DIRECTORATE GENERAL OF WATER RESOURCES,
MINISTRY OF PUBLIC WORKS
PUBLIC WORKS SERVICE, BALI PROVINCE

THE COMPREHESIVE STUDY
ON
WATER RESOURCES DEVELOPMENT
AND MANAGEMENT IN BALI PROVINCE
IN
THE REPUBLIC OF INDONESIA

FINAL REPORT
SUPPORTING REPORT

[D] HYDROLOGY

AUGUST 2006

JAPAN INTERNATIONAL COOPERATION AGENCY

YACHIYO ENGINEERING CO., LTD.
NIPPON KOEI CO., LTD.

THE COMPREHENSIVE STUDY ON WATER RESOURCES DEVELOPMENT AND MANAGEMENT IN BALI PROVINCE IN THE REPUBLIC OF INDONESIA

SUPPORTING REPORT (D) HYDROLOGY

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D-1 GENERAL

River Water Potential
This section describes the calculation process for river water potential (natural flow) of each sub-basin needed for studying supply-demand balance.

Water Use Calculation of Ayung Dam
This section shows the reasons for deciding; 1) the irrigation plan for Ayung River with the aim of supplying water and improving agricultural productivity within Denpasar area, and 2) a target value for required capacity of Ayung Dam.

Flood Control Plan in Denpasar Area
Results of hydrological analysis for the flood control plan are summarized in this section.

D-2 RIVER WATER POTENTIAL

This document describes the process of calculating river water potential (natural flow) for each sub-basin required for examining supply-demand balance.

D-2.1 Study Method and Conditions

As shown in Figure-D.1, amount of river water potential is calculated after summarizing conditions of each river and water use.

(1) Hydrological Data Collection

Data of rainfall, water level and discharge recorded in Bali Province are collected. The target period is to be the past 10 years (1994-2003).

(2) Accuracy Check and Selection of Data for Flow Discharge

Relationship between the amount of rainfall and runoff are found from the data and shown in a figure. Hydrological observatories, if there are problems in accuracy, will be left out.

(3) Analysis of Runoff Characteristics

Analyze runoff characteristics according to the data collected at the selected observation sites. The result will be used as a reference for selecting rivers.

(4) Selection of River for each Sub-basin

Using the data including analysis result and other data, river for each sub-basin is selected to calculate the surface water potential.

(5) Evaluation of Surface Water Potential by each Sub-basin

Natural flows of selected rivers are simulated and surface water potential of sub-basins is measured. The level of the flow discharge is set to be equivalent to the average flow discharge.

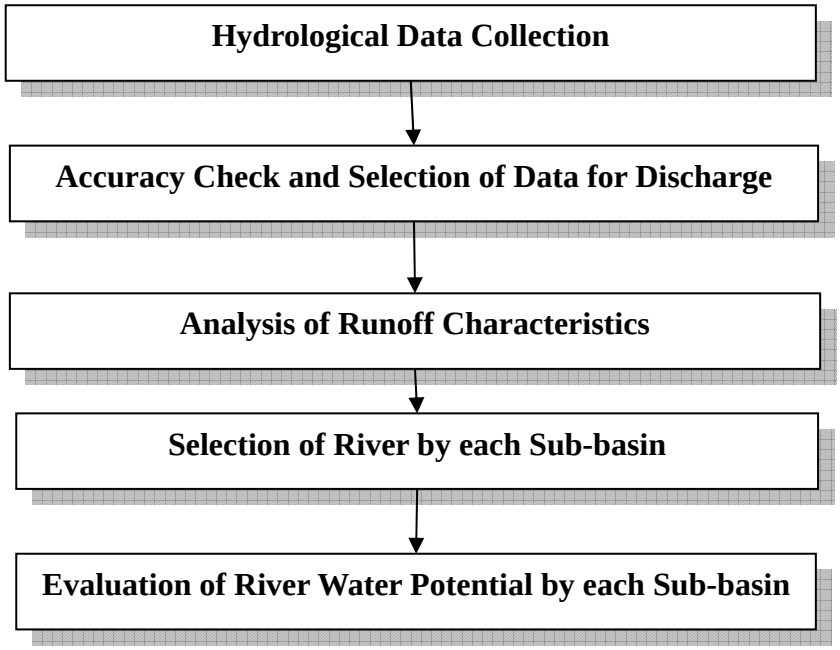


Figure-D.1 Calculation Process of River Water Potential

D-2.2 Current Conditions of Hydrological Data Collection

Locations, items, conditions of the hydraulic observation in Bali are shown in Figure-D.2, Figure-D.3 and Table-D.1.
Conditions for the flow discharge observation necessary for suggesting the water resource development plan implemented in major rivers by JICA Study Team are indicated in Figure-D.4 and Table-D.2 Thus;

(1) Rainfall observations in Bali are conducted by BMG and Dinas PU. BMG has 90 and Dinas PU has 23 observation sites.

(2) Water level and flow discharge observations are conducted by Dinas PU. The number of the observation sites is over 50.

(3) To figure out the influences of intake for irrigation use, JICA Study Team performed flow discharge observations at 11 rivers including Unda River, Ayung River Petanu River and Oos River, where are candidates for river water development.

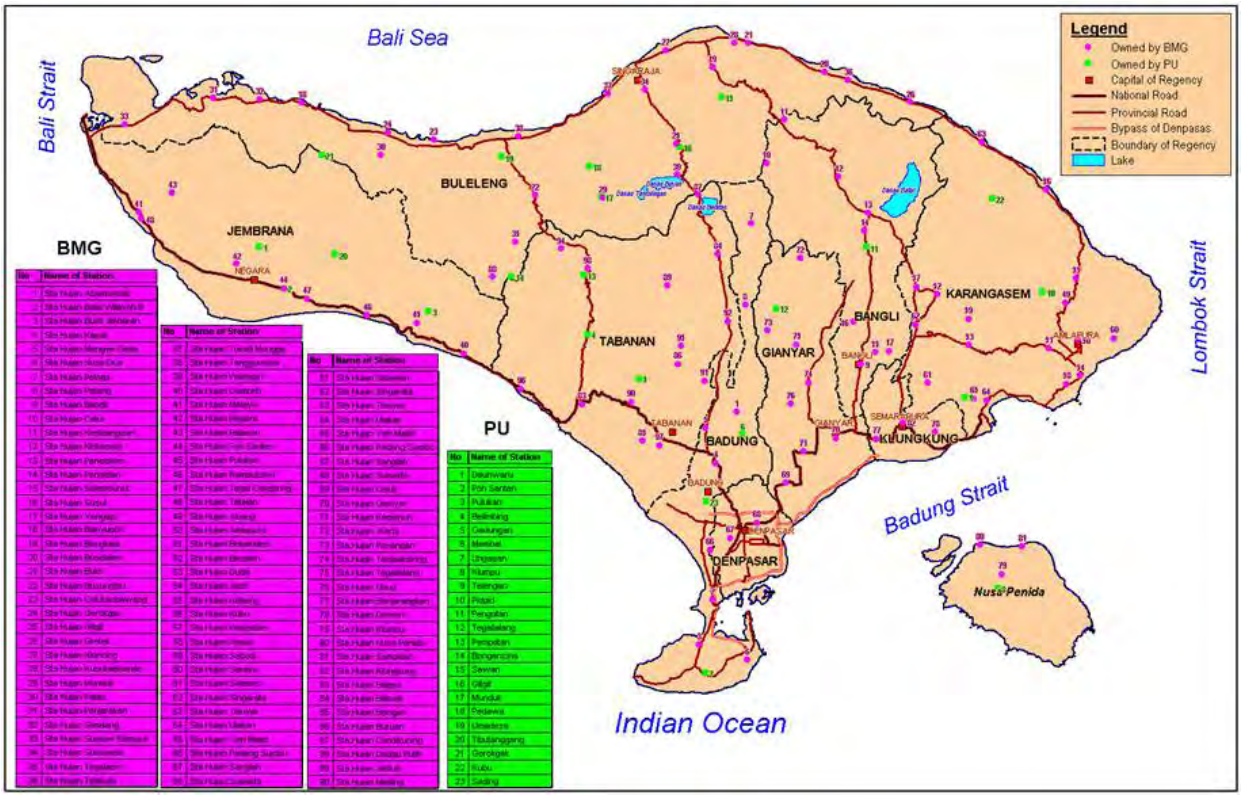


Figure-D.2 Location of Rainfall Station

No	SGS Code	Catchment
1	07-036-00-02	19.967
2	07-036-00-01 (new)	27.776
3	07-036-00-01 (old)	42.358
4	07-034-00-03	29.333
5	07-034-00-01	34.907
6	07-035-00-01	9.501
7	07-034-00-02	19.863
8	07-033-00-01	70.723
9	07-032-00-01	10.592
10	07-032-00-02	39.739
11	07-031-00-02	86.263
12	07-031-00-03	25.402
13	07-031-00-04	26.950
14	07-031-00-05	52.035
15	07-031-00-07	15.733
16	07-029-00-01	23.821
17	07-028-00-01	153.793
18	07-027-00-01	36.442
19	07-027-00-02	15.338
20	07-026-00-01 (old)	103.374
21	07-026-00-01 (new)	99.608
22	07-023-00-01	27.217
23	07-024-00-02	31.388
24	07-023-00-03	217.348
25	07-021-00-01	101.333
26	07-020-00-01	60.560
27	07-019-00-01	40.511
28	07-018-00-01	49.179
29	07-016-00-02	102.181
30	07-015-00-01 (old)	6.661
31	07-015-00-01 (new)	24.808
32	07-015-00-02 (old)	18.093
33	07-015-00-02 (new)	33.180
34	07-014-00-01 (new)	30.609
35	07-014-00-01 (old)	26.685
36	07-009-00-01	79.291
37	07-009-00-04	4.646
38	07-008-00-03	11.053
39	07-008-00-03	15.381
40	07-007-00-05 (old)	24.167
41	07-007-00-02 (old)	58.172
42	07-007-00-05 (new)	44.426
43	07-007-00-02	131.161

Figure-D.3 Location of SGS with Comparatively Long-Term Runoff Data

Table-D.1 List of Streamflow Gauging Stations in Bali Island

No.	ID No.	Type of Gauge	Name of River	Catchment Area (km²)	Data	Available Period
						1980's: 0 1 2 3 4 5 6 7 8 9 / 1990's: 0 1 2 3 4 5 6 7 8 9 / 2000's: 0 1 2 3
(1) Sreamflow Gauging Stations with Long-Term Runoff Data after 1992						
1	07-007-00-02	AWLR	Tk. Sabah (Old)	52.54	WL	
					Q	
			Tk. Sabah (New)	131.74	WL	
					Q	
2	07-007-00-05	AWLR	Tk. Mendaum (Old)	11.53	WL	
					Q	
			Tk. Mendaum (New)	45.38	WL	
					Q	
3	07-008-00-03	AWLR	Tk. Buleleng (Bakung)	12.69	WL	
					Q	
			Tk. Buleleng	44.02	WL	
					Q	
4	07-009-00-01	AWLR	Tk. Daya Sawan	77.39	WL	
					Q	
5	07-009-00-04	Manual	Tk. Penarukan	34.10	WL	
					Q	
6	07-014-00-01	AWLR	Tk. Nyuling (Old)	26.14	WL	
					Q	
			Tk. Nyuling (New)	30.12	WL	
					Q	
7	07-015-00-01	AWLR	Tk. Buhu (Old)	19.35	WL	
					Q	
			Tk. Buhu (New)	25.34	WL	
					Q	
8	07-015-00-02	AWLR	Tk. Janga (Old))	18.56	WL	
					Q	
			Tk. Janga (New))	34.56	WL	
					Q	
9	07-016-00-02	AWLR	Tk. Telagawaja	28.39	WL	
					Q	
10	07-018-00-01	AWLR	Tk. Melangit	52.90	WL	
					Q	
11	07-019-00-01	AWLR	Tk. Sangsang	43.93	WL	
					Q	
12	07-020-00-01	AWLR	Tk. Petanu	55.33	WL	
					Q	
13	07-021-00-01	AWLR	Tk. Oos	98.85	WL	
					Q	
14	07-023-00-01	AWLR	Tk. Badung Hulu		WL	
					Q	
15	07-024-00-02	AWLR	Tk. Sungi	35.00	WL	
					Q	
16	07-026-00-01	AWLR	Tk. Yeh Hoo (Old)	80.98	WL	
					Q	
			Tk. Yeh Hoo (New)	77.17	WL	
					Q	
17	07-027-00-01	AWLR	Tk. Yeh Otan	38.42	WL	
					Q	
18	07-028-00-01	AWLR	Tk. Balian	152.20	WL	
					Q	
19	07-029-00-01	AWLR	Tk. Yeh Leh	23.12	WL	
					Q	
20	07-031-00-02	AWLR	Tk. Yeh Sumbul	59.22	WL	
					Q	
21	07-031-00-03	AWLR	Tk. Yeh Satang	25.19	WL	
					Q	
22	07-031-00-04	AWLR	Tk. Medewi	32.77	WL	
					Q	
23	07-032-00-01	AWLR	Tk. Yeh Buah	10.60	WL	
					Q	
24	07-032-00-02	AWLR	Tk. Yeh Embang	39.83	WL	
					Q	
25	07-033-00-01	AWLR	Tk. Biluk Poh	67.47	WL	
					Q	
26	07-034-00-01	AWLR	Tk. Jogading	38.26	WL	
					Q	
27	07-034-00-02	AWLR	Tk. Pergung	20.22	WL	
					Q	
28	07-034-00-03	AWLR	Tk. Daya Timur	29.09	WL	
					Q	
29	07-036-00-01	AWLR	Tk. Sangiang Gede	42.02	WL	
					Q	
(2) Water Level Gauging Stations on Closed Lakes						
30	07-008-00-01	Manual	D. Buyan	24.25	WL	
31	07-008-00-02	Manual	D. Tamblingan	11.35	WL	
32	07-011-00-01	Manual	D. Batur	100.08	WL	
33	07-024-00-01	AWLR	D. Beratan	14.92	WL	
(3) Other Streamflow Gauging Stations						
34	07-002-00-003	Manual	Tk. Yeh Pekerisan	-	WL	
					Q	
35	07-006-00-001		Tk. Yeh Gemgem	100.08*	WL	
					Q	
36	07-009-00-05	2000	Tk. Buus	4.73*	WL	
					Q	
37	07-016-00-01	1982	Tk. Unda	41.20*	WL	
38	07-017-00-01	1982	Tk. Jinah	28.60*	WL	
39	07-020-00-01	1982	Tk. Pekerisan	29.88*	WL	
40	07-020-00-02	1982	Tk. Bubuh	32.35*	WL	
41	07-021-00-002		Tk. Ayung Sidang	65.00	WL	
					Q	
42	07-021-00-003		Tk. Ayung Buangga (Old)	217.00	WL	
					Q	
			Tk. Ayung Buangga (New)	178.80*	WL	
					Q	
43	07-024-00-03	1982	Tk. Penet	58.40*	WL	
44	07-024-00-04	2000	Tk. Mati	25.40*	WL	
45	07-025-00-02	1982	Tk. Panahan (Tk. Empas)	31.35*	WL	
					Q	
46	07-025-00-03	1982	Tk. Yeh Aba	10.05*	WL	
					Q	
47	07-027-00-02	1982	Tk. Yeh Matan	14.55*	WL	
48	07-031-00-05	1982	Tk. Pulukan	18.60	WL	
49	07-031-00-07	1982	Tk. Pangyangan	16.35	WL	
50	07-035-00-01	1982	Tk. Sebual	10.16	WL	
51	07-036-00-02	1982	Tk. Melaya	21.88	WL	

Notes

/1 : Catchment Area at SGS site

The catchment area with "*" is Measured by Hydrology Office of PU, while those at other SGSs are measured in this M/P with a digital planimeter based on 1 to 25,000 scale maps.

/2: Availability of Dischrge Measurement Results on the number

The following rating marks do not show the quality of discharg measurement results, but only the availability on the number of discharge measurement results provided by the PU Hydrology Office conducted by PU Hydrology Office.

○ : The number of discharge measurements between 1992 and 2003 are comparatively sufficient.

△ : The number of discharge measurements between 1992 and 2003 are not sufficient sufficient for examining the stage-discharge rating curve thereat.

× : No discharge measurement results were provided by the PU Hydrology Office in this M/P stage.

▭ : Shows that the water lavel data are completely available in the year

▯▯ : Shows that the water lavel data are partially available in the year

▬ : Shows that the discharge data are completely available in the year

▮▮ : Shows that the discharge data are partially available in the year

Table-D.2 River Discharge Measurement Location(by JICA TEAM)

Name of Rivers	Position		Regency	Remarks
	Latitude	Longitude		
Unda River				
a. Upstream	-8°31'34.88"	115°24'26.92"	Klungkung	300 m upstream to Sabo Dam
b. Downstream	-8°32'12.45"	115°24'39.70"		300 m downstream to Sabo Dam
Ayung River	-8°38'20.21"	115°14'31.96"	Badung	50 m Down Stream of Steel Bridge Sulatri Road
Petanu River	-8°36'34,13"	115°18'39,60"	Gianyar	Up Stream Bridge Sunrise Road
Oos River	-8°37'5.20"	115°18'2.19"	Gianyar	Up Stream Bridge Sunrise Road
Sangsang River	-8°32'15.21"	115°20'45.22"	Bangli	AWLR Sangsang
Nyuling River	-8°27'47.05"	115°37'34.52"	Karangasem	Bridge Close to Ujung
Yeh Ho River	-8°32'58.92"	115°3'28.15"	Tabanan	Yeh Malet Kelod, Kerambitan
Balian River	-8°29'32.19"	114°58'7.16"	Tabanan	AWLR Lalang Linggah
Sungi River	-8°36'38.23"	115°6'44.52"	Tabanan	Down Stream Sunrise Bridge
Yeh Empas River	-8°34'55.63"	115°5'11.57"	Tabanan	Wooden Bridge Sudimara
Saba River	-8°11'44.89"	114°55'53.42"	Buleleng	AWLR Seririt

Source: Field Survey, 2004/2005

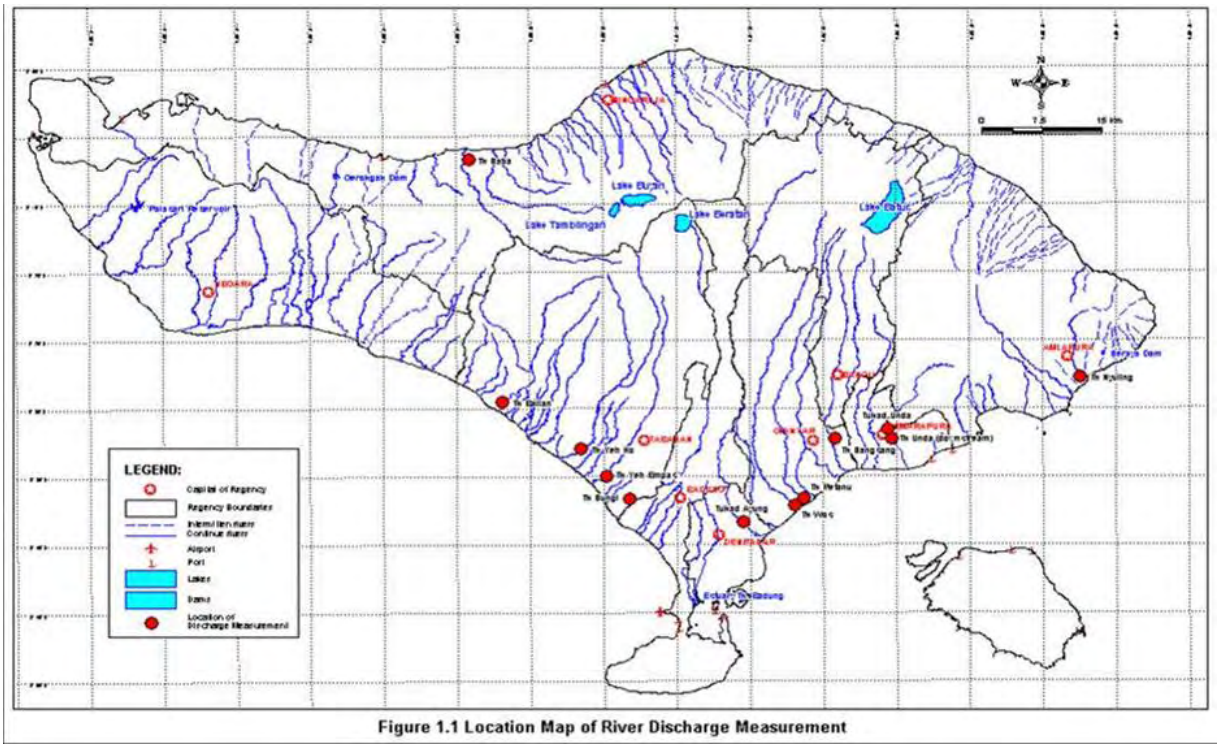


Figure-D.4 Location of Discharge Measurement Point Observed by JICA Study team

D-2.3 Accuracy Check and Selection of Observation Data

Selection of certain flow observation sites is a key element to evaluate river water potential by each sub-basin, but missing values or problems in accuracy are often found in some stations. In this section, data accuracy is checked and will be used as a reference for selecting rivers.
Based on the data collected at the observation sites for both discharge and rainfall, status of rainfall and discharge in the last 10 years, starting from 1994 to 2003, was found. Then, the rivers which have shorter missing terms and values with relatively natural movement were selected.

The results are shown in Table-D.3. A total of 14 discharge observation sites were selected.
The figure showing the variation of rainfall and discharge in all rivers is attached in Annex.

Table-D.3 List of Selected Discharge Observation site

Regacy	Sub-Basin	Area (km2)	ID	Name of riverr	Catchment area (km2)	ID	Name of Streamflow Gauging Stations	Catchment area (km2)	Method	Adoption
Badung	03.01.01	555.6	112	Tk. Ayung	301.92	07-021-00-003	Tk. Ayung Buangga	217.00	AWLR	○
			112	Tk. Ayung	301.92	07-021-00-002	Tk. Ayung Sidang	65.00	AWLR	
			116	Tk. Badung	41.09	07-023-00-01	Tk. Badung Hulu	21.10	AWLR	
Tabanan	03.01.02	601.8	122	Tk. Penet	190.36	07-024-00-02	Tk. Sungi	35.00	AWLR	○
			129	Tk. Yeh Hoo	170.61	07-026-00-01	Tk. Yeh Ho	80.98	AWLR	
			118	Tk. Yeh Poh	20.08	07-033-00-01	Tk. Yeh Poh	67.47	AWLR	
	01.01.03	288.3	139	Tk. Balian	154.74	07-028-00-01	Tk. Balian	152.20	AWLR	○
			133	Tk. Otan	49.38	07-027-00-01	Tk. Yeh Otan	38.42	AWLR	○
Jembrana	03.01.04	392.4	150	Tk. Yeh Sumbul	110.25	07-031-00-02	Tk. Yeh Sumbul	59.22	AWLR	
			148	Tk. Medewi	47.05	07-031-00-04	Tk. Medewi	32.77	AWLR	
			149	Tk. Yeh Satang	36.72	07-031-00-03	Tk. Yeh Satang	25.19	AWLR	○
			143	Tk. Yeh Leh	24.41	07-029-00-01	Tk. Yeh Leh	23.12	AWLR	
	03.01.05	158.9	153	Tk. Bilukpoh	91.25	07-033-00-01	Tk. Biluk Poh	67.47	AWLR	○
			151	Tk. Yeh Embang	61.35	07-032-00-02	Tk. Yeh Embang	39.83	AWLR	
	03.01.06	228.4		Tk. Pergung		07-034-00-02	Tk. Pergung	20.22	AWLR	
				Tk. Yeh Buah		07-032-00-01	Tk. Yeh Buah	10.06	AWLR	
			154	Tk. Sowan Perancak	186.54	07-034-00-01	Tk. Jogading	38.26	AWLR	○
				Tk. Daya Timur		07-034-00-03	Tk. Daya Timur	29.09	AWLR	○
	03.01.07	243.5	157	Tk. Sangianggede	86.71	07-036-00-01	Tk. Sangianggede	42.02	AWLR	
Buleleng	03.01.08	367.2	-	-	-	-	-	-	-	
	03.01.09	222.4	9	Tk. Sabah	132.89	07-007-00-02	Tk. Sabah	52.54	AWLR	○
	03.01.10	114.2	10	Tk. Mendaum	45.04	07-007-00-05	Tk. Mendaum	45.38	AWLR	○
	03.01.11	243.5	23	Tk. Buleleng	30.58	07-008-00-03	Tk. Buleleng	44.02	AWLR	○
			26	Tk. Penarukan	14.41	07-009-00-04	Tk. Penarukan	34.10	Manual	
	03.01.12	311.7	29	Tk. Daya	91.16	07-009-00-01	Tk. Daya Sawan	77.39	AWLR	○
Karangasem	03.01.13	357.1	-	-	-	-	-	-	-	
	03.01.14	295.4	86	Tk. Nyuling	73.56	07-014-00-01	Tk. Nyuling	30.12	AWLR	○
			90	Tk. Bulu	33.25	07-015-00-01	Tk. Buhu	25.34	AWLR	
	03.01.15	272.5	98	Tk. Unda	232.19	07-016-00-02	Tk. Telagawaja	28.39	AWLR	
	03.01.16	342.1	104	Tk. Sangsang	84.12	07-019-00-01	Tk. Sangsang	43.93	AWLR	
			103	Tk. Melangit	52.57	07-018-00-01	Tk. Melangit	52.90	AWLR	
Karangasem Bangli Klunkun	03.01.17	257.8	109	Tk. Oos	119.95	07-021-00-01	Tk. Oos	98.85	AWLR	
			108	Tk. Petanu	96.89	07-020-00-01	Tk. Petanu	55.33	AWLR	○
Gyanyar Bangli	03.01.18	48.8	-	-	-	-	-	-	-	
	03.01.19	102.2	-	-	-	-	-	-	-	
Nusa Penida	03.01.20	208.5	-	-	-	-	-	-	-	

D-2.4 Analysis of Runoff Characteristics

Runoff characteristics of the rivers which have 14 discharge observation site selected to evaluate surface water potential were analyzed. The result indicates the following conditions.

(1) As shown in Figure-D.6, runoff ratio is mostly about 0.5 except for few values. The correlation between annual rainfall and discharge is shown in Figure-D.5. The loss balance may be somewhere around 550mm. Additionally, relational expressions based on the past study results are shown in the same figure indicating the loss balance of 600mm, which is similar to the new data.

(2) In Figure-D.7, the lines showing discharge rating curves are distinctive. It shows the slopes of the rivers including Klunkung, Gyanyar and Buleleng are gradual, meaning a large amount of interflow. Runoff characteristics of major rivers in Bali extracted from a previous study report is summarized in Table-D.4, which shows the base flow discharge accounts for 90% of all discharge.

(3) Hydrogeological characteristics within Bali, as well as the locations of springs and observation spots, are illustrated in Figure-D.9 and river density and number of springs by sub-basin are listed in Figure-D.8. The data shows that the rivers with prominent interflow component are relatively located in the area where more springs are found.

Table-D.4 Runoff Characteristics of Major Rivers（Pawitan 1992）

River Name	Area	Rainfall (P)	Discharge (Q)	Baseflow (Qb)	Q/P	(Q-Qb)/P
Pergung	18.5	2212	1023	-	0.46	-
Balian	151.7	2441	1951	628	0.80	0.54
Badung	18.5	1900	2539	1508		
Ayung-Sidan	64.4	2282	1301	1239	0.57	0.03
Ayung-Buangga	221.0	2348	1352	1142	0.58	0.09
Oos-Silakarang	87.0	2103	1148	864	0.55	0.14
Buhu-Sibetan	10.9	2568	1722	1215	0.67	0.20
Daya-Sawan	82.5	2113	1038	722	0.49	0.15
Sabah-Titab	56.4	2786	1854	1028	0.66	0.30
Sabah-Lbksemawa	78.1	2670	2325	1415	0.87	0.34
Gemgem-Sorga	27.4	1974	1383	416	0.70	0.49

Source:Pawitan,H(1992):Regional Characteristics of Bali river runoff In Kayane,I.ed. Water Cycle and Water Use in Bali Island,87-102

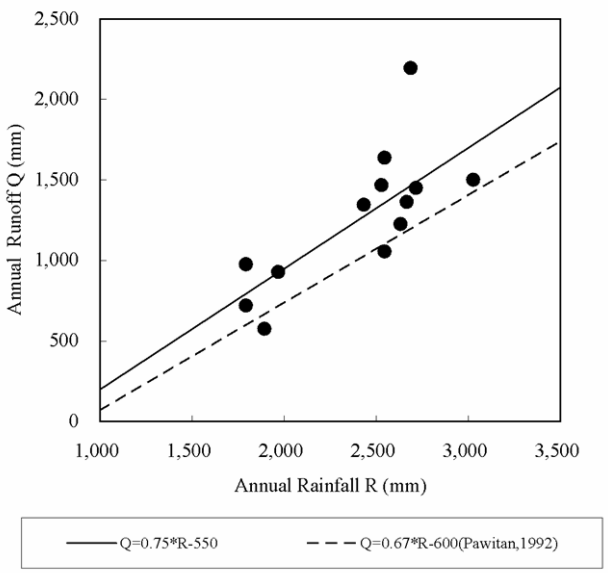


Figure-D.5 Relationship between Annual Rainfall and Runoff

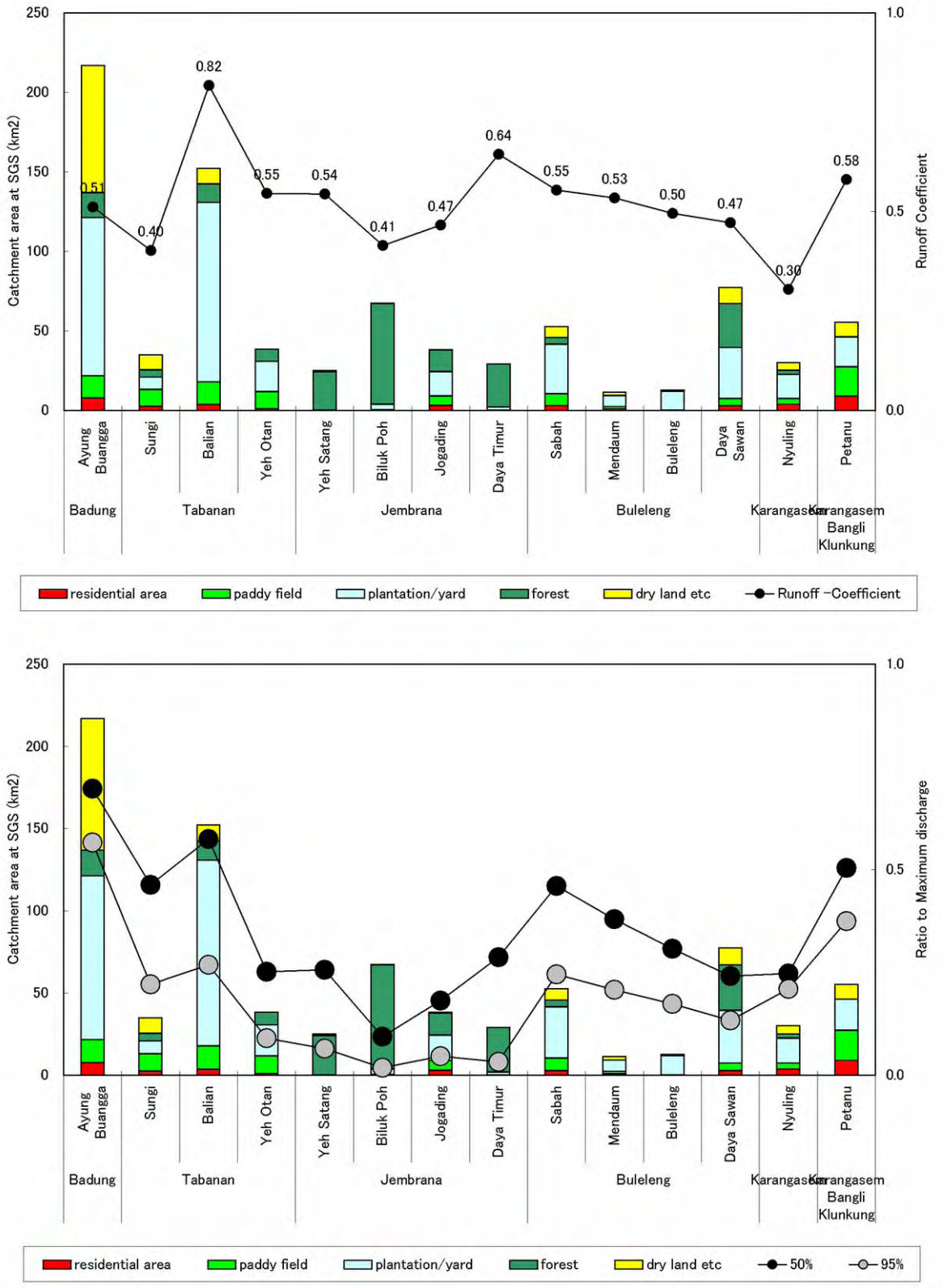


Figure-D.6 Comparison of Runoff Characteristics

above: Runoff coefficient
below: Ratio of 50% and 95% flow to maximum discharge

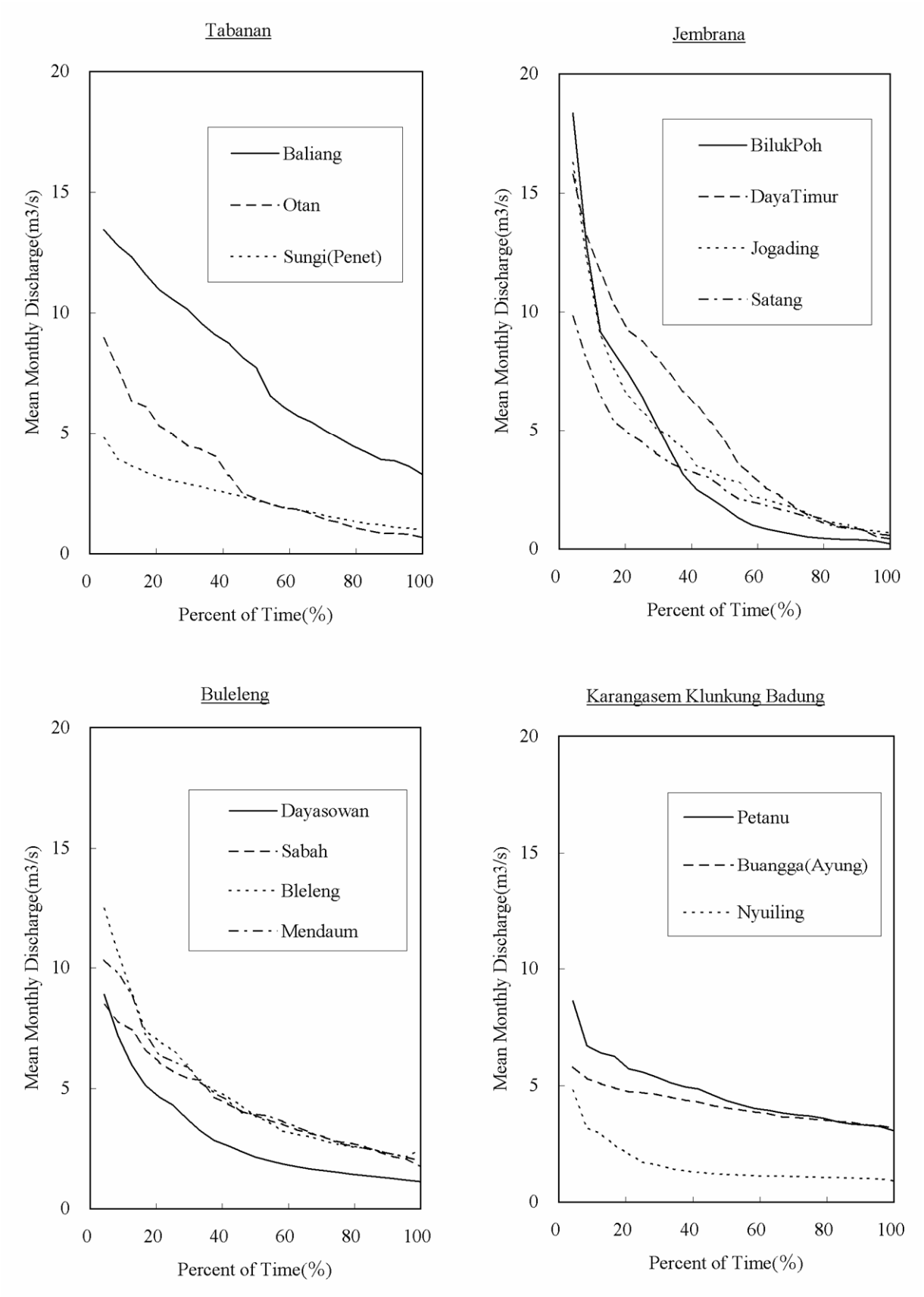


Figure-D.7 Discharge Rating Curve

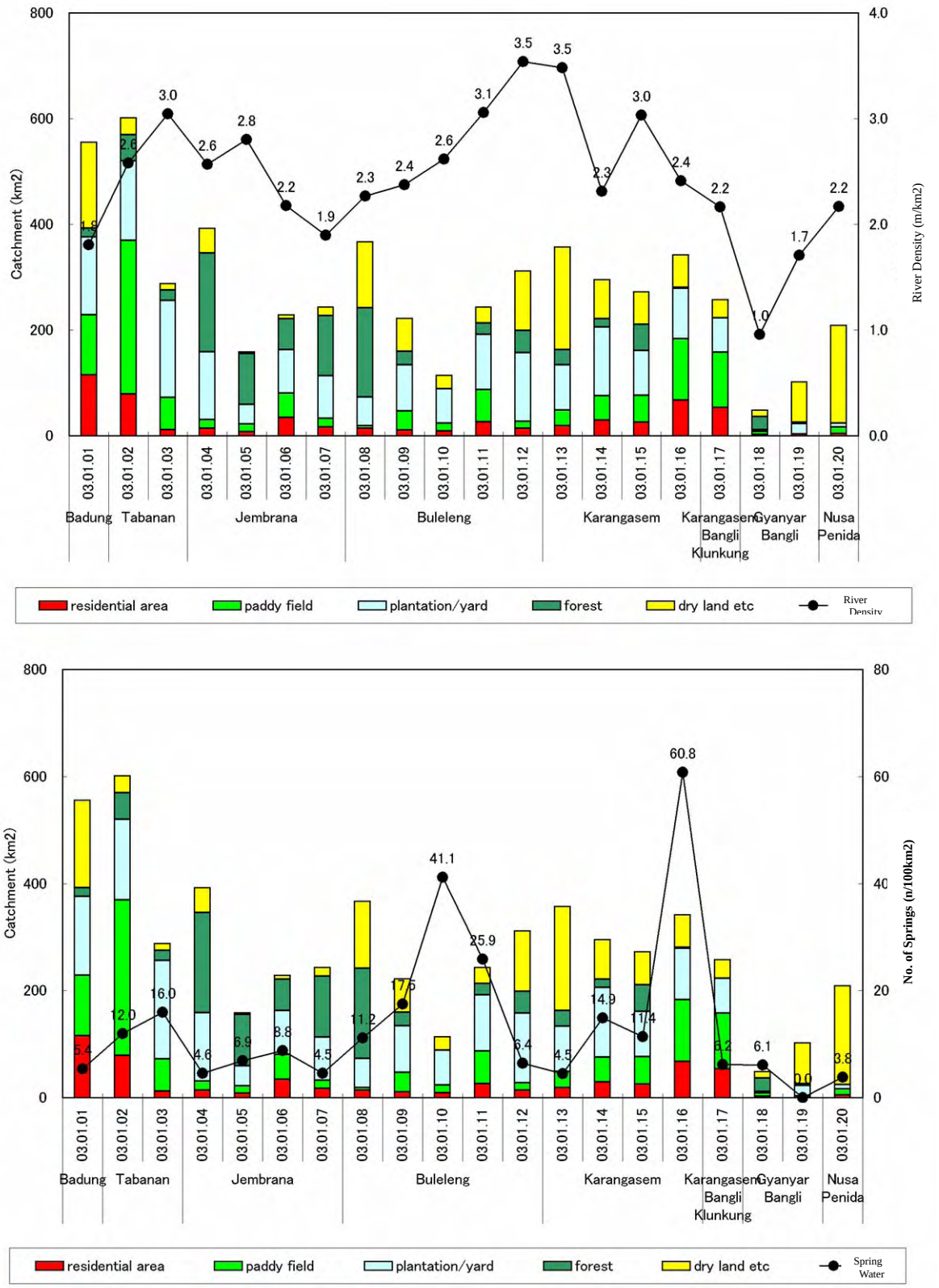


Figure-D.8 River Density & Number of Springs by Sub-basin

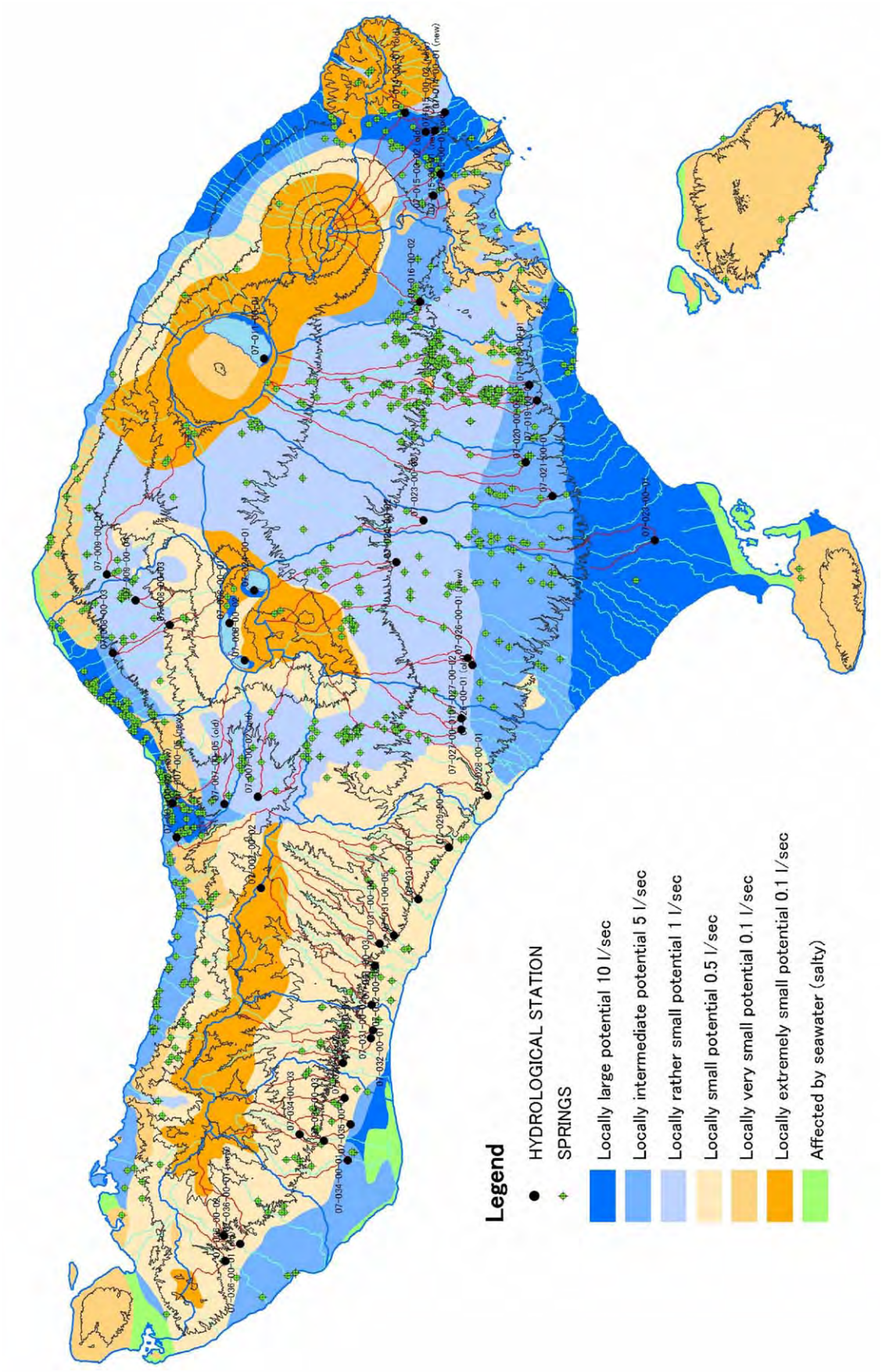


Figure-D.9 Springs and Observation Sites

D-2.5 Evaluation of Surface Water Potential by each Sub-basin

D-2.5.1 Selection of Rivers by each Sub-basin

Rivers of each sub-basin are selected from 14 candidates chosen in the Section 3, 'Accuracy Check and Selection of Observation Data,' based on the conditions summarized below. The data of the rivers selected in this section will be used in calculating river water potential by each sub-basin.
In the result, a total of 11 rivers are selected as shown in Table-D.5.

(1) All rivers selected in the first phase automatically become key rivers.
(2) Other selected river in nearby sub-basin with similar runoff characteristics will be adopted if; 1) the selected river is considered to be inadequate because the observation site stands upstream of the river and water such as spring water is not added in the calculation or; 2) no rivers are selected in the first phase.
(3) If there are more than one key river in one sub-basin, either one of those will be selected.

Table-D.5 Selected Rivers in each Sub-basin

Regacy	Sub-Basin	Area (km2)	Name of river	Catchment area (km2)	Name of Streamflow Gauging Stations	Catchment area (km2)	Referred Key river	Reason for selection		
								(1)	(2)	(3)
Badung	03.01.01	555.6	Tk. Ayung	301.9	Tk. Ayung Buangga	217.00	TK.Petanu		○	
			Others	111.3	-	-	TK.Petanu		○	
Tabanan	03.01.02	601.8	Tk. Penet	190.4	Tk. Sungi	35.00	TK.Petanu		○	
			Others	351.2	-	-	TK.Petanu		○	
	01.01.03	288.3	Tk. Balian	154.7	Tk. Balian	152.20	Tk. Balian	○		○
			Tk. Otan	49.4	Tk. Yeh Otan	38.42	Tk. Yeh Otan	○		○
			Others	84.2	-	-	Tk. Yeh Otan	○		
Jembrana	03.01.04	392.4	Tk. Yeh Satang	36.7	Tk. Yeh Satang	25.19	Tk. Yeh Satang	○		
			Others	84.2	-	-	Tk. Yeh Satang	○		
	03.01.05	158.9	Tk. Bilukpoh	91.3	Tk. Biluk Poh	67.47	Tk. Biluk Poh	○		
			Others	67.7	-	-	Tk. Biluk Poh	○		
	03.01.06	228.4	Tk. Sowan Perancak	186.5	Tk. Jogading	38.26	Tk. Jogading	○		
			Others	41.9	-	-	Tk. Jogading	○		
	03.01.07	243.5	All	243.5	-	-	Tk. Jogading		○	
Buleleng	03.01.08	367.2	All	367.2	-	-	Tk. Sabah		○	
	03.01.09	222.4	Tk. Sabah	132.9	Tk. Sabah	52.54	Tk. Sabah	○		
			Others	89.6	-	-	Tk. Sabah	○		
	03.01.10	114.2	Tk. Mendaum	45.0	Tk. Mendaum	45.38	Tk. Mendaum	○		
			Others	69.2	-	-	Tk. Mendaum	○		
	03.01.11	243.5	Tk. Buleleng	30.6	Tk. Buleleng	44.02	Tk. Buleleng	○		
			Others	212.9	-	-	Tk. Buleleng	○		
	03.01.12	311.7	Tk. Daya	91.2	Tk. Daya Sawan	77.39	Tk. Daya Sawan	○		
			Others	220.6	-	-	Tk. Daya Sawan	○		
Karangasem	03.01.13	357.1	All	357.1	-	-	Tk. Nyuling		○	
	03.01.14	295.4	Tk. Nyuling	73.56	Tk. Nyuling	30.12	Tk. Nyuling	○		
			Others	221.8	-	-	Tk. Nyuling	○		
	03.01.15	272.5	All	272.5	-	-	Petanu		○	
	03.01.16	342.1	All	342.1	-	-	Petanu		○	
Karangasem Bangli Klunkun	03.01.17	257.8	Tk. Petanu	96.89	Tk. Petanu	55.33	Petanu	○		
			Others	160.9	-	-	Petanu	○		
Gyanyar Bangli	03.01.18	48.8	All	48.8	-	-	-			
	03.01.19	102.2	All	102.2	-	-	-			
Nusa Penida	03.01.20	208.5	All	208.5	-	-	Tk. Nyuling		○	

D-2.6 Calculation of River Water Potential by each Sub-basin

(1) Calculation Method for River Water Potential

Natural flow of each river passing in a sub-basin is figured out with the formula shown below and the amount was added altogether to find river water potential by each sub-basin.

<Natural Discharge of Selected River>

Natural Discharge = (Observed Flow – Amount of Water Intake in Upstream)
× All Basin Area ÷ Basin Area at Discharge Observation Point

<Natural Discharge of River by each Sub-basin>

Natural Discharge = Natural Discharge of Selected River
× Ratio of Catchment Area × Ratio of Rainfall

(2) Calculation Result

Calculation result of surface water potential for each sub-basin is shown in

Table-D.7 and Figure-D.10 and calculation process is shown in Table-D.8. These tables and figure also reflect the result of the study in the Phase 1.

The result shows that the surface water potential on depth of runoff basis is 1,104mm/year, which is equivalent to 55% in water balance (see Table-D.6).

Table-D.6 Water Balance

	Elements of Hydrological Cycle	Height(mm)	Volume(mm3)	Percentage
-	Annual rainfall	2,003	11,242	100%
Naturalized Flow case	Evapotranspiration	758	4,256	38%
	River runoff	1,104	6,195	55%
	Groundwater recharge	141	791	7%

Table-D.7 General Overview of Surface Water Potential

	Basin	Area	Discharge				Discharge(10km2 and over)	
			New		Old		New	
		(km2)	(m3/sec)	(million m3)	(m3/sec)	(million m3)	(m3/sec)	(million m3)
Badung	03.01.01	555.64	22.78	718.5	22.86	720.9	17.72	558.8
Tabanan	03.01.02	601.75	29.09	917.4	28.89	911.0	25.93	817.8
	03.01.03	288.34	15.91	501.7	14.58	459.9	14.85	468.2
Jembrana	03.01.04	392.37	12.89	406.5	14.22	448.4	11.93	376.2
	03.01.05	158.92	6.30	198.7	5.15	162.5	6.04	190.5
	03.01.06	228.44	8.82	278.2	6.94	218.8	7.54	237.7
	03.01.07	243.52	7.52	237.2	5.92	186.6	6.21	195.9
Buleleng	03.01.08	367.22	10.43	328.8	7.70	242.7	3.36	105.9
	03.01.09	222.39	9.70	305.8	8.00	252.1	9.06	285.7
	03.01.10	114.24	5.38	169.5	2.96	93.3	4.38	138.2
	03.01.11	243.48	12.15	383.1	7.87	248.1	9.88	311.5
	03.01.12	311.65	8.11	255.7	8.49	267.7	5.40	170.2
Karangasem	03.01.13	357.14	5.22	164.6	9.76	307.8	3.02	95.4
	03.01.14	295.38	4.59	144.7	8.58	270.6	4.59	144.7
	03.01.15	272.53	8.76	276.2	9.89	312.0	8.43	265.9
	03.01.16	342.08	15.09	476.0	14.99	472.7	14.67	462.7
Karangasem Bangli Klunkun	03.01.17	257.78	11.89	374.9	11.80	372.2	11.58	365.3
Gyanyar Bangli	03.01.18	48.84	0.00	0.0	0.00	0.0	0.00	0.0
	03.01.19	102.19	0.00	0.0	0.00	0.0	0.00	0.0
Nusa Penida	03.01.20	208.87	1.83	57.8	3.43	108.0	0.27	8.5
	Total	5,612.8	196.45	6,195.2	192.01	6,055.3	164.9	5,199.0

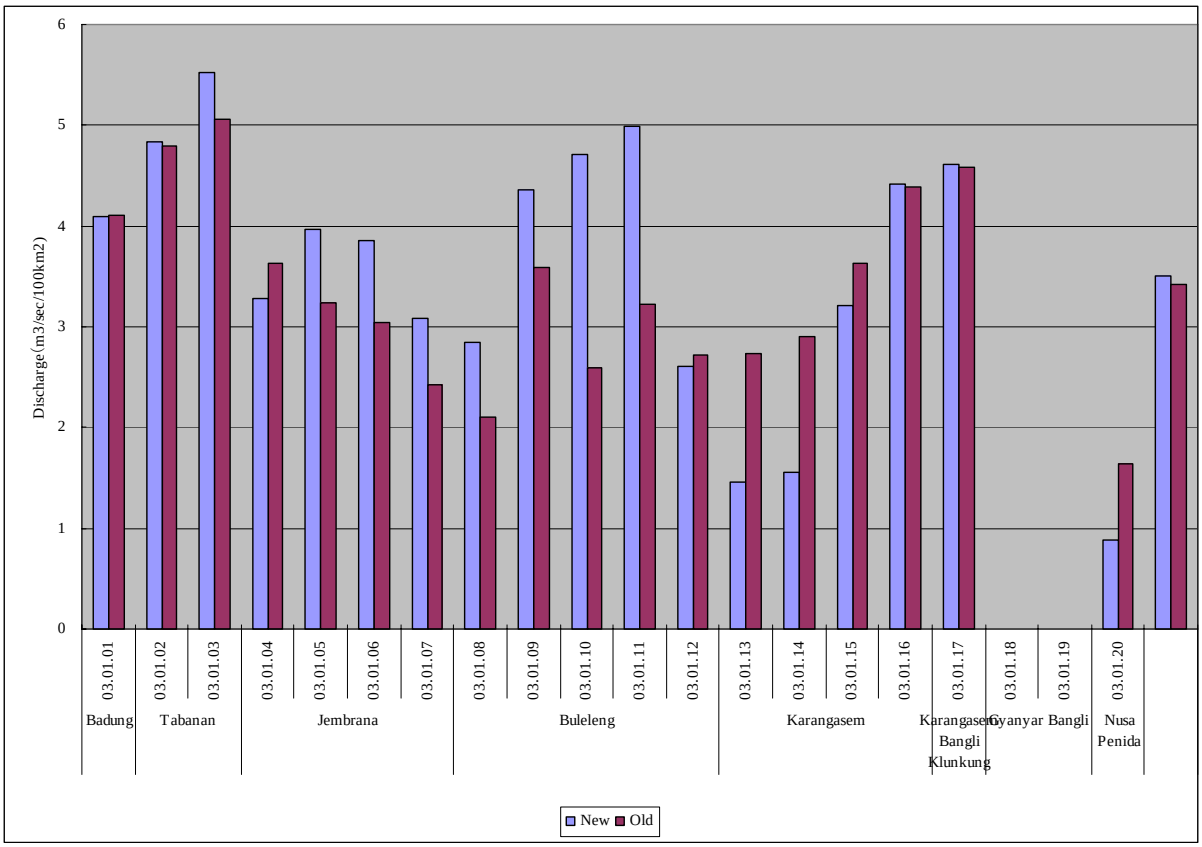


Figure-D.10 Calculation Result of River Water Potential

Table-D.8 Calculation Result of River Water Potential

Basin Average Rainfall and Discharge in Each of Main Basins

No.	Basin	Area (km2)	ID	River	Basin Area (km2)	Basin Average Rainfall (mm)	Mean Discharge New (m3/sec)	Mean Discharge Old (m3/sec)	Referred Key SGS New	Referred Key SGS Old
1	03.01.01	555.6	112	Tk. Ayung	301.9	2,297	13.68	13.82	Petanu	Petanu
			116	Tk. Badung	41.1	1,814	1.47	1.46	Petanu	Petanu
			117	Tk. Mati	40.7	1,873	1.50	1.49	Petanu	Petanu
			201	Tk. Sama	18.0	1,845	0.66	0.65	Petanu	Petanu
			115	Tk. Buaji	11.5	1,811	0.41	0.41	Petanu	Petanu
				Others	142.4	1,802	5.06	5.03	Petanu	Petanu
				(Sub-total)	(555.6)	(2,078)	(22.78)	(22.86)		
2	03.01.02	601.8	122	Tk. Penet	190.4	2,485	9.33	9.27	Petanu	Petanu
			129	Tk. Yeh Ho	170.6	2,280	7.68	7.62	Petanu	Petanu
			125	Tk. Yeh Empas	107.1	2,560	5.41	5.37	Petanu	Petanu
			126	Tk. Yeh Abe	38.8	2,274	1.74	1.73	Petanu	Petanu
			118	Tk. Yeh Poh	20.1	1,850	0.73	0.73	Petanu	Petanu
			127	Tk. Yeh lating	14.6	2,202	0.64	0.63	Petanu	Petanu
			120	Tk. Pangi	11.1	1,860	0.41	0.40	Petanu	Petanu
				Others	49.1	3,261	3.16	3.14	Petanu	Petanu
				(Sub-total)	(601.8)	(2,450)	(29.09)	(28.89)		
3	03.01.03	288.3	139	Tk. Balian	154.7	2,716	11.83	8.23	Balian	Jogading
			133	Tk. Otan	49.4	2,680	1.67	2.59	Otan	Jogading
			132	Tk. Yeh Matan	32.0	2,471	0.99	1.55	Otan	Jogading
			135	Tk. Payan	11.4	2,486	0.36	0.55	Otan	Jogading
				Others	40.8	2,065	1.06	1.65	Otan	Jogading
				(Sub-total)	(288.3)	(2,582)	(15.91)	(14.58)		
4	03.01.04	392.4	150	Tk. Yeh Sumbul	110.3	2,244	3.44	3.80	Satang	Jogading
			147	Tk. Pulukan	54.3	2,534	1.92	2.11	Satang	Jogading
			148	Tk. Medewi	47.1	2,482	1.63	1.79	Satang	Jogading
			149	Tk. Yeh Satang	36.7	2,441	1.25	1.38	Satang	Jogading
			146	Tk. Yeh Lebah	28.1	2,347	0.92	1.01	Satang	Jogading
			145	Tk. Pangyangan	28.0	2,343	0.91	1.01	Satang	Jogading
			143	Tk. Yeh Leh	24.4	2,499	0.85	0.94	Satang	Jogading
			142	Tk. Selabih	18.2	2,321	0.59	0.65	Satang	Jogading
			141	Tk. Bakung	13.4	2,309	0.43	0.48	Satang	Jogading
				Others	32.0	2,161	0.96	1.06	Satang	Jogading
				(Sub-total)	(392.4)	(2,360)	(12.89)	(14.22)		

No.	Basin	Area (km2)	ID	River	Basin Area (km2)	Basin Average Rainfall (mm)	Mean Discharge New (m3/sec)	Mean Discharge Old (m3/sec)	Referred Key SGS New	Referred Key SGS Old
5	03.01.05	158.9	153	Tk. Bilukpoh	91.3	1,989	3.41	2.79	Bilkpoh	Jogading
			151	Tk. Yeh Embang	61.4	2,288	2.63	2.15	Bilkpoh	Jogading
			152	Others	6.3	2,191	0.26	0.21	Bilkpoh	Jogading
				(Sub-total)	(158.9)	(2,112)	(6.30)	(5.15)		
6	03.01.06	228.4	154	Tk. Sowan Perancak	186.5	2,070	7.54	5.93	Jogading	JD
				Others	41.9	1,572	1.29	1.01	Jogading	JD
				(Sub-total)	(228.4)	(1,978)	(8.82)	(6.94)		
7	03.01.07	243.5	157	Tk. Sangianggede	86.7	1,655	2.80	2.20	Jogading	JD
			156	Tk. Aya Barat	61.5	1,773	2.13	1.67	Jogading	JD
			158	Tk. Melaya	44.1	1,489	1.28	1.01	Jogading	JD
				Others	51.2	1,312	1.31	1.03	Jogading	JD
				(Sub-total)	(243.5)	(1,583)	(7.52)	(5.92)		
8	03.01.08	367.2	1	Tk. Banyupoh	37.1	1,450	1.12	0.83	Sabah	JD
			4	Tk. Gerokgak	21.9	1,636	0.75	0.55	Sabah	JD
			162	Tk. Pengumbahan	21.5	1,400	0.63	0.46	Sabah	JD
			6	Tk. Tingatinga	17.3	1,588	0.57	0.42	Sabah	JD
			160	Tk. Teluktrima	10.8	1,315	0.30	0.22	Sabah	JD
				Others	258.6	1,314	7.07	5.22	Sabah	JD
				(Sub-total)	(367.2)	(1,365)	(10.43)	(7.70)		
9	03.01.09	222.4	9	Tk. Saba	132.9	2,390	6.61	5.74	Sabah	D Sowan
			8	Tk. Banyuraras	51.2	1,837	1.96	1.43	Sabah	D Sowan
			7	Tk. Sumaga	15.1	1,588	0.50	0.36	Sabah	D Sowan
				Others	23.3	1,316	0.64	0.47	Sabah	D Sowan
				(Sub-total)	(222.4)	(2,096)	(9.70)	(8.00)		
10	03.01.10	114.2	10	Tk. Mendaum	45.0	1,902	2.37	1.30	Mendaum	D Sowan
			11	Tk. Tampekan	16.6	1,865	0.85	0.47	Mendaum	D Sowan
			15	Tk. Anakan	15.1	1,614	0.67	0.37	Mendaum	D Sowan
			13	Tk. Bengkala	11.2	1,577	0.49	0.27	Mendaum	D Sowan
				Others	26.3	1,368	0.99	0.55	Mendaum	D Sowan
				(Sub-total)	(114.2)	(1,704)	(5.38)	(2.96)		
11	03.01.11	243.5	28	Tk. Sangsit	53.8	2,155	2.88	1.76	Buleleng	D Sowan
			22	Tk. Banyumala	35.6	2,353	2.08	1.27	Buleleng	D Sowan
			23	Tk. Buleleng	30.6	2,331	1.77	1.36	Buleleng	D Sowan
			24	Tk. Buwus	21.4	2,259	1.20	0.74	Buleleng	D Sowan
			26	Tk. Penarukan	14.4	2,933	1.05	0.81	Buleleng	D Sowan
			20	Tk. Bangka	13.8	1,822	0.63	0.38	Buleleng	D Sowan
			17	Tk. Asangan	11.6	871	0.25	0.15	Buleleng	D Sowan
				Others	62.3	1,465	2.27	1.39	Buleleng	D Sowan
				(Sub-total)	(243.5)	(2,005)	(12.15)	(7.87)		
12	03.01.12	311.7	29	Tk. Daya	91.2	2,180	2.88	3.02	D Sowan	D Sowan
			45	Tk. Yehalang	17.6	1,838	0.47	0.49	D Sowan	D Sowan
			47	Tk. Les	16.9	1,658	0.41	0.43	D Sowan	D Sowan
			39	Tk. Munggal	16.4	1,868	0.45	0.47	D Sowan	D Sowan
			46	Tk. Anyar	14.5	1,743	0.37	0.38	D Sowan	D Sowan
			31	Tk. Dalem	11.6	1,466	0.25	0.26	D Sowan	D Sowan
			44	Tk. Desa	11.0	1,822	0.29	0.30	D Sowan	D Sowan
			42	Tk. Buahan	10.7	1,851	0.29	0.30	D Sowan	D Sowan
				Others	121.9	1,533	2.71	2.84	D Sowan	D Sowan
				(Sub-total)	(311.7)	(1,792)	(8.11)	(8.49)		
13	03.01.13	357.1	225	Tk. Sringin	62.2	1,901	0.96	1.80	Nyuiling	D Sowan
			74	Tk. Canggah	44.5	2,054	0.74	1.39	Nyuiling	D Sowan
			73	Tk. Batuniti	18.4	2,125	0.32	0.60	Nyuiling	D Sowan
			76	Tk. Aya	13.6	1,620	0.18	0.33	Nyuiling	D Sowan
			54	Tk. Deling	12.8	1,626	0.17	0.32	Nyuiling	D Sowan
			63	Tk. Batang	11.9	1,812	0.18	0.33	Nyuiling	D Sowan
			56	Tk. Timbul	11.3	1,649	0.15	0.28	Nyuiling	D Sowan
			66	Tk. Peninggungan	11.2	1,862	0.17	0.32	Nyuiling	D Sowan
			68	Tk. Maong	10.9	1,803	0.16	0.30	Nyuiling	D Sowan
				Others	160.5	1,683	2.19	4.11	Nyuiling	D Sowan
				(Sub-total)	(357.1)	(1,798)	(5.22)	(9.76)		
14	03.01.14	295.4	86	Tk. Nyuling	73.6	1,975	1.18	2.21	Nyuiling	D Sowan
			90	Tk. Bulu	33.3	2,069	0.56	1.05	Nyuiling	D Sowan
			96	Tk. Betel	24.0	1,897	0.37	0.69	Nyuiling	D Sowan
			228	Tk. Ringuang	16.3	2,418	0.32	0.60	Nyuiling	D Sowan
			87	Tk. Bangka	14.0	2,052	0.23	0.44	Nyuiling	D Sowan
			92	Tk. Mengereng	11.4	2,100	0.19	0.36	Nyuiling	D Sowan
			88	Tk. Pedih	11.0	1,923	0.17	0.32	Nyuiling	D Sowan
				Others	111.8	1,713	1.56	2.91	Nyuiling	D Sowan
				(Sub-total)	(295.4)	(1,911)	(4.59)	(8.58)		
15	03.01.15	272.5	98	Tk. Unda	232.2	1,626	7.45	8.59	Petanu	Petanu
			97	Tk. Bugbugan	18.6	1,679	0.62	0.61	Petanu	Petanu
			230	Tk. Mati	11.4	1,629	0.37	0.36	Petanu	Petanu
				Others	10.3	1,617	0.33	0.33	Petanu	Petanu
				(Sub-total)	(272.5)	(1,629)	(8.76)	(9.89)		

No.	Basin	Area (km2)	ID	River	Basin Area (km2)	Basin Average Rainfall (mm)	Mean Discharge New (m3/sec)	Mean Discharge Old (m3/sec)	Referred Key SGS New	Referred Key SGS Old
16	03.01.16	342.1	104	Tk. Sangsang	84.1	2,347	3.89	3.87	Petanu	Petanu
			107	Tk. Kutul	66.4	2,314	3.03	3.01	Petanu	Petanu
			102	Tk. Bubuh	59.6	2,248	2.64	2.62	Petanu	Petanu
			103	Tk. Melangit	52.6	2,278	2.36	2.35	Petanu	Petanu
			101	Tk. Jinah	51.8	2,205	2.25	2.24	Petanu	Petanu
			105	Tk. Pakerisan	14.4	1,714	0.49	0.48	Petanu	Petanu
				Others	13.2	1,626	0.42	0.42	Petanu	Petanu
				(Sub-total)	(342.1)	(2,237)	(15.09)	(14.99)		
17	03.01.17	257.8	109	Tk. Oos	120.0	2,496	5.91	5.87	Petanu	Petanu
			108	Tk. Petanu	96.9	2,413	4.61	4.58	Petanu	Petanu
			111	Tk. Singapadu	31.6	1,709	1.07	1.06	Petanu	Petanu
				Others	9.3	1,642	0.30	0.30	Petanu	Petanu
				(Sub-total)	(257.8)	(2,337)	(11.89)	(11.80)		
18	03.01.18	48.8	231	Danau Buyan*	24.3	2,733	-	-	-	-
			232	Danau Beratan*	13.2	2,702	-	-	-	-
			233	Danau Tamblingan*	11.3	2,958	-	-	-	-
				(Sub-total)	(48.8)	(2,700)	(0.00)	(0.00)		
19	03.01.19	102.2	234	Danau Batur*	102.2	1,809	z-	-	-	-
				(Sub-total)	(102.2)	(1,809)	(0.00)	(0.00)		
20	03.01.20	208.9	235	Tk. Penida	18.7	1,125	0.17	0.32	Nyuiling	D Sowan
			236	Tk. Cemlagi	12.3	998	0.10	0.19	Nyuiling	D Sowan
				Others	177.9	1,080	1.56	2.92	Nyuiling	D Sowan
				(Sub-total)	(208.9)	(1,079)	(1.83)	(3.43)		
	Total				5,612.8		196.45	192.01		

D-3 WATER USE CALCULATION OF AYUNG DAM

This section shows the reasons for deciding; 1) the irrigation plan for Ayung River with the aim of supplying water and improving agricultural productivity within Denpasar area, and 2) a target value for required capacity of Ayung Dam.

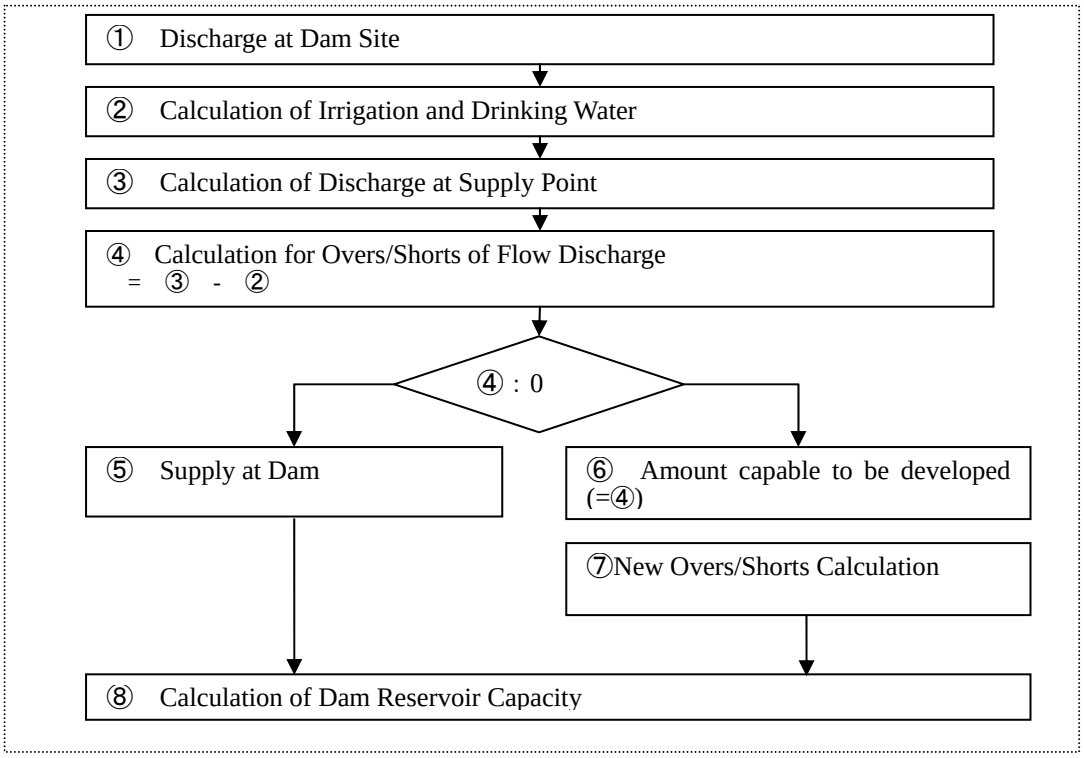
D-3.1 Methodology for Water Resources Development in Ayung River

Basic Policy for the development of water resources depending on Ayung dam reservoir is summarized as follows:

- For the municipal water supply, to cope with increasing of demand targeted 2025 in Denpsar urban area, water of 1,800 l/s shall be developed. Water supply plan was aimed at probability with 1 year for ten yeas during dry season.
- For the irrigation water supply, to keep up current cropping pattern in irrigated area, unspecified water shall be developed. Water supply plan was aimed at probability 1 year for 5 yeas. Cultivation area of paddy from single cropping to double cropping shall be expanded even during the drought season for the purpose of income increase.
- For the electric generation, by using the differential head of water stored in Ayung reservoir, electric power of 7,900 Kw shall be generated for the purpose of contribution for electric demand in Bali.
- For the environmental maintenance water of river, by outflow discharge stored by Ayung dam, existing habitat for fauna and flora as well as natural landscape shall be conserved or improved. In the river flowing to Denpasar City, water quality shall be improved due to the water conveyance of purification water developed by dam reservoir

D-3.2 Water Use Calculation Model

Water use calculation on capacity for municipal water and unspecified water such as river maintenance water and purification shall be proceeded in accordance with calculation flow as shown below:


① Discharge at Dam Site
② Calculation of Irrigation and Drinking Water
③ Calculation of Discharge at Supply Point
④ Calculation for Overs/Shorts of Flow Discharge
= ③ - ②
④ : 0
⑤ Supply at Dam
⑥ Amount capable to be developed (=④)
⑦New Overs/Shorts Calculation
⑧ Calculation of Dam Reservoir Capacity

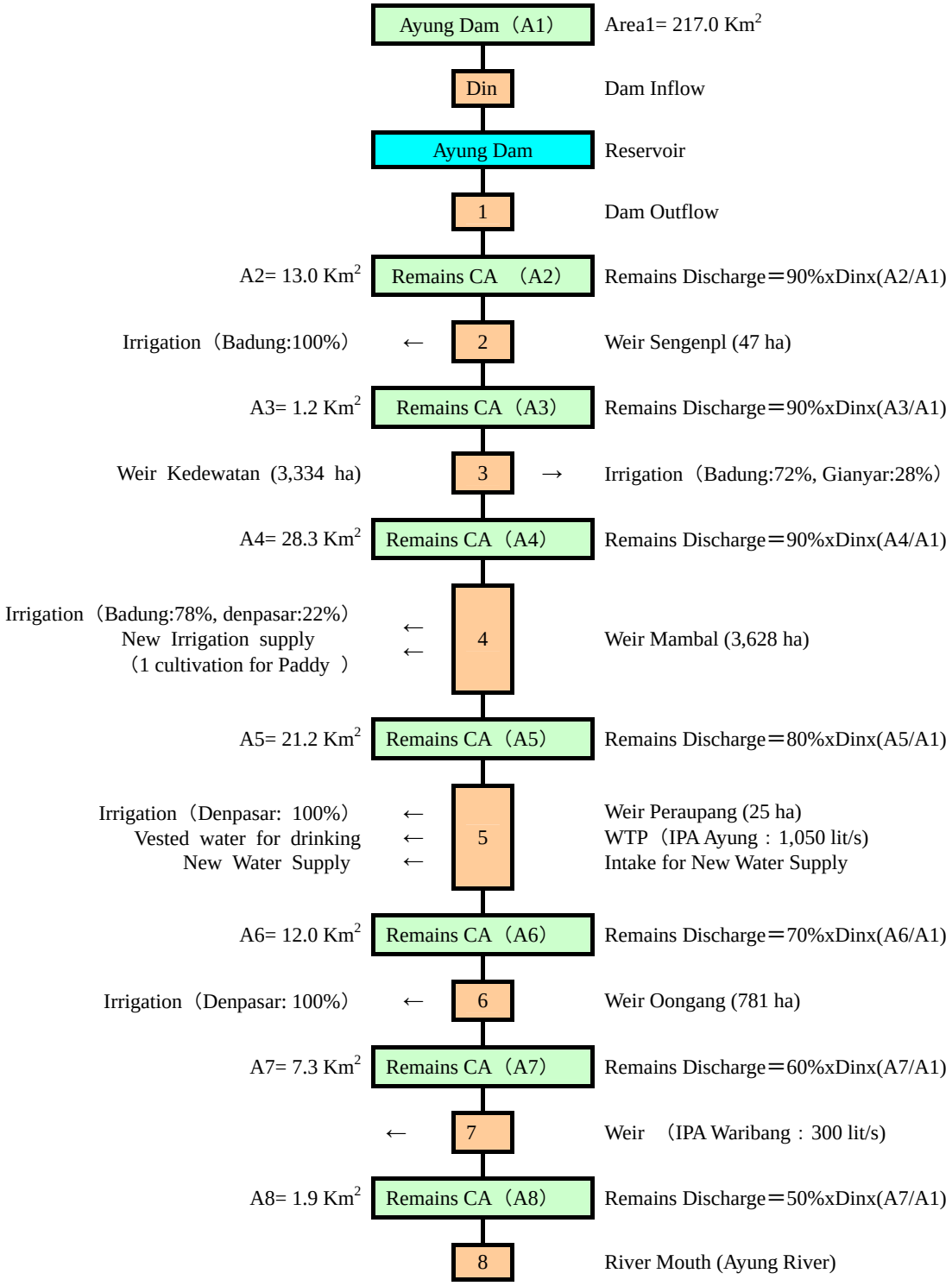


Figure-D.11 Requirement Capacity Calculation Flow for Municipal Water and Unspecified Water

D-3.3 Conditions for Calculation

Conditions for capacity calculation are shown in Table-D.9 and Table-D.10.

Table-D.9 Conditions for Calculation

Items	Contents	Remarks
Duration	1972～1986	15 years
Discharge Unit	5 days discharge	
Required Intake Rate for Irrigation	Unit Intake Rate per Ha × Area	Increase/decrease of Cultivation Time and Irrigated Area
Intake Rate for Current Drinking Water	1,350 lit/sec	Water Treatment Plant IPA AYUNG ;1,050 lit/s IPA WARIBANG; 300 lit/s
New Intake Rate for Municipal Water	1,800 lit/sec	Target Year :2015 (at Praupan)

Table-D.10 Calculation Conditions for Amount of Irrigation Water

Prefectural unit	Item		Numerical value		Remarks
			Present condition (2003)	Plan (2015)	
Badung	The irrigation method	1) Paddy×3	0.465	0.465	
		2) Paddy x 2 + Palawija x 1	0.389	0.393	
		3) Paddy x 1 + Palawija x 2	0.004	0.000	Double-cropping conversion
		4) Paddy x 2	0.098	0.107	
		5) Paddy x 1 + Palawija x 1	0.009	0.000	Double-cropping conversion
		6) Palawija x 2	0.015	0.015	
		7) Paddy x 1	0.020	0.020	
		Total	1.000	1.000	
	Irrigation area	1) Prefectural unit irrigation area (ha)	10,334	9,124	
		2) A ratio same as the above	1.000	0.883	
		3) Supply unit irrigation area (ha)	5,194	4,586	
		・ Sengenmpel	47	41	
		・ Mambal	5,147	4,544	
Gianyar	The irrigation method	1) Paddy×3	0.304	0.304	
		2) Paddy x 2 + Palawija x 1	0.074	0.095	
		3) Paddy x 1 + Palawija x 2	0.021	0.000	Double-cropping conversion
		4) Paddy x 2	0.471	0.495	
		5) Paddy x 1 + Palawija x 1	0.024	0.000	Double-cropping conversion
		6) Palawija x 2	0.038	0.038	
		7) Paddy x 1	0.068	0.068	
		Total	1.000	1.000	
	Irrigation area	1) Prefectural unit irrigation area (ha)	14,937	14,529	
		2) A ratio same as the above	1.000	0.973	
		3) Supply unit irrigation area (ha)	3,334	3,243	
		・ Kedewatan	3,334	3,243	
Denpasar	The irrigation method	1) Paddy×3	0.086	0.086	
		2) Paddy x 2 + Palawija x 1	0.274	0.452	
		3) Paddy x 1 + Palawija x 2	0.178	0.000	Double-cropping conversion
		4) Paddy x 2	0.153	0.318	
		5) Paddy x 1 + Palawija x 1	0.165	0.000	Double-cropping conversion
		6) Palawija x 2	0.102	0.102	
		7) Paddy x 1	0.042	0.042	
		Total	1.000	1.000	
	Irrigation area	1) Prefectural unit irrigation area (ha)	2,856	2,428	
		2) A ratio same as the above	1.000	0.850	
		3) Supply unit irrigation area (ha)	1,014	862	
		・ Peraupan	40	34	
		・ Oongan	974	828	

D-3.4 Calculation for Irrigation Water Volume

Based on the conditions mentioned above, existing/design amounts of irrigation water by season are calculated and shown in Figure-D.13. Also the calculation process for unit of water is shown in

Table-D.11 to Table-D.13.

The results are as follows:

(1) Since reduction of irrigation area was considered for calculation, any big difference was not found between the existing and design data.

(2) The value of irrigation water reaches to its peak, roughly within the range of 8.5m3/s - 9.5m3/s, from late in April to early in June.

(3) The value of the flow in Ayung River starts increasing in December when rainy season begins and reaches to its peak between January and April. Assuming the irrigation water is used effectively depending on the variation of river flow, variation patterns of irrigation water discharge is inconsistent with that of the river water discharge (See Figure-D.13).

(4) The calculation method used in the region is adopted for calculating the amount of irrigation water because of discussions with the authorities in Bali, as well as the following reasons.

- Intake/drainage system of Ayung River is elaborated and complicated but further detailed observational study has not yet operated.
- Since at least 3 years of consultation period shall be required to find design values, it is quite difficult to carry out such observational studies during this project.
- This method has been adopted in various irrigation projects in Bali, so it should be applicable to the new calculation as well.
- The maximum value of the irrigation water stays between the values at Ayung Dam and its river mouth. Actually the water is used within the amount of the discharge; therefore the number is logical.

(5) The actual condition, aside from the planning, should be understood in view of the accountability to Subak. Considering the typical water supply system of Subak excerpted from a document, as shown in Figure-D.12, activities including modeling of water system may be required.

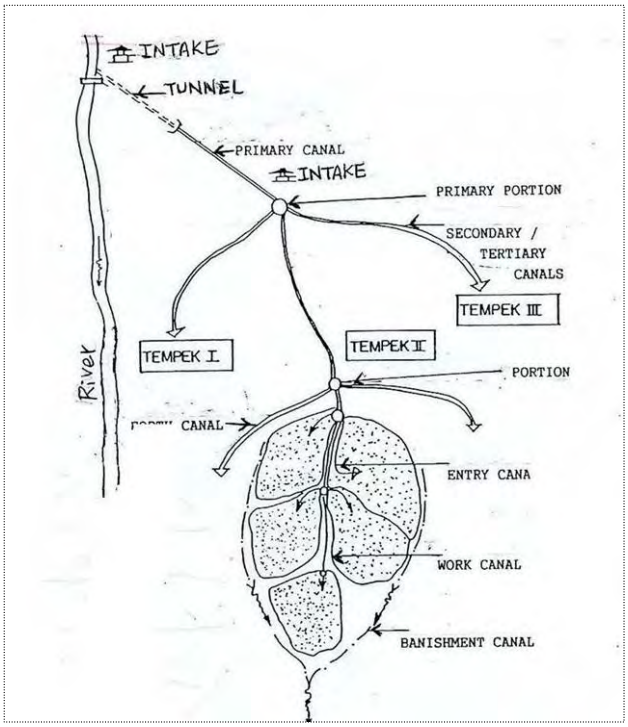


Figure-D.12 Concept of Subak Water Supply System

Classification	Contents	District	Area (ha)	Transition of the area according to prefectural unit			Land Preparation	Water Layer Replacement	Overall Efficiency	unit	Jan		Feb		Mar		Apr		May		Jun	
				2003	2015	2025	(mm/day)	(mm/day)			I	II	I	II	I	II	I	II	I	II	I	II
											15	16	15	13	15	16	15	15	15	16	15	15
Present condition	Present condition	Badung	5,194	10,334	9,124	8,704	100	25	0.6	L/s/ha	0.36	0.38	0.46	0.06	0.10	0.31	0.77	1.07	1.19	1.20	1.18	0.53
		Gianyar	3,334	14,937	14,529	14,377	100	25	0.6	L/s/ha	0.00	0.00	0.03	0.02	0.22	0.10	0.43	0.74	0.86	0.95	0.86	0.60
		Denpasar	1,014	2,856	2,428	2,283	100	25	0.6	L/s/ha	0.00	0.01	0.21	0.09	0.52	0.41	0.42	0.61	0.68	0.72	0.68	0.41
		Total	9,542							L/s	1,870	1,982	2,666	454	1,690	2,288	5,786	8,538	9,620	10,006	9,568	5,098
Plan	Semiannual crop Area future (2015)	Badung	4,586	10,334	9,124	8,704	100	25	0.6	L/s/ha	0.36	0.38	0.46	0.06	0.10	0.31	0.77	1.08	1.21	1.22	1.19	0.54
		Gianyar	3,243	14,937	14,529	14,377	100	25	0.6	L/s/ha	0.00	0.00	0.03	0.02	0.22	0.11	0.45	0.78	0.90	1.00	0.90	0.63
		Denpasar	862	2,856	2,428	2,283	100	25	0.6	L/s/ha	0.00	0.01	0.21	0.09	0.57	0.55	0.66	0.99	1.12	1.20	1.14	0.73
		Total	8,691							L/s	1,651	1,751	2,388	418	1,663	2,252	5,559	8,336	9,433	9,872	9,359	5,149

Classification	Contents	District	Area (ha)	Transition of the area according to prefectural unit			Land Preparation	Water Layer Replacement	Overall Efficiency	unit	Jul		Aug		Sep		Oct		Nov		Dec	
				2003	2015	2025	(mm/day)	(mm/day)			I	II	I	II	I	II	I	II	I	II	I	II
											15	16	15	16	15	15	15	16	15	15	15	16
Present condition	Present condition	Badung	5,194	10,334	9,124	8,704	100	25	0.6	L/s/ha	0.30	0.47	0.53	0.67	0.70	0.68	0.67	0.27	0.03	0.47	0.36	0.66
		Gianyar	3,334	14,937	14,529	14,377	100	25	0.6	L/s/ha	0.55	0.37	0.31	0.38	0.36	0.35	0.30	0.09	0.00	0.11	0.09	0.29
		Denpasar	1,014	2,856	2,428	2,283	100	25	0.6	L/s/ha	0.23	0.16	0.10	0.13	0.13	0.13	0.13	0.06	0.20	0.48	0.50	0.85
		Total	9,542							L/s	3,585	3,809	3,870	4,856	4,945	4,808	4,590	1,753	324	3,212	2,590	5,110
Plan	Semiannual crop Area future (2015)	Badung	4,586	10,334	9,124	8,704	100	25	0.6	L/s/ha	0.31	0.47	0.53	0.67	0.70	0.68	0.67	0.27	0.03	0.47	0.36	0.66
		Gianyar	3,243	14,937	14,529	14,377	100	25	0.6	L/s/ha	0.57	0.38	0.31	0.38	0.36	0.35	0.30	0.09	0.00	0.11	0.09	0.29
		Denpasar	862	2,856	2,428	2,283	100	25	0.6	L/s/ha	0.44	0.25	0.10	0.13	0.13	0.13	0.13	0.06	0.20	0.48	0.50	0.85
		Total	8,691							L/s	3,649	3,603	3,522	4,417	4,490	4,365	4,157	1,582	310	2,926	2,374	4,700

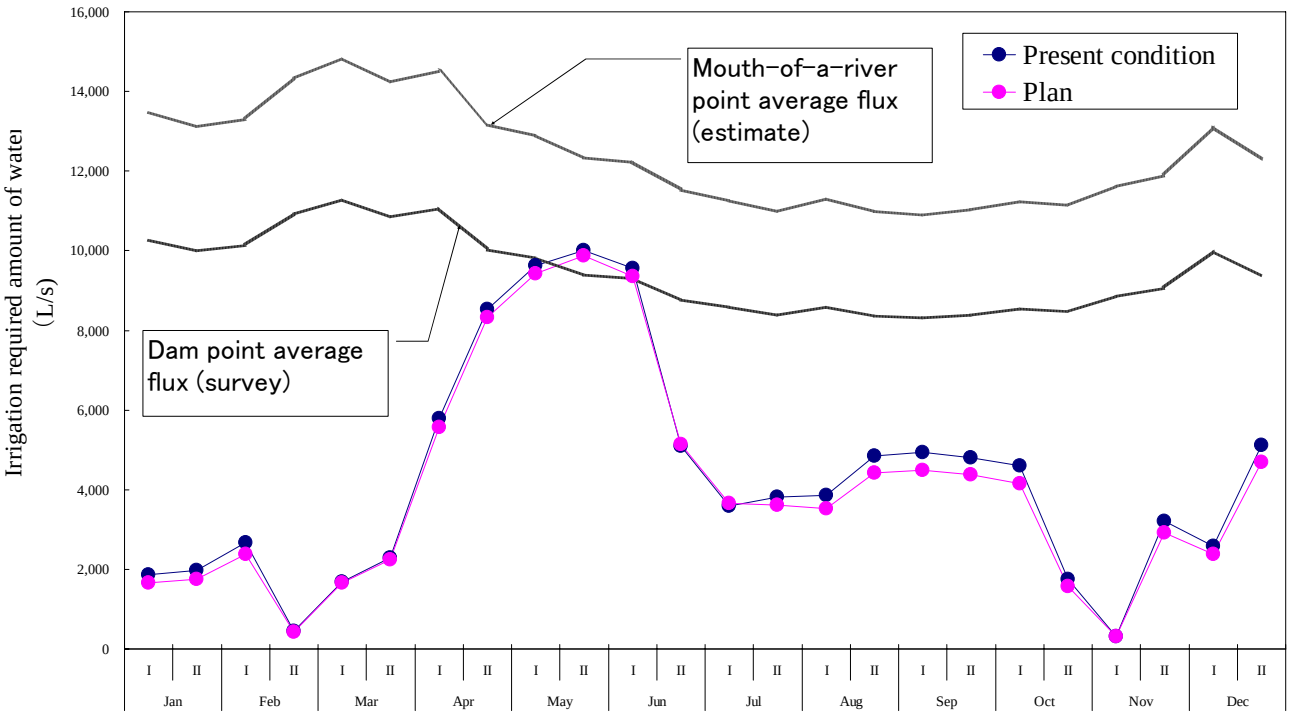


Figure-D.13 Amount of Water supply for Irrigation (Present & Plan)

Table-D.11 Calculation of Unit Area Required Amount of Water (Denpasar)

Denpasar

	Dec I	Dec II	Jan I	Jan II	Feb I	Feb II	Mar I	Mar II	Apr I	Apr II	May I	May II	Jun I	Jun II	Jul I	Jul II	Aug I	Aug II	Sep I	Sep II	Oct I	Oct II	Nov I	Nov II
1. Crop Coefficient																								
1) Paddy x 3	1.10	1.10	1.05	1.05	0.95		P	P	1.10	1.10	1.05	1.05	0.95		P	P	1.10	1.10	1.05	1.05	0.95		P	P
	P	1.10	1.10	1.05	1.05	0.95		P	P	1.10	1.10	1.05	1.05	0.95		P	P	1.10	1.10	1.05	1.05	0.95		P
average	1.10	1.10	1.08	1.05	1.00	0.95			1.10	1.10	1.08	1.05	1.00	0.95			1.10	1.10	1.08	1.05	1.00	0.95		
2) Paddy x 2 + Palawija x 1	1.10	1.10	1.05	1.05	0.95		P	P	1.10	1.10	1.05	1.05	0.95			0.50	0.68	0.86	1.05	1.05	0.95		P	P
	P	1.10	1.10	1.05	1.05	0.95		P	P	1.10	1.10	1.05	1.05	0.95			0.50	0.68	0.86	1.05	1.05	0.95		P
average	1.10	1.10	1.08	1.05	1.00	0.95			1.10	1.10	1.08	1.05	1.00	0.95		0.00	0.00	0.00	0.00	0.00	0.00	0.00		
3) Paddy x 1 + Palawija x 2	1.10	1.10	1.05	1.05	0.95		0.50	0.68	0.86	1.05	1.05	0.95			0.50	0.68	0.86	1.05	1.05	0.95			P	P
	P	1.10	1.10	1.05	1.05	0.95		0.50	0.68	0.86	1.05	1.05	0.95			0.50	0.68	0.86	1.05	1.05	0.95			P
average	1.10	1.10	1.08	1.05	1.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00			
4) Paddy x 2	P	P	1.10	1.10	1.05	1.05	0.95		P	P	1.10	1.10	1.05	1.05	0.95									
		P	P	1.10	1.10	1.05	1.05	0.95		P	P	1.10	1.10	1.05	1.05	0.95								
average			1.10	1.10	1.08	1.05	1.00	0.95			1.10	1.10	1.08	1.05	1.00	0.95								
5) Paddy x 1 + Palawija x 1	P	P	1.10	1.10	1.05	1.05	0.95		0.50	0.68	0.86	1.05	1.05	0.95										
		P	P	1.10	1.10	1.05	1.05	0.95		0.50	0.68	0.86	1.05	1.05	0.95									
average			1.10	1.10	1.08	1.05	1.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00									
6) Palawija x 2	0.50	0.68	0.86	1.05	1.05	0.95			0.50	0.68	0.86	1.05	1.05	0.95										
		0.50	0.68	0.86	1.05	1.05	0.95			0.50	0.68	0.86	1.05	1.05	0.95									
average	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00									
7) Paddy x 1	P	P	1.10	1.10	1.05	1.05	0.95																	
		P	P	1.10	1.10	1.05	1.05	0.95																
average			1.10	1.10	1.08	1.05	1.00	0.95																
2. Cropped Area Ratio																								
1) Paddy	0.5	1	1	1	1	0.5			0.5	1	1	1	1	0.5			0.5	1	1	1	1	0.5		
2) Paddy x 2 + Palawija x 1	0.5	1	1	1	1	0.5			0.5	1	1	1	1	0.5		0.5	1	1	1	1	1	0.5		
3) Paddy x 1 + Palawija x 2	0.5	1	1	1	1	0.5	0.5	1	1	1	1	1	0.5		0.5	1	1	1	1	1	0.5			
4) Paddy x 2			0.5	1	1	1	1	0.5			0.5	1	1	1	1	0.5								
5) Paddy x 1 + Palawija x 1			0.5	1	1	1	1	0.5	0.5	1	1	1	1	1	0.5									
6) Palawija x 2	0.5	1	1	1	1	1	0.5		0.5	1	1	1	1	1	0.5									
7) Paddy x 1			0.5	1	1	1	1	0.5																
3. ETo (mm/day) BMG-1	4.40	4.40	4.16	4.16	4.31	4.31	4.55	4.55	4.36	4.36	4.23	4.23	3.98	3.98	3.99	3.99	4.53	4.53	4.82	4.82	5.07	5.07	4.54	4.54
4. Crop Water Requirement (mm/day)																								
1) Paddy	2.42	4.84	4.49	4.37	4.31	2.05	0.00	0.00	2.40	4.80	4.57	4.44	3.98	1.89	0.00	0.00	2.49	4.98	5.21	5.06	5.07	2.41	0.00	0.00
2) Paddy x 2 + Palawija x 1	2.42	4.84	4.49	4.37	4.31	2.05	0.00	0.00	2.40	4.80	4.57	4.44	3.98	1.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3) Paddy x 1 + Palawija x 2	2.42	4.84	4.49	4.37	4.31	2.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4) Paddy x 2	0.00	0.00	2.29	4.58	4.65	4.53	4.55	2.16	0.00	0.00	2.33	4.65	4.30	4.18	3.99	1.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5) Paddy x 1 + Palawija x 1	0.00	0.00	2.29	4.58	4.65	4.53	4.55	2.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6) Palawija x 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7) Paddy x 1	0.00	0.00	2.29	4.58	4.65	4.53	4.55	2.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5. Effective Rainfall (mm/day) No.445	1.81	1.81	7.34	7.34	6.05	6.05	1.29	1.29	0.79	0.79	0.07	0.07	0.00	0.00	0.25	0.25	0.00	0.00	0.00	0.00	0.09	0.09	0.72	0.72
1) Paddy	1.81	1.81	7.34	7.34	6.05	6.05	1.29	1.29	0.79	0.79	0.07	0.07	0.00	0.00	0.25	0.25	0.00	0.00	0.00	0.00	0.09	0.09	0.72	0.72
2) Paddy x 2 + Palawija x 1	1.81	1.81	7.34	7.34	6.05	6.05	1.29	1.29	0.79	0.79	0.07	0.07	0.00	0.00	0.25	0.25	0.00	0.00	0.00	0.00	0.09	0.09	0.72	0.72
3) Paddy x 1 + Palawija x 2	1.81	1.81	7.34	7.34	6.05	6.05	1.29	1.29	0.79	0.79	0.07	0.07	0.00	0.00	0.25	0.25	0.00	0.00	0.00	0.00	0.09	0.09	0.72	0.72
4) Paddy x 2	1.81	1.81	7.34	7.34	6.05	6.05	1.29	1.29	0.79	0.79	0.07	0.07	0.00	0.00	0.25	0.25	0.00	0.00	0.00	0.00	0.09	0.09	0.72	0.72
5) Paddy x 1 + Palawija x 1	1.81	1.81	7.34	7.34	6.05	6.05	1.29	1.29	0.79	0.79	0.07	0.07	0.00	0.00	0.25	0.25	0.00	0.00	0.00	0.00	0.09	0.09	0.72	0.72
6) Palawija x 2	1.81	1.81	7.34	7.34	6.05	6.05	1.29	1.29	0.79	0.79	0.07	0.07	0.00	0.00	0.25	0.25	0.00	0.00	0.00	0.00	0.09	0.09	0.72	0.72
7) Paddy x 1	1.81	1.81	7.34	7.34	6.05	6.05	1.29	1.29	0.79	0.79	0.07	0.07	0.00	0.00	0.25	0.25	0.00	0.00	0.00	0.00	0.09	0.09	0.72	0.72
6. Land Preparation (mm/day)																								
1) Paddy	1.67						1.67	3.33	1.67						1.67	3.33	1.67						1.67	3.33
2) Paddy x 2 + Palawija x 1	1.67						1.67	3.33	1.67														1.67	3.33
3) Paddy x 1 + Palawija x 2	1.67																						1.67	3.33
4) Paddy x 2	1.67	3.33	1.67						1.67	3.33	1.67													
5) Paddy x 1 + Palawija x 1	1.67	3.33	1.67																					
6) Palawija x 2																								
7) Paddy x 1	1.67	3.33	1.67																					
7. Water Layer Replacement (mm/day)																								
1) Paddy		0.83	0.83	0.83	0.83					0.83	0.83	0.83	0.83					0.83	0.83	0.83	0.83			
2) Paddy x 2 + Palawija x 1		0.83	0.83	0.83	0.83					0.83	0.83	0.83	0.83											
3) Paddy x 1 + Palawija x 2		0.83	0.83	0.83	0.83																			
4) Paddy x 2				0.83	0.83	0.83	0.83					0.83	0.83	0.83	0.83									
5) Paddy x 1 + Palawija x 1				0.83	0.83	0.83	0.83																	
6) Palawija x 2																								
7) Paddy x 1				0.83	0.83	0.83	0.83																	
8. Seepage Loss (1mm/day)																								
1) Paddy	2	2	2	2	2	1	1	2	2	2	2	2	2	1	1	2	2	2	2	2	2	1	1	2
2) Paddy x 2 + Palawija x 1	2	2	2	2	2	1	1	2	2	2	2	2	2	1									1	2
3) Paddy x 1 + Palawija x 2	2	2	2	2	2	1																	1	2
4) Paddy x 2	1	2	2	2	2	2	2	1	1	2	2	2	2	2	2	1								
5) Paddy x 1 + Palawija x 1	1	2	2	2	2	2	2	1																
6) Palawija x 2																								
7) Paddy x 1	1	2	2	2	2	2	2	1																
9. Net Water Requirement by Cropping Pattern (mm/day)																								
1) Paddy	4.28	5.86	0.00	0.00	1.09	0.00	1.38	4.04	5.28	6.84	7.33	7.20	6.81	2.89	2.42	5.08	6.16	7.81	8.04	7.89	7.81	3.32	1.95	4.61
2) Paddy x 2 + Palawija x 1	4.28	5.86	0.00	0.00	1.09	0.00	1.38	4.04	5.28	6.84	7.33	7.20	6.81	2.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.95	4.61
3) Paddy x 1 + Palawija x 2	4.28	5.86	0.00	0.00	1.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.95	4.61
4) Paddy x 2	0.86	3.52	0.00	0.07	1.43	1.31	6.09	1.87	1.88	4.54	5.93	7.41	7.13	7.01	6.57	2.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5) Paddy x 1 + Palawija x 1	0.86	3.52	0.00	0.07	1.43	1.31	6.09	1.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6) Palawija x 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7) Paddy x 1	0.86	3.52	0.00	0.07	1.43	1.31	6.09	1.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10. Unit Irrigation Water Requirement by Cropping Pattern (mm/day) Overall Efficiency =50%																								
1) Paddy	7.13	9.77	0.00	0.00	1.82	0.00	2.30	6.73	8.80	11.40	12.22	12.00	11.35	4.82	4.03	8.47	10.27	13.02	13.40	13.15	13.02	5.53	3.25	7.68
2) Paddy x 2 + Palawija x 1	7.13	9.77	0.00	0.00	1.82	0.00	2.30	6.73	8.80	11.40	12.22	12.00	11.35	4.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.25	7.68
3) Paddy x 1 + Palawija x 2	7.13	9.77	0.00	0.00	1.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.25	7.68
4) Paddy x 2	1.43	5.87	0.00	0.12	2.38	2.18	10.15	3.12	3.13	7.57	9.88	12.35	11.88	11.68	10.95	4.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5) Paddy x 1 + Palawija x 1	1.43	5.87	0.00	0.12	2.38	2.18	10.15	3.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6) Palawija x 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7) Paddy x 1	1.43	5.87	0.00	0.12	2.38	2.18	10.15	3.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11. Unit Irrigation Water Requirement by Regency = Ratio of Cropping Pattern x Unit Irrigation Water Requirement by Cropping Pattern (mm/day)																								
0.086 1) Paddy	0.61	0.84	0.00	0.00	0.16	0.00	0.20	0.58	0.76	0.98	1.05	1.03	0.98	0.41	0.35	0.73	0.88	1.12	1.15	1.13	1.12	0.48	0.28	0.66	15.50
0.452 2) Paddy x 2 + Palawija x 1	3.22	4.42	0.00	0.00	0.82	0.00	1.04	3.04	3.98	5.15	5.52	5.42	5.13	2.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.47	3.47	44.86
0.000 3) Paddy x 1 + Palawija x 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.318 4) Paddy x 2	0.45	1.87	0.00	0.04	0.76	0.69	3.23	0.99	1.00	2.41	3.14	3.93	3.78	3.71	3.48	1.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.89
0.000 5) Paddy x 1 + Palawija x 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.102 6) Palawija x 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.042 7) Paddy x 1	0.06	0.25	0.00	0.01	0.10	0.09	0.43	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.07
1.000																								
Total (mm/day)	4.34	7.38	0.00	0.05	1.84	0.78	4.90	4.74	5.74	8.54	9.71	10.38	9.89	6.30	3.83	2.14	0.88	1.12	1.15	1.13	1.12	0.48	1.75	4.13	
Total (liter/sec/ha)	0.50	0.85	0.00	0.01	0.21	0.09	0.57	0.55	0.66	0.99	1.12	1.20	1.14	0.73	0.44	0.25	0.10	0.13	0.13	0.13	0.13	0.06	0.20	0.48	

12. Unit Irrigation Water Requirement by Regency (liter/sec/ha)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average (liter/sec/ha)	0.01	0.15	0.56	0.83	1.16	0.94	0.35	0.12	0.13	0.10	0.34	0.68

Note
P : Land Preparation
ETo : Reference Crop Evapotranspiration
Irrigation is applied to only paddy culture.

	Jan I	Jan II	Feb I	Feb II	Mar I	Mar II	Apr I	Apr II	May I	May II	Jun I	Jun II	Jul I	Jul II	Aug I	Aug II	Sep I	Sep II	Oct I	Oct II	Nov I	Nov II	Dec I	Dec II
Total (liter/sec/ha)	0.00	0.01	0.21	0.09	0.57	0.55	0.66	0.99	1.12	1.20	1.14	0.73	0.44	0.25	0.10	0.13	0.13	0.13	0.13	0.06	0.20	0.48	0.50	0.85

Land Preparation (mm/day)	100
Water Layer Replacement (mm/day)	25
Overall Efficiency	0.6

Table-D.12 Calculation of Unit Area Required Amount of Water（Badung）

Badung Regency

	Dec I	Dec II	Jan I	Jan II	Feb I	Feb II	Mar I	Mar II	Apr I	Apr II	May I	May II	Jun I	Jun II	Jul I	Jul II	Aug I	Aug II	Sep I	Sep II	Oct I	Oct II	Nov I	Nov II
1. Crop Coefficient																								
1) Paddy x 3	1.10	1.10	1.05	1.05	0.95		P	P	1.10	1.10	1.05	1.05	0.95		P	P	1.10	1.10	1.05	1.05	0.95		P	P
	P	1.10	1.10	1.05	1.05	0.95		P	P	1.10	1.10	1.05	1.05	0.95		P	P	1.10	1.10	1.05	1.05	0.95		P
average	1.10	1.10	1.08	1.05	1.00	0.95			1.10	1.10	1.08	1.05	1.00	0.95			1.10	1.10	1.08	1.05	1.00	0.95		
2) Paddy x 2 + Palawija x 1	1.10	1.10	1.05	1.05	0.95		P	P	1.10	1.10	1.05	1.05	0.95			0.50	0.68	0.86	1.05	1.05	0.95		P	P
	P	1.10	1.10	1.05	1.05	0.95		P	P	1.10	1.10	1.05	1.05	0.95			0.50	0.68	0.86	1.05	1.05	0.95		P
average	1.10	1.10	1.08	1.05	1.00	0.95			1.10	1.10	1.08	1.05	1.00	0.95		0.00	0.00	0.00	0.00	0.00	0.00	0.00		
3) Paddy x 1 + Palawija x 2	1.10	1.10	1.05	1.05	0.95		0.50	0.68	0.86	1.05	1.05	0.95			0.50	0.68	0.86	1.05	1.05	0.95			P	P
	P	1.10	1.10	1.05	1.05	0.95		0.50	0.68	0.86	1.05	1.05	0.95			0.50	0.68	0.86	1.05	1.05	0.95			P
average	1.10	1.10	1.08	1.05	1.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00			
4) Paddy x 2	P	P	1.10	1.10	1.05	1.05	0.95		P	P	1.10	1.10	1.05	1.05	0.95									
		P	P	1.10	1.10	1.05	1.05	0.95		P	P	1.10	1.10	1.05	1.05	0.95								
average			1.10	1.10	1.08	1.05	1.00	0.95			1.10	1.10	1.08	1.05	1.00	0.95								
5) Paddy x 1 + Palawija x 1	P	P	1.10	1.10	1.05	1.05	0.95		0.50	0.68	0.86	1.05	1.05	0.95										
		P	P	1.10	1.10	1.05	1.05	0.95		0.50	0.68	0.86	1.05	1.05	0.95									
average			1.10	1.10	1.08	1.05	1.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00									
6) Palawija x 2	0.50	0.68	0.86	1.05	1.05	0.95			0.50	0.68	0.86	1.05	1.05	0.95										
		0.50	0.68	0.86	1.05	1.05	0.95			0.50	0.68	0.86	1.05	1.05	0.95									
average	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00									
7) Paddy x 1	P	P	1.10	1.10	1.05	1.05	0.95																	
		P	P	1.10	1.10	1.05	1.05	0.95																
average			1.10	1.10	1.08	1.05	1.00	0.95																
2. Cropped Area Ratio																								
1) Paddy	0.5	1	1	1	1	0.5			0.5	1	1	1	1	0.5			0.5	1	1	1	1	0.5		
2) Paddy x 2 + Palawija x 1	0.5	1	1	1	1	0.5			0.5	1	1	1	1	0.5		0.5	1	1	1	1	1	0.5		
3) Paddy x 1 + Palawija x 2	0.5	1	1	1	1	0.5	0.5	1	1	1	1	1	0.5		0.5	1	1	1	1	1	0.5			
4) Paddy x 2			0.5	1	1	1	1	0.5			0.5	1	1	1	1	0.5								
5) Paddy x 1 + Palawija x 1			0.5	1	1	1	1	0.5	0.5	1	1	1	1	1	0.5									
6) Palawija x 2	0.5	1	1	1	1	1	0.5		0.5	1	1	1	1	1	0.5									
7) Paddy x 1			0.5	1	1	1	1	0.5																
3. ETo (mm/day) BMG1	4.40	4.40	4.16	4.16	4.31	4.31	4.55	4.55	4.36	4.36	4.23	4.23	3.98	3.98	3.99	3.99	4.53	4.53	4.82	4.82	5.07	5.07	4.54	4.54
4. Crop Water Requirement (mm/day)																								
1) Paddy	2.42	4.84	4.49	4.37	4.31	2.05	0.00	0.00	2.40	4.80	4.57	4.44	3.98	1.89	0.00	0.00	2.49	4.98	5.21	5.06	5.07	2.41	0.00	0.00
2) Paddy x 2 + Palawija x 1	2.42	4.84	4.49	4.37	4.31	2.05	0.00	0.00	2.40	4.80	4.57	4.44	3.98	1.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3) Paddy x 1 + Palawija x 2	2.42	4.84	4.49	4.37	4.31	2.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4) Paddy x 2	0.00	0.00	2.29	4.58	4.65	4.53	4.55	2.16	0.00	0.00	2.33	4.65	4.30	4.18	3.99	1.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5) Paddy x 1 + Palawija x 1	0.00	0.00	2.29	4.58	4.65	4.53	4.55	2.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6) Palawija x 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7) Paddy x 1	0.00	0.00	2.29	4.58	4.65	4.53	4.55	2.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5. Effective Rainfall (mm/day) No.44(	3.91	3.91	5.24	5.24	4.78	4.78	3.43	3.43	1.56	1.56	0.75	0.75	0.44	0.44	0.59	0.59	0.29	0.29	0.26	0.26	0.43	0.43	2.46	2.46
1) Paddy	3.91	3.91	5.24	5.24	4.78	4.78	3.43	3.43	1.56	1.56	0.75	0.75	0.44	0.44	0.59	0.59	0.29	0.29	0.26	0.26	0.43	0.43	2.46	2.46
2) Paddy x 2 + Palawija x 1	3.91	3.91	5.24	5.24	4.78	4.78	3.43	3.43	1.56	1.56	0.75	0.75	0.44	0.44	0.59	0.59	0.29	0.29	0.26	0.26	0.43	0.43	2.46	2.46
3) Paddy x 1 + Palawija x 2	3.91	3.91	5.24	5.24	4.78	4.78	3.43	3.43	1.56	1.56	0.75	0.75	0.44	0.44	0.59	0.59	0.29	0.29	0.26	0.26	0.43	0.43	2.46	2.46
4) Paddy x 2	3.91	3.91	5.24	5.24	4.78	4.78	3.43	3.43	1.56	1.56	0.75	0.75	0.44	0.44	0.59	0.59	0.29	0.29	0.26	0.26	0.43	0.43	2.46	2.46
5) Paddy x 1 + Palawija x 1	3.91	3.91	5.24	5.24	4.78	4.78	3.43	3.43	1.56	1.56	0.75	0.75	0.44	0.44	0.59	0.59	0.29	0.29	0.26	0.26	0.43	0.43	2.46	2.46
6) Palawija x 2	3.91	3.91	5.24	5.24	4.78	4.78	3.43	3.43	1.56	1.56	0.75	0.75	0.44	0.44	0.59	0.59	0.29	0.29	0.26	0.26	0.43	0.43	2.46	2.46
7) Paddy x 1	3.91	3.91	5.24	5.24	4.78	4.78	3.43	3.43	1.56	1.56	0.75	0.75	0.44	0.44	0.59	0.59	0.29	0.29	0.26	0.26	0.43	0.43	2.46	2.46
6. Land Preparation (mm/day)																								
1) Paddy	1.67						1.67	3.33	1.67						1.67	3.33	1.67						1.67	3.33
2) Paddy x 2 + Palawija x 1	1.67						1.67	3.33	1.67														1.67	3.33
3) Paddy x 1 + Palawija x 2	1.67																						1.67	3.33
4) Paddy x 2	1.67	3.33	1.67						1.67	3.33	1.67													
5) Paddy x 1 + Palawija x 1	1.67	3.33	1.67																					
6) Palawija x 2																								
7) Paddy x 1	1.67	3.33	1.67																					
7. Water Layer Replacement (mm/day)																								
1) Paddy		0.83	0.83	0.83	0.83					0.83	0.83	0.83	0.83					0.83	0.83	0.83	0.83			
2) Paddy x 2 + Palawija x 1		0.83	0.83	0.83	0.83					0.83	0.83	0.83	0.83											
3) Paddy x 1 + Palawija x 2		0.83	0.83	0.83	0.83																			
4) Paddy x 2				0.83	0.83	0.83	0.83					0.83	0.83	0.83	0.83									
5) Paddy x 1 + Palawija x 1				0.83	0.83	0.83	0.83																	
6) Palawija x 2																								
7) Paddy x 1				0.83	0.83	0.83	0.83																	
8. Seepage Loss (1mm/day)																								
1) Paddy	2	2	2	2	2	1	1	2	2	2	2	2	2	1	1	2	2	2	2	2	2	1	1	2
2) Paddy x 2 + Palawija x 1	2	2	2	2	2	1	1	2	2	2	2	2	2	1									1	2
3) Paddy x 1 + Palawija x 2	2	2	2	2	2	1																	1	2
4) Paddy x 2	1	2	2	2	2	2	2	1	1	2	2	2	2	2	2	1								
5) Paddy x 1 + Palawija x 1	1	2	2	2	2	2	2	1																
6) Palawija x 2																								
7) Paddy x 1	1	2	2	2	2	2	2	1																
9. Net Water Requirement by Cropping Pattern (mm/day)																								
1) Paddy	2.18	3.76	2.08	1.96	2.36	0.00	0.00	1.90	4.51	6.07	6.65	6.52	6.37	2.45	2.08	4.74	5.87	7.52	7.78	7.63	7.47	2.98	0.21	2.87
2) Paddy x 2 + Palawija x 1	2.18	3.76	2.08	1.96	2.36	0.00	0.00	1.90	4.51	6.07	6.65	6.52	6.37	2.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	2.87
3) Paddy x 1 + Palawija x 2	2.18	3.76	2.08	1.96	2.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	2.87
4) Paddy x 2	0.00	1.42	0.72	2.17	2.70	2.58	3.95	0.00	1.11	3.77	5.25	6.73	6.69	6.57	6.23	2.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5) Paddy x 1 + Palawija x 1	0.00	1.42	0.72	2.17	2.70	2.58	3.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6) Palawija x 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7) Paddy x 1	0.00	1.42	0.72	2.17	2.70	2.58	3.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10. Unit Irrigation Water Requirement by Cropping Pattern (mm/day) Overall Efficiency =50%																								
1) Paddy	3.63	6.27	3.47	3.27	3.93	0.00	0.00	3.17	7.52	10.12	11.08	10.87	10.62	4.08	3.47	7.90	9.78	12.53	12.97	12.72	12.45	4.97	0.35	4.78
2) Paddy x 2 + Palawija x 1	3.63	6.27	3.47	3.27	3.93	0.00	0.00	3.17	7.52	10.12	11.08	10.87	10.62	4.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	4.78
3) Paddy x 1 + Palawija x 2	3.63	6.27	3.47	3.27	3.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	4.78
4) Paddy x 2	0.00	2.37	1.20	3.62	4.50	4.30	6.58	0.00	1.85	6.28	8.75	11.22	11.15	10.95	10.38	3.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5) Paddy x 1 + Palawija x 1	0.00	2.37	1.20	3.62	4.50	4.30	6.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6) Palawija x 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7) Paddy x 1	0.00	2.37	1.20	3.62	4.50	4.30	6.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11. Unit Irrigation Water Requirement by Regency = Ratio of Cropping Pattern x Unit Irrigation Water Requirement by Cropping Pattern (mm/day)																								
0.465 1) Paddy	1.69	2.92	1.61	1.52	1.83	0.00	0.00	1.47	3.50	4.71	5.15	5.05	4.94	1.90	1.61	3.67	4.55	5.83	6.03	5.91	5.79	2.31	0.16	2.22	74.37
0.393 2) Paddy x 2 + Palawija x 1	1.43	2.46	1.36	1.29	1.54	0.00	0.00	1.25	2.96	3.98	4.35	4.27	4.17	1.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	1.88	32.68
0.000 3) Paddy x 1 + Palawija x 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.107 4) Paddy x 2	0.00	0.25	0.13	0.39	0.48	0.46	0.70	0.00	0.20	0.67	0.94	1.20	1.19	1.17	1.11	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.30
0.000 5) Paddy x 1 + Palawija x 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.015 6) Palawija x 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.020 7) Paddy x 1	0.00	0.05	0.02	0.07	0.09	0.09	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.45
1.000																								
Total (mm/day)	3.12	5.68	3.12	3.27	3.94	0.55	0.83	2.72	6.66	9.36	10.44	10.52	10.30	4.67	2.72	4.08	4.55	5.83	6.03	5.91	5.79	2.31	0.30	4.10	
Total (liter/sec/ha)	0.36	0.66	0.36	0.38	0.46	0.06	0.10	0.31	0.77	1.08	1.21	1.22	1.19	0.54	0.31	0.47	0.53	0.67	0.70	0.68	0.67	0.27	0.03	0.47	

12. Unit Irrigation Water Requirement by Regency (liter/sec/ha)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average (liter/sec/ha)	0.37	0.26	0.21	0.93	1.22	0.87	0.39	0.60	0.69	0.47	0.25	0.51

Note
P : Land Preparation
ETo : Reference Crop Evapotranspiration
Irrigation is applied to only paddy culture.

	Jan I	Jan II	Feb I	Feb II	Mar I	Mar II	Apr I	Apr II	May I	May II	Jun I	Jun II	Jul I	Jul II	Aug I	Aug II	Sep I	Sep II	Oct I	Oct II	Nov I	Nov II	Dec I	Dec II
Total (liter/sec/ha)	0.36	0.38	0.46	0.06	0.10	0.31	0.77	1.08	1.21	1.22	1.19	0.54	0.31	0.47	0.53	0.67	0.70	0.68	0.67	0.27	0.03	0.47	0.36	0.66

Land Preparation (mm/day)	100
Water Layer Replacement (mm/day)	25
Overall Efficiency	0.6

Table-D.13 Calculation of Unit Area Required Amount of Water (Gianyar)

Gianyar Regency

	Dec I	Dec II	Jan I	Jan II	Feb I	Feb II	Mar I	Mar II	Apr I	Apr II	May I	May II	Jun I	Jun II	Jul I	Jul II	Aug I	Aug II	Sep I	Sep II	Oct I	Oct II	Nov I	Nov II
1. Crop Coefficient																								
1) Paddy x 3	1.10	1.10	1.05	1.05	0.95		P	P	1.10	1.10	1.05	1.05	0.95		P	P	1.10	1.10	1.05	1.05	0.95		P	P
	P	1.10	1.10	1.05	1.05	0.95		P	P	1.10	1.10	1.05	1.05	0.95		P	P	1.10	1.10	1.05	1.05	0.95		P
average	1.10	1.10	1.08	1.05	1.00	0.95			1.10	1.10	1.08	1.05	1.00	0.95			1.10	1.10	1.08	1.05	1.00	0.95		
2) Paddy x 2 + Palawija x 1	1.10	1.10	1.05	1.05	0.95		P	P	1.10	1.10	1.05	1.05	0.95			0.50	0.68	0.86	1.05	1.05	0.95		P	P
	P	1.10	1.10	1.05	1.05	0.95		P	P	1.10	1.10	1.05	1.05	0.95			0.50	0.68	0.86	1.05	1.05	0.95		P
average	1.10	1.10	1.08	1.05	1.00	0.95			1.10	1.10	1.08	1.05	1.00	0.95		0.00	0.00	0.00	0.00	0.00	0.00	0.00		
3) Paddy x 1 + Palawija x 2	1.10	1.10	1.05	1.05	0.95		0.50	0.68	0.86	1.05	1.05	0.95			0.50	0.68	0.86	1.05	1.05	0.95			P	P
	P	1.10	1.10	1.05	1.05	0.95		0.50	0.68	0.86	1.05	1.05	0.95			0.50	0.68	0.86	1.05	1.05	0.95			P
average	1.10	1.10	1.08	1.05	1.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00			
4) Paddy x 2	P	P	1.10	1.10	1.05	1.05	0.95		P	P	1.10	1.10	1.05	1.05	0.95									
		P	P	1.10	1.10	1.05	1.05	0.95		P	P	1.10	1.10	1.05	1.05	0.95								
average			1.10	1.10	1.08	1.05	1.00	0.95			1.10	1.10	1.08	1.05	1.00	0.95								
5) Paddy x 1 + Palawija x 1	P	P	1.10	1.10	1.05	1.05	0.95		0.50	0.68	0.86	1.05	1.05	0.95										
		P	P	1.10	1.10	1.05	1.05	0.95		0.50	0.68	0.86	1.05	1.05	0.95									
average			1.10	1.10	1.08	1.05	1.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00									
6) Palawija x 2	0.50	0.68	0.86	1.05	1.05	0.95			0.50	0.68	0.86	1.05	1.05	0.95										
		0.50	0.68	0.86	1.05	1.05	0.95			0.50	0.68	0.86	1.05	1.05	0.95									
average	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00									
7) Paddy x 1	P	P	1.10	1.10	1.05	1.05	0.95																	
		P	P	1.10	1.10	1.05	1.05	0.95																
average			1.10	1.10	1.08	1.05	1.00	0.95																
2. Cropped Area Ratio																								
1) Paddy	0.5	1	1	1	1	0.5			0.5	1	1	1	1	0.5			0.5	1	1	1	1	0.5		
2) Paddy x 2 + Palawija x 1	0.5	1	1	1	1	0.5			0.5	1	1	1	1	0.5		0.5	1	1	1	1	1	0.5		
3) Paddy x 1 + Palawija x 2	0.5	1	1	1	1	0.5	0.5	1	1	1	1	1	0.5		0.5	1	1	1	1	1	0.5			
4) Paddy x 2			0.5	1	1	1	1	0.5			0.5	1	1	1	1	0.5								
5) Paddy x 1 + Palawija x 1			0.5	1	1	1	1	0.5	0.5	1	1	1	1	1	0.5									
6) Palawija x 2	0.5	1	1	1	1	1	0.5		0.5	1	1	1	1	1	0.5									
7) Paddy x 1			0.5	1	1	1	1	0.5																
3. ETo (mm/day) 511003	2.79	2.79	2.73	2.73	3.53	3.53	3.08	3.08	3.34	3.34	3.56	3.56	3.11	3.11	3.46	3.46	3.48	3.48	3.58	3.58	3.38	3.38	2.95	2.95
4. Crop Water Requirement (mm/day)																								
1) Paddy	1.53	3.07	2.95	2.87	3.53	1.68	0.00	0.00	1.84	3.67	3.84	3.74	3.11	1.48	0.00	0.00	1.91	3.83	3.87	3.76	3.38	1.61	0.00	0.00
2) Paddy x 2 + Palawija x 1	1.53	3.07	2.95	2.87	3.53	1.68	0.00	0.00	1.84	3.67	3.84	3.74	3.11	1.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3) Paddy x 1 + Palawija x 2	1.53	3.07	2.95	2.87	3.53	1.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4) Paddy x 2	0.00	0.00	1.50	3.00	3.81	3.71	3.08	1.46	0.00	0.00	1.96	3.92	3.36	3.27	3.46	1.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5) Paddy x 1 + Palawija x 1	0.00	0.00	1.50	3.00	3.81	3.71	3.08	1.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6) Palawija x 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7) Paddy x 1	0.00	0.00	1.50	3.00	3.81	3.71	3.08	1.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5. Effective Rainfall (mm/day) No.44(	4.00	4.00	7.50	7.50	6.38	6.38	3.92	3.92	1.33	1.33	0.86	0.86	0.84	0.84	1.20	1.20	0.27	0.27	0.61	0.61	1.11	1.11	3.90	3.90
1) Paddy	4.00	4.00	7.50	7.50	6.38	6.38	3.92	3.92	1.33	1.33	0.86	0.86	0.84	0.84	1.20	1.20	0.27	0.27	0.61	0.61	1.11	1.11	3.90	3.90
2) Paddy x 2 + Palawija x 1	4.00	4.00	7.50	7.50	6.38	6.38	3.92	3.92	1.33	1.33	0.86	0.86	0.84	0.84	1.20	1.20	0.27	0.27	0.61	0.61	1.11	1.11	3.90	3.90
3) Paddy x 1 + Palawija x 2	4.00	4.00	7.50	7.50	6.38	6.38	3.92	3.92	1.33	1.33	0.86	0.86	0.84	0.84	1.20	1.20	0.27	0.27	0.61	0.61	1.11	1.11	3.90	3.90
4) Paddy x 2	4.00	4.00	7.50	7.50	6.38	6.38	3.92	3.92	1.33	1.33	0.86	0.86	0.84	0.84	1.20	1.20	0.27	0.27	0.61	0.61	1.11	1.11	3.90	3.90
5) Paddy x 1 + Palawija x 1	4.00	4.00	7.50	7.50	6.38	6.38	3.92	3.92	1.33	1.33	0.86	0.86	0.84	0.84	1.20	1.20	0.27	0.27	0.61	0.61	1.11	1.11	3.90	3.90
6) Palawija x 2	4.00	4.00	7.50	7.50	6.38	6.38	3.92	3.92	1.33	1.33	0.86	0.86	0.84	0.84	1.20	1.20	0.27	0.27	0.61	0.61	1.11	1.11	3.90	3.90
7) Paddy x 1	4.00	4.00	7.50	7.50	6.38	6.38	3.92	3.92	1.33	1.33	0.86	0.86	0.84	0.84	1.20	1.20	0.27	0.27	0.61	0.61	1.11	1.11	3.90	3.90
6. Land Preparation (mm/day)																								
1) Paddy	1.67						1.67	3.33	1.67						1.67	3.33	1.67						1.67	3.33
2) Paddy x 2 + Palawija x 1	1.67						1.67	3.33	1.67														1.67	3.33
3) Paddy x 1 + Palawija x 2	1.67																						1.67	3.33
4) Paddy x 2	1.67	3.33	1.67						1.67	3.33	1.67													
5) Paddy x 1 + Palawija x 1	1.67	3.33	1.67																					
6) Palawija x 2																								
7) Paddy x 1	1.67	3.33	1.67																					
7. Water Layer Replacement (mm/day)																								
1) Paddy		0.83	0.83	0.83	0.83					0.83	0.83	0.83	0.83					0.83	0.83	0.83	0.83			
2) Paddy x 2 + Palawija x 1		0.83	0.83	0.83	0.83					0.83	0.83	0.83	0.83											
3) Paddy x 1 + Palawija x 2		0.83	0.83	0.83	0.83																			
4) Paddy x 2				0.83	0.83	0.83	0.83					0.83	0.83	0.83	0.83									
5) Paddy x 1 + Palawija x 1				0.83	0.83	0.83	0.83																	
6) Palawija x 2																								
7) Paddy x 1				0.83	0.83	0.83	0.83																	
8. Seepage Loss (1mm/day)																								
1) Paddy	2	2	2	2	2	1	1	2	2	2	2	2	2	1	1	2	2	2	2	2	2	1	1	2
2) Paddy x 2 + Palawija x 1	2	2	2	2	2	1	1	2	2	2	2	2	2	1									1	2
3) Paddy x 1 + Palawija x 2	2	2	2	2	2	1																	1	2
4) Paddy x 2	1	2	2	2	2	2	2	1	1	2	2	2	2	2	2	1								
5) Paddy x 1 + Palawija x 1	1	2	2	2	2	2	2	1																
6) Palawija x 2																								
7) Paddy x 1	1	2	2	2	2	2	2	1																
9. Net Water Requirement by Cropping Pattern (mm/day)																								
1) Paddy	1.20	1.90	0.00	0.00	0.00	0.00	0.00	1.41	4.18	5.17	5.81	5.71	5.10	1.64	1.47	4.13	5.31	6.39	6.09	5.98	5.10	1.50	0.00	1.43
2) Paddy x 2 + Palawija x 1	1.20	1.90	0.00	0.00	0.00	0.00	0.00	1.41	4.18	5.17	5.81	5.71	5.10	1.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.43
3) Paddy x 1 + Palawija x 2	1.20	1.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.43
4) Paddy x 2	0.00	1.33	0.00	0.00	0.26	0.16	1.99	0.00	1.34	4.00	4.77	5.89	5.35	5.26	5.09	1.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5) Paddy x 1 + Palawija x 1	0.00	1.33	0.00	0.00	0.26	0.16	1.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6) Palawija x 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7) Paddy x 1	0.00	1.33	0.00	0.00	0.26	0.16	1.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10. Unit Irrigation Water Requirement by Cropping Pattern (mm/day) Overall Efficiency =50%																								
1) Paddy	2.00	3.17	0.00	0.00	0.00	0.00	0.00	2.35	6.97	8.62	9.68	9.52	8.50	2.73	2.45	6.88	8.85	10.65	10.15	9.97	8.50	2.50	0.00	2.38
2) Paddy x 2 + Palawija x 1	2.00	3.17	0.00	0.00	0.00	0.00	0.00	2.35	6.97	8.62	9.68	9.52	8.50	2.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.38
3) Paddy x 1 + Palawija x 2	2.00	3.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.38
4) Paddy x 2	0.00	2.22	0.00	0.00	0.43	0.27	3.32	0.00	2.23	6.67	7.95	9.82	8.92	8.77	8.48	2.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5) Paddy x 1 + Palawija x 1	0.00	2.22	0.00	0.00	0.43	0.27	3.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6) Palawija x 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7) Paddy x 1	0.00	2.22	0.00	0.00	0.43	0.27	3.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11. Unit Irrigation Water Requirement by Regency = Ratio of Cropping Pattern x Unit Irrigation Water Requirement by Cropping Pattern (mm/day)																								
0.304 1) Paddy	0.61	0.96	0.00	0.00	0.00	0.00	0.00	0.71	2.12	2.62	2.94	2.89	2.58	0.83	0.74	2.09	2.69	3.24	3.09	3.03	2.58	0.76	0.00	0.72	35.20
0.095 2) Paddy x 2 + Palawija x 1	0.19	0.30	0.00	0.00	0.00	0.00	0.00	0.22	0.66	0.82	0.92	0.90	0.81	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	5.31
0.000 3) Paddy x 1 + Palawija x 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.495 4) Paddy x 2	0.00	1.10	0.00	0.00	0.21	0.13	1.64	0.00	1.10	3.30	3.94	4.86	4.42	4.34	4.20	1.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.43
0.000 5) Paddy x 1 + Palawija x 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.038 6) Palawija x 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.068 7) Paddy x 1	0.00	0.15	0.00	0.00	0.03	0.02	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.43
1.000																								
Total (mm/day)	0.80	2.51	0.00	0.00	0.24	0.15	1.87	0.93	3.88	6.74	7.80	8.65	7.81	5.43	4.94	3.28	2.69	3.24	3.09	3.03	2.58	0.76	0.00	0.95
Total (liter/sec/ha)	0.09	0.29	0.00	0.00	0.03	0.02	0.22	0.11	0.45	0.78	0.90	1.00	0.90	0.63	0.57	0.38	0.31	0.38	0.36	0.35	0.30	0.09	0.00	0.11

12. Unit Irrigation Water Requirement by Regency (liter/sec/ha)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average (liter/sec/ha)	0.00	0.03	0.17	0.62	0.95	0.77	0.48	0.35	0.36	0.20	0.06	0.19

Note
P : Land Preparation
ETo : Reference Crop Evapotranspiration
Irrigation is applied to only paddy culture.

	Jan I	Jan II	Feb I	Feb II	Mar I	Mar II	Apr I	Apr II	May I	May II	Jun I	Jun II	Jul I	Jul II	Aug I	Aug II	Sep I	Sep II	Oct I	Oct II	Nov I	Nov II	Dec I	Dec II
Total (liter/sec/ha)	0.00	0.00	0.03	0.02	0.22	0.11	0.45	0.78	0.90	1.00	0.90	0.63	0.57	0.38	0.31	0.38	0.36	0.35	0.30	0.09	0.00	0.11	0.09	0.29

Land Preparation (mm/day)	100
Water Layer Replacement (mm/day)	25
Overall Efficiency	0.6

D-3.5 Calculation Result and Capacity of Irrigation Water

Water was supplied from the dam to secure a certain amount for irrigation. The outcome is shown in Figure-D.14, which indicates the severest draught year is 1977, followed by 1983.

The project adopts the data of 1983 which is the second severest year for draught in the 15 years, considering facts such as the relationship between the dam's storage capacity and height and frequency of draught. The required capacity of the dam at this point is 9,000,000m^3.

Table-D.14 List of Calculation Result

No	Year	Average rainfall over watershed (mm/year)	Required capacity (1000m3)	Ranking
1	1972		0	-
2	1973	2,688	0	-
3	1974	2,552	0	-
4	1975	3,161	0	-
5	1976	2,232	0	-
6	1977	1,946	15,000	1
7	1978	4,263	800	7
8	1979	2,404	0	
9	1980	1,699	5,300	4
10	1981	3,341	600	8
11	1982	1,788	2,200	5
12	1983	2,794	9,000	2
13	1984	3,357	600	9
14	1985	2,381	8,400	3
15	1986	2,709	1,800	6

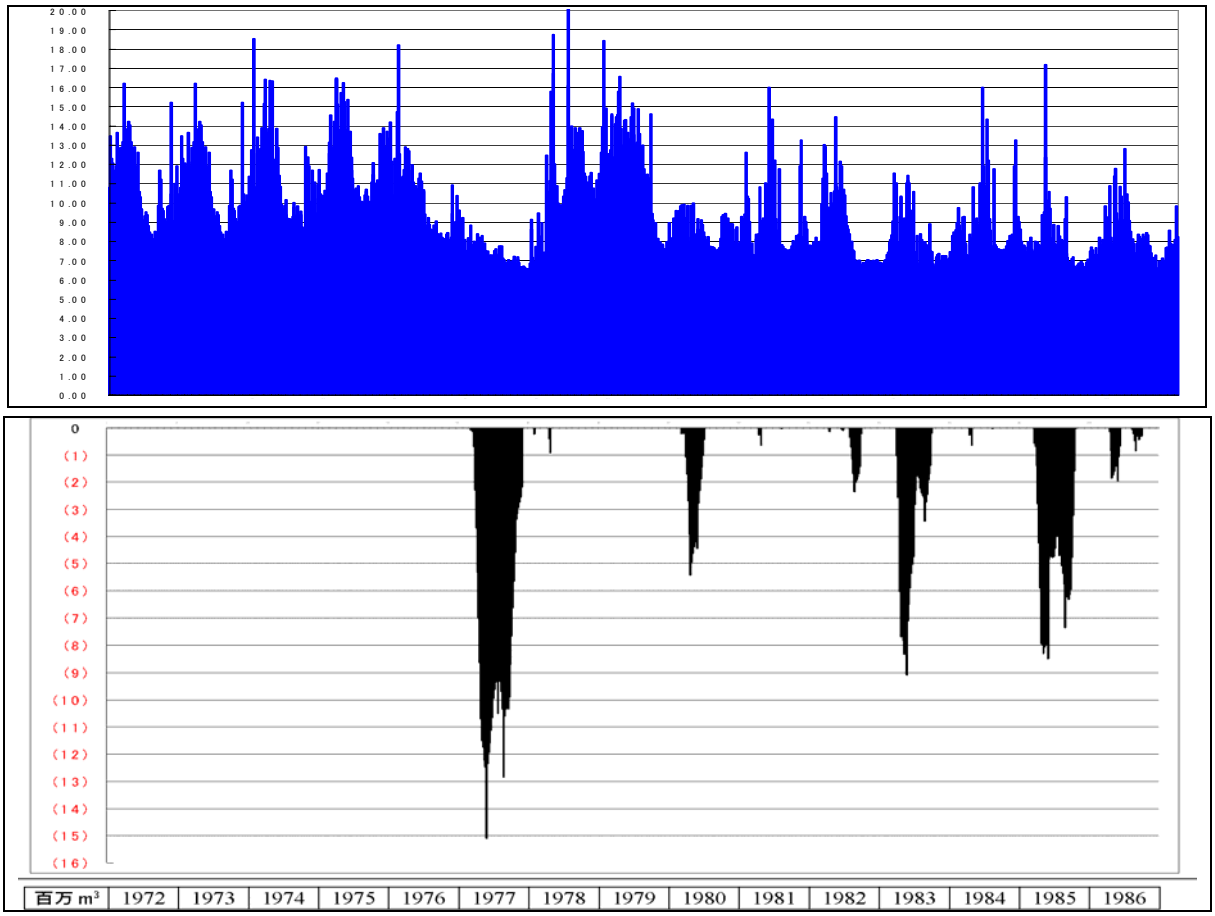


Figure-D.14 Amount of Water Intake from Ayung Dam

Table-D.15 Water Use Capacity (Base year: 1983)

				(1) Dam and Reservoir					(2) Sengenpel				(3) Kedewatan				(4) Mambal				
				Inflow	New W/S	Outflow	Deficit	Res. Vol.	Sub-Area	Dis-In	W/Right	Dis-Out	Sub-Area	Dis-In	W/Right	Dis-Out	Sub-Area	Dis-In	W/Right	New Irrig.	Dis-Out
				217.km2	lit/s				13.km2		47.ha		1.2km2		3,237.ha		28.3km2	977.ha	3,628.ha	1,000.ha	
Year	Month	5-days	Days	m3/s	lit/s	m3/s	m3/s	Mil.m3	m3/s	m3/s	m3/s	m3/s	m3/s	m3/s	m3/s	m3/s	m3/s	m3/s	m3/s		m3/s
1982	1	1	5	9.96	0.00	9.96	3.20	0.00	0.54	10.50	0.02	10.48	0.05	10.52	1.50	9.02	1.17	10.30	1.68	0.00	8.62
		2	5	11.28	0.00	11.28	2.70	0.00	0.61	11.89	0.02	11.87	0.06	11.92	1.50	10.42	1.32	11.86	1.68	0.00	10.18
		3	5	13.02	0.00	13.02	2.03	0.00	0.70	13.72	0.02	13.70	0.06	13.77	1.50	12.26	1.53	13.90	1.68	0.00	12.22
		4	5	12.94	0.00	12.94	2.06	0.00	0.70	13.64	0.02	13.62	0.06	13.68	1.50	12.18	1.52	13.81	1.68	0.00	12.13
		5	5	11.54	0.00	11.54	2.60	0.00	0.62	12.16	0.02	12.14	0.06	12.20	1.50	10.69	1.35	12.16	1.68	0.00	10.48
		6	6	8.60	0.00	8.60	3.72	0.00	0.46	9.06	0.02	9.04	0.04	9.08	1.50	7.58	1.01	8.70	1.68	0.00	7.02
	2	1	5	9.76	0.00	9.76	3.33	0.00	0.53	10.29	0.02	10.26	0.05	10.31	1.54	8.77	1.15	10.04	1.80	0.00	8.24
		2	5	8.16	0.00	8.16	3.95	0.00	0.44	8.60	0.02	8.58	0.04	8.62	1.54	7.07	0.96	8.15	1.80	0.00	6.36
		3	5	8.68	0.00	8.68	3.75	0.00	0.47	9.15	0.02	9.12	0.04	9.17	1.54	7.62	1.02	8.76	1.80	0.00	6.97
		4	5	10.54	0.00	10.54	3.04	0.00	0.57	11.11	0.02	11.08	0.05	11.14	1.54	9.59	1.24	10.95	1.80	0.00	9.16
		5	5	9.98	0.00	9.98	3.25	0.00	0.54	10.52	0.02	10.49	0.05	10.54	1.54	9.00	1.17	10.29	1.80	0.00	8.50
		6	3	8.93	0.00	8.93	3.65	0.00	0.48	9.41	0.02	9.39	0.04	9.44	1.54	7.89	1.05	9.06	1.80	0.00	7.27
	3	1	5	10.62	0.00	10.62	7.15	0.00	0.57	11.19	0.06	11.14	0.05	11.19	3.29	7.90	1.25	9.41	3.96	0.00	5.45
		2	5	11.02	0.00	11.02	7.00	0.00	0.59	11.61	0.06	11.56	0.05	11.61	3.29	8.32	1.29	9.88	3.96	0.00	5.92
		3	5	14.46	0.00	14.46	5.68	0.00	0.78	15.24	0.06	15.18	0.07	15.26	3.29	11.96	1.70	13.93	3.96	0.00	9.97
		4	5	10.84	0.00	10.84	7.07	0.00	0.58	11.42	0.06	11.37	0.05	11.42	3.29	8.13	1.27	9.67	3.96	0.00	5.71
		5	5	9.78	0.00	9.78	7.47	0.00	0.53	10.31	0.06	10.25	0.05	10.30	3.29	7.01	1.15	8.43	3.96	0.00	4.47
		6	6	10.65	0.00	10.65	7.14	0.00	0.57	11.22	0.06	11.17	0.05	11.22	3.29	7.93	1.25	9.45	3.96	0.00	5.49
	4	1	5	12.16	0.00	12.16	9.41	0.00	0.66	12.82	0.07	12.74	0.06	12.80	4.49	8.31	1.43	10.11	5.38	0.00	4.73
		2	5	11.90	0.00	11.90	9.51	0.00	0.64	12.54	0.07	12.47	0.06	12.53	4.49	8.04	1.40	9.80	5.38	0.00	4.42
		3	5	10.54	0.00	10.54	10.03	0.00	0.57	11.11	0.07	11.03	0.05	11.09	4.49	6.60	1.24	8.20	5.38	0.00	2.82
		4	5	10.04	0.00	10.22	10.22	(0.08)	0.54	10.77	0.07	10.69	0.05	10.74	4.49	6.25	1.18	7.80	5.38	0.00	2.42
		5	5	10.70	0.00	10.52	9.97	0.00	0.58	11.09	0.07	11.02	0.05	11.07	4.49	6.58	1.26	8.21	5.38	0.00	2.83
		6	5	10.42	0.00	10.42	10.08	0.00	0.56	10.98	0.07	10.91	0.05	10.96	4.49	6.47	1.22	8.06	5.38	0.00	2.68
	5	1	5	9.32	0.00	9.32	6.94	0.00	0.50	9.82	0.05	9.77	0.05	9.82	2.99	6.83	1.09	8.17	3.55	0.00	4.62
		2	5	8.80	0.00	8.80	7.14	0.00	0.47	9.27	0.05	9.23	0.04	9.27	2.99	6.28	1.03	7.56	3.55	0.00	4.01
		3	5	8.64	0.00	8.64	7.20	0.00	0.47	9.11	0.05	9.06	0.04	9.10	2.99	6.11	1.01	7.37	3.55	0.00	3.82
		4	5	8.38	0.00	8.38	7.30	0.00	0.45	8.83	0.05	8.78	0.04	8.82	2.99	5.84	0.98	7.06	3.55	0.00	3.51
		5	5	7.98	0.00	7.98	7.45	0.00	0.43	8.41	0.05	8.36	0.04	8.40	2.99	5.41	0.94	6.59	3.55	0.00	3.04
		6	6	7.90	0.00	7.90	7.49	0.00	0.43	8.33	0.05	8.28	0.04	8.32	2.99	5.33	0.93	6.50	3.55	0.00	2.95
	6	1	5	8.00	0.00	8.00	6.43	0.00	0.43	8.43	0.04	8.39	0.04	8.43	2.34	6.09	0.94	7.22	2.83	0.56	3.84
		2	5	7.54	0.00	7.54	6.61	0.00	0.41	7.95	0.04	7.91	0.04	7.94	2.34	5.60	0.88	6.68	2.83	0.56	3.30
		3	5	7.48	0.00	7.48	6.63	0.00	0.40	7.88	0.04	7.84	0.04	7.88	2.34	5.54	0.88	6.61	2.83	0.56	3.23
		4	5	7.04	0.00	7.04	6.80	0.00	0.38	7.42	0.04	7.38	0.04	7.41	2.34	5.08	0.83	6.10	2.83	0.56	2.71
		5	5	6.88	0.00	6.88	6.86	0.00	0.37	7.25	0.04	7.21	0.03	7.25	2.34	4.91	0.81	5.91	2.83	0.56	2.52
		6	5	6.86	0.00	6.87	6.87	(0.00)	0.37	7.24	0.04	7.20	0.03	7.23	2.34	4.90	0.81	5.89	2.83	0.56	2.51
	7	1	5	6.96	0.00	6.95	6.31	0.00	0.38	7.32	0.03	7.29	0.03	7.33	1.74	5.58	0.82	6.56	2.22	1.50	2.83
		2	5	7.00	0.00	7.00	6.30	0.00	0.38	7.38	0.03	7.34	0.03	7.38	1.74	5.64	0.82	6.61	2.22	1.50	2.89
		3	5	7.00	0.00	7.00	6.30	0.00	0.38	7.38	0.03	7.34	0.03	7.38	1.74	5.64	0.82	6.61	2.22	1.50	2.89
		4	5	6.76	0.00	6.76	6.39	0.00	0.36	7.12	0.03	7.09	0.03	7.13	1.74	5.38	0.79	6.33	2.22	1.50	2.61
		5	5	6.80	0.00	6.80	6.37	0.00	0.37	7.17	0.03	7.13	0.03	7.17	1.74	5.43	0.80	6.38	2.22	1.50	2.66
		6	6	6.90	0.00	6.90	6.34	0.00	0.37	7.27	0.03	7.24	0.03	7.27	1.74	5.53	0.81	6.50	2.22	1.50	2.77
	8	1	5	6.90	0.00	7.56	7.56	(0.28)	0.37	7.93	0.04	7.89	0.03	7.93	2.12	5.81	0.81	6.80	2.71	1.83	2.27
		2	5	6.82	0.00	7.59	7.59	(0.62)	0.37	7.96	0.04	7.92	0.03	7.95	2.12	5.83	0.80	6.82	2.71	1.83	2.29
		3	5	6.76	0.00	7.62	7.62	(0.98)	0.36	7.98	0.04	7.94	0.03	7.97	2.12	5.85	0.79	6.83	2.71	1.83	2.30
		4	5	6.98	0.00	7.53	7.53	(1.22)	0.38	7.91	0.04	7.87	0.03	7.90	2.12	5.78	0.82	6.79	2.71	1.83	2.25
		5	5	7.04	0.00	7.51	7.51	(1.42)	0.38	7.89	0.04	7.85	0.04	7.88	2.12	5.76	0.83	6.77	2.71	1.83	2.24
		6	6	7.00	0.00	7.52	7.52	(1.98)	0.38	7.90	0.04	7.86	0.03	7.90	2.12	5.77	0.82	6.78	2.71	1.83	2.25
	9	1	5	6.70	0.00	6.68	6.68	(1.64)	0.36	7.05	0.03	7.01	0.03	7.04	1.83	5.22	0.79	6.17	2.33	1.57	2.27
		2	5	6.96	0.00	6.58	6.58	(1.48)	0.38	6.96	0.03	6.93	0.03	6.96	1.83	5.13	0.82	6.11	2.33	1.57	2.21
		3	5	6.96	0.00	6.58	6.58	(1.32)	0.38	6.96	0.03	6.93	0.03	6.96	1.83	5.13	0.82	6.11	2.33	1.57	2.21
		4	5	6.98	0.00	6.58	6.58	(1.14)	0.38	6.95	0.03	6.92	0.03	6.95	1.83	5.13	0.82	6.11	2.33	1.57	2.21
		5	5	7.00	0.00	6.57	6.57	(0.90)	0.38	6.95	0.03	6.91	0.03	6.95	1.83	5.12	0.82	6.10	2.33	1.57	2.20
		6	5	6.96	0.00	6.58	6.58	(0.80)	0.38	6.96	0.03	6.93	0.03	6.96	1.83	5.13	0.82	6.11	2.33	1.57	2.21
	10	1	5	6.94	0.00	5.08	4.02	0.00	0.37	5.46	0.02	5.44	0.03	5.47	1.29	4.18	0.81	5.10	1.54	0.21	3.34
		2	5	7.04	0.00	7.04	3.98	0.00	0.38	7.42	0.02	7.40	0.04	7.43	1.29	6.14	0.83	7.07	1.54	0.21	5.32
		3	5	6.84	0.00	6.84	4.05	0.00	0.37	7.21	0.02	7.19	0.03	7.22	1.29	5.93	0.80	6.83	1.54	0.21	5.08
		4	5	6.84	0.00	6.84	4.05	0.00	0.37	7.21	0.02	7.19	0.03	7.22	1.29	5.93	0.80	6.83	1.54	0.21	5.08
		5	5	6.92	0.00	6.92	4.02	0.00	0.37	7.29	0.02	7.27	0.03	7.31	1.29	6.01	0.81	6.93	1.54	0.21	5.18
		6	6	6.90	0.00	6.90	4.03	0.00	0.37	7.27	0.02	7.25	0.03	7.29	1.29	5.99	0.81	6.91	1.54	0.21	5.15
	11	1	5	6.82	0.00	6.82	5.87	0.00	0.37	7.19	0.03	7.16	0.03	7.19	2.12	5.07	0.80	6.03	2.41	0.00	3.62
		2	5	6.86	0.00	6.86	5.86	0.00	0.37	7.23	0.03	7.20	0.03	7.23	2.12	5.11	0.81	6.08	2.41	0.00	3.67
		3	5	6.86	0.00	6.86	5.86	0.00	0.37	7.23	0.03	7.20	0.03	7.23	2.12	5.11	0.81	6.08	2.41	0.00	3.67
		4	5	7.02	0.00	7.02	5.80	0.00	0.38	7.40	0.03	7.37	0.03	7.40	2.12	5.28	0.82	6.27	2.41	0.00	3.86
		5	5	7.04	0.00	7.04	5.79	0.00	0.38	7.42	0.03	7.39	0.04	7.42	2.12	5.30	0.83	6.29	2.41	0.00	3.88
		6	5	7.04	0.00	7.04	5.79	0.00	0.38	7.42	0.03	7.39	0.04	7.42	2.12	5.30	0.83	6.29	2.41	0.00	3.88
	12	1	5	7.32	0.00	7.32	5.38	0.00	0.39	7.71	0.03	7.68	0.04	7.72	1.99	5.73	0.86	6.74	2.26	0.00	4.48
		2	5	7.42	0.00	7.42	5.34	0.00	0.40	7.82	0.03	7.79	0.04	7.83	1.99	5.83	0.87	6.86	2.26	0.00	4.60
		3	5	7.94	0.00	7.94	5.14	0.00	0.43	8.37	0.03	8.34	0.04	8.38	1.99	6.38	0.93	7.47	2.26	0.00	5.21
		4	5	8.08	0.00	8.08	5.09	0.00	0.44	8.52	0.03	8.49	0.04	8.53	1.99	6.53	0.95	7.63	2.26	0.00	5.37
		5	5	8.34	0.00	8.34	4.99	0.00	0.45	8.79	0.03	8.76	0.04	8.80	1.99	6.81	0.98	7.94	2.26	0.00	5.68
		6	6	9.05	0.00	9.05	4.72	0.00	0.49	9.54	0.03	9.51	0.05	9.55	1.99	7.56	1.06	8.77	2.26	0.00	6.51

				(5) Peraupangl						(6) Oonganl				(7) IPA Waribang				(8) River Mouth			Dam Inflow	Dam Reservoir	Q-sub	Q-return	Total Demand
				Sub-Area	Dis-In	W/Right	W/Right	New W/S	Dis-Out	Sub-Area	Dis-In	W/Right	Dis-Out	Sub-Area	Dis-In	W/Right	Dis-Out	Sub-Area	Dis-Out						
				21.2km2		25.ha	1,050lit/s	1,800lit/s		12.km2		781.ha		7.3km2		300lit/s		1.9km2				Volume			YYY
Year	Month	5-days	Days	m3/s	m3/s	m3/s	m3/s	m3/s	m3/s	m3/s	m3/s	m3/s	m3/s	m3/s	m3/s	m3/s	m3/s	m3/s	m3/s		m3/s	m3/s	m3/s	m3/s	m3/s
1982	1	1	5	0.78	9.60	0.01	1.05	1.80	6.74	0.39	7.27	0.37	6.90	0.20	7.19	0.30	6.89	0.05	6.94	1	10.78	0.00	3.17	0.54	6.39
		2	5	0.88	11.26	0.01	1.05	1.80	8.39	0.44	8.98	0.37	8.60	0.23	8.92	0.30	8.62	0.06	8.68		13.46	0.00	3.59	0.54	6.39
		3	5	1.02	13.44	0.01	1.05	1.80	10.58	0.50	11.23	0.37	10.85	0.26	11.21	0.30	10.91	0.07	10.97		12.30	0.00	4.15	0.54	6.39
		4	5	1.01	13.34	0.01	1.05	1.80	10.48	0.50	11.12	0.37	10.75	0.26	11.10	0.30	10.80	0.07	10.87		11.30	0.00	4.12	0.54	6.39
		5	5	0.90	11.58	0.01	1.05	1.80	8.72	0.45	9.31	0.37	8.94	0.23	9.26	0.30	8.96	0.06	9.02		12.06	0.00	3.68	0.54	6.39
		6	6	0.67	7.89	0.01	1.05	1.80	5.03	0.33	5.51	0.37	5.14	0.17	5.40	0.30	5.10	0.05	5.15		10.52	0.00	2.74	0.54	6.39
	2	1	5	0.76	9.21	0.01	1.05	1.80	6.35	0.38	6.88	0.29	6.59	0.20	6.88	0.30	6.58	0.05	6.63	2	11.70	0.00	3.11	0.58	6.46
		2	5	0.64	7.20	0.01	1.05	1.80	4.34	0.32	4.81	0.29	4.52	0.16	4.78	0.30	4.48	0.04	4.52		11.90	0.00	2.60	0.58	6.46
		3	5	0.68	7.85	0.01	1.05	1.80	5.00	0.34	5.49	0.29	5.19	0.18	5.46	0.30	5.16	0.05	5.21		13.66	0.00	2.77	0.58	6.46
		4	5	0.82	10.19	0.01	1.05	1.80	7.33	0.41	7.89	0.29	7.60	0.21	7.90	0.30	7.60	0.06	7.66		11.92	0.00	3.36	0.58	6.46
		5	5	0.78	9.49	0.01	1.05	1.80	6.63	0.39	7.17	0.29	6.87	0.20	7.17	0.30	6.87	0.05	6.92		11.70	0.00	3.18	0.58	6.46
		6	3	0.70	8.17	0.01	1.05	1.80	5.31	0.35	5.81	0.29	5.52	0.18	5.79	0.30	5.49	0.05	5.54		12.13	0.00	2.85	0.58	6.46
	3	1	5	0.83	6.74	0.02	1.05	1.80	3.87	0.41	4.62	0.48	4.14	0.21	4.56	0.30	4.26	0.06	4.31	3	12.88	0.00	3.38	1.26	10.60
		2	5	0.86	7.24	0.02	1.05	1.80	4.38	0.43	5.14	0.48	4.66	0.22	5.08	0.30	4.78	0.06	4.84		12.22	0.00	3.51	1.26	10.60
		3	5	1.13	11.56	0.02	1.05	1.80	8.69	0.56	9.59	0.48	9.11	0.29	9.60	0.30	9.30	0.08	9.38		13.16	0.00	4.61	1.26	10.60
		4	5	0.85	7.02	0.02	1.05	1.80	4.15	0.42	4.91	0.48	4.43	0.22	4.85	0.30	4.55	0.06	4.60		16.20	0.00	3.45	1.26	10.60
		5	5	0.76	5.69	0.02	1.05	1.80	2.82	0.38	3.54	0.48	3.06	0.20	3.45	0.30	3.15	0.05	3.20		13.56	0.00	3.12	1.26	10.60
		6	6	0.83	6.78	0.02	1.05	1.80	3.91	0.41	4.66	0.48	4.18	0.21	4.60	0.30	4.30	0.06	4.35		13.83	0.00	3.39	1.26	10.60
	4	1	5	0.95	6.30	0.02	1.05	1.80	3.43	0.47	4.35	0.67	3.69	0.25	4.20	0.30	3.90	0.06	3.97	4	13.50	0.00	3.87	1.71	13.43
		2	5	0.93	5.97	0.02	1.05	1.80	3.10	0.46	4.02	0.67	3.35	0.24	3.86	0.30	3.56	0.06	3.62		12.74	0.00	3.79	1.71	13.43
		3	5	0.82	4.27	0.02	1.05	1.80	1.39	0.41	2.26	0.67	1.59	0.21	2.07	0.30	1.77	0.06	1.83		14.24	0.00	3.36	1.71	13.43
		4	5	0.78	3.82	0.02	1.05	1.80	0.95	0.39	1.80	0.67	1.13	0.20	1.60	0.30	1.30	0.05	1.35		14.04	(0.18)	3.20	1.71	13.43
		5	5	0.84	4.28	0.02	1.05	1.80	1.41	0.41	2.28	0.67	1.61	0.22	2.10	0.30	1.80	0.06	1.86		13.18	0.00	3.41	1.71	13.43
		6	5	0.81	4.12	0.02	1.05	1.80	1.24	0.40	2.10	0.67	1.44	0.21	1.92	0.30	1.62	0.05	1.67		12.22	0.00	3.32	1.71	13.43
	5	1	5	0.73	5.76	0.02	1.05	1.80	2.89	0.36	3.55	0.49	3.07	0.19	3.44	0.30	3.14	0.05	3.18	5	12.86	0.00	2.97	1.13	9.89
		2	5	0.69	5.10	0.02	1.05	1.80	2.24	0.34	2.88	0.49	2.40	0.18	2.75	0.30	2.45	0.05	2.50		12.90	0.00	2.80	1.13	9.89
		3	5	0.68	4.90	0.02	1.05	1.80	2.04	0.33	2.68	0.49	2.19	0.17	2.54	0.30	2.24	0.05	2.29		11.70	0.00	2.75	1.13	9.89
		4	5	0.65	4.58	0.02	1.05	1.80	1.71	0.32	2.34	0.49	1.85	0.17	2.20	0.30	1.90	0.04	1.95		11.34	0.00	2.67	1.13	9.89
		5	5	0.62	4.08	0.02	1.05	1.80	1.21	0.31	1.82	0.49	1.34	0.16	1.68	0.30	1.38	0.04	1.42		11.90	0.00	2.54	1.13	9.89
		6	6	0.62	3.98	0.02	1.05	1.80	1.11	0.31	1.72	0.49	1.23	0.16	1.57	0.30	1.27	0.04	1.31		12.63	0.00	2.52	1.13	9.89
	6	1	5	0.63	4.84	0.01	1.05	1.80	1.98	0.31	2.56	0.32	2.24	0.16	2.55	0.30	2.25	0.04	2.29	6	10.60	0.00	2.55	0.98	8.89
		2	5	0.59	4.26	0.01	1.05	1.80	1.40	0.29	1.97	0.32	1.65	0.15	1.94	0.30	1.64	0.04	1.68		10.31	0.00	2.40	0.98	8.89
		3	5	0.58	4.19	0.01	1.05	1.80	1.33	0.29	1.89	0.32	1.57	0.15	1.86	0.30	1.56	0.04	1.60		9.68	0.00	2.38	0.98	8.89
		4	5	0.55	3.63	0.01	1.05	1.80	0.77	0.27	1.32	0.32	1.00	0.14	1.28	0.30	0.98	0.04	1.02		9.69	0.00	2.24	0.98	8.89
		5	5	0.54	3.43	0.01	1.05	1.80	0.57	0.27	1.11	0.32	0.80	0.14	1.07	0.30	0.77	0.04	0.81		9.12	0.00	2.19	0.98	8.89
		6	5	0.54	3.42	0.01	1.05	1.80	0.56	0.27	1.10	0.32	0.78	0.14	1.06	0.30	0.76	0.04	0.80		9.00	(0.01)	2.19	0.98	8.89
	7	1	5	0.54	3.77	0.00	1.05	1.80	0.91	0.27	1.46	0.10	1.36	0.14	1.60	0.30	1.30	0.04	1.34	7	9.31	0.00	2.22	0.92	8.40
		2	5	0.55	3.83	0.00	1.05	1.80	0.97	0.27	1.52	0.10	1.42	0.14	1.66	0.30	1.36	0.04	1.40		9.54	0.00	2.23	0.92	8.40
		3	5	0.55	3.83	0.00	1.05	1.80	0.97	0.27	1.52	0.10	1.42	0.14	1.66	0.30	1.36	0.04	1.40		9.38	0.00	2.23	0.92	8.40
		4	5	0.53	3.53	0.00	1.05	1.80	0.67	0.26	1.21	0.10	1.11	0.14	1.35	0.30	1.05	0.04	1.08		8.80	0.00	2.15	0.92	8.40
		5	5	0.53	3.58	0.00	1.05	1.80	0.72	0.26	1.26	0.10	1.16	0.14	1.40	0.30	1.10	0.04	1.14		8.48	0.00	2.17	0.92	8.40
		6	6	0.54	3.70	0.00	1.05	1.80	0.85	0.27	1.39	0.10	1.29	0.14	1.53	0.30	1.23	0.04	1.27		8.30	0.00	2.20	0.92	8.40
	8	1	5	0.54	3.28	0.00	1.05	1.80	0.43	0.27	1.03	0.12	0.91	0.14	1.17	0.30	0.87	0.04	0.91	8	8.16	(0.66)	2.20	1.12	9.62
		2	5	0.53	3.29	0.00	1.05	1.80	0.44	0.26	1.04	0.12	0.91	0.14	1.18	0.30	0.88	0.04	0.92		8.36	(1.43)	2.17	1.12	9.62
		3	5	0.53	3.30	0.00	1.05	1.80	0.45	0.26	1.04	0.12	0.92	0.14	1.18	0.30	0.88	0.04	0.92		8.12	(2.29)	2.15	1.12	9.62
		4	5	0.55	3.27	0.00	1.05	1.80	0.42	0.27	1.02	0.12	0.90	0.14	1.17	0.30	0.87	0.04	0.91		8.12	(2.84)	2.22	1.12	9.62
		5	5	0.55	3.26	0.00	1.05	1.80	0.41	0.27	1.02	0.12	0.89	0.14	1.16	0.30	0.86	0.04	0.90		8.52	(3.31)	2.24	1.12	9.62
		6	6	0.55	3.27	0.00	1.05	1.80	0.41	0.27	1.02	0.12	0.90	0.14	1.17	0.30	0.87	0.04	0.90		8.37	(3.83)	2.23	1.12	9.62
	9	1	5	0.52	3.20	0.00	1.05	1.80	0.34	0.26	0.89	0.11	0.78	0.14	1.03	0.30	0.73	0.04	0.76	9	8.20	(3.82)	2.13	0.97	8.67
		2	5	0.54	3.16	0.00	1.05	1.80	0.31	0.27	0.87	0.11	0.76	0.14	1.01	0.30	0.71	0.04	0.75		8.20	(3.44)	2.22	0.97	8.67
		3	5	0.54	3.16	0.00	1.05	1.80	0.31	0.27	0.87	0.11	0.76	0.14	1.01	0.30	0.71	0.04	0.75		9.87	(3.07)	2.22	0.97	8.67
		4	5	0.55	3.16	0.00	1.05	1.80	0.31	0.27	0.86	0.11	0.76	0.14	1.01	0.30	0.71	0.04	0.75		11.70	(2.66)	2.22	0.97	8.67
		5	5	0.55	3.16	0.00	1.05	1.80	0.30	0.27	0.86	0.11	0.76	0.14	1.01	0.30	0.71	0.04	0.74		11.21	(2.23)	2.23	0.97	8.67
		6	5	0.54	3.16	0.00	1.05	1.80	0.31	0.27	0.87	0.11	0.76	0.14	1.01	0.30	0.71	0.04	0.75		9.72	(1.86)	2.22	0.97	8.67
	10	1	5	0.54	4.08	0.01	1.05	1.80	1.23	0.27	1.64	0.21	1.43	0.14	1.65	0.30	1.35	0.04	1.39	10	9.61	0.00	2.21	0.52	6.08
		2	5	0.55	6.07	0.01	1.05	1.80	3.21	0.27	3.62	0.21	3.42	0.14	3.64	0.30	3.34	0.04	3.37		9.17	0.00	2.24	0.52	6.08
		3	5	0.53	5.81	0.01	1.05	1.80	2.96	0.26	3.37	0.21	3.16	0.14	3.38	0.30	3.08	0.04	3.11		9.16	0.00	2.18	0.52	6.08
		4	5	0.53	5.81	0.01	1.05	1.80	2.96	0.26	3.37	0.21	3.16	0.14	3.38	0.30	3.08	0.04	3.11		9.01	0.00	2.18	0.52	6.08
		5	5	0.54	5.91	0.01	1.05	1.80	3.06	0.27	3.47	0.21	3.26	0.14	3.48	0.30	3.18	0.04	3.22		8.36	0.00	2.20	0.52	6.08
		6	6	0.54	5.89	0.01	1.05	1.80	3.03	0.27	3.44	0.21	3.24	0.14	3.45	0.30	3.15	0.04	3.19		9.80	0.00	2.20	0.52	6.08
	11	1	5	0.53	4.44	0.02	1.05	1.80	1.57	0.26	2.04	0.47	1.57	0.14	1.84	0.30	1.54	0.04	1.57	11	9.86	0.00	2.17	0.78	7.85
		2	5	0.54	4.49	0.02	1.05	1.80	1.62	0.27	2.09	0.47	1.63	0.14	1.89	0.30	1.59	0.04	1.63		9.20	0.00	2.19	0.78	7.85
		3	5	0.54	4.49	0.02	1.05	1.80	1.62	0.27	2.09	0.47	1.63	0.14	1.89	0.30	1.59	0.04	1.63		15.22	0.00	2.19	0.78	7.85
		4	5	0.55	4.69	0.02	1.05	1.80	1.82	0.27	2.30	0.47	1.83	0.14	2.10	0.30	1.80	0.04	1.84		10.46	0.00	2.24	0.78	7.85
		5	5	0.55	4.71	0.02	1.05	1.80	1.85	0.27	2.33	0.47	1.86	0.14	2.13	0.30	1.83	0.04	1.86		9.08	0.00	2.24	0.78	7.85
		6	5	0.55	4.71	0.02	1.05	1.80	1.85	0.27	2.33	0.47	1.86	0.14	2.13	0.30	1.83	0.04	1.86		8.52	0.00	2.24	0.78	7.85
	12	1	5	0.57	5.31	0.01	1.05	1.80	2.45	0.28	2.93	0.45	2.48	0.15	2.75	0.30	2.45	0.04	2.49	12	11.02	0.00	2.33	0.73	7.55
		2	5	0.58	5.44	0.01	1.05	1.80	2.57	0.29	3.06	0.45	2.61	0.15	2.88	0.30	2.58	0.04	2.62		10.45	0.00	2.36	0.73	7.55
		3	5	0.62	6.09	0.01	1.05	1.80	3.23	0.31	3.73	0.45	3.28	0.16	3.56	0.30	3.26	0.04	3.30		11.92	0.00	2.53	0.73	7.55
		4	5	0.63	6.27	0.01	1.05	1.80	3.40	0.31	3.91	0.45	3.46	0.16	3.75	0.30	3.45	0.04	3.49		9.74	0.00	2.57	0.73	7.55
		5	5	0.65	6.59	0.01	1.05	1.80	3.73	0.32	4.25	0.45	3.80	0.17	4.09	0.30	3.79	0.04	3.83		9.24	0.00	2.66	0.73	7.55
		6	6	0.71	7.48	0.01	1.05	1.80	4.62	0.35	5.17	0.45	4.72	0.18	5.02	0.30	4.72	0.05	4.77		10.46	0.00	2.88	0.73	7.55

D-3.6 Correlation between Development amount of Water and Water Use

Several cases were applied for the calculation for the purpose of understanding the relationship between the amount of water to be developed and size of the dam.

(1) Calculation Case

The flowing 6 cases are used as parameters:

- 0.0 m^3/s
- 0.5
- 1.0
- 1.5
- 1.8 (present plan)
- 2.0

(2) Calculation Result

The correlation between the amounts of water to be developed and water use is illustrated in Figure-D.15.

Development amount of water (L/sec)	Water use capacity (10^3m3)	Storage capacity for sedimentation (10^3m3)	Total reservoir capacity (10^3m3)
0	3,000	1,000	4,000
500	4,000	1,000	5,000
1,000	5,000	1,000	6,000
1,500	7,000	1,000	8,000
1,800	9,000	1,000	10,000
2,000	10,000	1,000	11,000
2,500	16,000	1,000	17,000
3,000	25,000	1,000	26,000

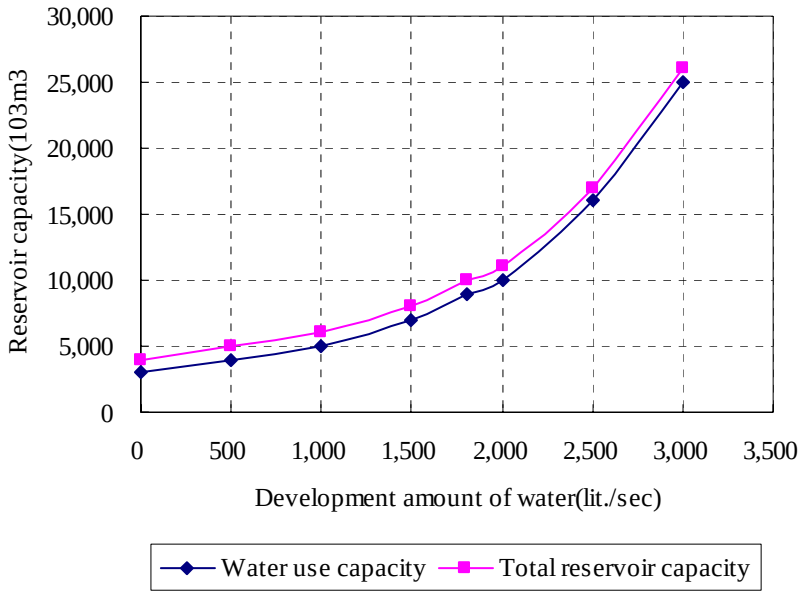


Figure-D.15 Correlation between the Amount of Water to be Developed and Water Use Capacity (1983)

D-4 FLOOD CONTROL PLAN IN DENPASAR AREA

Since Badung and Mati River are flooded repeatedly, flood control project based on riverbed excavation has been proposed. This section summarizes the contents for various types of hydrological analysis for the project.

D-4.1 General

Denpasar Area has two main rivers: Badung and Mati River. Basin area of Badung River is 41.1 km^2, running through the center of Denpasar city to the Badung Bay. Badung River is one of the typical unban rivers surrounded by residences and commercial facilities. About 50% of the river flows through urban area.

Mati River which flows west side of Badung River is similar in size to Badung River. It has basin area of 40.7 km^2 and the lower course of the river is adjacent to Kuta area known as an internationally-popular tourist spot.

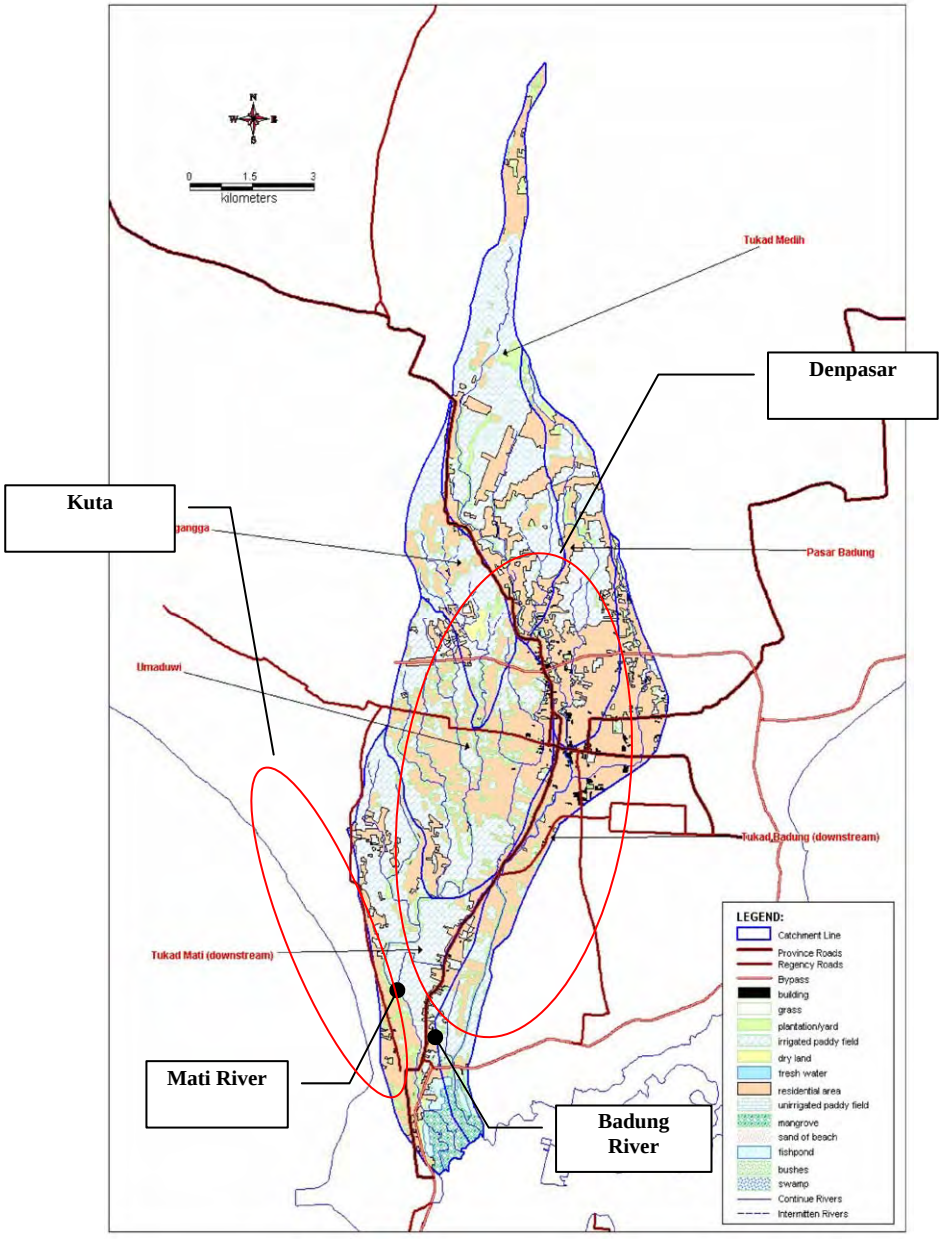


Figure-D.16 Map of Drainage System






Pictures of Badung River






Pictures of Mati River

D-4.2 River Improvement Plan and Current Conditions

River improvement plans for Badung and Mati River have already been proposed by Flood Control Project Office.
The plan and actual state of progress and issued will be discussed and used for safety-level evaluations and flood prevention plan.

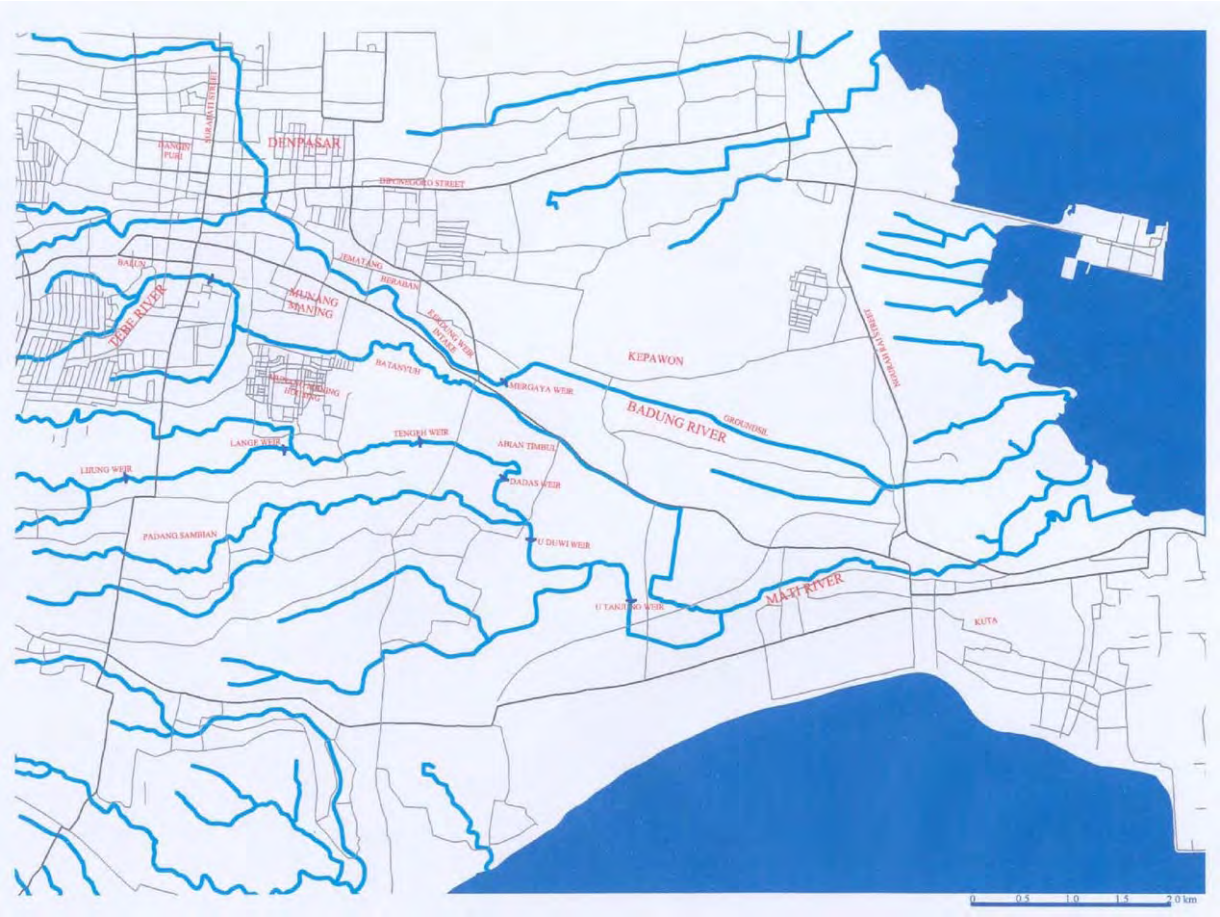


Figure-D.17 Location Map of Badung and Mati River

D-4.2.1 Badung River

Information of Badung River is described below.

(1) River Improvement Plan and Current Conditions

River improvement plan for Badung River and its current conditions are summarized as follows:

(a) 25 years of return period for flood control plan shall be adopted. River bed excavation and bank heightening shall be operated to improve the flow capacity.

(b) According to the hearings conducted by Flood Control Project Office, riverbed excavation is completed but bank heightening is remained untouched due to land acquisition problem.

(c) According to a field survey, it is trench-type river and river width is somewhere between 20 to 30m. No revetment heightening and establishment of parapet were found.

(2) Documentation Status and Problems

Documents including calculation of flow capacity of the current river channel, safety-level evaluations and data of current river channel required for suggesting the flood control plan are shown below.

(a) Figures showing the river improvement plan contain cross sections before/after the improvement work.

(b) The current river condition is equivalent to the figure after riverbed excavation.

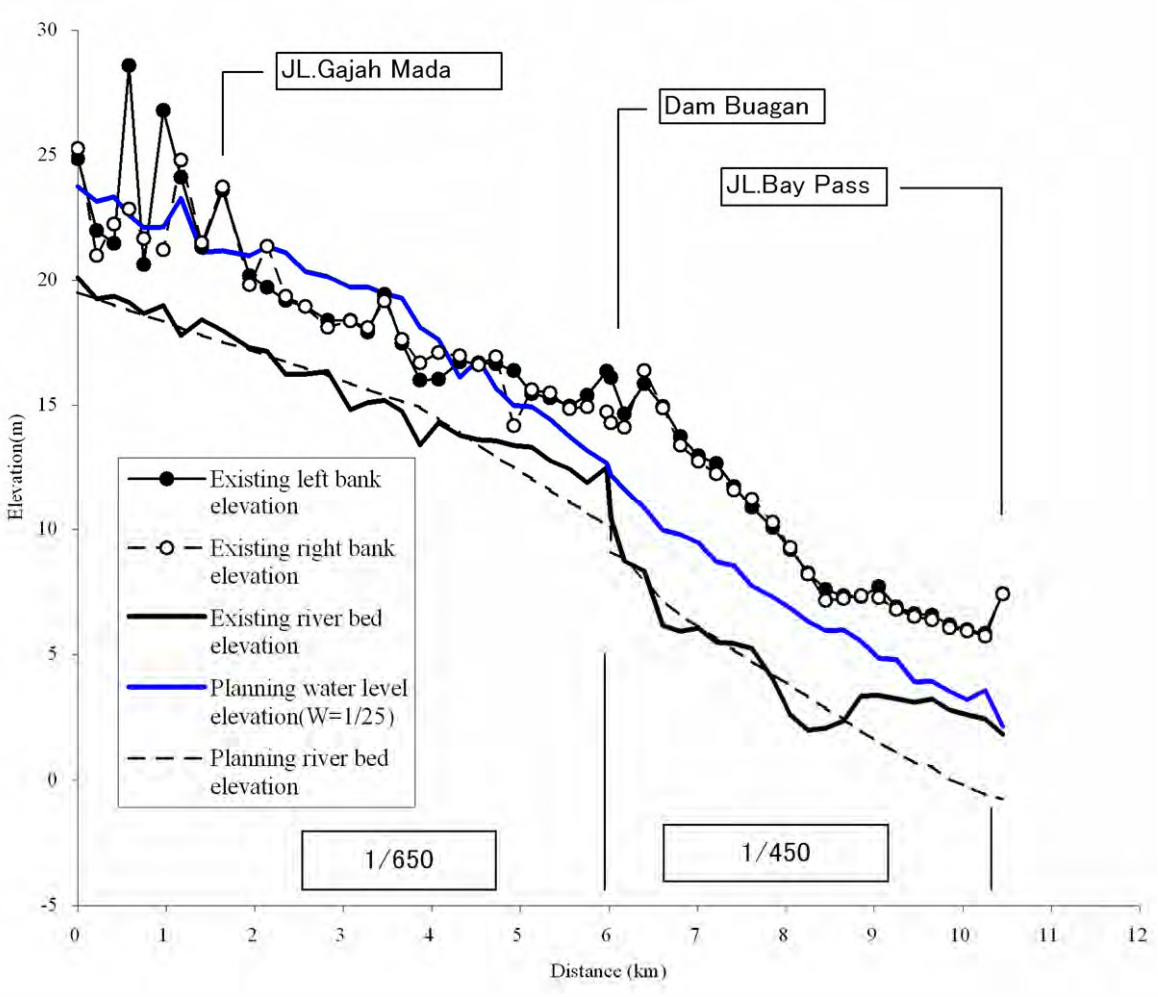


Figure-D.18 Designed Longitudinal Profile of Badung River

Source: LAPORAN AKHIR PERENCANAAN PENGELOLAAN SEDIMEN TUKAD BADUN DESEMBAR 2001

Table-D.16 PU Improvement Plan for Badung River

No	PROFILE NUMBER	PROFILE DISTANCE	COMMULATIVE DISTANCE	EXISTING			PLANNING		Remarks
				LEFT BANK ELEVATION	RIGHT BANK ELEVATION	RIVER BED ELEVATION	WATER LEVEL	RIVER BED ELEVATION	
		(m)	(m)	(m)	(m)	(m)	(m)	(m)	
1	B 200	0.00	0	24.86	25.27	20.110	23.744	19.522	
2	B 196	215.00	215	21.99	20.99	19.260	23.165	19.264	
3	B 192	195.00	410	21.48	22.25	19.370	23.333	19.006	
4	B 188	170.00	580	28.59	22.85	19.120	22.604	18.802	
5	B 184	165.00	745	20.64	21.67	18.670	22.105	18.611	
6	B 180	220.00	965	26.80	21.23	18.990	22.140	18.352	
7	B 176	200.00	1165	24.12	24.81	17.790	23.293	18.097	
8	B 172	235.00	1400	21.33	21.50	18.430	21.119	17.799	
9	B 168	235.00	1635	23.61	23.73	17.995	21.188	17.529	JL.GAJAMADA
10	B 164	305.00	1940	20.19	19.83	17.299	20.981	17.223	
11	B 160	200.00	2140	19.72	21.36	17.160	21.354	16.985	
12	B 156	210.00	2350	19.20	19.37	16.240	21.108	16.739	
13	B 152	220.00	2570	18.96	18.96	16.260	20.356	16.492	
14	B 148	255.00	2825	18.40	18.13	16.350	20.146	16.198	
15	B 144	255.00	3080	18.41	18.38	14.830	19.731	15.867	
16	B 140	195.00	3275	17.93	18.12	15.116	19.734	15.635	
17	B 136	190.00	3465	19.44	19.17	15.200	19.471	15.396	
18	B 132	200.00	3665	17.48	17.64	14.770	19.294	15.163	
19	B 128	200.00	3865	16.01	16.70	13.420	18.120	14.934	
20	B 124	210.00	4075	16.05	17.11	14.310	17.638	14.451	
21	B 120	240.00	4315	16.74	16.98	13.810	16.131	13.913	
22	B 116	215.00	4530	16.70	16.62	13.630	16.828	13.434	
23	B 112	195.00	4725	16.67	16.94	13.590	15.689	12.940	
24	B 108	200.00	4925	16.39	14.19	13.400	15.004	12.529	
25	B 104	205.00	5130	15.47	15.62	13.330	14.941	12.074	
26	B 100	205.00	5335	15.31	15.50	12.800	14.446	11.615	
27	B 96	220.00	5555	14.97	14.87	12.460	13.760	11.123	
28	B 92	200.00	5755	15.41	14.95	11.910	13.186	10.676	
29	B 88	220.00	5975	16.37	14.74	12.530	12.698	10.187	
	B BM	50.00	6025	16.11	14.30	10.450	12.218	10.076	DAM BUAGAN
		0.01	6025.01	16.11	14.30	10.450	12.218	9.105	
30	B 3	149.99	6175	14.67	14.13	8.750	11.641	8.830	
31	B 7	225.00	6400	15.87	16.40	8.350	10.872	7.975	
32	B 11	210.00	6610	14.96	14.90	6.170	9.975	7.180	
33	B 15	200.00	6810	13.75	13.41	5.940	9.800	6.576	
34	B 19	200.00	7010	12.99	12.77	6.070	9.477	6.121	
35	B 23	205.00	7215	12.68	12.27	5.500	8.726	5.657	
36	B 27	200.00	7415	11.76	11.61	5.450	8.559	5.203	
37	B 31	200.00	7615	10.90	11.25	5.260	7.745	4.753	
38	B 35	235.00	7850	10.08	10.30	4.040	7.313	4.228	
39	B 39	200.00	8050	9.21	9.29	2.610	6.864	3.779	
40	B 43	200.00	8250	8.27	8.22	2.000	6.336	3.330	
41	B 47	200.00	8450	7.60	7.17	2.070	5.965	2.880	
42	B 51	200.00	8650	7.36	7.25	2.360	5.998	2.427	
43	B 55	200.00	8850	7.33	7.36	3.360	5.547	1.964	
44	B 59	200.00	9050	7.72	7.28	3.380	4.865	1.510	
45	B 63	200.00	9250	6.91	6.81	3.250	4.809	1.104	
46	B 67	200.00	9450	6.65	6.53	3.110	3.930	0.702	
47	B 71	200.00	9650	6.58	6.40	3.241	3.938	0.549	
48	B 75	200.00	9850	6.20	6.08	2.797	3.546	0.031	
49	B 79	200.00	10050	6.01	5.95	2.608	3.209	-0.258	
50	B 83	200.00	10250	5.86	5.75	2.440	3.579	-0.576	

Source: LAPORAN AKHIR PERENCANAAN PENGELOLAAN SEDIMEN TUKAD BADUN DESEMBAR 2001

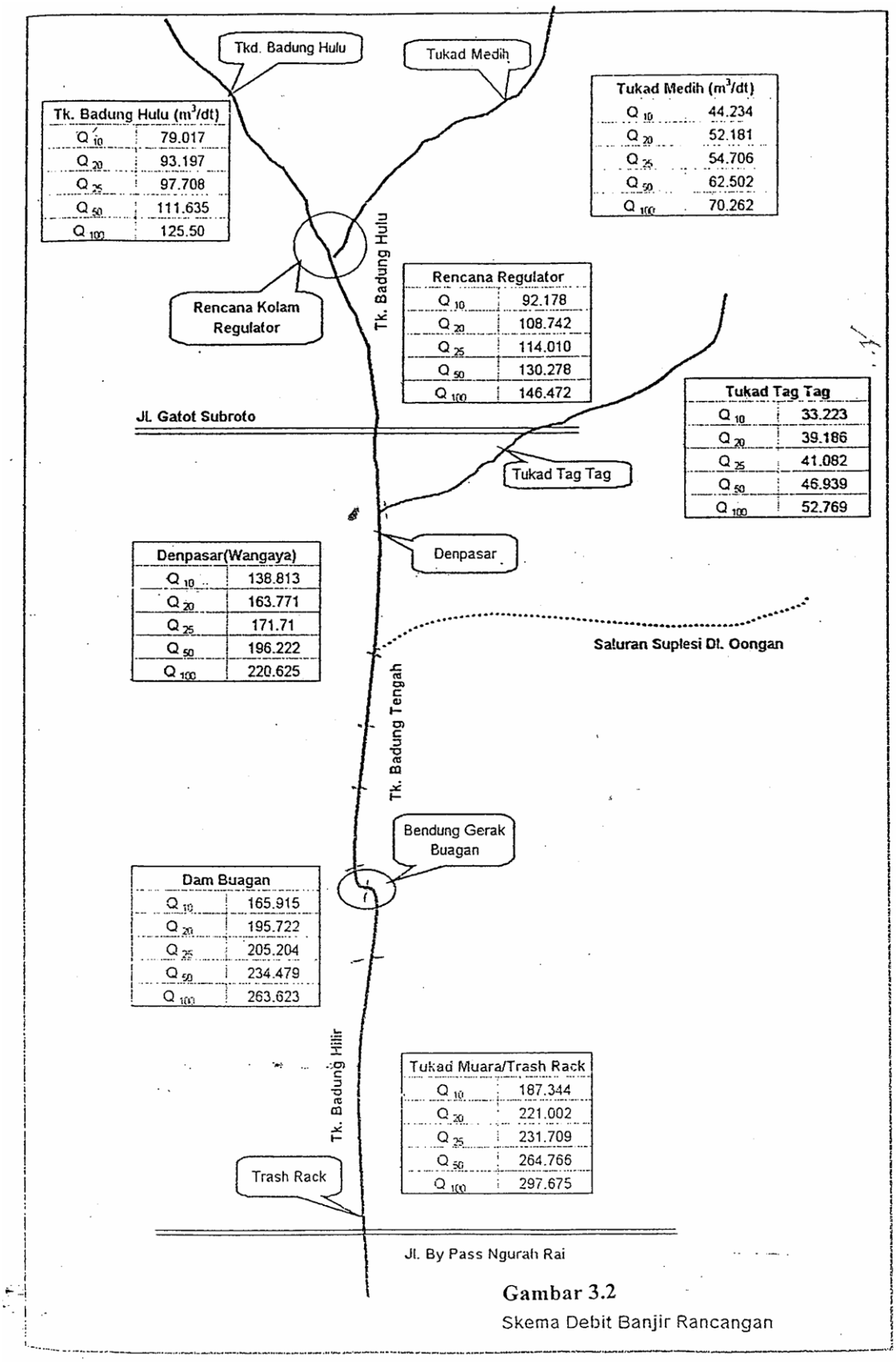


Figure-D.19 Outcomes of Past Survey: Design Discharge for each Return Period

Source: LAPORAN AKHIR PERENCANAAN PENGELOLAAN SEDIMEN TUKAD BADUN DESEMBAR 2001

D-4.2.2 Mati River

Information of Mati River is described below.

(1) River Improvement Plan and Current Conditions

River improvement plan for Mati River and its current conditions are summarized as follows:

(a) 25 years of return period for the flood control plan shall be adopted. Shortcut, river widening, riverbed excavation and bank heightening shall be operated to improve the flow capacity.
(b) The hearing conducted by Flood Control Project Office shows that river improvement works has been operated only on the point where flood occurred due to the difficulty in land acquisition. Currently the river improvement plan has been reviewed.
(c) According to a field survey, almost all of the revetment works excluding the urban area has been completed. No modification for trait of river channel was found.

(2) Documentation Status and Problems

Documents including calculation of flow capacity of the current river channel, safety-level evaluations and data of current river channel required for suggesting the flood control plan are shown below.

(a) River improvement plan covering all rivers has been developed, in which cross sections before/after the improvement work are described.
(b) According to a field survey, although some kind of improvement works is completed, cross sections of river width and revetment slopes are different from and inconsistent with those in the river improvement plan.

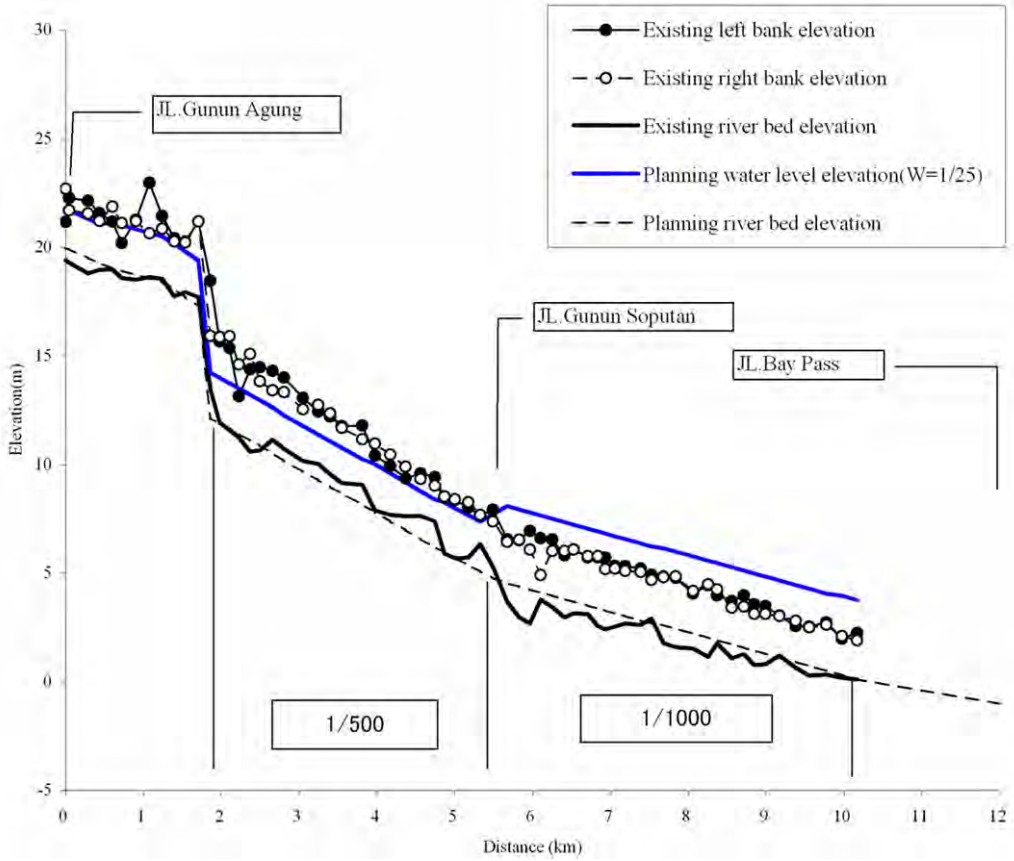


Figure-D.20 Designed Longitudinal Profile of Mati River

Source: LAPORAN AKHIR PENGUKURAN DAN PERENCANAAN TEKNIS TUKAD SUNGI DAN TUKADBAD MATI 1997/1998

Table-D. 17 PU River Improvement Plan for Mati River

No	PROFILE NUMBER		PROFILE DISTANCE	COMMULATIVE DISTANCE	EXISTING			PLANNING		Remarks
					LEFT BANK ELEVATION	RIGHT BANK ELEVATION	RIVER BED ELEVATION	WATER LEVEL	RIVER BED ELEVATION	
			(m)	(m)	(m)	(m)	(m)	(m)	(m)	
1	BM	M II	0	0	21.18	22.71	19.42	21.784	19.984	JL.Gunun Agung
2	M	248	42	42	22.28	21.72	19.31	21.716	19.916	
3	M	244	244	286	22.16	21.58	18.81	21.326	19.526	
4	M	240	147	433	21.59	21.23	18.98	21.091	19.291	
5	M	236	168	601	21.2	21.89	19.00	21.148	19.048	
6	CP	28	118	719	20.22	21.14	18.60	21.03	18.93	
7	M	228	184	903	21.28	21.22	18.52	20.846	18.746	
8	M	224	174	1077	22.99	20.66	18.64	20.672	18.572	
9	CP	27	161	1238	21.46	20.88	18.56	20.511	18.411	
10	M	215	157	1395	20.43	20.29	17.76	20.179	18.079	
11	M	212	140	1535	20.28	20.24	17.95	19.829	17.729	
12	M	208	170	1705	21.21	21.21	17.72	19.404	17.304	
13	M	204	152	1857	18.48	15.93	13.48	14.246	12.146	
14	BM	M9	120	1977	15.69	15.87	11.94	14.006	11.906	
15	M	196	127	2104	15.37	15.92	11.60	13.752	11.652	
16	CP	24	121	2225	13.16	14.62	11.26	13.510	11.410	
17	M	188	144	2369	14.40	15.10	10.60	13.222	11.122	
18	M	184	125	2494	14.49	13.85	10.66	12.972	10.872	
19	M	180	164	2658	14.33	13.43	11.15	12.644	10.544	
20	M	176	147	2805	14.01	13.35	10.74	12.270	10.170	
21	M	172	242	3047	13.09	12.56	10.17	11.786	9.686	
22	CP	21	197	3244	12.45	12.76	10.04	11.392	9.292	
23	M	164	153	3397	12.23	12.37	9.57	11.086	8.986	
24	M	160	149	3546	11.79	11.70	9.16	10.788	8.688	
25	M	156	263	3809	11.81	11.17	9.08	10.262	8.162	
26	M	152	163	3972	10.42	10.97	7.90	10.028	7.828	
27	M	148	199	4171	9.95	10.47	7.69	9.610	7.410	
28	M	144	197	4368	9.38	9.91	7.63	9.196	6.996	
29	M	140	192	4560	9.60	9.35	7.65	8.776	6.576	
30	M	136	182	4742	9.44	9.04	7.40	8.411	6.211	
31	M	132	124	4866	8.48	8.54	5.92	8.262	5.962	
32	M	128	134	5000	8.37	8.41	5.70	8.007	5.702	
33	M	124	174	5174	8.03	8.28	5.72	7.677	5.377	
34	M	120	150	5324	7.68	7.69	6.34	7.392	5.092	
35	M	116	165	5489	7.93	7.39	5.31	7.712	4.787	JL.Gunun Soputan
36	M	112	184	5673	6.57	6.45	3.70	8.093	4.543	
37	M	108	151	5824	6.52	6.55	2.98	7.942	4.392	
38	BM	M5	141	5965	6.95	6.09	2.69	7.801	4.251	
39	M	100	136	6101	6.62	4.92	3.79	7.665	4.115	
40	M	96	149	6250	6.56	6.04	3.44	7.516	3.966	
41	M	92	157	6407	5.83	6.03	2.97	7.359	3.809	
42	M	88	116	6523	6.11	6.09	3.16	7.243	3.693	
43	M	84	185	6708	5.74	5.80	3.12	7.058	3.508	
44	M	79	130	6838	5.74	5.80	2.57	6.928	3.378	
45	M	76	95	6933	5.73	5.20	2.42	6.833	3.283	
46	M	72	125	7058	5.34	5.22	2.55	6.708	3.158	
47	CP	9	128	7186	5.33	5.11	2.69	6.580	3.030	
48	M	64	200	7386	5.22	5.07	2.62	6.380	2.830	
49	M	60	140	7526	4.94	4.70	2.92	6.240	2.690	
50	CP	7	155	7681	4.85	4.83	1.79	6.159	2.609	

Source: LAPORAN AKHIR PENGUKURAN DAN PERENCANAAN TEKNIS TUKAD SUNGI DAN TUKADBAD MATI 1997/1998

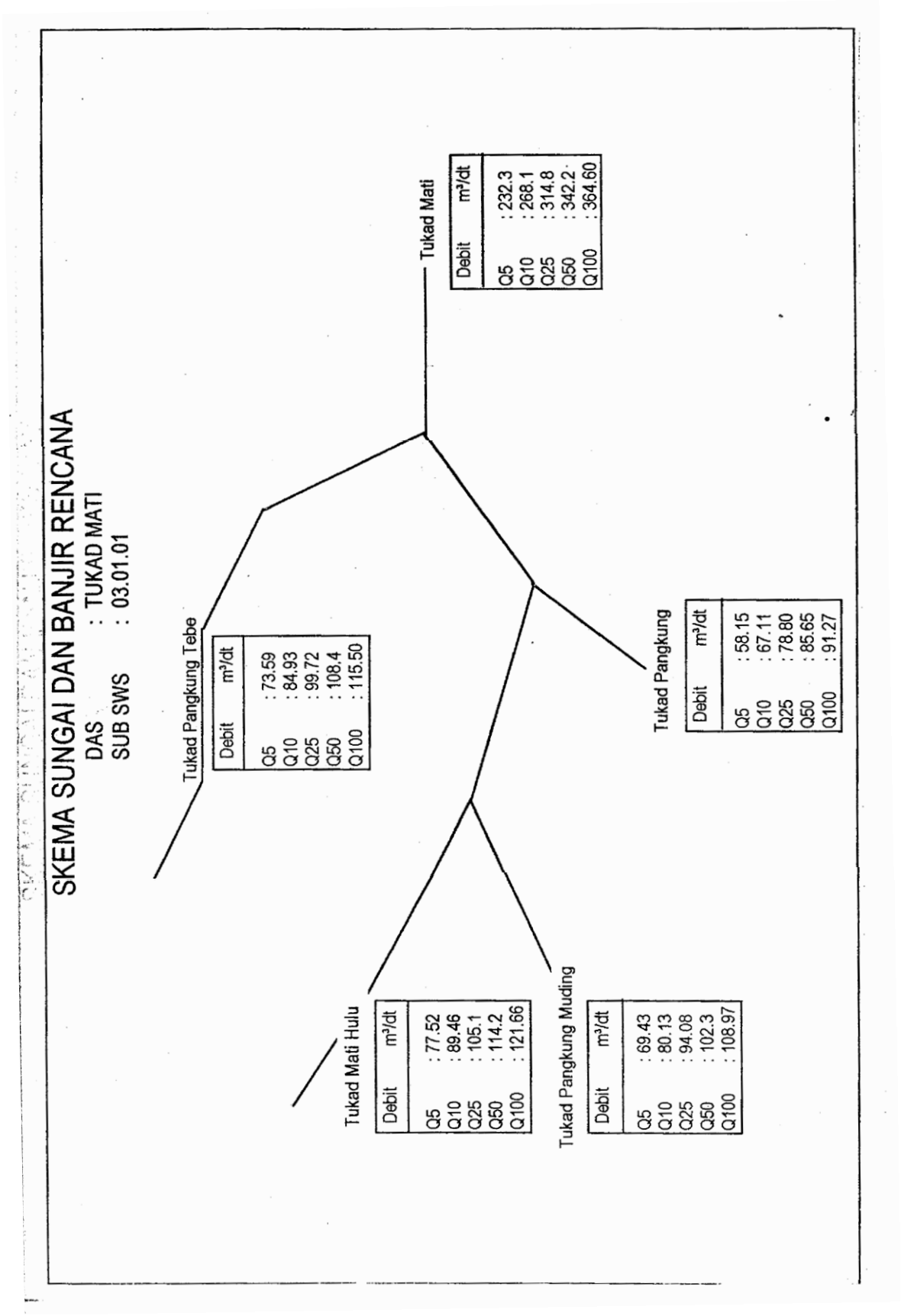


Figure-D.21 Outcomes of Past Survey (1): Design Discharge for Each Return Period

Source: LAPORAN AKHIR PENGUKURAN DAN PERENCANAAN TEKNIS TUKAD SUNGI DAN TUKADBAD MATI 1997/1998

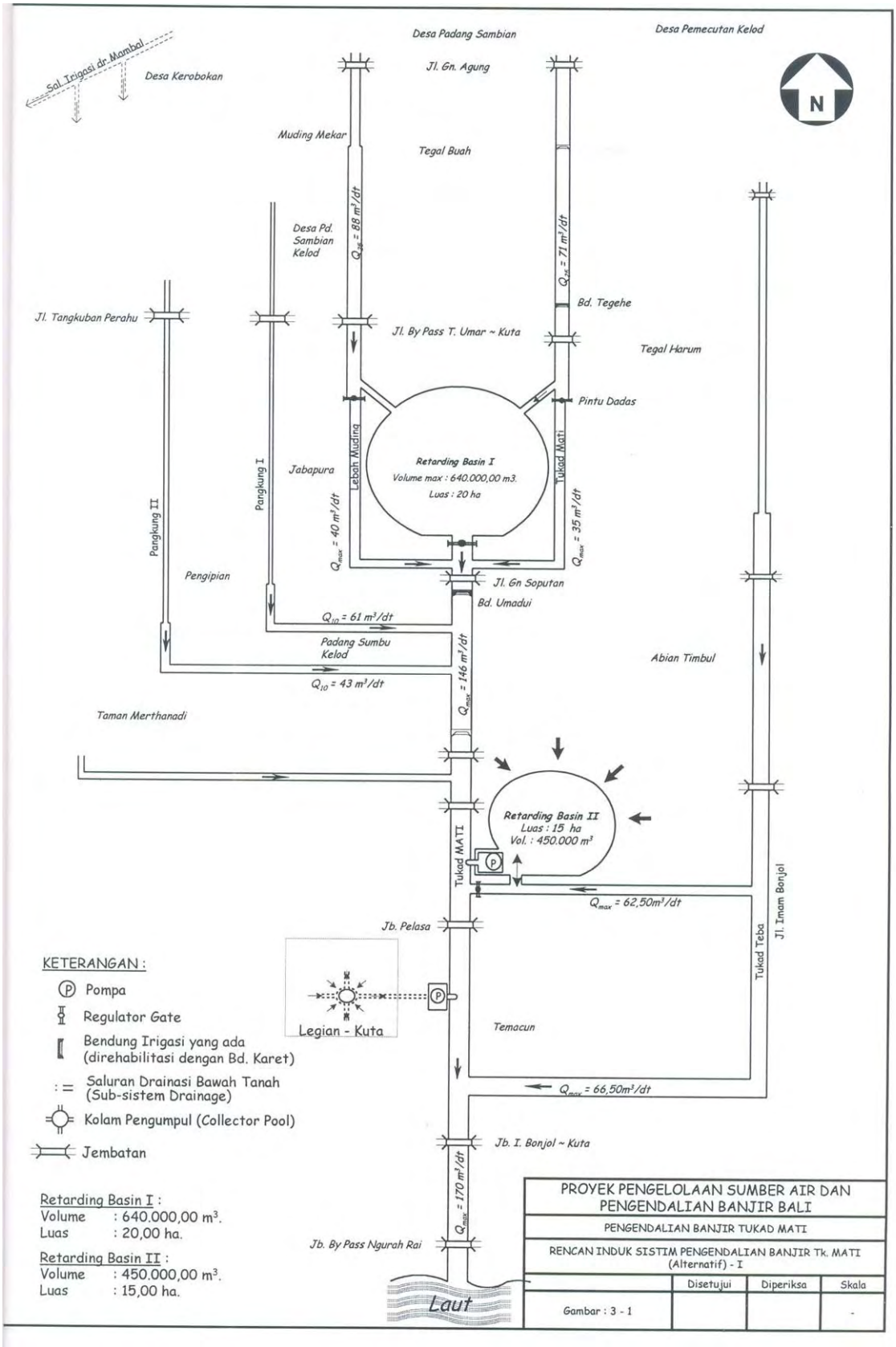


Figure-D.22 Outcomes of Past Survey (2): Plan for Retarding Basin and Rainwater Drainage

Source: STUDY KELAYAKAN PERENCANAAN PENGENDALIAN BANJIR SISTIM TUKAD MATI October 1999

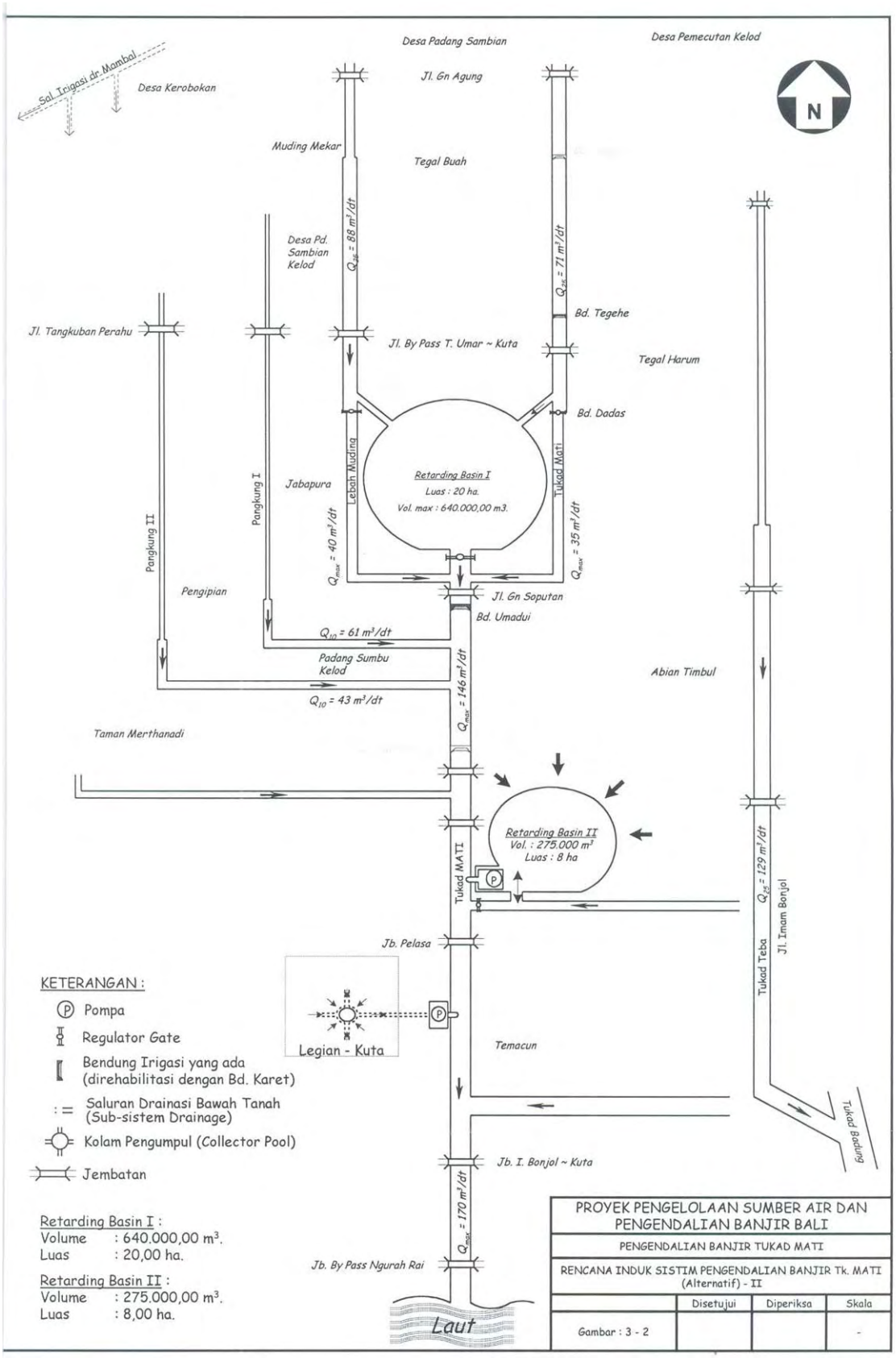


Figure-D.23 Outcomes of Past Survey (2): Plan for Retarding Basin and Rainfall Drainage (with Tebe River separated)

Source: STUDY KELAYAKAN PERENCANAAN PENGENDALIAN BANJIR SISTIM TUKAD MATI October 1999

D-4.2.3 River Flow Capacity of Existing River Channel

Calculation for river flow capacity of existing river channels and safety-level evaluations are operated. These data will be applied for a proposal of flood control plan.

(1) Badung River

The calculation result for Badung River is shown below. Minimum flow capacity of existing river channel is approximately 100m3/s, which means the return period is less than 10 years.

Table-D.18 Calculation Method and Conditions (Badung River)

River Name	Badung River	Remarks
1) Calculation Method	・Non-uniform Flow	
2) Section	・Buangan Dam - Gajah mada Street	
3) Distance between Calculation Points	・Approx. 200m	
4) Coefficient of Roughness	・0.025 is adopted	Making consistency with the result reviewed by PU
5) Cross Section	・"After riverbed excavation" and "no bank raising" based on PU's improvement plan are applied ・Find coordinate of each variation point from the data	
6) No. of Case	・8 cases including Estimated High Water Discharge	See Table-
7) Initial Water Level	・Buagan Dam ・Maximum Depth	See Table-

Table-D.19 Water Discharge and Initial Water Depth (Badung River)

Case of Discharge		Discharge Q (m3/sec)	Initial water depth hi=hc (Buagan) (m)	Initial water level Hi (Buagan) (m)
①	⑤×0.2	41	0.551	10.627
②	⑤×0.4	82	0.875	10.951
③	⑤×0.6	123	1.147	11.223
④	⑤×0.8	164	1.389	11.465
⑤	Desingn	205	1.612	11.688
⑥	⑤×1.2	246	1.820	11.896
⑦	⑤×1.4	287	2.017	12.093
⑧	⑤×1.6	328	2.205	12.281

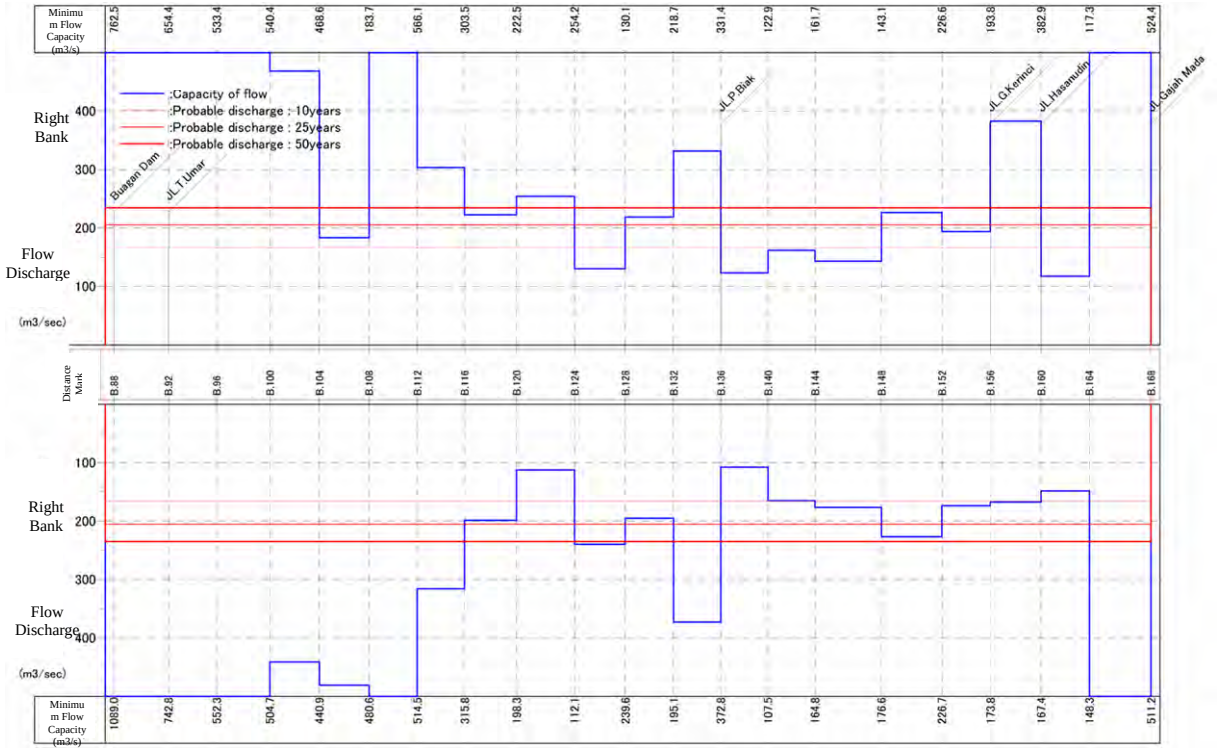


Figure-D.24 Current River Flow Capacity of Badung River (Buagan Dam to Gajamada St.)

(2) Mati River

The calculation result for Mati River is shown below. Minimum flow capacity of existing river channel is approximately 150m3/s, which means the return period is less than 10 years.

Table-D.20 Calculation Method and Conditions (Mati River)

River Name	Mati River	Remarks
1) Calculation Method	・Nonuniform Flow	
2) Section	・JL.Patih Jetantik～JL.G.Soputan	
3) Distance between Calculation Points	・Approx. 200m	
4) Coefficient of Roughness	・0.025 is adopted	Making consistency with the result reviewed by PU
5) Cross Section	・"After riverbed excavation" and "no bank raising" based on PU's improvement plan are applied ・Find coordinate of each variation point from the data	
6) No. of Cases	・8 cases including Estimated High Water Discharge	See Table-
7) Initial Water Level	・JL.Patih Jetantik ・Uniform Flow Depth	See Table-