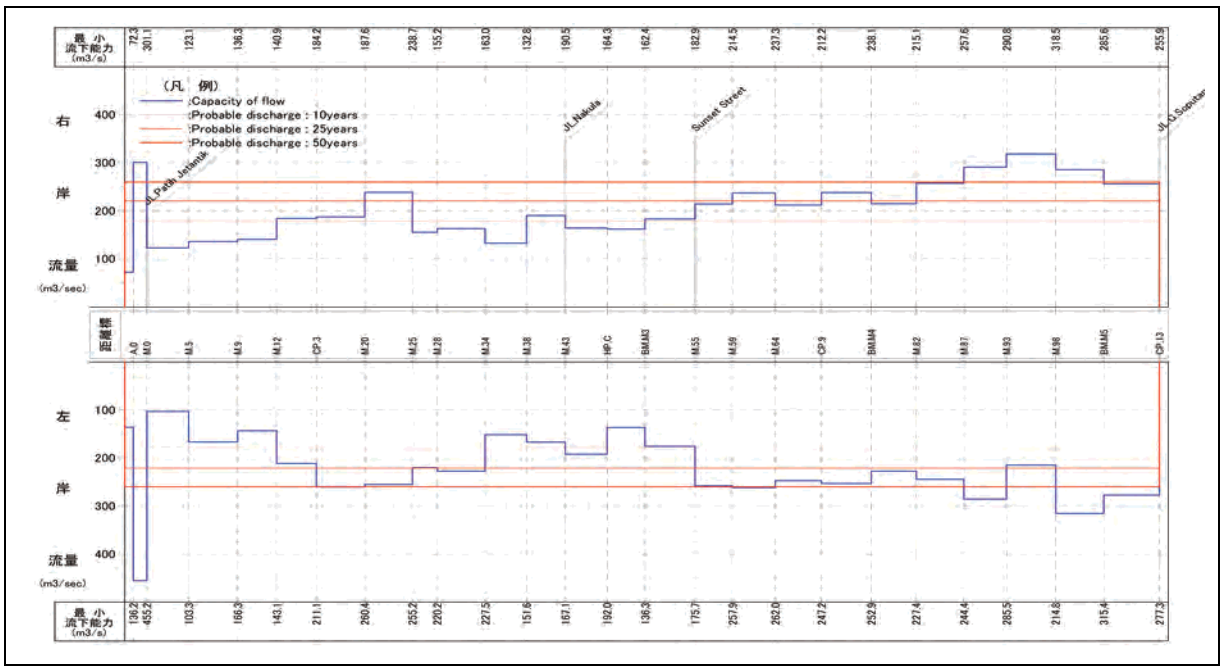


Figure-5.24 Calculation Result for Current River Flow Capacity (Mati River)

(2) Design Flood Calculation for Mati River

<Watershed Division>

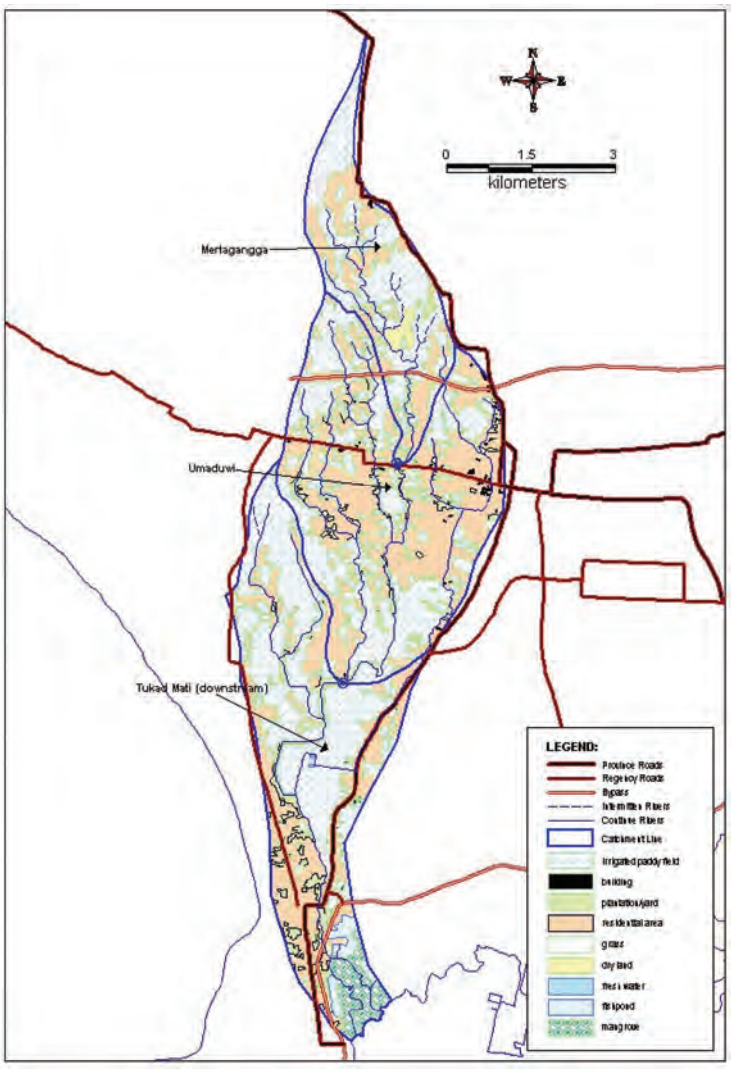
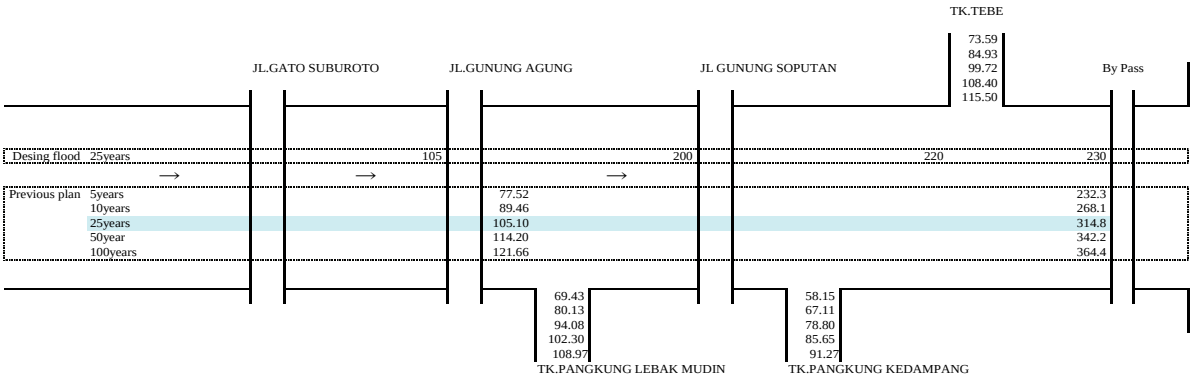


Figure-5.25 Watershed Division for Mati River Basin

<Basic Design Flood for Mati River>

Based on the calculation result as shown in Figure-5.26, basic design flood for Mati River should be determined to 230m^3/sec.



*Previous Plan : PENGUKURAN DAN PERENCANAAN TEKNIS TUKAD SUNGI DAN TUKAD MATI KAB.BADUNG/KODYA DENPASAR ,1997/1998

Figure-5.26 Distribution of Basic Design Discharge (Mati River)

(3) River Improvement for Mati River

<Flood Prevention Plan>

Flood prevention plan for Mati River consists of river improvement and natural retarding basin located in upstream of Umadui Weir based on the following reasons:

- In accordance with existing improvement plan prepared by Indonesian government, river improvement had already executed from downstream to upstream except section from Ulun Tanjug Weir to Umadui Weir.
- Current land use of planned retarding basin, showing topographical decline from Mati River to Lebakmudin River, is almost paddy field with natural retarding function. Because of inundation repeated at frequent intervals in this stretch area caused to land characteristics of low lying area, the land development is at a stop. The land use condition of planned retarding basin shall be secured in the future.
- River improvement shall be carried out for the section from Ulun Tanjung Weir to Umadui Weir with banking and normalization. The existing Ulun Tanjung Weir shall be removed for the reason of nonfunctional condition.

<Distribution of Design Discharge>

Distribution of Design discharge is shown in Figure-5.44 with following comment.

- As the area of retarding basin shall be 150,000 m^3, with about 15 ha in area and with 1.0m in depth.
- Design discharge of 226.2m^3/sec after flood control basin become 162.4m^3/sec, which is almost same with existing plan formulated by PU. Accordingly, distribution of design discharge is determined.

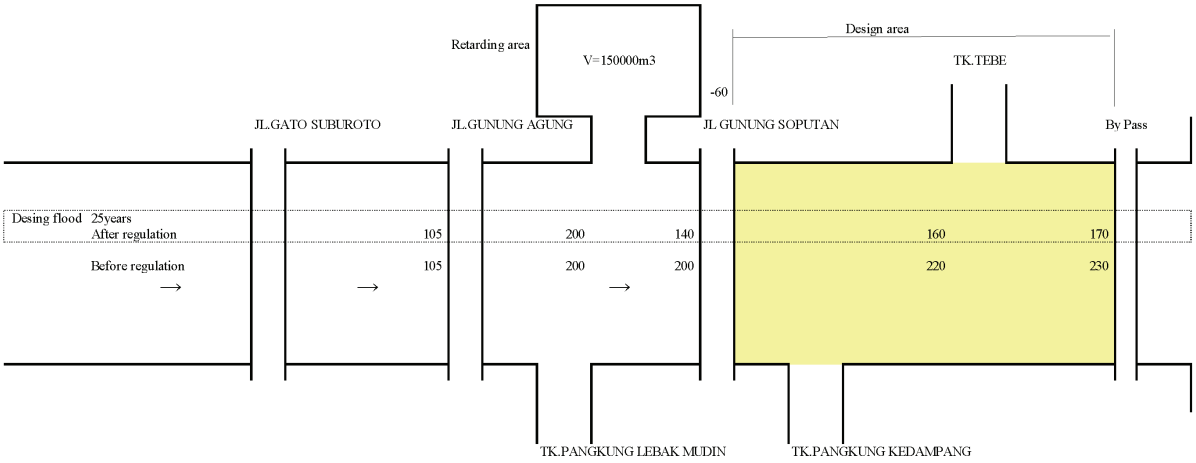


Figure-5.27 Distribution of Design Discharge (Mati River)

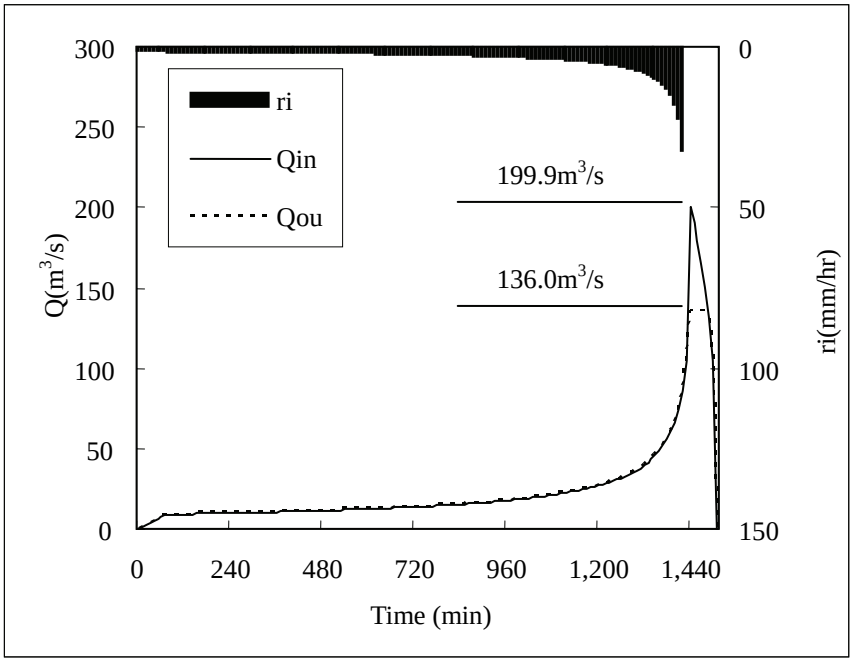


Figure-5.28 Calculation Result by Retarding Basin

(4) Flood Prevention Project for Mati River

<Basic policy for River Improvement>

According to river flow capacity calculation result, flow capacity with 170m^3/sec have secured by river improvement for the section from river mouth to Ulun Tanjung Weir near Sunset Road in Kuta. The section with distance of 2,000m from Ulun Taung Weir to Umadui Weir, flow capacity shows small discharge with 50 m^3/sec to 100m^3/sec because of no improvement. Land use condition along the river is almost paddy field and cropping land. Upstream section from Umadui Weir, river improvement with river widening is already to be finished.

For river improvement plan, only river course improvement plan from Ulung Tanjung Weir to Umadui Weir shall be designed. Existing Ulung Tanjung Weir shall be removed because of no necessity for the taking water of irrigation. With regard to retarding basin planned in the upstream of Umdui Weir in accordance with existing flood control plan, current land use which used for paddy field and cropping land should be conserved on the basis of precise land use regulations.

<Section for River Improvement and Adopted Method>

Section for river improvement should be designated from just upstream of Ulun Tanjung Weir to Umadui Weirs with about 2,500 m, based on the current flow capacity result.

An adopted method for river improvement in Mati River is shown as follows:

- Normalization Including River Widening and Banking
- Removal of Existing Ulun Tanjung Weir

<Plan for Longitudinal Profile>

Longitudinal profile plan was set to by taking into consideration with current profile prepared by topographic survey results by JICA Study Team. Longitudinal profile of Mati River is shown in Figure-5.29. Basically, longitudinal profile for Mati River is to be set in accordance with existing plan which is almost same with current river gradient. Rounded river gradient of the section is to be I=1/1,000.

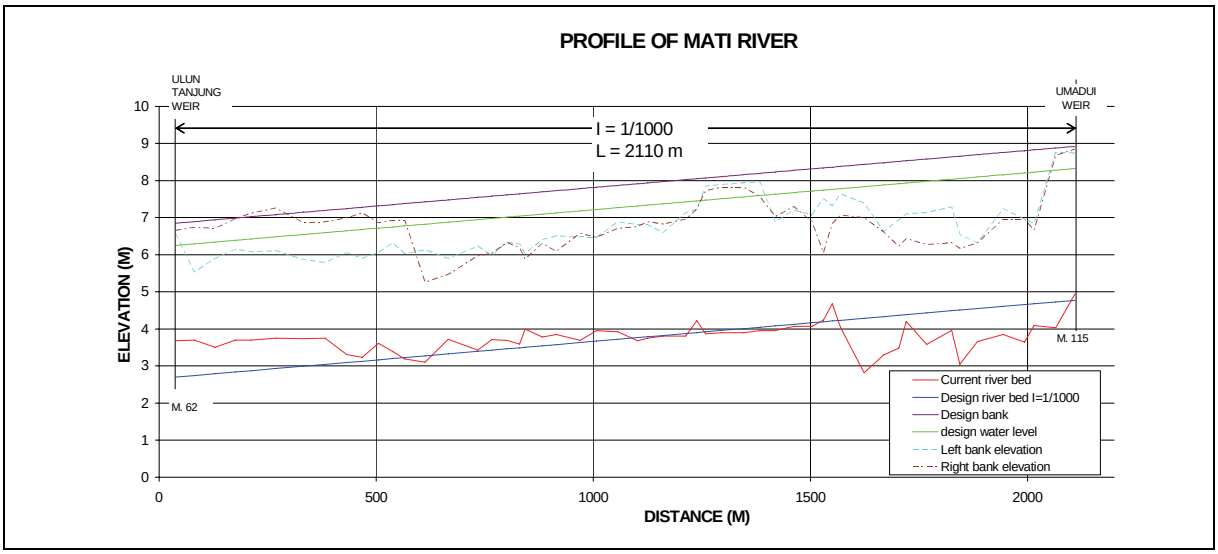


Figure-5.29 Designed Longitudinal Profile for Mati River

<Specifications for River Improvement of Mati River >

Specifications for river improvement works are shown in Table-5.17.

Table-5.17 Specifications for River Improvement of Mati River

Items	Specifications	Remarks
1) River Improvement Section and its Length	Ulun Tanjung Weir(Downstream) to Umadui Weir (Upstream) L=2,100 m	
2) Design Flood	170 m^3/sec	After Controlling by Retarding Basin
3) Designed River Gradient	I=1/1,000	
4) River Width & Cross Section Shape	B= 22-26.35 m (Trapezoid Shape with Slope1: 0.5)	
5) Adopted Works	◆ River Widening & Banking ◆ Removal of Ulun Tanjung Weir	

General plan of flood prevention project for Badung River is shown in Figure-5.30.

Outline of Works

1 Riverbed Excavation（Length = 2500m Width = 22m）
2 Retaing Wall Placement（Length = 2500m Height = 8m）
3 Removement of Existing Ulun Tanjung Weir

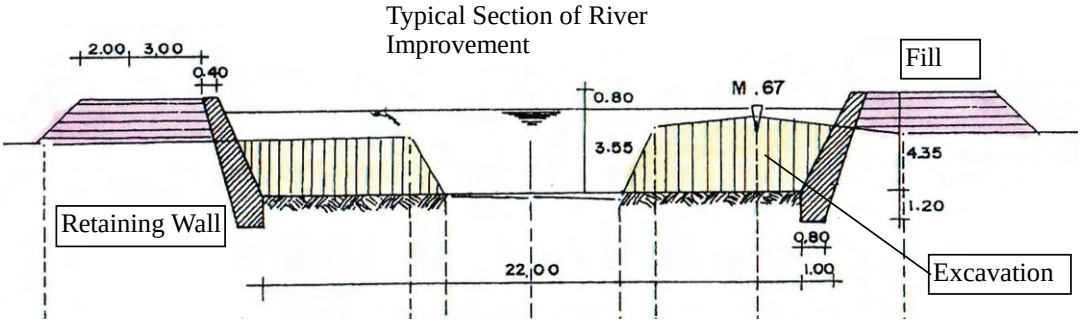


Figure-5.30　General Plan of Flood Prevention Project for Mati River

5.4.5 Work Quantities

Work quantities for river improvement project are shown as Table-5.18.

Table-5.18 Work Quantities for River Improvement Project

Description		Work Item	Unit	Quantity
River Facilities				
	New Grand sill W=20m, L=28m	Earth Works (Excavation)	m^3	100
		concrete	m^3	1,000
		Bed Protection Works (Block)	m^3	200
		Bed Protection Works (Flood Wall)	m^3	1,000
	Revetment for Low Flow Channel L=5,680m, H=1.6m	Concrete	m^3	7,130
	Parapet Wall Works L=3410m, H=0.3-1.7m	Concrete	m^3	1,190
		Sub total		
	River bed Excavation L=5,680m	Excavation	m^3	147,030
		(rock)		
Replacement for Bridges near JL. B.Tunggal				
	Removal for Existing Bridge	Steel	m^2	100
	Placement New Bridge	Steel	m^2	120
	Widening	Excavation	m^3	500
	Revetment	Concrete	m^3	900
		Sub total		
Buagan Weir Improvement				
	Improvement of Flushing Gate Foundation		LS	1

Works in detail for each project are shown in Table-5.19.

Table-5.19 Work Items for River Improvement Project

River	Description		Work Item	Unit	Quantity	Remark
Badung River	River Facilities	New Grand Sill Works W=20m, L=28m	Earth Works (Excavation)	m^3	100	
			Concrete Work	m^3	1,000	
			Bed Protection Works (Block)	m^3	200	
			Bed Protection Works (Flood Wall)	m^3	1,000	
		Revetment for Low Flow Channel L＝5,680 m, H=1.6m	Concrete Work	m^3	7,130	
		Parapet Wall Works L=3410m, H=0.3-1.7m	Concrete Work	m^3	1,190	
		River bed Excavation Work L＝5,680m	Earth Works (Soft Rock)	m^3	147,030	
	Replacement for Foot Bridges (At near JL. B. Tunggal)	Removal for Existing Bridge	Steel Bridge	m^3	100	
		Placement New Bridge	Steel Bridge	m^3	120	
		Widening	Earth Works (Excavation)	m^3	500	
		Revetment	Concrete Work	m^3	900	
	Bugan Weir Improvement	Flushing Gate Improvement		Ls	1	
Mati River	River Facilities	Removal Weir (Ulun Tanjung Weir)	Concrete Work 2.5m×9m	m^3	200	Wide =15m
		Revetment L= 2,110 m,H=5.5m	Concrete Work	m^3	19,200	
	Riverbed Excavation	Riverbed Excavation	Earth Works (Excavation)	m^3	62,500	
	Embankment		Earth Works (Embankment)	m^3	37,000	

5.4.6 Construction Plan

Construction Plan for Badung and Mati River improvement project shall be adopted as shown in Table-5.20 by taking into consideration with river and river side conditions such as bank, inspection road, housing density and river conditions, etc.

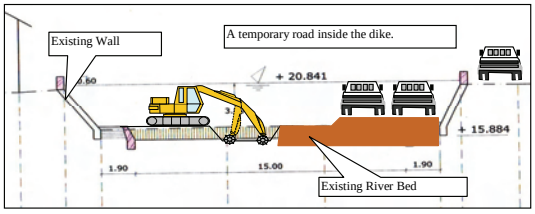
Table-5.20 Construction Plan for Badung and Mati River Improvement Project

Subject River	Description	Work Item	Construction Method
Badung River	Length of 5.7km from Buagan Weir located downstream to Maruti Street.	1) New Grand Sill (H=0.3-1.7m) 2) Revetment for Low Flow Channel Works (H=1.6m) 3) Parapet Wall Works (H=0.3-1.7m) 4) River bed Excavation Works and Revetment Works (L=5.7km) 5) Removal for Existing Foot Bridge Works Steel Bridge (W3.5m×L27m) 6) Improvement of Flushing Gate Foundation (1m) (Buagan Weir Improvement)	(a) Because of excavation in the river, works shall be done during dry season which water level is low. (b) Due to small width of the river, stage diversion method shall be adopted instead of simultaneous work for both sides. (c) Due to little clearance of bridges as well as small width of inspection road of both banks, excavated sand from river bed shall be conveyed to storage site located near bridges by 4 ton class truck with passing the temporary road with width of 6m in the river. (d) Excavation materials in the storage site shall be transshipped to the 10 ton class truck and shall be carried to disposal area.
Mati River	Length of 2.1km from the Ulun Tunjung Weir located downstream to the Umadui Weir.	1) Removal Existing Weir Ulun Tunjung Weir (H2.5m×W9m) 2) River bed Excavation Works and Revetment Works (L=2.1km)	(a) After diversion of water channel by trench, excavation for revetment shall be executed. (b) Excavation materials shall be conveyed by 10 ton class truck with passing temporary road in the river. (c) Backfilling behind retaining wall shall be executed by borrow sand.

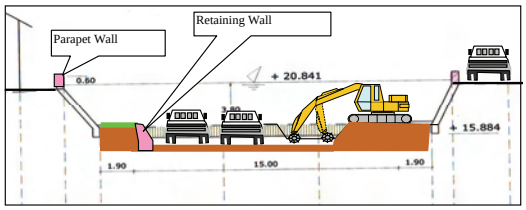
Work procedure for river improvement project is shown as Table-5.20.

Badung River

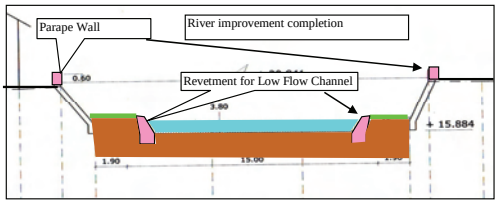
1) Setting up of temporary road in the river.



2) Revetment work by stage diversion method

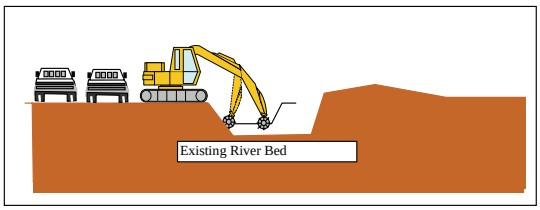


3) River improvement work

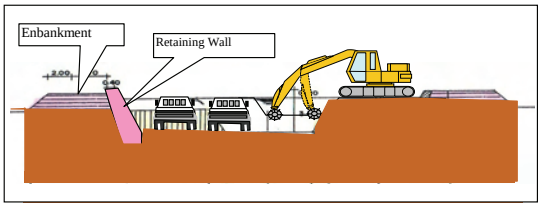


Mati River

1) Diversion work shall be done in the river before excavation



2) Conveyance of excavation materials on the temporary road



3) Backfillimg behaind wall by bollow sand.

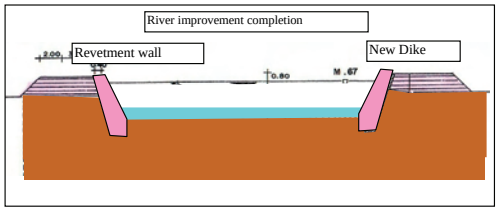


Figure-5.31 Work Procedure for River Improvement Project

Construction Schedule for River Improvement Project is shown in Table-5.21.

Table-5.21 Construction Schedule for River Improvement Project

Construction Year	First Year		Second year		Third Year		Fourth Year	
Season	Dry Season (May - Oct.)	Rainy Season (Nov. - April)	Dry Season (May - Oct.)	Rainy Season (Nov. - April)	Dry Season (May - Oct.)	Rainy Season (Nov. - April)	Dry Season (May - Oct.)	Rainy Season (Nov. - April)
Badung River	3mths							
Preparatory Work			18mths in total					
Ground Sill								
Earthwork (Using 2 Backhoes)			15mths in total					
River Bed Excavation								
Retaining wall					18mths in total			
Construction wall (small)								
			12mths in total					
Parapet Wall								
Bridge					6mths			
Dismantle & construction								
Buagan Weir			2mths					
Modify basement								
Mati River	3mths							
Preparatory Work								
Dismantle Urun Tanjung Weir		2mths						
Earthwork（Using 3 Backhoes)				12mths in total				
River bed (incld.wall exc.)								
Backfill behind big wall								
Retaining wall				10mths in total		12mths in total		

5.5 Operation and Maintenance

5.5.1 Organization Arrangement

The overall water related institutional framework in Bali will be as shown in Table-5.22.

Table-5.22 Overall Water related Institutional Framework after Reforms in Bali

	Raw Water Provision/Allocation	Water Supply		
		Construction	Water Transmission	Water Distribution
Province	Water Resources Coordination Council & Sub-Council Council/Sub-Council(s9		Regional Water Production Entity (SARBAGITAKU)	
	Dinas PSDA ← Sub-Dinas SDAPP	Dinas PU –Sub-Dinas TRP		
	- APBN Working Units -- construction			
	- Balai PSDAs -- management	- APBN Working Units		
Regency	Dinas PU or PSDA			
	- Sedehan Agung			PDAMs & PT.TB (in Badung)
	- Subak Coordination Unit			

Shaded organization: newly created or reformed

5.5.2 Management Activities and Capacity Development Support

The management activities that must be undertaken (by the APBN Working Unit and subsequently by Ayung Balai PSDA) concurrently with the construction and the necessary external capacity development support are shown in Table-5.23.

Table-5.23 Management Activities and Capacity Development Support

Areas	Activities	Responsibility	External Support (Experts & Equipment)
Setting up	Dinas PSDA (see Table-II-7--: Road Map) Ayung Balai PSDA - Drafting relevant Provincial and internal regulations & getting them approved (incl. provisions for annual budget allocation for O&M) - Staff transfer & physical arrangements - Receiving the support of Ministry of Public Works for organizational & managerial arrangements Ayung WWRC (to be organized by Governor supported by Dinas PSDA) - Drafting relevant Provincial regulations in consultation with the regencies/city and stakeholders & getting them approved (including provisions for annual budget allocation) - Selecting members (50% from non-government sector. Include Sedehan Agungs) - Ensure necessary budget allocation for the WWRC's activities	Bali Province, Dinas PSDA	
Water quantity management	Measurement & analysis of water use in the Ayung Development & maintenance of water allocation system and water resources information system	Dinas PSDA Working Unit (2007/08 – 2011/12) ⇩ Ayung Balai PSDA (2012/13-)	Hydrologist Hydro-geologist GIS/information system expert Agriculture & irrigation expert * GIS network & computer soft * Water measurement equipment
Water allocation/ reallocation	Development of water allocation plan Development of cropping plans (with Dinas Agriculture) Organizing socialization and discussion through Ayung WWRC Facilitating adoption of annual water allocation and cropping plans		
O&M of the dam	Development of O&M system comprising setting up observation network, data collection, decision criteria for discharge, operation of control equipment, communication/reporting system, prevention system, etc.		Dam and river O&M expert
Watershed management	Development land conservation plan & system (incl. clarification of responsibilities of other related government bodies like Dinas Forestry)		Land conservation expert
Water quality control	Introducing water quality measurement & control system		
Water Resources Information System	Development and maintenance of database which includes hydrological conditions, water licences issued, water quality, facilities and conditions, land use conditions, weirs and subaks, etc.		Hydrologist GIS/information system expert
Support to Subaks	Support to Sedehan Agungs and Subak Coordination Units in organizing functions and tasks. Facilitating in-depth stakeholders' consultations Support to Sedehan Agungs and subaks in their participation in the Ayung WRCC Facilitating identification of equitable solutions	Dinas PSDA/Ayung Balai PSDA, Ayung WRCC	Sociologist/Subak expert Agro-economist

5.6 Cost Estimate

5.6.1 Condition of Cost Estimate

Cost estimation for the Study is based on the costs and prices in Indonesian (Rp.) at the mean of one year in 2005, which exchange rate of 1 US$ = 9,750 Rp. = 110.74 JPY is applied for conversion of currencies. Estimated conditions are shown in the Table-5.24.

Table-5.24 Conditions of Cost Estimate

Breakdown	Conditions of Cost Estimate
(1) Construction Cost	Labor, material and equipment costs for construction
(2) Land Acquisition and Compensatoin	3% of the construction cost for reservoir project, 2% of construction cost for other projects
(3) Government Administration Expense	5% of the construction cost
(4) Engineering Service	10% of the construction cost
(5) Contingency	10% of construction cost, land acquisition and compensation, administration expense and engineering services
(6) Government Tax etc	The government tax in Indonesia is the Value Added Tax (10%) which is not included for project cost estimation.

5.6.2 Project Cost

The total project cost is about 1.7 trillion Rp. (19.4 billion yen) as shown in Table-5.25.

Table-5.25 Project Cost of Priority Project

(Unit: million Rp.)

Project	Direct Cost	Land Acquisition	Administration	Engineering Fee	Sub Total	Contingency	Project Cost
Ayung Dam	837,127	25,114	41,856	83,713	987,810	98,781	1,086,591
Water Supply Project	370,854	12,384	18,543	37,085	438,866	43,887	482,753
-West Water Supply System	87,957	1,759	4,398	8,796	102,910	10,291	113,201
-Central Water Supply System	136,996	7,707	6,850	13,700	165,252	16,525	181,778
-East Water Supply System	145,901	2,918	7,295	14,590	170,704	17,070	187,775
River Improvement Project	110,024	2,200	5,501	11,002	128,727	12,873	141,600
Badung River	56,274	1,125	2,814	5,627	65,840	6,584	72,424
Mati River	53,750	1,075	2,687	5,375	62,887	6,289	69,176
Grand Project Cost	1,318,005	39,698	65,900	131,800	1,555,403	155,541	1,710,944

Note) Central Water Supply System is based on the Water Supply plan of 600lit/s.

5.6.3 Operation and Maintenance Cost

Operation and maintenance (O&M) cost of the projects is estimated based on the actual cost of PDAMs of Bali province and data of Japan as shown in Table-5.26. Operation and maintenance (O&M) cost of the projects is estimated is estimated as shown in Table-5.27.

Table-5.26 Estimated O&M Cost for Ayung Dam and Water Supply Project

Items		Multi-purpose Ayung Dam	Water Supply System for Southern Bali Area		
			Western	Eastern	Central
Bases	General O&M for Dam	0.2% of construction cost	-	-	-
	Operation cost for Intake/Treatment	-	30kWh/(lit/sec)/day		20kWh/(lit/sec)/day
	Electricity Price	-	750 Rp/kWh		
	Chemical cost for Water Treatment	-	176 Rp/m^3 : average cost between upstream river and downstream river (respectively 88 Rp/m^3、264 Rp/m^3)		
	Repair/Maintenance	3% of Electric Equipment/Machinery Cost			
O&M Cost (Rp. million)		3,874	5,459	5,459	9,880

Table-5.27 Estimated O&M Cost for River Improvement

Item	Badung River	Mati River	Total
Base	0.5% of construction cost		-
O&M Cost (Rp. million)	362	346	708

5.7 Project Implementation

5.7.1 Institutional Formalities and Organization

The organization for the implementation of the priority project (including Multipurpose Ayung Dam Project, Water Supply Project for SARBAGI Area, Flood Control Project for Badung and Mati Rivers) is shown in Figure-5.32.

There are two implementation units. The water resources development unit is responsible for the Ayung Dam Project and Flood Control Project. Water supply development unit is responsible for the Water Supply Project for SARBAGI Area. The former unit is under the management of Directorate of General of Water Resources, Central Government or under the management of DINAS-PU (or DINAS-PSDA). The latter unit is under the management of DINAS-PU, Bali Province.

There is Project Management Unit to be established by two Directorate General, namely DG – Water Resources and DG - Resettlement and Housing. The project is steered by the Central Government Committee.

Figure-5.32 Organization for Project Implementation

5.7.2 Implementation Schedule

If the priority project starts in the year of 2006, it will complete in the year of 2012. Refer to Table-5.28.

Table-5.28 Implementation Schedule for Priority Project

Items	2006		2007		2008		2009		2010		2011		2012		2013	
1. Preparation	XX	XX	XX													
2. Engineering Services				XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX		
3. Procurement of Contractor				XX	XX											
4. Construction																
A) Ayung Dam						XX	XX	XX	XX	XX	XX	XX	XX	XX		
B) Western System (IPA)						XX	XX									
C) Central System (IPA)													XX	XX		
D) Eastern System (IPA)						XX	XX	XX	XX	XX	XX					
E) River Improvement for Badung River						XX	XX	XX	XX	XX	XX	XX				
F) River Improvement for Mati River						XX	XX	XX	XX	XX						
5. Land Acquisition				XX	XX						XX	XX				

5.7.3 Financial Disbursement Schedule

Total project cost of the priority project amounts 1,711 Billion Rp. The financial disbursement schedule is shown in Table-5.29.

Table-5.29 Disbursement Schedule of the Project

(Unit: Billion Rp.)

Projects	Total Cost	2008	2009	2010	2011	2012
Dam and Water Supply	1,569.3	100.4	418.5	187.5	388.2	474.7
◆ Ayung Dam	1,086.6	64.9	292.8	143.8	292.2	292.9
◆ Western System	113.2	24.0	89.2	-	-	-
◆ Central System	181.8	-	-	-	-	181.8
◆ Eastern System	187.7	11.5	36.5	43.7	96.0	-
Flood Control	141.6	25.3	45.9	48.8	21.6	-
◆ Badung River	72.4	10.5	18.7	21.6	21.6	-
◆ Mati River	69.2	14.8	27.2	27.2	-	-
Total	1,710.9	125.7	464.4	236.3	409.8	474.7

5.8 Environment and Social Study

5.8.1 Environment Study

Environment study was conducted for the purpose of following items shown in Table-5.30 in the targeted area of priority project from early January 2006 to late February 2006.

Table-5.30 Outline of Environment Study

Purpose	Study Items	Items in Detail
1) To grasp existing conditions	1) Geophysics-chemical component	1) Climate 2) Air Quality 3) Physiographic 4) Hydrology 5) Space, Land and Soil
	2) Biology Component	1) Terrestrial Flora and Fauna 2) Aquatic Flora and Fauna
	3) Socio-economic Environment	1) Demography Aspect 2) Economy 3) Socio-Cultural 4) Community Health
2) To predict significant and important impact	1) Activity impact prediction on pre-construction phase 2) Activity impact prediction on construction phase 3) Activity impact prediction on operation phase	
3) To evaluate significant and important impact	1) Analysis toward significant and important impact 2) Analysis as basic environmental feasibility	1) Holy analysis 2) Significant impact

The study results in detail are shown in Supporting Report and its Appendix. Only the study results of biology component including flora and fauna are shown in follows.

(1) Terrestrial Flora and Fauna

<Terrestrial Flora>

The investigation area is Ayung Dam Development Project, which is located between two regencies, Gianyar regency and Badung Regency.

From 44 vegetation types which have been identified at Ayung Dam development plan site (East Zone) at Buahan Kelod Village, Payangan Subdistrict, Gianyar regency, apparently, there are 17 types categorized as endanger species, consist of 3 nationally endanger species: cempaka putih *(Michelia champaca),* boni *(Antidesma bunius)* and pangi (*Pangium edule*) and 14 types are rare in Bali

From 46 types of vegetations/terrestrial flora which have been identified at the location of Ayung Dam Project development plan (West Zone) at four village locations (Petang, Pangsan, Getasan, Carangsari) Petang Subdistrict, Badung Regency, apparently there are 23 types which are categorized as endanger species, including 4 types of national endanger species; cempaka putih *(Michelia champaca),* pangi *(Pangium edule),* pule *(Alstonia scholaris)* and bayur *(Pterospermum indicum*), 19 type are rare in Bali

<Terrestrial Fauna>

The species richness of terrestrial fauna at the study area is rather high, those are 35 types of birds, 7 types of mammals and 8 types of insects/arthropodes.

In accordance to characteristic analysis and status of the terrestrial fauna, with its reference of valid laws in Indonesia, there are 9 types of protected animals by the Indonesian Government are found at the study area. Those types consist of 7 types of birds: Kuntul Kerbau (*Bulbulcus/Egretta ibis* : Cattle Egret (Eng), Kuntul kecil (*Egretta garzetta* : Little Egret (Eng), Cekakak Jawa (*Halcyon cyanoventris* : Javan Kingfisher), Cekakak Sungai (*Halcyon chloris*: White-Collared Kingfiher), Alap-alap api (*Falco moluccensis*: Spotted Kestrel), Elang Hitam (*Ictinaetus malayensis* : Black-Eagle), and Elang Brontok (*Spizatus cirrhatus* : Changeable Hawk-Eagle), and two types of mammals, Landak (*Hystrix brachyura* : Southeast-Asian Porcupine), and Trenggiling (*Manis javanica* : Pangolin).

According to those above, *cekakak jawa*(*Halcyon cyanoventris*: Java Kingfisher) categorized as

endemic in Java and Bali.

(2) Aquatic Fauna (Perifiton/ plankton Community)

Perifiton/plankton community is the terminology given to certain group of microscopic sized aquatic organisms, which is suspended organism in the water, or around the substrate with very limited motion ability (non-moving); consists of plants or microscopic animals. The investigation result of perifiton/plankton community at three Ayung River stations which are impacted areas of Ayung River Multifunction Dam is shown as follows.

The perifiton and plankton abundance at three monitoring stations are not equally distributed, it is between 972-1,602 cell/individu per liter. The highest plankton abundance can be obtained from Station I (Ayung River at Susut) of 1,602 individu per liter and the lowest is obtained from Station II (Ayung River Petang Village) of 972 cell/individu per liter. The perifiton/plankton abundance at those three stations are categorized as low abundance because the value is less than 2.000 individu per liter (Sigala ,1991). The prominent plankton composition at those three stations: phytoplankton community: *Synedra acus, Fragilaria sp, Navicula sp, Pinnularia sp, Melosira sp, Tabellaria sp, Spirogyra protecta, Anabaena sp, Pediastrum* and *Straurastrum sp*, and zooplankton community consists of *: Cyclops, Branchionus, Keratella, Volvox, Monas sp, Arcella*, and *Tintinnidium sp*. Among tose species there are some that are sensitive to eutrification process: *Pediastrum sp*, and *Straurastrum sp*, and it is rather dangerous if there was blooming of plankton in it.

Component of aquatic flora and fauna in Ayung River is a very strategic and important environment component to have considerations in the relation of Ayung River Development Plan**.**

(3) Environmental Issues of the Project

In accordance with the report issued by the Environmental Social Consideration Council (ESCC) of JICA, the Study Team recommend following analysis, additional study and field reconnaissance for the next phase.

1) Study on the disappearance and variation of ecological system, especially on disappearance of vegetation, terrestrial biota and aquatic biota by submerging of reservoir due to the construction of dam as well as accesses road.
2) Study on the variation of ecological system, influence of erosion, coastal change and agricultural land change caused to hydrological change in downstream of dam.
3) Ecological characteristics analysis based on the comparison between study area and another area in Bali as well as in Indonesia.
4) Evaluation and mitigation countermeasures not only for Java Kingfisher but for protected species as well as rare species described in the “red list” of International Union for Conservation of Nature and Natural Resources.
5) Flora study on the existence of the special purpose such as for medicine and for food.
6) Influence study caused by labor inflow to local community and ecological system near the project area during construction
7) Necessity of further EIA study during different season of this Feasibility study period.
8) Additional study including identification on the mammals.
9) EIA study for the construction materials sites.
10) Riverbed fluctuation in the downstream of dam
11) Influence on coastal erosion.

5.8.2 Second Social Study

Second social study was conducted for the purpose of grasp of people’s opinions to the proposed priority projects and to reflect them to the plan and design as well as grasp of social conditions of the people affected by the proposed project.

The information /data collected in the study comprising of primary as well as secondary data. Primary data/information was obtained by questionnaire and interview through RRA (Rural Rapid Appraisal) technique. The respondents for individual interview which were selected at random from lists of

persons/farmers provided by heads of relevant villages/Subaks ranged from 70-130 persons for each site. And as a whole, it amounted to 400 persons.

(1) Ayung Multipurpose Reservoir

<Religious Ritual>

There are several places of sacred values near Ayung River. One important temple (Tangluk Temple) belongs to Customary Village of Susut-Buahan in the Payangan Sub district, Gianyar Regency. About 200 households are involved in this temple's activities. It has close relation with the holy spring found very close to the site plan of the reservoir.

Other religious rituals/places which must be taken into consideration for planning and design are as follows.

- Stone cave used as a place for meditation
- Ashes after cremation ceremony is thrown to Ayung River
- Chinese Cemetery

<Economic Activities>

The area around as well as in the river is not used only for religious rituals, but also for certain economic activities. Important activities are related to tourism such as rafting and villa/hotel. At upstream there are found 3 rafting business: Bali Discovery, Bali Fantasi, and Bali Holiday. The most potentially affected is Bali Holiday with its route starting from Kesianan Hamlet of Pangsan Village and finish at Buangga Hamlet of Getasan Village. It takes around one hour. Two villas namely Ubud Hanging Garden and Vila Nandini are found close to the project site. These villas make best use of the view of the river side at the eastern part of the Siap tributary. If the water surface would be below the foot of the bridge of Susut it would be no problem.

<Opinion/Attitude towards Project Plan>

The local residents proposed that the project will consider the followings.

- Recruitment of the local people during the construction stage;
- Supply electricity and clean water to local community;
- More intensive socialization on the project specification to local community since most of them did not know yet about the project plan;
- The new habitat for the monkey (black and gray monkey) needs to be created if the existing habitat is to be disturb due to the reservoir in order the monkey will not annoy the villagers and disturb the fruit gardens of the local people;
- The quality/strength of the reservoir should be guaranteed for people's safety;
- The project implementer should provide a place for nganyut ritual somewhere along the river;
- A new bridge and road over the river to connect Petang and Payangan should be built so that the local people can take a shorter way to travel.

(2) Sungi/Penet River Raw Water Development (Western System)

<Current Use of River by Local Community>

River waters at the confluence points are believed to be sacred in Bali. In case of the confluence point between Sungi and Penet Rivers, it is often used for spiritual cleansing ceremony *(meruwat*) by local people. As the intake is to be located downstream of this confluence point, it is worried if the project might adversely affect this sacred location for such kind of activity.

<Opinion/Attitude towards Project Plan>

The subak heads proposed that the project should not cut the water supply during construction of access road and not to decrease water supply to the subak after operation, provide job opportunity for farmers, the existing road used by the farmers/subak needs widening. The village heads and local residents hoped that the local community would be able to share the project benefit through PDAM water faucet installed at hamlet hall. The project also is expected to employ local workers to the extent

possible, to assist the upgrading of villages road adjacent to the project, fair compensation for the land acquisition, assistance to the existing temples located close to the WTP, and so on.

(3) Petanu River Raw Water Development (Eastern System)

<Current Use of River by Local Community>

About 150 m to the east of the planned intake, there exists a holy spring at the adjacent to Anakan Temple. The anniversary ceremony of this temple is on the dark moon of the fourth month (around October) every year for three days duration exactly the same time with the anniversary ceremony of the Dalem Ulun Setra Temple (a village temple for the death) of Saba Village. The holy spring of Anakan Temple is used for various kinds of religious rituals.

The Er Jeruk Temple located at Sukawati Village at downstream of Petanu River close to the beach. This temple is managed by the Subak-gede of Sukawati assisted by the Customary Village of Sukawati. The anniversary festival of this temple is performed 35 days after *Galungan* Festival (a religious ritual to symbolically celebrate the "victory of the good deed against evil").

The Sukawati Subakgede is responsible for the management of Er Jeruk Temple as mentioned above. This subak also has several subak temples located surrounding the project site but not directly affected.

<Opinion/Attitude towards Project Plan>

The major expectation of respondents are among others it must be beneficial to the local community, also useful for irrigation, should not pollute environment, and many others. The subak heads proposed that the project should not decrease the water supply to the subak during the construction as well as after operation. To the extent possible, they request additional irrigation water supply especially for Cengceng Subak. Many respondents also proposed the following points:

- Since Petanu River is believed to very sacred, it is necessary to perform proper ritual prior to carrying out any activity;
- The use of local workers should be given priority during project implementation;
- Further socialization is necessary to local people (of Saba and Sukawati villages);
- The installment of transmission pipe should not disturb the existing irrigation canal and other subak's facilities;
- When the project is operational, the clean water supply for Er Jeruk Temple as well as for local community;
- Land acquisition should be carried out in a transparent manner.

(4) Badung & Mati River Flood Control

<Current Use of River by Local Community>

Badung River flows through the crowded city of Denpasar, a civic center of Bali Province and Mati River flows through Kuta area with a famous beach frequently visited by many tourists from various parts of the world. No wonder the dominant activities of the people living along the rivers are business and other services. A few people still sometimes used the rivers for fishing just for hobby and also to a limited extent especially at upper stream even for bathing and washing.

The paddy lands located at upper stream and lower stream from Umadui Bridge have important role as temporary natural retaining basin for the Mati River. The lands are still productive for farming activities, but the surrounding paddy land areas are planned to be converted to housing or for other non farming purpose. Considering the high land price, it is worried that the owners of the lands functioning as retaining basin would be tempted to sell their lands under Land Consolidation (LC) program.

There are many subaks taking water from one of several existing weirs along the river courses of both rivers. The subaks' land areas have been declining significantly because of conversion to other uses brought about by rapid development of tourism and urbanization. Most farmers in the said subaks are generally more than 50 years old, since the younger farm family members prefer working off-farm especially in tourism sector.

The farmers from the above mentioned subaks complained about the inorganic garbage coming from upstream and polluted irrigation water brought about by garment industry. The garbage often blocked the irrigation canal which caused inundation at the surrounding area and the farmers were compelled to clean the canal many times which is really a burden for them.

<Opinion/Attitude towards Project Plan>

Many respondents still worry about the project. Reasons for their worries are especially related to land acquisition, loss of job, unfair compensation, and pollution during construction phase. As for compensation of the lands, one of the following forms is accepted: cash money, exchanged with land of similar kind, exchanged with land of any type. Or, it depends on consensus among the owners. The land's value should range from RP 75 millions to RP 180 millions per m^2.

5.9 Project Evaluation

5.9.1 Technical Evaluation

The proposed Bali southern area water supply project, multi-purpose Ayung Dam project and river improvement project for Badung and Mati River on Water Resources Development and Management in Bali Province was planned according to the following technical information, standards, judgment and proper planning procedures, and is assessed to be technically feasible as a results.

1) The information related to socio-economic conditions, topographical and hydro-geological conditions, hydrological conditions, environmental conditions, water use conditions and so on are collected from the data and information that Government of Indonesia as well as Bali Province owned and was applied to the Feasibility Study after precise examination and careful selection. And the standards established by the Government of Indonesia were applied for the design of main facilities and works. For the gaining of information in detail, drilling for 5 holes in Ayung Dam and soil test for 3 sites for planned water treatment plant were executed during study. In addition, for the dam design, the international standards such as International Committee on Large Dams and Japan were also used when necessary.
2) Regarding to Bali southern area water supply project, western water supply system with 300l/s (25,900m^3/day) development shall be started firstly, eastern water supply system with 300l/s (25,900m^3/day) development also shall be started. Due to the project scale with 1,800l/s (155,000m^3/day) development of central water supply system, stage construction method for the mechanical equipment and water treatment plant based on the adjust supply for demand 600l/s(51,800 m^3/day) shall be adopted, whereas full construction for the weirs and infrastructures shall be executed. Though the location of water sources were selected through the stakeholders' meetings, further explanation and coordination with related bodies shall be required before detail design and construction.
3) For the multipurpose Ayung Dam project, on the basis of the calculation results of required capacity, the capacity of 9,000,000m^3, which is estimated based on 15 years return period with twice drought occurrence, shall be adopted in consideration for the safety of water supply, reservoir scale and frequency of drought occurrence, etc. According to the reservoir operation simulation, because the annual inflow volume to the reservoir was estimated around 300 to 400 million m3, it was realized that water level of reservoir shall go up easily even in the decrease of water level due to the supply for water use in drought. In addition, because of good water quality and large turnover rate of reservoir, it is unlikely that enrichment and turbid water in Ayung reservoir will occur. Check dams constructed at upstream in Ayung River and Siap River will store the sediment inflow, and the stored sediment at check dam shall be intermittently excavated to secure the planned sediment volume.
4) There is no available road for the passage between Badung Regency and Gianyar Regency near the dam site which is located at the boundary of the Regencies. In the dam plan, access roads and bridges of dam top will be utilized for the inter-passage between them. Moreover, the reservoir development plan was studied for the purpose of the distribution of the economic benefit to the communities of Ayung Dam. Further detail study shall be needed through the discussion of stakeholders' meetings in the future.
5) Based on the results of study and geological survey for Ayung Dam, dam site and dam type were carefully selected. In order to obtain more detailed information and data, further study at

the upstream and downstream of dam axis shall be needed in the next design stage.

6) To cope with the river flooding and inland inundation, also to mitigate flood damages in Badung and Mati River, the design flood was adopted basically for 25 years return period. Due to urbanization in Badung and Mati River basin, run-off volume shall be increased in future. With regard to retarding basin planned in the upstream of Umdui Weir in Mati River, current land use which used for paddy field and cropping land should be conserved on the basis of precise land use regulations.
7) In case of implementation of the project mentioned above, holy place shall be taken into account in Bali. There are many holy places such as meeting point of rivers, wells near river, strange rocks, caves, and air holes in nature, temples, small shrines and small old cemeteries in the project area. For avoiding holy places, various technical aspects were taken in consideration in design and planning of the projects. Further discussing with related bodies such as Hindu association, leader of communities on holy places shall be needed in next design stage.
8) For the environmental conservation on implementation of the project, the construction materials shall be procured from the existing quarry site in Bali without own quarry site. Restricted plastering method with low vibration and small noise was adopted for the excavation of dam project. Slope protection with greening was also designed for cut slope of road and dam. Construction machinery with low vibration and small noise was adopted for the river improvement project in Badung River and Mati River.

JICA Study Team was explained the project and had a meetings with related bodies. Plan of the project was also explained through the stakeholders' meetings for five times during the study. Therefore the selected priority project should be reviewed if necessary according to the change of geological importations, hydrological data and topographic survey results.

5.9.2 Analysis on Economic and Financial Aspects

(1) Economic Evaluation

<Assumptions and Benefits necessary for Economic Evaluation>

The necessary assumptions and benefit for economic evaluation are presented in Table-5.31 and Table-5.32.

Table-5.31 Assumptions

Items	Assumptions	
1. Prices	As of end 2005	
2. Exchange Rate	1 US$ = Rp.9,750	Average of middle rate of each month end of Year 2005
	1 US$ = 110.75 Yen	
3. Conversion Factor	Conversion rate of 0.9 for local portion cost	
4. Opportunity Cost of Capital	12%	
5. Project Evaluation Period	30 years	
6. Economic Life		
1) Dam	80 years	
2) Water Treatment Plant	40 years	
3) Water transmission/distribution pipeline	40 years	
4) Electrical Equipment and Machinery	30 years	
5) Pumping Motors	15 years	
6) Facilities for thermal generation plant	30 years	
7. Replacement Cost	Pumping motors: to be replaced in every 15 years	
8. Salvaged Value	The residue value of investment cost: to be salvaged at the 30th year.	

Source: Study Team

Table-5.32 Benefits

Benefit Items	Assumptions	Remarks	Sources
A. For Multipurpose Ayung Dam Project			
1. Central Water Supply	Same as B		
2. Hydropower Generation	Rp.116.8billion	Alternative cost of thermal power plant construction	Study Team estimate based on US$1million/MW of Indonesia Power

	Rp.139.1billion	and operation/maintenance	Study Team estimate based on Rp.2,000/kWh of Indonesia Power
	(Rp.3.2billion)	CDM (CO_2 emission right)	742g/kWh x US$7/t-$CO_2$
3. Irrigation Water Supply	Rp.1.4million/ha	Without-case: soybean product	Study Team estimate based on information of Food Crops Agriculture Service of Bali Province
	Rp.5.2million/ha	With-case: paddy product	
B. For Water Supply Project for Southern Area of Bali			
1. Domestic Water	Rp.2,000/m^3	3% of presumed household income of Rp.1,800,000/month	Household income is estimated by the Study Team based on the GRDP and interview.
		Household consumption: 27 m^3/month	Actual data of 3 PDAMs and PT.TB in year 2005
2. Commercial/Public /Institutional Water	Rp.3,700/m^3	All target area	Actual data of PDAM Badung and PT.TB in year 2005
3. Industrial Water	Rp.7,620/m^3	All target area	Actual data of PDAM Badung and PT.TB in year 2005
C. Flood Control Project			
1. Annual Average Benefit	see Table-5.37		

Source: Study Team

<Economic Cost>

The project cost necessary for economic evaluation is presented in Table-5.33 and Table-5.34. Incidentally, the project cost of Multipurpose Ayung Project is separated and allocated to respective purpose as presented in Table-5.34 by applying cost allocation method of multipurpose dam based on the justifiable expenditure and alternative costs of respective objectives that is generally utilized in Japan.

Table-5.33 Economic Cost of Water Supply Project and Flood Control Project

Unit: Rp.billion

Cost	Water Supply Project for Southern Area of Bali				Flood Control Project		
	Western System	Central System	Eastern System	Total	Badung River	Mati River	Total
Financial Cost	113.2	759.5	187.8	1,060.5	72.4	69.2	141.6
Economic Cost	108.8	731.0	175.9	1,015.7	65.5	62.5	128.0

Note: 1) Cost of Central System includes allocated cost of Multipurpose Ayung Dam presented in Table-5.57.
2) Economic cost of each Water Supply System includes distribution pipeline cost, respectively estimated at 2.6billion for Western, 15.5billion for Central, and 2.6billion for Eastern.

Source: Study Team

Table-5.34 Economic Cost of Multi-purpose Ayung Dam Project

Unit: Rp.billion

Cost	Ayung Dam [1)]	Cost allocated to		
		1. Water Supply (Central System)	2. Hydroelectric Power Generation[1)]	3. Irrigation Water
Financial Cost	1,086.6	263.6	617.5	205.5
Economic Cost	1,010.0	243.4	576.8	189.8

Note: 1) Cost for electric power generation facilities and equipment is included.

Source: Study Team

(2) Result of Economic Evaluation of the Projects

<Multipurpose Ayung Dam Project and Water Supply Project for Southern Area of Bali>

The economic evaluation is analyzed based on all data previously mentioned, and the result of the evaluation is presented in Table-5.35. . As shown in Table-5.32, economical benefit of hydropower generation consists of alternative cost of thermal power construction and operation cost. In case of

including benefit by trade for clean development mechanism (CDM) on CO2 emission right, calculation result is shown in Table-5.33. EIRR of both projects exceed 12% of opportunity cost of capital, and the both projects are judged to be economically feasible.

Table-5.35 Result of Economic Evaluation of the Projects

Items	Multipurpose Ayung Dam Project	Water Supply Project for Southern Area of Bali
EIRR	14.0%(14.2%)	12.5%

Source: Study Team
Note : ( ) shows EIIR in case of including CDM benefit

<Flood Control Project of Badung and Mati Rivers>

The economic evaluation of the project is carried out based on 25-year probable flood and probable direct damage to houses. The value of houses of the areas (year 2005) is estimated by referring to the number of households by different house size and construction cost in the areas. The household property value is estimated by applying the ratio of 20% to house value. See Table-5.36.

Table-5.36 Value of House and Household Property

Unit: Rp. billion

Area	<20m^2	20-49m^2	50-99m^2	100-149m^2	150m^2<	Total
Badung Reg.	172	656	4,171	1,862	2,,61	9,022
Denpasar	487	1,270	3,081	3,143	5,707	13,688

Source: Study Team

The annual average benefit is defined as the reduction of probable damage under with- and without-project conditions by applying damage ratio under the condition of less than 50cm floor level inundation (Manual for River Works in Japan), the flood area, and the probability. Overall flood damages are estimated, in addition to the above probable direct house damage, also from business related facilities (estimated at 10% of direct house damage), and indirect damage (estimated at 10% of all direct damage). See Table-5.37.

Table-5.37 Annual Average Benefit on Flood Damage Reduction and EIRR

Item	Annual Average Benefit on Flood Damage Reduction			EIRR
	Year 2005	Year 2015	Year 2025	
Badung + Mati	Rp.15.9bi.	Rp.19.5bi.	Rp.21.5bi.	15.0%

Source: Study Team

Economic evaluation is conducted by considering all mentioned above. EIRR of the project results in 15.0% as shown in Table-5.37 that exceeds the 12% of opportunity cost of capital. B/C ratio of the project shows 1.2 that exceeds 1.0. Accordingly, Flood Control Project is assessed to be economically feasible.

(3) Financial Consideration

<Water Supply Project for Southern Area of Bali>

The project cost amounts to Rp.1,086.6 billion including allocated cost from Multipurpose Ayung Dam Project. Obviously, the project cost is far beyond the financial capability of the Provincial Government because annual revenue of the Provincial Government was Rp.904billion in 2004. Accordingly, financing of Central Government loan and/or foreign soft loan would be inevitable in implementing the project.

<Hydroelectric Power Generation>

Electricity generation of Bali depends by 100% on thermal plant of Indonesia Power, an exclusive national electric power company. Though electricity is also transmitted from Jawa, the transmission volume is not sufficient to meet the whole demand of Bali. The thermal plants in Bali have to keep much higher level of operation rate than the planned peak-demand operation rate. Besides, operation cost per KWh has jumped from US$800 in 2004 to US$2,500 at the end of 2005 because of worldwide fuel price hike. Indonesia Power, by joining the Multipurpose Ayung Dam Project, could obviously expect to supply electricity more stably and achieve extremely lower operation cost.

If Indonesia Power joins the project, the company bears the project cost of its own power plant. As

to the multipurpose dam project cost, the cost sharing would be a subject of discussion among respective organizations of Central Government.

<Irrigation Water Supply>

The beneficiaries have to share the allocated cost of Ayung Dam (construction cost and O&M cost); however, the prudent dialogue with the parties interested such as SUBAK is necessary to avoid conflicts.

<Flood Control Project>

The project is suggested to be implemented soon as the expansion of damage could be foreseen in future because of growing population and rapid urbanization in future Bali.

The project cost of Rp.141.6 billion is also so big for the financial capability of Provincial Government, so that, on this, financing from Central Government and/or foreign soft loan is required in implementing the project.

5.9.3 Social Evaluation

Social evaluation of each priority project is described below based on information obtained from stakeholders' meetings and results of social survey in the study site where the project is to be located.

(1) Ayung Multipurpose Dam Project

The project plan is welcome by most of the stakeholders and they seem to be very eager that the project should be realized soon provided that several critical issues like compensation for land acquisition, and holy spring would have been already settled. No problem of access road, since it is already available from Petang to Payangan (its width is about 6 m) not included the drainage canals of both sides of the road. In connection with the access road possibly no land or other assets acquisition is required.

Concerning the land to be submerged still need further identification with special regard to the precise location, size, and owners of the land. Further socialization and negotiation about the value or terms of compensation is still needed. To avoid conflict after project has been in operation, the fair sharing of project benefit should be guaranteed between upstream and downstream resident on one side, and between resident of Badung Regency and Gianyar Regency on the other, especially with special regard to clean water supply, electricity and employment opportunity

There are many other requests raised by the participants as reflection of their worries which need to be considered such like the followings:

- The compensation to the workers of the rafting business;
- Further detail explanation concerning the definite specification of the project;
- The use of local people by the project implementer;
- A guarantee of safety of the physical structure;
- A guarantee of irrigation water supply for the subaks down stream; etc

Judging from the above information, it can be concluded that the project may be quite acceptable by the local people if the counter measures to such issues that make the local people worry about the project which may adversely affect them could be provided.

(2) Petanu River Raw Water Development Project (Eastern system)

The stakeholders also quite welcome the project plan and since its location is at downstream its implementation will be not so difficult. The local people are worried about the possibility of the existing holy springs to be submerged if intake is to be built. They suggested that the surface of river water should be kept at the same level as at the present condition.

During dry season the subak of Sukawati is in need of irrigation water. This subak requests a small share of the water from the project. During limited water discharge (dry season), it is worried if the project would disturb water supply of the upstream subaks through collusion with dam keeper. During construction work, the irrigation canal should not be disturbed so that the planting schedule can proceed as usual.

When the project has been already in operation, there should be certain kind of contribution to the local community in form of: clean water to the Er Jeruk Temple; donation from the project to Villages of Saba and Sukawati and Er Jeruk Temple;

Other important requests that need to be considered are as shown follows:

- Quick realization of the Master Plan for upstream areas and Unda River by clearly define the pattern of distribution and management of the available water among SARBAGITAKU regions;
- The construction of drainage from Gelumpang Hamlet toward Petanu River and Oos River to minimize the inundation problem.

Hence, this project is also socially feasible since quite acceptable.

(3) Penet/Sungi River Water Supply Project(Western system)

Since the project site is at downstream of the river, the project plan is quite welcome by most of the stakeholders especially the subaks and they seem to be very eager that the project should be realized as soon as possible. Initially, the project was to be located at upper stream of the river but since many subaks opposed it, then the site is to be moved to the down stream.

The access road to the project site is not a problem. It can use the existing subak road that enters from the Mengwi -Tanah Lot Road direct to the site (Village of Mengening). The better alternative is to modify it in order to be straight rather than to exactly following the present subak road. After completion of the project, the villagers surrounding the project especially from Cemagi and Munggu Villages need a share of the project's benefit in form of public clean water facilities to be placed at Banjar Hall, Temple, etc.

Several other requests were raised by the stakeholders are listed below:

- A small road to a cemetery owned by Christian residents needs upgrading and widening;
- A small road of about 200 m toward a small temple is needed;
- The road to the beach is required for the procession of religious ritual; etc

In conclusion, the Penet/Sungi River Water Supply Project is feasible from the social point of view since it is supported by most of the stakeholders including the related subaks.

(4) Badung-Mati Rivers Flood Control Project

Flooding from Badung and Mati Rivers almost occurs every year, so the people living in Denpasar and surrounding areas are expecting very much that the flood could soon be control or mitigated. Thus from the stakeholders' meetings it can be concluded that most of the people strongly support the project.

The project requires acquisition of land for retarding basin of around 15 ha located at Umadui. It was suggested that the matter needs to be tackled by related government agencies and socialization as well as negotiation with the landowners.

Important factors responsible for the floods are said to be as followings: garbage thrown to the river and drainage canals, changing uses of paddy land to other usage, the river body is used for planting certain kind of crops like banana, cassava, coconut trees, etc., and many buildings and houses protruding over both edges of the river completely ignoring the rule concerning river border.

Both rivers are also polluted, and the major causes of river pollution are garbage, sewage disposal from small industries like garment, printing, automotive repair shop, and restaurants located very close to both sides of the rivers. It was proposed that Prokasih should cover the entire river, not only at lower stream but also the upper stream as well and should be followed by strict law enforcement. Important proposal raised by participants especially in relation to flood mitigation for further consideration are among others:

- To build a connecting canal from Tebe Creek to Badung River along Imam Bonjol Street;
- River embankment construction can be continued until Pulau Roon Bridge;
- Other relevant garbage management improvement is needed at several point.

The project can be considered as socially acceptable, being no one may likely reject this flood control project. However, one crucial problem remains to be solved: whether or not the existing land which is required for retarding basin can be guaranteed not to be converted to non farming purpose. Further coordination efforts with related agencies such like Regional Planning Board, National Land Agency, Public Works, etc., is considered very important to confirm the future use of the concerned land.

5.9.4 Environmental Evaluation

Based on the findings of the EIA study environmental evaluation of priority projects is made as briefed below;

(1) Ayung Dam Project

<Pre-construction Phase>

The most significant social issue of pre-construction phase is the requirement for any resettlement of population involving housing compensation consequent to inundation with dam water. The planned location of dam is uninhabitable since it is a steep sloping terrain and hence no resettlement of population is involved.

<Construction Phase>

Short-term adverse effects on aquatic biota (fauna and flora) due to some increased turbidity of dredging works and also surrounding terrestrial biota due to land clearing and other construction activities is inevitable. However, the surrounding terrestrial environment shall be restored with re-plantation (reforestation) once construction works is over (*good engineering practice*), while the water environment of the dam shall be duly managed as dealt with under item (3) on Post-construction phase of below to ensure good aquatic ecology in dam.

Most biota identified in the dam site area by the EIA Study, both aquatic and terrestrial, are common and none belong to the category of endangered species. Still, there exist nine terrestrial fauna species, seven birds and two mammals, protected by Indonesian Law. Protected bird species are scientifically common except cekaka jawa while the two mammals are threatened. Still, the range of distribution (habitat) of all nine fauna species covers several surrounding islands and countries (in particular, Java Island and Malaysia).

Some habitat of these mammals will be lost consequent to dam inundation since they live in cave/hole/crack of the planned reservoir. Still there remains a large extent of area with similar characteristics along Ayung and Siap rivers. These mammals are highly responsive and swim well and are expected to escape inundation by moving to alternative terrestrial habitats located elsewhere in the surrounding sloping terrains. Accordingly, potential adverse effects on both of these threatened mammal species by dam is evaluated as not significant.

<Post-Construction (Operation) Phase>

The most significant long-term adverse effect the dam might encounter is the deterioration of its aquatic ecology represented by potential eutrophication and hence deterioration of dam water quality in addition to potential rapid sedimentation. It is extremely important to employ proactive long-term management and monitoring measures based on *precautionary principle* to mitigate such occurrence. The mitigation measures will focus integrally both upstream and downstream of dam.

The required protection measures for the terrestrial ecosystem of Ayung Dam so as to control both nutrient input and sediment input to the dam are given below.

- Promotion of organic farming for the existing agricultural lands;
- Promotion of eco-tourism in the area including the surroundings of the dam;
- Maintenance of all public owned lands in the area as conserved forestation with reforestation;
- Promotion to maintain even privately owned lands of critically sloping terrains in the area.

Regular water quality monitoring program in dam is necessary to effectively undertake the necessary protection measures in timely manner against any potential dam water quality deterioration (including eutrophication). A tentative monitoring program to determine the overall water environmental

condition of dam with respect to physical, biological, bacteriological and eutrophication potential aspects is proposed. This monitoring is to be carried out by Balai PSDA (new organization proposed in the Master Plan).

With these protection, management and monitoring measures integrally focused both on the terrestrial and aquatic ecosystems of the dam not only the potential eutrophication and rapid sediment inflow into the dam could be mitigated but also the long-term target of pristine aquatic environment in dam could be attained.

(2) Water Supply Projects

<Pre-construction Phase>

The most significant social issue of pre-construction phase is the requirement for any resettlement of population involving housing compensation consequent to the provision of project facilities of water supply systems, basically for the provision of water treatment plants. The locations of treatment plants are open rice fields that are uninhabited.

Water user rights conflict does not exist for the Central Project since stored water released from the Ayung Dam will be the raw water for intake. Accordingly, no water user rights conflict is involved.

<Post-Construction (Operation) Phase>

Potential adverse effects of river water intake with weirs

Reduced discharge at downstream of intake and its potential adverse effects on river ecology may be significant and shall be mitigated. Accordingly, in-built design mitigation measure is used in determining the quantity of water intakes.

Another potential adverse ecological effect due to weir intake, which should be the case with all existing weirs in Bali Rivers since they have no fish ladders, is the potential inhibition of fish migration upstream. Fish ladder for the weir of Central System in Ayung River was not incorporated. since there exist many weirs.

Generation of waste sludge at water treatment plants

The design of the three water treatment plants by this project (Western, Central and Eastern Systems) incorporates sludge-drying facilities as a precautionary measure against river water environmental degradation and also as good engineering practice of waste sludge management. The dried sludge could be beneficially used as soil conditioner or material for land reclamation.

Wastewater generation consequent to consumption of supplied water

In general, about 80% of water consumed is discharged as wastewater. In the absence of sewerage system such discharged wastewater finally ends up in surface river waters resulting in water environmental degradation as evident from the current status of Badung and Mati rivers.

Accordingly, as the long-term mitigation measure against potential surface water environmental degradation it is imperative to make the necessary plans in future to expand the sewerage system to cover the new water service areas as per these projects as well.

(3) Flood Control Projects in Badung and Mati River

<Pre-construction Phase>

The entire river improvement section of Badung river is surrounded with residential developments located right adjacent to their both river bank areas and hence no river widening work is possible without resettlement of population and demolition of houses located along banks. This is regarded as socially impractical and the entire river improvement works planned is basically composed only of deepening of riverbed and provision of floodwall (parapet walls).

Planned river improvement section of Mati River is still located in relatively low population density area surrounded with open fields including agricultural lands (rice fields). Some of such agricultural lands are planned to be reserved as retarding areas of flood control with nonstructural measure. Also the planned river improvement works would involve river-widening works as well since no residential settlement is involved and required land could be easily acquired.

<Construction Phase>

During annual flood discharge of rainy season the surface layers of these riverbeds where settled contaminants accumulate should be naturally flushed off to sea thereby resulting in clean riverbeds. Accordingly, by planning the dredging works just after the end of rainy season uncontaminated riverbed material could be dredged that could be beneficially used for land reclamation and others. It is natural to carry out the river improvement works just after the end of rainy season and terminate it well before the start of rainy season so as to avoid any interference with flood discharge due to the construction (river improvement) works itself. Accordingly, dredging work can easily avoid dredging of significantly contaminated material.

The dredged materials produced by river bed excavation during construction period will be managed and brought to the authorized final disposal place(s) by the contractor(s) according to the method accepted by the Project Implementation Agency (Provincial Government).

5.9.5 Conclusion of Environmental Evaluation

It is concluded that there are potential adverse environmental effects consequent to the implementation of the priority projects, in particular, the Multipurpose Ayung Dam Project and the Water Supply Projects. There are inevitable adverse effects for the species of not only terrestrial fauna and flora but aquatic fauna and flora due to construction. Based on the EIA study results to be implemented by AMDAL, countermeasures such as tree planting and water quality conservation for the mitigation against adverse effects should be curried out during construction as well as after construction. Detailed environmental study such as the location of nesting ground and the flight activities on endemic bird in Bali also shall be needed before construction of Ayung Dam Project. Accordingly, the proposed priority projects should be implemented carefully by adopting the proper countermeasures to minimize, to mitigate and to avoid adverse environmental effects.

5.10 Overall Evaluation

The overall evaluations classified both benefits and costs on quantified items and both beneficial effects and adverse effects on non-quantified items for Ayung Dam and SARBAGI water supply project are tabulated in Table-5.38.

Table-5.38 Overall Evaluation for Ayung Dam and SARBAGI Water Supply Projects

Items	Benefits	Costs
Quantified Items	1) Beneficial effects of water supply Household water supply Commercial and public water supply Industrial water supply 2) Hydropower generation (46,000 Mwh/year) 3) Expansion of double-cropping area resulting from irrigation water supply(310 ha)	1) Construction cost (including reservoir sediment management and environmental expenditures) 2) Land acquisition and compensation 3) Government administration expense 4) Engineering services 5) Contingency 6) Operation & Maintenance cost
	Evaluation: The projects are economically feasible, since economic internal rate of return (EIRR) would be 14.0% for the multipurpose dam and 12.5% for the water supply in SARBAGI area.	
ant ifie	Beneficial Effects	Adverse Effects

	1) Effects of installation of facilities ・ Avoidance of damage from water disruption through stable water supply ・ Reduction of health damage through prevention of waterborne infectious diseases ・ Improvement of living environment for users ・ New transportation route by using the road of dam crown ・ Use of dam body, reservoir, etc. for education and sports ・ Creation of tourism and other new business opportunities with secondary effects ・ Improvement of local living standards through increase in users of reservoir ・ Increase in asset value(Land price,etc) 2) Effects of project implementation ・ Expansion of employment opportunities ・ Increase in local sales through influx of workers	1) Effects on environmental aspect ・ Sludge generation from water purification treatment ・ Noise and vibration during construction ・ Topographical change due to creation of reservoir ・ Eutrophication and sedimentation in reservoir ・ Disappearance and alteration of existing ecosystems ・ Effects on endangered and precious wildlife species ・ Ecosystem change due to hydrological changes in downstream sections ・ River bed degradation in downstream 2) Effects on social and economic aspects ・ Decrease in tourists for existing tourism operations ・ Effects of worker influx on local community ・ Effects on existing sacred sites (sacred water, shrine, etc.)
Evaluation	The economic internal rate of return (EIRR) would be between 12.5% and 14.0%, exceeding the discount rate of 10 to 12% used as the basis for evaluating economic feasibility of Indonesian water resource projects by the World Bank and the Asian Development Bank. Therefore, the project is considered economically as feasible. Although adverse effects are expected to decrease by taking into account appropriate mitigation measures. In overall evaluation, implementation of this project is considered as appropriate.	

The overall evaluations for flood control project in Badung and Mati River are shown in Table-5.39.

Table-5.39 Overall Evaluation for Flood Control Project in Badung and Mati River

Items	Benefits	Costs
Quantified Items	Reduction of damage in flooding area (approx. 3,000 ha) (houses, household goods, farmland)	1) Construction cost (including environmental expenditures) 2) Land acquisition and compensation 3) Government administration expense 4) Engineering services 5) Contingency 6) Operation & maintenance cost
	Evaluation: The projects are economically feasible, since economic internal rate of return (EIRR) would be 15.0%.	
Non-quantified Items	Beneficial Effects	Adverse Effects
	1) Facility effects ・ Improvement of safety through reduction of damage by flood ・ Reduction of damage from interruption of business operation ・ Reduction of damage from interruption of traffic ・ Creation of new waterfront environment ・ Upgrading land use in surrounding areas resulting from reduction of damage by flood 2) Effects of project implementation ・ Offer for job opportunities	1) Effects on environmental aspect ・ Effects of construction work on existing ecosystems including fishes and vegetations ・ Effects of vibration and noise from construction work ・ Generation of turbid water from construction work 2) Effects on social and economic aspects ・ Effects on existing sacred sites (sacred water, shrine, etc.) ・ Restriction on land use in Retarding Basin of Mati River
Evaluation	The economic internal rate of return (EIRR) would be 15.0%, indicating economical feasibility. Although adverse effects are expected to decrease by taking into account appropriate mitigation measures. In overall evaluation, implementation of this project is considered appropriate.	

As a result of the overall evaluation, the priority projects are feasible to be implemented immediately from technical, economical, financial, social and environmental aspects. However, as the environmental study done by the Study Team is supplementary one, the executing agencies of the projects shall implement the AMDAL (Regal Environmental Assessment in Indonesia).

CHAPTER 6 RECOMENDATION

(1) Implementation of Projects Proposed in Master Plan

The proposed Water Master Plan is composed of the water resources development and management in the Bali Province, targeting the year of 2025. The Master Plan is prepared on the vision that the water resources is a component which forms identity of culture and development power of the Bali people based on the Bali philosophy of "Tri Hita Karma (Three Happiness Causes) ". To realize this vision, the Master Plan targets the four objectives: 1) To improve water use, 2) To increase food production, 3) To conserve eco-system and 4) To maintain identity of Bali culture supported by agricultural value system.

To achieve these objectives, the Master Plan proposes the reasonable plans on the basis of the socio-economic framework up to the year of 2025 projected by the Study Team considering the existing plans and projection discussed in the latest Bali Spatial Plan. During the preparation of the Master Plan, three times of the Stakeholder Meeting were held at each regency/city. This method is quite a new system in Indonesia during the preparation of Master Plan. In this sense, the Master Plan was prepared through information disclosure and exchange opinion with the Stakeholder related to the water resources development and management.

The Master Plan prepared in such process proposes to solve or minimize water issues at present and in future. That is why the Master is useful and important plans to Bali people. It is very important to implement securely the plans or projects proposed in the Master Plan.

(2) Water Resources Development

The proposed Master Plan was set to target the year of 2025 based on the population and economic growth projection conducted by the Study Team. Therefore the plan should be reviewed regularly and changed if necessary according to the change of socio-economic conditions and accumulated collection of new data.

Water resources development plan discusses the multi-purpose dam plans, water supply plans, irrigation plans and flood control plans. The multi-purpose dam plans and water supply plans design the optimum water resources development programs which include the most reasonable, economical and less impact methods to natural and social environments. The targets water sources to develop (surface water, groundwater, spring water) are carefully examined and selected considering the characteristics of demand (demand volume, demand location). Among the water resources development plans proposed in the Master Plan, the multi-purpose dam plan (Ayung Dam and Benel Dam) and the integrated water supply plan for SARBAGI area shall conduct environmental impact assessment (AMDAL) before the commencement of construction.

Before the implementation of the groundwater development projects proposed in the Master Plan, careful assessment is necessary to evade seawater intrusion in the coastal areas and to minimize impact to groundwater, spring and surface water in the inland areas.

As the water resources are limited, effective water use (or appropriate water demand control) shall be employed. Water supply companies (PDAM) to supply water to the users shall take the following demand control methods:

<Leakage Management>
The current average unaccounted water rate is 23 %, relatively low, in Bali. In the Master Plan, 20% of unaccounted water rate is proposed. The leakage counter measures for the existing distribution networks, addition to the measures for the new networks.

<Reuse and Save Water>
The application of the reuse and save water technology to the industrial water is effective to decrease the industrial water demand. It is necessary for PDAM to promote this technology. Also it is necessary for the government to give subsidy in the industry promotion program.

<Water Use Regulation>
Educational activity (water save campaign and poster) is effective methods to decrease water use. Other methods to control water demand are decrease of water pressure and water use regulation by

time and so on. These methods are emergent measures as they cause less public service. It is common that water use volume increase if the water tariff is cheaper. The water supply plan for SARBAGI area is designed under the conditions that such water use regulation is employed. The increased unit consumption rate in the area is planned to be 10 lit./capita/day. For example, Denpasar: 210 lit/capita/day → 220 lit/head/day, Kuta area: 200 lit /capita /day → 210 lit/ capita /day.

The Master Plan also discusses the water supply plans for the remote and isolated area. These plans will be entered the PDAM program. These plans will be sustainable if the construction is implemented with public investment (or subsidy), and users maintain the system by themselves.

(3) Water Resources Management

Water resources management plan discusses the institutional plans, water quality improvement plans, river basin conservation plans, database for water resources management and capacity building program.

Step by step, to implement securely the proposed projects proposed in the master Plan, the Master Plan proposes the following new organizations considering the current issues on water resources management. Those are 1) DINAS-PSDA, 2) Water Resources Coordination Council for Bali Province or for Ayung River Basin, 3) BALAI-PSDA for Bali Province or Ayung River Basin, 4) Regional Water Production Entities, 5) SEDAHAN-AGUNG and 6) Subak Coordination Unit. It is recommendable to implement shortly the institutional reformation. The proposed Capacity Building Program is one which supports the improvement of new organizations capabilities.

The main program for the water quality improvement plan is the River Clean Water Campaign (PROKASIH) under the control of by the Provincial Environmental Control Agency (BAPEDALDA). As shown in this Program, the short-term target is to decrease pollutant roads by mind reformation of the people living along the rivers.

Among the basin conservation plans, the Forest Conservation Plan is the most important plan. The main framework of the Forest Conservation Plan is the Master Plan for Forest and Land Rehabilitation prepared by BP-DAS UNDA ANYAR and DINAS-FORESTRY, Bali. It is important to implement this Master Plan. Especially in the critical area, it is necessary to employ the hard measures such as check dam and channel works as well as soft measures.

The water resources database prepared in the Master Plan shall be used for the water resources management. New observed data and information will be stored in this GIS. This system is able to be used for planning of water supply.

(4) Implementation of Priority Projects

Regarding the priority projects selected in the Master Plan, namely 1) Multi-purpose Ayung Dam, Project, 2) Integrated Water Supply Project for SARBAGI areas and 3) Flood Control Project for Badung and Mati Rivers, the feasibility study was conducted. These projects will contribute greatly to the solution of water supply, irrigation, power generation and flood control in the southern Bali areas. Urgent implementation of the projects is necessary. As EIRRs of the projects are over 12%: Opportunity Cost of Capital – Indonesia, the projects are economically feasible. From the aspects of environment and social consideration, the feasibility of the projects with necessary countermeasures to minimize or mitigate the impacts has been confirmed.

Before the implementation of the priority projects, the following matters shall be considered and conducted by the Government of Bali Province without fail:

<AMDAL – Regal Environmental Impact Assessement>

Due to the scale of the projects, AMDAL shall cover two priority projects, namely 1) Multi-purpose Ayung Dam, Project and 2) Integrated Water Supply Project for SARBAGI Areas. According to the clarification of the assessment, appropriate countermeasures and monitoring program shall be proposed to mitigate the environment and social impacts to the project areas.

<Monitoring of Water Demands>

The water demand projection for the Integrated Water Supply Project for SARBAGI Areas was carried out carefully and properly by the Study Team and the Counterpart Team. However, the projection is not always definite. Careful monitoring of the water demand is required before the implementation of the project.

<Socialization of the Priority Projects>

Generally, dam construction gives environmental and social impacts to the people at the project site. To minimize the adverse impacts and receive the cooperation of the inhabitants, at any occasion, before and during detailed design stage, the project implementation agency or the Bali Government shall conduct the socialization to the societies at the projects site.

<Clarification of Current Water Right in Term of Discharge>

The new dam and reservoir will increase water availability in the dry seasons even in that of drought years. However, unless the water use will be operated in term of the discharge of the intake water, it will be impossible to take the new developed water for the water supply. Thus, it is necessary to establish the new system to manage the intake discharge for irrigation and water supply along the Ayung River, by involving the current water users, such as SUBAKs and PDAMs.

As the cost of the projects is large, it is hard for the Bali Provincial Government to implement the project by himself due to the financial reason. It is recommendable that the Central Government gives financial assistant to the projects by employing the foreign soft loan.

(5) Disclosure of Information

The information on the Master Plan and the priority projects have been disclosed to the stakeholders through the stakeholder meetings (3 times in Master Plan phase and 3 times in F/S phase) and three times workshops. To disclose more information on the Master Plan and the priority projects, it is recommendable to put the Study results in the Bali Government Homepage.