

	<p>most important measure to achieve the goal of master plan (improvement of rice productivity).</p> <p>(b) Effectiveness</p> <p>Implementation of the project can highly contribute to delivering irrigation water to the downstream beneficiaries.</p> <p>(c) Efficiency</p> <p>The project facility is planned to deliver water to the paddy field by gravity. The utilization of existing canals is also considered if the canal fit in this concept. The project cost is reasonably minimized by rehabilitating existing structures. The project was evaluated as efficient.</p> <p>(d) Impact</p> <p>The project gives a positive impact to farmers in the project area in increase of rice production and farmers in downstream area by assuring irrigation water supply. In addition success of this project will increase farmers' trust on irrigation system in the Target Area, since the project is the first irrigation project with proper standard of irrigation facilities. No significant negative impact by the project is anticipated.</p> <p>(e) Sustainability</p> <p>On-farm canal construction by farmers raises sustainability on maintenance of such canals by farmers. The government will continue to take responsibility for operation and maintenance of the main and secondary facility. Sustainability of the project is high.</p>
(8) Project Components	<p>(i) Construction works</p> <ul style="list-style-type: none"> - Rehabilitation of SMC from Vat Kruoch Intake Gate for a length of 7 km, including construction of related structures - Rehabilitation of existing secondary canals (6.1 km), construction of new secondary canals (1.0 km), and rehabilitation of tertiary canal systems for 570 ha, including related structures and drainage canals - Rehabilitation of 4 water harvesting facilities (ponds) including intake structures and irrigation canal systems <p>(ii) Procurement of O&M (operation and maintenance) equipment</p> <p>(iii) Formation and strengthening of FWUCs/FWUGs/WUGs</p> <p>(iv) Agricultural support services</p> <ul style="list-style-type: none"> - Field Programs, Farmer/Farmers' Group Training Programs (including training of village extension agents), Mass Guidance & Workshops, and staff empowerment <p>(v) Engineering Services</p> <ul style="list-style-type: none"> - Survey, design, preparation of tender documents, and construction supervision - Prepare operation rules and operation manual for the facilities - Reinforce organization for O&M of the facilities.
(9) Cost	US\$1,679,000 including price contingency
(10) Executing Agency	MOWRAM and MAFF
(11) Implementation	4.5 years
(12) Environmental Management/ Social Consideration	<p>(i) Proper procedures for land acquisition/involuntary resettlement</p> <ul style="list-style-type: none"> - Public meetings with the affected people, discussions with stakeholders, resettlement and compensation <p>(ii) Proper management of construction work (including social considerations)</p> <ul style="list-style-type: none"> - A series of public meetings from the design phase, proper management of

	workers' sanitation, regular watering for unpaved roads, etc (iii) Regular monitoring at the construction phase (watering, sanitation, waste, etc) and at the operation phase (management of FWUC/FWUGs/WUGs, water quality, etc)
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(2) Implementation Schedule

Activities	Expected Results	2009				2010				2011				2012				2013				In-charge	Equipment	Remarks									
		1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12												
(1) Survey, Design, Preparation of Tender Documents including Drawings	Design reports & drawings, tender docs.																																
		- Topo survey of main and secondary canals																												Consultant	As required		
		- Design of main and secondary canals																													Consultant	As required	
		- Topo survey of tertiary area																															
(2) Tender and Contract award	Contract	- Main, secondary & tertiary canals																												MOWRAM	As required		
		- Design of tertiary canal																												MOWRAM	As required		
(3) Construction work of irrigation facilities	Facilities	- Main, secondary & tertiary canals																												Contractor	As required		
		- Quaternary canals																												Contractor	As required		
		- Quaternary canals																												Farmers/PDOWRAM			
(4) Preparation of O&M manual	O&M manual																												Consultant/Contractor	As required			
(5) Formation of FWUC	FWUC, FWUG and WUG																												PDOWRAM/NGO	As required			
(6) Workshop for tertiary canal system layout	Tertiary canal layout																												PDOWRAM/NGO	As required			
(7) Training FWUC for water management	Dissemination of water saving system																												PDOWRAM/NGO	As required			
(8) Implementation of agriculture support program	Dissemination of improved rice production system																												MAFF/PDA/NGO	As required			

Rainy season

(3) Project Design Matrix



(Target Group: Farmers related to the South Main Canal)

Narrative Summary	Objectively Verifiable Indicator	Means of Verification	Important Assumption
<p>Overall Goal Agricultural productivity centering rice is improved in the Target Area</p>	<p>1-1 Agricultural productivity in the Target Area is improved as proposed in the Master Plan by year 2015</p>	<p>1-1 Agricultural statistics</p>	/
<p>Project Purpose Effectiveness and actual benefit of irrigated agriculture improvement in the model project area is demonstrated</p>	<p>1-1 Agricultural productivity in the model project area is increased</p>	<p>1-1 Agricultural statistics</p>	<p>All the proposed activities in the Master Plan in post-project stage are implemented as scheduled</p> <p>No significant climatic change</p> <p>No severe damage on the irrigation facilities by natural disaster</p>
<p>Outputs 1 Design report, drawings, and tender documents 2. Rehabilitated and constructed irrigation facilities 3. Irrigation facilities in the project area is properly operated by government agencies and FWUCs 4 Improved rice farming practice is applied by farmers</p>	<p>1-1 Irrigation and drainage facilities are properly designed in accordance with government guideline and standard 2-1 Irrigation and drainage facilities are constructed in accordance with government guideline and standard 3-1 Irrigation facilities in the project area is properly operated by government agencies and FWUCs as proposed in the water management manual 4-1 Improved farming practice is applied for 60% of the model project area</p>	<p>1-1 Reports, drawings, and tender documents prepared by engineering consultant, 2-1 Constructed facilities 3-1 Record of water management made by government agencies and FWUCs 4-1 Monitoring survey</p>	<p>No significant climatic change in the project period</p> <p>No severe damage on the irrigation facilities by natural disaster in the project period</p>
<p>Activities 1-1 To survey and design of irrigation facilities 1-2 To tender and contract for construction work 1-3 To execute construction work of irrigation facilities by contractor 1-4 To construct quaternary canals by farmers 2-1 To prepare water management and operation manual of the facility for FWUCs 2-2 To have workshops with farmers for formation of FWUCs 2-3 To assist and advise FWUCs to determine tertiary canal layouts 2-4 To assist and advise farmers to construct quaternary canals 3-1 To train FWUCs for water management practice 3-2 To strengthen related government agencies for proper water management 4-1 To provide agricultural support services on improved rice farming practice</p>	<p style="text-align: center;">Input</p> <p style="text-align: center;">Donor</p> <p style="text-align: center;">Cambodia</p> <p>Construction cost for major irrigation facilities Experts for engineering services - Irrigation engineers 12M/M - Civil engineers 3M/M - Topographic engineers 10M/M - Field Inspectors 6M/M - On farm water management engineer 1M/M - Farmers organization expert 1M/M - Environmental expert 1M/M FWUCs/FWUGs formation and strengthening cost Agriculture supporting service cost</p>	<p style="text-align: center;">FWUCs, FWUGs and WUGs</p> <p style="text-align: center;">FWUC,FWUG and WUG members</p> <p style="text-align: center;"><u>Provincial government</u> Counterparts from PDOWRAM and PDA</p> <p style="text-align: center;"><u>Central government</u> Counterparts from MOWRAM and MAFF Part of agricultural support services cost</p> <p style="text-align: center;"><u>NGO</u> Facilitators</p>	<p>Continuous involvement of related government agencies, FWUCs, FWUGs and WUGs during the project period</p> <p>No severe damage of irrigation facilities by natural disaster within the project period</p> <p>Precondition High need for irrigated agriculture in the Target Area</p> <p>Good understanding of related organizations on the Master Plan and importance of proper water management</p> <p>Related proposed activities in the Master Plan in pre-project stage are implemented as scheduled</p>

1.1.2 A.1(2) Upper North Main Canal Irrigated Agriculture Improvement Project

(1) Project Proposal

(1) Title of Project	Upper North Main Canal Irrigated Agriculture Improvement Project
(2) Location	District: Chbar Mon, Samraong Tong, Province: Kampong Speu
(3) Objective of Project	The project aims to increase rice production in the upper north area (2,210ha) by improvement of irrigation systems and strengthening of agricultural support services and FWUCs.
(4) Site Description	<p>The construction of the North Main Canal (NMC) was planned in the late 1960s and started in the early 1970s as a part of the Prek Thnot Multi Purpose Project. The construction started from Roleang Chrey Regulator. The construction ceased completely because of war activities. After 1979, the construction was resumed by the Government of Cambodia under assistance of donor countries. Its design, however, deviate considerably from the original design. The most downstream part of NMC has been recently constructed by MOWRAM. However, none of the canals have been well maintained up to now. Further, secondary and tertiary canals, related structures such as turnouts, regulators, and culverts are not sufficiently constructed due to lack of budget. Water in NMC is not efficiently delivered to paddy fields at present because of the reasons above. This appears to be one of the important reasons of low agricultural productivity in the area. Farmers excavate canal embankment and bury small pipe intakes in the embankment without compacting soils. This frequently causes collapse of NMC.</p> <p>NMC and related structures</p> <ul style="list-style-type: none"> - NMC is about 25 km in length. However, its design considerably deviates from the original design. The present canal is designed to maintain the water level lower than the adjacent paddy fields. No water level regulator was constructed, so, the water level in the secondary or tertiary canals is also lower than the paddy fields. Pump irrigation is practiced in many places. - The excavated sandy soil is being deposited on both sides of the canal without compaction due to lack of construction budget. The soil, therefore, severely erodes and flows into the canal decreasing flow capacity. - Permanent turnouts which divert water from the main canal to secondary and tertiary canals are rarely constructed. It makes it difficult for farmers to take water from the main canal. To solve this problem, farmers excavated the canal and buried pipes. They do not properly backfill the canal causing collapse of the canal. <div style="display: flex; justify-content: space-around;"> <div>  </div> <div>  </div> </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div> <p><i>Pump irrigation from main canal due to low water level in the canal</i></p> </div> <div> <p><i>The excavated sandy soils are deposited on the canal bank causing severe erosion</i></p> </div> </div>

																														
	<p><i>Canal bank collapsed due to water seepage along pipes illegally buried by farmers</i></p>	<p><i>Culvert constructed by people blocks main canal</i></p>																												
<p>No turnout to the secondary canal, water level in the canal is lower than the paddy fields making gravity irrigation impossible.</p> <p>Secondary canals and related structures</p> <ul style="list-style-type: none"> - The number and length of secondary canals are insufficient for adequate irrigation. - The water level is designed lower than adjacent paddy fields. - Turnouts and check gates are insufficient for proper water management. - At present, definition and classification of the secondary and tertiary canals is not clear and not precise, so some existing secondary canals command very large areas in which proper water management activities are not able to be implemented. <p>Tertiary canal systems</p> <ul style="list-style-type: none"> - The size and number of tertiary systems is insufficient causing inadequate water management. <p>Reservoirs</p> <ul style="list-style-type: none"> - The existing 11 reservoirs in the project area were mostly constructed the late 1970s to collect rainfall. These have been used for irrigation of paddy fields. They are presently deteriorated due to lack of maintenance work. 																														
<p>(5) Agricultural Development Plan</p>	<p>The agricultural development plan indicated in comparison with the present condition is as follows;</p> <p style="text-align: center;">Agricultural Development Plan (Paddy Production)</p> <table border="1"> <thead> <tr> <th rowspan="2"></th> <th colspan="3">With Project</th> <th>Present</th> <th rowspan="2">Increment</th> </tr> <tr> <th>Early Rainy</th> <th>Rainy Season</th> <th>Annual</th> <th>Annual</th> </tr> </thead> <tbody> <tr> <td>Cropped Area</td> <td>215ha</td> <td>2,210ha</td> <td>2,425ha</td> <td>2,445ha</td> <td>-20ha</td> </tr> <tr> <td>Yield</td> <td>3.3t/ha</td> <td>3.0 ~ 3.3t/ha</td> <td>3.0 ~ 3.3t/ha</td> <td>1.5 ~ 2.4t/ha</td> <td>-</td> </tr> <tr> <td>Production</td> <td>710t</td> <td>6,695t</td> <td>7,405t</td> <td>4,797t</td> <td>2,608t</td> </tr> </tbody> </table> <p>At the full development stage, an increase in the production of paddy of 2,600 t/year from the present level is aimed at.</p>			With Project			Present	Increment	Early Rainy	Rainy Season	Annual	Annual	Cropped Area	215ha	2,210ha	2,425ha	2,445ha	-20ha	Yield	3.3t/ha	3.0 ~ 3.3t/ha	3.0 ~ 3.3t/ha	1.5 ~ 2.4t/ha	-	Production	710t	6,695t	7,405t	4,797t	2,608t
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Production	710t	6,695t	7,405t	4,797t	2,608t																									
<p>(6) Irrigation Development Plan</p>	<p>The project is planned to develop irrigated agriculture in 2,210 ha of paddy fields. The project area is scattered along the NMC in Chbar Mon and Samraong Tong Districts in Kampong Speu province.</p> <p>Complete irrigation will be achieved in the entire project area at least 4 years out of 5 years (80% dependability) from the viewpoint of water availability in the rainy season.</p> <p>Water is to be diverted from the Prek Thnot River at the Roleang Chrey Regulator where it flows into the NMC, and will be finally distributed to paddy fields through secondary and tertiary canals. To achieve this, all canals are proposed to be rehabilitated and improved to maintain proper water level for gravity irrigation. Related structures such as check structures and turnouts are planned at the diversion</p>																													

	<p>points on the main canal. To avoid the canals being obstacles to public transportation, culverts or bridges are also planned on the canal.</p> <p>The design discharge of NMC varies from 10.4 m³/sec to 5.8 m³/sec at the end point. All stretches of NMC (32 km) are proposed to be rehabilitated by the project, so that water availability in the downstream area will also be improved.</p> <p>Existing reservoirs are also to be rehabilitated to recover the original designed storage capacity. Those reservoirs are planned to receive irrigation water from NMC and function as regulating ponds to store inflow and regulate outflow to the downstream paddy fields.</p> <p>The project proposes to apply a participatory approach in the planned tertiary canal system and construction of watercourses. Tertiary canal and water course layout will be determined through workshops with farmers in the planning stage. Watercourses will be constructed by the farmers under guidance of the government. Formation and strengthening of FWUC shall be therefore implemented before detailed design work.</p>
(7) Project Justification	<p>(a) Relevance</p> <p>The project has high relevancy, since adequate irrigation water supply is one of the most important measure to achieve the goal of master plan (improvement of rice productivity).</p> <p>(b) Effectiveness</p> <p>Implementation of the project can highly contribute to deliver irrigation water to the downstream beneficiaries.</p> <p>(c) Efficiency</p> <p>The project facility is planned to deliver water to the paddy field by gravity. The utilization of existing canals is also considered if the canal fit in this concept. The project cost is reasonably minimized by rehabilitating existing structures. The project was evaluated as efficient.</p> <p>(d) Impact</p> <p>The project gives a positive impact to farmers in the downstream area by assuring irrigation water supply. The project targets existing paddy fields using existing facilities as much as possible.</p> <p>No significant negative impact by the project is anticipated.</p> <p>(e) Sustainability</p> <p>Tertiary canal systems are planned to be constructed by farmers. The Government will continue to take responsibility for operation and maintenance of the main and secondary facility. Sustainability of the project is high.</p>
(8) Project Components	<p>(i) Construction works</p> <ul style="list-style-type: none"> - Rehabilitation of NMC from Andong Sla Intake Gate to the end of the canal (32 km) including construction of related structures - Rehabilitation of existing secondary canals (4.9 km), construction of new secondary canals (5.2 km), and rehabilitation of tertiary canal systems for 2,210 ha, including related structures such as turnouts, checks, culverts and drainage canals - Rehabilitation of 11 water harvesting facilities (reservoirs) including intake structures and irrigation canal systems <p>(ii) Procurement of O&M (operation and maintenance) equipment</p> <p>(iii) Formation and strengthening of FWUC/FWUGs/WUGs</p> <p>(iv) Agricultural support services</p> <ul style="list-style-type: none"> - Field Programs, Farmer/Farmers' Group Training Programs (including training of village extension agents), Mass Guidance & Workshops, staff empowerment

	(v) Engineering Services <ul style="list-style-type: none"> - Survey, design, preparation of tender documents, and construction supervision - Prepare operation rules and an operation manual for the facilities - Reinforce organization for O&M of the facility.
(9) Cost	US\$11.332,000 including price contingency
(10) Executing Agency	MOWRAM and MAFF
(11) Implementation	5 years
(12) Environmental Management/ Social Considerations	(i) Proper procedures for land acquisition/involuntary resettlement <ul style="list-style-type: none"> - Public meetings with the affected people, discussions with the stakeholders, resettlement and compensation (ii) Proper management of construction work (including social considerations) <ul style="list-style-type: none"> - A series of public meetings from the design phase, proper management of workers' sanitation, regular watering for unpaved roads, etc (iii) Regular monitoring at the construction phase (watering, sanitation, waste, etc) and at the operation phase (management of FWUC/FWUGs/WUGs, water quality, etc)

(2) Implementation Schedule

Activities	Expected Results	2011				2012				2013				2014				2015	In-charge	Equipmen	Remarks
		1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12				
(1) Survey, Design, Preparation of Tender Documents including Drawings	Design reports & drawings, tender docs.	- Topo survey of main and secondary canals	■	■	■																
		- Design of main and secondary canals		■	■	■														Consultant	As required
		- Topo survey of tertiary area				■	■	■													
		- Design of tertiary canal					■	■	■											Consultant	As required
(2) Tender and Contract award	Contract	- Main and secondary canals			■	■													MOWRAM	As required	
		- Tertiary canals					■	■											MOWRAM	As required	
		Construction work of irrigation facilities																			
(3) Construction work of irrigation facilities	Facilities	- Main and secondary canals				■	■	■	■										Contractor	As required	
		- Tertiary canals							■	■	■	■							Contractor	As required	
		- Quaternary canals									■	■	■	■					Farmers/PDOWRAM		
		Preparation of O&M manual																	Consultant/ Contractor	As required	
(4) Preparation of O&M manual	O&M manual																				
(5) Formation of FWUC	FWUC, FWUG and		■	■	■													PDOWRAM/ NGO	As required		
(6) Workshop for tertiary canal system layout	Tertiary canal layout		■	■	■													PDOWRAM/ NGO	As required		
(7) Training FWUC for water management	Dissemination of water saving system										■	■	■	■	■	■	■	■	PDOWRAM/ NGO	As required	
(8) Implementation of agriculture support programs	Dissemination of improved rice production system											■	■	■	■	■	■	■	MAFF/PDA/ NGO	As required	

■ Rainy season



(3) Project Design Matrix



(Target Group: Farmers related to the South Main Canal)

Narrative Summary	Objectively Verifiable Indicator	Means of Verification	Important Assumption
Overall Goal Agricultural productivity centering rice is improved in the Target Area	1-1 Agricultural productivity in the Target Area is improved as proposed in the Master Plan by year 2015	1-1 Agricultural statistics	/
Project Purpose Rice productivity in the project area is improved	1-1 Rice productivity in the project area is improved as proposed in the Master Plan	1-1 Agricultural statistics	All the proposed activities in the Master Plan in post-project stage are implemented as scheduled No significant climatic change No severe damage on the irrigation facilities by natural disaster
Outputs 1 Design report, drawings, and tender documents 2. Rehabilitated and constructed irrigation facilities 3. Irrigation facilities in the project area is properly operated by government agencies and FWUCs 4 Improved rice farming practice is applied by farmers	1-1 Irrigation and drainage facilities are properly designed in accordance with government guideline and standard 2-1 Irrigation and drainage facilities are constructed in accordance with government guideline and standard 3-1 Irrigation facilities in the project area is properly operated by government agencies and FWUCs as proposed in the water management manual 4-1 Improved farming practice is applied for 60% of the model project area	1-1 Reports, drawings, and tender documents prepared by engineering consultant, 2-1 Constructed facilities 3-1 Record of water management made by government agencies and FWUCs 4-1 Monitoring survey	No significant climatic change in the project period No severe damage on the irrigation facilities by natural disaster in the project period
Activities 1-1 To survey and design of irrigation facilities 1-2 To tender and contract for construction work 1-3 To execute construction work of irrigation facilities by contractor 1-4 To construct quaternary canals by farmers 2-1 To prepare water management and operation manual of the facility for FWUC 2-2 To have workshops with farmers for formation of FWUC 2-3 To assist and advise FWUC to determine tertiary canal systems layout 2-4 To assist and advise farmers to construct quaternary canals 3-1 To train FWUCs for water management practice 3-2 To strengthen related government agencies for proper water management 4-1 To provide agricultural support services on improved rice farming practice	Input Donor Construction cost for major irrigation facilities Experts for Engineering Services - Irrigation engineers 47M/M - Civil engineers 23M/M - Topographic engineers 40M/M - Field Inspectors 30M/M - Quantity surveyors 32M/M - On farm water management engineers 20M/M - Farmers organization experts 8M/M - Environmental expert 1M/M FWUCs/FWUGs formation and strengthening cost Agriculture supporting service cost		Cambodia <u>FWUCs, FWUGs and WUGs</u> FWUC, FWUG and WUG members <u>Provincial government</u> Counterparts from PDOWRAM and PDA <u>Central government</u> Counterparts from MOWRAM and MAFF Part of agricultural support services cost <u>NGO</u> Facilitators Continuous involvement of related government agencies, FWUCs, FWUGs and WUGs during the project period No severe damage of irrigation facilities by natural disaster within the project period Precondition High need for irrigated agriculture in the Target Area Good understanding of related organizations on the Master Plan and importance of proper water management Related proposed activities in the Master Plan in pre-project stage are implemented as scheduled

1.1.3 A.1(3) Upper South Main Canal Irrigated Agriculture Improvement Project

(1) Project Proposal

(1) Title of Project	Upper South Main Canal Irrigated Agricultural Improvement Project
(2) Location	District: Chbar Mon, Samraong Tong, Province: Kampong Speu
(3) Objective of Project	The project aims to increase rice production in the upper south area (2,880ha) by improvement of the irrigation systems and strengthening of agricultural support services and FWUCs
(4) Site Description	<p>The South Main Canal (SMC) has been recently constructed by MOWRAM. However, none of the canals have been well maintained until now due to lack of government budget. Further, secondary and tertiary canals, related structures such as turnouts, regulators, and culverts are not sufficiently constructed. Water in SMC is not efficiently delivered to the paddy fields at present because of the reasons above. This appears to be one of the important reasons of low agricultural productivity in the area. Farmers excavate the canal embankment and bury small pipe intakes in the embankment without compacting soils. This frequently causes collapse of SMC.</p> <p>SMC and related structures</p> <ul style="list-style-type: none"> - SMC of about 26 km in length, has been recently constructed. However, its design considerably deviates from the ordinal irrigation canal design. The present canal is designed to maintain the water level lower than the adjacent paddy fields. A few water level regulators were constructed; however, the water level in the secondary or tertiary canals is still lower than the paddy fields. Pump irrigation is practiced in many places. <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;">  <p><i>Water level in the canal is lower than the paddy fields</i></p> </div> <div style="text-align: center;">  <p><i>Breach of bank of SMC due to seepage</i></p> </div> </div> <ul style="list-style-type: none"> - Permanent turnouts which divert water from main canal to secondary and tertiary canals are rarely constructed. It makes it difficult for farmers to take water from the main canal. To solve this problem, farmers excavated the canal and buried pipes. They do not properly backfill the canal causing collapse of canal. <p>Water level in the subsidiary canal is lower than the paddy fields making gravity irrigation impossible.</p> <p>Secondary canals and related structures</p> <ul style="list-style-type: none"> - The number and length of secondary canals are not sufficient for adequate irrigation. - The water level is designed lower than the adjacent paddy fields. - Existing turnouts and regulators are deteriorated, and insufficient for proper water management. - At present, the definition and classification of the secondary and tertiary canals is not clear and not precise, so some existing secondary canals command very large areas in which proper water management activities are not able to be implemented.

	<p>Tertiary canal systems</p> <ul style="list-style-type: none"> - The size and number of tertiary systems is insufficient causing inadequate water management. <p>Reservoirs</p> <ul style="list-style-type: none"> - The existing 4 reservoirs in the project area were mostly constructed in the late 1970s to collect rainfall. These have been used for irrigation of paddy fields. They are deteriorated due to lack of maintenance work. <div style="display: flex; justify-content: space-around;">   </div> <div style="display: flex; justify-content: space-around;"> <p>A reservoir for collecting rain. The dike was severely washed away</p> <p>An intake structure at a water harvesting reservoir is deteriorated</p> </div>																												
<p>(5) Agricultural Development Plan</p>	<p>The agricultural development plan indicated in comparison with the present condition is as follows;</p> <p style="text-align: center;">Agricultural Development Plan (Paddy Production)</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2"></th> <th colspan="3">With Project</th> <th>Present</th> <th rowspan="2">Increment</th> </tr> <tr> <th>Early Rainy</th> <th>Rainy Season</th> <th>Annual</th> <th>Annual</th> </tr> </thead> <tbody> <tr> <td>Cropped Area</td> <td></td> <td>2,880ha</td> <td>2,880ha</td> <td>2,905</td> <td>-25ha</td> </tr> <tr> <td>Yield</td> <td></td> <td>3.0t/ha</td> <td>3.0t/ha</td> <td>1.5 ~ 2.1t/ha</td> <td>-</td> </tr> <tr> <td>Production</td> <td></td> <td>8,640t</td> <td>8,640t</td> <td>5,471t</td> <td>3,169t</td> </tr> </tbody> </table> <p>At the full development stage, an increase in the production of paddy of some 3,200 t/year from the present level is aimed at.</p>		With Project			Present	Increment	Early Rainy	Rainy Season	Annual	Annual	Cropped Area		2,880ha	2,880ha	2,905	-25ha	Yield		3.0t/ha	3.0t/ha	1.5 ~ 2.1t/ha	-	Production		8,640t	8,640t	5,471t	3,169t
	With Project			Present	Increment																								
	Early Rainy	Rainy Season	Annual	Annual																									
Cropped Area		2,880ha	2,880ha	2,905	-25ha																								
Yield		3.0t/ha	3.0t/ha	1.5 ~ 2.1t/ha	-																								
Production		8,640t	8,640t	5,471t	3,169t																								
<p>(6) Irrigation Development Plan</p>	<p>The project is planned to develop irrigated agriculture in 2,880 ha of paddy fields. The project area is scattered along SMC in Chbar Mon and Samraong Tong Districts in Kampong Speu province.</p> <p>Irrigation will be achieved in the entire project area at least 4 years out of 5 years (80% dependability) from the viewpoint of water availability in the rainy season.</p> <p>Water is to be diverted from the Prek Thnot River at the Roleang Chrey Regulator where it flows into SMC, and will be finally distributed to the paddy fields through secondary and tertiary canals. To achieve this, all canals are proposed to be rehabilitated and improved to maintain proper water level for gravity irrigation. Related structures such as check structures and turnouts are planned at the diversion points on SMC. To avoid the canals being an obstacle to public transportation, culverts or bridges are also planned on the canal.</p> <p>The design discharge of SMC varies from 16.3 m³/sec to 6.6 m³/sec at the end point. Of the total length of 32km, 25 km is proposed to be rehabilitated by the project, so that water availability in the upstream and middle stream area will also be improved.</p> <p>Existing reservoirs are also to be rehabilitated to recover the original design storage capacity. Those reservoirs are planned to receive irrigation water from SMC, and function as regulating ponds to store inflow and regulate outflow to the downstream paddy fields.</p> <p>The project proposes to apply a participatory approach in planning the tertiary canal system and construction of watercourses. Tertiary canal and watercourses layout will be determined through workshops with farmers in the planning stage. Watercourses will be constructed by farmers under assist and advice from the</p>																												

	government. Formation and strengthening of the FWUC shall be implemented in parallel with project implementation.
(7) Project Justification	<p>(a) Relevance</p> <p>Irrigation water is one of the key factors to stabilize and increase rice productivity. The project aims at to construct irrigation facilities. The irrigation area is determined taking into account available water resources and water demand for irrigation. The project has high relevancy, since adequate irrigation water supply is one of the most important measure to achieve the goal of master plan (improvement of rice productivity).</p> <p>(b) Effectiveness</p> <p>Implementation of the project can highly contribute to deliver irrigation water to the downstream beneficiaries.</p> <p>(c) Efficiency</p> <p>The project facility is planned to deliver water to the paddy field by gravity. The utilization of existing canals is also considered if the canal fit in this concept. The project cost is reasonably minimized by rehabilitating existing structures. The project was evaluated as efficient.</p> <p>(d) Impact</p> <p>The project gives a positive impact to farmers in the downstream area by assuring irrigation water supply. The project targets existing paddy fields using existing facilities as much as possible. No significant negative impact by the project is anticipated.</p> <p>(e) Sustainability</p> <p>Tertiary canal systems are planned to be constructed by farmers. The Government will continue to take responsibility for operation and maintenance of the main and secondary facility. Sustainability of the project is high.</p>
(8) Project Components	<p>(i) Construction works</p> <ul style="list-style-type: none"> - Rehabilitation of SMC from station 7 km to station 25 km, including construction of related structures - Rehabilitation of existing secondary canals (9.5 km), construction of new secondary canals (21.3 km), and rehabilitation of tertiary canal systems for 2,880 ha, including related structures such as turnouts, checks, culverts and drainage canals, - Rehabilitation of 4 water harvesting facilities (reservoirs) including intake structures and irrigation canal systems <p>(ii) Procurement of O&M (operation and maintenance) equipment</p> <p>(iii) Formation and strengthening of FWUC/FWUGs/WUGs</p> <p>(iv) Agricultural support services</p> <ul style="list-style-type: none"> - Field Programs, Farmer/Farmers' Group Training Programs (including training of village extension agents), Mass Guidance & Workshops, staff empowerment <p>(v) Engineering Services</p> <ul style="list-style-type: none"> - Survey, design, preparation of tender documents, and construction supervision - Prepare operation rules and an operation manual for the facilities - Reinforce organization for operation and maintenance of the facilities.
(9) Cost	US\$ 9,871,000 including price contingency
(10) Executing Agency	MOWRAM and MAFF
(11) Implementation	5 years

(12) Environmental Management/ Social Considerations	<p>(i) Proper procedures for land acquisition/involuntary resettlement</p> <ul style="list-style-type: none"> - Public meetings with the affected people, discussions with the stakeholders, resettlement and compensation <p>(ii) Proper management of construction work (including social considerations)</p> <ul style="list-style-type: none"> - A series of public meetings from the design phase, proper management of workers' sanitation, regular watering for unpaved roads, etc <p>(iii) Regular monitoring at the construction phase (watering, sanitation, waste, etc) and at the operation phase (management of FWUC/FWUGs/WUGs, water quality, etc)</p>
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(2) Implementation Schedule

Activities	Expected Results	2011				2012				2013				2014				2015	In-charge	Equipment	Remarks
		1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12				
(1) Survey, Design, Preparation of Tender Documents including Drawings	Design reports & drawings, tender docs.																				
	- Topo survey of main and secondary canals																				
	- Design of main and secondary canals																				
	- Topo survey of tertiary area																				
(2) Tender and Contract award	- Design of tertiary canal																				
	Contract																				
(3) Construction work of irrigation facilities	- Main and secondary canals																				
	- Tertiary canals																				
	- Quaternary canals																				
	Facilities																				
(4) Preparation of O&M manual	O&M manual																				
(5) Formation of FWUC	FWUC, FWUG and																				
(6) Workshop for tertiary canal system layout	Tertiary canal layout																				
(7) Training FWUC for water management	Dissemination of water saving system																				
(8) Implementation of agriculture support programs	Dissemination of improved rice production																				

 Rainy season

(3) Project Design Matrix


(Target Group: Farmers related to the South Main Canal)

Narrative Summary	Objectively Verifiable Indicator	Means of Verification	Important Assumption
Overall Goal Agricultural productivity centering rice is improved in the Target Area	1-1 Agricultural productivity in the Target Area is improved as proposed in the Master Plan by year 2015	1-1 Agricultural statistics	/
Project Purpose Rice productivity in the project area is improved	1-1 Rice productivity in the project area is improved as proposed in the Master Plan	1-1 Agricultural statistics	All the proposed activities in the Master Plan in post-project stage are implemented as scheduled No significant climatic change No severe damage on the irrigation facilities by natural disaster
Outputs 1 Design report, drawings, and tender documents 2. Rehabilitated and constructed irrigation facilities 3. Irrigation facilities in the project area is properly operated by government agencies and FWUCs 4 Improved rice farming practice is applied by farmers	1-1 Irrigation and drainage facilities are properly designed in accordance with government guideline and standard 2-1 Irrigation and drainage facilities are constructed in accordance with government guideline and standard 3-1 Irrigation facilities in the project area is properly operated by government agencies and FWUCs as proposed in the water management manual 4-1 Improved farming practice is applied for 60% of the model project area	1-1 Reports, drawings, and tender documents prepared by engineering consultant, 2-1 Constructed facilities 3-1 Record of water management made by government agencies and FWUCs 4-1 Monitoring survey	No significant climatic change in the project period No severe damage on the irrigation facilities by natural disaster in the project period
Activities 1-1 To survey and design of irrigation facilities 1-2 To tender and contract for construction work 1-3 To execute construction work of irrigation facilities by contractor 1-4 To construct quaternary canals by farmers 2-1 To prepare water management and operation manual of the facility for FWUC 2-2 To have workshops with farmers for formation of FWUC 2-3 To assist and advise FWUC to determine tertiary canal systems layout 2-4 To assist and advise farmers to construct quaternary canals 3-1 To train FWUCs for water management practice 3-2 To strengthen related government agencies for proper water management 4-1 To provide agricultural support services on improved rice farming practice	<p style="text-align: center;">Input</p> <p style="text-align: center;">Donor</p> <p style="text-align: center;">Cambodia</p> Construction cost for major irrigation facilities Experts for Engineering Services - Irrigation engineers 40M/M - Civil engineers 26M/M - Topographic engineers 45M/M - Field Inspectors 28M/M - Quantity surveyors 30M/M - On farm water management engineers 9M/M - Farmers organization experts 6M/M - Environmental Expert 1M/M FWUC/FWUGs/WUGs formation and strengthening cost Agriculture supporting service cost	Provincial government Counterparts from PDOWRAM and PDA Provincial government Counterparts from MOWRAM and MAFF Part of agricultural support services cost NGO Facilitators	Continuous involvement of related government agencies, FWUCs, FWUGs and WUGs during the project period No severe damage of irrigation facilities by natural disaster within the project period Precondition High need for irrigated agriculture in the Target Area Good understanding of related organizations on the Master Plan and importance of proper water management Related proposed activities in the Master Plan in pre-project stage are implemented as scheduled

1.2 Zone-2 Projects

1.2.1 A.2(1) Lower North Main Canal Irrigated Agriculture Improvement Project

(1) Project Proposal

(1) Title of Project	Lower North Main Canal Irrigated Agriculture Improvement Project																												
(2) Location	District: Angk Snuol, Province: Kandal																												
(3) Objective of Project	The project aims to increase rice production in the lower north area (1,390ha) by improvement of the irrigation system and strengthening of agricultural support services and FWUCs.																												
(4) Site Description	<p>The most downstream part of NMC has been constructed recently by MOWRAM. However, the secondary and tertiary canals and related structures are not sufficiently constructed due to lack of budget. Water in NMC is not delivered efficiently to the paddy fields at present due to the reasons above. This appears to be one of the important reasons for the low agricultural productivity in the area. Farmers bury small pipe intakes in the embankment without compacting the soils. This frequently causes collapse of embankment of NMC.</p> <p>Secondary canals and related structures</p> <ul style="list-style-type: none"> - The number and length of secondary canals are insufficient. - The water level is designed to be lower than the adjacent paddy fields. - At present, the definition and classification of the secondary and tertiary canals is not clear and not precise, so some existing secondary canals command very large areas in which proper water management activities can not be conducted. - Permanent turnouts which divert water from the secondary canals to the tertiary canals are rarely constructed. It makes it difficult for farmers to take water from the canal. - Culverts are not sufficiently provided in the canals causing people difficulty in crossing the canals for daily activities. To solve this, people block the canal by soil burying pipes resulting in a decrease of flow capacity in the canal. <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;">  <p><i>No turnout to the tertiary canal, water level in the canal is lower than the paddy field making gravity irrigation impossible.</i></p> </div> <div style="text-align: center;">  <p><i>Water level in the canal is too low to irrigate by gravity</i></p> </div> </div> <p>Tertiary canal systems</p> <ul style="list-style-type: none"> - Sizes and number of tertiary systems are insufficient. 																												
(5) Agricultural Development Plan	<p>The agricultural development plan indicated in comparison with the present condition is as follows;</p> <p style="text-align: center;">Agricultural Development Plan (Paddy Production)</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2"></th> <th colspan="3">With Project</th> <th>Present</th> <th rowspan="2">Increment</th> </tr> <tr> <th>Early Rainy</th> <th>Rainy Season</th> <th>Annual</th> <th>Annual</th> </tr> </thead> <tbody> <tr> <td>Cropped Area</td> <td>200ha</td> <td>1,390ha</td> <td>1,590ha</td> <td>1,400</td> <td>190ha</td> </tr> <tr> <td>Yield</td> <td>3.3t/ha</td> <td>2.8t/ha</td> <td>2.8 ~ 3.3t/ha</td> <td>1.5 ~ 2.1t/ha</td> <td>-</td> </tr> <tr> <td>Production</td> <td>660t</td> <td>3,892t</td> <td>4,552t</td> <td>2,430t</td> <td>2,122t</td> </tr> </tbody> </table>		With Project			Present	Increment	Early Rainy	Rainy Season	Annual	Annual	Cropped Area	200ha	1,390ha	1,590ha	1,400	190ha	Yield	3.3t/ha	2.8t/ha	2.8 ~ 3.3t/ha	1.5 ~ 2.1t/ha	-	Production	660t	3,892t	4,552t	2,430t	2,122t
	With Project			Present	Increment																								
	Early Rainy	Rainy Season	Annual	Annual																									
Cropped Area	200ha	1,390ha	1,590ha	1,400	190ha																								
Yield	3.3t/ha	2.8t/ha	2.8 ~ 3.3t/ha	1.5 ~ 2.1t/ha	-																								
Production	660t	3,892t	4,552t	2,430t	2,122t																								

	At the full development stage, an increase in the production of paddy of 2,100 t/year from the present level is aimed at.
(6) Irrigation Development Plan	<p>The project is planned to develop irrigated agriculture in 1,390 ha of paddy fields. The project area is scattered downstream of the NMC in Angk Snuol District in Kandal Province. Supplemental irrigation will be achieved in the entire project area in at least 3 years out of 6 years (50% dependability) from the viewpoint of water availability in the rainy season.</p> <p>Water is to be diverted from the Prek Thnot River at the Roleang Chrey Regulator where it flows into NMC, and will be finally distributed to paddy fields through secondary and tertiary canals. To achieve this, all canals are proposed to be rehabilitated and improved to maintain proper water level for gravity irrigation. Related structures such as check structures and turnouts are planned at the diversion points on the main canal. To avoid the canals being obstacles to public transportation, culverts or bridges are also planned on the canal. Design discharge of 5.8m³/sec will be conveyed to the project area in the peak period. All secondary and tertiary canals are proposed to be rehabilitated by the project, so that water availability in the downstream area will be also improved.</p> <p>The project proposes to apply a participatory approach in planning tertiary canal system and watercourses. Tertiary canal and watercourse layout will be determined through workshops with the farmers. Watercourses will be constructed by the farmers with support from the government. Formation and strengthening of the FWUC shall be implemented before detailed design work.</p>
(7) Project Justification	<p>(a) Relevance</p> <p>Irrigation water is one of the key factors to stabilize and increase rice productivity. The project aims at to construct irrigation facilities. The irrigation area is determined taking into account available water resources and water demand for irrigation. The project has high relevancy, since adequate irrigation water supply is one of the most important measure to achieve the goal of master plan (improvement of rice productivity).</p> <p>(b) Effectiveness</p> <p>Implementation of the project can highly contribute to deliver irrigation water to the downstream beneficiaries.</p> <p>(c) Efficiency</p> <p>The project facility is planned to deliver water to the paddy field by gravity. The utilization of existing canals is also considered if the canal fit in this concept. The project cost is reasonably minimized by rehabilitating existing structures. The project was evaluated as efficient.</p> <p>(d) Impact</p> <p>The project gives a positive impact to farmers in the downstream area by assuring irrigation water supply. The project targets existing paddy fields using existing facilities as much as possible. No significant negative impact by the project is anticipated.</p> <p>(e) Sustainability</p> <p>Tertiary canal systems are planned to be constructed by farmers. The Government will continue to take responsibility for operation and maintenance of the main and secondary facility. Sustainability of the project is high.</p>
(8) Project Components	<p>(i) Construction works</p> <ul style="list-style-type: none"> - Rehabilitation of existing secondary canals (8.6 km), construction of new secondary canals (10.9 km), and rehabilitation of tertiary canal systems for 1,390 ha, including related structures such as turnouts, checks, culverts and drainage canals

	<p>(ii) Procurement of O&M (operation and maintenance) equipment</p> <p>(iii) Formation and strengthening of FWUC/FWUGs/WUGs</p> <p>(iv) Agricultural support services</p> <ul style="list-style-type: none"> - Field Programs, Farmer/Farmers' Group Training Programs (including training of village extension agents), Mass Guidance & Workshops, staff empowerment <p>(v) Engineering Services</p> <ul style="list-style-type: none"> - Survey, design, preparation of tender documents, and construction supervision - Prepare operation rules and an operation manual for the facilities - Reinforce organization for O&M of the project facility.
(9) Cost	US\$ 3,190,000 including price contingency
(10) Executing Agency	MOWRAM and MAFF
(11) Implementation	3 years
(12) Environmental Management/ Social Considerations	<p>The following activities are planned;</p> <p>(i) Proper procedures for land acquisition/involuntary resettlement</p> <ul style="list-style-type: none"> - Public meetings with the affected people, discussions with the stakeholders, resettlement and compensation <p>(ii) Proper management of construction work (including social considerations)</p> <ul style="list-style-type: none"> - A series of public meetings from the design phase, proper management of workers' sanitation, regular watering for unpaved roads, etc <p>(iii) Regular monitoring at the construction phase (watering, sanitation, waste, etc) and at the operation phase (management of FWUC/FWUGs/WUGs, water quality, etc)</p>

(2) Implementation Schedule

Activities	Expected Results	2012				2013				2014				2015				In-charge	Equipment	Remarks
		1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12			
(1) Survey, Design, Preparation of Tender Documents including Drawings	Design reports & drawings, tender docs.																			
	- Topo survey of secondary canals																			
	- Design of secondary canals																	Consultant	As required	
	- Topo survey of tertiary area																	Consultant	As required	
(2) Tender and Contract award	Contract																			
	- Secondary canals																	MOWRAM	As required	
	- Tertiary canals																	MOWRAM	As required	
(3) Construction work of irrigation facilities	Facilities																			
	- Secondary canals																	Contractor	As required	
	- Tertiary canals																	Contractor	As required	
	- Quaternary canals																	Farmers/PDOWRAM		
(4) Preparation of O&M manual	O&M manual																	Consultant/ Contractor	As required	
(5) Formation of FWUC	FWUC, FWUG and																	PDOWRAM/ NGO	As required	
(6) Workshop for tertiary canal system layout	Tertiary canal layout																	PDOWRAM/ NGO	As required	
(7) Training FWUC for water management	Dissemination of water saving system																	PDOWRAM/ NGO	As required	
(8) Implementation of agriculture support programs	Dissemination of improved rice production system																	MAFF/PDA/ NGO	As required	

 Rainy season



(3) Project Design Matrix



(Target Group: Farmers related to the North Main Canal)

Narrative Summary	Objectively Verifiable Indicator	Means of Verification	Important Assumption
Overall Goal Agricultural productivity centering rice is improved in the Target Area	1-1 Agricultural productivity in the Target Area is improved as proposed in the Master Plan by year 2015	1-1 Agricultural statistics	/
Project Purpose Rice productivity in the project area is improved	1-1 Rice productivity in the project area is improved as proposed in the Master Plan	1-1 Agricultural statistics	All the proposed activities in the Master Plan in post-project stage are implemented as scheduled No significant climatic change No severe damage on the irrigation facilities by natural disaster
Outputs 1 Design report, drawings, and tender documents 2. Rehabilitated and constructed irrigation facilities 3. Irrigation facilities in the project area is properly operated by government agencies and FWUCs 4 Improved rice farming practice is applied by farmers	1-1 Irrigation and drainage facilities are properly designed in accordance with government guideline and standard 2-1 Irrigation and drainage facilities are constructed in accordance with government guideline and standard 3-1 Irrigation facilities in the project area is properly operated by government agencies and FWUCs as proposed in the water management manual 4-1 Improved farming practice is applied for 60% of the model project area	1-1 Reports, drawings, and tender documents prepared by engineering consultant, 2-1 Constructed facilities 3-1 Record of water management made by government agencies and FWUCs 4-1 Monitoring survey	No significant climatic change in the project period No severe damage on the irrigation facilities by natural disaster in the project period
Activities 1-1 To survey and design of irrigation facilities 1-2 To tender and contract for construction work 1-3 To execute construction work of irrigation facilities by contractor 1-4 To construct quaternary canals by farmers 2-1 To prepare water management and operation manual of the facility for FWUC 2-2 To have workshops with farmers for formation of FWUC 2-3 To assist and advise FWUC to determine tertiary canal systems layout 2-4 To assist and advise farmers to construct quaternary canals 3-1 To train FWUCs for water management practice 3-2 To strengthen related government agencies for proper water management 4-1 To provide agricultural support services on improved rice farming practice	<p style="text-align: center;">Input</p> <p style="text-align: center;">Donor</p> <p style="text-align: center;">Cambodia</p> Construction cost for major irrigation facilities Experts for Engineering Services - Irrigation eng.14M/M - Civil engs.18M/M - Topographic surveyors. 24M/M - Field Inspectors.18M/M - Quantity surveyors.20M/M - On farm water manag. eng.4M/M - Farmers org. 4M/M FWUC/FWUGs/WUGs formation and strengthening cost Agriculture supporting service cost	Provincial government Counterparts from PDOWRAM and PDA Central government Counterparts from MOWRAM and MAFF Part of agricultural support services cost NGO Facilitators	Continuous involvement of related government agencies, FWUCs, FWUGs and WUGs during the project period No severe damage of irrigation facilities by natural disaster within the project period Precondition High need for irrigated agriculture in the Target Area Good understanding of related organizations on the Master Plan and importance of proper water management Related proposed activities in the Master Plan in pre-project stage are implemented as scheduled

1.2.2 A.2(2) Lower South Main Canal Irrigated Agriculture Improvement Project

(1) Project Proposal

(1) Title of Project	Lower South Main Canal Irrigated Agricultural Improvement Project
(2) Location	District: Kong Pisei, Kandal Stung, Province: Kampong Speu, Kandal
(3) Objective of Project	The project aims to increase rice production in the lower south area (6,750ha) by improvement of the irrigation system and strengthening of agricultural support services and FWUCs
(4) Site Description	<p>The South Main Canal (SMC) has been recently constructed by MOWRAM. However, none of the canals have been well maintained until now due to lack of government budget. Further, secondary and tertiary canals and related structures such as turnouts, check gates, and culverts are not sufficiently constructed. Water in SMC is not efficiently delivered to the paddy fields at present because of the reasons above. This appears to be one of the important reasons for the low agricultural productivity in the area. Farmers excavate canal the embankment and bury small pipe intakes in the embankment without compacting the soils. This frequently causes collapse of SMC.</p> <p>SMC and related structures</p> <ul style="list-style-type: none"> - The SMC, of about 26 km total length, has been recently constructed. However, its design considerably deviates from the original irrigation canal design. The present canal is designed to maintain the water level lower than adjacent paddy fields. A few water level regulators were constructed; however, the water level in the secondary or tertiary canals is still lower than paddy fields. Pump irrigation is practiced in many places. <div style="display: flex; justify-content: space-around;"> <div>  </div> <div>  </div> </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div> <p><i>Secondary canal from SMC, water level is low because the canal was a river before</i></p> </div> <div> <p><i>End structure of SMC</i></p> </div> </div> <ul style="list-style-type: none"> - Permanent turnouts which divert water from the main canal to secondary and tertiary canals are rarely constructed. It makes it difficult for farmers to take water from the main canal. To solve this problem, farmers excavated the canal and buried pipes. They do not properly backfill the canal causing collapse of the canal. <p>Water level in the subsidiary canal is lower than the paddy fields making gravity irrigation impossible.</p> <p>Secondary canals and related structures</p> <ul style="list-style-type: none"> - The number and length of secondary canals are not sufficient for adequate irrigation. - The water level is designed lower than the adjacent paddy fields. - Existing turnouts and regulators are deteriorated, and insufficient for proper water management. - At present, the definition and classification of the secondary and tertiary canals is not clear and not precise, so some existing secondary canals command very large areas in which proper water management activities are not able to be

	<p>implemented.</p> <p>Tertiary canal systems</p> <ul style="list-style-type: none"> - The size and number of tertiary systems is insufficient causing inadequate water management. <p>Reservoirs</p> <ul style="list-style-type: none"> - The existing 5 reservoirs in the project area were mostly constructed in the late 1970s to collect rainfall (water harvesting). These have been used for irrigation of the paddy fields. They are deteriorated due to adverse soil characteristics and lack of maintenance work. <div style="display: flex; justify-content: space-around;">   </div> <div style="display: flex; justify-content: space-around;"> <p><i>Erosion at dispersive soil embankment</i></p> <p><i>Embankment collapsed due to seepage along buried pipe</i></p> </div>																												
<p>(5) Agricultural Development Plan</p>	<p>The agricultural development plan indicated in comparison with the present condition is as follows;</p> <p style="text-align: center;">Agricultural Development Plan (Paddy Production)</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2"></th> <th colspan="3">With Project</th> <th>Present</th> <th rowspan="2">Increment</th> </tr> <tr> <th>Early Rainy</th> <th>Rainy Season</th> <th>Annual</th> <th>Annual</th> </tr> </thead> <tbody> <tr> <td>Cropped Area</td> <td>1,000ha</td> <td>6,750ha</td> <td>7,750ha</td> <td>6,880ha</td> <td>870ha</td> </tr> <tr> <td>Yield</td> <td>3.3t/ha</td> <td>2.8t/ha</td> <td>2.8 ~ 3.3t/ha</td> <td>1.5t/ha</td> <td>-</td> </tr> <tr> <td>Production</td> <td>3,300t</td> <td>18,900t</td> <td>22,200t</td> <td>10,320t</td> <td>11,880t</td> </tr> </tbody> </table> <p>At the full development stage, an increase in the production of paddy of 11,900 t/year from the present level is aimed at.</p>		With Project			Present	Increment	Early Rainy	Rainy Season	Annual	Annual	Cropped Area	1,000ha	6,750ha	7,750ha	6,880ha	870ha	Yield	3.3t/ha	2.8t/ha	2.8 ~ 3.3t/ha	1.5t/ha	-	Production	3,300t	18,900t	22,200t	10,320t	11,880t
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<p>(6) Irrigation Development Plan</p>	<p>The project is planned to develop irrigated agriculture in 6,750 ha of paddy fields. The project area is scattered along the South Main Canal in Kong Pisei District and Kandal Stung District in Kampong Speu province and Kandal Province respectively.</p> <p>Irrigation will be achieved in the entire project area at least 3 years out of 6 years (50% dependability) from the viewpoint of water availability in the rainy season.</p> <p>Water is to be diverted from the Prek Thnot River at the Roleang Chrey Regulator where it flows into SMC, and will finally be distributed to the paddy fields through secondary and tertiary canals. To achieve this, all canals are proposed to be rehabilitated and improved to maintain proper water level for gravity irrigation. Related structures such as check structures and turnouts are planned at the diversion points on the main canal. To avoid the canals being obstacles to public transportation, culverts or bridges are also planned on the canal.</p> <p>The design discharge of SMC varies from 6.6 m³/sec to 16.3 m³/sec. Out of the 31km total length, 6 km in the downstream part is proposed to be rehabilitated by the project, so that water availability in the upstream and middle stream area will also be improved.</p> <p>Existing reservoirs are also to be rehabilitated to recover the original design storage capacity. These reservoirs are planned to receive irrigation water from SMC, and function as regulating reservoirs to store inflow and regulate outflow to the downstream paddy field.</p> <p>The project proposes to apply a participatory approach in the planning of the tertiary canal systems and watercourses. Tertiary canal and watercourse layout will be determined through workshops with the farmers in the planning stage. Watercourses</p>																												

	will be constructed by the farmers under the assistance and advice of the government. Formation and strengthening of the FWUC shall be implemented in parallel with project implementation.
(7) Project Justification	<p>The need and effect were evaluated from the following five items:</p> <p>(a) Relevance</p> <p>Irrigation water is one of the key factors to stabilize and increase rice productivity. The project aims at to construct irrigation facilities. The irrigation area is determined taking into account available water resources and water demand for irrigation. The project has high relevancy, since adequate irrigation water supply is one of the most important measure to achieve the goal of master plan (improvement of rice productivity).</p> <p>(b) Effectiveness</p> <p>Implementation of the project can highly contribute to deliver irrigation water to the downstream beneficiaries.</p> <p>(c) Efficiency</p> <p>The project facility is planned to deliver water to the paddy field by gravity. The utilization of existing canals is also considered if the canal fit in this concept. The project cost is reasonably minimized by rehabilitating existing structures. The project was evaluated as efficient.</p> <p>(d) Impact</p> <p>The project gives a positive impact to farmers in the downstream area by assuring irrigation water supply. The project targets existing paddy fields using existing facilities as much as possible. No significant negative impact by the project is anticipated.</p> <p>(e) Sustainability</p> <p>Tertiary canal systems are planned to be constructed by farmers. The Government will continue to take responsibility for operation and maintenance of the main and secondary facility. Sustainability of the project is high.</p>
(7) Project Components	<p>(i) EIA Study</p> <p>(ii) Construction works</p> <ul style="list-style-type: none"> - Rehabilitation of SMC from station 25 km to station 31 km including construction of related structures - Rehabilitation of existing secondary canals (5.8 km), construction of new secondary canals (60.5 km), and rehabilitation of tertiary canal systems for 6,750 ha, including related structures such as turnouts, checks, culverts and drainage canals, - Rehabilitation of 5 water harvesting facilities (reservoirs) including intake structures and irrigation canal systems <p>(iii) Procurement of O&M equipment</p> <p>(iv) Formation and strengthening of FWUC/FWUGs/WUGs</p> <p>(v) Agricultural Support Services</p> <ul style="list-style-type: none"> - Field Programs, Farmer/Farmers' Group Training Programs (including training of village extension agents), Mass Guidance & Workshops, staff empowerment <p>(vi) Engineering Services</p> <ul style="list-style-type: none"> - Survey, design, preparation of tender documents, and construction supervision - Prepare operation rules and an operation manual for the facilities - Reinforce the organization for the operation and maintenance of the project

	facility.
(8) Cost	US\$15,183,000 including price contingency
(9) Executing Agency	MOWRAM and MAFF
(10) Implementation	5 years
(11) Environmental Management/ Social Considerations	In addition to the EIA Study, the following activities are planned; (i) Proper procedures for land acquisition/involuntary resettlement - Public meetings with the affected people, discussions with stakeholders, resettlement and compensation (ii) Proper management of construction work (including social considerations) (iii) Regular monitoring at the construction phase (watering, sanitation, waste, etc) and at the operation phase (management of FWUC/FWUGs/WUGs, water quality, etc)

(2) Implementation Schedule

Activities	Expected Results	2011				2012				2013				2014				2015				In-charge	Equipment	Remarks
		1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12			
(1) Survey, Design, Preparation of Tender Documents including Drawings	Design reports & drawings, tender docs.	[Gantt bar: 2011 Q1-Q2]																						
- Topo survey of main and secondary canals		[Gantt bar: 2011 Q1-Q2]																						
- Design of main and secondary canals		[Gantt bar: 2011 Q2-Q3]																				Consultant	As required	
- Topo survey of tertiary area		[Gantt bar: 2011 Q3-Q4]																						
- Design of tertiary canal		[Gantt bar: 2011 Q4-Q1]																						
- Environmental Impact Assessment Study	EIA report	[Gantt bar: 2011 Q3-Q4]																				Consultant	As required	
(2) Tender and Contract award	Contract	[Gantt bar: 2011 Q4]																						
- Main and secondary canals		[Gantt bar: 2011 Q4]																				MOWRAM	As required	
- Tertiary canals	[Gantt bar: 2012 Q1]																				MOWRAM	As required		
(3) Construction work of irrigation facilities	Facilities	[Gantt bar: 2012 Q1-Q2]																						
- Main and secondary canals		[Gantt bar: 2012 Q1-Q2]																				Contractor	As required	
- Tertiary canals		[Gantt bar: 2012 Q2-Q3]																				Contractor	As required	
- Quaternary canals		[Gantt bar: 2012 Q3-Q4]																				Farmers/PDOWRAM		
(4) Preparation of O&M manual	O&M manual	[Gantt bar: 2012 Q3]																				Consultant/ Contractor	As required	
(5) Formation of FWUC	FWUC, FWUG and WUG	[Gantt bar: 2011 Q3-Q4]																				PDOWRAM/ NGO	As required	
(6) Workshop for tertiary canal system layout	Tertiary canal layout	[Gantt bar: 2011 Q3-Q4]																				PDOWRAM/ NGO	As required	
(7) Training FWUC for water management	Dissemination of water saving system	[Gantt bar: 2013 Q1-Q4]																				PDOWRAM/ NGO	As required	
(8) Implementation of agriculture support programs	Dissemination of improved rice production	[Gantt bar: 2013 Q1-Q4]																				MAFF/PDA/ NGO	As required	

Rainy season

(3) Project Design Matrix

(Target Group: Farmers related to the North Main Canal)

Narrative Summary	Objectively Verifiable Indicator	Means of Verification	Important Assumption
<p>Overall Goal Agricultural productivity centering rice is improved in the Target Area</p>	<p>1-1 Agricultural productivity in the Target Area is improved as proposed in the Master Plan by year 2015</p>	<p>1-1 Agricultural statistics</p>	/
<p>Project Purpose Rice productivity in the project area is improved</p>	<p>1-1 Rice productivity in the project area is improved as proposed in the Master Plan</p>	<p>1-1 Agricultural statistics</p>	<p>All the proposed activities in the Master Plan in post-project stage are implemented as scheduled</p> <p>No significant climatic change</p> <p>No severe damage on the irrigation facilities by natural disaster</p>
<p>Outputs 1 Design report, drawings, and tender documents</p> <p>2. Rehabilitated and constructed irrigation facilities</p> <p>3. Irrigation facilities in the project area is properly operated by government agencies and FWUCs</p> <p>4 Improved rice farming practice is applied by farmers</p>	<p>1-1 Irrigation and drainage facilities are properly designed in accordance with government guideline and standard</p> <p>2-1 Irrigation and drainage facilities are constructed in accordance with government guideline and standard</p> <p>3-1 Irrigation facilities in the project area is properly operated by government agencies and FWUCs as proposed in the water management manual</p> <p>4-1 Improved farming practice is applied for 60% of the model project area</p>	<p>1-1 Reports, drawings, and tender documents prepared by engineering consultant,</p> <p>2-1 Constructed facilities</p> <p>3-1 Record of water management made by government agencies and FWUCs</p> <p>4-1 Monitoring survey</p>	<p>No significant climatic change in the project period</p> <p>No severe damage on the irrigation facilities by natural disaster in the project period</p>
<p>Activities 1-1 To conduct EIA Study 1-2 To survey and design of irrigation facilities 1-3 To tender and contract for construction work 1-4 To execute construction work of irrigation facilities by contractor 1-5 To construct quaternary canals by farmers 2-1 To prepare water management and operation manual of the facility for FWUC 2-2 To have workshops with farmers for formation of FWUC 2-3 To assist and advise FWUC to determine tertiary canal systems layout 2-4 To assist and advise farmers to construct quaternary canals 3-1 To train FWUCs for water management practice 3-2 To strengthen related government agencies for proper water management 4-1 To provide agricultural support services on improved rice farming practice</p>	<p style="text-align: center;">Input</p> <p style="text-align: center;">Donor</p> <p>Construction cost for major irrigation facilities Experts for Engineering Services - Irrigation engineers 48M/M - Civil engineers 26M/M - Topographic engineers 30M/M - Field Inspectors 29M/M - Quantity surveyors 29M/M - On farm water management engineers 19M/M - Farmers organization experts 6M/M - Environmental experts 6M/M</p> <p>FWUCs/FWUGs/WUGs formation and strengthening cost</p> <p>Agriculture supporting service cost</p>	<p style="text-align: center;">Cambodia</p> <p><u>FWUCs, FWUGs and WUGs</u> FWUC, FWUG and WUC members</p> <p style="text-align: center;"><u>Provincial government</u> Counterparts from PDOWRAM and PDA</p> <p style="text-align: center;"><u>Central government</u> Counterparts from MOWRAM and MAFF Part of agricultural support services cost</p> <p style="text-align: center;"><u>NGO</u> Facilitators</p>	<p>Continuous involvement of related government agencies, FWUCs, FWUCs and WUGs during the project period</p> <p>No severe damage of irrigation facilities by natural disaster within the project period</p> <p>Precondition High need for irrigated agriculture in the Target Area</p> <p>Good understanding of related organizations on the Master Plan and importance of proper water management</p> <p>Related proposed activities in the Master Plan in pre-project stage are implemented as scheduled</p>

1.2.3 A.2(3) Ou Krang Ambel Irrigated Agriculture Improvement Project

(1) Project Proposal

(1) Title of Project	Ou Krang Ambel Irrigated Agriculture Improvement Project
(2) Location	District: Samraong Tong, Angk Snuol, Province: Kampong Speu, Kandal
(3) Objective of Project	The project aims to increase rice production in the Ou Krang Ambel area (2,900ha) by improvement of the irrigation system and strengthening of agricultural support services and FWUCs.
(4) Site Description	<p>Ou Krang Ambel Reservoir and irrigation system was constructed on the Krang Ambel River to irrigate about 500 ha in the late 1970s. The catchment area of the reservoir was about 450 km². Inflow to the reservoir, however, has been decreasing due to further irrigated agriculture development in the upstream.</p> <p>Construction of Ta Hor Canal was also started in the late 1970s from the Prek Thnot River to the beneficial area. A diversion weir was once constructed in the Prek Thnot river, but it was washed away by a flood. To cope with this problem the Government connected a main canal from Ou Krang Ambel Pond with Ta Hor Canal. The Government extended NMC from Roleang Chrey 14 km, and constructed a diversion channel and Tousamn Ang Check Gate to supply irrigation water from the Prek Thnot River to the reservoir. At present, the irrigation area of the reservoir and Ta Hor Canal mostly receive irrigation water from the Prek Thnot River in addition to the flow in the Krang Ambel River.</p> <div style="display: flex; justify-content: space-around;"> <div>  <p><i>Tousamn Ang Check Structure to divert water from NMC to Ou Krang Ambel Reservoir.</i></p> </div> <div>  <p><i>Ou Krang Ambel Intake Gate, 4 steel slide gates are manually operated</i></p> </div> </div> <p>The downstream apron of the Tousamn Ang Check Structure is eroded and requires some modification work to prevent further erosion. The approach road also needs modification to ease ox-drawn cart and motor cycle traffic.</p> <p>Ou Krang Ambel Intake functions fairly well at present except for leakage from damaged rubber seals.</p> <div style="display: flex; justify-content: space-around;"> <div>  <p><i>Ta Hor Canal water level is lower than the paddy field</i></p> </div> <div>  <p><i>End of Ta Hor Canal</i></p> </div> </div> <p>Ta Hor Canal is deteriorated due to lack of maintenance. The water level in the canal is not enough high for gravity irrigation. Secondary and tertiary canals and related structures such as turnouts, regulators, and culverts are not</p>

	<p>sufficiently constructed due to lack of budget. This appears to be one of the important reasons for low agricultural productivity in the area.</p> <p>Secondary canals and related structures</p> <ul style="list-style-type: none"> - The number and length of secondary canals are not sufficient for adequate irrigation. - The water level is designed lower than the adjacent paddy fields. - At present, the definition and classification of the secondary and tertiary canals is not clear and not precise, so some existing secondary canals command very large areas in which proper water management activities are not able to be implemented. - Permanent turnouts which divert water from secondary canals to tertiary canals are rarely constructed. It makes it difficult for farmers to take water from the canal. - Culverts are not sufficiently provided in the canal causing people difficulty in crossing the canal for daily activities. To solve this, people block the canal by burying pipes resulting in a decrease of flow capacity in the canal. <p>Tertiary canal systems</p> <ul style="list-style-type: none"> - The low density of tertiary canals is causing poor water management. 																												
(5) Agricultural Development Plan	<p>The agriculture development plan indicated in comparison with the present condition is as follows;</p> <p style="text-align: center;">Agricultural Development Plan (Paddy Production)</p> <table border="1"> <thead> <tr> <th rowspan="2"></th> <th colspan="3">With Project</th> <th>Present</th> <th rowspan="2">Increment</th> </tr> <tr> <th>Early Rainy season</th> <th>Rainy Season</th> <th>Annual</th> <th>Annual</th> </tr> </thead> <tbody> <tr> <td>Cropped Area</td> <td>400ha</td> <td>2,900ha</td> <td>3,300ha</td> <td>2,930ha</td> <td>370ha</td> </tr> <tr> <td>Yield</td> <td>3.3t/ha</td> <td>2.8t/ha</td> <td>2.8 ~ 3.3t/ha</td> <td>1.5 ~ 2.1t/ha</td> <td>-</td> </tr> <tr> <td>Production</td> <td>1,320t</td> <td>8,120t</td> <td>9,440t</td> <td>5,091t</td> <td>4,349t</td> </tr> </tbody> </table> <p>At the full development stage, an increase in the production of paddy of 4,300 t/year from the present level is aimed at.</p>		With Project			Present	Increment	Early Rainy season	Rainy Season	Annual	Annual	Cropped Area	400ha	2,900ha	3,300ha	2,930ha	370ha	Yield	3.3t/ha	2.8t/ha	2.8 ~ 3.3t/ha	1.5 ~ 2.1t/ha	-	Production	1,320t	8,120t	9,440t	5,091t	4,349t
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(6) Irrigation Development Plan	<p>The project is planned to develop irrigated agriculture in 2,900 ha of paddy fields. The project area is scattered downstream of Ou Krang Ambel Reservoir in Samraong Tong District and Angk Snuol District in Kampong Speu Province and Kandal Province respectively. Supplemental irrigation will be achieved in the entire project area at least 3 years out of 6 years (50% dependability) from the viewpoint of water availability in the rainy season.</p> <p>Water is to be diverted from the Prek Thnot River at Roleang Chrey Regulator where it flows into NMC, Tousamn Check Gate, and Ou Krang Ambel Reservoir.</p> <p>To achieve this, all canals are proposed to be rehabilitated and improved to maintain proper water level for gravity irrigation. Related structures, such as check structures and turnouts are planned at the diversion points on the main canal. To avoid the canals being obstacles to public transportation, culverts or bridges are also planned on the canal.</p> <p>A 4.6 m³/sec flow will be conveyed to the project area in the peak period and depending on the river discharge of the Prek Thnot River. All secondary and tertiary canals are proposed to be rehabilitated by the project, so that water availability in the downstream area will be also improved.</p> <p>The project proposes to apply a participatory approach in planning the tertiary canal systems and watercourses. Tertiary canal and watercourse layout will be determined through workshops with the farmers at the planning stage. Watercourses will be constructed by the farmers with assistance and advice</p>																												

	from the government. Formation and strengthening of FWUCs shall be implemented before the detailed design work.
(7) Project Justification	<p>The need and effect were evaluated from the following five items:</p> <p>(a) Relevance</p> <p>Irrigation water is one of the key factors to stabilize and increase rice productivity. The project aims at to construct irrigation facilities. The irrigation area is determined taking into account available water resources and water demand for irrigation. The project has high relevancy, since adequate irrigation water supply is one of the most important measure to achieve the goal of master plan (improvement of rice productivity).</p> <p>(b) Effectiveness</p> <p>Implementation of the project can highly contribute to deliver irrigation water to the downstream beneficiaries.</p> <p>(c) Efficiency</p> <p>The project facility is planned to deliver water to the paddy field by gravity. The utilization of existing canals is also considered if the canal fit in this concept. The project cost is reasonably minimized by rehabilitating existing structures. The project was evaluated as efficient.</p> <p>(d) Impact</p> <p>The project gives a positive impact to farmers in the downstream area by assuring irrigation water supply. The project targets existing paddy fields using existing facilities as much as possible. No significant negative impact by the project is anticipated.</p> <p>(e) Sustainability</p> <p>Tertiary canal systems are planned to be constructed by farmers. The Government will continue to take responsibility for operation and maintenance of the main and secondary facility. Sustainability of the project is high.</p>
(7) Project Components	<p>The followings project components are planned:</p> <p>(i) Construction works</p> <ul style="list-style-type: none"> - Rehabilitation of the Tousamn Check Gate, Ou Krang Ambel Intake Gate, about 21 km of the Ta Hor Canal , existing secondary canals (11.7 km), construction of new secondary canals (8.3 km), and rehabilitation of tertiary canal systems for 2,900 ha, including related structures such as turnouts, checks, culverts and drainage canals <p>(ii) Procurement of O&M (operation and maintenance) equipment</p> <p>(iii) Formation and strengthening of FWUC/FWUGs/WUGs</p> <p>(iv) Agricultural support services</p> <ul style="list-style-type: none"> - Field Programs, Farmer/Farmers' Group Training Programs (including training of village extension agents), Mass Guidance & Workshops, staff empowerment <p>(v) Engineering Services</p> <ul style="list-style-type: none"> - Survey, design, preparation of tender documents, and construction supervision - Prepare operation rules and an operation manual for the facilities - Reinforce FWUCs for O&M of the facilities
(8) Cost	US\$7,219,000 including price contingency
(9) Executing Agency	MOWRAM and MAFF

(10) Implementation	3 years
(11) Environmental Management/ Social Considerations	<p>The following activities are planned;</p> <p>(i) Proper procedures for land acquisition/involuntary resettlement</p> <ul style="list-style-type: none"> - Public meetings with the affected people, discussions with stakeholders, resettlement and compensation <p>(ii) Proper management of construction work (including social considerations)</p> <ul style="list-style-type: none"> - A series of public meetings from the design phase, proper management of workers' sanitation, regular watering for unpaved roads, etc <p>(iii) Regular monitoring at the construction phase (watering, sanitation, waste, etc) and at the operation phase (management of FWUC/FWUGs/WUGs, water quality, etc)</p>

(2) Implementation Schedule

Activities	Expected Results	2012				2013				2014				2015				In-charge	Equipment	Remarks
		1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12			
(1) Survey, Design, Preparation of Tender Documents including Drawings	Design reports & drawings, tender docs.																			
- Topo survey of main and secondary canals																		Consultant	As required	
- Design of main and secondary canals																		Consultant	As required	
- Topo survey of tertiary area																				
- Design of tertiary canal																				
(2) Tender and Contract award	Contract																			
- Main and secondary canals																		MOWRAM	As required	
- Tertiary canals																		MOWRAM	As required	
(3) Construction work of irrigation facilities	Facilities																			
- Main and secondary canals																		Contractor	As required	
- Tertiary canals																		Contractor	As required	
- Quaternary canals																		Farmers/PDOWRAM		
(4) Preparation of O&M manual	O&M manual																	Consultant/ Contractor	As required	
(5) Formation of FWUC	FWUA and WUG																	PDOWRAM/ NGO	As required	
(6) Workshop for tertiary canal system layout	Tertiary canal layout																	PDOWRAM/ NGO	As required	
(7) Training FWUC for water management	Dissemination of water saving system																	PDOWRAM/ NGO	As required	
(8) Implementation of agriculture support services	Dissemination of improved rice production																	MAFF/PDA/ NGO	As required	

 Rainy season

(3) **Project Design Matrix**



(Target Group: Farmers related to the North Main Canal)

Narrative Summary	Objectively Verifiable Indicator	Means of Verification	Important Assumption
Overall Goal Agricultural productivity centering rice is improved in the Target Area	1-1 Agricultural productivity in the Target Area is improved as proposed in the Master Plan by year 2015	1-1 Agricultural statistics	/
Project Purpose Rice productivity in the project area is improved	1-1 Rice productivity in the project area is improved as proposed in the Master Plan	1-1 Agricultural statistics	All the proposed activities in the Master Plan in post-project stage are implemented as scheduled No significant climatic change No severe damage on the irrigation facilities by natural disaster
Outputs 1 Design report, drawings, and tender documents 2. Rehabilitated and constructed irrigation facilities 3. Irrigation facilities in the project area is properly operated by government agencies and FWUCs 4 Improved rice farming practice is applied by farmers	1-1 Irrigation and drainage facilities are properly designed in accordance with government guideline and standard 2-1 Irrigation and drainage facilities are constructed in accordance with government guideline and standard 3-1 Irrigation facilities in the project area is properly operated by government agencies and FWUCs as proposed in the water management manual 4-1 Improved farming practice is applied for 60% of the model project area	1-1 Reports, drawings, and tender documents prepared by engineering consultant, 2-1 Constructed facilities 3-1 Record of water management made by government agencies and FWUCs 4-1 Monitoring survey	No significant climatic change in the project period No severe damage on the irrigation facilities by natural disaster in the project period
Activities 1-1 To survey and design of irrigation facilities 1-2 To tender and contract for construction work 1-3 To execute construction work of irrigation facilities by contractor 1-4 To construct quaternary canals by farmers 2-1 To prepare water management and operation manual of the facility for FWUC 2-2 To have workshops with farmers for formation of FWUC 2-3 To assist and advise FWUC to determine tertiary canal systems layout 2-4 To assist and advise farmers to construct quaternary canals 3-1 To train FWUCs for water management practice 3-2 To strengthen related government agencies for proper water management 4-1 To provide agricultural support services on improved rice farming practice	<p style="text-align: center;">Input</p> <p style="text-align: center;">Donor</p> <p style="text-align: center;">Cambodia</p> Construction cost for major irrigation facilities Experts for Engineering Services - Irrigation engs.21M/M - Civil engs.14M/M - Topographic surveyors. 30M/M - Field Inspectors.22M/M - Quantity surveyors.24M/M - On farm water manag. eng.12M/M - Farmers org. 4M/M FWUC/FWUGs/WUGs formation and strengthening cost Agriculture supporting service cost	FWUCs, FWUGs and WUGs FWUC,FWUG,WUG members <u>Provincial government</u> Counterparts from PDOWRAM and PDA <u>Central government</u> Counterparts from MOWRAM and MAFF Part of agricultural support services cost <u>NGO</u> Facilitators	Continuous involvement of related government agencies, FWUCs, FWUGs and WUGs during the project period No severe damage of irrigation facilities by natural disaster within the project period Precondition High need for irrigated agriculture in the Target Area Good understanding of related organizations on the Master Plan and importance of proper water management Related proposed activities in the Master Plan in pre-project stage are implemented as scheduled

1.3 Zone-3 Project

1.3.1 A.3(1) Water Harvesting Irrigated Agriculture Improvement Project

(1) Project Proposal

(1) Title of Project	Water Harvesting Irrigated Agriculture Improvement Project																		
(2) Location	District: Chbar Mon, Samraong Tong, Kong Pisei, Angk Snuol Province: Kampong Speu, Kandal																		
(3) Objective of Project	The project aims to increase rice production in the Zone-3 area (1,200 ha in total) by improvement of the irrigation system, strengthening of agricultural support services and formation of FWUCs																		
(4) Site Description	<p>There are 49 water harvesting reservoirs in the project area. Those were mostly constructed in the 1970s. Total catchment area of those reservoirs is 181 km² individually varying from 22km² to 10 ha. Storage volume is 22,000,000 m³ in total of all ponds varying from 10,000 m³ to 4,900,000 m³ at one pond. None of the streams that flow into the catchment areas have perennial flow, so they should be classified as water harvesting facilities.</p> <p>All reservoirs have deteriorated due to lack of maintenance. Further, irrigation canals and related structures such as turnouts, division boxes, checks, and culverts are hardly constructed. Water in the reservoirs is not efficiently delivered to the paddy fields at present because of the reasons mentioned above. This appears to be one of the important reasons of low agricultural productivity in the area.</p> <p>Water Harvesting Reservoirs</p> <ul style="list-style-type: none"> - The existing 49 reservoirs in the project area were mostly constructed the late 1970s to collect rainfall (water harvesting) although some of them were recently rehabilitated under SEILA program. These have been used for irrigation of the paddy fields. They are deteriorated due to adverse soil characteristics and lack of maintenance work. - It was found that intake gates had been removed or broken in some systems. 																		
	 	<p><i>Erosion at dispersive soil embankment</i></p>	<p><i>Embankment collapsed due to seepage along buried pipe</i></p>																
(5) Agricultural Development Plan	<p>The agriculture development plan indicated in comparison with the present condition is as follows;</p> <p style="text-align: center;">Cropping Pattern of Rice</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th></th> <th>Cropping Season</th> <th>Cropped Area</th> <th>Yield</th> <th>Production</th> </tr> </thead> <tbody> <tr> <td>Without Project</td> <td>Rainy Season</td> <td>1,200ha</td> <td>1.5 ~ 2.1 t/ha</td> <td>2,160 t</td> </tr> <tr> <td>With Project</td> <td>Rainy Season</td> <td>1,200ha</td> <td>2.8 t/ha</td> <td>3,360 t</td> </tr> </tbody> </table> <p>At the full development stage, an increase in the production of paddy of 1,200 t/year from the present level is aimed at.</p>					Cropping Season	Cropped Area	Yield	Production	Without Project	Rainy Season	1,200ha	1.5 ~ 2.1 t/ha	2,160 t	With Project	Rainy Season	1,200ha	2.8 t/ha	3,360 t
	Cropping Season	Cropped Area	Yield	Production															
Without Project	Rainy Season	1,200ha	1.5 ~ 2.1 t/ha	2,160 t															
With Project	Rainy Season	1,200ha	2.8 t/ha	3,360 t															
(6) Irrigation Development Plan	<p>The project is planned to develop irrigated agriculture in 1200 ha of paddy fields as a whole. The project area is scattered outside of the command areas of SMC and NMC.</p> <p>Irrigation will be achieved in the entire project area with a probability of 3 years out of 6 years (50% dependability) from the viewpoint of available water in the</p>																		

	<p>rainy season.</p> <p>The existing reservoirs are also to be rehabilitated to recover the original design storage capacity. The project proposes to apply a participatory approach in planning the supply canal systems and watercourses. Supply canal and watercourse layout will be determined through workshops with the farmers in the planning stage. Watercourses will be constructed by the farmers with assistance and advice from the government. Formation and strengthening of the FWUC shall be implemented in parallel with project implementation.</p>
(7) Project Justification	<p>(a) Relevance</p> <p>Irrigation water is one of the key factors to stabilize and increase rice productivity. The project aims at to construct irrigation facilities. The irrigation area is determined taking into account available water resources and water demand for irrigation. The project has high relevancy, since adequate irrigation water supply is one of the most important measure to achieve the goal of master plan (improvement of rice productivity).</p> <p>(b) Effectiveness</p> <p>Implementation of the project can highly contribute to deliver irrigation water to the downstream beneficiaries.</p> <p>(c) Efficiency</p> <p>The project facility is planned to deliver water to the paddy field by gravity. The utilization of existing canals is also considered if the canal fit in this concept. The project cost is reasonably minimized by rehabilitating existing structures. The project was evaluated as efficient.</p> <p>(d) Impact</p> <p>The project gives a positive impact to farmers in the downstream area by assuring irrigation water supply. The project targets existing paddy fields using existing facilities as much as possible. No significant negative impact by the project is anticipated.</p> <p>(e) Sustainability</p> <p>Tertiary canal systems are planned to be constructed by farmers. The Government will continue to take responsibility for operation and maintenance of the main and secondary facility. Sustainability of the project is high.</p>
(8) Project Components	<p>(i) Construction works</p> <ul style="list-style-type: none"> - Rehabilitation of existing water harvesting facilities (reservoirs) at 49 sites - Rehabilitation of existing supply canals and construction of new supply canals of about 18 km. <p>(ii) Procurement of O&M (operation and maintenance) equipment</p> <p>(iii) Formation and strengthening of FWUC/FWUGs/WUGs</p> <p>(iv) Agricultural Support Services</p> <ul style="list-style-type: none"> - Field Programs, Farmer/Farmers' Group Training Programs (including training of village extension agents), Mass Guidance & Workshops, staff empowerment <p>(v) Engineering Services</p> <ul style="list-style-type: none"> - Survey, design, preparation of tender documents, and construction supervision - Prepare operation rules and an operation manual for the facilities - Reinforce the farmers organization for O&M of the facilities.
(9) Cost	US\$7,427,000 including price contingency

(10) Executing Agency	MOWRAM and MAFF
(11) Implementation	6 years
(12) Environmental Management/ Social Considerations	<p>The following activities are planned;</p> <p>(i) Proper procedures for land acquisition/involuntary resettlement</p> <ul style="list-style-type: none"> - Public meetings with the affected people, discussions with stakeholders, resettlement and compensation <p>(ii) Proper management of construction work (social considerations)</p> <ul style="list-style-type: none"> - A series of public meetings from the design phase, proper management of workers' sanitation, regular watering for unpaved roads, etc <p>(iii) Regular monitoring at the construction phase (watering, sanitation, waste, etc) and at the operation phase (management of FWUC/FWUGs/WUGs, water quality, etc)</p>

(2) Implementation Schedule

Activities	Expected Results	2010		2011		2012		2013		2014		2015		In-charge	Equipment	Remarks		
		1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12				1-3	4-6
(1) Survey, Design, Preparation of Tender Documents including Drawings - Topo survey of reservoirs & canals by every system - Design of reservoir, intake & canal by every system	Design reports & drawings, tender docs.														Consultant	As required		
																Consultant	As required	
(2) Tender and Contract award - Reservoir & canal system by every system	Contract														MOWRAM	As required		
(3) Construction work of irrigation facilities - reservoir & canal system by every system - Watercourses by every system	Facilities															Contractor/Farmers	As required	
																Contractor/Farmers	As required	
(4) Preparation of O&M manual by every system	O&M manual														Consultant	As required		
(5) Formation of FWUC by every system	FWUC, FWUG and														PDOWRAM/NGO	As required		
(6) Workshop for canal system layout by every system	Tertiary canal layout														Farmers/NGO	As required		
(7) Training FWUC for water management	Dissemination of water saving system														PDOWRAM/NGO	As required		
(8) Implementation of agriculture support programs	Dissemination of improved rice production														MAFF/PDA/NGO	As required		

 Rainy season

(3) Project Design Matrix

(Target Group: Farmers related to the North Main Canal)

Narrative Summary	Objectively Verifiable Indicator	Means of Verification	Important Assumption
Overall Goal Agricultural productivity centering rice is improved in the Target Area	1-1 Agricultural productivity in the Target Area is improved as proposed in the Master Plan by year 2015	1-1 Agricultural statistics	/
Project Purpose Rice productivity in the project area is improved	1-1 Rice productivity in the project area is improved as proposed in the Master Plan	1-1 Agricultural statistics	All the proposed activities in the Master Plan in post-project stage are implemented as scheduled No significant climatic change No severe damage on the irrigation facilities by natural disaster
Outputs 1 Design report, drawings, and tender documents 2. Rehabilitated and constructed irrigation facilities 3. Irrigation facilities in the project area is properly operated by government agencies and FWUCs 4 Improved rice farming practice is applied by farmers	1-1 Irrigation and drainage facilities are properly designed in accordance with government guideline and standard 2-1 Irrigation and drainage facilities are constructed in accordance with government guideline and standard 3-1 Irrigation facilities in the project area is properly operated by government agencies and FWUCs as proposed in the water management manual 4-1 Improved farming practice is applied for 60% of the model project area	1-1 Reports, drawings, and tender documents prepared by engineering consultant, 2-1 Constructed facilities 3-1 Record of water management made by government agencies and FWUCs 4-1 Monitoring survey	No significant climatic change in the project period No severe damage on the irrigation facilities by natural disaster in the project period
Activities 1-1 To survey and design of irrigation facilities 1-2 To tender and contract for construction work 1-3 To execute construction work of irrigation facilities by contractor 1-4 To construct quaternary canals by farmers 2-1 To prepare water management and operation manual of the facility for FWUC 2-2 To have workshops with farmers for formation of FWUC 2-3 To assist and advise FWUC to determine tertiary canal systems layout 2-4 To assist and advise farmers to construct quaternary canals 3-1 To train FWUCs for water management practice 3-2 To strengthen related government agencies for proper water management 4-1 To provide agricultural support services on improved rice farming practice	Input Donor Cambodia Construction cost for major irrigation facilities Experts for Engineering Services - Irrigation eng.47M/M - Civil engs. 30M/M - Topographic engs. 80M/M FWUCs/FWUGs/WUGs formation and strengthening cost Agriculture supporting service cost		Continuous involvement of related government agencies, FWUCs, FWUGs and WUGs during the project period No severe damage of irrigation facilities by natural disaster within the project period Precondition High need for irrigated agriculture in the Target Area Good understanding of related organizations on the Master Plan and importance of proper water management Related proposed activities in the Master Plan in pre-project stage are implemented as scheduled

1.4 Zone-4 Project

1.4.1 A.4(1) Rainfed Agriculture Improvement Project

(1) Project Proposal

(1) Title of Project	Rainfed Agriculture Improvement Project																
(2) Location	Zone-4 (rainfed paddy areas) in the Target Area																
(3) Objective of Project	The project aims at the improvement of rainfed agriculture productivity and increased production of rice in Zone-4 in the Target Area																
(4) Site Description	Rainfed paddy growing is the largest land use within the area. The Zone-4 area is estimated at 23,980ha and is extensively distributed in the northern and southern parts of the Target Area located away from the Prek Thnot River. Rainfed paddy fields are solely used for a single cropping of rice in the rainy season, and because of unstable rainfall, traditional farming practices and cultivation of traditional varieties, productivities are limited and unstable.																
(5) Project Description	<p>Improvement of rainfed agriculture should duly be sought through the integrated interventions of agronomic, extension and farmer organizational approaches. The strategies include:</p> <ul style="list-style-type: none"> - Improvement of productivity and increased production of rice is envisaged by the introduction of improved farming practices; in this regard, the expansion of ecological SRI in Kampong Speu Province and promising results obtained in the SRI fields in 2005 as shown in Table 8.6.3 indicate the possibility for the attainment of the objectives, - Improvement of productivity and increased production of rice supported by the strengthening of agricultural support services is envisaged, and - Introduction of upland crops/vegetable production in the early rainy season to a limited pilot scale as a trial crop diversification for the future. <p>The proposed intervention is the strengthening of agricultural support services in the zone implemented by MAFF/PDA in collaboration with NGOs and supported by the experts. Therefore, the primary scope of the Project is the dissemination of an improved rice production system to the farming communities in Zone-4 through: (i) the strengthening of agricultural support services and (ii) formation and empowerment of farmers/farmers' groups. The agriculture development plan indicated in comparison with the without-project condition is as follows;</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <caption>Agricultural Development Plan (Paddy Production)</caption> <thead> <tr> <th>Condition</th> <th>Cropped Area</th> <th>Unit Yield</th> <th>Annual Production</th> </tr> </thead> <tbody> <tr> <td>Without-Project</td> <td>23,380</td> <td>1.5 t/ha</td> <td>35,070 t</td> </tr> <tr> <td>With-Project</td> <td>23,380</td> <td>2.0 t/ha</td> <td>46,760 t</td> </tr> <tr> <td>Increment</td> <td>0</td> <td>0.5 t/ha</td> <td>11,690 t</td> </tr> </tbody> </table> <p>A production increase of paddy of 11,700 ton/year is targeted under the Project.</p>	Condition	Cropped Area	Unit Yield	Annual Production	Without-Project	23,380	1.5 t/ha	35,070 t	With-Project	23,380	2.0 t/ha	46,760 t	Increment	0	0.5 t/ha	11,690 t
Condition	Cropped Area	Unit Yield	Annual Production														
Without-Project	23,380	1.5 t/ha	35,070 t														
With-Project	23,380	2.0 t/ha	46,760 t														
Increment	0	0.5 t/ha	11,690 t														
(6) Project Justification	<p>(a) Relevance</p> <p>The agriculture sector is the key sector of Cambodian economy and the primary economic activity of the nation. As a leading agricultural sub-sector, the crop sub-sector productivity improvement is defined as one of the primary development target in the national development plan of "Rectangular Strategy for Growth, Employment, Equity and Efficiency and Agricultural Development Plan for Long, Medium and Short Term 2001-2010". The purpose & goal of the Project surely meet the national development policies.</p> <p>Rice production is the primary income sources of the target groups (farmers) of the Project and the productivity improvement of rice through the Project exactly</p>																

	<p>meet the needs of the groups.</p> <p>(b) Effectiveness</p> <p>For the attainment of the present Master Plan target of improvement of agricultural productivity in the Target Area, the improvement of rainfed agriculture, agriculture activities accounting the largest area extent in the Area, should duly be aimed at. The expansion of modified SRI in Kampong Speu Province in 2005 and promising results obtained in the SRI fields indicate the possibility for the attainment of ambitious attempt of this Project. The Project plan to strengthen agricultural support services and to introduce farmer-to-farmer extension by training & deploying village extension agents at village level, which will contribute to the attainment of expected outputs and project purpose.</p> <p>(c) Efficiency</p> <p>The Project envisages to enhancing farmer-to-farmer extension by introducing village extension agents as services providers at village level. Further, formation of farmer groups as the target groups of extension services is also attempted. Through such approach, the strengthening of agricultural services will be made with low costs in the Project Area. The project implementation will be scheduled based on the Annual Work Plan formulated in the initial year or in the previous year to ensure efficient project implementation.</p> <p>(d) Impact</p> <p>The project will present direct positive impacts on the target communities as rice production is one of primary income sources of the target groups (farmers) of the Project. The possibility of the attainment of the project goal will be largely affected by the market prices & marketability of paddy. Basically, no serious negative impacts are predicted.</p> <p>(e) Sustainability</p> <p>Village extension agents' continuous presence in the Project Area is an essential factor to sustain the project impacts. To motivate those, the provision of some sort of incentives might be necessary in addition to periodical refresher training of them</p>
(7) Project Components	<ul style="list-style-type: none"> - Field programs for demonstration & training - Farmer/farmers' group training (including training of village extension agents & refresher training of them, and study tours) - Mass guidance/workshops - Farmers' group formation & empowerment - Provision of transportation means to project staffs and village extension agents - Staff empowerment - Field guidance & monitoring by PDA/DAO/NGO staffs
(8) Cost	US\$ 2,975,000.including price contingency
(9) Executing Agency	Department of Agricultural Extension, MAFF
(10) Implementing Agency	Kampong Speu & Kandal PDA /CARDI/NGO
(11) Implementation	5 years
(12) Environmental Management/ Social Considerations	The included activities are explanation of environmental risks at the training (impacts from excess agrochemicals, etc)

(2) Implementation Plan

Activities	Expected Results	Year					In-charge
		2009	2010	2011	2012	2013	
(1) Capacity building of local authorities, NGOs and other stakeholders	Local authorities, NGOs and other stakeholders are trained & involved in or provide support to the Project	■					Project PDA/DAO/CARDI/NGO
(2) Baseline survey	Present agriculture socio-economic conditions identified	■					Project PDA/DAO/NGO
(3) Formulation of Annual Work Plan	Local authorities, NGOs and other stakeholders are trained & involved in or provide support to the Project	■	■	■	■	■	Project PDA
(4) Farmer groups formation	Small scale farmer groups formed as target groups of extension	■	■	■	■	■	Project PDA/DAO/NGO
(5) Training & deployment of village extension agents (VEAs) to villages	VEAs are trained and and deployed at village level	■	■	■	■	■	Project PDA/DAO/CARDI/NGO
(6) Strengthening of agricultural support services in the Project Area	Strengthened agricultural support services in the Project Area	■	■	■	■	■	MAFF/PDA Project
(7) Adaptability test /technology development of improved rainfed rice production system	Verified improved irrigated rice production system	■	■				Project PDA/DAO/CARDI/NGO
(8) Verification of adoptability of the improved rainfed rice production system in farmers field with participation of farmers (including plot demonstration)	Improved rainfed rice production system verified in farmers fields with participation of farmers		■	■			Project PDA/DAO/CARDI/NGO VEAs
(9) Dissemination of the verified improved rainfed rice production system to farmers/farmer groups in a pilot scale through strengthening of support services	Dissemination of improved production system in a pilot scale			■	■		Project PDA/DAO/NGO VEAs
(10) Dissemination of the improved rainfed rice production system in the Project Area through strengthening of support services	Dissemination of improved production system in the Project		■	■	■	■	Project PDA/DAO/NGO VEAs
(11) Field guidance & monitoring by PDA/DAO staffs	Continuous field guidance by PDA/DAO staffs	■	■	■	■	■	PDA/DAO Project

(3) Project Design Matrix



(Target Group: Farmers in Zone-4)

Narrative Summary	Objectively Verifiable Indicator	Means of Verification	Important Assumption
Overall Goal Agricultural productivity centering rice is improved in the Target Area	1-1 Agricultural productivity in the Target Area is improved as proposed in the Master Plan by year 201	1-1 Agricultural statistics	/
Project Purpose Rice productivity in the project area is improved	1-1 Rice productivity in the project area is improved as proposed in the Master Plan	1-1 Agricultural statistics	All the proposed activities in the Master Plan in post-project stage are implemented as scheduled No significant climatic change
Outputs 1 Strategy to improve rainfed agriculture in the Target Area is set 2 Capacity of related organizations on rainfed agriculture is strengthened 3 Further improved rainfed rice production system is developed and disseminated in the Target Area	1-1 Prepared strategy is appreciated by well informed experts 2-1 No. of trained staff of related organizations 3-1 Rice production from rainfed area in the Target Area 3-2 No. of villages applying the further improved rice production system	1-1 Minutes of steering committee meetings 2-1 Record of training 3-1 Agricultural statistics 3.2 Monitoring survey	There are no significant changes in supply demand balance and prices of rice There is no significant hike in farm input prices No significant climatic change in the project period
Activities 1-1 To formulate Annual Work Plan for strengthening agricultural support services 2-1 To implement capacity building of local authorities, NGOs and other stakeholders 2-2 To support formation of farmer groups 2-3 To train & deploy village extension agents to villages 2-4 To strengthen agricultural support services including farmer group empowerment in the Project Area 3-1 To develop further improved rainfed rice production system 3-2 To verify adoptability of the improved rainfed rice production system with participation of farmers (including plot demonstration) 3-3 To disseminate the further improved rainfed rice production system to farmers/farmer groups in a pilot scale (including area demonstration) 3-4 To disseminate the further improved rainfed rice production system in the Project Area through strengthening of support services 3-5 To implement field guidance & monitoring on further improved rainfed rice production system continuously	Input Donor Cambodia Foreign/Local Consultant/ Provincial government NGO Counterparts from PDA Team Leader (rice agronomist) Central government Co-team Leader Counterparts from MAFF Extension Farmer Organization CARDI Other experts Counterparts from CARDI Project Cost Part of project cost NGO Facilitators Office spaces, training & extension facilities		Continuous involvement of related government agencies during the project period Precondition High need for rice production in the Target Area Good understanding of related organizations on the Master Plan and importance of rice production Related proposed activities in the Master Plan in pre-project stage are implemented as scheduled

1.5 Zones Crosscutting Projects

1.5.1 B.1(1) Roleang Chrey Regulator Gates Urgent Improvement Project

(1) Project Proposal

(1) Title of Project	Roleang Chrey Regulator Gates Urgent Improvement Project
(2) Location	Kampong Speu Province
(3) Objective of Project	To ensure the proper gate operation for irrigation water supply and flood water control.
(4) Site Description	<p>The Roleang Chrey Regulator was constructed on the Prek Thnot River in 1974, about 100 km upstream from its confluence with the Bassac River. The Roleang Chrey Regulator was originally planned to supply the irrigation water for the left and right riparian areas of 34,000 ha provided that the Prek Thnot Multipurpose Dam was constructed upstream. However, the construction of the Prek Thnot Multipurpose Dam was suspended in 1973 due to political change. At present, the Roleang Chrey Regulator is planned to serve the irrigation water supply to the on-going Western Phnom Penh Integrated Development Center Project commanding 24,000ha in the Target Area. It can be said that the Roleang Chrey Regulator is thus a key structure for agricultural development for the Target Area.</p> <div style="display: flex; justify-content: space-around;">   </div> <div style="display: flex; justify-content: space-around; margin-top: 5px;"> <p><i>Temporary Hoisting Wire</i></p> <p><i>Aged Diesel Generator</i></p> </div>
(5) Project Description	<p>The gates and relevant accessories of the Roleang Chrey Regulator are so severely deteriorated that it does not function properly. The urgent recovery of gate function is strongly requested by the government. Thus, the project aims at recovery of gate function by providing the minimum rehabilitation work as a temporary treatment. The required work is to replace the wire ropes and to install a diesel generator with sufficient capacity. It is noted that the project should be implemented early in this Study period. If the project is delayed and the gates malfunction, river water could not be supplied to SMC and NMC. This means that the pilot projects to be conducted in this Study will be greatly interfered with and finally be discontinued.</p>
(6) Project Justification	<p>The need and effect of Roleang Chrey Regulator Gates Urgent Improvement Project is evaluated from the following five items:</p> <p>(a) Relevance</p> <p>In the Target Area, the Roleang Chrey Regulator is a sole permanent structure abstracting river water from the Prek Thnot River. Without it, the irrigated agriculture in the Target Area is not realized, and also the improvement of agricultural production which is one of principal targets of agricultural sector, could not be achieved. In particular, the relevant farmers as well as the government eagerly desire the urgent repairs of gates in the regulator for stable water intake</p> <p>(b) Effectiveness</p> <p>Presently, gate operation of the regulator could not be made smoothly due to damage of wire ropes and insufficient capacity of existing diesel generator. The project will bear the easy gate operation which will result in the stable water supply to the left and right main canals and also smooth release of flood water to downstream. These are benefits for the relevant farmers in the Target Area.</p>

	<p>(c) Efficiency</p> <p>The main water resource for agriculture of the Target Area is the Prek Thnot River, the runoff of which is limited in the dry season. The project will be able to realize the effective use of the limited water in the dry season, to expand the irrigated area, and also properly release the flood water to the downstream in the rainy season, to reduce water stagnant area.</p> <p>(d) Impact</p> <p>The project will make a temporary treatment required for the proper gate operation. If, with the project, the expected results such as stable water supply and smooth release of flood water are produced, the subsequent permanent treatment will be keenly desired by the farmers and the government.</p> <p>(e) Sustainability</p> <p>The project aims at the temporary treatment for gates and generator. However, it is indispensable for irrigated agricultural development in the Target Area. The project is highly expected to proceed to further rehabilitation of the Prek Thnot Regulator for its sustainable use.</p>
(7) Project Components	<p>As temporary measures, the following are planned:</p> <ul style="list-style-type: none"> - Replacement of the counter weight wire rope in all 5 gates. - Installation of one additional diesel generator of 75 kVA as a main source although the existing one is used as an auxiliary electric source - Provision of spare parts such as fuses, magnetic switches and air filters for the diesel generator - Provision of standard maintenance tools such as wrenches, screw drivers, hammers and grease guns
(8) Required Cost	US\$ 75,000
(9) Executing Agency	MOWRAM
(10) Implementation	4 months after Notice to Proceed
(11) Environmental Management/ Social Considerations	<p>The following activities are planned;</p> <p>(i) Careful management of construction work (proper management of workers, heavy equipment, waste, etc)</p>

(2) Implementation Schedule

Activities	Expected Results	2006					In-charge	Equipment	Remarks
		6	7	8	9	10			
(1) Preparation of Tender Documents	Report	■					Consultant	As required	
(2) Tendering		■					MOWRAM Consultant	As required	
(3) Tender Evaluation	Successful Tenderer		■				Consultant	As required	
(4) Contract Award and Notice to Proceed	Capable Contractor		■				MOWRAM	As required	
(5) Construction Supervision	Improved Works		■■■■■				PDOWRAM	Vehicle	
(6) Acceptable Test	Good Quality Works						▲ Consultant PDOWRAM	As required	
(7) Establishment of O&M System	Proper O&M System						■ PDOWRAM	As required	
(8) Training of PDOWRAM Staff	Skilled Staff						■ Consultant	As required	



(3) Project Design Matrix

(Target Group: Farmers related to the North and South Main Canal Irrigation System)

Narrative Summary	Objectively Verifiable Indicator	Means of Verification	Important Assumption
<p>Overall Goal Agricultural productivity centering rice is improved in the Target Area</p>	<p>1-1 Agricultural productivity in the Target Area is improved as proposed in the Master Plan by year 2015</p>	<p>1-1 Agricultural statistics</p>	/
<p>Project Purpose Timely and efficient water control of Roleang Chrey regulator is carried out by temporary means</p>	<p>1 Roleang Chrey Regulator, upstream area, and Intakes are safe from damage for 3 years after the project</p> <p>2 Irrigation water taking from the Prek Thnot River is controlled in accordance with actual river flow and water demand for 3 years after the project</p>	<p>1 Monitoring reports by Kampong Speu PDOWRAM</p> <p>2 Operation records of the regulator and intakes</p>	<p>All the proposed activities in the Master Plan in post-project stage are implemented as scheduled</p> <p>No significant climatic change</p> <p>No severe damage on the irrigation facilities by natural disaster</p> <p>Organization of Kampong Speu PDOWRAM is not largely changed</p>
<p>Outputs 1 Gates of Roleang Chrey regulators are tentatively improved for operation</p> <p>2 Proper O&M system for gates is established</p>	<p>1 Wire ropes are replaced and new diesel generator is installed by August 2006</p> <p>2 O&M system is established by August 2006</p>	<p>1. Monitoring reports by Kampong Speu PDOWRAM</p> <p>2. O&M manual of the regulator and intakes</p>	<p>Operation cost is available on time</p> <p>Sufficient number of staff is available in Kampong Speu PDOWRAM</p>
<p>Activities</p> <p>1-1 To prepare the tender documents for temporary improvement work in cooperation of MOWRAM</p> <p>1-2 To make tendering for improvement work</p> <p>1-3 To execute tender evaluation</p> <p>1-4 To make contract and notice to proceed</p> <p>1.5 To supervise the improvement work</p> <p>1-6 To conduct the acceptance test</p> <p>2-1 To establish the O&M system</p> <p>2-2 To train the Kampong Speu PDOWRAM staff concerned</p>	<p>Input</p> <p>Donor Cambodia</p> <p>Mobilization cost (2 trips) Cost for expatriate staff Mechanical engineer (1 M/M) Preparation cost of tender documents Cost for field allowance for counter parts</p> <p><u>MOWRAM</u> Assignment of counter part (1 M/M)</p> <p><u>Kampong Speu PDOWRAM</u> Assignment of counter part (3 M/M) Transportation for counter part</p>		<p>MOWRAM and Kampong Speu PDOWRAM staffs in charge are not replaced in mid course of the implementation.</p> <p><u>Pre-conditions</u> MOWRAM realizes that improvement of gates of Roleang Chrey is indispensable for improvement of agricultural productivity centering rice in the Target Area.</p> <p>There is demand of irrigation water in the Target Area.</p>

1.5.2 B.1(2) Roleang Chrey Regulator and Intakes Improvement Project

(1) Project Proposal

(1) Title of Project	Roleang Chrey Regulator and Intakes Improvement Project
(2) Location	Village: Roleang Chrey, Commune: Taing Kruoch, District: Samraong Tong, Province: Kampong Speu
(3) Objective of Project	The project aims to provide a stable supply of water to the main canals by improving the Roleang Chrey Regulator, Andong Sla intake and Vat Kroch Intake.
(4) Site Description	<p>Roleang Chrey Regulator, Andong Sla Intake Gate, and Vat Kroch Intake Gate, and approach channels were constructed as main facilities of the irrigation systems in the Prek Thnot river basin in the early 1970s. The operation of these facilities control and affect irrigation water distribution for about 20,250 ha in Kampong Speu and Kandal provinces.</p> <p>Roleang Chrey Regulator</p> <ul style="list-style-type: none"> - The Regulator has not been well maintained since it was constructed in the early 1970s - Almost all the gate wheels are not able to rotate due to rusting of shafts causing overload to the hoist mechanism, which makes it difficult to operate precisely - Hoist systems are very old - All gates have deteriorated since installation in the early 1970s causing a large amount of water leakage - The downstream apron and river side are severely eroded - A small outlet structure is required to control and release irrigation water and maintenance flow to the downstream <p>Andong Sla Intake Gate and Vat Kruoch Intake Gate</p> <ul style="list-style-type: none"> - These structures have not been well maintained since they were constructed in the early 1970s, - A very large amount of leakage is observed from the gates, - Electric parts such as motors and the control cabinets were removed; the gates are operated by manual cranks. Their operation is limited. - Approach channels need to be rehabilitated to recover the design flow capacity. <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p><i>Vat Kruoch Intake Gate</i></p> </div> <div style="text-align: center;">  <p><i>leakage at Andong Slat Intake Gate</i></p> </div> </div>
(5) Project Description	Roleang Chrey Regulator will supply irrigation and domestic water to the areas served by NMC (6,500ha) and SMC (10,200 ha). It is a linchpin of water utilization in the downstream portions of the Prek Thnot river basin. Should it malfunction, it will directly and severely affect irrigation water supply to all the

	<p>irrigation systems concerned.</p> <p>All gates and hoisting systems are to be rehabilitated. The downstream apron and river side slope are severely eroded due to insufficient length of the apron and side slope protection. The downstream apron and river side slope are to be improved to assure the safety of the structure.</p> <p>The Regulator also has to release water to the downstream for the on-going Kandal Stung Irrigation Project (1,950 ha) and planned Tonle Bati Irrigation Project (1,600 ha). The size of the gates, however, are too large to control the amount of water to the downstream, which will vary from less than 1 m³/sec to about 5 m³/sec from month to month. A structure is to be constructed to assure and control the amount of water released to the downstream.</p> <p>Andong Sla Intake Gate and its approach channels are the first facility of NMC. The gates produce a large amount of leakage, and are not able to be operated adequately at present and need rehabilitation and improvement for modernized irrigation water management. Vat Kruoch Intake Gate and its approach channel are the first facilities of SMC. Appropriate operation is not executed at present due to poor condition of facilities.</p> <p>The project is a key, not only to maintain the present situation, but also to achieve sustainable development of the downstream area of 16,700ha of paddy field as a whole.</p>
(6) Project Justification	<p>The need and effect were evaluated from the following five items:</p> <p>(a) Relevance</p> <p>The project has high relevancy, since adequate irrigation water supply is one of the most important measure to achieve the goal of master plan (improvement of rice productivity).</p> <p>(b) Effectiveness</p> <p>The project facility is a key controller for timely and precise irrigation water supply from the Prek Thnot River to the downstream beneficiaries as a whole. The project also assure precise irrigation water supply to the on-going Kandal Stung Irrigation Project and planned Tonle Bati Irrigation Project.</p> <p>(c) Efficiency</p> <p>The water taken at the project site is delivered to all irrigation areas about 20,250 ha. The project is a key of the development of the Prek Thnot river basin. The project cost is minimized by rehabilitating existing structures. The beneficiary of the project expands up to 20,250 ha of paddy field. A unit cost per hectare is very small. The project was evaluated as efficient from above view points.</p> <p>(d) Impact</p> <p>The project gives a positive impact to farmers in the downstream area by assuring irrigation water supply. No significant negative impact by the project is anticipated.</p> <p>(e) Sustainability</p> <p>The Roleang Chrey Regulator and Intake Gates were not removed even past civil war time. This shows all stakeholders understood the importance of the project facility as a key facility for irrigation water supply in the Prek Thnot river basin. The Government will continue to take responsibility for operation and maintenance of the project facility. Sustainability of the project is extremely high.</p>
(7) Project Components	<p>The following activities are planned:</p> <p>(i) Rehabilitation and Improvement of Roleang Chrey Regulator</p> <ul style="list-style-type: none"> - Rehabilitation of all gates and hoist systems of the Regulator,

	<ul style="list-style-type: none"> - Improvement of the downstream apron and river side slope protection - Construction of a river outlet structure at the right side of the Regulator - Construction of an operators hut <p>(ii) Reconstruction of the Intake Gates</p> <ul style="list-style-type: none"> - Reconstruction of Andong Sla Intake Gate and Vat Kruoch Intake Gate - Rehabilitation of the approach channels to the Intake Gates - Construction of a power transmission line from the Regulator and Intake Gates <p>(iii) Engineering Support Services</p> <ul style="list-style-type: none"> - Survey, design, preparation of tender documents, and construction supervision - Prepare operation rules and an operation manual for the facilities - Reinforce the organization for the operation and maintenance of the project facility
(8) Cost	US\$4,786,000 including price contingency
(9) Executing Agency	MOWRAM
(10) Implementation	3 years
(11) Environmental Management/ Social Considerations	<p>The following activities are planned;</p> <p>(i) A reconnaissance survey of the natural conditions at the design phase</p> <p>(ii) Proper management of construction work (including social considerations)</p> <ul style="list-style-type: none"> - A series of public meetings from the design phase, proper management of workers' sanitation, regular watering for unpaved roads, etc <p>(iii) Regular monitoring at the construction phase (watering, sanitation, waste, water flow, etc) and at the operation phase (water quality, etc)</p>

(2) Implementation Schedule

Activities	Expected Results	2009				2010				2011				In-charge	Equipment	Remarks
		1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12			
(1) Survey, Design, Preparation of Tender Documents including Drawings	Design reports & drawings, tender docs.	■	■	■	■									Consultant	As required	
(2) Tender and Contract award	Contract			■	■									MOWRAM	As required	
(3) Construction work	Facilities			■	■	■	■	■	■	■	■	■	■	Contractor	As required	
(4) Preparation of gate operation rule and manual	O&M manual											■	■	Consultant/Contractor	As required	
(5) Training for Operator(s)	Upgraded operator(S)											■	■	Consultant/MOWRA	As required	

■ Rainy season

(3) Project Design Matrix

(Target Group: Farmers related to the North and South Main Canal Irrigation System)

Narrative Summary	Objectively Verifiable Indicator	Means of Verification	Important Assumption
<p>Overall Goal Agricultural productivity centering rice is improved in the Target Area</p>	<p>1-1 Agricultural productivity in the Target Area is improved as proposed in the Master Plan by year 2015</p>	<p>1-1 Agricultural statistics</p>	/
<p>Project Purpose Timely and efficient water control of Roleang Chrey regulator is carried out</p>	<p>1 Roleang Chrey Regulator, upstream area, and Intakes are safe from damage</p> <p>2 Roleang Chrey and Intakes are operated adequately without any engineering difficulty</p> <p>3 Irrigation water taking from the Prek Thnot River is controlled in accordance with actual river flow and water demand</p>	<p>1 Monitoring reports by Kampong Speu PDOWRAM</p> <p>2 Monitoring reports by Kampong Speu PDOWRAM</p> <p>3 Record of Roleang Chrey regulator operation</p>	<p>All the proposed activities in the Master Plan in post-project stage are implemented as scheduled</p> <p>No significant climatic change</p> <p>No severe damage on the irrigation facilities by natural disaster</p> <p>Organization of Kampong Speu PDOWRAM is not largely changed</p>
<p>Outputs 1 Roleang Chrey regulator and intakes are improved for operation</p> <p>2 Proper O&M for gates is conducted by Kampong Speu PDOWRAM</p>	<p>1. Roleang Chrey regulator and intakes are improved according to the concepts proposed in the feasibility study</p> <p>2. O&M system is improved</p>	<p>1. Feasibility study report</p> <p>2. Operation records of the regulator and intakes</p>	<p>Operation cost is available on time</p> <p>Sufficient number of staff is available in Kampong Speu PDOWRAM</p>
<p>Activities.</p> <p>1-1 To survey, design, prepare tender documents, and supervise the construction works</p> <p>1-2 To rehabilitate all gates and hoist systems of the regulator,</p> <p>1-3 To improve downstream apron and river side slope protection</p> <p>1-4 To construction of river outlet structure at right side of the regulator</p> <p>1-5 To construction of operators hut</p> <p>1-6 To reconstruct Andong Sla intake gate and Vat Kruoch Intke gate</p> <p>1-7 To rehabilitate approach channels to the intake gates</p> <p>1-8 To construct power transmission line from regulator and intake gates</p> <p>2-1 To prepare operation rule and operation manual of facilities</p> <p>2-2 To reinforce organization for operation and maintenance of the project facility</p>	<p style="text-align: center;">Input</p> <p style="text-align: center;">Donor</p> <p>1. Construction cost for civil and mechanical works</p> <p>2. Experts for Engineering Supporting Services</p> <ul style="list-style-type: none"> - Civil engineers - Hydro-mechanical engineers - Electrical engineers 	<p style="text-align: center;">Cambodia</p> <p><u>Provincial government</u></p> <p>1. Project Manager and his staff for the project from PDOWRAM</p> <p>2. Administration cost for construction work contract arrangement</p> <p>3. Public consultation to stakeholders</p> <p><u>Central government</u></p> <p>1. Counterparts from MOWRAM</p> <p>2. Land resettlement cost, as necessity arises</p>	<p>1. Continuous involvement of related government agencies and beneficiaries during the project period</p> <p>2. No severe damage of irrigation facilities by natural disaster within the project period</p> <p>Precondition High need for irrigated agriculture in the Target Area</p> <p>Good understanding of related organizations on the Master Plan and importance of proper water management</p> <p>Related proposed activities in the Master Plan in pre-project stage are implemented as scheduled</p>

1.5.3 B.2(1) Veterinary Services Strengthening and Livestock Raising Improvement Project

(1) Project Proposal

(1) Title of Project	Veterinary Services Strengthening and Livestock Raising Improvement Project								
(2) Location	Target Area (Kampong Speu & Kandal Province)								
(3) Objective of Project	The project aims at recruiting new Village Livestock Agents (VLAs) or empowering existing VLAs in each village as providers of animal health and livestock extension services.								
(4) Site Description	<p>The livestock sub-sector is the primary income source of farmers in the Target Area and draft cattle are primary sources of labor for land preparation and transport of farm products. The average holding sizes of livestock per farm household are:</p> <table border="1"> <thead> <tr> <th>Beef Cattle</th> <th>Milk Cows</th> <th>Draft Cattle</th> <th>Pigs</th> </tr> </thead> <tbody> <tr> <td>2.3</td> <td>0.7</td> <td>0.9</td> <td>1.0</td> </tr> </tbody> </table> <p>However, livestock husbandry in the Area is still not very intensive and faces unstable and low productivity. Major constraints for the development of the livestock sub-sector include problems in animal health and raising practices.</p>	Beef Cattle	Milk Cows	Draft Cattle	Pigs	2.3	0.7	0.9	1.0
Beef Cattle	Milk Cows	Draft Cattle	Pigs						
2.3	0.7	0.9	1.0						
(5) Project Description	<p>The project plans to recruit new Village Livestock Agents (VLAs) or empower existing VLAs as providers of animal health and livestock extension services at the village level with the objective of improving livestock productivity through the strengthening of veterinary services and the strengthening of livestock extension services to support improvement of livestock raising practices for farmers.</p> <p>Such veterinary & extension services are to be provided to farmers by the VLAs trained under the Project.</p> <p>Target Area: Chbar Mon, Kandal Stueng, Angk Snuol District</p> <p>Target districts of SLPP are excluded from the Project because similar activities are planned under SLPP.</p> <p>Target Group:</p> <p>Existing VLAs and VLA candidates in the project Target Area Beneficiaries of Project: Farmers in the project Target Area Total No. of target groups: 500 (one from each project village) New VLAs: 400 & existing VLAs: 100</p>								
(6) Project Justification	<p>(a) Relevance</p> <p>The agriculture sector is the key sector of Cambodian economy and the primary economic activity of the nation. As a leading agricultural sub-sector, the livestock sub-sector productivity improvement is defined as one of the primary development target in the national development plan of “Rectangular Strategy for Growth, Employment, Equity and Efficiency” and “Agricultural Development Plan for Long, Medium and Short Term 2001-2010”. The purpose & goal of the Project surely consistent with the said national development policies.</p> <p>The sub-sector is the primary income sources of the beneficiaries (farmers) of the Project and the productivity improvement of the sub-sector through the Project exactly meet the needs of the beneficiaries.</p> <p>(b) Effectiveness</p> <p>The predominant veterinary services and simple extension services to farmers are provided by existing VLAs (Animal Health Agents) in the Target Area. The effectiveness of the Project approaches, therefore, appears to have been verified. The Project aims at strengthening and expanding such services.</p>								

	<p>SLPP (Smallholder Livestock production Program) of European Union having a similar component has started in 2005 and a part of the Target Area in Kampong Speu is covered by SLPP. To avoid the overlapping of the project activities, close coordination and partnership arrangement should better be sought.</p> <p>(c) Efficiency</p> <p>The Project envisages to enhancing farmer-to-farmer veterinary & extension services to strengthen such services with low costs in the Target Area.</p> <p>The project implementation will be scheduled based on the Overall Plan and Annual Work Plan formulated in the initial year or in the previous year to ensure efficient project implementation.</p> <p>(d) Impact</p> <p>The project will present direct positive impacts on the target communities as the sub-sector is the primary income sources of the beneficiaries (farmers) of the Project. The possibility of the attainment of the project goal will be largely affected by the market prices & marketability of livestock. Basically, no serious negative impacts are predicted.</p> <p>(e) Sustainability</p> <p>VLAs continuous presence in the project area is an essential factor to sustain the project impacts. To motivate VLAs, the provision of some sort of incentives might be necessary in addition to periodical refresher training of them.</p>
(7) Project Components	<p>Field demonstrations on improved livestock raising at selected villages</p> <ul style="list-style-type: none"> - 100 villages (± 20% of project villages) - Subject: Pig fattening & chick & hen management (tentative) <p>Field guidance & monitoring by PDA/DAO staffs</p>
(8) Cost	US\$ 377,000 including price contingency
(9) Executing Agency	Department of Animal Health & Production, MAFF
(10) Executing Agency	Kampong Speu & Kandal PDA
(11) Implementation	5 years
(12) Environmental Management/ Social Considerations	<p>The following activity is included;</p> <p>(i) Explanation of environmental risks at the training (offensive odors caused by improper management, etc)</p>

(2) Implementation Schedule

Activities	Expected Results	Year					In-charge
		2008	2009	2010	2011	2012	
(1) Trainers Training of PDA/DAO Staffs	Trained trainers for the Project	■					Project PDA/DAO
(2) Recruiting VLAs Candidates	VLAs candidate recruited		■				Project PDA/DAO
(3) Preparation of Overall Plan & Annual Work Plan	Overall Plan & Annual Work Plan prepared	■					Project PDA/DAO
(4) Preparation of guidance & training materials	Guidance & training materials prepared	■					Project PDA/DAO
(5) Train & Qualify VLAs Candidates & Existing VLAs	Trained & qualified VLAs		■	■	■	■	Project PDA/DAO
(6) Provision of Veterinary Equipment & Seed Medicine to VLAs	Veterinary equipment & seed medicine are provided to VLAs		■	■	■	■	Project PDA/DAO
(7) Deployment of Trained VLAs to Field	Trained VLAs are deployed to village		■	■	■	■	Project PDA/DAO
(8) To operate field demonstration on improved livestock raising at selected	Field demonstration on improved livestock raising at selected village		■	■	■	■	Project VLAs
(9) Field Guidance to VLAs & Monitoring/ Supervision VLAs Activities	Field guidance to VLAs & monitoring/supervision VLAs activities implemented		■	■	■	■	Project PDA/DAO

(3) Project Design Matrix

(Target Group: Livestock Farmers in the Target Area)

Narrative Summary	Objectively Verifiable Indicator	Means of Verification	Important Assumption
Overall Goal Agricultural productivity centering rice is improved in the Target Area	1-1 Agricultural productivity in the Target Area is improved as proposed in the Master Plan by year 2015	1-1 Agricultural statistics	/
Project Purpose Veterinary services & livestock extension services are intensified through the increased deployment of qualified & well-trained VLAs (Village Livestock Agents) in the Target Area	1-1 No. of VLAs deployed 2-1 No. veterinary services provided by VLAs 3-1 Mortality rate of livestock in the Area	1-1 Monitoring record of PDA 2-1 VLAs activity report Monitoring by DAO 3-1 Sample survey	All the proposed activities in the Master Plan in post-project stage are implemented as scheduled No significant climatic change No disastrous livestock diseases does occur Marketing prices of livestock do not decline drastically
Outputs 1 Strategy to strengthen veterinary services and improve livestock raising is set 2 Extension activities on animal health and livestock extension services at village level is strengthened 3 Improved livestock raising technology is applied in villages	1-1 Prepared strategy is appreciated by well-informed experts 2-1 No. of well-trained VLAs in the Target Area 3-1 No. of villages applying the improved livestock raising technology	1-1 Minutes of steering committee meetings 2-1 Monitoring survey 3-1 Monitoring survey	VLAs continue to provide services in the Target Area
Activities. 1-1 To prepare Overall & Annual Work Plan 2-1 To prepare guidance & training materials 2-2 To train PDA/DAO staffs in trainer training 2-3 To recruit VLAs candidates 2-4 To train & qualify VLAs candidates & existing VLAs 2-5 To provide veterinary equipment & seed medicine to VLAs 2-6 To deploy trained VLAs to field 2-7 To provide field guidance to VLAs & monitor / supervise VLAs activities 3-1 To operate field demonstration on improved livestock raising at selected village	<p style="text-align: center;">Input</p> <p style="text-align: center;">Donor</p> <p style="text-align: center;">Cambodia</p> 1. Local Consultant (120 M/M) 2. Livestock husbandry expert 3. Veterinary expert 4. Project Cost	<p style="text-align: center;">Counterparts</p> Full time counterparts corresponding to consultant experts in number & specialty Part of project cost Office space & facilities	1. Continuous involvement of related government agencies and beneficiaries during the project period 2. No severe damage of irrigation facilities by natural disaster within the project period Precondition High need for livestock development in the Target Area Good understanding of related organizations on the Master Plan and importance of livestock development SLPP does not expand its Target Area to cover the project area Related proposed activities in the Master Plan in pre-project stage are implemented as scheduled

1.5.4 B.3(1) Community Inland Fisheries Development Project

(1) Project Proposal

(1) Title of Project	Community Inland Fisheries Development Project															
(2) Location	Ponds used for the Water Harvesting Irrigated Agriculture Improvement Project in the Target Area															
(3) Objective of Project	The Project aims at promoting inland fish culture in the water bodies of the Water Harvesting Irrigated Agriculture Improvement Project. Income from the inland fisheries could be placed in a common fund for the FWUC responsible for the O&M of the subject irrigation system.															
(4) Site Description	The project target ponds are distributed in a scattered way in the Target Area of Kampong Speu. The size of ponds expressed by water surface area in the rainy season varies from 0.4 ha to 111 ha.															
(5) Project Description	<p>The Fisheries Office of PDA Kampong Speu has fish breeding facilities with fingerling production capacity of 3 ~ 4 million per year and efforts to introduce freshwater fish culture in the Target Area have been made, although they are still at the threshold level, the existence of 150 small fish ponds in Vosai District (outside of the Target Area) is reported. Freshwater culture in the Area is carried out both in small ponds and rice fields on a micro scale. However, fish culture on a substantial scale in ponds or reservoirs constructed for irrigation purposes have not been established yet in the province.</p> <p>The Project aims at introduction of such substantial scales of inland fish culture in the water bodies used for irrigation.</p> <p>In the project, the development of community based inland fish culture is envisaged in the water bodies. Objective areas of the development are reservoirs for the Water Harvesting Irrigated Agriculture Improvement Projects of the present Study and the groups of beneficiaries (FWUCs) of the irrigation development who are responsible for O&M of the irrigation systems will be the target groups. Returns from the development are to be utilized as a source of funds for O&M of the irrigation systems.</p> <p>Target reservoirs:</p> <p>Reservoirs free from flooding throughout the year</p> <p>Size Distribution of Target Reservoirs: in total 49 reservoirs</p> <table border="1"> <thead> <tr> <th>Mini-scale</th> <th>Small-scale</th> <th>Medium-scale</th> <th>Large-scale</th> </tr> </thead> <tbody> <tr> <td>(0.4 – 3.0ha)</td> <td>(3.6 -10.3ha)</td> <td>(11.5 – 34.3ha)</td> <td>(57.6–111.4ha)</td> </tr> <tr> <td>5</td> <td>27</td> <td>14</td> <td>3</td> </tr> </tbody> </table>				Mini-scale	Small-scale	Medium-scale	Large-scale	(0.4 – 3.0ha)	(3.6 -10.3ha)	(11.5 – 34.3ha)	(57.6–111.4ha)	5	27	14	3
Mini-scale	Small-scale	Medium-scale	Large-scale													
(0.4 – 3.0ha)	(3.6 -10.3ha)	(11.5 – 34.3ha)	(57.6–111.4ha)													
5	27	14	3													
(6) Project Justification	<p>(a) Relevance</p> <p>The inland fisheries sub-sector development and the agricultural diversification is one of the primary development targets in the national development plan of “Agricultural Development Plan for Long, Medium and Short Term 2001-2010”.</p> <p>The development of fish culture in ponds or reservoirs is a new development target of Fisheries Department of MAFF. Although the target water surfaces of the Project are rather limited, the experiences obtained through the project implementation will become an important asset to the future activities of the Department. The overall goal of the Project is to sustaining Water Harvesting Irrigated Agriculture proposed in the Master Plan, through introducing income generating opportunities for FWUGs (farmer groups) who are responsible for O&M of the subject ponds or reservoirs.</p> <p>(b) Effectiveness</p> <p>Inland fish cultures in ponds are rather new development intervention in Cambodia. Therefore, the employment of experienced foreign experts is considered essential for the attainment of the project goal as planned in the</p>															

	<p>Project.</p> <p>(c) Efficiency</p> <p>The Project envisages to efficient utilization of existing water resources and cost for the development intervention is limited.</p> <p>(d) Impact</p> <p>The conflict among stakeholders for the use of ponds or ponds for fishing purposes is predictable social conflict brought about with the project implementation. To avoid such conflict, the Project is to carry out in-depth inventory on water use, fishing & water rights on the subject ponds or reservoirs.</p> <p>(e) Sustainability</p> <p>The Project can be sustained with low cost by beneficiaries FWUGs if fish cultures in ponds/pond become successful intervention. Therefore, employment of experienced experts and intensive technology transfer to local authorities will become an important factor for the project sustainability.</p>
(7) Project Components	<ul style="list-style-type: none"> - Initial technical guidance - Provision of fingerlings - Provision of fish nets & boats - Periodical field guidance by PDA/DAO staffs
(8) Required Cost	US\$ 413,000 including price contingency
(9) Executing Agency	Department of Fisheries, MAFF
(10) Implementation	5 years with 1 year pilot operation
(11) Environmental Management/ Social Considerations	<p>The following activities are planned;</p> <ul style="list-style-type: none"> - Reconnaissance survey of the natural conditions, including aqua-diversity and careful selection of fish as fingerlings at the design phase - Careful site selection at the design phase - Regular monitoring of the pond environment and management condition

(2) Implementation Schedule

Activities	Expected Results	Year						In-charge
		2009	2010	2011	2012	2013	2014	
(1) Inventory survey on candidate reservoirs for the selection of target reservoirs	List of eligible reservoirs & FWUGs	■	■	■	■			Project PDA/DAO FWUG
(2) Selection of target FWUGs (FWUC)	Project target FWUGs & reservoirs selected	■	■	■	■			Project PDA/DAO FWUG
(3) Preparation of an action plan & annual work plan	Action plan & annual work plan	■		■	■	■	■	Project PDA/DAO
(4) Technical training of PDA/DAO staffs	PDA/DAO staffs trained	■		■				Project PDA/DAO
(5) Preparation of guidance/extension materials	Guidance/extension materials prepared	■	■	■	■	■		Project PDA/DAO
(6) Initial technical guidance to a target FWUG (FWUC)	Target FWUGs are trained & ready for project implementation	■	■	■	■	■		Project PDA/DAO FWUG
(7) Provision of fingerings, fishing gear & boat to a target FWUG	Fingerings, fertilizers, fishing gear & boat provided to a target FWUG	■	■	■	■	■		Project PDA/DAO FWUG
(8) Periodical field guidance & monitoring	Periodical field guidance & monitoring made by PDA/DAO		■	■	■	■	■	Project PDA/DAO
(9) Monitoring of fish production	Fish production data obtained		■	■	■	■	■	Project PDA/DAO

(3) Project Design Matrix

(Target Group: FWUGs or FWUCs in Zone-3)

Narrative Summary	Objectively Verifiable Indicator	Means of Verification	Important Assumption		
<p>Overall Goal Agricultural productivity centering rice is improved in the Target Area</p>	<p>1-1 Agricultural productivity in the Target Area is improved as proposed in the Master Plan by year 2015</p>	<p>1-1 Agricultural statistics</p>	/		
<p>Project Purpose Fish production in the ponds for the water harvesting irrigated agriculture improvement project is increased</p>	<p>1-1 Annual fish production (volume & amount)</p>	<p>1-1 FWUG's (FWUC's) monitoring record 1-2 PDA/DAO monitoring record</p>	<p>All the proposed activities in the Master Plan in post-project stage will be implemented as scheduled</p> <p>No significant climatic change</p> <p>No severe damage on the small ponds by natural disaster</p> <p>O&M of ponds are properly carried out by FWUGs (FWUCs)</p>		
<p>Outputs 1 Action plan & annual work plan for the project implementation is prepared 2 Capacity of target FWUGs (FWUCs) is strengthened 3 Fingerings are stocked in target ponds</p>	<p>1-1 Action plan & annual work plan 2-1 No. of FWUCs/ FWUGs & members trained 3-1 No. of fingerings stocked in each pond</p>	<p>1-1 Monitoring survey 2-1 Monitoring survey 3-1 Monitoring survey</p>	<p>No severe damage of small ponds by natural disaster</p> <p>No serious outbreak of fish diseases does occur</p> <p>No serious drought to dry up pond does take place</p>		
<p>Activities 1-1 To carry out inventory survey on candidate ponds for the selection of target ponds for the project implementation 1-2 To get consent of a target FWUG (FWUC) 1-3 To prepare an action plan & annual work plan 2-1 To prepare guidance/extension materials 2-2 To implement technical training of PDA/DAO staffs 2-3 To provide initial technical guidance to target FWUGs (FWUCs) 2-4 To implement periodical field guidance & monitoring 3-1 To provide fingerings, fertilizers, fishing gear & boat to target FWUGs (FWUCs)</p>	<p>Input</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <p>Donor</p> <p><u>Foreign/Local Consultant</u> Foreign 30 M/M (ASEAN) Local 120 M/M</p> <p>Project Cost</p> </td> <td style="width: 50%; vertical-align: top;"> <p>Cambodia</p> <p><u>Counterparts</u> Full time counterparts corresponding to foreign & local consultant in number & specialty</p> <p>Part of project cost Office space & facilities</p> </td> </tr> </table>		<p>Donor</p> <p><u>Foreign/Local Consultant</u> Foreign 30 M/M (ASEAN) Local 120 M/M</p> <p>Project Cost</p>	<p>Cambodia</p> <p><u>Counterparts</u> Full time counterparts corresponding to foreign & local consultant in number & specialty</p> <p>Part of project cost Office space & facilities</p>	<p>1. Continuous involvement of related government agencies and beneficiaries during the project period</p> <p>2. No severe damage of small ponds by natural disaster within the project period</p> <p>Precondition High need for inland fisheries in the Target Area</p> <p>Good understanding of related organizations on the Master Plan and importance of inland fisheries development</p> <p>Fish culture right is vested to FWUG (FWUC)</p> <p>Related proposed activities in the Master Plan in pre-project stage are implemented as scheduled</p>
<p>Donor</p> <p><u>Foreign/Local Consultant</u> Foreign 30 M/M (ASEAN) Local 120 M/M</p> <p>Project Cost</p>	<p>Cambodia</p> <p><u>Counterparts</u> Full time counterparts corresponding to foreign & local consultant in number & specialty</p> <p>Part of project cost Office space & facilities</p>				

1.5.5 B.4(1) Income Generation Project for Marginal Farmers

(1) Project Proposal

(1) Title of Project	Income Generation Project for Marginal Farmers
(2) Location	Target Area (Kampong Speu & Kandal Province)
(3) Objective of Project	The main objective of this development intervention, enhancement/introduction of income generation activities targeting marginal farmers, is to increase the income of marginal farmers and to improve the level of food security, thereby contributing to human security and reducing the vulnerability of the target groups. The project aims to achieve this by promoting the income diversification of the target groups.
(4) Project Description	<p>Poverty reduction is the primary development goal of Cambodia and the NPRS dictates the improvement of the agricultural sector and the enhancement of assistance to farmers as the backbone of poverty reduction.</p> <p><u>Target Groups:</u> 4,200 households</p> <p>Target groups of the schemes are marginal farmers who are poor and the most vulnerable group for food insecurity in the Target Area and landless households, households with holding size less than 0.1ha and women headed households are tentatively defined as target households. As similar projects have been implemented in or around the Target Area by SPFS, SEILA and NGOs, the project target groups are tentatively set to be 20% of the said households or 4,200 households (actual target groups are to be selected in the preparatory stage of the project).</p>
(5) Project Justification	<p>(a) Relevance</p> <p>The Project aims at providing income generation opportunities for marginal farmers and supporting improvement of their livelihoods. The poverty reduction is the national top priority development direction stated in NPRS and NSDP (Third National Strategy Development Plan 2006-2010). The project framework involves the procedures to reflect needs of beneficiaries and the project income generation activities are selected and carried out by themselves.</p> <p>(b) Effectiveness</p> <p>The approaches envisaged in the Project are the ones employed by FAO SPFS and the ones refined based on the substantial lessons learned from the past experiences. However, the employment or support of well experienced NGOs or experts will be essential. The stabilization of market prices of inputs or products is an important assumption to affect the effectiveness of the Project.</p> <p>(c) Efficiency</p> <p>The Project is rather low cost development intervention carried out by Self-help Groups and their members based on their needs and interests. However, management and technical skills of NGOs or experts will be a necessary input as planned in the Project.</p> <p>(d) Impact</p> <p>The positive impacts of the Project toward the target marginal farmers will be high. However, the attainment of the overall goal, sustainability of the development interventions by beneficiaries by themselves, is largely depending on outcomes of income generation activities implemented. Management and technical skills of NGOs or experts will be essential as stated above.</p> <p>(e) Sustainability</p> <p>The Project involves a component to ensure the sustainability of development interventions, saving & credit function of Self-help Groups. Management and technical skills of NGOs or experts will also be essential in this view point.</p>
(5) Project Components	<u>Preparatory Stage</u>

	<ul style="list-style-type: none"> - Inventory survey (selection of target groups and villages) - Preparation of Annual Work Plan - Preparation of scheme lists & guidelines - Field staffs (PDA/DAO/NGOs staffs) training; trainer training <p>Project Operation Stage</p> <ul style="list-style-type: none"> - PRA at village level - Farmers' group (Self-help Group) formation of members having similar intentions or preference toward income generating activities - Membership: 30 members & 3 sub-groups of 10 members - Board members: President, vice president & treasurer - Selection of a scheme to be introduced by a group - Training program for board members - IFFS (Integrated Farmer Field School) curriculum development - IFFS (including a study plot/scheme operation) at target villages - Provision of credit for farm inputs, seedlings, farm tools, fingerlings, animals and poultry etc. depending on schemes selected and beneficiaries' needs - Credit amount US\$ ±50/member (depending on schemes selected), - Credit provision & revolving arrangements - Monitoring & evaluation <p>Conceivable Candidate Schemes</p> <ul style="list-style-type: none"> - Village Chick & Hen Management Scheme - Fish Culture Scheme in Rice Fields - Fruit Seedling Production Scheme Small scale aquaculture - Small-scale Fish Culture Scheme - Small scale livestock production - Fruit production - Mushroom production with local inputs
(6) Cost	US\$ 679,000 including price contingency
(7) Executing Agency	Department of Fisheries, Animal Health & Production, and Extension, MAFF in collaboration with Kampong Speu & Kandal PDA, NGOs and other organizations
(8) Implementation	5 years (Preparatory Stage: 1 year, Operation Stage: 4 years)

(2) Implementation Schedule

Activities	Expected Results	Year					In-charge
		2009	2010	2011	2012	2013	
Project Target Groups by Year							Total
No. of Target Self-help Groups		10	20	30	40	40	140
No. of Target Self-help Groups Members		300	600	900	1,200	1,200	4,200
Preparatory Stage							
(1) Inventory survey (selection of target groups and villages)	Target groups and prioritization of villages are selected	■	■	■	■	■	Project PDA/DAO Communities
(2) Preparation of Annual Work Plan	Annual Work Plans are prepared	■	■	■	■	■	Project PDA/DAO Communities
(3) Preparation of candidate scheme lists & scheme guidelines	Scheme guidelines are prepared	■	■	■	■	■	Project PDA/DAO
(4) Field staffs (PDA/DAO/NGO staffs) training; trainer training	Field staffs (extension staffs) are trained as project trainers	■	■	■	■	■	Project PDA/DAO
Operation Stage							
(1) PRA at village level	PRA at village level implemented & village features identified	■	■	■	■	■	Project PDA/DAO Communities
(2) Farmer group (Self-help Group) formation	Self-help Groups formulated	■	■	■	■	■	Project PDA/DAO Self-help Group
(3) IFFS (Integrated Farmer Field School) curriculum development	IFFS curriculum are developed	■	■	■	■	■	Project PDA/DAO
(3) IFFS (Integrated Farmer Field School: including pilot plot or scheme operation) at	IFFSs at target villages are implemented and Self-help Groups & group members are trained for a proposed scheme implementation	■	■	■	■	■	Project PDA/DAO Self-help Group Members
(4) Provision of credit for farm inputs, seedlings, farm tools, fingering, animal and poultry etc. depending on beneficiaries	Credit for farm inputs, seedlings, farm tools, fingering, animal and poultry are provided to Self-help Group members	■	■	■	■	■	Project PDA/DAO Self-help Group Members
(5) Implementation of income generation schemes by members of Self-help Group	Income generation schemes are implemented by members of Self-help Groups	■	■	■	■	■	Self-help Group Members Project
(6) Field guidance, monitoring & evaluation	Periodical field guidance & monitoring made by trainers	■	■	■	■	■	Project PDA/DAO

(3) Project Design Matrix

(Target Group: Marginal farmers in the Target Area)

Narrative Summary	Objectively Verifiable Indicator	Means of Verification	Important Assumption
Overall Goal Poverty in the Target Area is alleviated	1-1 Poverty ratio in the Target Area is decreased	1-1 Monitoring survey	
Project Purpose Income of marginal farmers in the Target Area from agricultural activities is increased	1-1 Gross & net returns of marginal farmers from the schemes	2-1 Performance reports by Self-help Groups 2-2 Monitoring/supervision report	All the proposed activities in the Master Plan in post-project stage will be implemented as scheduled No significant climatic change There are no significant changes in market prices of products
Outputs 1 Project implementation plan is prepared 2 Farmer groups (Self-help Groups) based on schemes selected by individual farmers are formed 3 IFFSs are operated to train Self-help Groups at target villages 4 Credit for procurement of necessities for schemes are provided to Self-help Groups being trained 5 Income generation schemes are implemented by members of Self-help Groups with assistance of field staffs (extension staffs)	1-1 Project implementation plan 2-1 No. of Self-help Groups formed by scheme 3-1 No. of IFFSs implemented & their performances 4-1 No. of Self-help Groups received credit & credit amount 5-1 No. of schemes implemented & performances	1-1 Monitoring survey 2-1 Monitoring survey 3-1 Monitoring survey 4-1 Monitoring survey 5-1 Monitoring survey	Natural disaster, pest & diseases and other detrimental damages do not occur in scheme operation There are no significant changes in market prices of products during the project period There is no significant hike in prices of necessities Field staffs trained are continuously involved in the Project
Activities 1-1 To conduct inventory survey to select of target groups and villages 1-2 To prepare Annual Work Plan 1-3 To prepare candidate scheme lists & scheme guidelines 2-1 To execute PRA at village level 2-2 To assist farmers to form farmer group (Self-help Group) 3-1 To develop IFFS curriculum 3-2 To conduct IFFS at target villages 4-1 To provide credit for farm inputs, seedlings, farm tools, fingerling, animal and poultry etc. depending on beneficiaries needs 5-1 To conduct field staffs (PDA/DAO/NGO staffs) training; trainer training 5-2 To provide field guidance, monitoring & evaluation are implemented by trainers 5-3 To implement income generation schemes by members of Self-help Groups	Input		
	Donor	Cambodia	Counterparts & local authorities staffs trained are continuously stationed at the Project or continuously support the Project
	Consultant Services Cost (local /NGO)	Counterparts	Precondition High need for income generation of marginal farmers
	Long-term Experts - Chief Adviser - Operation Officers Short-term Experts - Livestock Expert - Inland Fishery Expert - Rural Credit - Others as required	Full time counterparts corresponding to expert in number & specialty	Good understanding of related organizations on the Master Plan and importance of income generation of marginal farmers
	Provision of Equipment - Training equipment & office equipment & facilities	Office space & facilities	Related proposed activities in the Master Plan in pre-project stage are implemented as scheduled
	Project Cost	Part of project cost	

2. Subject-wise Improvement

2.1 C.1(1) Coordination between MOWRAM and MAFF Strengthening Project

(1) Project Proposal

(1) Title of Project	Coordination between MOWRAM and MAFF Strengthening Project
(2) Location	Phnom Penh (MOWRAM or/and MAFF)
(3) Objective of Project	To strengthen the coordination between MOWRAM and MAFF for efficient and smooth implementation of irrigated agriculture projects
(4) Site Description	Office buildings located in Phnom Penh
(5) Project Description	It is important to improve the coordination between MOWRAM and MAFF for effective execution of the projects/ implementation of the action plans for irrigated agriculture. In a current condition, it is hard to say the coordination between MOWRAM and MAFF goes very well. Some donors are confused and embarrassed to execute irrigated agriculture projects because both Ministries are required to involve in. Some of the staffs in MAFF are aware of this condition and raise the alarm. In order to improve this condition, it is proposed to establish a “Project Management Group (PMG)” or “Advisory Team” consisting of MOWRAM and PDOWRAM.
(6) Project Justification	<p>(a) Relevance</p> <p>It is enthusiastically demanded to improve the coordination between MOWRAM and MAFF by some donors. Some of MAFF staffs also find it important to collaborate with MOWRAM especially in irrigated agriculture project. This coordination can be expected to play an important role in achieving “Good Governance” aimed in NPRS. Moreover, improvement of the coordination surely contributes to achieve Overall Goal.</p> <p>(b) Effectiveness</p> <p>It is not very hard to improve the coordination between MOWRAM and MAFF if there is a trigger; the offer of irrigated agricultural project. Management capacity of high ranking officers is anticipated contributing to smooth establishment of a “Project Management Group.”</p> <p>(c) Efficiency</p> <p>Input is the minimum but would be fully utilized for achieving the objective of the project. Quality, amount, and timing are properly planned.</p> <p>(d) Impact</p> <p>As the coordination between MOWRAM and MAFF is improved, it would influence the coordination between PDOWRAM and PDA, and that among MOWRAM, MAFF, and MRD. Good coordination can be an initial point to increase the offer of irrigated agriculture projects.</p> <p>(e) Sustainability</p> <p>Once the activities of a PMG are perceived among the officers of MOWRAM and MAFF, and donors, this system could take root. After the cost of the project period, the huge expense would not arise. RGC and the donors would have a keen interest in agriculture of Cambodia continuously because agriculture is going to remain a main income source of the majority of the population. This means it is highly expected that PMG would continue to receive the offers of irrigated agriculture projects. Established coordination system is going to be sustained.</p>
(7) Project Components	<p>The following activities are planned:</p> <ul style="list-style-type: none"> - To hold a participatory workshop. - To organize a Project Management Group/ Advisory Team for implementation of an irrigated agriculture project.

	<ul style="list-style-type: none"> - To have regular meetings to exchange the information and the ideas about the irrigated agriculture project. - To monitor and evaluate the irrigated agriculture project jointly. - To publish quarterly reports about the irrigated agriculture project. - To do PR activities of a Project Management Group/ Advisory Team. - To monitor and evaluate the Coordination between MOWRAM and MAFF Strengthening Project.
(8) Cost	US\$ 98,000 including price contingency
(9) Executing Agency	MOWRAM and MAFF
(10) Implementation	12 months

(2) Implementation Schedule

Activities	Expected Results	2009												In-charge	Equipment	Remarks	
		Jan-March			April-June			July-Sep.			Oct.-Dec.						
(1) To hold a participatory workshop	Minutes/ Record of the workshop	■													Facilitator, MOWRAM, MAFF	Workshop materials	
(2) To organize a Project Management Group (PMG)	Mutual agreement	■													Expert, MOWRAM, MAFF	As required	
(3) To have regular meetings	Solidarity, exchange of information		■	■	■	■	■	■	■	■	■	■	■	■	Expert, PMG	As required	
(4) To monitor and evaluate the project	Monitoring and evaluation reports			■	■	■	■	■	■	■	■	■	■	■	Expert, PMG	Vehicle	
(5) To publish quarterly newsletters	Quarterly newsletters			▲		▲		▲		▲		▲		PMG	Printing equipment		
(6) To publish quarterly reports	Quarterly reports			▲		▲		▲		▲		▲		PMG	Printing equipment		
(7) To do PR activities of a PMG	Penetration of PMG activities			▲		▲		▲		▲		▲		PMG	As required		
(8) To esteem PMG activities by itself	Self-esteem report					▲				▲		▲		PMG	As required		
(9) To reflect the results of self-esteem and the feedbacks from the officers of MOWRAM and MAFF, and donors to	Future action plan												■	Expert, PMG	As required		

(3) Project Design Matrix

(Target Group: MOWRAM and MAFF staff)

Narrative Summary	Objectively Verifiable Indicator	Means of Verification	Important Assumption
Overall Goal Agricultural productivity centering rice is improved in the Target Area	1-1 Agricultural productivity in the Target Area is improved as proposed in the Master Plan by year 2015	1-1 Agricultural statistics	
Project Purpose Coordination between MOWRAM and MAFF is strengthened	Number of the project managed by Project Management Groups (PMGs)	Quarterly report prepared by PMGs	All the proposed activities in the Master Plan in post-project stage will be implemented as scheduled No significant climatic change
Outputs 1. A project management group is established 2. Responsible line by project is clarified	1-1 Times of meeting (once a week) 1-2 Existence of Mutual agreement 2-1 Statement of the responsible line in the report	1-1 Record of meeting 1-2 Existence of Mutual agreement 2-1 Statement of the responsible line in the report prepared by PMG	
Activities 1-1 To hold a participatory workshop to discuss the problems and the solutions on the coordination between MAFF and MOWRAM and a Project Management Group 1-2 To select the persons in charge of preparing the establishment of a PMG from MOWRAM and MAFF 1-3 To have a meeting once a week and issue the mutual agreement on establishment of PMG 1-4 To have a project offer from RGC, JICA or the other donors 1-5 To assign the persons for the project from MOWRAM and MAFF 1-6 To organize the project management group and decide a group leader and a deputy group leader based on the discussion among the group members from MOWRAM and MAFF 1-7 To implement the project until its completion responsibly 1-8 To monitor and evaluate the project regularly (monitoring: once 2-4 weeks, evaluation once 1-2 months) 1-9 To summarize M&E of the project and self-esteem 1-10 To feed back the results of M&E to the project and the other similar projects 2-1 To do PR activities for existing a PMG by using notice boards in MOWRAM and MAFF 2-2 To publish a newsletter on the project at least quarterly and put it on the notice boards in both ministries 2-3 To receive the feedbacks from the officers and the donors 2-4 To reflect them to further implementation of the PMG	Input Donor Cambodia		Precondition Irrigated agriculture project is going to be implemented during the project period Related proposed activities in the Master Plan in pre-project stage are implemented as scheduled
	<i>Personnel</i> Facilitator for a participatory workshop: 0.5 M/M Expert in project management: 12M/M <i>Equipment</i> Workshop materials: 1 set Printing equipment: 1 set <i>Cost</i> Transportation cost (Donor country ⇔ Cambodia): 2 round-trips 4WD rental fee: 12 months (USD 1,200/ month)	<u>MOWRAM and MAFF</u> <i>Personnel</i> Workshop participants: 3.0 M/M Workshop assistants: 1.0M/M Chief of a project management group (PMG): 12M/M Deputy Chief of a PMG: 12M/M <i>Equipment</i> Facilitator/ Expert office Workshop venue <i>Cost</i> Running cost: 12 months USD 400/ month	

2.2 C.1(2) Provincial Departments Strengthening Project

(1) Project Proposal

(1) Title of Project	Provincial Departments Strengthening Project
(2) Location	Kampong Speu Province and Kandal Province
(3) Objective of Project	To strengthen Provincial Departments for efficient and smooth implementation of irrigated agriculture projects
(4) Site Description	Irrigated farmland and Provincial Department offices in Kampong Speu Province and Kandal Province
(5) Project Description	It can be said that the knowledge and skills of the provincial officers in the fields; planning, designing, and management and O &M of irrigation systems and new high yielding technology are still limited at PDOWRAMs and PDAs. It is said that about 50% of the officers lack the incentives to work due to low salary; however, it is true that there are some officers that are highly motivated but have not developed their potentials.
(6) Project Justification	<p>(a) Relevance</p> <p>It is strongly needed to strengthen the Provincial Departments by the officers working there. The strengthening of Provincial Departments directly contributes to decentralization because the capacity/ capability of Provincial Departments should be improved, prior to decentralization. RGC states “Decentralization offers new possibilities to bring about a broader-based economic growth and to implement a more effective and efficient strategy for poverty alleviation” in SEDP II.</p> <p>(b) Effectiveness</p> <p>RGC and many donors pay much attention to irrigated agriculture in Provinces. Thus, seizing of the project offers can greatly anticipated. Furthermore, it can be expected that RGC would not change decentralization policy. Intensive technical trainings and study tours would inspire the officers and improve their technical level.</p> <p>(c) Efficiency</p> <p>Experts are dispatched consequently for efficient technology transfer. Then, the officers would not loose their attention to improving their expertise. Necessary equipment, instruments, and materials can be put in as scheduled.</p> <p>(d) Impact</p> <p>Strengthening of Provincial Department directly influences to increase of farmers’ productivity. Moreover, decentralization may result in substantial efficiency gains for poverty reduction. It also may bring about more efficient allocation of resources to match local demands and priorities.</p> <p>(e) Sustainability</p> <p>This project can increase highly motivated officers with expertise. They would not quit working at Provincial Departments. Sharing information and knowledge within the Departments and in inter-departments can work as “moral hazard.”</p>
(7) Project Component	<ul style="list-style-type: none"> - To hold a participatory workshop on strengths, weaknesses, opportunities, and threats. - To seize the opportunities of the training courses, the study tours, and the On-the-Job-Training during the implementation of an irrigated agriculture/ a rainfed agriculture project. - To have technical awards for attained technique and knowledge through the implementation of irrigated agriculture / a rainfed agriculture project. - To have inter-departments/ offices meetings regularly to exchange the information and the ideas about the irrigated agriculture project/ the rainfed agriculture project.

	- To monitor and evaluate the Provincial Departments Strengthening Project.
(8) Cost	US\$ 330,000 including price contingency
(9) Executing Agency	Kampong Speu and Kandal PDOWRAMs and PDAs
(10) Implementation	12 months

(2) Implementation Schedule

Activities	Expected Results	2009												In-charge	Equipment	Remarks		
		Jan-March			April-June			July-Sep.			Oct.-Dec.							
(1) To hold a participatory workshop	Minutes/ Record of the workshop	■													Facilitator, PDOWRAMs , PDAs	Workshop materials		
(2) To seize the opportunities of the training courses and the study tours	Technical training courses and study tours	■												PDOWRAM, PDAs	Surveyong instrument, hydrometer, PC, Auto CAD	Input of experts as trainers		
(3) To have regular meetings	Solidarity, exchange of information	■												Expert, PDOWRAMs , PDAs	As required			
(4) To have inter-departments/ office meetings regularly	Exchange of information			■												Expert, PDOWRAMs , PDAs	As required	
(5) To study the conditions before and after the project	Quarterly M & E reports	▲													▲ PDOWRAMs , PDAs	As required		
(6) To monitor and evaluate the project	Quarterly reports		▲		▲				▲						▲ PDOWRAMs , PDAs	As required		

2.3 C.2(1) Livestock Sub-sector Development Study

(1) Project Proposal

(1) Title of Project	Livestock Sub-sector Development Study									
(2) Location	Target Area (Kampong Speu & Kandal Province)									
(3) Objective of Project	The Study aims at the formulation of an integrated livestock sub-sector development plan in the Target Area for medium and long term development scopes.									
(4) Site Description	<p>The livestock sub-sector is the primary income source of farmers in the Target Area and draft cattle are the primary sources of labor for land preparation and transport of farm products. The average holding sizes of livestock per farm household are shown in the right table. However, livestock husbandry in the Area is still not very intensive and faces unstable and low productivity. Major constraints include problems in animal health and raising practices. Other constraints are the lack of a comprehensive study on livestock development potential in the environment of the Target Area, including investigations on improvement of genetic resources and feed supply conditions as well as animal health issues.</p>	<table border="1"> <tr> <td>Cattle</td> <td>2.3</td> </tr> <tr> <td>Cow</td> <td>0.7</td> </tr> <tr> <td>Draft Cattle</td> <td>0.9</td> </tr> <tr> <td>Pig</td> <td>1.0</td> </tr> </table>	Cattle	2.3	Cow	0.7	Draft Cattle	0.9	Pig	1.0
Cattle	2.3									
Cow	0.7									
Draft Cattle	0.9									
Pig	1.0									
(5) Project Description	<p>For the enhancement of livestock productivity in the Target Area, the integrated implementation of improvement of genetic resources, development of feed resources and improvement of veterinary services are considered essential. As the sub-sector is a main income source of the farming communities, the development of the sub-sector will be a primary target sub-sector in the long term agricultural development in the Area. However, the overall investigations and study on present conditions, development potentials, approach for development and formulation of the integrated development plan are yet to be made. To tackle the said weaknesses in the sub-sector, the Study aims at executing a development study for the formulation of an integrated livestock sub-sector development plan in the Area for medium and long term development scopes.</p>									
(6) Project Justification	<p>(a) Relevance</p> <p>As a leading agricultural sub-sector, the livestock sub-sector development is defined as one of the primary development target in the national development plan of “Rectangular Strategy for Growth, Employment, Equity and Efficiency, Third National Strategy Development Plan and Agricultural Development Plan for Long, Medium and Short Term 2001-2010”. The purpose & goal of the Project do consistent with the said national development policies. Further, the sub-sector development plan under the Project is to be formulated to meet the actual needs of the target groups of the study.</p> <p>(b) Effectiveness</p> <p>The attainment of the project purpose and overall goal is solely depending on whether a well qualified consultant firm is selected or not. The Study is to be conducted by a qualified international consultant firm. In the scope of the consultant services, the formulation of practical development plans should duly be indicated as the primary task of the consultant.</p> <p>(c) Efficiency</p> <p>For ensuring efficiency of the Study, the recruitment of a qualified international consultant firm and formation of a study team composed of well experienced experts are essential. Further, the technology transfer to the executing agency should be accommodated as an essential component of TOR for the team.</p> <p>(d) Impact</p> <p>The possibility for the attainment of the project goal is completely subject to the implementation of development plans formulated under the Study. Accordingly,</p>									

	<p>the formulation of practical development plans based on area specific conditions and needs are essential. No negative impacts are predicted from the implementation of the Study.</p> <p>(e) Sustainability</p> <p>The formulation of the development plans duly taken into consideration of sustainability of development interventions should be accommodated in the TOR for the study team to ensure the sustainability of the proposed development interventions.</p>
(7) Scope of the Study	<ul style="list-style-type: none"> - Identification of present conditions (livestock population, genetic resources, feed resources, production, raising practices & systems, diseases, marketing, processing, support systems & activities, the private sector etc.) - Identification of development constraints & potential - Study of integrated livestock development concepts - Formulation of integrated development plan - Technology transfer - Workshops & seminars - Cost estimate & project evaluation
(8) Cost	US\$ 1,551,000 including price contingency
(9) Executing Agency	Department of Animal Health & Production, MAFF
(10) Implementation	12 months

(2) Implementation Schedule

Activities	Expected Results	2009												In-charge		
		1	2	3	4	5	6	7	8	9	10	11	12			
(1) Inception meeting	Study approach & method mutually agreed	■														Study Team Counterpart
(2) Identification of present conditions of the livestock sub-sector in the Target Area	Present conditions of the sub-sector identified	■	■	■	■											Study Team Counterpart
(3) Study on development constraints & potentials	Development constraints & potentials of the sub-sector identified	■	■	■	■	■										Study Team Counterpart
(4) Study on development concepts from technical, socio-economic, institutional & marketing aspects	Development concepts formulated			■	■	■										Study Team Counterpart
(5) Study and formulation of integrated development plan - Formulation of development plan - Estimation of cost for projects/schemes accommodated in the development plan - Study on institutional set-up for project implementation Project evaluation	Development study report						■	■	■	■	■	■	■	■		Study Team Counterpart
(6) Workshop/seminar/meeting		■	■	■	■	■	■	■	■	■	■	■	■	■		Study Team Counterpart Stakeholders
(7) Reporting Schedule		▲ LR					▲ IT						▲ DF	▲ F		


(3) **Project Design Matrix**

(Target Group: Livestock farmers in the Target Area)

Narrative Summary	Objectively Verifiable Indicator	Means of Verification	Important Assumption
<p>Overall Goal Agricultural productivity centering rice is improved in the Target Area</p>	1-1 Agricultural productivity in the Target Area is improved as proposed in the Master Plan by year 2015	1-1 Agricultural statistics	/
<p>Project Purpose Integrated livestock sub-sector development plan in the Target Area of international standard eligible for requesting financing for donors or international organizations is formulated</p>	1-1 Integrated livestock sub-sector development plan is formulated as scheduled	1-1 Integrated livestock sub-sector development plan report	<p>All the proposed activities in the Master Plan in post-project stage will be implemented as scheduled</p> <p>No significant climatic change</p> <p>There are no significant changes in market prices of livestock</p> <p>Development plans are successfully executed</p>
<p>Outputs 1. Study report on integrated livestock sub-sector development plan is prepared</p>	1-1 Prepared report meets requirements for international cooperation project	1-1 Minutes of meeting of steering committee of the study	Steering committee of the study is held with well-informed experts on time
<p>Activities 1-1 To identify present conditions of the livestock sub-sector in the Target Area - Data collection, analysis & compilation - Field survey & market survey - Baseline survey (sample survey) - Other related survey & study 1-2 To study development constraints & potentials on the basis of the findings of 1. 1-3 To study on development concepts from technical, socio-economic, institutional & marketing aspects 1-4 To study and formulate integrated development plan</p>	<p style="text-align: center;">Input</p> <p style="text-align: center;">Donor Cambodia</p> <p style="text-align: center;"><u>Study Team</u> / <u>Counterparts</u></p> <p>Team Leader / Livestock Development Livestock Raising Animal Health Animal Feed Animal Breed Agronomist Socio-economist Institutional Expert</p> <p>Study Cost</p>	<p>Full time counterparts corresponding to number & specialty of the Study Team</p> <p>Office space & facilities</p>	<p>Counterparts & local authorities staffs trained are continuously stationed at the Project or continuously support the Project</p> <p>Precondition High need for livestock development in the Target Area</p> <p>Good understanding of related organizations on the Master Plan and importance of livestock development</p> <p>Related proposed activities in the Master Plan in pre-project stage are implemented as scheduled</p>

2.4 C.3(1) Technical Guidelines Preparation Project

(1) Project Proposal

(1) Title of Project	Technical Guidelines Preparation Project
(2) Location	Irrigation areas in Zones-1, 2 and 3
(3) Objective of Project	The project aims at preparation of irrigation related technical guidelines such as (i) Irrigation Planning, (ii) Irrigation Design, (iii) Construction Supervision of Irrigation Facilities, and (iv) Irrigation System Operation and Maintenance.
(4) Site Description	<p>In the Target Area, it is observed that some irrigation facilities are not planned or designed properly. This hinders proper function of irrigation facilities and proper water distribution.</p> <p>In addition, dispersive clay soil, which is commonly distributed in the Target Area, has caused problems in irrigation facilities. Canal embankments constructed of such soil were heavily eroded and damaged by water flow. However, it is unavoidable to use the dispersive clay soil as embankment material since it is very costly to bring in other types of soil from very far away. Scientific reasoning and the mechanism of the erosion is not clarified due to lack of basic data.</p>  <p style="text-align: center;"><i>A type of damaged canal embankment constructed by dispersive clay soil</i></p>
(5) Project Description	<p>The project activity includes preparation of technical guidelines on irrigation planning, design, construction, operation and maintenance by foreign senior irrigation specialists. Standard drawings of irrigation facilities and a check list of works will support the guidelines. The guidelines should be able to be applied to all irrigation projects in the country. This means that the guidelines show only general procedures of planning and design. It should be stressed that planning concepts or design criteria need to be prepared for each irrigation project referring to the guidelines' procedures.</p> <p>As described above, special consideration on dispersive clay soil is required in preparation of the guidelines. Data collection and analysis of the soil in laboratory and on site is required. Required soil test in the laboratory will be as follows.</p> <ol style="list-style-type: none"> 1) density test 2) water content test 3) grain size analysis 4) liquid limit / plastic limit test 5) compaction test by tamping 6) permeability test 7) dispersive characteristics test by double hydrometer 8) dispersive characteristics test by crumb test 9) soil chemical test 10) pinhole test <p>After collection of such basic data, proper measures for using dispersive clay soil as embankment material will be developed by senior foreign soil mechanical engineers. The effectiveness of such methods needs to be confirmed by experimental construction on site. The procedures developed for treatment of dispersive clay soil will be described in the guidelines. In addition, appropriate irrigation method will be mentioned in the guidelines considering the results of Pilot Projects.</p>

	The guidelines should be prepared in both the English and Khmer languages. The guidelines also need to be prepared by a participatory approach. The effectiveness of the draft guidelines need to be checked by PDOWRAM irrigation engineers in actual irrigation development as much as possible. Based on findings in such trial usage of the guidelines, they should be revised.
(6) Project Justification	<p>(a) Relevance</p> <p>The project has high relevancy, since target of the pilot project, which “efficient use of irrigation water by proper provision of irrigation facilities”, fully fits goal of the Master Plan (improvement of rice productivity).</p> <p>(b) Effectiveness</p> <p>Implementation of the project makes government staffs enable to plan and design irrigation system properly. It highly contributes proper irrigation water distribution in future.</p> <p>(c) Efficiency</p> <p>Preparation of guidelines by super-experienced irrigation expert will make the project efficient.</p> <p>(d) Impact</p> <p>The project brings a broad positive impact to government irrigation engineers. Not only PDOWRAM staff in the Target Area but also staff in other province can use the guidelines. No negative impact by the project is anticipated.</p> <p>(e) Sustainability</p> <p>Sustainability of the project is very high, since prepared technical guidelines can be used for long time.</p>
(7) Project Components	<ul style="list-style-type: none"> - Development of proper measures for use of dispersive clay soil for embankment - Preparation of irrigation planning / design / construction supervision / operation and maintenance guidelines - Distribution of prepared guidelines - Dissemination activity on proper guidelines usage by MOWRAM
(8) Required Cost	US\$ 1,725,000 including price contingency
(9) Executing Agency	MOWRAM and PDOWRAM
(10) Implementation	2.5 years

(2) Implementation Schedule

Activities	Expected Results	2009												2010												2011			In-charge	Equipment	Remarks
		4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3						
I. Preparation of Practical Guidelines with Trial Usage and Participation of Guideline Users																															
(1) Development of Proper Measure for Using Dispersive Clay Soil for Embankment Material	Technical knowledge	■															Consultant MOWRAM	Equipment	-												
(2) Preparation of Irrigation Planning Guideline	Guideline	■												■			Consultant MOWRAM PDOWRAM	None	-												
(3) Preparation of Irrigation Design Guideline	Guideline													■						■			Consultant MOWRAM PDOWRAM	None	-						
(4) Preparation of Irrigation Construction Supervision Guidelines	Guideline																			■			Consultant MOWRAM PDOWRAM	None	-						
(5) Preparation of Irrigation Operation and Maintenance Guideline	Guideline																			■			Consultant MOWRAM PDOWRAM	None	-						
II. Dissemination of Guidelines by MOWRAM to PDOWRAMs																															
(1) Distribution of Prepared Guidelines	PDOWRAMs' understandings													■			MOWRAM	None	-												
(2) Dissemination Activities on Proper Guidelines Usage by MOWRAM to PDOWRAMs	PDOWRAMs' understandings													■			MOWRAM	None	-												


(3) Project Design Matrix

(Target Group: PDOWRAM irrigation engineers in Kampong Speu and Kandal provinces)

Narrative Summary	Objectively Verifiable Indicator	Means of Verification	Important Assumption
Overall Goal Agricultural productivity centering rice is improved in the Target Area	1-1 Agricultural productivity in the Target Area is improved as proposed in the Master Plan by year 2015	1-1 Agricultural statistics	
Project Purpose Technical knowledge of PDOWRAM irrigation engineers on irrigation engineering is improved	1-1 Technical activities on irrigation development by PDOWRAM irrigation engineers are improved by year 2009	1-1 Outcome of actual irrigation development planning, designing, construction, and operation and maintenance by PDOWRAM	All the proposed activities in the Master Plan in post-project stage are implemented as scheduled No significant climatic change No severe damage on the irrigation facilities by natural disaster
Outputs 1 Practical irrigation planning guideline (in English and Khmer) with instruction in using dispersive clay soil is available at government offices 2 Practical irrigation design guideline (in English and Khmer)with instruction in using dispersive clay soil is available at government offices 3 Practical irrigation construction supervision guideline (in English and Khmer)with instruction in using dispersive clay soil is available at government offices 4 Practical irrigation operation and maintenance guideline (in English and Khmer) is available at government offices	1-1 Irrigation planning guideline with instruction in using dispersive clay soil is accepted by PDOWRAM irrigation engineers by year 2009 2-1 Irrigation design guideline with instruction in using dispersive clay soil is accepted by PDOWRAM irrigation engineers by year 2009 3-1 Irrigation construction supervision guideline with proper instruction in using dispersive clay soil is accepted by PDOWRAM irrigation engineers by year 2009 4-1 Irrigation operation and maintenance guideline is accepted by PDOWRAM irrigation engineers by year 2009	1-1 Questionnaire to PDOWRAM irrigation engineers 2-1 Questionnaire to PDOWRAM irrigation engineers 3-1 Questionnaire to PDOWRAM irrigation engineers 4-1 Questionnaire to PDOWRAM irrigation engineers	Involvement of PDOWRAM irrigation engineers
Activities 1-1 To develop proper measure for using dispersive clay soil for embankment material in planning stage 1-2 To prepare irrigation planning guideline 1-3 To distribute planning guideline with guidance of MOWRAM 2-1 To prepare irrigation design guideline 2-2 To distribute design guideline with guidance of MOWRAM 3-1 To prepare irrigation construction supervision guideline 3-2 To distribute construction supervision guideline with guidance of MOWRAM 4-1 To prepare irrigation operation and maintenance guideline 4-2 To distribute operation and maintenance guideline with guidance of MOWRAM	Input Donor Senior irrigation experts Senior soil mechanical experts Printing cost of guidelines Experimental equipment for dispersive clay soil test Cost for experimental embankment construction with dispersive clay soil	Cambodia <u>Central government</u> MOWRAM irrigation engineers <u>Provincial government</u> PDOWRAM irrigation engineers	Continuous involvement of related government agencies during the project period Precondition High need for irrigated agriculture in the Target Area Good understanding of related organizations on the Master Plan and importance of proper irrigation engineering knowledge Related proposed activities in the Master Plan in pre-project stage are implemented as scheduled

2.5 C.4(1) Environmental Management Basic Capacity Development Project

(1) Project Proposal

(1) Title of Project	Environmental Management Basic Capacity Development Project
(2) Location	In and around Target Area
(3) Objective of Project	To strength basic capabilities of the relevant staff of MOWRAM and MAFF regarding EIA and environmental management
(4) Project Description	<p>This is the supportive project of implementation of the other projects under the Master Plan. One of the projects requires environmental impact assessment (EIA) study under the RGC sub-decree, while some others require proper environmental management. This signifies that environmental management capacity is required in order to identify proper environmental management measure for avoidance and/or mitigation of negative impact caused by agricultural practice and sustain the effectiveness of the project with environmentally-friendly approach. On the other hand, both MOWRAM and MAFF have few experiences and knowledge about environmental management for agricultural practice, especially for EIA study.</p> <p>In order to strength their capabilities, two components of activities are proposed in this project, namely, 1) Case study of EIA and preparation of draft TOR, 2) Training for environmental conservation and management planning.</p> <p>Implementation of the project requires technical support from Ministry of Environment and environmental consultants.</p> <div style="display: flex; justify-content: space-around;">  </div> <p style="text-align: center;"><i>Images of Workshop/Discussion</i></p>
(5) Project Justification	<p>(a) Relevance</p> <p>The capability for environmental management will support the proposed Master Plan to be conducted with minimum negative impact. In addition, in the case the project requires EIA study, MOWRAM and/or MAFF as the executing agencies have responsibility to conduct EIA study. On the other hand, both MOWRAM and MAFF have realized that adequate capacity for conducting EIA is insufficient in the ministry at the moment. As for MOWRAM, they are planning to set up environmental and social impact assessment section under the Strategic Development Plan (2006-2010). Accordingly, it can be said that the project will meet the needs of target ministries and have highly validity of approaches.</p> <p>(b) Effectiveness</p> <p>Both case study of EIA and preparation work for draft TOR will provide knowledge for a package of EIA. This knowledge will be utilized for supervision and monitoring of EIA study with the check list that will be prepared under the project. In addition, preparation work of the environmental mitigation sample paper will provide proper environmental management of agricultural practices to be implemented toward both EIA section and technical section.</p> <p>(c) Efficiency</p> <p>Environmental management capacity is required in order to identify proper environmental management measure. Moreover, the executing agency of the project that requires EIA study has to be acquainted with, if not more, preparation of draft terms of reference of EIA study, supervision and monitoring of EIA process. This stipulates that the project activities will be efficient for the target</p>

	<p>group before the projects which require environmental management are implemented. In addition, discussion with the technical section under the preparation of the environmental mitigation sample paper will provide good opportunity to utilize their knowledge and idea efficiently as much as possible. Therefore, it can be said that the project components will be satisfied from the view point of efficiency.</p> <p>(d) Impact</p> <p>The capability of EIA and proper environmental management for agricultural practices to the relevant staff of MOWRAM and MAFF can be utilized for implementation of projects by environmentally-friendly process in the future. This means that the project will provide positive impact indirectly toward the environment including human being. In addition, through the preparation of the environmental mitigation sample paper, the target organization can share the significant information and knowledge among EIA section and technical section so that good coordination among them will be established.</p> <p>(e) Sustainability</p> <p>The project will provide several documents which will be utilized among the relevant staff as manual at a practical matter. It is also noted that a series of discussion among EIA section and the relevant technical section staff will establish good coordination between them so that they can cooperate for EIA and other environmental management activities in the future.</p>
(6) Project Component	<p>1. Case Study of EIA/ Preparation of draft TOR</p> <ul style="list-style-type: none"> - To conduct case study of EIA as a training (including site visit) - To prepare the check list of EIA for agricultural practices. - To be trained for preparation of draft terms of reference (TOR) of EIA study toward the project that requires EIA study. <p>2. Training for Environmental Conservation and Management Planning</p> <ul style="list-style-type: none"> - To clarify causes and mechanisms of the environmental issues related to agricultural practice through discussion among the relevant staff including technical section. - To identify proper management technology/measure for avoidance and/or mitigation of negative impact caused by agricultural practice through discussion among the relevant staff - To summarize those results as “Environmental mitigation sample paper for agricultural practice (tentative)”.
(7) Required Cost	US\$ 70,000
(8) Executing Agency	MAFF (Office of EIA, Department of Planning and Statistics), MOWRAM (Staff in charge of EIA)
(9) Implementation	2-3 months

(2) Implementation Schedule

Activities	Expected Results	2007				2008				In-charge	Equipment	Remarks
		I	II	III	IV	I	II	III	IV			
1 Case Study of EIA/ Preparation of draft TOR												
1-1 Implementation of case study of EIA	Improved Works	■								MAFF, MOWRAM, Consultants	As required	
1-2 Preparation of the check list of EIA study for agricultural practices	Checklist							■		MAFF, MOWRAM, Consultants	As required	
1-3 Implementation of training for preparation of draft TOR	Draft TOR							■		MAFF, MOWRAM, Consultants	As required	
2 Training for Environmental Conservation and Management Planning												
2-1 Discussion among relevant staff including technical section	Improved Works							■		MAFF, MOWRAM, Consultants	As required	
2-2 Preparation of “Environmental mitigation sample paper for agricultural practices	EM sample paper							■		MAFF, MOWRAM, Consultants	As required	


(3) Project Design Matrix

(Target Group: MOWRAM, MAFF, PDOWRAM, and PDA)

Narrative Summary	Objectively Verifiable Indicator	Means of Verification	Important Assumption
<p>Overall Goal Agricultural productivity centering rice is improved in the Target Area</p>	<p>1-1 Agricultural productivity in the Target Area is improved as proposed in the Master Plan by year 2015</p>	<p>1-1 Agricultural statistics</p>	/
<p>Project Purpose Basic capabilities of the relevant staff of MOWRAM and MAFF regarding EIA and environmental management for agricultural practices are strengthened.</p>	<p>A package of EIA and basic measures of mitigation can be understood and terms of reference of EIA study can be prepared with support of environmental expert.</p>	<p>Questionnaire</p>	<p>All the proposed activities in the Master Plan are implemented as scheduled</p> <p>No significant climatic change</p> <p>No severe damage on the irrigation facilities by natural disaster</p>
<p>Outputs 1 Case study is completed with preparation of check list and draft TOR. 2 “Environmental mitigation sample paper for agricultural practices” is prepared with support of external environmental expert.</p>	<p>1 Check list for EIA of agricultural practices and draft TOR of EIA study are announced. 2 Environmental mitigation sample paper for agricultural practices is announced.</p>	<p>1 Check list for EIA of agricultural practices, draft TOR of EIA study 2 Environmental mitigation sample paper</p>	<p>Trained staff in charge of EIA are not replaced before their technology obtained transfer to other responsible staff.</p>
<p>Activities 1-5 To conduct case study of EIA as a training 1-6 To conduct site visit to construction field of irrigation infrastructural development 1-7 To prepare the check list of EIA for agricultural practices 1-8 To be trained for preparation of draft terms of reference (TOR) of EIA study toward the project that requires EIA study. 2-1 To clarify causes and mechanisms of the environmental issues related to agricultural practice through discussion among the relevant staff including technical section. 2-2 To identify proper management technology/measure for avoidance and/or mitigation of negative impact caused by agricultural practice through discussion among the relevant staff 2-3 To summarize those results as “Environmental mitigation sample paper for agricultural practices (tentative)”.</p>	<p style="text-align: center;">Input</p> <p style="text-align: center;">Donor</p> <p style="text-align: center;">Cambodia</p> <p><i>Personnel;</i> Environmental expert (2 M/M) Local consultant (2 M/M)</p> <p><i>Equipment;</i> Vehicle for site visit Training materials Preparation of sample paper and check list</p> <p><i>Budget;</i> Cost for field allowance for counterparts</p>	<p style="text-align: center;"><u>MOWRAM</u> Counterparts who are in charge of EIA (Two at least) Relevant staff of technical department</p> <p style="text-align: center;"><u>MAFF</u> Counterparts who are in charge of EIA (At least two) Relevant staff of technical department</p> <p style="text-align: center;"><u>PDOWRAM and PDA of Kampong Speu and Kandal</u> Relevant staff (At least one of each)</p> <p style="text-align: center;"><u>MOE</u> Staff of EIA Section</p>	<p>Relevant staff is made available for attending the workshops, meetings and a site visit.</p> <p>Precondition Relevant staffs of MOWRAM and MAFF are assigned as the target people of capacity development.</p>

2.6 C.4(2) Environmental Management Applied Capacity Development Project

(1) Project Proposal

(1) Title of Project	Environmental Management Applied Capacity Development Project
(2) Location	In and around the Target Area
(3) Objective of Project	To follow-up environmental management activities and to redeem capabilities of the relevant staff of MOWRAM and MAFF.
(4) Project Description	<p>After the Environmental Management Basic Capacity Development Project, practical implementation of environmental management including EIA study will require to be conducted for implementation of the projects under the Master Plan on a project-by-project basis. Following the practical implementation under the Master Plan, “Environmental Management Applied Capacity Development Project” will be conducted at the latter phase of the Master Plan. This aims to follow-up environmental management activities and capabilities of the relevant staff of MOWRAM and MAFF. For that, this project consists of two components; i.e. i) Monitoring of Environmental Management Activities, and ii) Implementation of Follow-up Program.</p> <p>As a first step, external monitoring of the environmental management activities will be conducted with the relevant staff of MOWRAM and MAFF. Based on the results of monitoring including discussion and evaluation among stakeholders, components of the follow-up program including training course will be built up. After that, the follow-up program will be implemented with the relevant staff of MOWRAM and MAFF. As for the follow-up training, the course will focus on to the issues to be reinforced toward the relevant staff efficiently. Under the training, the practical paper for “Case Studies of Environmental Management Measures” and the check list for EIA Study which have been published at Environmental Management Basic Capacity Development Project will be modified based on the practical activities.</p> <p>These follow-up will help the capacity more strengthen and sustain the projects under the Master Plan with environmentally-friendly approach. Implementation of the project requires technical support from Ministry of Environment and environmental consultants.</p> <div style="text-align: center;">  <p><i>Images of Monitoring/ Training</i></p> </div>
(5) Project Justification	<p>(a) Relevance</p> <p>Periodical monitoring and follow-up empowerment of environmental management activities will be important to implement agricultural development in the Target Area smoothly. The project could also contribute to MOWRAM own effort in setting up environmental and social impact assessment section by 2008, according to the Strategic Development Plan (2006-2010). Therefore, the project has highly validity of approaches.</p> <p>(b) Effectiveness</p> <p>The project will start from monitoring activities so that proper and effective follow-up program could be proposed. In addition, the follow-up program components consist of both practical activities and training. Two approaches will provide more effective output toward MOWRAM and MAFF.</p>

	<p>(c) Efficiency</p> <p>The timing of implementation of follow-up program will be valid after several projects are implemented under the Master Plan. Through monitoring activities by both external experts and the relevant staff of MOWRAM and MAFF, proper and efficient follow-up program including training course will be built up. This stipulates that appropriate follow-up activities and capacity development training will be implemented for the target group. In addition, modified documents under this project can be utilized among each organization in the future.</p> <p>(d) Impact</p> <p>Because the main component of this project is implementation of follow-up program of environmental management activities, the environmental management for agricultural practices will progress in quality through this project. Moreover, the follow-up training will redeem capability of EIA and environmental management toward the relevant staff of MOWRAM and MAFF. This will provide positive impact indirectly toward the environment when agricultural practice will be implemented.</p> <p>(e) Sustainability</p> <p>Because environmental consideration is one of necessity issues to sustain the project successfully, this project will improve sustainability toward the agricultural practices under the Master Plan. In addition, the project will provide practical documents, i.e., environmental management paper for agricultural practices and the check list for EIA of agricultural practice. These documents can be utilized among the relevant staff as practical manual in the future.</p>
(6) Project Component	<p>1. Monitoring of Environmental Management Activities</p> <ul style="list-style-type: none"> - To monitor and review environmental activities with external experts - To make clear the condition of environmental management - To formulate the follow-up program including the follow-up training course in order to redeem both environmental management activities and skills. <p>2. Implementation of Follow-up Program</p> <ul style="list-style-type: none"> - To conduct the follow-up training toward the relevant staff - To conduct the follow-up activities - To modify the check list for EIA and the practical paper for “Case Studies of Environmental Management Measures” to be more practical.
(7) Required Cost	US\$ 520,000 including price contingency
(8) Executing Agency	MAFF (Office of EIA, Department of Planning and Statistics), MOWRAM (Staff in charge of EIA)
(9) Implementation	4 years

(2) Implementation Schedule

Activities	Expected Results	2012				2013				2014				2015				In-charge	Equipment	Remarks
		I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV			
1 Monitoring of Environmental Activities																				
1-1 Monitoring of environmental activities	Monitoring report		■	■														MAFF, MOWRAM, Consultants	As required	
1-2 Analysis of current management condition					■													MAFF, MOWRAM, Consultants	As required	
1-3 Preparation of follow up program	Follow up program				■													MAFF, MOWRAM, Consultants	As required	
2 Implementation of Follow Up Program																				
2-1 Implementation of follow up training	Improved works						■	■	■									MAFF, MOWRAM, Consultants	As required	
2-2 Implementation of follow up activities	Improved works									■	■	■	■					MAFF, MOWRAM, Consultants	As required	
2-3 Modification of E.M sample paper /check list	EM sample paper/															■		MAFF, MOWRAM	As required	

(3) Project Design Matrix

(Target Group: MOWRAM, MAFF, PDOWRAM, and PDA)

Narrative Summary	Objectively Verifiable Indicator	Means of Verification	Important Assumption
<p>Overall Goal Agricultural productivity centering rice is improved in the Target Area</p>	<p>1-1 Agricultural productivity in the Target Area is improved as proposed in the Master Plan by year 2015</p>	<p>1-1 Agricultural statistics</p>	/
<p>Project Purpose Applied capabilities of the relevant staff of MOWRAM and MAFF regarding EIA and environmental management for agricultural practices are strengthened.</p>	<p>International expert recognize their capabilities enough to conduct EIA study and proper environmental management toward each agricultural practice by themselves.</p>	<p>Questionnaire</p>	<p>All the proposed activities in the Master Plan in post-project stage are implemented as scheduled</p> <p>No significant climatic change</p>
<p>Outputs 1 Proper follow-up program including training course toward relevant staff of MOWRAM and MAFF are prepared. 2 Follow-up program including training is conducted properly.</p>	<p>1 Follow-up program components are announced. 2 Environmental mitigation sample paper for agricultural practices and check list for EIA are modified by themselves with comment from external expert.</p>	<p>1 Follow-up program 2 Environmental mitigation sample paper for agricultural practices and check list for EIA</p>	<p>Trained staff in charge of EIA are not replaced.</p>
<p>Activities 1-1 To monitor and review environmental activities with support of external experts 1-2 To make clear the condition of environmental management 1-3 To formulate follow-up program including follow-up training course in order to redeem both environmental management activities and skills. 2-1 To conduct follow-up training toward the relevant staff 2-2 To conduct follow-up activities 2-3 To modify the environmental management paper for agricultural practices and the check list for EIA of agricultural practices in order to develop more practical one.</p>	<p style="text-align: center;">Input</p> <p style="text-align: center;">Donor</p> <p style="text-align: center;">Cambodia</p> <p><i>Personnel;</i> Environmental expert (6 M/M) Local consultant (total 10 M/M)</p> <p><i>Equipment;</i> Vehicle for site visit Training materials Environmental mitigation sample paper /check list</p> <p><i>Budget;</i> Cost for field allowance for counterparts</p>	<p style="text-align: center;"><u>MOWRAM</u> Counterparts who are in charge of EIA (Two at least) Relevant staff of technical department</p> <p style="text-align: center;"><u>MAFF</u> Counterparts who are in charge of EIA (At least two) Relevant staff of technical department</p> <p style="text-align: center;"><u>PDOWRAM and PDA of Kampong Speu and Kandal</u> Relevant staff (At least one of each)</p> <p style="text-align: center;"><u>MOE</u> Staff of EIA Section</p>	<p>Relevant staff is made available for attending the workshops, meetings and a series of field survey.</p> <hr/> <p>Precondition Relevant staffs of MOWRAM and MAFF are assigned as the target people of capacity development.</p> <p>Related proposed activities in the Master Plan in pre-project stage are implemented as scheduled</p>

2.7 C.5(1) Irrigated Agriculture On-farm Technology Improvement Pilot Project

(1) Project Proposal

(1) Title of Project	Irrigated Agriculture On-farm Technology Improvement Pilot Project
(2) Location	<p>Upstream of the irrigation system where the efficient water use is most probable.</p> <p>Zone-1: A tertiary block in Kandal Dom commune which is within the upstream command area of SMC.</p> <p>Zone-3: Standard water harvesting irrigation systems will be selected.</p>
(3) Objective of Project	The project aims at establishment of on-farm level efficient water use models in irrigated agriculture areas.
(4) Site Description	<p>Hydrological analysis in the Master Plan study concluded that water resources were so limited for agricultural development of the Target Area. Thus, the necessity of efficient irrigation water use is emphasized in the Master Plan. However, in the Target Area, proper irrigation water management is not practiced. The reasons for this improper water management are i) hardware constraints (such as insufficient provision of irrigation facilities) and ii) software constraints (such as lack of water distribution schedules). In some advanced areas, secondary canals, tertiary canals and structures on the secondary canals are currently in existence but water is not used efficiently due to insufficient on-farm facilities and software constraints. The photo on the right shows an advanced area in Kandal Dom commune located upstream of the SMC.</p> <div> </div> <p style="text-align: right;"><i>Turnout Structure on Secondary Canal (RS-3) to Tertiary Canal (RT-2)</i></p>
(5) Project Description	<p>The government's responsibility is to operate the major irrigation system, and the FWUCs' responsibility is to operate the minor systems, say on-farm system. However, no on-farm irrigation block in the Target Area is using irrigation water efficiently, so that it is essential to establish a model of efficient water use. As the first step of improvement, on-farm level improvement is required. Efficient water use could be achieved by collaboration with i) FWUCs/FWUGs/WUGs and ii) the government. The project plans to increase the water management capabilities of all the stakeholders at the same time. It is expected that such simultaneous capacity development will make the involved stakeholders realize their responsibilities. If the project activities start without proper irrigation facilities, farmers in the area will be discouraged regarding the project activities. The pilot project areas need to be selected considering this matter. If there could not find proper pilot project area from this viewpoint, minimum facilities should be constructed for smooth execution of proper water management activities.</p> <p>In Zone-3, project approach is quite different from Zone-1 since the available water is so limited. Water management and farming practice should also be conducted in different manner with Zone-1. The Pilot Project activities should be therefore planned and executed in due consideration of the above. The Pilot Project site will be selected considering that the small reservoir functions well for irrigation water supply subject to no provision of additional facilities.</p> <p>The project activity also includes introduction of improved farming practice in irrigated agricultural land. Introduction of improved farming practice could increase rice yield and encourage farmers to join project activities since only water management could not give an incentive to farmers. The effect of the pilot project will be disseminated to the outer areas of the pilot project by implementing the "Irrigated Agriculture Improvement Model Project" after the pilot project.</p>
(6) Project Justification	(a) Relevance

	<p>The project has high relevancy, since target of the pilot project, which “efficient use of irrigation water”, fully fits the goal of Master Plan (improvement of rice productivity).</p> <p>(b) Effectiveness</p> <p>Implementation of the project can highly contribute to delivery of irrigation water to the downstream beneficiaries.</p> <p>(c) Efficiency</p> <p>No major input by farmers such as equipment or material is required for the project. As for manpower, the project is designed to apply local resources as much as possible. The project was evaluated as efficient from above view points.</p> <p>(d) Impact</p> <p>The project brings a positive impact to farmers in the project area by increasing yield of rice. There is another positive impact to downstream farmers by supplying excess water from the upstream. No significant negative impact is anticipated.</p> <p>(e) Sustainability</p> <p>Sustainability of the project is very high, since no major input for the project is planned to be made by farmers.</p>
(6) Project Components	<p>The following practices will be conducted for Zone-1</p> <ul style="list-style-type: none"> - Preliminary landholding map preparation - Water use map preparation - Water loss identification and minimization - FWUC sub-group establishment - FWUC administration improvement. - Proper irrigation water use education - Irrigation service plan preparation - On-farm irrigation facility construction - Watercourse construction/rehabilitation - Water management training - FWUC meeting building construction <p>The following practices will be conducted for Zone-3</p> <ul style="list-style-type: none"> - Preliminary landholding map preparation - Water use map preparation - FWUC establishment - Reservoir capacity clarification - Irrigation service plan preparation - Water management training <p>The following practices will be conducted for Zone-1 and Zone-3</p> <ul style="list-style-type: none"> - Farmer-to farmer ecological SRI extension - Farmers’ group strengthening - Experimental trial of improved farming practice - Execution of small scale adaptability tests for planting method, field level water management, fertilizer trial, variety trial, and upland crop cultivation trail
(7) Cost	US\$ 800,000 (including cost for additional on-farm facilities)
(8) Executing Agency	MOWRAM, MAFF, PDOWRAM, and PDA
(9) Implementation	2 years

(2) Implementation Schedule

Activities	Expected Results	2006												2007												2008			In-charge	Equipment	Remarks
		4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3						
I. Government Level Water Management																															
(1)	Preparation of water management manual	Manual			■																							Consultant MOWRAM PDOWRAM	None	-	
(2)	Holding seminar on water management procedure	Government's Understanding			■																							Consultant MOWRAM PDOWRAM	None	-	
II. FWUC and FWUG Level Water Management																															
(1)	Baseline Survey	Survey Result			■																							Consultant	Vehicle	-	
(2)	Explanation of Water Management Plan to FWUC and FWUG	Farmers' Understanding			■																							Consultant	Vehicle	-	
(3)	Preparation of Water Distribution Map	Map				■	■	■																				Consultant PDOWRAM	Handheld GPS Vehicle	-	
(4)	Measurement of Water Flow in the Canals	Record					■	■	■	■	■																	Consultant PDOWRAM	Current Meter Vehicle	-	
(5)	Trial Water Distribution with FWUC and FWUG	Record					■	■	■	■	■																	Consultant PDOWRAM	Current Meter Vehicle	-	
(6)	Preparation of Water Management Manual for FWUC and FWUG	Manual								■	■																	Consultant PDOWRAM	None	-	
(7)	Provision of Additional On-farm Irrigation Facilities	Facilities																										Consultant PDOWRAM	As Required	-	
(8)	Study Tour	Farmers' Understanding								■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Consultant	Vehicle	-	
III. Farmer Level Water Management																															
(1)	Implementation of Water Saving Farming Practice in Experimental Plot	Improved Farming Skill								■	■	■	■	■														Consultant PDA	Vehicle	-	
(2)	Study Tour	Farmers' Understanding								■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Consultant PDA	Vehicle	-	
IV. Evaluation of Pilot Project Result																															
(1)	Evaluation	Report																										Consultant	None	-	

Note: ■ Continuous work ■■■■■ Intermittent work


(3) Project Design Matrix

(Target Group: Farmers related to canals in the project area)

Narrative Summary	Objectively Verifiable Indicator	Means of Verification	Important Assumption
Overall Goal Agricultural productivity centering rice is improved in the target area	1-1 Agricultural productivity in the target area is improved as proposed in the Master Plan by year 2015	1-1 Agricultural statistics	/
Project Purpose Model of improved on-farm irrigated agriculture is established	1-1 Result of the pilot project is evaluated as applicable model for Zone-1, 2, and 3 in the target area by stakeholders by year 2007	1-1 Questionnaire to the stakeholders	All the proposed activities in the Master Plan in post-project stage are implemented as scheduled No significant climatic change No severe damage on the irrigation facilities by natural disaster
Outputs 1 Water management manual for entire project is prepared by government agencies 2 Irrigation water is distributed based on the actual water demand by model FWUC, FWUG and WUGs 3 Water saving rice farming technology suitable for the Prek Thnot river basin in the experimental farm is developed	1-1 Water management manual for entire project is prepared by year 2007 2-1 Irrigation water is distributed based on the actual water demand by model FWUC, FWUG and WUGs by year 2007 3-1 Water consumption of the experimental farm is less than that of in year 2006 by year 2007 3-2 Yield of rice from the experimental farm is higher than that of surrounding farms by year 2007	1-1 Monitoring survey 2-1 Record of water distribution 3-1 Record of water consumption of the experimental farm 3-2 Yield of rice from the experimental farm	Responsibility of each stakeholder in water management is not changed within the project period
Activities 1-1 To prepare water management manual 1-2 To hold seminar on water management procedure 2-1 To carry out baseline survey 2-2 To explain water management plan to FWUC, FWUG and WUGs 2-3 To prepare water distribution map 2-4 To organize study tours on irrigated agriculture technology 2-5 To measure water flow in the canals 2-6 To conduct trial water distribution with FWUC, FWUG and WUGs 2-7 To prepare water management manual for FWUC, FWUG and WUGs 2-8 To provide additional on-farm irrigation facilities, if necessary 3-1 To introduce water saving farming practice in experimental plot 3-2 To organize study tours on irrigated agriculture technology	Input Donor Cambodia Experts Transportation Equipment for monitoring irrigation water distribution Cost of study tour Construction cost of model irrigation facilities <u>FWUC, FWUG and WUGs</u> FWUC, FWUG and WUG members <u>Provincial government</u> Counterparts from PDOWRAM and PDA <u>Central government</u> Counterparts from MOWRAM and MAFF <u>NGO</u> Facilitators		Continuous involvement of related government agencies, model FWUC, FWUG and WUGs during the project period No severe damage of irrigation facilities by natural disaster within the project period Precondition High need for irrigated agriculture in the target area Good understanding of related organizations on the Master Plan and importance of proper water management Basic irrigation facilities are provided in the project area

2.8 C.6(1) Irrigation Facility Maintenance Capacity Strengthening Pilot Project

(1) Project Proposal

(1) Title of Project	Irrigation Facility Maintenance Capacity Strengthening Pilot Project
(2) Location	Model project areas in Zones-1, 2 and 3. For Zones-1 and 2, the model project areas will be tertiary blocks. For Zone-3, the model area will be an area which has a small pond.
(3) Objective of Project	The objective of the project is to establish a good model for irrigation facility maintenance in an irrigated agricultural area.
(4) Site Description	<p>FWUCs are not formed for entire irrigated agricultural area in the Target Area. Even the existing FWUCs are not active and incomplete. Some FWUCs only are collecting ISF for O&M of irrigation facilities but collection rate is still low. Reasons for this inactivity are i) insufficient water, mainly in the dry season when farmers really need the water, and ii) less irrigation facility, especially for on-farm facility.</p>  <p style="text-align: center;"><i>A Sample of irrigation area with no provision of on-farm facility</i></p>
(5) Project Description	<p>The project activities need to be executed in irrigated agricultural areas which have proper irrigation facilities to control and measure irrigation water. In Zone-3, the small reservoir supplying water to the irrigation area needs to function well. For this, it is indispensable to observe rainfall in advance, to clarify the storage condition of reservoir. If there are no proper irrigation facilities in the Target Area, such facilities should be constructed during the activities. It is also necessary that water is properly distributed to the fields by proper irrigation facilities. If activities start without proper irrigation facilities, farmers in the Target Area will be discouraged regarding the project activities.</p> <p>The project activity is mainly strengthening of FWUC/FWUGs/WUGs, since maintenance of on-farm irrigation facilities should be done by FWUC, FWUGs and WUGs. To maintain such facilities, ISF should be collected from water users and properly saved. Next, long-term rehabilitation plans for the facilities need to be prepared. Saved funds need to be made available for repairing and maintaining on-farm facilities. The long-term rehabilitation plan for the facilities needs to be revised based on the results of such rehabilitation works to reflect the lessons learned. Proper attention of the FWUC leaders should be given to collection and usage of ISF. The projects also include procedures for acquiring budgets/funds for annual maintenance and periodic replacements (for gates, etc.) by a responsible government agency.</p>
(6) Project Justification	<p>(a) Relevance</p> <p>The project has high relevancy, since target of the pilot project, which “sustainable use of irrigation facilities”, fully fits the goal of Master Plan (improvement of rice productivity).</p> <p>(b) Effectiveness</p> <p>Implementation of the project can highly contribute to avoiding devastation of the irrigation facilities.</p> <p>(c) Efficiency</p> <p>No major equipment or material is required to implement the project. As for manpower, the project is designed to apply local resources as much as possible.</p>

	<p>The project was evaluated as efficient from above view points.</p> <p>(d) Impact</p> <p>The project brings a positive impact to farmers in the project area by increasing sustainability of the irrigation system. Some side-effects of strengthening of group activity could also be expected. No significant negative impact by the project is anticipated.</p> <p>(e) Sustainability</p> <p>Sustainability of the project is high, since most of the activities will be done by farmers themselves. However execution of periodic monitoring by facilitators is desirable to raise sustainability higher.</p>
(7) Project Components	<ul style="list-style-type: none"> - Problem analysis of selected FWUCs and FWUGs - Awareness raising campaign on the importance of facility maintenance - Preparation of a long-term rehabilitation plan by selected FWUCs - Establishment of local rules of selected FWUCs/FWUGs on collection of ISF - Preparation of a long-term rehabilitation plan for major facilities by a responsible government agency - Setting procedure for acquisition of maintenance budgets/funds for large-scale irrigation facilities by a responsible government agency
(8) Cost	US\$ 909,000
(9) Executing Agency	MOWRAM and PDOWRAM
(10) Implementation	2.5 years

(2) Implementation Schedule

Activities	Expected Results	2009				2010				2011			In-charge	Equipment	Remarks								
		4	5	6	7	8	9	10	11	12	1	2				3	4	5	6	7	8	9	10
I. FWUC and FWUG Level Water Management																							
(1) Baseline Survey and Problem Analysis	Survey Result	■															Consultant	Vehicle	-				
(2) Awareness Raising Campaign	Farmers' Understanding	■	■														Consultant PDOWRAM	Vehicle	-				
(3) Study Tour	Farmers' Understanding			■	■	■	■	■	■	■	■	■	■	■	■	■	Consultant	Vehicle	-				
(4) Preparation of Long-term Rehabilitation Plan for On-farm Facilities	Plan				■	■	■	■	■	■	■	■	■	■	■	■	Consultant PDOWRAM	None	-				
(5) Collection of Water Fees by Established Local Rule by Model FWUC	Collected Fund						■	■	■	■	■	■	■	■	■	■	Consultant PDOWRAM	None	-				
II. Government Level Water Management																							
(1) Preparation of Long-term Rehabilitation Plan for Major Facilities	Manual		■	■	■	■	■	■	■	■	■	■	■	■	■	■	Consultant MOWRAM PDOWRAM	None	-				
(2) Set Up Procedure for Acquisition of Maintenance Cost for Major Facilities	Government's understanding			■	■	■	■	■	■	■	■	■	■	■	■	■	Consultant MOWRAM PDOWRAM	None	-				
III. Evaluation of Pilot Project Result																							
(1) Evaluation	Report																Consultant	None	-				

Note: ■ Continuous work ■■■■■ Intermittent work



(3) Project Design Matrix

(Target Group: Farmers in model tertiary block)

Narrative Summary	Objectively Verifiable Indicator	Means of Verification	Important Assumption
<p>Overall Goal Agricultural productivity centering rice is improved in the Target Area</p>	<p>1-1 Agricultural productivity in the Target Area is improved as proposed in the Master Plan by year 2015</p>	<p>1-1 Agricultural statistics</p>	/
<p>Project Purpose Model of irrigation facility maintenance is established</p>	<p>1-1 Result of the pilot project is evaluated as applicable model for Zone-1, 2, and 3 in the Target Area by stakeholders by year 2007</p>	<p>1-1 Questionnaire to the stakeholders</p>	<p>All the proposed activities in the Master Plan in post-project stage are implemented as scheduled</p> <p>No significant climatic change</p> <p>No severe damage on the irrigation facilities by natural disaster</p>
<p>Outputs 1 Capability on irrigation facility maintenance of model FWUCs and FWUGs are strengthened</p> <p>2 Capability on irrigation facility maintenance of responsible government agency for the project area is strengthen</p>	<p>1-1 Long-term rehabilitation plan for on-farm facilities is established by model FWUCs and FWUGs by year 2007</p> <p>1-2 Water fee is properly collected by model FWUCs and FWUGs by year 2007</p> <p>2-1 Long-term rehabilitation plan for major facilities is established by responsible government agency by year 2007</p> <p>2-2 Required budget for maintenance of major facilities in project area is acquired is by responsible government agency by year 2007</p>	<p>1-1 Long-term rehabilitation plan for on-farm facilities</p> <p>1-2 Cashbook of model FWUCs and FWUGs</p> <p>2-1 Long-term rehabilitation plan for major facilities</p> <p>2-2 Budget of responsible government agency</p>	<p>Responsibility of each stakeholder in irrigation facilities maintenance is not changed within the project period</p>
<p>Activities</p> <p>1-1 To conduct baseline survey and problem analysis on selected FWUCs and FWUGs</p> <p>1-2 To conduct awareness raising campaign on importance of irrigation facility maintenance</p> <p>1-3 To organize study tour on irrigation facility maintenance</p> <p>1-4 To prepare long-term rehabilitation plan for on-farm facilities by selected FWUC</p> <p>1-5 To collect water fees by established local rule by model FWUCs and FWUGs</p> <p>2-1 To prepare long-term rehabilitation plan for major facilities by responsible government agency</p> <p>2-2 To set up procedure for acquisition of maintenance cost for major irrigation facilities by responsible government agency</p>	<p>Input</p> <p>Donor</p> <p>Experts</p> <p>Transportation</p> <p>Cambodia</p> <p><u>FWUC and FWUGs</u></p> <p>FWUC and FWUG members</p> <p><u>Provincial government</u></p> <p>Counterparts from PDOWRAM</p> <p><u>Central government</u></p> <p>Counterparts from MOWRAM</p> <p><u>NGO</u></p> <p>Facilitators</p>		<p>Continuous involvement of related government agencies and model FWUC and FWUG during the project period</p> <p>No severe damage of irrigation facilities by natural disaster within the project period</p> <p>Precondition High need for irrigated agriculture in the Target Area</p> <p>Good understanding of related organizations on the Master Plan and importance of proper maintenance of irrigation facilities</p> <p>Irrigation water is properly distributed by properly proved irrigation facilities</p> <p>Related proposed activities in the Master Plan in pre-project stage are implemented as scheduled</p>

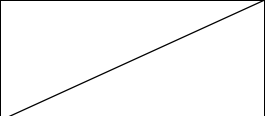
2.9 C.7(1) Rainfed Agriculture Improvement Pilot Project

(1) Project Proposal

(1) Title of Project	Rainfed Agriculture Improvement Pilot Project
(2) Location	Zone-4 (rainfed paddy areas) of Target Area
(3) Objective of Project	The project aims at development of an improved rainfed rice cultivation system.
(4) Site Description	Rainfed paddy cultivation occupies the largest land within the Target Area. The Zone-4 area is estimated at 23,980ha and its extensive distributions are found in the Target Area located away from the Prek Thnot River. Rainfed paddy fields are solely used for a single cropping of rice in the rainy season and unstable rainfall distribution and traditional farming practices bring about unstable and low productivity of paddy.
(5) Project Description	<p>For the attainment of the target of improvement of agricultural productivity in the Target Area, the improvement of rainfed agriculture should be sought through the integrated interventions of agronomic, extension and farmers' organizational approaches. The strategies established in the Master Plan include:</p> <p>(a) Improvement of rice productivity is envisaged by the introduction of improved farming practices; in this regard, the expansion of ecological SRI in Kampong Speu Province and promising results obtained in such fields in 2005 indicate the possibility for the attainment of the target, and</p> <p>(b) Improvement of rice productivity supported by the strengthening of agricultural support services is envisaged.</p> <div style="display: flex; justify-content: space-around;">   </div> <p style="text-align: center;"><i>Modified SRI Field (rainfed) Medium Variety/Riang Chery</i></p> <p style="text-align: center;"><i>CARDI Demonstration Plot (rainfed) Early Variety/Sen Pidao</i></p> <p>The development approaches taken under the project include:</p> <ul style="list-style-type: none"> - To test/verify the adoptability of improved rainfed rice farming practices, - To organize small-scale farmers' groups as target groups of extension services and train selected members as village extension agents, - To implement agricultural support programs including demonstrations, farmers' training, workshops, study tours and farmers' field days, - To involve agricultural government agencies (MAFF/CARDI and PDA) and NGOs having experience in rainfed rice cultivation activities and to the promote collaborative activities of such institutions, - Feed back the results and findings of the project to the Master Plan, and - Apply useful local knowledge obtained from the successful models.
(6) Project Justification	<p>(a) Relevance</p> <p>The project has high relevancy, since the development of improved rainfed rice production system with farmers participation will contribute to the attainment of the Master Plan target of "improvement of rice productivity".</p> <p>(b) Effectiveness</p> <p>The development interventions or approaches directed to Zone-4, rainfed paddy</p>



(3) Project Design Matrix

(Target Group: Farmers in the pilot project area)

Narrative Summary	Objectively Verifiable Indicator	Means of Verification	Important Assumption
<p>Overall Goal Agricultural productivity centering rice is improved in the Target Area</p>	<p>1-1 Agricultural productivity in the Target Area is improved as proposed in the Master Plan by year 2015</p>	<p>1-1 Agricultural statistics</p>	
<p>Project Purpose Model of improved rice production system is established</p>	<p>1-1 Result of the pilot project is evaluated as applicable model for Zone-4 in the Target Area by stakeholders by year 2007</p>	<p>1-1 Questionnaire to the stakeholders</p>	<p>All the proposed activities in the Master Plan in post-project stage are implemented as scheduled</p> <p>No significant climatic change</p> <p>There are no significant changes in supply demand & prices of rice and in farm input price</p>
<p>Outputs 1 Small scale farmer group(s) as target group of extension services/ project activities is formed. 2 Village extension agents are nominated 3 Adoptability of improved rainfed rice production system is proved</p>	<p>1-1 No. of Small scale farmer group(s) formed 2-1 No. of village extension agents selected 3-1 Productivity of improved rainfed rice production system</p>	<p>1-1 Monitoring survey 2-1 List of extension agents 3-1 Rice productivity survey</p>	<p>Responsibility of each stakeholder in irrigation facilities maintenance is not changed within the project period</p>
<p>Activities 1-1 To carry out baseline survey in the project area 1-2 To support formation of small scale farmer group as target group of extension services/project activities 2-1 To hold village meeting 2-2 To select village extension agents 3-1 To introduce improved rainfed rice production system 3-2 To provide agricultural support program</p>	<p style="text-align: center;">Input</p> <p style="text-align: center;">Donor Cambodia</p> <p>Experts Project operation cost Transportation</p> <p style="text-align: center;"><u>PDA</u> Counterparts</p> <p style="text-align: center;"><u>MAFF</u> Counterparts</p> <p style="text-align: center;"><u>NGO</u> Facilitators</p> <p>Office spaces Training & extension facilities</p>		<p>Continuous involvement of related government agencies and farmer groups during the project period</p> <hr/> <p>Precondition High need for rainfed agriculture in the Target Area</p> <p>Good understanding of related organizations on the Master Plan and importance of rainfed agriculture</p>

2.10 C.8(1) Community Inland Fisheries Development Pilot Project

(1) Project Proposal

(1) Title of Project	Community Inland Fisheries Development Pilot Project	
(2) Location	Model project area in Zone-3: the model project area should have small reservoirs for irrigation or natural ponds in good condition. The reservoirs/ponds are also required to be free of flooding throughout the year.	
(3) Objective of Project	The project aims at establishment of a productive community inland fishery model.	
(4) Site Description	<p>There are many small reservoirs on small tributaries in and around the Target Area. The man-made reservoirs are normally constructed for irrigation purposes. However, most of the reservoirs are shallow and thus storage capacity is generally small. The reservoirs are filled with water but dry in the dry season due to their small storage capacity.</p> <div style="display: flex; justify-content: space-around;">   </div> <p style="text-align: center;"><i>A type of small reservoir for irrigation in the Target Area</i> <i>Another type of small reservoir for irrigation in the Target Area</i></p>	
(5) Project Description	<p>There is a possibility to promote inland fish culture in such small reservoirs in the rainy season. However, water availability should be carefully checked before starting the promotion. Since river flow data for small tributaries are not available, proper procedure for selecting the sites should be developed. Also farmers' willingness to accept introduction of community inland fishery should be confirmed. For these purposes, the execution of a Pilot Project on community inland fishery development is required. Since the main purpose of storing water in the reservoirs is not inland fishery but irrigation, inland fishery activities should be cooperated well with the irrigation activities. In this connection, the organization responsible for O&M of the reservoir for irrigation purpose, FWUC, will be selected as the target group of the project. Income obtained from the inland fishery production could be used as a fund to pay for O&M of the irrigation facilities.</p>	
(6) Project Justification	<p>(a) Relevance</p> <p>The project has relevancy, since target of the pilot project, which “productive community inland fishery”, fits the goal of Master Plan (improvement of agricultural productivity).</p> <p>(b) Effectiveness</p> <p>Implementation of the project can contribute to farmers' income generation.</p> <p>(c) Efficiency</p> <p>The project requires minimum input by farmers such as equipment or material. As for manpower, the project is designed to apply local resources as much as possible. The project was evaluated as efficient from above view points.</p> <p>(d) Impact</p> <p>The project brings a positive impact to farmers in the project area by increasing cash income. No significant negative impact by the project is anticipated.</p> <p>(e) Sustainability</p>	

	Sustainability of the project is very high, since no major input for the project is planned to be made by farmers.
(7) Project Components	<ul style="list-style-type: none"> - Provision of fingerlings, fertilizers, fishing gear and fishing boats for initial set up - Organize seminars on introduction of inland fishery - Provision of field guidance - Preparation of a field extension manual
(8) Required Cost	US\$ 110,000
(9) Executing Agency	PDA and DAO
(10) Implementation	2 years
(11) Environmental Management/ Social Considerations	<ul style="list-style-type: none"> (i) Careful selection of site and fish as fingerlings at the design phase (ii) Explanation of environmental risks (iii) Regular monitoring of the environmental and management condition of the reservoirs

(2) Implementation Schedule

Activities	Expected Results	2009												2010												2011			In-charge	Equipment	Remarks
		4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3						
I. Initial Support by the Government																															
(1) Holding seminar on introduction of inland fishery	Farmers' Understanding				■																					Consultant PDA DAO	None	-			
(2) Provision of Fingerings, Fertilizers, Fishing Gear and Fishing Boat for Initial Set Up	Well Organized Initial Setup					■	■										■	■								Consultant PDA DAO	None	-			
(3) Provision fo Field Guidance	Farmers' Understanding						■	■	■	■	■							■	■	■						Consultant PDA DAO	None	-			
(4) Preparation of Field Extension Manual	Manual																■	■					■	■		Consultant PDA DAO	None	-			
II. Evaluation of Pilot Project Result																															
(1) Evaluation	Report																									Consultant	None	-			



(3) Project Design Matrix

(Target Group: Farmers in Model Project Area in Zone-3)

Narrative Summary	Objectively Verifiable Indicator	Means of Verification	Important Assumption
Overall Goal Agricultural productivity centering rice is improved in the Target Area	1-1 Agricultural productivity in the Target Area is improved as proposed in the Master Plan by year 2015	1-1 Agricultural statistics	/
Project Purpose Model of productive community inland fishery is established	1-1 Result of the pilot project is evaluated as applicable model for Zone-3 of the Target Area by stakeholders by year 2007	1-1 Questionnaire to the stakeholders	All the proposed activities in the Master Plan in post-project stage are implemented as scheduled No significant climatic change No severe damage on the small pond by natural disaster
Outputs 1 Productivity of community inland fishery is improved 2 Practical community inland fishery field extension manual is prepared	1-1 Average productivity of fish cultivation in year 2007 and 2008 is higher than that of year 2006 2-1 Community inland fishery field extension manual is appreciated by stakeholders	1-1 Record of fish productivity 2-1 Questionnaire	Responsibility of each stakeholder in inland fishery is not changed within the project period
Activities 1-1 To organize seminar on introduction of inland fishery 1-2 To provide fingerings, fertilizers, fishing gear and fishing boat for initial set up 1-3 To provide field guidance 2-1 To prepare draft field extension manual 2-2 Improve field extension manual with extension workers	Input Donor Cambodia Experts Transportation Cost of study tour FWUC and FWUGs FWUC and FWUG members <u>District government</u> Counterparts from DAO <u>Provincial government</u> Counterparts from PDA <u>Central government</u> Counterparts from MAFF <u>NGO</u> Facilitators		Continuous involvement of related government agencies and model FWUC and FWUG during the project period No severe damage of small ponds by natural disaster within the project period Precondition High need for inland fishery in the Target Area Good understanding of related organizations on the Master Plan and importance of inland fishery improvement Small ponds in good condition is provided in the project area

2.11 B.9(1) River Basin Effective Water Use Awareness Raising Project

(1) Project Proposal

(1) Title of Project	River Basin Effective Water Use Awareness Raising Project
(2) Location	The Prek Thnot river basin. Especially the irrigated areas in Zones-1, 2 and 3 (First priority: Zone-1: Second priority: Zone-2: Third priority: Zone-3)
(3) Objective of Project	The objective of the project is to raise the awareness and knowledge of the farmers in the river basin on efficient water use by introducing them to the results of the “Irrigated Agriculture On-farm Technology Improvement Pilot Project”.
(4) Site Description	<p>(River basin)</p> <p>According to the hydrological analysis in the Master Plan, water resources of the Prek Thnot river are revealed to be very limited. This means that such limited water resources should be used effectively with proper river basin level water management.</p> <p>Even now, it is obvious that there are many water users in the upstream of the Prek Thnot river. Since the hydrological model applied in the Master Plan considered such water users in the model, it can be said that the model is accurate for the present. However, the model might not be accurate in the future if the upstream situation changes. It is said by some government officers that deforestation is progressing in the upstream area of the Prek Thnot river basin. It is also feared that reclamation of the upstream area makes people in the upstream area take more water from Prek Thnot river.</p>  <p style="text-align: right;"><i>Situation of upstream area of Prek Thnot river</i></p> <p>(Downstream irrigation area)</p> <p>The participatory survey conducted in the Master Plan study shows that farmers’ knowledge on irrigation in the Target Area is limited. Water is not distributed properly and water fees are not being paid by the users. Most of the farmers seem to misunderstand the necessity of such important activities. The reasons for this insufficient knowledge might be that i) farmers are discouraged by poor water delivery from the irrigation system, ii) farmers are not aware of the importance of proper operation and maintenance of irrigation systems, and iii) farmers do not understand or were not instructed on how to operate the irrigation systems properly.</p>  <p style="text-align: right;"><i>A Sample of Secondary Canal not Operated Properly basin</i></p>
(5) Project Description	<p>The project is composed of two stages:</p> <p><u>Stage-1 (River Basin Water Use Study)</u></p> <p>In the Master Plan, water availability at Roleang Chrey regulator was estimated by hydrological model analysis. However, the current model will not be fitted if the situation of the upstream area changes in the future. In this connection, a river basin water use study is required. Water users of the Prek Thnot river need to be</p>

	<p>surveyed and listed periodically (at least every five years). When new water users are found, water allocation rules should be determined that will be fair to both the new water users and existing water users.</p> <p>Another objective of the study is to transfer technology to MOWRAM staff on how to conduct river basin water use studies. It is planned that the study will be executed on a project basis the first time (five years after the Master Plan formulation) and all the technical skills will be transferred to MOWRAM officials in that study period. Each of the following studies will be routinely conducted by MOWRAM every five years.</p> <p><u>Stage-2 (Awareness Raising Campaign)</u></p> <p>The project aims at creating mutual understanding among the stakeholders that are related to the irrigation systems. In this regard, upstream farmers play a key role in saving water. The upstream farmers should understand how severe the downstream situation is. Downstream farmers should also understand that the upstream farmers understand that the situation is severe and that the downstream farmers need to start to take action. These kinds of discussions should be entered into by the farmers themselves in the basin level conferences.</p> <p>It is also important that irrigation farmers keep the importance of water saving in their minds and take action for it. To encourage them to take action, dissemination material should be distributed to them. Distribution of calendars with water management schedules might be a good dissemination material for farmers. In addition, various other types of dissemination materials need to be distributed to them after confirming their effects.</p> <p>To motivate the farmers to take action, it is important to introduce the possibility of irrigated agriculture as practiced by farmers in the Target Area. Status and effects of the “Irrigated Agriculture On-farm Technology Improvement Pilot Project” need to be introduced to the farmers in the other areas. It is also important that the government should prepare a legal water rights system or a water law urgently.</p>
(6) Project Justification	<p>(a) Relevance</p> <p>Target of the project, which “efficient use of irrigation water”, fully fits the goal of Master Plan (improvement of rice productivity).</p> <p>(b) Effectiveness</p> <p>Implementation of the project can highly contribute to delivery of irrigation water to the downstream beneficiaries.</p> <p>(c) Efficiency</p> <p>The project is efficient since most of the work will be carried out by local resources.</p> <p>(d) Impact</p> <p>The project brings a positive impact to farmers by realizing that there is a necessity of water saving in the Target Area. No significant negative impact by the project is anticipated.</p> <p>(e) Sustainability</p> <p>Sustainability of the project is high, if farmers realize that they can take water by improvement of irrigation facilities or other means.</p>
(7) Project Components	<p><u>Stage-1 (River Basin Water Use Study)</u></p> <ul style="list-style-type: none"> - Acquisition of satellite images of the river basin - Inventory survey of water users in the river basin - River basin vegetation analysis by remote sensing technology - Propose proper water allocations between water users, if required

(3) Project Design Matrix

(Target Group: Farmers in Irrigated area)

Narrative Summary	Objectively Verifiable Indicator	Means of Verification	Important Assumption
<p>Overall Goal Agricultural productivity centering rice is improved in the Target Area</p>	<p>1-1 Agricultural productivity in the Target Area is improved as proposed in the Master Plan by year 2015</p>	<p>1-1 Agricultural statistics</p>	/
<p>Project Purpose Mutual understanding on efficient use of waer is obtained between stakeholders related to irrigation in the target</p>	<p>1-1 Necessity of basin level proper water distribution is mentioned in the minutes of basin level conference</p>	<p>1-1 Minutes of basin level conference</p>	<p>All the proposed activities in the Master Plan in post-project stage are implemented as scheduled</p> <p>No significant climatic change</p> <p>No severe damage on the irrigation facilities by natural disaster</p>
<p>Outputs 1 Present condition of the river basin is understood</p> <p>2 Countermeasure plan for identified problems in the river basin is prepared</p> <p>3 Necessity of efficient water use is understood by related government agencies</p> <p>4 Necessity of efficient water use is understood by irrigation beneficiary farmers</p> <p>5 Necessity of efficient water use is understood by water users in the river basin</p>	<p>1-1 Report on present condition analysis is prepared</p> <p>2-1 Report on countermeasure plan is prepared</p> <p>3-1 Action plans are prepared by related government agencies</p> <p>4-1 More than 80% of planned participants are attended the awareness raising seminar</p> <p>4-2 Dissemination material is used by 50% of attendance of the awareness raising program</p> <p>5-1 Agreement on water distribution plan is prepared</p>	<p>1-1 Study report</p> <p>2-1 Study report</p> <p>3-1 Action plan report</p> <p>4-1 Monitoring survey</p> <p>4-2 Monitoring survey</p> <p>5-1 Minutes of conference</p>	<p>No severe social conflict within the stakeholders</p>
<p>Activities</p> <p>1-1 To acquire of satellite imageries of the river basin</p> <p>1-2 To conduct inventory survey of water users in the river basin</p> <p>1-3 To grasp vegetation condition of the river basin</p> <p>2-1 To propose water distribution plan</p> <p>2-2 To propose measures for deforestation</p> <p>3-1 To hold seminar on efficient water use in government level</p> <p>3-2 Result of the Master Plan Study is explained to related government agencies</p> <p>4-1 To hold awareness raising seminar on efficient water use</p> <p>4-2 To organize study tours on efficient water use</p> <p>4-3 To distribute dissemination material to irrigation beneficiary farmers</p> <p>5-1 To hold basin level conference on efficient water use with stakeholders related to irrigation in the Target Area</p>	<p style="text-align: center;">Input</p> <p>Donor</p> <p><u>Expert</u></p> <p>Water resources expert Irrigation expert GIS and remote sensing expert Forestry expert Transportation</p> <p>Satellite imageries cost GIS software cost Survey cost Seminar cost Dissemination material cost Study tour cost</p>	<p>Cambodia</p> <p><u>FWUCs and FWUGs</u> FWUC and FWUG members</p> <p><u>Provincial government</u> PDOWRAM and PDA staff</p> <p><u>Central government</u> MOWRAM and MAF staff</p> <p><u>NGO</u> Facilitators</p>	<p>No severe social conflict within the farmers</p> <p>No severe distrust of dissemination activities by the farmers</p> <p>Precondition High need for irrigated agriculture in the Target Area</p> <p>Good understanding of related organizations on the Master Plan and importance of proper water management</p> <p>Related proposed activities in the Master Plan in pre-project stage are implemented as scheduled</p>

2.12 C.10(1) Institutional and Agricultural Support Services Strengthening Project

(1) Project Proposal

(1) Title of Project	Institutional and Agricultural Support Services Strengthening Project
(2) Location	The Target Area (Kampong Speu & Kandal Province)
(3) Objective of Project	The present project is proposed as a technical cooperation project with the objectives of: i) establishment of an institutional set-up responsible for the promotion of agricultural improvement centering on rice in the Target Area at the initial stage of the Master Plan, ii) development and extension of improved and sustainable farming technologies on rice production to enhance productivity of the primary agricultural activity in the Area, iii) development and extension of irrigation water management and O&M technologies and practices for sustaining the irrigation systems in the Area and iv) formation and empowerment of FWUGs , FWUCs, WUGs and other farmers' organizations.
(4) Site Description	The subject project areas are the irrigated and rainfed paddy fields in the Target Area of the Master Plan.
(5) Project Description	<p>For the attainment of the objectives stated above, the development strategies of the Project have been set as follows;</p> <ul style="list-style-type: none"> - The insufficient coordination and collaboration between MAFF and MOWRAM appears to be one of the most crucial constraints for the irrigated agricultural development in the Target Area. This Project aims at the establishment of a coordination and collaboration body at the central and project level to tackle such sustained constraints for the development. The project envisages attaining the well coordinated implementation of the Project under the support of the foreign donors, - Establishing the Project Management Unit or Project Office organized by staffs of MAFF/PDA and MOWRAM/PDOWRAM in the Target Area as an institute responsible for the integrated & collaborative activities of MAFF & MOWRAM and project implementation, - This project has been formulated with five main components of activities including: i) institutional strengthening, ii) improvement of irrigated & rainfed rice production systems with farmers' participation, iii) establishment of village extension agents (VEAs), iv) introduction of proper water management & O&M systems and v) capacity building of farmers' organizations (FWUG/FWUCs/WUGs & other organizations).
(6) Project Justification	<p>(a) Relevance</p> <p>The Project envisages to strengthening institution and agricultural support in the Target Area through the establishment of the Project Office for Agricultural Productivity Improvement. The overall goal of the Project of "agricultural productivity in the Target Area centering rice is improved" is surely consistent with the said national development policies.</p> <p>The sub-sector is the primary income sources of the target groups of the Project and the productivity improvement of the sub-sector through the Project exactly meet the needs of the groups.</p> <p>(b) Effectiveness</p> <p>The primary institutional target of the Project (project purpose) is to establish a sustainable agricultural improvement promotion support institution organized in collaboration by MAFF and MOWRAM. The attainment of such objective is largely affected by the government support for the project establishment. The Project is, therefore, a pilot operation of such development efforts of the both ministries and every possible effort will be required for the attainment of the target.</p>

	<p>(c) Efficiency</p> <p>The assignment of qualified full time counterparts and experts will become a key factor for the envisaged technology development or extension component of both agronomic and water management aspect. Further, to ensure technical support for the Project, the establishment of the Task Force Team at the central level is planned.</p> <p>(d) Impact</p> <p>The success of extension activities in a pilot scale with farmers' participation will present a great impact to farmers and farming communities in the Target Area. Further, capacity building of local authorities is also attained through the project implementation.</p> <p>(e) Sustainability</p> <p>The project sustainability is largely depending on the provision of funds for the operation of the Project Office as the capacities of project manpower resources will be established to ensure the project sustainability.</p>
(7) Project Components	<p>The Project is formulated as a technical cooperation project for the period of 5 years and the project purpose is to establish an institution responsible for the agricultural productivity improvement, Project Management Unit or Project Office, and to strengthen agricultural support services provided through the Project Office.</p> <p>The project's major activities include: i) institutional strengthening, ii) improvement of irrigated rice production systems with farmers' participation, iii) improvement of rainfed rice production systems with farmers' participation, iv) technical development & extension of upland crops production in paddy fields in early rainy season, v) establishment of village extension agents (VEAs), vi) Introduction of proper water management & O&M systems and vii) capacity building of farmers' organizations as discussed in PDM.</p>
(8) Cost	US\$ 2,928,000 including price contingency
(9) Executing Agency	MAFF & MOWRAM
(10) Implementation	6 years

(2) Implementation Schedule

Activities	Expected Results								In-charge
		0	1st	2nd	3rd	4th	5th		
		2010	2011	2012	2013	2014	2015		
1. Institutional Strengthening	Standing Steering Committee & Task Force Team are established Project Office established	■							MAFF/MOWRAM/ CARDI
- Establishment of Standing Steering Committee & Task Force Team		■							
- Establishment of Project Office (Project Management Unit)		■							
- Capacity building of local authorities, NGOs and other stakeholders	Local authorities, NGOs and other stakeholders are trained & involved in or provide support to the Project		■					■	Project MAFF/MOWRAM CARDI/PDA/DAO
2. Improvement of Irrigated Rice Production System with Farmers Participation	Verified improved irrigated rice production system is disseminated to farmers/farmer groups in a pilot		■	■	■	■	■	■	Project CARDI/PDA DAO/VEAs
3. Improvement of Rainfed Rice Productivity	Verified improved rainfed rice production system is disseminated to farmers/farmer groups in a pilot		■	■	■	■	■	■	Project CARDI/PDA VEAs
4. Establishment of Village Extension Agent (VEA)	Trained farmers are qualified as VEAs and are deployed		■	■	■				Project PDA/DAO/VEAs
5. Introduction of Proper Water Management & O&M System	The water management & O&M system is introduced in a pilot scale		■	■	■	■	■	■	Project MOWRAM/ PDOWRAM FWUC/FWUG
6. Capacity Building of Farmer Organizations	FWUC/FWUG & other farmer organizations needed are formed & trained to a pilot scale		■	■	■	■	■	■	Project PDOWRAM PDA/DAO
7. Coordination & Partnership Arrangement	Coordination committee with donor agencies & NGOs operated in & around the Target Area is	■	■	■	■	■	■	■	Project MAFF/MOWRAM Stakeholders

(3) Project Design Matrix

(Target Group: Farmers in the Target Area)

Narrative Summary	Objectively Verifiable Indicator	Means of Verification	Important Assumption
Overall Goal Agricultural productivity centering rice is improved in the Target Area	1-1 Agricultural productivity in the Target Area is improved as proposed in the Master Plan by year 2015	1-1 Agricultural statistics	/
Project Purpose Agricultural support services and project related institutions are strengthened and sustained in the Target Area for the agricultural productivity improvement	1-1 Agricultural support services provided by the project & VEAs	1-1 Project monitoring report 1-2 VEA activity reports	All the proposed activities in the Master Plan in post-project stage are implemented as scheduled No significant climatic change Agriculture development policy is not changed Demand and prices of rice is not changed Farm inputs prices are not changed
Outputs 1 Related institutions for agricultural production in the Target Area are strengthened 2 Rice production system in the Target Area is improved	1-1 No. of Steering Committee Meeting & Task Force Meeting held 1-2 Performance of Project Office 1-3 No. of local authorities staffs trained 1-4 No. of farmers/FWUC/FWUG trained 2-1 No. of villages applying the improved rice production system	1-1 Record of meetings 1-2 Monitoring survey 1-3 Record of training 1-4 Record of training 2-1 Monitoring survey	Necessary budget or support funds are allocated to the Project
Activities 1-1 To conduct government institutional strengthening 1-2 To establish Village Extension Agent (VEA) 1-3 To strengthen farmer organizations 1-4 To improve coordination & partnership arrangement 2-1 To improve irrigated rice production system with farmers participation 2-2 To introduce proper water management & O&M system 2-3 To improve rainfed rice productivity with farmers participation	<p style="text-align: center;">Input</p> <p style="text-align: center;">Donor</p> <p style="text-align: center;"><u>Long-term Experts</u></p> Chief Adviser Agronomist Water management Farmer Organization <p style="text-align: center;"><u>Short-term Experts</u></p> As required <p style="text-align: center;"><u>Equipment</u></p> Vehicle, training equipment & office equipment & facilities Project operation cost	<p style="text-align: center;">Cambodia</p> <p style="text-align: center;"><u>MAFF, MOWRAM, PDAs & PDOWRAMs</u></p> Full time counterparts corresponding to long term experts in number & specialty Office Space Extension & Training Facilities Part of project operation cost	Counterparts & local authorities staffs trained are continuously stationed at the Project or continuously support the Project <p style="text-align: center;">Precondition</p> Related proposed activities in the Master Plan in pre-project stage are implemented as scheduled

2.13 C.11(1) Hydrological Observation Strengthening Project

(1) Project Proposal

(1) Title of Project	Hydrological Observation Strengthening Project
(2) Location	Kampong Speu Province
(3) Objective of Project	To strengthen the hydrological data acquisition system for water resources
(4) Site Description	In the past, there was only one automatic rainfall gauging station in the Prek Thnot river basin, which was situated at the Kampong Speu PDOWRAM. Now 10 rainfall automatic gauging stations and 5 water level automatic gauging stations have been established in the basin. From these automatic gauging stations, necessary hourly data on rainfall and water level can be obtained.
(5) Project Description	All the data are to be stored in a data logger and periodic downloading of the data from the data logger will now be required. By downloading and arranging the data, necessary hourly rainfall and water level data become available for analyzing the runoff model and flood forecasting method analysis. In addition, the discharge measurements are needed for preparation of discharge rating curves at the water level gauging stations. The project includes, not only installation of hydrological equipment, but also training of the MOWRAM staff concerned.
(6) Project Justification	<p>(a) Relevance</p> <p>The National Water Resources Policy for the Kingdom of Cambodia says that the Royal Government of Cambodia has the policies to strengthen and extend the hydrological and meteorological systems that provide the technical basis for responding to hazards such as climate change and floods, delimiting flood prone areas, defining the frequencies of hazardous weather conditions, etc. The proposed hydrological observation conforms to the national policy.</p> <p>(b) Effectiveness</p> <p>Presently, there is only one automatic rainfall gauging station in the basin. Now from the newly established 10 gauging station, the important hourly rainfall and water level data can be obtained automatically. These data will surely contribute to the flood analysis conducive to the flood warning and flood control planning of the basin.</p> <p>(c) Efficiency</p> <p>By the ordinary rainfall gauge, it is practically impossible to get the hourly rainfall data in the basin. But by use of the newly established automatic gauge, the hourly data can be easily obtained.</p> <p>(d) Impact</p> <p>In the basin, 10 automatic rainfall gauging stations and 6 water level gauging stations are now established, but these are still not enough numbers from the view point of runoff analysis. In the basin, there are still many ordinary rainfall and water level gauging stations. If the hourly data in the basin are collected smoothly, the importance of hourly data will be strongly realized by the government officials concerned. Then the other stations' gauges might be replaced with automatic ones, and the better hydrological information could be obtained in the long view.</p> <p>(e) Sustainability</p> <p>Now the government officials concerned can handle the automatic hydrological observation gauges including downloading the data and arranging the downloaded data files. If the continuous budget is provided appropriately, the hydrological observation system will perpetually continue.</p>
(7) Project Components	<ul style="list-style-type: none"> - Continuation of discharge measurements. - Battery changes, data downloading, and arrangement of downloaded data files

(3) Project Design Matrix

(Target Group: MOWRAM staff)

Narrative Summary	Objectively Verifiable Indicator	Means of Verification	Important Assumption
Overall Goal Agricultural productivity centering rice is improved in the Target Area	1-1 Agricultural productivity in the Target Area is improved as proposed in the Master Plan by year 2015	1-1 Agricultural statistics	/
Project Purpose Hydrological observation system of MOWRAM for implementation of scheme-wise improvement project is strengthened	1-1 Hydrological data can be used for scheme-wise improvement project are evaluated as increased by foreign expert	1-1 Monitoring survey	All the proposed activities in the Master Plan in post-project stage are implemented as scheduled No significant climatic change No severe damage on the irrigation facilities by natural disaster
Outputs 1 Hourly rainfall data in the basin and hourly water level data are obtained 2 Discharge rating curves are prepared	1-1 No. of hourly rainfall monthly tables at each gauging station 1-2 No. of hourly water level monthly tables at each gauging station 2-1 Discharge rating curves with formulas to express the relationship between water level and discharge	1-1 Hourly rainfall monthly tables of each gauging station 1-2 Hourly water level monthly tables of each gauging station 2-1 Discharge rating curve graph of each gauging station	The observation stations will not be broken or damaged by people or natural disaster A mobile computer of MOWRAM to download the data from the logger in the field is available. A computer of MOWRAM to arrange the downloaded data file is available.
Activities 1-1 To prepare the necessary batteries for the automatic gauging stations (by inspection team) 1-2 To prepare the mobile computer that the necessary software for downloading the data files from the logger is installed (by inspection team) 1-3 To download the data record from the logger (by the inspection team) 1-4 To arrange the downloaded data files to prepare hourly monthly table (by inspection team) 2-1 To prepare the survey team themselves to go to the site at any time of flooding during the rainy season 2-2 To conduct discharge measurement during a flood as many times as possible 2-3 To arrange the recorded data to prepare the discharge rating curve at each station	Input Donor Cambodia Hydrologist (1.2 M/M) <u>MOWRAM</u> Pivotal staff to conduct downloading and arranging the downloaded data files 2 engineers/hydrologists (12 M/M in total) Staff to conduct discharge measurement: 2 engineers/hydrologists (12 M/M in total) and workforces (24 M/M) <u>PDOWRAM</u> Staff to guide to the fields (6 M/M) and keep records: 1 staff		The necessary financial resources for conducting the hydrological observation are available The trip to the gauging station is possible from the view point of road conditions and political stability Necessary maintenance of equipment can be done by MOWRAM Precondition High need for agricultural development in the Target Area Good understanding of related organizations on the Master Plan and importance of proper hydrological observation MOWRAM is ready to conduct periodical inspection of hydrological gauging stations and downloading the recorded data and arranging the downloaded files

2.14 C.11(2) Flood Forecasting and Warning Study

(1) Project Proposal

(1) Title of Project	Flood Forecasting and Warning Study
(2) Location	Kampong Speu Province
(3) Objective of Project	To prepare a flood forecasting and warning system plan for mitigation of flood damage in the downstream basin of the Prek Thnot river
(4) Site Description	In the Prek Thnot River downstream basin, flooding has often occurred and brought damage to the people in the area. Since the Prek Thnot River basin has a rather high mountainous area, the runoff is very rapid compared with those of the Mekong and the Tonle Sap Rivers. Due to the absence of a flood forecasting and warning system, the people have been suffering from the sudden inundation in the area.
(5) Project Description	Now that the hydrological observation system has been established in the basin, hydrological analysis of the Prek Thnot river basin will soon be possible based on the data collected by the observation system. Based on the hydrological analysis, it will be possible to make flood forecasts in the basin. And based on the flood forecasts, a flood warning could be given to the people in the basin and the flood damage to the people could be mitigated.
(6) Project Justification	<p>(a) Relevance</p> <p>The National Water Resources Policy for the Kingdom of Cambodia says that the Royal Government of Cambodia has the policies to provide short, medium and long-term forecasts and warning of droughts, floods and storms to the public and related institutions. Forecasts and warning about meteorological conditions, including drought, will be provided to the whole country. Flood warning will be provided to places at risk from flooding. Accordingly the establishment of flood forecasting and warning system in the Prek Thnot river basin conforms to the national policy of the Kingdom of Cambodia.</p> <p>(b) Effectiveness</p> <p>Presently there is no flood forecasting and warning system in the basin. Accordingly the people in the basin did not know any information on coming flooding. People have just encountered flooding all of a sudden. Accordingly people were not ready for evacuation and forced to suffer from flood damage. But by being given flood warning, the people can prepare for coming flooding and the flood damage can be mitigated to a great extent.</p> <p>(c) Efficiency</p> <p>Presently it is not planned to provide any flood control facilities in the basin, and accordingly the flood damage mitigation can be achieved only by flood forecasting and warning. Providing flood control facilities such as flood control reservoir and flood embankment need a lot of fund and may cause some adverse effect in preserving environment and resettlement of people. But providing flood forecasting and warning system would not need much cost neither cause any adverse effect to environment nor need any people's resettlement.</p> <p>(d) Impact</p> <p>Once the flood forecasting and warning system in the Prek Thnot river basin is established, and works well, the fear of the people against sudden flooding will be eased and since people can be ready for coming flooding, the people's damage due to flooding will be much mitigated, and then the people's life becomes comfortable, and accordingly the welfare of people's life in the basin will be much improved.</p> <p>(e) Sustainability</p> <p>The maintenance cost of flood forecasting and warning system is much smaller</p>

	than that of flood control facilities and the system maintenance would need very limited human resources, and accordingly the sustainability of the flood forecasting and warning should be good.
(7) Project Components	<ul style="list-style-type: none"> - Data arrangement of rainfall and water level in the basin - Preparation of runoff and inundation models - Analysis of relationships between water level upstream, rainfall in the upstream basin, and the water level in the downstream reaches and the inundation area. - Analysis of hydrological impact to the downstream basin of the Prek Thnot River on gate operation of the Roleang Chrey regulator and Kandal Stueng regulator.
(8) Cost	US\$ 120,000
(9) Executing Agency	MOWRAM
(10) Implementation	3.5 months

(2) Implementation Schedule

Items	2007						
	7	8	9	10	11	12	1
1 Arrangement of hydrological data			■				
2 Delineation of basin for runoff and inundation method			■				
3 Preparation of runoff and inundation model			■				
4 Verification of runoff and inundation model				■			
5 Runoff probability analysis				■			
6 Calculation of probable runoff				■			
7 correlation analysis					■		
8 Study on flood forecasting method					■		
9 Study on flood warning method and tool					■		
10 Study on necessary organization for conducting flood forecasting and warning					■		
11 Preparation of operation manual						■	

(3) Project Design Matrix

(Target Group: MOWRAM staff)

Narrative Summary	Objectively Verifiable Indicator	Means of Verification	Important Assumption
<p>Overall Goal Agricultural productivity centering rice is improved in the Target Area</p>	<p>1-1 Agricultural productivity in the Target Area is improved as proposed in the Master Plan by year 2015</p>	<p>1-1 Agricultural statistics</p>	/
<p>Project Purpose Practical flood forecasting and warning plan for the Prek Thnot River to protect downstream agricultural land is prepared</p>	<p>1-1 Prepared flood forecasting and warning plan is evaluated as practical by well-informed experts</p>	<p>1-1 Minutes of meeting of steering committee</p>	<p>All the proposed activities in the Master Plan in post-project stage are implemented as scheduled</p> <p>Flood forecasting and warning plan will be implemented for the target basin</p> <p>No significant climatic change</p>
<p>Outputs 1 Flood forecasting and warning method is developed</p>	<p>1. Flood forecasting method 2. Flood warning method</p>	<p>1 Report on flood forecasting 2 Report on flood warning</p>	<p>Steering committee of the study is held with well-informed experts on time</p>
<p>Activities 1-1 Arrangement of hydrological data for preparation of runoff and inundation model 1-2 Delineation of basin for runoff and inundation model 1-3 Preparation of runoff and inundation model 1-4 Verification of runoff and inundation model 1-5 Runoff probability analysis 1-6 Calculation of probable runoff 1-7 Correlation analysis 1-8 Study on flood forecasting method 1-9 Study on flood warning method and tool 1-10 Study on necessary organization for conducting flood forecasting and warning. 1-11 Preparation of operation manual</p>	<p>Input</p> <p>Donor Cambodia</p> <p>Hydrologist with necessary financial resources <u>MOWRAM</u></p> <p>Pivotal staff to study on flood forecasting and warning</p> <p><u>PDOWRAM</u></p> <p>Staff to support for preparation of flood forecasting and warning to give local information on flooding and warning in the basin</p>		<p>Data collection by the newly established hydrological observation network is going well and the necessary hourly data are available</p> <p>Precondition High need for agricultural development in the Target Area</p> <p>Good understanding of related organizations on the Master Plan and importance of proper hydrological observation</p> <p>MOWRAM is ready to study on flood forecasting and warning in the downstream basin of the Prek Thnot River.</p> <p>Related proposed activities in the Master Plan in pre-project stage are implemented as scheduled</p>