J.2.2 Domestic Water Supply Plan

(1) Urban Water Supply System

The construction work for the urban water supply system is to be executed by the contractor selected by international competitive tenders, considering the scale and kinds of the construction works.

Construction cost is estimated on the basis of the preliminary design and work quantities at a master plan level. Major unit prices are worked out considering local conditions, availability of materials and equipment and referring to the similar international projects. For the cost estimation, foreign and local currency portions of the project cost are estimated.

The project cost comprises of the following costs:

1) Direct construction cost of civil works is estimated principally on the unit cost basis, in which the unit cost for each work item is multiplied by the corresponding work quantity to calculate the construction cost. The unit cost includes labor, material, equipment and overhead cost.

2) Cost for import materials and equipment are estimated based on the recent international contract prices of similar works and considering the local conditions.

3) The administration cost is estimated at 3 % of the direct construction cost and engineering services, and expressed in local currency portion.

4) The physical contingency cost is assumed to be 10 % of total direct construction cost for both and foreign currency portions. While, the price contingency cost is not included in those project costs taking into account of the unforeseen escalation rates of prices during the long time span of the implementation period.

5) Only the direct construction cost and administration cost are included in the installation works of house pipeline connection and meter system which are scheduled to be completed in the final target year and hence the installation works are to be executed by beneficiaries themselves.

Applying the same unit construction cost as that of the irrigation improvement plan as shown Appendix H, the direct construction cost is estimated as shown in Table J.2.1 including the proportion between the foreign and local currency. The total construction cost is summarized as shown below;

Summary of Total Construction Cost for Urban Water Supply

(Unit: Nu. 1,000,000)

Description	Costs
1. Direct Costs	172.6
1.1 Conveyance Pipeline	60.1
1.2 Treatment and Water Distribution Station	95.4
1.3 Distribution Networks and House Meters	17.1
2. Engineering Service	35.0
3. Administration Costs	6.2
Sub-total	213.9
4. Physical Contingency	17.3
Total	231.2

Based on the implementation schedule, the annual disbursement schedule is considered as shown in Table J.2.2 and is summarized below;

Summary Annual Disbursement Schedule for Urban Water Supply Scheme

(Unit: Nu.1,000,000)

Work Items	Year										
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1. Direct Construction Costs			60.1	95.4	9.3				3.9	3.9	
1.1 Conveyance Pipeline			60.1								
1.2 Water Treatment and Distribution Station				95.4							
1.3 Distribution Networks and House Meters					9.3				3.9	3.9	
2. Engineering Service		10.4	9.8	9.8	4.9						
3. Administration Costs		0.3	2.1	3.2	0.4				0.1	0.1	
Sub-total		10.7	72.0	108.4	14.6				4.0	4.0	
4. Physical Contingency			6.0	9.5	0.9				0.4	0.4	
Total		10.7	78.0	117.9	15.5				4.4	4.4	

(2) Rural Water Supply System

The construction work for the rural water supply system is to be executed by the local inhabitants using the construction materials provided by the Government.

The project cost consists of direct construction cost and administration cost. The direct construction cost is estimated using the same conditions of urban water supply system on the basis of the preliminary design at a master plan level. The administration cost is estimated at 3 % of the direct construction cost. The engineering service cost is not included and hence the design and supervision works are to be conducted by PWD engineers. The physical contingency is not included in this project cost since each unit construction cost is estimated with some allowances of civil works.

The unit construction cost estimation is presented in Data Book VI and the construction costs of each development method are summarized as shown in Table J.2.3. The project cost for rural water supply system are summarized as shown below;

Project Cost of Rural Water Supply System

(Unit : 1000Nu.)

Sub-area/Scheme	Type	No.	Unit Cost			Project Cost
			Construction	Administration	Subtotal	
Lobeysa Sub-area						
New Scheme (A)	L-1	1	2,418	73	2,491	2,491
New Scheme (C)	L-2	2	657	20	677	1,354
Extension Scheme(B)	S-4	1	353	11	364	364
Subtotal		4				4,208
Bajo Sub-area						
New Scheme (A)	S-1	1	1,718	52	1,769	1,769
New Scheme (A)	B-1	2	4,276	128	4,404	8,808
New Scheme (C)	B-2	1	3,066	92	3,158	3,158
Additional Scheme	B-1	1	4,276	128	4,404	4,404
Subtotal		5				18,138
Phangyul Sub-area						
New Scheme (A)	S-1	3	1,718	52	1,769	5,308
New Scheme (B)	S-1	1	1,718	52	1,769	1,769
New Scheme (C)	S-2	7	353	11	364	2,546
Extension Scheme(A)	S-3	3	1,718	52	1,769	5,308
Subtotal		14				14,932
Rubeysa Sub-area						
New Scheme (A)	S-1	2	1,718	52	1,769	3,539
New Scheme (C)	S-2	2	353	11	364	727
Extension Scheme(A)	S-3	1	1,718	52	1,769	1,769
Extension Scheme(B)	S-4	2	353	11	364	727
Water Treatment Scheme	T-1	1	134	4	138	138
Subtotal		8				6,902
Total		31				44,080

The annual disbursement schedule is set as shown below based on the implementation schedule discussed in Appendix G.

Annual Disbursement for Implementing Rural Water Supply Schemes

(Unit: Nu.1,000,000)

Sub-area/Scheme	Year										
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Lobeysa Sub-area											
New Scheme (A)									2.5		
New Scheme (C)										1.4	
Extension Scheme (B)										0.4	
Bajo Sub-area											
New Scheme (A)				10.6							
New Scheme (C)					3.2						
Additional Scheme					4.4						
Phangyul Sub-area											
New Scheme (A)	5.3										
New Scheme (B)		1.8									
New Scheme (C)			2.5								
Extension Scheme (A)		5.3									
Rubeysa Sub-area											
New Scheme (A)						3.5					
New Scheme (C)								0.7			
Extension Scheme (A)							1.8				
Extension Scheme (B)								0.7			
Water Treatment Scheme										0.1	
Total	5.3	7.1	2.5	10.6	7.6	3.5	1.8	1.5	2.5	1.9	0.6

J.2.3 Irrigation Improvement Plan

The project cost for irrigation improvement plan is estimated based on the implementation schedule and the necessary structures which are designed on a preliminary basis as described in Appendix H.

The cost estimation is prepared based on the same conditions as the rural water supply system. The project cost consists of the construction cost and the research cost for applying optimum diversification crops. The Administration cost and physical contingency cost is not included in this project cost because each unit construction cost is estimated with some allowances. The construction cost for irrigation improvement plan is estimated as shown in Table J.2.4 and is summarized below;

Summary of Construction Cost for the Irrigation Improvement Plan

Category of Land	Sub-Area	Name of Canal	Code	Command Area (ha)	Length of Canal (km)	Number of Offtakes	Construction Cost (1000 Nu.)
Low Flat Area	Lobeysa	Upper Lobeysa	C1	61	7.1	32	1,152
		Lower Lobeysa	C2	300	8.1	52	3,027
	Bajo	Bajo	C9	143	15.0	35	5,016
High Hilly Area	Phangyul	Phangyul	C10	91	16.0	32	286
		Genkha	C15	15	3.5	12	47
	Rubeysa	Nalakha	C18	29	3.9	20	119
		Rutekha	C19	40	2.2	28	207
		Maphekha	C20	27	2.2	25	148
		Naykoyuwa	C21	24	1.7	20	119
		Rumina	C22	28	1.1	16	95
Total				758	60.8	272	10,216

Based on the implementation schedule discussed in Appendix H, the annual disbursement schedule is also set as shown below;

Proposed Disbursement Schedule for the Irrigation Improvement Project

(unit: 1000 Nu.)

Category of Land	Sub-Area	Name of Canal	Code	Year										
				1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Low Flat Area	Lobeysa	Upper Lobeysa	C1				230	922						
		Lower Lobeysa	C2		605	968	1,514							
	Bajo	Bajo	C9	2,257	1,756	1,003								
High Hilly Area	Phangyul	Phangyul	C10	257	79									
		Genkha	C15					47						
	Rubeysa	Nalakha	C18				71	48						
		Rutekha	C19		41	166								
		Maphekha	C20			15	133							
		Naykoyuwa	C21			83	36							
		Rumina	C22		95									
Research for the Optimum Diversification Crop						487	487	487	487	487	487	487	487	487
Annual Total				2,515	2,526	2,662	2,471	1,503	487	487	487	487	487	487

J.2.4 Total Project Cost

The total project cost for implementing the domestic water supply plan as well as the irrigation improvement plan are estimated at Nu. 289,900,000. For the domestic water supply plan, Nu. 275,300,000, consisting of Nu. 231,200,000 and Nu.44,100,000 are estimated for urban and the rural water supply plan, respectively. While, the total cost for irrigation improvement plan is estimated as Nu.14,600,000.

The total project cost and the total annual disbursement schedule are summarized as shown below.

Summary of Project Cost and Disbursement Schedule

(Unit: 1,000 Nu.)

Year order	Irrigation Improvement Plan	Domestic Water Supply Plan	Total
1997	2,515	5,308	7,823
1998	2,526	17,820	20,346
1999	2,662	80,629	83,291
2000	2,471	128,506	130,977
2001	1,503	23,116	24,619
2002	487	3,539	4,026
2003	487	1,769	2,256
2004	487	1,455	1,942
2005	487	6,898	7,385
2006	487	6,263	6,750
2007	487	0	487
Total	14,599	275,303	289,902

J.3 Operation and Maintenance Cost

J.3.1 Domestic Water Supply Plan

(1) Urban Water Supply System

The urban water supply system is to be operated and managed by the Dzongkhags administration. The PWD section of the Dzongkhag is responsible for the operation and management of water supply system from the intake to the distribution pipelines for house connections.

The operation and maintenance costs consist of the following items:

- the salary and other necessary expenditures for the operation and maintenance staff,
- the costs for electric charge to operate the distribution station,
- costs for chemicals which are applied for treating the distributed water such as chlorine and coagulant, and
- repairing costs for water supply system from the intake to the distribution pipeline

(2) Rural Water Supply System

The rural water supply system is to be operated by local inhabitants and to be maintained by Rural Water Supply and Sanitation Section of the Dzongkhag. The following operation and maintenance costs are estimated:

- the salary and necessary expenditures for the operation and maintenance staff,
- the electric cost to operate well pumps for lift up of groundwater, and
- repairing cost for water supply facilities

The annual operation and maintenance costs for both urban and rural water supply systems are estimated based on the above items as shown below.

Operation and Maintenance Costs for Domestic Water Supply Schemes

(Unit: NU.1,000)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Urban Water Supply	526.2	526.2	526.2	526.2	2,219.5	2,312.4	2,312.4	2,312.4	2,312.4	2,628.0	2,667.0
Rural Water Supply	282.0	335.1	405.9	431.3	582.7	704.0	739.4	757.1	771.6	796.5	815.1
Total	808.2	861.3	932.1	957.5	2,802.2	3,016.4	3,051.8	3,069.5	3,084.0	3,424.5	3,482.1

J.3.2 Irrigation Improvement Plan

The irrigation improvement plan is to be implemented by present organization considering the scale and the construction works of the project. Therefore, it is not required to establish any kind of new organization.

The operation and maintenance costs are classified into two categories as low flat area and high hilly area. The costs composed of the following items;

- For low flat area
  - O/M cost for canal maintenance
  - O/M cost for water management
  - Additional O/M cost for double cropping

- For high hilly area
  - O/M cost for water management
  - Additional O/M cost for crop diversification

The annual operation and maintenance cost are shown below.

Operation and Maintenance Cost for the Irrigation Water Supply

(unit: 1000 Nu.)

Category of Land	Sub-Area	Name of Canal	Code	Year										
				1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Low Flat Area	Lobeysa	Upper Lobeysa	C1						21	21	21	21	21	21
		Lower Lobeysa	C2					32	32	32	32	32	32	32
	Bajo	Bajo	C9				48	48	48	48	48	48	48	48
High Hilly Area	Phangyul	Phangyul	C10			58	58	58	58	58	58	58	58	58
		Genkha	C15						12	12	12	12	12	12
	Rubeysa	Nalakha	C18						15	15	15	15	15	15
		Rutekha	C19				10	10	10	10	10	10	10	10
		Maphekha	C20					9	9	9	9	9	9	9
		Naykeyuwa	C21					7	7	7	7	7	7	7
		Rumina	C22				5	5	5	5	5	5	5	5
Annual Total						62	120	168	216	216	216	216	216	216

J.3.3 Total Operation and Maintenance Cost

Based on the operation and maintenance cost for each plan, total O/M cost is summarized as shown below;

Total Operation and Maintenance Costs

(Unit: NU.1,000)

Description	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Water Supply	808	861	932	958	2,802	3,016	3,052	3,070	3,084	3,425	3,482
Irrigation Improvement			63	120	168	216	216	216	216	216	216
Total	808	861	994	1,077	2,970	3,233	3,268	3,286	3,300	3,641	3,698

APPENDIX J
TABLES

Table J.2.1 Direct Construction Cost of Urban Water Supply System

(Unit : 1000 Nu)

	Description	Unit	Quantity	Foreign currency		Local Currency		Total	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
1	Conveyance Facilities								
1.1	Conveyance pipeline, DCIP 200mm dia.								
	1.1.1 Excavation for DCIP pipeline								
	a. Excavation, rock	m	5,000		0	0.53	2,666	0.53	2,666
	b. Excavation, common	m	5,790		0	0.21	1,206	0.21	1,206
	1.1.2 Construction valve chamber	site	29		0	25.41	737	25.41	737
	1.1.3 Concrete for road crossing, pipe bending, aqueduct	site	110		0	13.96	1,535	13.96	1,535
	1.1.4 Restoration road	m	10,790		0	0.30	3,237	0.30	3,237
1.2	Plumbing and valve installation								
	1.2.1 Installation DCIP pipeline	m	10,790		0	0.10	1,036	0.10	1,036
	1.2.2 Installation valves	site	29		0	4.43	128	4.43	128
1.3	Pipe and valve materials								
	1.3.1 DCIP pipes, 200 mm dia.	m	10,790	3.18	34,265		0	3.18	34,265
	1.3.2 DCIP bend pipes, 200 mm dia.	pc	102	17.12	1,746		0	17.12	1,746
	1.3.3 Valves	pc	29	185.68	5,385		0	185.68	5,385
1.4	Transportation, insurance, etc.	FT	870	9.44	8,209		0	9.44	8,209
	Sub-total (1)				49,605		10,545		60,150
2	Treatment Facilities								
2.1	Raw water receiving pit	Lot	1		2,055		138		2,192
2.2	Water chemical mixing pipeline	Lot	1		717		68		785
2.3	Flocculator	Lot	1		14,493		644		15,138
2.4	Aluminum dosing system	Lot	1		15,548		10		15,559
2.5	Sedimentation tanks	Lot	1		3,165		720		3,885
2.6	Distribution reservoirs	Lot	1		3,221		2,304		5,525
2.7	Rapid sand filter	Lot	1		15,548		1,079		16,628
2.8	Waste water treatment pond	Lot	1		2,314		1,134		3,448
2.9	Operation house	m2	90	55.53	4,998	15.13	1,362	70.66	6,359
2.10	O & M Equipment, tools and material	LS	1		7,087		0		7,087
2.11	Electrical facility	LS	1		2,217		0		2,217
2.12	Approach road	m	80		0	8.27	662	8.27	662
2.13	Temporary construction road	m	40		0	10.22	409	10.22	409
2.14	Enforcement of concrete tanks	m2	700		0	4.67	3,272	4.67	3,272
2.15	Transportation, insurance, etc.	FT	600	20.41	12,246		0	20.41	12,246
	Sub-total (2)				83,609		11,802		95,412
3	Distribution networks								
3.1	SGP pipeline installation	m	4,760		0	0.36	1,701	0.36	1,701
3.2	Plumbing and valve installation	LS	1		0		2,470		2,470
3.3	Pipe and valve materials	m	4,760	1.08	5,119		0	1.08	5,119
3.4	House pipeline connection	House	1,000	7.02	7,020	0.78	780	7.80	7,800
	Sub-total (3)				12,139		4,951		17,091
	Total (1), (2), (3)				145,354		27,298		172,652

Table J.2.2 Annual Disbursement Schedule of Urban Water Supply System

(Unit : 1,000Nu)

No	Work Item	1997			1998			1999			2000			2001			2002		
		F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total
I	Direct Construction Cost							49,605	10,545	60,150	83,610	11,802	95,412	5,119	4,171	9,291			
1)	Conveyance Facilities							49,605	10,545	60,150									
2)	Water Treatment Facilities										83,610	11,802	95,412						
3)	Distribution Facilities													5,119	4,171	9,291			
II	Engineering Services				9,199	1,230	10,429	8,644	1,175	9,819	8,644	1,175	9,819	4,322	588	4,910			
	Subtotal (I to II)				9,199	1,230	10,429	58,249	11,720	69,969	92,254	12,977	105,231	9,441	4,759	14,200			
III	Administration Cost(3% of I+II)					313	313		2,099	2,099		3,157	3,157		426	426			
	Subtotal (I to III)				9,199	1,543	10,742	58,249	13,819	72,0680	92,254	16,134	108,388	9,441	5,185	14,626			
IV	Physical Contingency(10% of I)							4,961	1,054	6,0150	8,361	1,180	9,541	512	417	929			
	Grand Total				9,199	1,543	10,742	63,210	14,873	78,085	100,615	17,314	117,929	9,953	5,602	15,555			

No	Work Item	2003			2004			2005			2006			2007			Total		
		F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total
I	Direct Construction Cost							3,510	390	3,900	3,510	390	3,900				145,354	27,298	172,652
1)	Conveyance Facilities																49,605	10,545	60,150
2)	Water Treatment Facilities																83,610	11,802	95,412
3)	Distribution Facilities							3,510	390	3,900	3,510	390	3,900				12,139	4,951	17,091
II	Engineering Services																30,810	4,168	34,977
	Subtotal (I to II)							3,510	390	3,900	3,510	390	3,900				176,164	31,466	207,629
III	Administration Cost(3% of I+II)								117	117		117	117					6,229	6,229
	Subtotal (I to III)							3,510	507	4,017	3,510	507	4,017				176,164	37,694	213,858
IV	Physical Contingency(10% of I)							351	39	390	351	39	390				14,535	2,730	17,265
	Grand Total							3,861	546	4,407	3,861	546	4,407				190,699	40,424	231,123

Note; 1)Exchange Rate:US$1.00=Nu.30.85=Yen100.0

Table J.2.3 Summary of Cost Estimation for Rural Water Supply System (1/5)

(unit: : Nu)

Category of Development Methods	Case S-1 and Case S-3 (Spring Water, Large)				
Description	Unit	Quantity	Unit Price	Amount	Remarks
INTAKE FACILITIES					
Spring intake and					
Collection tank(3 m3)	site	3	157,774.0	473,322	
TRANSMISSION FACILITIES					
Reservoir tank					
10 m3 tank	No	1	85,601.0	85,601	
Pipelines					
HDPE pipeline(20 mm dia.)	m	3,000	60.8	182,400	
DISTRIBUTION FACILITIES					
Pipelines					
HDPE pipeline(20 mm dia.)	m	12,500	60.8	760,000	
Break pressure tank	No	5	25,002.0	125,010	
Public tap	No	15	6,106.0	91,590	
Total				1,717,923	
Category of Development Methods	Case S-2 and Case S-4 (Spring Water, Small)				
Work	Unit	Quantity	Unit Price	Amount	Remarks
INTAKE FACILITIES					
Spring intake and					
Collection tank(3 m3)	site	1	157,774.0	157,774	
TRANSMISSION FACILITIES					
Pipelines					
HDPE pipeline(20 mm dia.)	m	2,500	60.8	152,000	
Break pressure tank	No	1	25,002.0	25,002	
DISTRIBUTION FACILITIES					
Public tap	No	3	6,106.0	18,318	
Total				353,094	
Category of Development Methods	Case T-1 (Water Treatment)				
Work	Unit	Quantity	Unit Price	Amount	Remarks
TREATMENT FACILITY					
Iron filtration system					
Filtration tank(1 m3)	No	1		25,000	
Mangan sand	m3	1	140,000.0	98,000	
Gravel	m3	0	310.0	93	
HDP Strainer	m	4	415.0	1,660	
Dismantling of existing tank	No	1		9,600	
Total				134,353	

Table J.2.3 Summary of Cost Estimation for Rural Water Supply System (2/5)

(unit: : Nu)

Category of Development Methods	Case B-1 (Groundwater, Large)				
Work	Unit	Quantity	Unit Price	Amount	Remarks
INTAKE FACILITIES					
Deep well					
50 m depth, 10 inch dia.	well	1		824,400	
Well pump					
Electrical facilities					
200 l/m*60m*5.5kw	Lot	1		450,000	
Electrical facilities	Lot	1		361,800	
TRANSMISSION FACILITIES					
Elevated reservoir(Panel tank)					
15 m3 tank	No	1		1,833,638	
Pipelines					
GI pipeline(60 mm dia.)	m	500	515.8	257,900	
DISTRIBUTION FACILITIES					
Pipelines					
HDPE pipeline(20 mm dia.)	m	7,000	60.8	425,600	
Public tap	No	20	6,106.0	122,120	
Total				4,275,458	

Category of Development Methods	Case B-1 (Sub-surface water, Large)				
Work	Unit	Quantity	Unit Price	Amount	Remarks
INTAKE FACILITIES					
Shallow well(Liner plate)					
7m depth, 3.5 m dia.	well	1		1,001,834	
Well pump					
200 l/m*30m*2.2kw	Lot	1		338,000	
Electrical facilities	Lot	1		361,800	
TRANSMISSION FACILITIES					
Elevated reservoir(Panel tank)					
15 m3 tank	No	1		1,833,638	
Pipelines					
GI pipeline(60 mm dia.)	m	500	515.8	257,900	
DISTRIBUTION FACILITIES					
Pipelines					
HDPE pipeline(20 mm dia.)	m	7,000	60.8	425,600	
Public tap	No	20	6,106.0	122,120	
Total				4,340,892	

Table J.2.3 Summary of Cost Estimation for Rural Water Supply System (3/5)

(unit: : Nu)

Category of Development Methods	Case B-2 (Groundwater, Small)				
Work	Unit	Quantity	Unit Price	Amount	Remarks
INTAKE FACILITIES					
Deep well					
50 m depth, 10 inch dia.	Well	1		824,400	
Well pump					
Electrical facilities					
100 l/m*60m*2.2kw	No	1		302,000	
Electrical facilities	Lot	1		361,800	
TRANSMISSION FACILITIES					
Elevated type reservoir(Panel tank)					
7 m3 tank	No	1		1,252,370	
Pipelines					
GI pipeline(50 mm dia.)	m	500	345.7	172,850	
DISTRIBUTION FACILITIES					
Pipelines					
HDPE pipeline(20 m dia.)	m	2,000	60.8	121,600	
Public tap	No	5	6,106.0	30,530	
Total				3,065,550	

Category of Development Methods	Case B-2 (Sub-surface Water, Small)				
Work	Unit	Quantity	Unit Price	Amount	Remarks
INTAKE FACILITIES					
Shallow well(Liner plate)					
7 m depth, 3.5 m dia	well	1		1,063,934	
Well pump					
100 l/m*30m*1.5kw	No	1		270,000	
Electrical facilities	Lot	1		361,800	
TRANSMISSION FACILITIES					
Elevated type reservoir(Panel tank)					
7 m3 tank	No	1		1,252,370	
Pipelines					
GI pipeline(50 mm dia.)	m	500	345.7	172,850	
DISTRIBUTION FACILITIES					
Pipelines					
HDPE pipeline(20 m dia.)	m	2,000	60.8	121,600	
Public tap	No	5	6,106.0	30,530	
Total				3,316,684	

Table J.2.3 Summary of Cost Estimation for Rural Water Supply System (4/5)

(unit: : Nu)

Category of Development Methods	Case L-1 (Spring Water, Large)				
Work	Unit	Quantity	Unit Price	Amount	Remarks
INTAKE FACILITIES					
Spring intake and					
Collection tank(3 m3)	Site	6	157,774.0	946,644	
TRANSMISSION FACILITIES					
Ground type reservoir					
25 m3 tank	No	1		130,137	
Pipelines					
HDPE pipeline(20 mm dia.)	m	6,000	60.8	364,800	
DISTRIBUTION FACILITIES					
Pipelines					
HDPE pipeline(20 mm dia.)	m	12,500	60.8	760,000	
Break pressure tank	No	5	25,002.0	125,010	
Tap stands	No	15	6,106.0	91,590	
Total				2,418,181	
Category of Development Methods	Case L-1 (Groundwater, Large)				
Work	Unit	Quantity	Unit Price	Amount	Remarks
INTAKE FACILITIES					
Deep well					
80 m depth, 10 inch dia.	Well	1		1,156,680	
Well pump	No	1		585,000	
400l/m*100*15kw					
Electrical facilities	Lot	1		361,800	
TRANSMISSION FACILITIES					
Reservoir tank					
25 m3 tank	No	1		130,137	
Pipelines					
GI pipe,(80 mm dia.)	m	1,000	628.0	628,000	
DISTRIBUTION FACILITIES					
Pipelines					
HDPE pipeline(20 mm dia.)	m	12,500	60.8	760,000	
Break pressure tank	No	5	25,002.0	125,010	
Tap stands	No	15	6,106.0	91,590	
Total				3,838,217	

Table J.2.3 Summary of Cost Estimation for Rural Water Supply System (5/5)

(unit: : Nu)

Category of Development Methods	Case L-2 (Spring Water, Small)				
Work	Unit	Quantity	Unit Price	Amount	Remarks
INTAKE FACILITIES					
Spring intake and					
Collection tank(3 m3)	Site	1		157,774	
TRANSMISSION FACILITIES					
Pipelines					
HDPE pipeline(20 mm dia.)	m	7,500	60.8	456,000	
Break pressure tank	No	1		25,002.00	
DISTRIBUTION FACILITIES					
Public tap	No	3	6,106.0	18,318	
Total				657,094	
Category of Development Methods	Case L-2 (Groundwater, Small)				
Work	Unit	Quantity	Unit Price	Amount	Remarks
INTAKE FACILITIES					
Deep well					
80 m depth, 10 inch dia.	Well	1		1,156,680	
Well pump	No	1		362,000	
100l/m*80*2.8kw					
Electrical facilities	Lot	1		361,800	
TRANSMISSION FACILITIES					
Reservoir tank					
3 m3 tank	No	1		64,936	
Pipelines					
GI pipe,(50 mm dia.)	m	1,000	345.7	345,700	
DISTRIBUTION FACILITIES					
Pipelines					
HDPE pipeline(20 mm dia.)	m	4,500	60.8	273,600	
Break pressure tank	No	1	25,002.0	25,002	
Tap stands	No	3	6,106.0	18,318	
Total				2,608,036	

Table J.2.4 Construction Cost of Irrigation Improvement Plan (1/2)

Canal Code	Name	Command Area (ha)	Canal Length (km)	Design Discharge (l/s)
C1	Upper Lobeysa	61	7.1	88
Description	Unit	Quantity	Unit Price	Amount
Canal Works				
Masonry Canal Type M3	m	245.00	862.08	211,210
Earth Lining Canal Type S3	m	6855.00	38.79	265,891
Chute Type C5	m (height)	8.80	1,576.20	13,871
Chute Type C6	m (height)	66.41	1,485.50	98,652
Offtake Works Type 05	unit	32.00	5,708.81	182,682
Sub Total				772,306
Protection Works				
Protection Works Type PA4	m	7.00	6,167.59	43,173
Protection Works Type PB4	m	25.00	1,962.70	49,067
Protection Works Type PC4	m	25.00	5,178.40	129,460
Protection Works Type PD4	m	133.20	1,038.96	138,390
Steel Flume Aqueduct Type SFA4	m	3.60	3,816.52	13,739
Pipe Canal Type PPC3	m	5.00	1,125.81	5,629
Sub Total				379,459
Total Construction Cost				1,151,765

Canal Code	Name	Command Area (ha)	Canal Length (km)	Design Discharge (l/s)
C2	Lower Lobeysa	300	8.1	434
Description	Unit	Quantity	Unit Price	Amount
Canal Works				
Masonry Canal Type M1	m	871.00	1,292.20	1,125,509
Earth Lining Canal Type S1	m	7229.00	59.40	429,384
Chute Type C1	m (height)	99.55	2,051.54	204,230
Chute Type C3	m (height)	40.97	1,703.41	69,789
Offtake Works Type 01	unit	52.00	11,512.24	598,637
Sub Total				2,427,548
Protection Works				
Protection Works Type PA1	m	21.50	6,487.69	139,485
Protection Works Type PB1	m	23.10	2,729.24	63,045
Protection Works Type PC1	m	23.10	5,152.75	119,028
Protection Works Type PD1	m	149.40	1,476.10	220,530
Steel Flume Aqueduct Type SFA1	m	5.80	6,740.98	39,098
Pipe Canal Type PPC	m	9.62	1,949.25	18,752
Sub Total				599,939
Total Construction Cost				3,027,487

Table J.2.4 Construction Cost of Irrigation Improvement Plan (2/2)

Canal Code	Name	Command Area (ha)	Canal Length (km)	Design Discharge (l/s)
C9	Bajo	143	15	210
Description	Unit	Quantity	Unit Price	Amount
Canal Works				
Masonry Canal Type M2	m	614.00	1,238.28	760,301
Earth Lining Canal Type S2	m	14,386.00	50.92	732,485
Chute Type C2	m (height)	18.00	2,255.39	40,597
Chute Type C4	m (height)	162.00	1,935.38	313,531
Offtake Works Type 4	unit	35.00	9,810.81	343,378
Sub Total				2,190,293
Protection Works				
Protection Works Type PA2	m	235.90	7,602.83	1,793,507
Protection Works Type PB2	m	39.90	2,790.93	111,358
Protection Works Type PC2	m	39.90	6,250.68	249,402
Protection Works Type PD2	m	176.70	1,525.62	269,577
Steel Flume Aqueduct Type SFA2	m	39.24	6,708.75	263,251
Pipe Canal Type PPC 2	m	82.18	1,683.45	138,346
Sub Total				2,825,442
Total Construction Cost				5,015,735
Canal Code	Name	Command Area (ha)	Canal Length (km)	Design Discharge (l/s)
C10	Phangyul	91	16	150
Description	Unit	Quantity	Unit Price	Amount
Offtake Works Type 4	unit	32	8,924	285,568
Canal Code	Name	Command Area (ha)	Canal Length (km)	Design Discharge (l/s)
C15	Gemkha	15	3.5	26
Description	Unit	Quantity	Unit Price	Amount
Offtake Works Type 7	unit	12	3,893	46,716
Canal Code	Name	Command Area (ha)	Canal Length (km)	Design Discharge (l/s)
C18	Nalakha	29	3.9	48
Description	Unit	Quantity	Unit Price	Amount
Offtake Works Type 6	unit	20	5,939	118,780
Canal Code	Name	Command Area (ha)	Canal Length (km)	Design Discharge (l/s)
C19	Rutekha	40	2.2	65
Description	Unit	Quantity	Unit Price	Amount
Offtake Works Type 5	unit	28	7,403	207,284
Canal Code	Name	Command Area (ha)	Canal Length (km)	Design Discharge (l/s)
C20	Maphekha	27	2.2	45
Description	Unit	Quantity	Unit Price	Amount
Offtake Works Type 6	unit	25	5,939	148,475
Canal Code	Name	Command Area (ha)	Canal Length (km)	Design Discharge (l/s)
C21	Naykoyuwa	24	1.7	40
Description	Unit	Quantity	Unit Price	Amount
Offtake Works Type 6	unit	20	5,939	118,780
Canal Code	Name	Command Area (ha)	Canal Length (km)	Design Discharge (l/s)
C22	Rumina	28	1.1	50
Description	Unit	Quantity	Unit Price	Amount
Offtake Works Type 6	unit	16	5,939	95,024

APPENDIX K
PROJECT EVALUATION

THE STUDY
ON
GROUNDWATER DEVELOPMENT
IN
WANGDUEPKODRANG DISTRICT OF BHUTAN

FINAL REPORT

VOLUME III: SUPPORTING REPORT

APPENDIX-K PROJECT EVALUATION

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APPENDIX-K PROJECT EVALUATION

K.1 BASIS OF EVALUATION

K.1.1 Approach

The project evaluation method to assess a Water Resources Development Plan for validity of its implementation includes economic evaluation, financial evaluation and socio-economic evaluation (effect). Emphasis is placed on the economic evaluation since the main objectives of the Plan are agricultural development by irrigation water supply and urban and rural water supply development, and public profitability is also emphasised. The financial evaluation is oriented to the farm household economic analysis and water charge. The basic approach of the project evaluation confirms to the methodology and guide line adopted by the international financial organisations and the adopted parameters are related to MOA of Bhutan.

K.1.2 Conditions of Evaluation

The evaluation criteria used in the estimation of economic and financial evaluations are as follows:

a. The project life is set as 30 years from the commencement of the Plan including detailed design period and construction works period, considering the working life periods of the main facilities.

b. The currency used for the estimation is the money of the Bhutan Ngultrum(Nu).

c. The foreign exchange rate used set as US$ 1.00 = Nu 30.85 as monthly average rate of the official foreign exchange rate of the Royal Monetary Authority of Bhutan (RMA) as of July 1995.

d. The prices of agricultural products are farm-gate prices and the prices of agricultural production input materials and construction materials are prices on delivery at the production and construction sites.

e. The economic discount rate applied in the evaluation is 10%. This figure represents the opportunity cost of capital for the country, as estimated in recent studies (Study on Promotion of Export Oriented Industries, 1991; Bhutan Power System Master Plan, 1993; An Analysis of Comparative Advantage and Development Policy Options in Bhutanese Agriculture, 1995; etc.).

K.2 BENEFIT AND COST OF THE PLAN

The project evaluation is made on the Water Resources Development Plan in the Study Area which comprises of the following plans:

a. Agricultural Development Plan including Irrigation Improvement Plan

b. Urban and Rural Water Supply Plans including Wangduephodrang Town Plan

K.2.1 Estimation of Benefit

The benefit of the Plan refers to a difference of net profit expected between With Project and Without Project conditions under the water resources development plan through the whole project life. The project benefits consist of tangible benefits, i.e. an increase in agricultural production, supply of safe and stable water, a saving effect of operation and maintenance cost of irrigation and/or urban and rural water supply systems, an increase of returns of farmers, etc. and intangible benefits such as a stabilised food supply, a creation of employment opportunities, an improvement of living standard of inhabitants, etc. Tangible benefit is directly subjected to economic and financial evaluations, while intangible benefit is analysed for socio-economic effects.

K.2.2 Agricultural Production Benefit

(1) Generation of Benefit

The agricultural production benefit is derived from an increase in cropping rate, a change of cropping pattern, introduction of crop diversification, etc., which are resulted from improvement of the irrigation systems and effective production practices. The proposed agricultural development plan is prepared on condition that most of the farmers in the Study Area would receive some technical assistance from the Government of Bhutan.

(2) Annual Variation of Benefit Accrual

In the case of With Project condition, the gestation period before maturing of agricultural production is one year, since this plan of rehabilitation and construction works don't disturb the production system during long time. The benefit is generated from the next year after the completion of construction works for the area which can be irrigated and the targeted benefit is attained on the same year after completion of construction works.

On the other hand, for the Without Project condition, some increase in agricultural production is attainable by effects except for the implementation of the Plan, but at the same time some decrease of production is also expected on account of inappropriate operation and maintenance of the existing irrigation systems, etc. Accordingly, the production on the Without Project condition would not be changed and remain constant as the present condition.

AGRICULTURAL PRODUCTION BENEFIT

(Unit: 1,000 Nu.)

Item	With Project	Without Project	Increased Value
Gross Production Value	14,800	11,500	3,300
Production Cost	6,900	5,300	1,600
Net Production Value	7,900	6,200	1,700

Annual net production value on the With Project condition is about Nu. 7.9 million and about 1.28 times as on the Without Project condition, and the annual agricultural production benefit is about Nu. 1.7 million

(3) Saving Effect of Operation and Maintenance Cost

Actual operation and maintenance cost with a value of Nu.325 thousand per year is a considerable project benefit because of saving effect by canal improvement.

K.2.3 Urban and Rural Water Supply Benefit

In order to determine the unit water value of domestic use water corresponding to the willingness to pay, the water requirement is divided into two categories, minimum requirement of water for living (45 l/p/d) and the rest. Willingness to pay could only be proved at the minimum level for living.

Inhabitants who have no water supply service must go to streams or springs and obtain limited living water. The quantity of water on one trip is averaging 20 litters and it needs about 2 hours for going and returning. A laborious wage in rural area is approximately Nu. 55 including meals and drink values, hence, 2 hours labour has a value of Nu. 13.75. Therefore, it is assumed that people would pay Nu. 687.5/m^3 to get 45 l/p/d of water for living for the Without Project condition.

WATER VALUE ESTIMATION OF MINIMUM WATER FOR LIFE

Description	Water Value
Average Rural Wage (Agriculture at 1995)	55 Nu./day
Average Rural Wage Value for 2 hours	13.75 Nu/20 litters
Water value	687.5 Nu./m^3

In case of water used for the purposes other than the minimum requirement, the following consideration is made :
If a minimum wage earner brings home Nu. 1,400 at the end of a month, he may give his consent to pay its three percent for water rate, and if his family of five uses 18.75 m^3 per month (125 l/p/d), the unit rate per cubic meter would be Nu. 2.24.
Hence, the level of willingness to pay hovers between Nu. 2.24 and 687.5. As a result, it is assumed that it is equivalent to the unit cost per cubic meter, estimated at Nu. 4.53, which comprise capital expenditure and operational cost of water supply activities for the Wangduephodrang town.

WATER VALUE ESTIMATION OF ACTUAL WATER SUPPLY SYSTEM

Description Total water production	per year (thou. m^3) 285		per day (m^3) 780	
Description	Cost	Present value		
		(thou. Nu. at 1995)	(thou. Nu./year)	(Nu./m^3)
Capital expenditure I (1969, thou. Nu. at 1990)	1,350	2,255	75.2	0.26
Capital expenditure II (1991,thou. Nu. at 1991)	2,627	4,072	407.2	1.43
Total capital expenditure		6,326	482.3	1.69
Total monthly O/M cost (Nu. at 1995)	67,333		808.0	2.84
Total value				4.53

The benefits attained from an increased water supply are as follows:

URBAN AND RURAL WATER SUPPLY BENEFIT

(Unit: 1,000 Nu.)

Item	With Project	Without Project	Increased Value
Urban Water Supply	112,800	71,100	41,700
Rural Water Supply	41,100	18,500	22,600
Total	153,900	89,600	64,300

Total annual net water value on the With Project condition is about Nu. 154 million and about 1.72 times as on the Without Project condition, and the annual water supply benefit is about Nu. 64 million.

The supply rate of safe and stable water in the Study Area is low. Many inhabitants are obliged to use surface water, such as river and canal water, which is contaminated by domestic sewerage and animal excrement. For these inhabitants, the health and hygienic environment is extremely poor and the occurrence rate of waterborne diseases is high. The benefit from the urban and rural water supply plan is also considered as the decrease of these diseases and the improvement of living standard of inhabitants. However, this benefit is considered as intangible.

K.2.4 Project Costs

Capital cost for the Plan totals Nu. 290 million, over the 10 year construction period and agricultural research activities, as summarised as shown below. The project costs include the cost of construction of irrigation facilities and water supply facilities.

PROJECT COST

(Unit: 1,000 Nu.)

Year order	Irrigation Facilities	Water Supply Facilities	Total
1	2,515	5,308	7,823
2	2,526	17,820	20,346
3	2,662	80,629	83,291
4	2,471	128,506	130,977
5	1,503	23,116	24,619
6	487	3,539	4,026
7	487	1,769	2,256
8	487	1,455	1,942
9	487	6,898	7,385
10	487	6,263	6,750
11 -	487	0	487

Annual operation and maintenance (O & M) costs after the completion of the construction works are included during the operation period, Nu. 216 thousand and Nu. 2,674 thousand on irrigation facilities and water supply facilities, respectively. With the project evaluation period applied, 30 years, no replacement of equipment is included. Salvage values at the end of the evaluation period are not included.

K.3 ECONOMIC EVALUATION

K.3.1 Evaluation Criteria

The economic evaluation is to analyse economic effect of the implementation of the Plan on the basis of economic benefit and economic cost as computed at economic prices in the light of national economy. Based on the incremental benefit and the project cost (initial investment cost or capital cost) and operation and maintenance cost of the Plan, all the prices are converted into economic prices.

The evaluation uses three relevant indexes: economic net present value (ENPV), economic benefit-cost ratio (E.B/C) and economic internal rate of return (EIRR). The benefit and cost of the Plan which are estimated based on the implementation schedule of the Plan are discounted by the opportunity cost of capital through the project life. The term ENPV is a difference between accumulated benefit and accumulated cost, and E.B/C is the ratio of the former to the latter. The term EIRR means a discount rate by which accumulated benefit is equalised to accumulated cost.

The criteria to economically validate the implementation of the Plan are that ENPV is positive, E.B/C is more than 1 and EIRR exceeds the opportunity cost of capital. The opportunity cost of capital (discount rate) is social marginal productivity of capital input in the Plan, and the discount rate is considered to be 10%.

K.3.2 Price Conversion

The evaluation in economic prices corrects financial prices (market prices) to reflect distortions in the impacts of taxes, subsidies, rents, foreign exchange rate, etc., and possibly to reflect distortions of prices of trade commodity and wages. The adjusted set of prices is used in the evaluation of the cost and benefit of the Plan, reflecting their true resource values and thus determining the true economic returns from the Plan to Bhutan.

The economic prices used in the economic estimation correspond to shadow prices. To obtain shadow prices, market prices are subtracted by transfer items other than real resources used for the Plan, and the differences obtained are multiplied by the conversion factors to correct distortions of the market prices. However, these conversion factors are not established by the Government of Bhutan.

On the other hand, the Ngultrum is tied to the Indian Rupee at a value of one to one and this situation is likely to remain in the foreseeable future, in view of the close ties between the two economies. In this sense, the export and import products with India could be likened to sales of products within Bhutan.

Hence, standard conversion factor and shadow prices are not applied for this economic evaluation because of the difficulty in obtaining basic and adequate economic data. As a sensitivity analysis, however, a standard conversion factor (SCF) of 0.8 is applied to local costs.

K.3.3 EIRR, ENPV and E.B/C

The cash flow for benefit and cost of the Plan is prepared including each of the following plan to assets the economic viability:

a. Agricultural development plan
b. Water supply plan for the Wangduephodrang Town
c. Water supply plan for the rural areas
d. The whole of the water resources development plan (a+b+c)

The period of evaluation is 30 years of the whole project life. If the evaluation proves that EIRR exceeds the opportunity cost of capital of 10%, ENPV is positive and E.B/C exceeds 1, it will be judged that the implementation of the Plan is economically validated.

The flow of project cost, operation and maintenance cost and the project benefit of the whole Plan are shown in Table K.3.3. In original case, EIRR is 15.4% and at discount rate of 10%, ENPV is Nu. 127 million at price for July 1995, E.B/C is 1.53 at the same discount rate. Project evaluation has proven that EIRR exceeds the opportunity cost of capital 10%, ENPV is positive and E.B/C exceeds 1. It is judged that the implementation of the Plan is economically sound.

K.3.4 Sensitivity Analysis

Sensitivity analysis is done to estimate the variation of the main factors of the project evaluation, and made under the following conditions: 1) 10% increase of the project cost, 2) 10% decrease of the project benefit and 3) 1 year delay of the completion of the construction works.

Increase in the estimated project cost is attributed to rise of construction material cost and wage and increase in work volume. Decrease in the project benefit is attributed to increase in the estimated production cost, reduction in the expected yield and fall in farm-gate price of agricultural product, and delay of the completion of the construction works means delay in occurrence of the benefit.

SENSITIVITY ANALYSIS OF ECONOMIC EVALUATION

Item	EIRR (%)	ENPV (1,000 Nu.)	E.B/C
Base	15.4	126,849	1.53
Project cost increased by 10%	14.2	104,528	1.40
Project benefit decreased by 10%	14.0	90,264	1.38
Construction delayed for 1 year	13.7	91,390	1.38

Sensitivity analysis has proven that a change in the construction period has stronger influence on economy of the Plan than a change in project cost and project benefit.

A standard conversion factor (SCF) of 0.8 has been applied to local cost components, resulting in an EIRR of 16.8% and at discount rate of 10%, ENPV is Nu. 149 million, and E.B/C is 1.68 at the same discount rate.

K.3.5 Urban Water Supply Plan for Wangduephodrang Town

(1) EIRR, ENPV and E.B/C

The flow of project cost, operation and maintenance cost and the project benefit of only the urban water supply plan for the Wangduephodrang town are shown in Table K.3.4.4. EIRR of the Plan is 11.1% and at discount rate of 10%, ENPV is Nu. 20.9 million at price for July 1995, and E.B/C is 1.11 at the same discount rate. Project evaluation has proven that EIRR exceeds the opportunity cost of capital 10%, ENPV is positive and E.B/C exceeds 1. It is judged that the implementation of this Plan is economically sound.

EIRR is a little larger than the opportunity cost of capital of 10%. However, this Plan is considered profitable in case that the intangible benefits such as health conditions and living standards in the Wangduephodrang town are taken into account.

(2) Sensitivity Analysis

The result of sensitivity analysis is shown as follows:

SENSITIVITY ANALYSIS OF URBAN WATER SUPPLY PLAN

Item	EIRR (%)	ENPV (1,000 Nu.)	E.B/C
Base	11.1	20,867	1.11
Project cost increased by 10%	10.2	3,122	1.02
Project benefit decreased by 10%	10.0	11	1.00
Construction delayed for 1 year	10.0	567	1.00

Sensitivity analysis has proven that a change in the construction period has stronger influence on economy of the Plan than a change in project cost and project benefit.

A standard conversion factor (SCF) of 0.8 has been applied to local cost components, resulting in an EIRR of 11.7% and at discount rate of 10%, ENPV is Nu. 31.1 million, and E.B/C is 1.17 at the same discount rate.

K.3.6 Irrigation Improvement Plan

(1) EIRR, ENPV and E.B/C

The flow of project cost, operation and maintenance cost and the project benefit of only the irrigation improvement plan of the agricultural development plan are shown in Table k.3.5. In the original case, EIRR of the Plan is 11.2% and at discount rate of 10%, ENPV is Nu. 525 thousand at price for July 1995, and E.B/C is 1.09 at the same discount rate. Project evaluation has proven that EIRR exceeds the opportunity cost of capital 10%, ENPV is positive and E.B/C exceeds 1. It is judged that the implementation of this Plan is economically sound. The EIRR is a little larger than that of the whole agricultural development plan of 10.7%.

(2) Sensitivity Analysis

The result of sensitivity analysis is shown as follows:

SENSITIVITY ANALYSIS OF IRRIGATION IMPROVEMENT PLAN

Item	EIRR (%)	ENPV (1,000 Nu.)	E.B/C
Base	11.2	525	1.99
Project cost increased by 10%	10.1	28	1.00
Project benefit decreased by 10%	10.2	76	1.01
Construction delayed for 1 year	10.0	-13	1.00

Sensitivity analysis has proven that a change in the construction period has stronger influence on economy of the Plan than a change in project cost and project benefit.

A standard conversion factor (SCF) of 0.8 has been applied to local cost components, resulting in an EIRR of 17.0% and at discount rate of 10%, ENPV is Nu. 2.6 million, and E.B/C is 1.59 at the same discount rate.

K.4 FINANCIAL EVALUATION

K.4.1 Evaluation Criteria

The financial evaluation is to evaluate soundness of financial state of the Plan which generate justifiable profit by the implementation of the Plan, from the viewpoint of project execution organisation and/or beneficiary based on financial benefit and financial cost with financial prices (market prices).

K.4.2 FIRR, FNPV and F.B/C

The evaluation uses three relevant indexes as same as the economic evaluation; financial net present value (FNPV), financial benefit-cost ratio (F.B/C) and financial internal rate of return (FIRR). The benefit and cost of the Plan which are estimated based on the implementation schedule of the Plan are discounted by the financial discount rate through the project life. The term FNPV is a difference between accumulated benefit and accumulated cost, and F.B/C is the ratio of the former to the latter. The term FIRR means a discount rate by which accumulated benefit is equalised to accumulated cost.

The criteria to financially validate the implementation of the Plan are that FNPV is positive, F.B/C is more than 1 and FIRR exceeds the financial discount rate. The financial discount rate of 10%, which is the rate of interest of fixed deposit on the Royal Monetary Authority of Bhutan, is applied for the evaluation.

Calculation would give basically the same results as the calculations presented above in the economic evaluation, for reasons related to the approach adopted. At this stage, therefore, no such analysis is presented.

K.4.3 Farm Household's Economic Analysis

(1) Water Resources Development Plan

Direct beneficiaries of the Water Resources Development Plan are farmers in the Study Area through the implementation of the agricultural development plan. Agricultural net returns have been calculated deducting production costs from gross production values.

AGRICULTURAL NET RETURNS

(Unit: Nu.)

Sub-Area	Condition	per Farm Household	per hectare
Lobeysa	Without Project	14,450	9,607
	With Project	18,622	12,380
Bajo	Without Project	25,762	9,368
	With Project	34,310	12,476
Phangyul	Without Project	8,141	4,992
	With Project	10,202	6,256
Rubeysa	Without Project	5,111	5,807
	With Project	5,915	6,719
Average	Without Project	11,814	8,178
	With Project	15,084	10,442

After the completion of the Plan, expected annual agricultural net returns are increased in the range between 1.16 and 1.33 times (average is 1.28 times) in comparison of Without Project. Increased value of agricultural net returns are in the range between Nu. 804 and Nu.8,548 (average is Nu. 3,270) which is equivalent to 0.57 to 6.11 man-month of the minimum wages (Nu. 1,400). The effect of the Plan is the largest in the Bajo sub-area.

(2) Irrigation Improvement Plan

After the completion of the Irrigation Improvement Plan which includes the Bajo Canal 9 Improvement Plan and the Phangyul Canal 10 Improvement Plan, expected annual agricultural net returns are increased by 1.29 and 1.26 times respectively in comparison of Without Project. Increased value of agricultural net returns are Nu.8,548 and Nu. 2,642 which are equivalent to 6.11 and 1.89 man-month of the minimum wages (Nu. 1,400).

K.4.4 Water Charge Analysis

Charging of water has the dual purposes of reducing excessive consumption and to cover the costs involved in operating, maintaining and renewing the system. To make the water supply plan successful, at least the operation and maintenance costs should be paid by the beneficiaries. However, a deep-rooted conviction remained in the minds of the people that water would be provided free of charge by the Government, especially in the rural areas.

(1) Water Supply Plan for Rural Areas

The participation of inhabitants would be very important for the development of a water supply plan. Without their participation, the chances of a successful plan would be slim. It is possible to utilise the inhabitant's labour services in the construction works. The inhabitants would also be allowed to participate in the operation and maintenance works with a view to promoting their enthusiasm for the Plan. Also, the PWD and Dzongkhag are that the Water Supply System would be self-supporting through the participation of the inhabitants.

(2) Water Supply Plan for Wangduephodrang Town

After the completion of the Plan, annual operation and maintenance cost is increased by 5.07 times in comparison of Without Project from Nu. 526 thousand to Nu. 2,667 thousand. Until now, Wangduephodrang town has not charged water tariff for water supply service. Thimphu and Phuntsholing have been the only towns where consumers are required to pay for water. Recently, the Urban Water and Sewerage Project in Thimphu is proceeding by the Thimphu City Corporation. This project provides new tariff rates for water supply which are risen after 20 m^3 per month. According to this new rates, a household of five persons using a normal amount of water, will have to pay approximately Nu. 25.0 a month.

If Wangduephodrang Dzongkhag would apply the same water tariff system, after the completion of the Plan, Dzongkhag or City Corporation could charge Nu. 564 thousand which values approximately 21% of the whole operation and maintenance cost.

K.5 SOCIO-ECONOMIC EVALUATION

As stated before, the Plan brings about direct, tangible benefit as well as the secondary or indirect, intangible benefit, which is important in reviewing validity of the implementation of the Plan.

(1) Contribution to the National Development Plan

Implementation of the Plan contributes to the national development in ensuring accomplishment of many objectives of the agricultural development and water supply plans, which are the important political policies of the agricultural and water supply sectors of the national development plan.

(2) Stable Supply of Food

Bhutan is 66% self-sufficient in all cereals. It is virtually self sufficient in maize, barley, millet and buckwheat, but it is only 52% self-sufficient in rice and only 24% self sufficient in wheat. To meet the food deficits cereals are imported from India.

Productions of rice and wheat, which are the basic major crops, are maintained and become stable with irrigation agricultural method. Furthermore, diversity of agricultural production becomes possible, because of new crop introduction such

as vegetables, and stable supply of food will be available for people and contributes to improve of self-sufficiency rate.

(3) Improvement of Living Standard

As evidently proven by the financial evaluation, farmer's economic surplus is increased to a great extent by the implementation of the Plan. A rapid increase in funds in farmer's economy by far exceeds cost of improving living environment.

(4) Water Quantity and Quality Improvement

Improvement of drinking water supply has two aspects, quantity and quality. The former is by far the dominant factor, as quality is always attained by the treatment of water. Increase of water supply would give tremendous impact on the domestic users.

Increase of the water supply to the existing distribution system would reduce the area and time of suppressed use and it will result in reduction of a chance for the poor who will suffer from water-borne diseases like diarrhoea, typhoid, cholera, worm infestations (hepatitis), especially in the hot rainy season when water is contaminated.

Expansion of the water supply area would result in the overall improvement of the marginal areas of the town economically and ecologically and has two folded effects. This is the area where quality aspect of the drinking water would need keen attention. It would reduce the incidents of epidemics of water-borne diseases by enhancing the standard of hygiene. This would contribute to build-up of better human resources in the area. At the same time it would liberate may womenfolk and children from the laborious task of carrying water from sources some distance away from the home.

(5) Economical Stimulation

As stated, the implementation of the Plan increases the income of local farmer and improves the living standard to a great extent. Improved income further increases purchasing power of the local farmer and vitalises local commercial activities. Increased purchase power and vigorous commercial activities are expected to promote local industries. In this way, the implementation of the Plan will bring about significant repercussive effect to Wangduephodrang district and finally to the economy of Bhutan, and not limited to the Study Area.

(6) Environmental Consideration

The environmental impacts and influence on the confirmed environmental elements especially ground water are summarised as follows: Ground water potential is rather poor in the Study Area except for limited areas. Therefore the ground water resources are scarcely used as a source of drinking water. Presently, there is no health hazards connected to the contamination of the ground water resources. The Water Resources Development Plan in the Study Area involves no ground water

development plan on a grand scale. Accordingly, it is considered that the environmental impact of the ground water would be insignificant.

(7) Gender Issue

According to the previous studies, generally in the rural area of Bhutan, women are the predominant proprietors whether it concerns the house, land or livestock. Ownership gives women a stronger position than men at the household level. Women most often decide about household labour mobilisation, selling of livestock and cash expenditure.

In paddy cultivation, women provide more than 60% of the labour. Irrigation Implementation Plan which increases the wetland area or cultivation ratio could bring relatively more work for women than for men. In other words, irrigation development would have high positive impacts on women more than men.

On the other hand, one of the important and hard household works by the rural women is fetching water, traditionally carrying water from streams or springs on long distance. Water supply for rural area could supply water near to the houses. A part of women's work would be decrease for fetching water.

K.6 COMPREHENSIVE EVALUATION

The implementation of present Water Resources Development Plan is judged as valid with the result of economic evaluation and financial evaluation as computed from tangible benefit. In addition, socio-economic impact evaluated from intangible benefit is also judged as sufficiently expectable. Large negative impact from the implementation the Plan is not confirmed on the environmental evaluation and the Plan is evaluated as a sustainable water resources development plan considering the environment. Moreover, the implementation of the Plan is justified to be feasible from view points of technical suitability and organizational management. Accordingly, it is recommended that a high priority should be given to the present Plan be implemented in the early stage.

APPENDIX K
TABLES

Table K.3.1 Cost and Benefit Flow of Agricultual Development Plan (1/2)

- EIRR -

(Unit: thou. Nu.)

Year	Cost			Benefit			Present Value	
in Order	Const. Cost	O/M Cost	Total	Agricul. Prod.	Saving O/M	Total	Cost	Benefit
1	2,515	0	2,515	0	0	0	2,515	0
2	2,526	0	2,526	0	0	0	2,282	0
3	2,662	62	2,724	492	93	585	2,224	478
4	2,471	120	2,591	952	181	1,133	1,911	835
5	1,503	168	1,671	1,333	253	1,586	1,113	1,057
6	487	216	703	1,714	325	2,039	423	1,228
7	487	216	703	1,714	325	2,039	382	1,109
8	487	216	703	1,714	325	2,039	345	1,002
9	487	216	703	1,714	325	2,039	312	905
10	487	216	703	1,714	325	2,039	282	818
11	487	216	703	1,714	325	2,039	255	739
12	487	216	703	1,714	325	2,039	230	668
13	487	216	703	1,714	325	2,039	208	603
14	487	216	703	1,714	325	2,039	188	545
15	487	216	703	1,714	325	2,039	170	492
16	487	216	703	1,714	325	2,039	153	445
17	487	216	703	1,714	325	2,039	139	402
18	487	216	703	1,714	325	2,039	125	363
19	487	216	703	1,714	325	2,039	113	328
20	487	216	703	1,714	325	2,039	102	296
21	487	216	703	1,714	325	2,039	92	268
22	487	216	703	1,714	325	2,039	83	242
23	487	216	703	1,714	325	2,039	75	219
24	487	216	703	1,714	325	2,039	68	198
25	487	216	703	1,714	325	2,039	62	178
26	487	216	703	1,714	325	2,039	56	161
27	487	216	703	1,714	325	2,039	50	146
28	487	216	703	1,714	325	2,039	45	132
29	487	216	703	1,714	325	2,039	41	119
30	487	216	703	1,714	325	2,039	37	107
Total	23,852	5,750	29,602	45,627	8,652	54,279	14,084	14,084

E. B / C =	1.00000
ENPV =	0.00
E I R R =	10.68146

Table K.3.1 Cost and Benefit Flow of Agricultual Development Plan (2/2)

ENPV and E.B/C

(Unit: thou. Nu.)

Year	Cost			Benefit			Present Value	
in	Const.	O/M		Agricul.	Saving			
Order	Cost	Cost	Total	Prod.	O/M	Total	Cost	Benefit
1	2,515	0	2,515	0	0	0	2,515	0
2	2,526	0	2,526	0	0	0	2,296	0
3	2,662	62	2,724	492	93	585	2,251	484
4	2,471	120	2,591	952	181	1,133	1,947	851
5	1,503	168	1,671	1,333	253	1,586	1,141	1,083
6	487	216	703	1,714	325	2,039	437	1,266
7	487	216	703	1,714	325	2,039	397	1,151
8	487	216	703	1,714	325	2,039	361	1,046
9	487	216	703	1,714	325	2,039	328	951
10	487	216	703	1,714	325	2,039	298	865
11	487	216	703	1,714	325	2,039	271	786
12	487	216	703	1,714	325	2,039	246	715
13	487	216	703	1,714	325	2,039	224	650
14	487	216	703	1,714	325	2,039	204	591
15	487	216	703	1,714	325	2,039	185	537
16	487	216	703	1,714	325	2,039	168	488
17	487	216	703	1,714	325	2,039	153	444
18	487	216	703	1,714	325	2,039	139	403
19	487	216	703	1,714	325	2,039	126	367
20	487	216	703	1,714	325	2,039	115	333
21	487	216	703	1,714	325	2,039	104	303
22	487	216	703	1,714	325	2,039	95	276
23	487	216	703	1,714	325	2,039	86	250
24	487	216	703	1,714	325	2,039	79	228
25	487	216	703	1,714	325	2,039	71	207
26	487	216	703	1,714	325	2,039	65	188
27	487	216	703	1,714	325	2,039	59	171
28	487	216	703	1,714	325	2,039	54	156
29	487	216	703	1,714	325	2,039	49	141
30	487	216	703	1,714	325	2,039	44	129
Total	23,852	5,750	29,602	45,627	8,652	54,279	14,509	15,059

E. B / C =	1.03792
ENPV =	550
E I R R =	10.00000

Table K.3.2 Cost and Benefit Flow of Water Supply Development Plan (1/2)

- EIRR -

(Unit: thou. Nu.)

Year	Cost							Benefit			Present Value	
in Order	Const. W. Town	Const. Rural A.	Const. Total	O/M W. Town	O/M Rural A.	O/M Total	Total	Wangd. Town	Rural Areas	Total	Cost	Benefit
1	0	5,309	5,309	0	0	0	5,309	0	0	0	5,309	0
2	10,742	7,078	17,820	0	98	98	17,918	0	3,555	3,555	15,496	3,074
3	78,083	2,545	80,628	0	156	156	80,784	0	5,651	5,651	60,418	4,227
4	117,929	10,580	128,509	0	194	194	128,703	0	7,018	7,018	83,243	4,539
5	15,555	7,561	23,116	0	273	273	23,389	0	9,844	9,844	13,082	5,506
6	0	3,539	3,539	566	333	899	4,438	11,516	12,032	23,548	2,147	11,391
7	0	1,770	1,770	862	389	1,251	3,021	17,548	14,037	31,585	1,264	13,213
8	0	1,454	1,454	1,159	447	1,606	3,060	23,580	16,133	39,714	1,107	14,367
9	4,407	2,491	6,898	1,455	495	1,950	8,848	29,612	17,865	47,478	2,768	14,854
10	4,407	1,855	6,262	1,752	568	2,320	8,582	35,645	20,509	56,153	2,322	15,193
11	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	626	15,041
12	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	541	13,008
13	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	468	11,249
14	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	405	9,728
15	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	350	8,413
16	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	303	7,276
17	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	262	6,292
18	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	226	5,442
19	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	196	4,706
20	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	169	4,070
21	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	146	3,520
22	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	127	3,044
23	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	109	2,632
24	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	95	2,276
25	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	82	1,969
26	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	71	1,702
27	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	61	1,472
28	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	53	1,273
29	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	46	1,101
30	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	40	952
Total	231,123	44,182	275,305	46,757	15,472	62,229	337,534	951,435	558,745	1,510,180	191,531	191,532

Note: O/M cost means With Project condition minus Without Project condition.

E. B / C = 1.00000

ENPV = 0.64

E I R R = 15.63260

Table K.3.2 Cost and Benefit Flow of Water Supply Development Plan (2/2)

- ENPV and E.B/C -

(Unit: thou. Nu.)

Year	Cost							Benefit			Present Value	
in	Const.	Const.	Const.	O/M	O/M	O/M		Wangd.	Rural			
Order	W. Town	Rural A.	Total	W. Town	Rural A.	Total	Total	Town	Areas	Total	Cost	Benefit
1	0	5,309	5,309	0	0	0	5,309	0	0	0	5,309	0
2	10,742	7,078	17,820	0	98	98	17,918	0	3,555	3,555	16,289	3,232
3	78,083	2,545	80,628	0	156	156	80,784	0	5,651	5,651	66,764	4,670
4	117,929	10,580	128,509	0	194	194	128,703	0	7,018	7,018	96,697	5,273
5	15,555	7,561	23,116	0	273	273	23,389	0	9,844	9,844	15,975	6,724
6	0	3,539	3,539	566	333	899	4,438	11,516	12,032	23,548	2,756	14,621
7	0	1,770	1,770	862	389	1,251	3,021	17,548	14,037	31,585	1,705	17,829
8	0	1,454	1,454	1,159	447	1,606	3,060	23,580	16,133	39,714	1,570	20,379
9	4,407	2,491	6,898	1,455	495	1,950	8,848	29,612	17,865	47,478	4,128	22,149
10	4,407	1,855	6,262	1,752	568	2,320	8,582	35,645	20,509	56,153	3,639	23,814
11	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	1,031	24,783
12	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	937	22,530
13	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	852	20,482
14	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	775	18,620
15	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	704	16,927
16	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	640	15,389
17	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	582	13,990
18	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	529	12,718
19	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	481	11,562
20	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	437	10,511
21	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	397	9,555
22	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	361	8,686
23	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	329	7,897
24	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	299	7,179
25	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	271	6,526
26	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	247	5,933
27	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	224	5,394
28	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	204	4,903
29	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	185	4,458
30	0	0	0	2,048	626	2,674	2,674	41,677	22,605	64,282	169	4,052
Total	231,123	44,182	275,305	46,757	15,472	62,229	337,534	951,435	558,745	1,510,180	224,487	350,786

Note: O/M cost means With Project condition minus Without Project condition.

E. B / C = 1.56261

ENPV = 126199

E I R R = 10.00000

Table K.3.3 Cost and Benefit Flow of Water Resources Development Plan (1/10)

- EIRR -

(Unit: thou. Nu.)

Year	Cost					Benefit			Present Value	
in Order	Const. Agri.Dev.	Const. Wat. Sup.	O/M Agri.Dev.	O/M Wat.Sup.	Total	Agricul. Prod.	Water Supply	Total	Cost	Benefit
1	2,516	5,300	0	0	7,824	0	0	0	7,824	0
2	2,526	17,820	0	98	20,444	0	3,555	3,555	17,709	3,079
3	2,662	80,628	62	156	83,508	585	5,651	6,237	62,657	4,679
4	2,471	128,509	120	194	131,294	1,133	7,018	8,151	85,331	5,298
5	1,503	23,116	168	273	25,060	1,586	9,844	11,430	14,108	6,435
6	487	3,539	216	899	5,141	2,039	23,548	25,587	2,507	12,477
7	487	1,770	216	1,251	3,724	2,039	31,585	33,624	1,573	14,203
8	487	1,454	216	1,606	3,763	2,039	39,714	41,753	1,377	15,277
9	487	6,898	216	1,950	9,551	2,039	47,478	49,517	3,027	15,693
10	487	6,262	216	2,320	9,285	2,039	56,153	58,192	2,549	15,975
11	487	0	216	2,674	3,377	2,039	64,282	66,321	803	15,771
12	487	0	216	2,674	3,377	2,039	64,282	66,321	696	13,661
13	487	0	216	2,674	3,377	2,039	64,282	66,321	603	11,833
14	487	0	216	2,674	3,377	2,039	64,282	66,321	522	10,250
15	487	0	216	2,674	3,377	2,039	64,282	66,321	452	8,879
16	487	0	216	2,674	3,377	2,039	64,282	66,321	392	7,691
17	487	0	216	2,674	3,377	2,039	64,282	66,321	339	6,662
18	487	0	216	2,674	3,377	2,039	64,282	66,321	294	5,770
19	487	0	216	2,674	3,377	2,039	64,282	66,321	255	4,998
20	487	0	216	2,674	3,377	2,039	64,282	66,321	220	4,330
21	487	0	216	2,674	3,377	2,039	64,282	66,321	191	3,750
22	487	0	216	2,674	3,377	2,039	64,282	66,321	165	3,249
23	487	0	216	2,674	3,377	2,039	64,282	66,321	143	2,814
24	487	0	216	2,674	3,377	2,039	64,282	66,321	124	2,437
25	487	0	216	2,674	3,377	2,039	64,282	66,321	108	2,111
26	487	0	216	2,674	3,377	2,039	64,282	66,321	93	1,829
27	487	0	216	2,674	3,377	2,039	64,282	66,321	81	1,584
28	487	0	216	2,674	3,377	2,039	64,282	66,321	70	1,372
29	487	0	216	2,674	3,377	2,039	64,282	66,321	61	1,189
30	487	0	216	2,674	3,377	2,039	64,282	66,321	52	1,030
Total	23,852	275,305	5,750	62,229	367,136	54,279	1,510,180	1,564,459	204,325	204,325

E. B / C = 1.00000
ENPV = 0.00
E I R R = 15.44608

Table K.3.3 Cost and Benefit Flow of Water Resources Devel. Plan (2/10)

- ENPV and E.B/C -

(Unit: thou. Nu.)

Year	Cost					Benefit			Present Value	
in	Const.	Const.	O/M	O/M		Agricul.	Water			
Order	Agri.Dev.	Wat. Sup.	Agri.Dev.	Wat.Sup.	Total	Prod.	Supply	Total	Cost	Benefit
1	2,515	5,309	0	0	7,824	0	0	0	7,824	0
2	2,526	17,820	0	98	20,444	0	3,555	3,555	18,586	3,232
3	2,662	80,628	62	156	83,508	585	5,651	6,237	69,015	5,154
4	2,471	128,509	120	194	131,294	1,133	7,018	8,151	98,643	6,124
5	1,503	23,116	168	273	25,060	1,586	9,844	11,430	17,116	7,807
6	487	3,539	216	899	5,141	2,039	23,548	25,587	3,192	15,887
7	487	1,770	216	1,251	3,724	2,039	31,585	33,624	2,102	18,980
8	487	1,454	216	1,606	3,763	2,039	39,714	41,753	1,931	21,426
9	487	6,898	216	1,950	9,551	2,039	47,478	49,517	4,456	23,100
10	487	6,262	216	2,320	9,285	2,039	56,153	58,192	3,938	24,679
11	487	0	216	2,674	3,377	2,039	64,282	66,321	1,302	25,570
12	487	0	216	2,674	3,377	2,039	64,282	66,321	1,184	23,245
13	487	0	216	2,674	3,377	2,039	64,282	66,321	1,076	21,132
14	487	0	216	2,674	3,377	2,039	64,282	66,321	978	19,211
15	487	0	216	2,674	3,377	2,039	64,282	66,321	889	17,464
16	487	0	216	2,674	3,377	2,039	64,282	66,321	808	15,877
17	487	0	216	2,674	3,377	2,039	64,282	66,321	735	14,433
18	487	0	216	2,674	3,377	2,039	64,282	66,321	668	13,121
19	487	0	216	2,674	3,377	2,039	64,282	66,321	607	11,928
20	487	0	216	2,674	3,377	2,039	64,282	66,321	552	10,844
21	487	0	216	2,674	3,377	2,039	64,282	66,321	502	9,858
22	487	0	216	2,674	3,377	2,039	64,282	66,321	456	8,962
23	487	0	216	2,674	3,377	2,039	64,282	66,321	415	8,147
24	487	0	216	2,674	3,377	2,039	64,282	66,321	377	7,407
25	487	0	216	2,674	3,377	2,039	64,282	66,321	343	6,733
26	487	0	216	2,674	3,377	2,039	64,282	66,321	312	6,121
27	487	0	216	2,674	3,377	2,039	64,282	66,321	283	5,565
28	487	0	216	2,674	3,377	2,039	64,282	66,321	258	5,059
29	487	0	216	2,674	3,377	2,039	64,282	66,321	234	4,599
30	487	0	216	2,674	3,377	2,039	64,282	66,321	213	4,181
Total	23,852	275,305	5,750	62,229	367,136	54,279	1,510,180	1,564,459	238,996	365,845

E.B/C = 1.53076
ENPV = 126,849
EIRR = 10.00000

Table K.3.3 Sensitivity Analysis: Project Cost Increased by 10% (3/10)

- EIRR -

(Unit: thou. Nu.)

Year	Cost					Benefit			Present Value	
in Order	Const. Agri.Dev.	Const. Wat. Sup.	O/M Agri.Dev.	O/M Wat.Sup.	Total	Agricul. Prod.	Water Supply	Total	Cost	Benefit
1	2,767	5,840	0	0	8,606	0	0	0	8,606	0
2	2,779	19,602	0	98	22,479	0	3,555	3,555	19,687	3,113
3	2,928	88,691	62	156	91,837	585	5,651	6,237	70,442	4,784
4	2,718	141,360	120	194	144,392	1,133	7,018	8,151	96,998	5,476
5	1,653	25,428	168	273	27,521	1,586	9,844	11,430	16,192	6,725
6	536	3,893	216	899	5,544	2,039	23,548	25,587	2,856	13,184
7	536	1,947	216	1,251	3,950	2,039	31,585	33,624	1,782	15,173
8	536	1,599	216	1,606	3,957	2,039	39,714	41,753	1,564	16,502
9	536	7,588	216	1,950	10,289	2,039	47,478	49,517	3,562	17,139
10	536	6,888	216	2,320	9,960	2,039	56,153	58,192	3,019	17,641
11	536	0	216	2,674	3,426	2,039	64,282	66,321	910	17,608
12	536	0	216	2,674	3,426	2,039	64,282	66,321	797	15,421
13	536	0	216	2,674	3,426	2,039	64,282	66,321	698	13,506
14	536	0	216	2,674	3,426	2,039	64,282	66,321	611	11,828
15	536	0	216	2,674	3,426	2,039	64,282	66,321	535	10,359
16	536	0	216	2,674	3,426	2,039	64,282	66,321	469	9,073
17	536	0	216	2,674	3,426	2,039	64,282	66,321	410	7,946
18	536	0	216	2,674	3,426	2,039	64,282	66,321	359	6,959
19	536	0	216	2,674	3,426	2,039	64,282	66,321	315	6,095
20	536	0	216	2,674	3,426	2,039	64,282	66,321	276	5,338
21	536	0	216	2,674	3,426	2,039	64,282	66,321	241	4,675
22	536	0	216	2,674	3,426	2,039	64,282	66,321	211	4,094
23	536	0	216	2,674	3,426	2,039	64,282	66,321	185	3,586
24	536	0	216	2,674	3,426	2,039	64,282	66,321	162	3,140
25	536	0	216	2,674	3,426	2,039	64,282	66,321	142	2,750
26	536	0	216	2,674	3,426	2,039	64,282	66,321	124	2,409
27	536	0	216	2,674	3,426	2,039	64,282	66,321	109	2,110
28	536	0	216	2,674	3,426	2,039	64,282	66,321	95	1,848
29	536	0	216	2,674	3,426	2,039	64,282	66,321	84	1,618
30	536	0	216	2,674	3,426	2,039	64,282	66,321	73	1,417
Total	26,237	302,836	5,750	62,229	397,052	54,279	1,510,180	1,564,459	231,516	231,516

E. B / C = 1.00000
ENPV = 0.00
E I R R = 14.18109

Table K.3.3 Sensitivity Analysis: Project Cost Increased by 10% (4/10)

- ENPV and E.B/C -

(Unit: thou. Nu.)

Year	Cost					Benefit			Present Value	
in Order	Const. Agri.Dev.	Const. Wat. Sup.	O/M Agri.Dev.	O/M Wat.Sup.	Total	Agricul. Prod.	Water Supply	Total	Cost	Benefit
1	2,767	5,840	0	0	8,606	0	0	0	8,606	0
2	2,779	19,602	0	98	22,479	0	3,555	3,555	20,435	3,232
3	2,928	88,691	62	156	91,837	585	5,651	6,237	75,899	5,154
4	2,718	141,360	120	194	144,392	1,133	7,018	8,151	108,484	6,124
5	1,653	25,428	168	273	27,521	1,586	9,844	11,430	18,798	7,807
6	536	3,893	216	899	5,544	2,039	23,548	25,587	3,442	15,887
7	536	1,947	216	1,251	3,950	2,039	31,585	33,624	2,230	18,980
8	536	1,599	216	1,606	3,957	2,039	39,714	41,753	2,030	21,426
9	536	7,588	216	1,950	10,289	2,039	47,478	49,517	4,800	23,100
10	536	6,888	216	2,320	9,960	2,039	56,153	58,192	4,224	24,679
11	536	0	216	2,674	3,426	2,039	64,282	66,321	1,321	25,570
12	536	0	216	2,674	3,426	2,039	64,282	66,321	1,201	23,245
13	536	0	216	2,674	3,426	2,039	64,282	66,321	1,092	21,132
14	536	0	216	2,674	3,426	2,039	64,282	66,321	992	19,211
15	536	0	216	2,674	3,426	2,039	64,282	66,321	902	17,464
16	536	0	216	2,674	3,426	2,039	64,282	66,321	820	15,877
17	536	0	216	2,674	3,426	2,039	64,282	66,321	746	14,433
18	536	0	216	2,674	3,426	2,039	64,282	66,321	678	13,121
19	536	0	216	2,674	3,426	2,039	64,282	66,321	616	11,928
20	536	0	216	2,674	3,426	2,039	64,282	66,321	560	10,844
21	536	0	216	2,674	3,426	2,039	64,282	66,321	509	9,858
22	536	0	216	2,674	3,426	2,039	64,282	66,321	463	8,962
23	536	0	216	2,674	3,426	2,039	64,282	66,321	421	8,147
24	536	0	216	2,674	3,426	2,039	64,282	66,321	383	7,407
25	536	0	216	2,674	3,426	2,039	64,282	66,321	348	6,733
26	536	0	216	2,674	3,426	2,039	64,282	66,321	316	6,121
27	536	0	216	2,674	3,426	2,039	64,282	66,321	287	5,565
28	536	0	216	2,674	3,426	2,039	64,282	66,321	261	5,059
29	536	0	216	2,674	3,426	2,039	64,282	66,321	238	4,599
30	536	0	216	2,674	3,426	2,039	64,282	66,321	216	4,181
Total	26,237	302,836	5,750	62,229	397,052	54,279	1,510,180	1,564,459	261,317	365,845

B/C =	1.40000
ENPV =	104,528
EIRR =	10.00000

Table K.3.3 Sensitivity Analysis: Project Benefit Decreased by 10% (5/10)

- EIRR -

(Unit: thou. Nu.)

Year	Cost					Benefit			Present Value	
in Order	Const. Agri.Dev.	Const. Wat. Sup.	O/M Agri.Dev.	O/M Wat.Sup.	Total	Agricul. Prod.	Water Supply	Total	Cost	Benefit
1	2,515	5,309	0	0	7,824	0	0	0	7,824	0
2	2,526	17,820	0	98	20,444	0	3,199	3,199	17,936	2,807
3	2,662	80,628	62	156	83,508	527	5,086	5,613	64,271	4,320
4	2,471	128,509	120	194	131,294	1,020	6,317	7,336	88,649	4,953
5	1,503	23,116	168	273	25,060	1,427	8,860	10,287	14,844	6,093
6	487	3,539	216	899	5,141	1,835	21,193	23,028	2,672	11,967
7	487	1,770	216	1,251	3,724	1,835	28,427	30,262	1,698	13,796
8	487	1,454	216	1,606	3,763	1,835	35,742	37,577	1,505	15,029
9	487	6,898	216	1,950	9,551	1,835	42,730	44,565	3,351	15,636
10	487	6,262	216	2,320	9,285	1,835	50,538	52,373	2,858	16,121
11	487	0	216	2,674	3,377	1,835	57,854	59,689	912	16,118
12	487	0	216	2,674	3,377	1,835	57,854	59,689	800	14,141
13	487	0	216	2,674	3,377	1,835	57,854	59,689	702	12,405
14	487	0	216	2,674	3,377	1,835	57,854	59,689	616	10,883
15	487	0	216	2,674	3,377	1,835	57,854	59,689	540	9,548
16	487	0	216	2,674	3,377	1,835	57,854	59,689	474	8,376
17	487	0	216	2,674	3,377	1,835	57,854	59,689	416	7,348
18	487	0	216	2,674	3,377	1,835	57,854	59,689	365	6,446
19	487	0	216	2,674	3,377	1,835	57,854	59,689	320	5,655
20	487	0	216	2,674	3,377	1,835	57,854	59,689	281	4,961
21	487	0	216	2,674	3,377	1,835	57,854	59,689	246	4,353
22	487	0	216	2,674	3,377	1,835	57,854	59,689	216	3,819
23	487	0	216	2,674	3,377	1,835	57,854	59,689	190	3,350
24	487	0	216	2,674	3,377	1,835	57,854	59,689	166	2,939
25	487	0	216	2,674	3,377	1,835	57,854	59,689	146	2,578
26	487	0	216	2,674	3,377	1,835	57,854	59,689	128	2,262
27	487	0	216	2,674	3,377	1,835	57,854	59,689	112	1,984
28	487	0	216	2,674	3,377	1,835	57,854	59,689	98	1,741
29	487	0	216	2,674	3,377	1,835	57,854	59,689	86	1,527
30	487	0	216	2,674	3,377	1,835	57,854	59,689	76	1,340
Total	23,852	275,305	5,750	62,229	367,136	48,851	1,359,162	1,408,013	212,497	212,497

E. B / C = 1.00000
ENPV = 0.00
E I R R = 13.98743

Table K.3.3 Sensitivity Analysis: Project Benefit Decreased by 10% (6/10)

- ENPV and E.B/C -

(Unit: thou. Nu.)

Year	Cost					Benefit			Present Value	
in Order	Const. Agri.Dev.	Const. Wat. Sup.	O/M Agri.Dev.	O/M Wat.Sup.	Total	Agricul. Prod.	Water Supply	Total	Cost	Benefit
1	2,516	5,309	0	0	7,824	0	0	0	7,824	0
2	2,526	17,820	0	98	20,444	0	3,199	3,199	18,586	2,908
3	2,662	80,628	62	156	83,508	527	5,086	5,613	69,015	4,639
4	2,471	128,509	120	194	131,294	1,020	6,317	7,336	98,643	5,512
5	1,503	23,116	168	273	25,060	1,427	8,860	10,287	17,116	7,026
6	487	3,539	216	899	5,141	1,835	21,193	23,028	3,192	14,299
7	487	1,770	216	1,251	3,724	1,835	28,427	30,262	2,102	17,082
8	487	1,454	216	1,606	3,763	1,835	35,742	37,577	1,931	19,283
9	487	6,898	216	1,950	9,551	1,835	42,730	44,565	4,456	20,790
10	487	6,262	216	2,320	9,285	1,835	50,538	52,373	3,938	22,211
11	487	0	216	2,674	3,377	1,835	57,854	59,689	1,302	23,013
12	487	0	216	2,674	3,377	1,835	57,854	59,689	1,184	20,921
13	487	0	216	2,674	3,377	1,835	57,854	59,689	1,076	19,019
14	487	0	216	2,674	3,377	1,835	57,854	59,689	978	17,290
15	487	0	216	2,674	3,377	1,835	57,854	59,689	889	15,718
16	487	0	216	2,674	3,377	1,835	57,854	59,689	808	14,289
17	487	0	216	2,674	3,377	1,835	57,854	59,689	735	12,990
18	487	0	216	2,674	3,377	1,835	57,854	59,689	668	11,809
19	487	0	216	2,674	3,377	1,835	57,854	59,689	607	10,736
20	487	0	216	2,674	3,377	1,835	57,854	59,689	552	9,760
21	487	0	216	2,674	3,377	1,835	57,854	59,689	502	8,872
22	487	0	216	2,674	3,377	1,835	57,854	59,689	456	8,066
23	487	0	216	2,674	3,377	1,835	57,854	59,689	415	7,333
24	487	0	216	2,674	3,377	1,835	57,854	59,689	377	6,666
25	487	0	216	2,674	3,377	1,835	57,854	59,689	343	6,060
26	487	0	216	2,674	3,377	1,835	57,854	59,689	312	5,509
27	487	0	216	2,674	3,377	1,835	57,854	59,689	283	5,008
28	487	0	216	2,674	3,377	1,835	57,854	59,689	258	4,553
29	487	0	216	2,674	3,377	1,835	57,854	59,689	234	4,139
30	487	0	216	2,674	3,377	1,835	57,854	59,689	213	3,763
Total	23,852	275,305	5,750	62,229	367,136	48,851	1,359,162	1,408,013	238,996	329,261

E.B/C = 1.37768
ENPV = 90,264
EIRR = 10.00000

Table K.3.3 Sensitivity Analysis: Construction Delayed for 1 Year (7/10)

- EIRR -

(Unit: thou. Nu.)

Year	Cost					Benefit			Present Value	
in Order	Const. Agri.Dev.	Const. Wat. Sup.	O/M Agri.Dev.	O/M Wat.Sup.	Total	Agricul. Prod.	Water Supply	Total	Cost	Benefit
1	2,515	5,309	0	0	7,824	0	0	0	7,824	0
2	2,526	17,820	0	0	20,346	0	0	0	17,898	0
3	2,662	80,628	0	98	83,388	0	3,555	3,555	64,531	2,751
4	2,471	128,509	62	156	131,198	585	5,651	6,237	89,314	4,246
5	1,503	23,116	120	194	24,933	1,133	7,018	8,151	14,931	4,881
6	487	3,539	168	273	4,467	1,586	9,844	11,430	2,353	6,021
7	487	1,770	216	899	3,372	2,039	23,548	25,587	1,563	11,858
8	487	1,454	216	1,251	3,408	2,039	31,585	33,624	1,389	13,708
9	487	6,898	216	1,606	9,207	2,039	39,714	41,753	3,302	14,974
10	487	6,262	216	1,950	8,915	2,039	47,478	49,517	2,813	15,622
11	487	0	216	2,320	3,023	2,039	56,153	58,192	839	16,150
12	487	0	216	2,674	3,377	2,039	64,282	66,321	824	16,191
13	487	0	216	2,674	3,377	2,039	64,282	66,321	725	14,244
14	487	0	216	2,674	3,377	2,039	64,282	66,321	638	12,530
15	487	0	216	2,674	3,377	2,039	64,282	66,321	561	11,022
16	487	0	216	2,674	3,377	2,039	64,282	66,321	494	9,696
17	487	0	216	2,674	3,377	2,039	64,282	66,321	434	8,530
18	487	0	216	2,674	3,377	2,039	64,282	66,321	382	7,504
19	487	0	216	2,674	3,377	2,039	64,282	66,321	336	6,601
20	487	0	216	2,674	3,377	2,039	64,282	66,321	296	5,807
21	487	0	216	2,674	3,377	2,039	64,282	66,321	260	5,108
22	487	0	216	2,674	3,377	2,039	64,282	66,321	229	4,494
23	487	0	216	2,674	3,377	2,039	64,282	66,321	201	3,953
24	487	0	216	2,674	3,377	2,039	64,282	66,321	177	3,477
25	487	0	216	2,674	3,377	2,039	64,282	66,321	156	3,059
26	487	0	216	2,674	3,377	2,039	64,282	66,321	137	2,691
27	487	0	216	2,674	3,377	2,039	64,282	66,321	121	2,367
28	487	0	216	2,674	3,377	2,039	64,282	66,321	106	2,082
29	487	0	216	2,674	3,377	2,039	64,282	66,321	93	1,832
30	487	0	216	2,674	3,377	2,039	64,282	66,321	82	1,612
Total	23,852	275,305	5,534	59,555	364,246	52,240	1,445,898	1,498,138	213,010	213,010

E. B / C = 1.00000
ENPV = 0.00
E I R R = 13.67614

Table K.3.3 Sensitivity Analysis: Construction Delayed for 1 Year (8/10)

- ENPV and E.B/C -

(Unit: thou. Nu.)

Year	Cost					Benefit			Present Value	
in	Const.	Const.	O/M	O/M		Agricul.	Water			
Order	Agri.Dev.	Wat. Sup.	Agri.Dev.	Wat.Sup.	Total	Prod.	Supply	Total	Cost	Benefit
1	2,515	5,309	0	0	7,824	0	0	0	7,824	0
2	2,526	17,820	0	0	20,346	0	0	0	18,496	0
3	2,662	80,628	0	98	83,388	0	3,555	3,555	68,916	2,938
4	2,471	128,509	62	156	131,198	585	5,651	6,237	98,571	4,686
5	1,503	23,116	120	194	24,933	1,133	7,018	8,151	17,030	5,567
6	487	3,539	168	273	4,467	1,586	9,844	11,430	2,773	7,097
7	487	1,770	216	899	3,372	2,039	23,548	25,587	1,903	14,443
8	487	1,454	216	1,251	3,408	2,039	31,585	33,624	1,749	17,254
9	487	6,898	216	1,606	9,207	2,039	39,714	41,753	4,295	19,478
10	487	6,262	216	1,950	8,915	2,039	47,478	49,517	3,781	21,000
11	487	0	216	2,320	3,023	2,039	56,153	58,192	1,165	22,436
12	487	0	216	2,674	3,377	2,039	64,282	66,321	1,184	23,245
13	487	0	216	2,674	3,377	2,039	64,282	66,321	1,076	21,132
14	487	0	216	2,674	3,377	2,039	64,282	66,321	978	19,211
15	487	0	216	2,674	3,377	2,039	64,282	66,321	889	17,464
16	487	0	216	2,674	3,377	2,039	64,282	66,321	808	15,877
17	487	0	216	2,674	3,377	2,039	64,282	66,321	735	14,433
18	487	0	216	2,674	3,377	2,039	64,282	66,321	668	13,121
19	487	0	216	2,674	3,377	2,039	64,282	66,321	607	11,928
20	487	0	216	2,674	3,377	2,039	64,282	66,321	552	10,844
21	487	0	216	2,674	3,377	2,039	64,282	66,321	502	9,858
22	487	0	216	2,674	3,377	2,039	64,282	66,321	456	8,962
23	487	0	216	2,674	3,377	2,039	64,282	66,321	415	8,147
24	487	0	216	2,674	3,377	2,039	64,282	66,321	377	7,407
25	487	0	216	2,674	3,377	2,039	64,282	66,321	343	6,733
26	487	0	216	2,674	3,377	2,039	64,282	66,321	312	6,121
27	487	0	216	2,674	3,377	2,039	64,282	66,321	283	5,565
28	487	0	216	2,674	3,377	2,039	64,282	66,321	258	5,059
29	487	0	216	2,674	3,377	2,039	64,282	66,321	234	4,599
30	487	0	216	2,674	3,377	2,039	64,282	66,321	213	4,181
Total	23,852	275,305	5,534	59,555	364,246	52,240	1,445,898	1,498,138	237,396	328,786

E.B/C =	1.38497
ENPV =	91,390
EIRR =	10.00000

Table K.3.3 Sensitivity Analysis: SCF is Applied for Local Costs (9/10)

- EIRR -

(Unit: thou. Nu.)

Year	Cost					Benefit			Present Value	
in	Const.	Const.	O/M	O/M		Agricul.	Water			
Order	Agri.Dev.	Wat. Sup.	Agri.Dev.	Wat.Sup.	Total	Prod.	Supply	Total	Cost	Benefit
1	2,012	4,247	0	0	6,259	0	0	0	6,259	0
2	2,021	15,910	0	79	18,010	0	3,555	3,555	15,421	3,044
3	2,130	76,527	50	125	78,832	665	5,651	6,316	57,795	4,631
4	1,977	120,968	96	155	123,197	1,287	7,018	8,306	77,337	5,214
5	1,202	20,888	134	218	22,443	1,802	9,844	11,646	12,063	6,260
6	390	2,831	173	719	4,113	2,317	23,548	25,864	1,893	11,904
7	390	1,416	173	1,001	2,979	2,317	31,585	33,902	1,174	13,360
8	390	1,163	173	1,284	3,010	2,317	39,714	42,030	1,016	14,182
9	390	6,197	173	1,560	8,319	2,317	47,478	49,794	2,404	14,386
10	390	5,688	173	1,856	8,106	2,317	56,153	58,470	2,005	14,464
11	390	0	173	2,139	2,702	2,317	64,282	66,599	572	14,107
12	390	0	173	2,139	2,702	2,317	64,282	66,599	490	12,079
13	390	0	173	2,139	2,702	2,317	64,282	66,599	420	10,342
14	390	0	173	2,139	2,702	2,317	64,282	66,599	359	8,856
15	390	0	173	2,139	2,702	2,317	64,282	66,599	308	7,582
16	390	0	173	2,139	2,702	2,317	64,282	66,599	263	6,492
17	390	0	173	2,139	2,702	2,317	64,282	66,599	226	5,559
18	390	0	173	2,139	2,702	2,317	64,282	66,599	193	4,760
19	390	0	173	2,139	2,702	2,317	64,282	66,599	165	4,076
20	390	0	173	2,139	2,702	2,317	64,282	66,599	142	3,490
21	390	0	173	2,139	2,702	2,317	64,282	66,599	121	2,988
22	390	0	173	2,139	2,702	2,317	64,282	66,599	104	2,558
23	390	0	173	2,139	2,702	2,317	64,282	66,599	89	2,191
24	390	0	173	2,139	2,702	2,317	64,282	66,599	76	1,876
25	390	0	173	2,139	2,702	2,317	64,282	66,599	65	1,606
26	390	0	173	2,139	2,702	2,317	64,282	66,599	56	1,375
27	390	0	173	2,139	2,702	2,317	64,282	66,599	48	1,178
28	390	0	173	2,139	2,702	2,317	64,282	66,599	41	1,008
29	390	0	173	2,139	2,702	2,317	64,282	66,599	35	863
30	390	0	173	2,139	2,702	2,317	64,282	66,599	30	739
Total	19,082	255,837	4,600	49,783	329,302	61,674	1,510,180	1,571,854	181,169	181,169

E. B / C = 1.00000
ENPV = 0.00
EIRR = 16.78954

Table K.3.3 Sensitivity Analysis: SCF is Applied for Local Costs (10/10)

- ENPV and E.B/C -

(Unit: thou. Nu.)

Year	Cost					Benefit			Present Value	
in Order	Const. Agri.Dev.	Const. Wat. Sup.	O/M Agri.Dev.	O/M Wat.Sup.	Total	Agricul. Prod.	Water Supply	Total	Cost	Benefit
1	2,012	4,247	0	0	6,259	0	0	0	6,259	0
2	2,021	15,910	0	79	18,010	0	3,555	3,555	16,373	3,232
3	2,130	76,527	50	125	78,832	665	5,651	6,316	65,150	5,220
4	1,977	120,968	96	155	123,197	1,287	7,018	8,306	92,559	6,240
5	1,202	20,888	134	218	22,443	1,802	9,844	11,646	15,329	7,954
6	390	2,831	173	719	4,113	2,317	23,548	25,864	2,554	16,060
7	390	1,416	173	1,001	2,979	2,317	31,585	33,902	1,682	19,137
8	390	1,163	173	1,284	3,010	2,317	39,714	42,030	1,545	21,568
9	390	6,197	173	1,560	8,319	2,317	47,478	49,794	3,881	23,229
10	390	5,688	173	1,856	8,106	2,317	56,153	58,470	3,438	24,797
11	390	0	173	2,139	2,702	2,317	64,282	66,599	1,042	25,677
12	390	0	173	2,139	2,702	2,317	64,282	66,599	947	23,342
13	390	0	173	2,139	2,702	2,317	64,282	66,599	861	21,220
14	390	0	173	2,139	2,702	2,317	64,282	66,599	783	19,291
15	390	0	173	2,139	2,702	2,317	64,282	66,599	711	17,537
16	390	0	173	2,139	2,702	2,317	64,282	66,599	647	15,943
17	390	0	173	2,139	2,702	2,317	64,282	66,599	588	14,494
18	390	0	173	2,139	2,702	2,317	64,282	66,599	535	13,176
19	390	0	173	2,139	2,702	2,317	64,282	66,599	486	11,978
20	390	0	173	2,139	2,702	2,317	64,282	66,599	442	10,889
21	390	0	173	2,139	2,702	2,317	64,282	66,599	402	9,899
22	390	0	173	2,139	2,702	2,317	64,282	66,599	365	8,999
23	390	0	173	2,139	2,702	2,317	64,282	66,599	332	8,181
24	390	0	173	2,139	2,702	2,317	64,282	66,599	302	7,438
25	390	0	173	2,139	2,702	2,317	64,282	66,599	274	6,761
26	390	0	173	2,139	2,702	2,317	64,282	66,599	249	6,147
27	390	0	173	2,139	2,702	2,317	64,282	66,599	227	5,588
28	390	0	173	2,139	2,702	2,317	64,282	66,599	206	5,080
29	390	0	173	2,139	2,702	2,317	64,282	66,599	187	4,618
30	390	0	173	2,139	2,702	2,317	64,282	66,599	170	4,198
Total	19,082	255,837	4,600	49,783	329,302	61,674	1,510,180	1,571,854	218,524	367,897

E.B/C = 1.68355
ENPV = 149,373
EIRR = 10.00000

Table K.3.4 Cost and Benefit Flow of Wangduephodrang Town Plan (1/10)

- EIRR -

(Unit: thou. Nu.)

Year	Cost			Benefit		Present Value	
in Order	Const. W. Town	O/M W. Town	Total	Wangd. Town	Total	Cost	Benefit
1	0	0	0	0	0	0	0
2	10,742	0	10,742	0	0	9,668	0
3	78,083	0	78,083	0	0	63,248	0
4	117,929	0	117,929	0	0	85,972	0
5	15,555	0	15,555	0	0	10,206	0
6	0	566	566	11,516	11,516	334	6,800
7	0	862	862	17,548	17,548	458	9,326
8	0	1,159	1,159	23,580	23,580	554	11,279
9	4,407	1,455	5,862	29,612	29,612	2,524	12,748
10	4,407	1,752	6,159	35,645	35,645	2,386	13,810
11	0	2,048	2,048	41,677	41,677	714	14,532
12	0	2,048	2,048	41,677	41,677	643	13,079
13	0	2,048	2,048	41,677	41,677	578	11,771
14	0	2,048	2,048	41,677	41,677	521	10,594
15	0	2,048	2,048	41,677	41,677	469	9,535
16	0	2,048	2,048	41,677	41,677	422	8,581
17	0	2,048	2,048	41,677	41,677	380	7,723
18	0	2,048	2,048	41,677	41,677	342	6,951
19	0	2,048	2,048	41,677	41,677	307	6,256
20	0	2,048	2,048	41,677	41,677	277	5,630
21	0	2,048	2,048	41,677	41,677	249	5,067
22	0	2,048	2,048	41,677	41,677	224	4,561
23	0	2,048	2,048	41,677	41,677	202	4,105
24	0	2,048	2,048	41,677	41,677	182	3,694
25	0	2,048	2,048	41,677	41,677	163	3,325
26	0	2,048	2,048	41,677	41,677	147	2,992
27	0	2,048	2,048	41,677	41,677	132	2,693
28	0	2,048	2,048	41,677	41,677	119	2,424
29	0	2,048	2,048	41,677	41,677	107	2,181
30	0	2,048	2,048	41,677	41,677	96	1,963
Total	231,123	46,757	277,880	951,435	951,435	181,623	181,623

Note: O/M cost means With Project condition minus Without Project condition.

E. B / C =	1.00000
ENPV =	0.00
E I R R =	11.11057

Table K.3.4 Cost and Benefit Flow of Wangduephodrang Town Plan (2/10)

- ENPV and E.B/C -

(Unit: thou. Nu.)

Year	Cost			Benefit		Present Value	
in	Const.	O/M		Wangd.			
Order	W. Town	W. Town	Total	Town	Total	Cost	Benefit
1	0	0	0	0	0	0	0
2	10,742	0	10,742	0	0	9,765	0
3	78,083	0	78,083	0	0	64,531	0
4	117,929	0	117,929	0	0	88,602	0
5	15,555	0	15,555	0	0	10,624	0
6	0	566	566	11,516	11,516	351	7,150
7	0	862	862	17,548	17,548	487	9,905
8	0	1,159	1,159	23,580	23,580	595	12,100
9	4,407	1,455	5,862	29,612	29,612	2,735	13,814
10	4,407	1,752	6,159	35,645	35,645	2,612	15,117
11	0	2,048	2,048	41,677	41,677	790	16,068
12	0	2,048	2,048	41,677	41,677	718	14,607
13	0	2,048	2,048	41,677	41,677	653	13,279
14	0	2,048	2,048	41,677	41,677	593	12,072
15	0	2,048	2,048	41,677	41,677	539	10,975
16	0	2,048	2,048	41,677	41,677	490	9,977
17	0	2,048	2,048	41,677	41,677	446	9,070
18	0	2,048	2,048	41,677	41,677	405	8,246
19	0	2,048	2,048	41,677	41,677	368	7,496
20	0	2,048	2,048	41,677	41,677	335	6,814
21	0	2,048	2,048	41,677	41,677	304	6,195
22	0	2,048	2,048	41,677	41,677	277	5,632
23	0	2,048	2,048	41,677	41,677	252	5,120
24	0	2,048	2,048	41,677	41,677	229	4,654
25	0	2,048	2,048	41,677	41,677	208	4,231
26	0	2,048	2,048	41,677	41,677	189	3,847
27	0	2,048	2,048	41,677	41,677	172	3,497
28	0	2,048	2,048	41,677	41,677	156	3,179
29	0	2,048	2,048	41,677	41,677	142	2,890
30	0	2,048	2,048	41,677	41,677	129	2,627
Total	231,123	46,757	277,880	951,435	951,435	187,697	208,565

Note: O/M cost means With Project condition minus Without Project condition.

E. B / C =	1.11117
ENPV =	20,867
E I R R =	10.00000

Table K.3.4 Sensitivity Analysis: Project Cost Increased by 10% (3/10)

- EIRR -

(Unit: thou. Nu.)

Year	Cost			Benefit		Present Value	
in	Const.	O/M		Wangd.			
Order	W. Town	W. Town	Total	Town	Total	Cost	Benefit
1	0	0	0	0	0	0	0
2	11,816	0	11,816	0	0	10,727	0
3	85,891	0	85,891	0	0	70,784	0
4	129,722	0	129,722	0	0	97,049	0
5	17,111	0	17,111	0	0	11,621	0
6	0	566	566	11,516	11,516	349	7,100
7	0	862	862	17,548	17,548	483	9,822
8	0	1,159	1,159	23,580	23,580	589	11,981
9	4,848	1,455	6,303	29,612	29,612	2,907	13,659
10	4,848	1,752	6,599	35,645	35,645	2,763	14,926
11	0	2,048	2,048	41,677	41,677	779	15,843
12	0	2,048	2,048	41,677	41,677	707	14,382
13	0	2,048	2,048	41,677	41,677	642	13,056
14	0	2,048	2,048	41,677	41,677	582	11,852
15	0	2,048	2,048	41,677	41,677	529	10,760
16	0	2,048	2,048	41,677	41,677	480	9,768
17	0	2,048	2,048	41,677	41,677	436	8,867
18	0	2,048	2,048	41,677	41,677	396	8,050
19	0	2,048	2,048	41,677	41,677	359	7,308
20	0	2,048	2,048	41,677	41,677	326	6,634
21	0	2,048	2,048	41,677	41,677	296	6,022
22	0	2,048	2,048	41,677	41,677	269	5,467
23	0	2,048	2,048	41,677	41,677	244	4,963
24	0	2,048	2,048	41,677	41,677	221	4,505
25	0	2,048	2,048	41,677	41,677	201	4,090
26	0	2,048	2,048	41,677	41,677	182	3,713
27	0	2,048	2,048	41,677	41,677	166	3,371
28	0	2,048	2,048	41,677	41,677	150	3,060
29	0	2,048	2,048	41,677	41,677	137	2,778
30	0	2,048	2,048	41,677	41,677	124	2,522
Total	254,235	46,757	300,992	951,435	951,435	204,497	204,497

E. B / C =	1.00000
ENPV =	0.00
E I R R =	10.15566

Table K.3.4 Sensitivity Analysis: Project Cost Increased by 10% (4/10)

- ENPV and E.B/C -

(Unit: thou. Nu.)

Year	Cost			Benefit		Present Value	
in	Const.	O/M		Wangd.			
Order	W. Town	W. Town	Total	Town	Total	Cost	Benefit
1	0	0	0	0	0	0	0
2	11,816	0	11,816	0	0	10,742	0
3	85,891	0	85,891	0	0	70,985	0
4	129,722	0	129,722	0	0	97,462	0
5	17,111	0	17,111	0	0	11,687	0
6	0	566	566	11,516	11,516	351	7,150
7	0	862	862	17,548	17,548	487	9,905
8	0	1,159	1,159	23,580	23,580	595	12,100
9	4,848	1,455	6,303	29,612	29,612	2,940	13,814
10	4,848	1,752	6,599	35,645	35,645	2,799	15,117
11	0	2,048	2,048	41,677	41,677	790	16,068
12	0	2,048	2,048	41,677	41,677	718	14,607
13	0	2,048	2,048	41,677	41,677	653	13,279
14	0	2,048	2,048	41,677	41,677	593	12,072
15	0	2,048	2,048	41,677	41,677	539	10,975
16	0	2,048	2,048	41,677	41,677	490	9,977
17	0	2,048	2,048	41,677	41,677	446	9,070
18	0	2,048	2,048	41,677	41,677	405	8,246
19	0	2,048	2,048	41,677	41,677	368	7,496
20	0	2,048	2,048	41,677	41,677	335	6,814
21	0	2,048	2,048	41,677	41,677	304	6,195
22	0	2,048	2,048	41,677	41,677	277	5,632
23	0	2,048	2,048	41,677	41,677	252	5,120
24	0	2,048	2,048	41,677	41,677	229	4,654
25	0	2,048	2,048	41,677	41,677	208	4,231
26	0	2,048	2,048	41,677	41,677	189	3,847
27	0	2,048	2,048	41,677	41,677	172	3,497
28	0	2,048	2,048	41,677	41,677	156	3,179
29	0	2,048	2,048	41,677	41,677	142	2,890
30	0	2,048	2,048	41,677	41,677	129	2,627
Total	254,235	46,757	300,992	951,435	951,435	205,442	208,565

E. B / C =	1.01520
ENPV =	3,122
E I R R =	10.00000

Table K.3.4 Sensitivity Analysis: Project Benefit Decreased by 10% (5/10)

- EIRR -

(Unit: thou. Nu.)

Year	Cost			Benefit		Present Value	
in	Const.	O/M		Wangd.			
Order	W. Town	W. Town	Total	Town	Total	Cost	Benefit
1	0	0	0	0	0	0	0
2	10,742	0	10,742	0	0	9,765	0
3	78,083	0	78,083	0	0	64,531	0
4	117,929	0	117,929	0	0	88,600	0
5	15,555	0	15,555	0	0	10,624	0
6	0	566	566	10,364	10,364	351	6,435
7	0	862	862	15,793	15,793	487	8,915
8	0	1,159	1,159	21,222	21,222	595	10,890
9	4,407	1,455	5,862	26,651	26,651	2,735	12,432
10	4,407	1,752	6,159	32,080	32,080	2,612	13,604
11	0	2,048	2,048	37,509	37,509	790	14,461
12	0	2,048	2,048	37,509	37,509	718	13,146
13	0	2,048	2,048	37,509	37,509	653	11,951
14	0	2,048	2,048	37,509	37,509	593	10,864
15	0	2,048	2,048	37,509	37,509	539	9,877
16	0	2,048	2,048	37,509	37,509	490	8,979
17	0	2,048	2,048	37,509	37,509	446	8,162
18	0	2,048	2,048	37,509	37,509	405	7,420
19	0	2,048	2,048	37,509	37,509	368	6,746
20	0	2,048	2,048	37,509	37,509	335	6,132
21	0	2,048	2,048	37,509	37,509	304	5,575
22	0	2,048	2,048	37,509	37,509	277	5,068
23	0	2,048	2,048	37,509	37,509	252	4,607
24	0	2,048	2,048	37,509	37,509	229	4,188
25	0	2,048	2,048	37,509	37,509	208	3,808
26	0	2,048	2,048	37,509	37,509	189	3,461
27	0	2,048	2,048	37,509	37,509	172	3,147
28	0	2,048	2,048	37,509	37,509	156	2,861
29	0	2,048	2,048	37,509	37,509	142	2,601
30	0	2,048	2,048	37,509	37,509	129	2,364
Total	231,123	46,757	277,880	856,291	856,291	187,694	187,694

E. B / C =	1.00000
ENPV =	0.00
E I R R =	10.00059

Table K.3.4 Sensitivity Analysis: Project Benefit Decreased by 10% (6/10)

- ENPV and E.B/C -

(Unit: thou. Nu.)

Year	Cost			Benefit		Present Value	
in	Const.	O/M		Wangd.			
Order	W. Town	W. Town	Total	Town	Total	Cost	Benefit
1	0	0	0	0	0	0	0
2	10,742	0	10,742	0	0	9,765	0
3	78,083	0	78,083	0	0	64,531	0
4	117,929	0	117,929	0	0	88,602	0
5	15,555	0	15,555	0	0	10,624	0
6	0	566	566	10,364	10,364	351	6,435
7	0	862	862	15,793	15,793	487	8,915
8	0	1,159	1,159	21,222	21,222	595	10,890
9	4,407	1,455	5,862	26,651	26,651	2,735	12,433
10	4,407	1,752	6,159	32,080	32,080	2,612	13,605
11	0	2,048	2,048	37,509	37,509	790	14,461
12	0	2,048	2,048	37,509	37,509	718	13,147
13	0	2,048	2,048	37,509	37,509	653	11,952
14	0	2,048	2,048	37,509	37,509	593	10,865
15	0	2,048	2,048	37,509	37,509	539	9,877
16	0	2,048	2,048	37,509	37,509	490	8,979
17	0	2,048	2,048	37,509	37,509	446	8,163
18	0	2,048	2,048	37,509	37,509	405	7,421
19	0	2,048	2,048	37,509	37,509	368	6,746
20	0	2,048	2,048	37,509	37,509	335	6,133
21	0	2,048	2,048	37,509	37,509	304	5,575
22	0	2,048	2,048	37,509	37,509	277	5,069
23	0	2,048	2,048	37,509	37,509	252	4,608
24	0	2,048	2,048	37,509	37,509	229	4,189
25	0	2,048	2,048	37,509	37,509	208	3,808
26	0	2,048	2,048	37,509	37,509	189	3,462
27	0	2,048	2,048	37,509	37,509	172	3,147
28	0	2,048	2,048	37,509	37,509	156	2,861
29	0	2,048	2,048	37,509	37,509	142	2,601
30	0	2,048	2,048	37,509	37,509	129	2,365
Total	231,123	46,757	277,880	856,291	856,291	187,697	187,708

E.B/C =	1.00006
ENPV =	11
EIRR =	10.00000

Table K.3.4 Sensitivity Analysis: Construction Delayed for 1 year (7/10)

- EIRR -

(Unit: thou. Nu.)

Year	Cost			Benefit		Present Value	
in	Const.	O/M		Wangd.			
Order	W. Town	W. Town	Total	Town	Total	Cost	Benefit
1	0	0	0	0	0	0	0
2	10,742	0	10,742	0	0	9,763	0
3	78,083	0	78,083	0	0	64,497	0
4	117,929	0	117,929	0	0	88,531	0
5	15,555	0	15,555	0	0	10,613	0
6	0	0	0	0	0	0	0
7	0	566	566	11,516	11,516	319	6,490
8	0	862	862	17,548	17,548	442	8,988
9	4,407	1,159	5,566	23,580	23,580	2,591	10,977
10	4,407	1,455	5,862	29,612	29,612	2,480	12,529
11	0	1,752	1,752	35,645	35,645	674	13,706
12	0	2,048	2,048	41,677	41,677	716	14,565
13	0	2,048	2,048	41,677	41,677	651	13,237
14	0	2,048	2,048	41,677	41,677	591	12,031
15	0	2,048	2,048	41,677	41,677	537	10,934
16	0	2,048	2,048	41,677	41,677	488	9,937
17	0	2,048	2,048	41,677	41,677	444	9,032
18	0	2,048	2,048	41,677	41,677	403	8,208
19	0	2,048	2,048	41,677	41,677	367	7,460
20	0	2,048	2,048	41,677	41,677	333	6,780
21	0	2,048	2,048	41,677	41,677	303	6,162
22	0	2,048	2,048	41,677	41,677	275	5,601
23	0	2,048	2,048	41,677	41,677	250	5,090
24	0	2,048	2,048	41,677	41,677	227	4,626
25	0	2,048	2,048	41,677	41,677	207	4,204
26	0	2,048	2,048	41,677	41,677	188	3,821
27	0	2,048	2,048	41,677	41,677	171	3,473
28	0	2,048	2,048	41,677	41,677	155	3,156
29	0	2,048	2,048	41,677	41,677	141	2,869
30	0	2,048	2,048	41,677	41,677	128	2,607
Total	231,123	44,709	275,832	909,758	909,758	186,485	186,485

E. B / C =	1.00000
ENPV =	0.00
EIRR =	10.02914

Table K.3.4 Sensitivity Analysis: Construction Delayed for 1 year (8/10)

- ENPV and E.B/C -

(Unit: thou. Nu.)

Year	Cost			Benefit		Present Value	
in	Const.	O/M		Wangd.			
Order	W. Town	W. Town	Total	Town	Total	Cost	Benefit
1	0	0	0	0	0	0	0
2	10,742	0	10,742	0	0	9,765	0
3	78,083	0	78,083	0	0	64,531	0
4	117,929	0	117,929	0	0	88,602	0
5	15,555	0	15,555	0	0	10,624	0
6	0	0	0	0	0	0	0
7	0	566	566	11,516	11,516	319	6,500
8	0	862	862	17,548	17,548	443	9,005
9	4,407	1,159	5,566	23,580	23,580	2,596	11,000
10	4,407	1,455	5,862	29,612	29,612	2,486	12,559
11	0	1,752	1,752	35,645	35,645	675	13,743
12	0	2,048	2,048	41,677	41,677	718	14,607
13	0	2,048	2,048	41,677	41,677	653	13,279
14	0	2,048	2,048	41,677	41,677	593	12,072
15	0	2,048	2,048	41,677	41,677	539	10,975
16	0	2,048	2,048	41,677	41,677	490	9,977
17	0	2,048	2,048	41,677	41,677	446	9,070
18	0	2,048	2,048	41,677	41,677	405	8,246
19	0	2,048	2,048	41,677	41,677	368	7,496
20	0	2,048	2,048	41,677	41,677	335	6,814
21	0	2,048	2,048	41,677	41,677	304	6,195
22	0	2,048	2,048	41,677	41,677	277	5,632
23	0	2,048	2,048	41,677	41,677	252	5,120
24	0	2,048	2,048	41,677	41,677	229	4,654
25	0	2,048	2,048	41,677	41,677	208	4,231
26	0	2,048	2,048	41,677	41,677	189	3,847
27	0	2,048	2,048	41,677	41,677	172	3,497
28	0	2,048	2,048	41,677	41,677	156	3,179
29	0	2,048	2,048	41,677	41,677	142	2,890
30	0	2,048	2,048	41,677	41,677	129	2,627
Total	231,123	44,709	275,832	909,758	909,758	186,648	187,216

E.B/C =	1.00304
ENPV =	567
EIRR =	10.00000

Table K.3.4 Sensitivity Analysis: SCF Is Applied for Local Costs (9/10)

- EIRR -

(Unit: thou. Nu.)

Year	Cost			Benefit		Present Value	
in	Const.	O/M		Wangd.			
Order	W. Town	W. Town	Total	Town	Total	Cost	Benefit
1	0	0	0	0	0	0	0
2	10,248	0	10,248	0	0	9,174	0
3	74,491	0	74,491	0	0	59,701	0
4	112,504	0	112,504	0	0	80,720	0
5	14,839	0	14,839	0	0	9,532	0
6	0	453	453	11,516	11,516	260	6,622
7	0	690	690	17,548	17,548	355	9,033
8	0	927	927	23,580	23,580	427	10,867
9	4,204	1,164	5,368	29,612	29,612	2,215	12,217
10	4,204	1,401	5,606	35,645	35,645	2,070	13,165
11	0	1,639	1,639	41,677	41,677	542	13,780
12	0	1,639	1,639	41,677	41,677	485	12,337
13	0	1,639	1,639	41,677	41,677	434	11,044
14	0	1,639	1,639	41,677	41,677	389	9,887
15	0	1,639	1,639	41,677	41,677	348	8,851
16	0	1,639	1,639	41,677	41,677	312	7,924
17	0	1,639	1,639	41,677	41,677	279	7,094
18	0	1,639	1,639	41,677	41,677	250	6,351
19	0	1,639	1,639	41,677	41,677	224	5,685
20	0	1,639	1,639	41,677	41,677	200	5,090
21	0	1,639	1,639	41,677	41,677	179	4,557
22	0	1,639	1,639	41,677	41,677	160	4,079
23	0	1,639	1,639	41,677	41,677	144	3,652
24	0	1,639	1,639	41,677	41,677	129	3,269
25	0	1,639	1,639	41,677	41,677	115	2,927
26	0	1,639	1,639	41,677	41,677	103	2,620
27	0	1,639	1,639	41,677	41,677	92	2,346
28	0	1,639	1,639	41,677	41,677	83	2,100
29	0	1,639	1,639	41,677	41,677	74	1,880
30	0	1,639	1,639	41,677	41,677	66	1,683
Total	220,491	37,405	257,897	951,435	951,435	169,060	169,060

E. B / C =	1.00000
ENPV =	0.00
E I R R =	11.70253

Table K.3.4 Sensitivity Analysis: SCF is Applied for Local Costs (10/10)

- ENPV and E.B/C -

(Unit: thou. Nu.)

Year	Cost			Benefit		Present Value	
in	Const.	O/M		Wangd.			
Order	W. Town	W. Town	Total	Town	Total	Cost	Benefit
1	0	0	0	0	0	0	0
2	10,248	0	10,248	0	0	9,316	0
3	74,491	0	74,491	0	0	61,563	0
4	112,504	0	112,504	0	0	84,526	0
5	14,839	0	14,839	0	0	10,136	0
6	0	453	453	11,516	11,516	281	7,150
7	0	690	690	17,548	17,548	389	9,905
8	0	927	927	23,580	23,580	476	12,100
9	4,204	1,164	5,368	29,612	29,612	2,504	13,814
10	4,204	1,401	5,606	35,645	35,645	2,377	15,117
11	0	1,639	1,639	41,677	41,677	632	16,068
12	0	1,639	1,639	41,677	41,677	574	14,607
13	0	1,639	1,639	41,677	41,677	522	13,279
14	0	1,639	1,639	41,677	41,677	475	12,072
15	0	1,639	1,639	41,677	41,677	431	10,975
16	0	1,639	1,639	41,677	41,677	392	9,977
17	0	1,639	1,639	41,677	41,677	357	9,070
18	0	1,639	1,639	41,677	41,677	324	8,246
19	0	1,639	1,639	41,677	41,677	295	7,496
20	0	1,639	1,639	41,677	41,677	268	6,814
21	0	1,639	1,639	41,677	41,677	244	6,195
22	0	1,639	1,639	41,677	41,677	221	5,632
23	0	1,639	1,639	41,677	41,677	201	5,120
24	0	1,639	1,639	41,677	41,677	183	4,654
25	0	1,639	1,639	41,677	41,677	166	4,231
26	0	1,639	1,639	41,677	41,677	151	3,847
27	0	1,639	1,639	41,677	41,677	137	3,497
28	0	1,639	1,639	41,677	41,677	125	3,179
29	0	1,639	1,639	41,677	41,677	114	2,890
30	0	1,639	1,639	41,677	41,677	103	2,627
Total	220,491	37,405	257,897	951,435	951,435	177,485	208,565

E.B/C =	1.17511
ENPV =	31,080
EIRR =	10.00000

Table K.3.5 Cost and Benefit Flow of Irrigation Improvement Plan (1/10)

- EIRR -

(Unit: thou. Nu.)

Year	Cost			Benefit			Present Value	
in Order	Const. Cost	O/M Cost	Total	Agricul. Prod.	Saving O/M	Total	Cost	Benefit
1	2,515	0	2,515	0	0	0	2,515	0
2	1,784	0	1,784	0	0	0	1,605	0
3	1,003	58	1,061	304	126	430	858	347
4	0	106	106	555	230	785	77	571
5	0	106	106	555	230	785	69	514
6	0	106	106	555	230	785	62	462
7	0	106	106	555	230	785	56	416
8	0	106	106	555	230	785	50	374
9	0	106	106	555	230	785	45	336
10	0	106	106	555	230	785	41	302
11	0	106	106	555	230	785	37	272
12	0	106	106	555	230	785	33	245
13	0	106	106	555	230	785	30	220
14	0	106	106	555	230	785	27	198
15	0	106	106	555	230	785	24	178
16	0	106	106	555	230	785	22	160
17	0	106	106	555	230	785	19	144
18	0	106	106	555	230	785	17	129
19	0	106	106	555	230	785	16	116
20	0	106	106	555	230	785	14	105
21	0	106	106	555	230	785	13	94
22	0	106	106	555	230	785	11	85
23	0	106	106	555	230	785	10	76
24	0	106	106	555	230	785	9	69
25	0	106	106	555	230	785	8	62
26	0	106	106	555	230	785	7	55
27	0	106	106	555	230	785	7	50
28	0	106	106	555	230	785	6	45
29	0	106	106	555	230	785	5	40
30	0	106	106	555	230	785	5	36
Total	5,302	2,920	8,222	15,289	6,336	21,625	5,701	5,701

E.B/C =	1.00000
ENPV =	0.00
EIRR =	11.18465

Table K.3.5 Cost and Benefit Flow of Irrigation Improvement Plan (2/10)

- ENPV and E.B/C -

(Unit: thou. Nu.)

Year	Cost			Benefit			Present Value	
in Order	Const. Cost	O/M Cost	Total	Agricul. Prod.	Saving O/M	Total	Cost	Benefit
1	2,515	0	2,515	0	0	0	2,515	0
2	1,784	0	1,784	0	0	0	1,622	0
3	1,003	58	1,061	304	126	430	877	355
4	0	106	106	555	230	785	80	590
5	0	106	106	555	230	785	72	536
6	0	106	106	555	230	785	66	487
7	0	106	106	555	230	785	60	443
8	0	106	106	555	230	785	54	403
9	0	106	106	555	230	785	49	366
10	0	106	106	555	230	785	45	333
11	0	106	106	555	230	785	41	303
12	0	106	106	555	230	785	37	275
13	0	106	106	555	230	785	34	250
14	0	106	106	555	230	785	31	227
15	0	106	106	555	230	785	28	207
16	0	106	106	555	230	785	25	188
17	0	106	106	555	230	785	23	171
18	0	106	106	555	230	785	21	155
19	0	106	106	555	230	785	19	141
20	0	106	106	555	230	785	17	128
21	0	106	106	555	230	785	16	117
22	0	106	106	555	230	785	14	106
23	0	106	106	555	230	785	13	96
24	0	106	106	555	230	785	12	88
25	0	106	106	555	230	785	11	80
26	0	106	106	555	230	785	10	72
27	0	106	106	555	230	785	9	66
28	0	106	106	555	230	785	8	60
29	0	106	106	555	230	785	7	54
30	0	106	106	555	230	785	7	49
Total	5,302	2,920	8,222	15,289	6,336	21,625	5,823	6,348

E.B/C =	1.09013
ENPV =	525
EIRR =	10.00000

Table K.3.5 Sensitivity Analysis: Project Cost Increased by 10% (3/10)

- EIRR -

(Unit: thou. Nu.)

Year	Cost			Benefit			Present Value	
in	Const.	O/M		Agricul.	Saving			
Order	Cost	Cost	Total	Prod.	O/M	Total	Cost	Benefit
1	2,767	0	2,767	0	0	0	2,767	0
2	1,962	0	1,962	0	0	0	1,783	0
3	1,103	58	1,161	304	126	430	959	355
4	0	106	106	555	230	785	80	589
5	0	106	106	555	230	785	72	535
6	0	106	106	555	230	785	66	486
7	0	106	106	555	230	785	60	442
8	0	106	106	555	230	785	54	401
9	0	106	106	555	230	785	49	365
10	0	106	106	555	230	785	45	331
11	0	106	106	555	230	785	41	301
12	0	106	106	555	230	785	37	274
13	0	106	106	555	230	785	34	249
14	0	106	106	555	230	785	30	226
15	0	106	106	555	230	785	28	205
16	0	106	106	555	230	785	25	186
17	0	106	106	555	230	785	23	169
18	0	106	106	555	230	785	21	154
19	0	106	106	555	230	785	19	140
20	0	106	106	555	230	785	17	127
21	0	106	106	555	230	785	16	115
22	0	106	106	555	230	785	14	105
23	0	106	106	555	230	785	13	95
24	0	106	106	555	230	785	12	87
25	0	106	106	555	230	785	11	79
26	0	106	106	555	230	785	10	71
27	0	106	106	555	230	785	9	65
28	0	106	106	555	230	785	8	59
29	0	106	106	555	230	785	7	54
30	0	106	106	555	230	785	7	49
Total	5,832	2,920	8,752	15,289	6,336	21,625	6,313	6,313

E. B / C =	1.00000
ENPV =	0.00
EIRR =	10.05910

Table K.3.5 Sensitivity Analysis: Project Cost Increased by 10% (4/10)

- ENPV and E.B/C -

(Unit: thou. Nu.)

Year	Cost			Benefit			Present Value	
in	Const.	O/M		Agricul.	Saving			
Order	Cost	Cost	Total	Prod.	O/M	Total	Cost	Benefit
1	2,767	0	2,767	0	0	0	2,767	0
2	1,962	0	1,962	0	0	0	1,784	0
3	1,103	58	1,161	304	126	430	960	355
4	0	106	106	555	230	785	80	590
5	0	106	106	555	230	785	72	536
6	0	106	106	555	230	785	66	487
7	0	106	106	555	230	785	60	443
8	0	106	106	555	230	785	54	403
9	0	106	106	555	230	785	49	366
10	0	106	106	555	230	785	45	333
11	0	106	106	555	230	785	41	303
12	0	106	106	555	230	785	37	275
13	0	106	106	555	230	785	34	250
14	0	106	106	555	230	785	31	227
15	0	106	106	555	230	785	28	207
16	0	106	106	555	230	785	25	188
17	0	106	106	555	230	785	23	171
18	0	106	106	555	230	785	21	155
19	0	106	106	555	230	785	19	141
20	0	106	106	555	230	785	17	128
21	0	106	106	555	230	785	16	117
22	0	106	106	555	230	785	14	106
23	0	106	106	555	230	785	13	96
24	0	106	106	555	230	785	12	88
25	0	106	106	555	230	785	11	80
26	0	106	106	555	230	785	10	72
27	0	106	106	555	230	785	9	66
28	0	106	106	555	230	785	8	60
29	0	106	106	555	230	785	7	54
30	0	106	106	555	230	785	7	49
Total	5,832	2,920	8,752	15,289	6,336	21,625	6,319	6,348

E. B / C =	1.00447
ENPV =	28
E I R R =	10.00000

Table K.3.5 Sensitivity Analysis: Project Benefit Decreased by 10% (5/10)

- EIRR -

(Unit: thou. Nu.)

Year	Cost			Benefit			Present Value	
in Order	Const. Cost	O/M Cost	Total	Agricul. Prod.	Saving O/M	Total	Cost	Benefit
1	2,515	0	2,515	0	0	0	2,515	0
2	1,784	0	1,784	0	0	0	1,619	0
3	1,003	58	1,061	273	126	399	874	329
4	0	106	106	500	230	730	79	545
5	0	106	106	500	230	730	72	495
6	0	106	106	500	230	730	65	449
7	0	106	106	500	230	730	59	408
8	0	106	106	500	230	730	54	370
9	0	106	106	500	230	730	49	336
10	0	106	106	500	230	730	44	305
11	0	106	106	500	230	730	40	277
12	0	106	106	500	230	730	37	251
13	0	106	106	500	230	730	33	228
14	0	106	106	500	230	730	30	207
15	0	106	106	500	230	730	27	188
16	0	106	106	500	230	730	25	171
17	0	106	106	500	230	730	22	155
18	0	106	106	500	230	730	20	140
19	0	106	106	500	230	730	19	128
20	0	106	106	500	230	730	17	116
21	0	106	106	500	230	730	15	105
22	0	106	106	500	230	730	14	95
23	0	106	106	500	230	730	13	87
24	0	106	106	500	230	730	11	79
25	0	106	106	500	230	730	10	71
26	0	106	106	500	230	730	9	65
27	0	106	106	500	230	730	9	59
28	0	106	106	500	230	730	8	53
29	0	106	106	500	230	730	7	48
30	0	106	106	500	230	730	6	44
Total	5,302	2,920	8,222	13,760	6,336	20,096	5,804	5,804

E. B / C =	1.00000
ENPV =	0.00
E I R R =	10.17460

Table K.3.5 Sensitivity Analysis: SCF is Applied for Local Costs (6/10)

- ENPV and E.B/C -

(Unit: thou. Nu.)

Year	Cost			Benefit			Present Value	
in	Const.	O/M		Agricul.	Saving			
Order	Cost	Cost	Total	Prod.	O/M	Total	Cost	Benefit
1	2,515	0	2,515	0	0	0	2,515	0
2	1,784	0	1,784	0	0	0	1,622	0
3	1,003	58	1,061	273	126	399	877	330
4	0	106	106	500	230	730	80	548
5	0	106	106	500	230	730	72	498
6	0	106	106	500	230	730	66	453
7	0	106	106	500	230	730	60	412
8	0	106	106	500	230	730	54	374
9	0	106	106	500	230	730	49	340
10	0	106	106	500	230	730	45	309
11	0	106	106	500	230	730	41	281
12	0	106	106	500	230	730	37	256
13	0	106	106	500	230	730	34	232
14	0	106	106	500	230	730	31	211
15	0	106	106	500	230	730	28	192
16	0	106	106	500	230	730	25	175
17	0	106	106	500	230	730	23	159
18	0	106	106	500	230	730	21	144
19	0	106	106	500	230	730	19	131
20	0	106	106	500	230	730	17	119
21	0	106	106	500	230	730	16	108
22	0	106	106	500	230	730	14	99
23	0	106	106	500	230	730	13	90
24	0	106	106	500	230	730	12	81
25	0	106	106	500	230	730	11	74
26	0	106	106	500	230	730	10	67
27	0	106	106	500	230	730	9	61
28	0	106	106	500	230	730	8	56
29	0	106	106	500	230	730	7	51
30	0	106	106	500	230	730	7	46
Total	5,302	2,920	8,222	13,760	6,336	20,096	5,823	5,899

E. B / C =	1.01306
ENPV =	76
E I R R =	10.00000

Table K.3.5 Sensitivity Analysis: Construction Delayed for 1 year (7/10)

- EIRR -

(Unit: thou. Nu.)

Year	Cost			Benefit			Present Value	
in Order	Const. Cost	O/M Cost	Total	Agricul. Prod.	Saving O/M	Total	Cost	Benefit
1	2,515	0	2,515	0	0	0	2,515	0
2	1,784	0	1,784	0	0	0	1,622	0
3	1,003	0	1,003	0	0	0	829	0
4	0	58	58	304	126	430	44	323
5	0	106	106	555	230	785	72	537
6	0	106	106	555	230	785	66	488
7	0	106	106	555	230	785	60	444
8	0	106	106	555	230	785	54	404
9	0	106	106	555	230	785	50	367
10	0	106	106	555	230	785	45	334
11	0	106	106	555	230	785	41	303
12	0	106	106	555	230	785	37	276
13	0	106	106	555	230	785	34	251
14	0	106	106	555	230	785	31	228
15	0	106	106	555	230	785	28	207
16	0	106	106	555	230	785	25	189
17	0	106	106	555	230	785	23	172
18	0	106	106	555	230	785	21	156
19	0	106	106	555	230	785	19	142
20	0	106	106	555	230	785	17	129
21	0	106	106	555	230	785	16	117
22	0	106	106	555	230	785	14	107
23	0	106	106	555	230	785	13	97
24	0	106	106	555	230	785	12	88
25	0	106	106	555	230	785	11	80
26	0	106	106	555	230	785	10	73
27	0	106	106	555	230	785	9	66
28	0	106	106	555	230	785	8	60
29	0	106	106	555	230	785	7	55
30	0	106	106	555	230	785	7	50
Total	5,302	2,814	8,116	14,734	6,106	20,840	5,742	5,742

E. B / C =	1.00000
ENPV =	0.00
E I R R =	9.97202

Table K.3.6 Sensitivity Analysis: SCF Is Applied for Local Costs (8/10)

- ENPV and E.B/C -

(Unit: thou. Nu.)

Year	Cost			Benefit			Present Value	
in Order	Const. Cost	O/M Cost	Total	Agricul. Prod.	Saving O/M	Total	Cost	Benefit
1	2,515	0	2,515	0	0	0	2,515	0
2	1,784	0	1,784	0	0	0	1,622	0
3	1,003	0	1,003	0	0	0	829	0
4	0	58	58	304	126	430	44	323
5	0	106	106	555	230	785	72	536
6	0	106	106	555	230	785	66	487
7	0	106	106	555	230	785	60	443
8	0	106	106	555	230	785	54	403
9	0	106	106	555	230	785	49	366
10	0	106	106	555	230	785	45	333
11	0	106	106	555	230	785	41	303
12	0	106	106	555	230	785	37	275
13	0	106	106	555	230	785	34	250
14	0	106	106	555	230	785	31	227
15	0	106	106	555	230	785	28	207
16	0	106	106	555	230	785	25	188
17	0	106	106	555	230	785	23	171
18	0	106	106	555	230	785	21	155
19	0	106	106	555	230	785	19	141
20	0	106	106	555	230	785	17	128
21	0	106	106	555	230	785	16	117
22	0	106	106	555	230	785	14	106
23	0	106	106	555	230	785	13	96
24	0	106	106	555	230	785	12	88
25	0	106	106	555	230	785	11	80
26	0	106	106	555	230	785	10	72
27	0	106	106	555	230	785	9	66
28	0	106	106	555	230	785	8	60
29	0	106	106	555	230	785	7	54
30	0	106	106	555	230	785	7	49
Total	5,302	2,814	8,116	14,734	6,106	20,840	5,739	5,726

E.B/C =	0.99770
ENPV =	-13
EIRR =	10.00000

Table K.3.6 Sensitivity Analysis: SCF is Applied for Local Costs (9/10)

- EIRR -

(Unit: thou. Nu.)

Year	Cost			Benefit			Present Value	
in Order	Const. Cost	O/M Cost	Total	Agricul. Prod.	Saving O/M	Total	Cost	Benefit
1	2,012	0	2,012	0	0	0	2,012	0
2	1,784	0	1,784	0	0	0	1,524	0
3	0	46	46	364	101	465	34	340
4	0	85	85	666	184	850	53	530
5	0	85	85	666	184	850	45	453
6	0	85	85	666	184	850	39	387
7	0	85	85	666	184	850	33	331
8	0	85	85	666	184	850	28	282
9	0	85	85	666	184	850	24	241
10	0	85	85	666	184	850	21	206
11	0	85	85	666	184	850	18	176
12	0	85	85	666	184	850	15	151
13	0	85	85	666	184	850	13	129
14	0	85	85	666	184	850	11	110
15	0	85	85	666	184	850	9	94
16	0	85	85	666	184	850	8	80
17	0	85	85	666	184	850	7	69
18	0	85	85	666	184	850	6	59
19	0	85	85	666	184	850	5	50
20	0	85	85	666	184	850	4	43
21	0	85	85	666	184	850	4	37
22	0	85	85	666	184	850	3	31
23	0	85	85	666	184	850	3	27
24	0	85	85	666	184	850	2	23
25	0	85	85	666	184	850	2	19
26	0	85	85	666	184	850	2	17
27	0	85	85	666	184	850	1	14
28	0	85	85	666	184	850	1	12
29	0	85	85	666	184	850	1	10
30	0	85	85	666	184	850	1	9
Total	3,796	2,336	6,132	18,346	5,069	23,415	3,928	3,928

E. B / C =	1.00000
ENPV =	0.00
E I R R =	17.04335

Table K.3.5 Sensitivity Analysis: SCF is Applied for Local Costs (10/10)

- ENPV and E.B/C -

(Unit: thou. Nu.)

Year	Cost			Benefit			Present Value	
in	Const.	O/M		Agricul.	Saving			
Order	Cost	Cost	Total	Prod.	O/M	Total	Cost	Benefit
1	2,012	0	2,012	0	0	0	2,012	0
2	1,784	0	1,784	0	0	0	1,622	0
3	0	46	46	364	101	465	38	384
4	0	85	85	666	184	850	64	639
5	0	85	85	666	184	850	58	581
6	0	85	85	666	184	850	53	528
7	0	85	85	666	184	850	48	480
8	0	85	85	666	184	850	44	436
9	0	85	85	666	184	850	40	397
10	0	85	85	666	184	850	36	360
11	0	85	85	666	184	850	33	328
12	0	85	85	666	184	850	30	298
13	0	85	85	666	184	850	27	271
14	0	85	85	666	184	850	25	246
15	0	85	85	666	184	850	22	224
16	0	85	85	666	184	850	20	203
17	0	85	85	666	184	850	18	185
18	0	85	85	666	184	850	17	168
19	0	85	85	666	184	850	15	153
20	0	85	85	666	184	850	14	139
21	0	85	85	666	184	850	13	126
22	0	85	85	666	184	850	11	115
23	0	85	85	666	184	850	10	104
24	0	85	85	666	184	850	9	95
25	0	85	85	666	184	850	9	86
26	0	85	85	666	184	850	8	78
27	0	85	85	666	184	850	7	71
28	0	85	85	666	184	850	6	65
29	0	85	85	666	184	850	6	59
30	0	85	85	666	184	850	5	54
Total	3,796	2,336	6,132	18,346	5,069	23,415	4,320	6,873

E.B/C =	1.59122
ENPV =	2,554
EIRR =	10.00000