Supporting Report D

HYDROLOGY AND WATER BALANCE STUDY

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D1 Meteorological Conditions in Jeneberang River Basin

The Jeneberang river basin is under the tropical climate, which shows high and rather constant air temperature throughout a year but distinct variation of rainfall in wet and dry seasons in a year. The northwest monsoon prevails from December to June, while the southeast monsoon from May to November. The northwest monsoon has high moisture contents, which are unloaded by Mt. Bawakaraeng, Mt. Lompobatang and their adjacent mountain ranges at the west edge of the river basin. As a result, the river basin, the mountainous/hilly area in particular, receives a large volume of rainfall during the period of northwest monsoon. On the other hand, the river basin receives little rainfall during the east monsoon due to sheltering effect by the mountain ranges. Monthly rainfall depth and other details of rainfall in the river basin are as mentioned in the following Chapter D3.

The climatic indices such as temperature, humidity, wind velocity, sunshine hour and evaporation other than the aforesaid rainfall are extracted from two meteorological gauging stations at Bonto Sunggu and Bonto Bili and summarized as below (refer to Table D1.1).

Meteorological Conditions in Jeneberang River Basin

Observed Item	Bonto Sunggu In Lower Reaches of Bili-Bili Dam	Bonto Bili Located adjacent to Bili-Bili dam
Mean Temperature (°C)	27.5	23.6
Mean Max. Temperature (°C)	31.4	25.9
Mean Min. Temperature (°C)	22.4	21.3
Relative Humidity (%)	85.0	81.0
Wind Velocity (m/s)	0.9	1.3
Sunshine Hour (hr/day)	7.0	4.0
Evaporation (mm/day)	5.3	4.3

The gauging station at Bonto Sunggu is located in the lower reaches of Bili-Bili dam, while the station at Bonto Bili is located adjacent to Bili-Bili dam, and therefore in the more mountainous upper reaches as compared with Bonto Bili. The particular characters of the above climatic indices are as enumerated hereinafter:

(1) Temperature

The average monthly temperatures at Bonto Sunggu show small fluctuation with a difference between the highest of about 28 ^{o}C in May and November and the lowest of about 27 ^{o}C in August. On the other hand, Bonto Bili shows more fluctuation with a difference between about 24.5 ^{o}C in December to May and 21.4 ^{o}C in August and September. Moreover, the annual average temperature of 23.6 ^{o}C at Bonto Bili is much lower than that of 27.5 ^{o}C at Bonto

Sunggu. Thus, the temperature in the upper reaches tends to show lower degree with more monthly fluctuations than that in the lower reaches.

(2) Relative Humidity

Both of the two climatic gauging stations show the rather small monthly variations of relative humidity with a range from about 79 % to 88 %. There is also no distinct difference of the annual average humidity between the two stations.

(3) Wind

Similar to the above relative humidity, there is no distinct variation in the monthly wind velocities at each of two gauging stations. The annual average wind velocities between the two stations have also small difference with a range of 0.9 m/s to 1.2 m/s.

(4) Sunshine

Bonto Sunggu has rather large monthly variations of one-day sunshine hours with a range from 4.4 hours/day in January (rainy season) to 9.2 hours/day in August (dry season). On the other hand, Bonto Bili tends to show the rather constant but shorter sunshine hours with a range of 3.3 to 4.9 hours/day.

(5) Evaporation

Bonto Sunggu and Bonto Bili show the annual average one-day evaporation of 5.3 mm/day (= 1,930 mm/year) and 4.3 mm/day (= 1,570 mm/year). Thus, the evaporation at Bonto Bili in the upper reaches has the less evaporation, which could be attributed to the cooler temperature, and the shorter sunshine hours.

D2 Hydrological Monitoring Network in the Jeneberang River Basin

There exist the following climate and hydrological gauging stations in the Jeneberang river basin, which are under administration of Meteorology and Geophysics Agency (BMD), Provincial Water Resources Management (Dinas PSDA) and JRBDP.

Meteorological and Rainfall Stations in Jeneberang River Basin

	BMG	Dinas PSDA	JRBDP	Total
Climatic Gauging Station	1	2	-	3
Rainfall Station	5	(20)*	3	(28)*
Water Level Gauging Station	-	-	3	3
Rainfall and Water Level Station	-	-	4	4

*: The figure is subject to further clarification

D2.1 Monitoring System by BMG

BMG currently operates one climatic gauging station and five rainfall gauging stations in the Jeneberang river basin (refer to Figure D2.1 and Table D2.1). As for the climatic gauging station, however, the current available gauging item is limited to only rainfall. Accordingly, when the comprehensive climatic data (including wind velocity/direction, temperature, humidity, sunshine duration and evaporation) related to the Jeneberang river basin are required, it is obliged to collect them from other three gauging stations located adjacent to the basin, namely: (1) Stamet. Mritim, (2) Stamet. Hasanuddin and (3) PG. Takalar.

D2.2 Monitoring System by Dinas PSDA and Balai PSDA

The location map and the inventory list of the gauging stations collected from Dinas PSDA are as shown in Figure D2.2 and Table D2.2, respectively. These are, however, detected to contain a certain inconsistency such that the number, the location and the name of the stations presented in the location map do not accord with those in the inventory list, and the gauging data at such uncertain stations were discarded for analysis in this Study.

The climatic and/or rainfall data are currently used for operation of irrigation facilities, formulation of irrigation plan and/or other relevant water resources development plan. Gauging and processing of all climatic and hydrological data had been undertaken by Dinas PSDA, but these works has been taken over to Balai PSDA after 2004. The monitoring results are sent to MSRI and published as the annual reports by MSRI.

D2.3 Monitoring System by JRBDP

JRBDP has operated seven water level gauging stations and seven rainfall gauging stations since 1998 (refer to Figure D2.3 and Table D2.3). All of these gauging stations are provided with the automatic gauging equipment and telemetry data transmittal system. The gauging data are transmitted at real-time base to the Bili-Bili Dam Control Office and the Monitoring Office placed at JRBDP Makassar Office.

D3 Rainfall Analysis

D3.1 Objectives of Analysis and Basic Data

The analysis aims at clarifying (a) the variations of long-term rainfall and (b) the magnitude of probable storm rainfall in the Jeneberang River Basin. The item (a) is used as the basic data to generate the long-term basin runoff discharge through simulation model as described in the following Chapter D4. As for the item (b), the estimated value could be used as the basic information for the proposed flood management.

Among the above existing gauging stations, the rainfall gauged at the following nine stations were selected as the basic data for analysis on the long-term basin average rainfall in due consideration of their locations and the available data length.

(1) Malino (Non-telemetry gauging station, which had been operated until 1998);
(2) Malino (New telemetry gauging station, which started its operation 1998);
(3) Jonggoa;
(4) Bili-Bili Intake (Non-telemetry station installed at the intake of the Bili-Bili Dam in 1975);
(5) Bili-Bili (New telemetry gauging station installed adjacent to the existing Bili-Bili dam site in 1998);
(6) Kampili (New telemetry gauging station, which was sifted from the under-mentioned old non-telemetry gauging station in 1998);
(7) Maccini Sombala;
(8) Limbunga; and
(9) Mangempang.

The irrigation water requirement for three major irrigation areas of Bili-Bili, Bissua, and Kampili irrigation areas in the Jeneberang River basin had been estimated by the Bili-Bili Irrigation Project in 1998. The basic rainfall data for the estimation were given from the following seven gauging stations.

(1) Kampili (Old non-telemetry gauging stations, which had been operated from 1974 to1998):
(2) Bontosunggu;
(3) Mandalle;
(4) Kalabajeng;
(5) Bonto Sallang;
(6) Barembeng; and
(7) Sandro Bone.

The estimated irrigation water requirement is essential for water supply-demand balance simulation, while the length of the estimation is limited to a period from 1972 to 1997. In this connection, an attempt was made to estimate the irrigation water requirement for the supplementary years from 1998 to 2001 with using the rainfall records at the above seven gauging stations.

Thus, the rainfall data used in this Study is summed up to sixteen gauging stations. Inventory list and location map of these selected gauging stations are as shown in Table D3.1 and Figure D3.1, respectively. The data collected in this Study is recorded in Volume IV-2 – Data Book.

D3.2 Analysis on Long-term Rainfall

The rainfall data at the above gauging stations were collected and processed in a form of annual rainfall tables. As the result, the average monthly rainfall from a 30-year period from 1972 to 2003 are estimated as listed below (refer to Table D3.2 and Figure D3.2):

Average Monthly and Annual Rainfall

(Unit: mm)

Gauging Station	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total	Gauge Period
Malino	864	706	532	439	216	145	91	25	49	101	381	735	4,284	72 - 03
Jonggoa	794	484	386	197	50	106	15	22	5	172	346	677	3,254	99 - 03
Bili-Bili	677	529	448	336	130	60	70	17	63	88	356	615	3,389	72 - 03
Kampili	656	465	330	235	94	58	28	16	36	107	346	556	2,926	72 - 03
Maccini Sombala	797	561	295	132	42	44	4	0	13	54	184	587	2,712	99 - 03
Limbunga	726	602	408	272	99	88	48	9	21	164	223	729	3,388	99 - 03
Mangempang	1057	854	511	330	157	102	38	4	32	197	546	1097	4,925	99 - 03
Bonto Sunggu	669	410	273	140	89	47	23	6	24	83	203	482	2,449	78 - 02

As listed above, the Malino gauging station, which is located upstream from Bili-Bili dam reservoir, recorded the average annual rainfall of more than 4,000 mm. Mangempang in the upper reaches of the Jenelata River basin also recorded the similar range of annual rainfall as Malino. In contrast to these gauging stations, the gauging stations in the lower reaches such as Kampili, Bontosunggu and Maccini Sombala record the far less annual rainfall in a range of 2,400 to 2,500 mm.

The variations of the annual basin mean rainfalls from 1972 to 2003 were further estimated through the Thiessen Polygon Method. As shown in the Table D3.3, the annual rainfall at each of the gauging station tends to have the large variation year by year. The rainfall gauging station at Malino in particular shows the largest variation of annual rainfall with a range of 2,344 mm in 1972 to 7,230 mm in 1989. Due to this, the variation of the annual basin mean rainfall also has a large variation with a range of about 2,500 mm to 5,300 mm.

A seasonal distribution of the rainfall is described by two (2) distinct seasons: dry season (June to November) and wet season (December to May). The heaviest month is December and January, while the lightest month takes place in August. More than 80 % rainfall concentrates in the rainy season as listed below:

Rainfall Depth in Dry Season and rainy Season

Gauging Station	Rainfall in a Dry Season (Jun.-Nov.) Depth (mm)	Share to Annual Total (%)	Rainfall in Rainy Season (Dec.-May) Depth (mm)	Share to Annual Total (%)
Malino	792	18.5	3,492	81.5
Jonggoa	666	20.5	2,587	79.5
Bili-Bili	654	19.3	2,735	80.7
Kampili	589	20.1	2,337	79.9
Maccini Sombala	299	11.0	2,413	89.0
Limbunga	552	16.3	2,836	83.7
Mangenpang	919	18.7	4,006	81.3
Bonto Sunggu	386	15.8	2,064	84.2
Average	607	17.8	2,809	82.2

D3.3 Analysis on Probable Storm Rainfall

The annual one-day maximum rainfalls gauged at the two key gauging stations, Malino and Bili-Bili were collected for a period of 1923 to 2003. As listed in Table D3.4, the annual maxim one-day rainfall has a range from about 70 mm to the recorded maximum rainfall of 296mm.

Based on the annual maximum rainfall data, the probable one-day rainfall was estimated by Gumbel Distribution Method as listed below (refer to Figure D3.3):

Probable One-day Rainfall

Return Period	Malino	Bili-Bili
100 -years	333 mm/day	317 mm/day
50 -years	303 mm/day	291 mm/day
20 -years	264 mm/day	255 mm/day
10 -years	234 mm/day	228 mm/day
5 -years	202 mm/day	200 mm/day
2 -years	154 mm/day	157 mm/day

D4 Runoff Analysis

D4.1 Objectives of Analysis and Basic Data

The runoff analysis aims at estimating the long-term basin runoff discharge, which is essential for the under-mentioned water supply-demand balance simulation (refer to Section D4.2). Objective areas of the analysis were given to the following two sub-basins, which are the principal water source in Jeneberang: (a) Upper reaches of the Jeneberang River above Bili-Bili dam reservoir, and (b) the whole of Jenelata River basin.

D4.1.1 Discharge Data Converted from Gauged Water Level

Before completion of Bili-Bili dam, the water level had been gauged at two key gauging stations. One is Patarikan Gauging Station on the Jeneberang River, which was located near to the present Bili-Bili dam site. Another is Patarikan Gauging Station on the Jenelata River located at the existing Patarikan Bridge adjacent to the confluence with the mainstream of the Jeneberang River (refer to Table D2.2). The reliability of H-Q rating curves of the two gauging stations were verified through the Detailed Design of Bili-Bili Irrigation Project, and, the river flow discharge converted from the water levels gauged at these key gauging stations were applied to the objective water supply-balance simulation.

After completion of Bili-Bili dam reservoir, however, the above two gauging stations were abandoned, and instead, seven telemetry water level gauging stations had been newly installed in the Jeneberang River basin as shown in Figure D4.1. All H-Q rating curves at these new gauging stations have never been updated since they were originally installed as shown in Table D4.1. As a result, the river flow discharge converted from the water level could hardly contain the reliable accuracy, and it is difficult to apply the river flow discharge as base for the runoff-analysis.

As a result, the available discharge data for water supply-demand simulation is concluded to be within the following gauging period at the aforesaid two gauging stations:

- Runoff discharge from the Jeneberang River: From 1978 to 1990 gauged at Patarikan gauging station on Jeneberang River;
- Runoff Discharge from the Jenelata River: From 1990 to 1997 gauged at Patarikan Station on the Jenelata River.

D4.1.2 Rainfall and Evaporation Data Used for Runoff Simulation

In order to generate the daily runoff discharge for the period not to be covered by the above available water level gauging periods, the runoff simulation was made based on the following rainfall and evaporation data:

(1) Rainfall Gauging Data:

Nine rainfall-gauging stations as described in the foregoing Subsection D3.1 were applied for analysis in this Study. Among others, two non-telemetry gauging stations of Malino and Bili-Bili Intake were used to estimate the basin average rainfall before 1998 by arithmetic mean of their point rainfall. Other seven gauging stations were for estimation of the basin average rainfall after 1999 by Thiessen Polygon Method, where the following Thiessen ratios were adopted:

Thiessen Ratio for Runoff Simulation

Station name	Catcment Are All Jeneberang River Basin	Bili-Bili Damsite	Jenelata Station
Malino*	0.263	0.517	0.006
Jonggoa	0.168	0.331	0.004
Bili-Bili*	0.107	0.099	0.131
Kampili	0.086	0.000	0.000
Macini Sombala	0.087	0.000	0.000
Limbunga	0.153	0.002	0.499
Mangempang	0.135	0.051	0.359

* : New gauging stations

(2) Evaporation:

The following monthly average evaporation gauged at Bontosunggu station from 1972 to 1997:

Evaporation for Runoff Simulation

Unit: mm/day

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
4.3	4.2	4.7	5.1	4.9	4.7	5.1	6.1	6.9	6.7	5.6	4.9

D4.2 Runoff Simulation Model

The runoff simulation was made to generate the long-term runoff discharge. The simulation is based on the "Tank Model Method", which has been widely practiced to simulate low flow discharge. The model can physically express the actual runoff mechanism, which is in nature non-linear in relation to rainfall and has a function of rain infiltration into surface or sub-surface soils.

The serial three-staged tank was applied to the Tank Model in this Study. The model structure and parameters are presented in Figure D4.2. The process of the simulation is in serial order from the upper to the middle and the lower tank as presented below:

(1) Upper Tank

Ss1(t) = S11(t-1) + Fc x R (t-1) – Fe.Ev (t-1)

Sql(t) = Alf1 x [Ss1 (t) – Ha1] : upper side outlet

Sq2(t) = Alf2 x [Ss1 (t) – Ha2] : lower side outlet

Sq3(t) = Alf3 x Ss1 (t) : bottom outlet

S11(t) = Ss1(t) – [Sq1(t) + Sq2(t) + Sq3(t)]

(2) Middle Tank

Ss2(t)	= S12(t-1) + Sq3 (t)	
Sq4(t)	= Bet1 x [Ss2 (t) – Hb]	: side outlet
Sq5(t)	= Bet2 x Ss2 (t)	: bottom outlet
S12(t)	= Ss2(t) – [Sq4(t) + Sq5(t)]	

(3) Lower Tank

Ss3(t)	= S13(t-1) + Sq5 (t)	
Sq6(t)	= Gam1 x [Ss3 (t) – Hg]	: side outlet
Sq7(t)	= Gam2 x Ss3 (t)	: bottom outlet
S13(t)	= Ss3(t) – [Sq6(t) + Sq7(t)]	

(4) Runoff Discharge

Q (t) = Aa x [Sq1(t) + Sq2(t) + Sq4(t) + Sq6 (t)] / 86.4

where :

Aa	=	catchment area (km^2)
Sq1 – Sq6	=	runoff from side outlet or infiltration through bottom outlet (mm/day)
S11, S12, S13	=	storage depth of previous time in upper, middle and lower tanks (mm)
Ss1, Ss2, Ss3	=	total storage depth in upper, middle and lower tanks (mm)
Ha1, Ha2	=	height of upper and lower side outlets in upper tank (mm)
Hb	=	height of side outlet in middle tank (mm)
Hg	=	height of side outlet in lower tank (mm)
Alf1, Alf2, Alf3	=	multiplying constant of upper tank
Bet1, Bet2	=	multiplying constant of middle tank
Gam1, Gam2	=	multiplying constant of lower tank
Fc	=	effective rainfall ratio
Fe	=	evaporation factor
Ev	=	Evaporation (mm/day)
R	=	Rainfall (mm/day).

D4.3 Estimated Long-term Runoff Discharge

As the results of the aforesaid runoff simulation, the annual average rainfall, runoff depth and runoff ratio for a 30-year period from 1972 to 2001 are estimated as below (refer to Table D4.2 and D4.3):

Average Annual Rainfall Depth, Runoff Depth and Runoff Ratio

Item	Upper Reaches of Bili-Bili Dam ($384.4\ km^2$)	Jenelata River Basin ($226.3\ km^2$)
Rainfall Depth	4,200 mm	4,400 mm
Runoff Depth	2,900 mm	2,500 mm
Runoff Ratio	0.68	0.57

As estimated above, the annual runoff depth from the upper reaches of Bili-Bili Dam is about 2,900 mm or 1,100 million m^3 (= 2,900mm x 384.4 km^2), which is equivalent to almost three times of the effective storage capacity of Bili-Bili Dam. Adding the annual runoff of 570 million m^3 from the Jenelata River basin (= 2,500mm x 226.3 km^2) to the runoff from the upper reaches of Bili-Bili Dam, the effective water resources of the Jeneberang River basin is estimated at about 1,670 million m^3.

The long-term discharge runoff from the upper reaches of Bili-Bili dam reservoir (Bili-Bili inflow) and the Jenelata River from 1972 to 2001 is further estimated as shown in Figures D4.3 to D4.5 and Volume IV-2 (Data Book A Part-I). The minimum mean monthly discharges are extracted from the results of estimation as below:

Monthly and Annual Mean Discharge

Unit : m^3/s

	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
Bili-Bili Inflow	93.8	85.5	60.2	39.4	19.1	11.5	7.7	3.8	4.5	7.4	23.6	64.9	35.1
Jenelata	43.3	43.1	30.2	23.2	11.3	7.4	3.9	1.8	1.9	3.1	12.4	33.9	18.0

The average flow regime of Bili-Bili inflow and the discharge of Jenelata station are further enumerated as below:

Average Flow Regime

Item	Bili-Bili Inflow	Jenelata
95-day discharge	47.5 m^3/s	26.3 m^3/s
185-day discharge	14.7 m^3/s	8.0 m^3/s
275-day discharge	4.8 m^3/s	2.2 m^3/s
355-day discharge	2.3 m^3/s	0.8 m^3/s

D5 Water Balance Simulation

D5.1 Objectives of Simulation

The simulation was made to clarify the balance between the available water supply volume from and the water demand to the source of the Jeneberang River. The available water supply is classified into (a) the regulated outflow discharge from Bili-Bili dam reservoir, (b) the non-regulated runoff discharge from the Jenelata River, and (c) the non-regulated runoff discharge from other residual areas. Among others, the regulated outflow discharge of the item (a) is estimated from the aforesaid simulated long-term inflow discharge to Bili-Bili dam reservoir and the flow regulation effect by the dam reservoir. On the other hand, the long-term runoff discharge from the Jenelata river basin could be directly assumed as the value of item (b). As for the runoff discharge from other residual area (item (c)), assumed was the average of the simulated runoff discharge from the upper reaches of Bili-Bili dam (item (a)) and from the Jenelata river basin (item (b)).

The water demand to the source of Jeneberang includes the municipal water demand, the irrigation water demand, the private factory water demand and the requirement for river maintenance flow. The water balance simulation is made on the premise of the present and future incremental water demand. The future water demand is herein assumed on the premises of the increment of only municipal water demand. Details of these water requirements are as described in the Section D5.2.

D5.2 Water Demand

The water demand is classified into the irrigation water demand, the municipal water demand, and others. The details of each of these demands are as described hereinafter:

D5.2.1 Irrigation Water Demand

The water demand for irrigation use is exclusively for three irrigation schemes of Bili-Bili, Bissua and Kampili, which are being developed under on-going Bili-Bili Irrigation Project. The demand could be expressed as the "Net Field requirement", which is defined as the water requirement for crop growth at the field, and estimated as shown in Volume IV-2 (Data Book A Part-II). On the other hand, the irrigation water requirement at the river intake point (called diversion water requirement) includes net field requirement and water required for compensation of losses of water during conveyance and operation. The unit diversion water requirement is expressed as the requirement of water discharge for the unit irrigation area (l/s/ha), and estimated on half-monthly basis as below:

<u>Unit diversion water requirement</u>:

$$DR = NFR / E$$
$$NFR (l/s/ha) = 1 / 8.64 * NFR (mm/day)$$

<u>NFR for paddy</u>

$$NFR = ETc + P + WLR – Re$$
$$NFR = IR – Re \quad \text{(during land preparation)}$$

<u>NFR for palawija</u>

$$NFR = ETc – Re$$

Where,

DR	:	Unit diversion water requirement (l/s/ha)
NFR	:	Net field water requirement (mm/day or l/s/ha)
ETc	:	Consumptive use of water (mm/day)
P	:	Percolation loss (mm/day)
WLR	:	Water layer replacement requirement (mm/day)
IR	:	Irrigation requirement at field level during land preparation (mm/day)
Re	:	Effective rainfall (mm/day)
E	:	Overall irrigation efficiency

As presented above, the irrigation water demand varies year by year depending on the effective rainfall of each year. In this connection, the half-month water demand in each of 26 years from 1972 to 1997 had been estimated by Bili-Bili Irrigation Project. In addition, the water demands in each of four years from 1998 to 2001 were further estimated in this Study with same calculation method as that of Bili-Bili Irrigation Project. The details of the calculation methods are as described hereinafter:

(1) Consumptive Water Requirement (ETc)

Since there exits no actual measurement data, the crop water consumption in the target irrigation area was estimated based on empirical prediction method, using the climatic data and crop coefficient at rating crop growth stages as expressed below:

$$ETc = Kc * ETo$$

Where,

Kc	:	Crop coefficient at rating crop growth stages
ETo	:	Reference crop evapotranspiration or potential evapotranspiration (mm/day) (Eto was estimated by the modified Penman method).

(2) Crop Coefficients (Kc)

The following coefficients for wet paddy, dry paddy and palawija were assumed. Among others, the coefficients for palawija were derived as the combined coefficients of soybeans, peanuts, green beans and maize.

Crop Coefficient at Rating Crop Growth Stages

Period	Growth Stage	Wet Paddy	Dry Paddy	Palawija
1st month	1st half month	1.10	1.10	0.50
	2nd half month	1.10	1.10	0.70
2nd month	1st half month	1.05	1.05	0.95
	2nd half month	1.05	1.05	1.00
3rd month	1st half month	0.95	0.95	0.85
	2nd half month	0.00	0.00	0.50

(3) Reference Crop Evapotranspiration (ETo)

The following the average value of Eto from 1972 to 1997 was applied as the representative value of ETo.

Reference Crop Evapotranspiration

Unit:mm/day

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
3.83	3.97	4.15	4.34	4.20	3.97	4.21	4.84	5.22	5.35	4.77	4.00

(4) Percolation loss (P)

Percolation loss of 2mm/day was assumed.

(5) Water Requirement for Land Preparation

The water requirement for land preparation includes the requirement for water layer replacement, nursery water requirement and puddling water requirement. The water layer replacement was assumed to require 50 mm twice, one month and two months after transplanting. As for the nursery water requirement and puddling water requirement during land preparation, the method developed by Van de Goor and Zijlstra (1968) was used to estimate their required water. As a result, the water requirement for land preparation was estimated at 250 mm in total, which consists of 50 mm for water layer replacement, 150 mm for nursery water requirement and 50 mm for puddling water requirement. In this estimation, the preparation period is assumed as 30 days.

(6) Effective Rainfall

The effective rainfall for paddy was estimated through the following formula:

$$Rep = 0.7 * R \text{ (half monthly rainfall)}$$

The Effective rainfall for palawija was further estimated based on the USDA Soil Conservation Service Method, which introduces the following regression equation:

Pe = (0.049 * ETc + 0.567) Ra 0.915 Re < ETc

Where,

Pe : Effective rainfall for palawija
Ra : Daily mean rainfall = half-monthly rainfall / 15 days (mm/day)

(7) Irrigation Efficiency

Irrigation efficiency is mainly subject to the rate of loss caused by infiltration and evaporation in the irrigation channels of paddy field. The efficiency is 0.6885 on the assumption of the following rates of efficiency.

Main channels	:	0.90
Secondary channels	:	0.90
Tertiary cannels	:	0.85

The half-month rainfalls from 1972 to 2001 are herein calculated as the average of the gauged data at seven gauging stations as mentioned in the foregoing Section D3.1 (i.e., Kampili, Bontosunggu, Mandalle, Kalabajeng, Bontosallang, Barembeng and Sandrobone) (refer to Table D5.1).

As the result of estimation, the water requirement to the Jeneberang River for each year from 1972 to 2001 was estimated as shown in Figure D5.1 and summarized as listed below:

Average Monthly Crop Requirement and Net Field Requirement

Month	Crop Requirement		Net Field Requirement	
	liter/s/ha	10^6m^3	liter/s/ha	10^6m^3
Jan	0.96	61.28	0.13	8.22
Feb	0.94	55.89	0.15	8.88
Mar	0.81	51.66	0.19	12.06
Apr	0.81	49.89	0.35	21.47
May	1.03	65.27	0.80	50.76
Jun	0.94	57.76	0.84	51.44
Jul	0.78	49.67	0.71	44.75
Aug	0.39	24.37	0.34	21.45
Sep	0.20	12.56	0.17	10.38
Oct	0.20	12.51	0.14	8.86
Nov	0.12	7.27	0.02	1.36
Dec	0.49	31.33	0.05	3.20
Annual		479.45		242.83

As listed above, the crop requirement shows its two peaks in January and May. The peak in January is, however, in a rainy season and its substantial part could be covered by the effective rainfall. On the other hand, another peak in May is in the dry season, and therefore, most of the water requirement needs to be supplied from the Jeneberang River. As a result, the peak of the net field requirement occurs in May to June.

D5.2.2 Municipal Water Demand

The following present and future municipal water demands to the Jeneberang River are estimated through the clarification and assumptions in the under-mentioned items of (a) and (b) (refer to Table D5.2).

Present and Future Municipal Water to the Source of Jeneberang River

Year	Wet Season m^3/s	Dry Season m^3/s	Annual $10^6 m^3/year$
Present (2004)	1.66	2.16	60.3
2018	4.02	4.52	134.8
2019	4.23	4.73	141.2
2020	4.43	4.93	147.6

(1) Present Water Demand

The actual outputs of the existing water treatment plants (WTP) for the Jeneberang River in year 2003 were clarified in Supporting Report C, and assumed as the present potential municipal water demand. The actual water demand to Jeneberang River was further estimated on the premises of the following conveyance loss from the river to WTPs: 10% for Somba Opu and Borong Loe WTP and 5% for other existing WTPs.

(2) Future Water Demand

The future municipal water demand for PDAM Makassar was clarified in Supporting Report C and assumed as the future water demand to the source of Jeneberang. In addition, the future water demand for PDAM Gowa was estimated as a part of the future municipal water demand with referring to the projection in "Consulting Engineering Services for Comprehensive Water Management Plan Study for Maros-Jeneponto River Basin, Nov. 2001".

The treatment capacity of WTP was further assumed to increase to meet the future incremental water demand on the premises of the following conditions:

- All existing WTPs would recover to their designed full treatment capacity levels.
- The water requirement of Somba Opu WTP and Borong Loe WTP would increase from present 1.122 m^3/s to 3.3 m^3/s[1], which corresponds to the present capacity of raw water transmission line from Bili-Bili dam reservoir to the WTP;
- New WTPs would be constructed to meet a part of the future incremental water demand, which could not be covered by the above two items.

(3) Other Water Demand

The following water demands are regarded as the customary water use right to be promised by supply from Bili-Bili dam reservoir and incorporated into the water supply-demand simulation:

[1] Part of water may be transferred to Panaikang WTP depending on PDAM's future plan

- Industry water demand of 0.5 m^3/s for Takalar Sugar Factory; and
- River maintenance flow of 1.0 m^3/s for downstream of the Jeneberang River below Sungguminasa Bridge.

D5.3 Result of Water Supply-Demand Balance Simulation

The results of the water balance simulation for the present water demand are as shown in Table D5.3 and Figure D5.2. As shown in these Table and Figure, among the simulated 30years from 1972 to 2001, three years of 1972, 1982 and 1997 are identified as the drought years, during which Bili-Bili dam reservoir drops to Lowest Water Level (EL. 65.0 m) having no available water supply capacity to meet the present water demand. Thus, the drought years could occur with a frequency of once for ten years (= 3 years of the identified drought years divided by 30 years of the simulation period), and it is concluded that the present supply capacity of Bili-Bili dam could promise the present water demand against a 10-year drought.

The water balance simulation was further made on the premises of the future incremental municipal water demand. As the result of simulation, the following years are identified as the droughts years (i.e., the years, when Bili-Bili dam reservoir could promise the allocated water demand):

Drought Years against Water Municipal Demand

Year of Demand Projection	Drought year	Number of Drought Years	Frequency of Drought Years
Present (2003)	1972, 82, 97	3/30	1/10 years
2018	1972, 76, 82, 87, 92, 97	6/30	1/5 years
2019	1972, 76, 82, 83, 87, 91, 92, 97	8/30	1/3.8 years
2020	1972, 76, 82, 83, 87, 91, 92, 97	8/30	1/3.8 years

As estimated above, the frequency of occurrence of drought year would increase from 1/10years at present to 1/5years in 2018 and 1/3.8 years in 2019.

The irrigation water demand takes a dominant share of the whole water demand, and therefore, has a decisive factor to cause the drought. The typical influence of irrigation water demand on occurrence of drought is seen in a three-month period from April to June. The three-month period is regarded as the critical month such that the period is the begging of the dry season and, at the same time, the crop water requirement starts to significantly increase during this period. The drought years tend to occur, when the rainfall during this critical period is far less than those in other normal years as below (refer to Table D5.4):

- The drought years of 1972, 1982 and 1997 received rainfall of less than 110 mm during the critical three-month, which is far less than the average of 273 mm from 1972 to 2001;
- On the other hand, the years of 1985, 1990 and 1993 received the annual rainfall of less than 2,000m, which is rather small value as compared with the average of 2,434 mm from 1972 to 1998. However, these years received a rather large rainfall during the critical-three month from April to June, and therefore did not cause drought.

The year of 1976 is identified as the marginal non-drought year, during which full supply of the net field requirement of 381.70 m^3/year is marginally promised by the supply capacity of Bili-Bili dam reservoir on the premises that the dam reservoir also need to promise the full supply for the municipal water demand and other all allocated water demand. Accordingly, the following diversion requirement for irrigation use in the year of 1976 could be regarded as the maximum limit to be promised by the supply capacity of Bili-Bili dam. This maximum limit of 381.70 million m^3 corresponds to about 1.6 times the average net field requirement from 1972 to 1983 (i.e., 242.83 million m^3).

Diversion Requirement for Irrigation in the Standard Drought Year of 1976

Month	Bili-Bili Irrigation Scheme	Bissua Irrigation Scheme	Kampili Irrigation Scheme	Total
Jan	2.35	10.72	10.49	23.56
Feb	0.00	0.00	0.00	0.00
Mar	0.00	0.00	0.00	0.00
Apr	5.71	26.11	25.53	57.36
May	7.92	36.17	35.37	79.46
Jun	7.64	34.94	34.16	76.74
Jul	7.21	32.93	32.20	72.33
Aug	3.64	16.63	16.26	36.53
Sep	1.96	8.95	8.75	19.66
Oct	1.22	5.56	5.43	12.21
Nov	0.00	0.00	0.00	0.00
Dec	0.38	1.76	1.72	3.86
Annual	38.03	173.77	169.91	381.70

D6 Improvement Plan of Hydrological Gauging Network

The improvement plan hydrological gauging network was preliminarily proposed to facilitate the river basin management including the low flow and flood management as described in the following subsections.

D6.1 Proposed Telemetry Rainfall Gauging Network

JRBDP currently gauge the rainfall on real-time base through seven-telemetry rainfall gauging station in order to facilitate the effective gate operations for Bili-Bili dam, Rubber dam and other various river structures. Dinas PSDA also gauges the daily rainfall through information from gauge keeper assigned to twenty non-telemetry gauging stations in order to facilitate the water management for irrigation purpose. Moreover, BMG has six climatic gauging stations in the Jeneberang River basin, out of which five stations are now operational but one station temporally suspends its gauging operation due to trouble of gauging equipment. Thus, there exist 33 rainfall-gauging stations in the Jeneberang River basin, but most of them are biased to the lower reaches below Bili-Bili dam as shown in Figure D2.1 to D2.3.

Among others, the telemetry gauging stations in particular are useful for the real-time flood management as well as the low flow management. The density of the telemetry-gauging stations is 109 km^2/station (=seven stations/catchment area of 762 km^2, which satisfy the minimum density of 100 to 250 km^2/stations recommended by the World Meteorological Organization (WMO).

However, there are some hydrological blind areas in the Jeneberang River basin, and in order to get rid of the blind areas the following supplementary telemetry gauging stations were provisionally proposed (refer to Figures D6.1 and D6.2).

- Up most area of Jeneberang River: The existing two non-telemetry gauging stations at Tanralili and Bungabaji operated by Dinas PSDA should be provided with the telemetry equipment. Another new telemetry gauging station is further proposed at Lengkese, which is located at the just downstream of the huge sediment deposit produced from the collapse of Mt. Bawakaraeng.
- Upper reaches of Jene Rakikang River: One new gauging station is proposed at Patuku Village.
- Upstream of Jeneberang River between Bili-Bili dam reservoir and the existing Jonggoa station; The telemetry rainfall equipment should be installed at the existing telemetry water level gauging station at Bonto Jai.
- Upstream of Binanga Tokka; One new gauging station is proposed at the Village Parang-Parang.

An open space of 10 m around should be preferably selected as the suitable rainfall gauging site and it is necessary to avoid the narrow pass topography, where the deviate wind direction and velocity would cause difficulties in gauging the accurate rainfall gauge. It is also necessary to consider the accessibility to the gauging site and to avoid the risk of flood inundation at the proposed gauging site.

D6.2 Proposed Telemetry Water Level Gauging Network

JRBDP currently gauge the water level of the Jeneberang River as well as its tributaries on the real-time base through seven water level gauging stations. The gauged data are useful for the low flow and flood management including the gate operations of Bili-Bili dam and other various river structures.

The present water level gauging stations are well distributed to observe all critical river flow discharge. The gauging station at Bonto Jai on the mainstream of Jeneberang in particular is important to observe the inflow discharge into Bili-Bili dam reservoir. The Jenelata Station installed at the Patarikan Bridge is also important to observe the natural flow discharge from the Jenelata River. Accordingly, it would not be necessary to expand the existing telemetry gauging network.

However, Bayang water level gauging station at the estuary of the Jeneberang River has been not operational, since its gauging equipment was stolen in 2002. The water level gauging station is useful to observe the salinity water intrusion into the river, and therefore, it is important to resume the gauging operation at the earliest opportunity.

Relocation of the gauging site would be also required to Bonto Jai water level gauging station. The present location of the gauging station is just downstream of the existing Sand Pocket No.1, where the stable river flow is hardly expected and the riverbed tends to easily fluctuate. From these viewpoints, it is preferable to transfer the location of gauging site above the sand pocket dam, where the flow channel is fixed and more accurate flow discharge could be estimated from the gauged water level.

In addition to the aforesaid necessary rehabilitation and relocation of the existing telemetry gauging stations, another crucial issue is addressed to renewal of H-Q rating curves given to the existing water level gauging stations.

Among the existing seven water level gauging stations, four gauging stations, namely Jonggoa, Bonto Jai, Kampili and Jenelata station have the H-Q rating curve. However, these H-Q rating curves have never been updated, since they were originally developed in 1999. Riverbed tended to fluctuate specially after a flood, which seriously affects the accuracy of the rating curves. In fact, the extensive riverbed fluctuation was confirmed after collapse of Mt. Bawakaraeng in March 2004, and it is indispensable to update the existing H-Q rating curves and at the same time, to establish the renewal system of the rating curves at the end of the every rainy season and/or immediately after the occurrence of large flood.

Tables

Table D1.1 Meteorological Conditions

Station : BONTOSUNGGU

Element	Unit	Jan	Feb	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Okt.	Nov.	Dec.	Annual	Observation Periob
Temperature															
mean	^{o}C	27.1	27.0	27.4	28.0	28.1	27.8	27.1	26.9	27.6	28.1	28.2	27.3	27.5	1977 to 1997
mean max.	^{o}C	29.5	29.6	30.3	31.5	31.9	31.5	31.3	32.0	33.0	33.5	32.2	30.0	31.4	1977 to 1998
mean min.	^{o}C	23.6	23.4	23.3	23.1	23.1	22.5	21.3	20.3	20.7	21.1	22.9	23.4	22.4	1977 to 1999
Relative Humidity	%	89.8	90.9	89.4	87.4	85.6	84.7	83.8	81.3	78.5	80.0	84.7	88.2	85.0	1980 to 1997
Wind Velocity	m/s	1.3	1.0	0.7	0.7	0.7	0.7	0.7	0.8	1.0	1.1	1.0	1.1	0.9	1977 to 1982
Sunshine Hour	hr/day	4.3	5.0	5.7	6.7	7.6	7.4	8.2	9.2	8.7	8.5	7.1	5.0	7.0	1977 to 1997
Evaporation	mm/day	4.3	4.2	4.7	5.1	4.9	4.7	5.1	6.1	6.9	6.7	5.6	4.9	5.3	1977 to 1997
Rainfall	mm	669	410	273	140	89	47	23	6	24	83	203	482	2,449	1975 - 2001

Station : BONTO BILI

Element	Unit	Jan	Feb	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Okt.	Nov.	Dec.	Annual	Observation Periob
Temperature															
mean	^{o}C	24.5	24.2	24.2	24.4	24.6	24.0	22.8	21.4	21.4	22.7	24.0	24.3	23.6	1975 to 2000
mean max.	^{o}C	26.5	26.7	26.4	26.3	26.4	25.9	24.6	24.5	24.0	25.4	28.1	26.6	25.9	1975 to 2000
mean min.	^{o}C	23.1	22.1	22.3	22.6	22.2	21.8	20.0	18.9	19.3	19.5	21.1	22.3	21.3	1975 to 2000
Relative Humidity	%	87.6	86.0	84.6	86.0	80.3	79.7	76.7	72.3	72.8	75.0	82.7	88.3	81.0	1975 to 2000
Wind Velocity	m/s	1.2	1.3	1.1	1.1	1.0	1.0	0.9	1.1	1.1	1.8	1.1	1.1	1.2	1975 to 2000
Sunshine Hour	hr/day	3.3	3.3	4.1	3.8	4.6	3.5	3.7	4.6	4.9	4.8	4.1	3.8	4.0	1975 to 2000
Evaporation	mm/day	3.9	3.7	3.0	3.2	3.5	3.4	3.8	5.2	5.4	5.2	6.7	4.0	4.3	1975 to 2000
Rainfall	mm	509	322	236	324	89	39	5	12	26	80	454	604	2,701	1990 to 1998

Table D2.1 BMG Monitoring Stations and Cooperations in and around Jeneberang River Basin

Regency	NO.	Station Name			Stasion No.	Location Latitude(S)	Location Longitude(E)	Elevation MSL	Starting Operation	Missing Data
GOWA	1	BB.Garing			430	05° 26' 32"	119° 50' 29"	300	Jan - 1982	Apr-89 - Feb-90, Jan-2000 - Dec-2002
	2	BB.Malino		**	419B	05° 15' 40"	119° 51' 13"	1021	Jan - 1976	76/1,94/1,96/5, Jan-2000 - Dec-2002
	3	BB.Punaga/Limbung			388A				Jan - 1977	Jan-80 - Feb-81, 85/1, 96, Jan-2000 - Dec-2002
	4	Bontobili	*	**	424	05° 18' 00"	119° 34' 00"	45	Jul - 1979	Nov-86 - May-88, 90/1, 91/1, 99/1, Nov-2000 - Des-2002
	5	Bontonompo/Barembeng			425A	05° 21' 12,0"	119° 25' 29,0"		Jan - 1985	91/8, 92/2, Oct-94 - Dec-96, Apr-2002 - Dec-2002
	6	BPP.Bonto-bonto		**	424F	05° 17' 08"	119° 40' 54"	-	Jan - 1985	96/1, 99/5, Jan-2000 - Dec-2002
	7	BPP.Bulubalea/Kanreapia			419A	05° 14' 56"	119° 56' 13"	-	Jan - 1981	81/1, 88/1, Nov-95 - Dec-96, Feb-2000 - Dec-2002
	8	BPP.Limbung		**	425	05° 17' 26"	119° 26' 16"	10	Jan - 1979	83/1, 88/2, Feb-2001 - Dec-2002
	9	BPP.Malakaji			431	05° 27' 00"	119° 50' 00"	750	Jan - 1976	94/1, 95/2, 97/1, Dec-2000 - Dec-2002
	10	Pa'ladingan/Paranglompoa		**		05° 22' 54"	119° 48' 10"	-	Jan - 1993	96/2, 97/1, Jan-2000 - Dec-2002
	11	Sungguminasa		**	423	05° 13' 00"	119° 27' 00"	5	Jan - 1976	95/5, Feb-2001 - Dec-2002
MAKASSAR	1	BPP.Barombong							Feb - 1991	96, 97/1, 02/6
	2	BPP. Sudiang							Jan - 2002	Apr-02 - Dec-02
	3	Ex.Staklim Panakkukang	*		415d	05° 11' 00"	119° 28' 00"	10	Jan - 1972	Jul-1998 - Feb-2000
	4	Ex THR Macini								
	5	Panaikang/Bawil IV BMG	*						Jan - 1985	85/4, May-97 - Jul-99
	6	Stamar. Paotere			415c	05° 06' 38"	119° 25' 02"	2	Peb - 1985	May-85
	7	Stamet Maritim	*							
TAKALAR	1	BPP. Galesong / Polsel	*		426F				Sep - 1983	Dec-83, Nov-Dec-90, Nov-94, Dec-96, Dec-98, Oct-00, Dec-01
	2	BPP. Pattalassang / Polut	*		423D	05° 25' 29,0"	119° 25' 56,0"		Jan - 1985	Jan-Nov-87, 88/2, Dec-96, Dec-98, 00/4, Feb-Dec-01
	3	Lakatong / Cikoang			426D				Mar - 1984	Dec-96, 97/4, May-99
	4	Paddingin / Mappakasunggu			426E				Jan - 1985	Dec-90 - Mar-91, Nov-96 - Jul-97, Apr-99 - Dec-99, Dec-00 - Dec-02
	5	Pattalassang / Polsel	*		426A				Jan - 1976	76/3, 78/1, 79/3, 80/1, 83/1, 84/8, 96/1, 99/2, 01/1
	6	PG. Takalar	*		426	05° 21' 28,0"	119° 30' 04,0"	20	Apr - 1983	Dec-95, Feb-96, Dec-97, 99/4, Nov-01 - Dec-02
	7	TammulopE / Lassang	*		423C				Jan - 1985	Apr-Nov-85, Nov-Dec-87, Feb-Mar-91, Feb-92, 95/2, 96/3, 97/10, 98/1, 00/2, 01
	8	Tottalassa				05° 28' 00,0"	119° 24' 58,0"		Jan - 1992	Dec-94, Dec-95, Feb&Dec-96, Dec-98 - Dec-03
MAROS	1	Allaere / Tanralili			415A				Jan - 1976	77/2, 78/5, 79/6, Mar-80 - Sep-81, 82/1, 84/1, 86/2, 99/1, 02/2
	2	Balitjas / Maros Baru			415H				Jan - 1985	Nov-2000 - Dec-2002
	3	Batubassi/Bantimurung			428	05° 00' 35,0"	119° 28' 03,0"	10	Jan - 1976	78/2, 79/1, 84/1
	4	Bonti-bonti/Bantimurung			428A				Jan - 1976	77/1, 78/6, 79/1, Apr-80 - Aug-81, 82/1, 84/2, 99/1
	5	BPP.Mandai								
	6	Padaelo / Mallawa							Jan - 1991	Des-91, Mar-96, Mar-98 - Nov-00, 02/5
	7	Labuaja / Camba			416	05° 01' 23,0"	119° 46' 53,0"	300	Sep - 1981	84/1, Jun-98 - Oct-00, 01/1, 02/1
	8	Minasabaji / Bantimurung			415F				Mar - 1979	Apr-79 - Aug-81, 84/1, 86/4
	9	Solojirang			415	05° 01' 00,0"	119° 33' 00,0"		Jan - 1970	70/2, 80/10, 84/1, 01/3
	10	Staklim Panakkukang	*			04° 59' 05,0"	119° 46' 53,0"	10	Jul - 1998	Nothing
	11	Stamet Hasanuddin	*		415c	05° 04' 00,0"	119° 31' 00,0"	15	Jan - 1950	Sep-57

Note: From Panakkukang Station in Maros
*: Active Station in Mar-2004
**: In Jeneberang River Basin

Table D2.2 (1/2) Inventory of Hydrological Observation Station Administrated by Dinas PSDA

Rainfall Station

No.	*	Station Name	Location Longitude (E)	Location Latitude (S)	Regency	District	Village	Year Installed	Type	Remarks
1	-	Makassar	~~199 25'39"~~	~~5 12'16"~~	Gowa	Panakukang	Panakukang	1979	Manual	wrong location
2	**	Malino	~~119 55'15"~~	~~5 15'25"~~	Gowa	Tinggimoncong	Malino	1977	Manual	wrong location Probably same as No.32
3	?	Senre	~~119 35'01"~~	~~5 12'59"~~	Gowa	~~Bontorannu~~	~~Patalikang~~	1975	Manual	Pallantikang or Pattalassang village or wrong location.
4	**	Kampili	119 30'40"	5 16'51"	Gowa	Pallangga	Kampili	1974	Manual	ok
5	-	Kassi BK.5	119 29'24"	5 11'05"	Gowa	~~Manggala~~	Samata	1975	Manual	Village name is Somba Opu
6	?	Allu Keke	~~119 29'24"~~	~~5 11'05"~~	Gowa	~~Parangloha~~	~~Allu Keke~~	1995	Manual	There is no district and village name in our collected database.
7	?	Sungguminasa	119 27'36"	5 12'32"	Gowa	~~Batangkaluku~~	~~Somba Opu~~	1975	Manual	Somba Opu district and Bonto Kamase village if location is correct
8	**	Cambaya	119 26'35"	5 13'30"	Gowa	Pallangga	Tetebatu	1975	Manual	ok
9	?	Boka	~~119 25'42"~~	~~5 14'56"~~	Gowa	~~Bontosunggu~~	~~Boka~~	1975	Manual	There in no village name in our cllected database
10	**	Paku	119 27'37"	5 16'20"	Gowa	Pallangga	Paku	1975	Manual	ok
11	**	Tamanyeleng	119 25'09"	5 12'30"	Gowa	Barombong	Tamanyeleng	1992	Manual	ok
12	-	Bilaji	119 24'24"	~~5 18'18"~~	Gowa	Barombong	Kanjilo	1995	Manual	wrong location
13	-	Tamacina	119 26'37"	5 17'18"	Gowa	Bajeng	Maccini Baji	1975	Manual	ok
14	-	Majannang	119 26'11"	5 18'10"	Gowa	Bajeng	Kalabajeng	1975	Manual	ok
15	-	Manjaling	119 24'25"	5 17'59"	Gowa	Bajeng	Manjaling	1975	Manual	ok
16	-	Tarantang	119 25'26"	5 17'59"	Gowa	Bajeng	Kalabajeng	1995	Manual	ok
17	-	Patarungan	119 24'42"	5 14'56"	Gowa	Bajeng	Manjalling	1992	Manual	wrong location if village name is correct or same as No.42
18	-	Bonto Sallang	119 24'36"	5 19'51"	Gowa	Bontonompo	Bontobriaing	1975	Manual	ok from Dinas PSDA Jeneberang
19	-	Barembeng	119 23'00"	5 23'00"	Gowa	Bontonompo	Barembeng	1975	Manual	ok from Dinas PSDA Jeneberang
20	-	Tamalayang	119 26'39"	5 20'18"	Gowa	Bontonompo	Tamalayang	1976	Manual	Is village name Tamalaeng ?
21	-	Bonto Ramba	119 23'11"	5 23'52"	Gowa	Bontonompo	Pabundukang	1975	Manual	wrong location if village name is correct
22	-	Jipang	119 26'02"	5 26'02"	Gowa	Bontonompo	Jipang	1999	Manual	wrong location if village name is correct
23	**	Pakalo Dam	119 31'26"	5 14'59"	Gowa	Bontomarannu	Pakato	1991	Manual	is village name Pakatto ?
24	-	Bonto Manai	119 31'19"	5 13'47"	Gowa	Bontomarannu	Bt. Manai	1997	Manual	ok
25	**	Songkoio	~~119 29'13"~~	~~5 14'14"~~	Gowa	Bontomarannu	Bt. Manai	1996	Manual	wrong location if village name is correct
26	**	Bungabaji	~~119 40'05"~~	~~5 20'36"~~	Gowa	Bongaya	Sapaya	1987	Manual	wrong location if village name is correct
27	-	Paladingan	119 49'31"	5 22'40"	Gowa	Bongaya	~~Tamapana~~	1991	Manual	village name is Paladingan
28	?	~~Lembaya~~	~~119 26'35"~~	~~5 13'30"~~	~~Gowa~~	Tompobulu	~~Tetebatu~~	1998	Manual	wrong data if village name is correct
29	?	Rappolemba	~~119 52'18"~~	~~5 13'30"~~	Gowa	Tompobulu	Tetebatu	-	Manual	wrong data if village name is correct
30	-	Pasosokia	119 56'44"	5 11'34"	Gowa	Tinggimoncong	~~Kalabajeng~~	1991	Manual	village name is Tamaona
31	**	Tanralili	119 50'45"	5 17'07"	Gowa	Tinggimoncong	~~Tanralili~~	1995	Manual	village name is Majannang

* : "**" is in the Jeneberang River Basin, "-" is out of Jeneberang river basin and "?" is unknown or something wrong
remarks : turned out in this study and need to up-date. "blank" is no check in this study.
source : Specific Activity Report for Hydrology (Dec. 2003)

Table D2.2 (2/2) Inventory of Hydrological Observation Station Administrated by Dinas PSDA

Rainfall Station

No.	*	Station Name	Location		Regency	District	Village	Year Installed	Type	Remarks
			Longitude (E)	Latitude (S)						
32	**	Malino	119 51'14.6"	5 15'11.5"				1971	Code :22(H)	
33	**	Mangasa	119 43'05"	5 20'04"				1983	Code :57(H)	
34	**	Intake Bili-Bili	119 34'27"	5 17'20"				1975	Code :25(H)	
35	**	Borongloe	~~119 30'00"~~	~~5 15'00"~~				1975	Code :87(op)	have to check its location
36	**	Lebong	119 45'38"	5 16'41"				1975	Code :50(H)	
37	**	Lemoe	119 36'05"	5 18'20"				1975	Code :40(H)	
38	**	Palekoang Tallue	119 35'36"	5 15'08"				1984	Code :26(H)	
39	?	Majannang	~~119 45'3.5"~~	~~5 16'14.7"~~				1983	Code :52(H)	have to check its location
40	**	Parang-Parang	119 40'04"	5 21'12"				1984	Code :46(H)	

* : "**" is in Jeneberang River Basin, "-" is out of Jeneberang river basin and "?" is unknown or something wrong
remarks : turned out in this study and need to up-date. "blank" is no check in this study.
source : Consulting Eingineering Services for Comprehensive Water Management Plan Study for Maros-Jeneponto River Basin Report in Nov. 2001

No.	*	Station Name	Location		Regency	District	Village	Year Installed	Type	Remarks
			Longitude (E)	Latitude (S)						
41	-	Kalabajen	119 26'00"	5 19'00"					have to check	from Dinas PSDA Jeneberang
42	-	Mandalle/Patarunga	119 24'00"	5 18'00"					have to check	from Dinas PSDA Jeneberang
43	-	Sandro Bone	119 22'00"	5 26'00"					have to check	from Dinas PSDA Jeneberang

* : "**" is in Jeneberang River Basin, "-" is out of Jeneberang river basin and "?" is unknown or something wrong

Climatrology Station

No.	*	Station Name	Location		Regency	District	Village	Year Installed	Type	Remarks
			Longitude (E)	Latitude (S)						
44	**	Bontosunggu	119 25'30"	5 16'44"	Gowa	Bontonompo	Bt. Sunggu	1977	Automatic	
45	**	Bonto Bili	119 34'37"	5 17'28"	Gowa	Parangloe	Romangtoe	1980	Automatic	is village name Ramangloe ?

* : "**" is in Jeneberang River Basin, "-" is out of Jeneberang river basin and "?" is unknown or something wrong
source : Status report of BWRM-IWIRIP in Sep. 2003

Water Level Gauging Station

No.	*	Station Name	Location		Regency	District	Village	Year Installed	Type	Remarks
			Longitude (E)	Latitude (S)						
46	**	Pattalikang			for Jeneberang river			1974-1993	Staff Gauge	Sediment load was measured at the same time but now quit.
47	**	Sungguminasa	119 25'00"	5 13'00"				1983-2000	Staff Gauge	Quit
48	**	Pattalikang	119 35'58"	5 17'28"	for Jenelata river			1980-1998	Staff Gauge	Quit

* : "**" is in Jeneberang River Basin, "-" is out of Jeneberang river basin and "?" is unknown or something wrong.
source : Hearing to Dinas PSDA in Mar. 4 2004

Table D2.3 Inventory of Hydrological Observation Station Administrated by JRBDP

Rainfall Station

Station Name	Location		Regency	District	Village	Year Installed	Type	Remarks
	Longitude (E)	Latitude (S)						
** Malino	119 51'12"	5 15'10"	Gowa	Tinggimoncong	Malino	1998	Telemetring	
** Limbunga	119 44'05"	5 21'48"	Gowa	Bungaya	Mangasa	1998	Telemetring	
** Mangempang	119 40'50"	5 20'07"	Gowa	Bungaya	Mangasa	1998	Telemetring	

Water Level Gauging Station

Station Name	Location		Regency	District	Village	Year Installed	Type	Remarks
	Longitude (E)	Latitude (S)						
** Banto Jai	119 39'40"	5 15'25"	Gowa	Parangloe	-	1998	Telemetring	
** Jenelata	119 35'50"	5 17'34"	Gowa	Parangloe	-	1998	Telemetring	Reconstruction in Feb.2004
** Bayang	119 23'04"	5 11'30"	Makassar	Tamalate	-	1998	Telemetring	Interupting(Stolen in 2002)

Rainfall and Water Level Gauging Station

** Jonggoa	119 44'37"	5 16'26"	Gowa	Paranglohe	Jonggoa	1998	Telemetring
** Bili-Bili	119 35'08"	5 16'46"	Gowa	Bontomarannu	Bili-Bili	1998	Telemetring
** Kampili	119 34'02"	5 17'13"	Gowa	Pallangga	Kampili	1998	Telemetring
** Macini Sombala	119 24'50"	5 11'41"	Makassar	Tamalate	Somba Opu	1998	Telemetring

** : In Jenebarang River Basin

source : Status report of BWRM-IWIRIP in Sep. 2003

Note : Jenelata Station were flushed out in Jan.2002

Table D3.1 Climetological and Rainfall station Collected Data in this Study

	Station Name	Location		Year Installed	Type	Administration	Purpose	Remarks
		Longitude (E)	Latitude (S)					
-	Kalabajen	119 26'00"	5 19'00"	1975	Mnual	Dinas	*1	
-	Mandalle/Patarungan	119 24'00"	5 18'00"	1975	Mnual	Dinas	*1	
-	Sandro Bone	119 22'00"	5 26'00"	1975	Mnual	Dinas	*1	
-	Bontosunggu	119 25'30"	5 16'44"	1977	Automatic	Dinas	*1	Climetological Station
-	Bonto Sallang	119 24'51"	5 19'51"	1975	Mnual	Dinas	*1	
-	Barembeng	119 24'36"	5 20'01"	1975	Mnual	Dinas	*1	
**	Malino	119 51'14.6"	5 15'11.5"	1971	Mnual	Dinas	*2	
**	Malino	119 51'12"	5 15'10"	1998	Telemetring	JRDBP	*2	
**	Jonggoa	119 44'37"	5 16'26"	1998	Telemetring	JRDBP	*2	
**	Limbunga	119 44'05"	5 21'48"	1998	Telemetring	JRDBP	*2	
**	Mangempang	119 40'50"	5 20'07"	1998	Telemetring	JRDBP	*2	
**	Intake Bili-Bili	119 34'27"	5 17'20"	1975	Mnual	Dinas	*2	
**	Bili-Bili	119 35'08"	5 16'46"	1998	Telemetring	JRDBP	*2	
**	Kampili	119 30'40"	5 16'51"	1974	Manual	Dinas	*1, *2	
**	Kampili	119 34'02"	5 17'13"	1998	Telemetring	JRDBP	*1, *2	
**	Macini Sombala	119 24'50"	5 11'41"	1998	Telemetring	JRDBP	*2	

** : in the Jeneberang river basin
*1 : utilizede for calculation of Irrigation Water Requirement
*2 : utilizede for Runoff calculation by Tank model

Table D3.2 (1/5) Mean Monthly Rainfall (Malino)

Unit : mm

Year	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1972	1624	566	273	221	63	0	0	0	0	0	352	342	3441
1973	532	315	491	311	292	88	243	110	241	26	730	591	3970
1974	375	700	1393	313	265	116	181	11	161	527	348	795	5185
1975	621	621	558	570	275	205	63	64	23	194	472	615	4281
1976	831	784	912	238	196	46	5	5	0	269	187	495	3968
1977	900	1476	663	475	195	324	0	17	0	0	241	684	4975
1978	765	655	378	371	236	237	282	111	154	156	446	987	4778
1979	771	589	821	287	278	134	26	0	4	70	170	671	3821
1980	969	1480	1075	868	488	129	32	12	0	252	610	1124	7039
1981	1026	678	417	498	267	184	253	3	231	46	744	1231	5578
1982	1114	690	818	954	190	111	1	0	2	2	113	419	4414
1983	684	552	274	606	542	332	60	18	1	49	613	207	3938
1984	830	770	694	794	474	220	68	48	232	218	314	1062	5724
1985	667	486	660	595	411	199	277	0	59	105	566	460	4485
1986	1453	415	262	416	68	113	174	42	1	134	298	436	3812
1987	1376	952	373	264	100	11	0	0	0	6	436	1327	4845
1988	677	1726	622	167	218	52	56	64	75	103	718	2005	6483
1989	2015	1234	702	1133	466	604	140	105	46	89	197	499	7230
1990	648	363	404	209	140	92	120	2	0	0	168	549	2695
1991	1207	584	135	525	86	27	12	3	0	6	343	450	3378
1992	579	374	328	252	94	103	94	11	46	108	86	269	2344
1993	1039	608	877	558	176	203	14	0	36	13	357	1104	4985
1994	575	378	583	373	249	11	3	8	0	66	172	439	2857
1995	948	475	619	643	169	429	62	7	41	120	986	1110	5609
1996	871	767	481	351	119	59	127	141	78	310	359	1638	5301
1997	1028	1244	937	473	23	20	68	0	0	0	0	433	4226
1998	338	276	474	284	138	142	249	54	124	210	413	677	3379
1999	786	829	483	202	0	0	0	7	1	169	448	873	3798 *
2000	616	636	567	424	224	390	80	35	3	215	379	816	4385 *
2001	677	702	410	267	89	219	8	2	0	268	361	1129	4132 *
2002	705	583	498	265	173	90	7	0	0	2	125	362	2810 *
2003	1005	727	420	132	79	40	23	41	17	80	-	-	- *
Ave.	883	726	581	439	212	154	85	29	49	119	379	768	4424

Note : 1972 - 1977 data were obtained from previous report.
* : obtained from telemetric system.

Table D3.2 (2/5) Mean Monthly Rainfall (Intake Bili-Bili & Bili-Bili)

Unit : mm

Year	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1972	1175	807	594	152	23	0	0	6	0	0	204	312	3273
1973	505	135	407	699	193	30	168	26	371	126	772	733	4165
1974	319	654	919	261	109	53	167	7	124	356	478	702	4149
1975	416	565	481	737	151	25	213	16	91	52	616	593	3956
1976	746	496	390	49	73	78	80	55	0	188	264	401	2820
1977	1177	1527	374	442	36	81	0	24	0	0	258	540	4459
1978	610	584	350	209	379	101	303	52	211	134	322	664	3919
1979	877	676	538	249	134	122	0	0	7	0	239	745	3587
1980	754	703	369	325	70	0	0	15	0	13	384	790	3423
1981	587	390	276	262	104	88	144	0	162	121	360	824	3318
1982	566	530	374	328	117	0	0	12	0	0	34	624	2585
1983	245	160	265	441	184	66	87	0	28	114	445	693	2728
1984	633	620	612	517	312	91	0	0	144	148	254	557	3888
1985	315	404	477	405	105	106	70	0	0	102	407	353	2744
1986	1488	275	350	189	74	58	350	0	0	170	293	479	3726
1987	1339	384	434	157	57	0	0	0	0	0	109	1272	3752
1988	278	757	418	218	159	40	0	42	182	129	404	442	3069
1989	735	460	596	545	78	174	148	53	38	174	208	273	3482
1990	679	352	257	267	319	0	0	0	0	44	119	648	2685
1991	760	206	208	415	24	0	0	0	0	0	828	803	3244
1992	482	422	410	17	41	7	0	0	214	114	490	318	2515
1993	582	442	336	382	1003	408	9	0	13	45	329	818	4367 **
1994	733	523	1205	260	27	15	0	3	0	25	6	380	3177
1995	975	477	473	381	220	217	43	0	32	86	405	642	3951
1996	596	872	328	281	24	26	34	59	66	133	526	1166	4111
1997	435	723	223	71	22	1	24	0	0	39	214	393	2145
1998	188	148	406	817	221	158	41	96	23	108	714	471	3391
1999	543	686	377	119	0	0	0	2	5	255	367	577	2931 *
2000	787	629	505	299	167	220	72	0	5	274	313	440	3711 *
2001	691	758	509	180	78	118	1	0	10	179	270	770	3564 *
2002	561	448	400	323	186	31	0	0	0	9	151	497	2606 *
2003	725	341	218	154	30	18	3	0	4	61	178	920	2652 *
Ave.	672	536	440	317	148	73	61	15	54	100	343	620	3378

Note : 1972 - 1998 at Intake Bili-Bili station

* : 1999 - 2003 at Bili-Bili station of telemetric system.

Table D3.2 (3/5) Mean Monthly Rainfall (Kampili)

Unit : mm

Year	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1972	935	494	383	69	15	-	-	-	-	-	-	-	-
1973	-	-	-	-	-	-	-	-	-	-	-	-	-
1974	-	-	-	-	-	-	-	-	94	203	327	452	-
1975	362	345	310	381	99	24	82	13	69	154	326	513	2678
1976	658	379	341	26	37	14	8	0	0	98	255	309	2125
1977	976	618	128	107	12	82	0	41	0	0	84	393	2441
1978	470	388	209	212	232	170	140	41	109	44	333	558	2906
1979	657	627	385	84	135	128	0	28	13	34	69	507	2667
1980	674	417	330	86	50	0	0	11	14	58	175	614	2429
1981	408	200	157	198	85	33	70	13	32	62	199	366	1823
1982	304	241	142	56	28	3	0	0	0	0	26	427	1227
1983	272	222	120	304	121	51	49	0	3	112	482	557	2293
1984	506	613	426	303	182	43	17	5	142	57	250	581	3125
1985	433	273	493	213	89	73	45	3	11	34	214	315	2196
1986	1018	355	513	143	101	151	11	0	33	348	215	311	3199
1987	1129	371	385	167	102	10	-	0	0	8	112	1379	-
1988	328	473	405	193	168	60	0	15	192	174	342	600	2950
1989	750	204	285	459	82	118	116	30	24	163	330	397	2958
1990	673	350	195	112	247	8	25	0	0	90	194	153	2047
1991	609	489	123	251	15	0	0	0	0	0	289	483	2259
1992	456	328	720	186	13	91	65	0	245	78	394	318	2894
1993	873	514	247	370	157	98	0	0	0	80	28	776	3143
1994	537	517	526	89	105	11	0	0	0	5	344	400	2534
1995	750	406	241	449	-	7	30	0	11	52	442	798	-
1996	483	617	237	184	0	0	0	25	0	40	97	974	2657
1997	427	638	127	98	56	5	0	0	11	9	75	270	1716
1998	60	168	380	1129	196	100	100	90	50	498	813	514	4098
1999	-	-	286	127	0	0	0	0	0	122	271	501	1307 *
2000	571	651	355	183	81	95	53	4	0	0	192	410	2595 *
2001	618	900	468	151	33	76	0	0	0	119	284	817	3466 *
2002	617	441	436	168	102	42	1	0	0	0	128	139	2074 *
2003	901	406	155	121	61	25	1	0	21	87	228	802	2808 *
Ave.	602	436	317	221	90	52	29	11	36	91	251	521	2656

* : 1999 - 2003 Kampili station of telemetric system

Table D3.2 (4/5) Mean Monthly Rainfall

Station : Jonggoa Unit : mm

Year	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1999	1019	356	521	138	0	0	0	3	5	224	360	768	3394
2000	805	398	484	281	139	295	27	40	3	351	537	496	3856
2001	702	902	440	464	34	131	33	4	3	204	213	488	3618
2002	464	122	0	0	0	82	1	0	0	1	388	506	1564
2003	978	640	484	104	76	23	12	65	16	78	233	1128	3837
Ave.	794	484	386	197	50	106	15	22	5	172	346	677	3254

Station : Maccini Sombala Unit : mm

Year	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1999	1178	432	318	73	0	0	0	0	7	112	185	521	2826
2000	510	735	242	226	38	61	12	2	21	75	293	403	2618
2001	801	729	430	122	50	87	0	0	27	42	244	898	3430
2002	748	473	396	125	49	57	4	0	0	0	112	409	2373
2003	749	436	89	112	72	13	4	0	9	43	84	703	2314
Ave.	797	561	295	132	42	44	4	0	13	54	184	587	2712

Station : Limbunga Unit : mm

Year	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1999	648	412	492	176	0	0	0	3	49	291	242	682	2995
2000	673	690	590	349	133	232	137	30	6	196	108	548	3692
2001	729	956	366	365	73	109	77	4	8	217	367	841	4112
2002	704	512	347	275	103	79	11	0	0	0	180	534	2745
2003	878	439	244	195	187	21	13	6	43	114	216	1038	3394
Ave.	726	602	408	272	99	88	48	9	21	164	223	729	3388

Station : Mangempang Unit : mm

	Jan.	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1999	919	632	577	117	0	0	0	5	29	275	588	662	3804
2000	772	784	452	313	180	319	156	4	14	227	647	488	4356
2001	965	1147	503	369	78	21	0	3	19	238	643	1483	5469
2002	1210	887	499	553	342	137	14	0	0	7	374	1101	5124
2003	1421	819	525	296	187	34	21	7	98	239	477	1749	5873
Ave.	1057	854	511	330	157	102	38	4	32	197	546	1097	4925

Table D3.2 (5/5) Mean Monthly Rainfall (Bontosunggu)

Unit : mm

Year	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1978	408	482	220	168	356	78	97	19	49	12	161	626	2675
1979	805	407	313	90	100	136	0	0	2	5	147	538	2539
1980	643	524	316	159	32	12	0	0	16	19	111	736	2567
1981	601	329	138	36	41	35	109	0	16	6	406	-	-
1982	604	463	374	69	55	0	0	0	0	0	0	159	1723
1983	126	46	25	170	55	18	0	0	0	31	415	548	1433
1984	638	599	347	180	150	9	26	0	120	52	145	518	2784
1985	452	287	470	256	109	27	28	5	106	18	207	56	2020
1986	866	184	364	170	31	27	46	3	3	85	164	152	2094
1987	975	388	495	59	63	0	0	0	6	0	66	1181	3232
1988	480	769	201	184	222	18	15	14	94	186	528	741	3452
1989	760	756	285	277	87	57	11	12	17	24	181	140	2606
1990	355	145	155	29	214	0	2	4	0	53	92	335	1384
1991	726	460	43	211	11	0	5	0	0	8	60	215	1739
1992	375	241	423	153	13	71	24	15	72	20	114	317	1837
1993	450	357	227	166	41	25	0	-	-	34	202	782	-
1994	704	364	497	143	16	10	0	0	0	12	217	232	2193
1995	772	546	408	333	111	74	11	0	19	37	412	584	3305
1996	787	782	236	115	0	11	12	0	15	59	317	1398	3731
1997	410	848	230	214	13	0	12	0	0	0	21	274	2021
1998	155	53	196	253	64	45	147	74	0	0	0	0	986
1999	2791	32	94	36	29	24	18	-	-	1190	741	630	-
2000	819	244	542	0	322	432	16	0	0	219	211	521	3326
2001	543	810	202	25	35	39	0	0	3	0	94	682	2433
2002	472	147	33	12	62	27	5	0	14	0	54	205	1031
Ave.	669	410	273	140	89	47	23	6	24	83	203	482	2449

Table D3.3 Thiessen Ratio and Basin mean Rainfall

Pattarn	Station name	Area (km^2)	Thiessen Ratio
1	Malino	200.26	0.263
	Jonggoa	128.25	0.168
	Bili-Bili	81.45	0.107
	Kampili	65.74	0.086
	Macini Sombala	66.18	0.087
	Limbunga	116.92	0.153
	Mangempang	103.19	0.135
2	Malino	377.03	0.495
	Bili-Bili	384.96	0.505
3	Malino	380.98	0.500
	Bili-Bili	249.12	0.327
	Kampili	131.90	0.173
4	Malino	200.26	0.263
	Jonggoa	128.26	0.168
	Bili-Bili	120.47	0.158
	Macini Sombala	92.91	0.122
	Limbunga	116.91	0.153
	Mangempang	103.19	0.135
5	Jonggoa	328.20	0.431
	Bili-Bili	81.46	0.107
	Kampili	65.74	0.086
	Macini Sombala	66.18	0.087
	Limbunga	117.18	0.154
	Mangempang	103.24	0.135
6	Bili-Bili	630.10	0.827
	Kampili	131.90	0.173

C.A. = 762.0 km^2

Unit : mm

Year	Malino	Jonggoa	Bili-Bili	Kampili	Macini Sombala	Limbunga	Mangempang	Basin Mean
1972	3441	-	3273	-	-	-	-	3356
1973	3970	-	4165	-	-	-	-	4069
1974	5185	-	4149	-	-	-	-	4662
1975	4281	-	3956	2678	-	-	-	3897
1976	3968	-	2820	2125	-	-	-	3274
1977	4975	-	4459	2441	-	-	-	4368
1978	4778	-	3919	2906	-	-	-	4173
1979	3821	-	3587	2667	-	-	-	3545
1980	7039	-	3423	2429	-	-	-	5059
1981	5578	-	3318	1823	-	-	-	4189
1982	4414	-	2585	1227	-	-	-	3264
1983	3938	-	2728	2293	-	-	-	3258
1984	5724	-	3888	3125	-	-	-	4674
1985	4485	-	2744	2196	-	-	-	3520
1986	3812	-	3726	3199	-	-	-	3678
1987	4845	-	3752	-	-	-	-	4293
1988	6483	-	3069	2950	-	-	-	4755
1989	7230	-	3482	2958	-	-	-	5265
1990	2695	-	2685	2047	-	-	-	2580
1991	3378	-	3244	2259	-	-	-	3140
1992	2344	-	2515	2894	-	-	-	2495
1993	4985	-	4367	3143	-	-	-	4464
1994	2857	-	3177	2534	-	-	-	3066
1995	5609	-	3951	-	-	-	-	4771
1996	5301	-	4111	2657	-	-	-	4454
1997	4226	-	2145	1716	-	-	-	3111
1998	3379	-	3391	4098	-	-	-	3507
1999	3798	3394	2931	1307	2826	2995	3804	3352
2000	4385	3856	3711	2595	2618	3692	4356	3806
2001	4132	3618	3564	3466	3430	4112	5469	4044
2002	2810	1564	2606	2074	2373	2745	5124	2780
2003	-	3837	2652	2808	2314	3394	5873	3697

Table D3.4 Maximum One-day Rainfall

Unit : mm

Year	Malino	Bili-Bili	Year	Malino	Bili-Bili	Year	Malino	Bili-Bili
1923	-	97	1950	-	-	1977	208	235
1924	-	98	1951	-	-	1978	168	148
1925	-	235	1952	-	-	1979	131	211
1926	-	113	1953	225	157	1980	138	108
1927	-	143	1954	225	102	1981	135	118
1928	-	113	1955	-	182	1982	135	147
1929	-	182	1956	193	145	1983	130	206
1930	-	152	1957	-	143	1984	190	129
1931	117	125	1958	-	143	1985	143	131
1932	115	217	1959	150	200	1986	200	215
1933	202	156	1960	235	-	1987	133	296
1934	150	210	1961	201	-	1988	275	155
1935	252	210	1962	169	-	1989	221	118
1936	118	97	1963	119	-	1990	86	169
1937	154	139	1964	-	-	1991	160	170
1938	225	165	1965	200	-	1992	99	143
1939	181	138	1966	111	147	1993	246	198
1940	143	117	1967	190	172	1994	71	193
1941	216	-	1968	127	87	1995	177	140
1942	-	-	1969	88	213	1996	108	178
1943	-	-	1970	130	131	1997	160	121
1944	-	-	1971	150	151	1998	101	138
1945	-	-	1972	205	249	1999	185	200
1946	-	-	1973	105	271	2000	237	183
1947	-	-	1974	294	194	2001	130	167
1948	-	-	1975	86	264	2002	134	213
1949	-	-	1976	134	160	2003	161	116

Source : 1931 - 1977 Malino and 1923 - 1971 Bili-Bili data are obtained from
Supporting Report on Detailed Design of Bili-Bili Multipurpose Dam Project
Others are newly collected

Table D4.1 Rating Curve of Water Level Gauging Station

Station Name	Rating Curve	The Date of Creation	Update	Formula	Remarks
Jonggoa	○	1999	×	$Q=12.295(h-0.1826)^2$	No check for high flows*
Bont Jai	○	1999	×	$Q=475.22h^3-3961h^2+11046h-10272$	
Bili-Bili	×	—	—	—	dam reservoir
Kampili	○	1999	×	$Q=205.5(h+0.1451)^2$	
Maccini Sombala	×	—	—	—	
Bayang	×	—	—	—	Equipment were stallen in 2002 Now Interrupting
Jenelata	○	1999	×	$Q=82.93(h-0.614)^2$	2002.1 Flushed out 2004.2 Reconstruction

* : The water level gauge was not functioning during the peak flood perio
Source : JRBDP information

Table D4.2 Monthly Mean Discharge

Station : Bili-Bili Damsite

Year	Monthly Mean Discharge (m^3/s)												
	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
1972	183.8	86.8	50.0	18.9	3.8	0.6	0.3	0.1	0.0	0.0	22.2	32.8	*
1973	54.2	27.3	46.1	59.0	21.7	4.1	20.5	3.8	29.4	5.0	85.9	89.1	
1974	44.2	85.3	167.1	40.8	17.2	7.1	18.2	1.3	13.8	55.0	41.8	94.5	
1975	57.4	76.7	58.2	92.4	23.7	8.1	11.2	4.1	0.7	5.0	53.5	67.2	
1976	95.1	81.9	74.8	15.0	15.0	2.4	5.1	1.9	0.2	17.5	15.7	45.2	
1977	126.1	210.9	62.7	59.0	11.9	23.4	1.3	0.7	0.3	0.1	19.7	67.4	
1978	99.2	66.9	41.2	35.0	22.3	23.3	19.9	11.0	12.2	8.1	18.3	85.7	*
1979	112.4	80.4	71.6	29.6	26.7	10.6	3.0	0.9	0.2	2.9	5.1	75.2	*
1980	162.5	197.0	98.6	50.1	20.1	6.3	2.0	0.7	0.1	0.9	7.1	92.8	*
1981	158.0	94.1	30.0	43.0	33.0	6.6	11.6	1.6	2.3	3.0	36.7	122.4	*
1982	118.8	114.0	42.1	48.2	16.9	6.2	1.5	0.8	0.9	1.0	1.3	7.3	*
1983	13.3	27.6	14.7	27.5	21.4	12.2	4.9	2.0	1.3	2.9	19.1	70.2	*
1984	91.1	110.1	70.8	67.3	37.7	9.2	4.5	2.0	7.8	2.9	7.7	66.7	*
1985	50.5	58.5	102.7	37.9	21.8	14.9	4.3	2.7	1.0	1.2	9.4	21.8	*
1986	162.3	51.9	57.5	42.8	11.9	9.0	6.9	6.7	4.6	7.0	18.8	30.0	*
1987	138.7	100.9	49.6	22.7	12.7	5.2	4.6	4.4	4.4	18.1	14.7	73.8	*
1988	38.4	147.2	82.9	16.6	7.2	5.9	17.6	5.1	5.7	8.1	25.3	89.9	*
1989	122.0	65.0	63.3	46.6	26.7	16.2	15.2	12.7	11.5	11.8	13.4	37.9	*
1990	66.9	38.1	39.3	15.3	21.5	15.8	11.9	11.6	11.4	12.0	13.6	30.7	*
1991	168.7	136.5	19.9	43.2	14.1	11.4	4.0	2.8	1.0	11.4	3.1	10.8	*
1992	52.6	43.7	38.1	14.1	6.8	4.4	2.8	1.7	1.8	1.4	16.8	22.9	
1993	110.6	53.1	63.4	51.8	68.1	29.2	9.2	5.7	3.5	2.1	22.6	99.4	
1994	68.2	55.1	96.7	36.3	18.5	8.1	5.0	3.1	1.9	1.2	0.9	29.5	
1995	101.2	53.0	59.0	59.6	17.1	30.8	8.6	5.4	3.4	2.2	61.5	96.9	
1996	74.8	99.7	47.5	35.6	10.4	6.8	4.3	3.0	2.2	5.6	37.6	156.2	
1997	80.2	127.6	64.0	33.8	11.3	7.1	4.7	3.0	1.9	1.2	2.3	31.3	
1998	26.6	21.8	39.8	41.7	15.4	9.9	10.3	5.4	5.1	4.6	42.9	60.5	
1999	92.0	78.7	52.0	25.3	8.7	5.4	3.3	2.0	1.2	2.8	33.8	79.5	
2000	70.9	70.4	55.6	40.5	18.3	32.5	8.8	5.6	3.5	14.7	35.2	68.9	
2001	73.7	103.7	45.6	32.9	11.3	11.3	5.5	3.4	2.1	11.0	21.3	90.7	
Ave.	93.8	85.5	60.2	39.4	19.1	11.5	7.7	3.8	4.5	7.4	23.6	64.9	

Station : Jenelata

Year	Monthly Mean Discharge (m^3/s)												
	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
1972	96.8	26.5	9.7	7.6	2.5	1.2	0.6	0.2	0.1	0.0	13.8	11.9	
1973	20.7	13.7	19.5	10.2	9.5	2.3	10.1	2.6	6.0	1.0	31.9	26.3	
1974	21.7	36.5	84.3	15.1	9.3	4.0	5.2	1.3	5.4	26.1	11.3	38.2	
1975	26.6	32.8	25.9	26.1	11.5	5.9	2.2	2.1	0.7	3.3	13.0	26.9	
1976	43.5	39.9	45.0	11.5	9.9	2.2	1.2	0.6	0.2	9.3	2.8	17.3	
1977	46.4	91.7	32.4	25.6	7.9	17.0	2.0	1.1	0.5	0.2	4.9	28.8	
1978	38.3	33.3	14.9	15.4	8.1	7.3	8.9	2.7	3.7	2.9	17.1	47.9	
1979	40.3	29.8	43.6	10.4	11.9	5.3	1.5	0.8	0.3	0.6	1.1	26.4	
1980	53.4	89.3	60.2	46.6	25.1	6.5	2.5	1.4	0.7	7.3	26.1	56.9	
1981	55.8	36.7	18.6	23.9	11.4	7.5	9.5	1.7	6.5	1.0	30.0	65.3	
1982	60.5	41.2	39.4	51.9	11.5	5.3	1.9	1.0	0.4	0.2	2.9	11.4	
1983	28.8	29.9	9.8	27.8	23.7	12.0	3.9	1.7	0.9	0.4	23.6	7.5	
1984	35.7	42.2	34.4	38.0	25.0	8.0	2.8	1.7	6.6	6.5	12.1	52.8	
1985	31.2	21.5	32.3	31.7	14.2	10.7	10.6	1.9	1.7	3.3	22.4	16.1	
1986	82.4	20.1	10.1	18.0	2.9	1.7	2.9	1.3	0.6	1.1	6.3	13.4	
1987	73.5	55.7	16.6	11.2	3.5	1.8	0.9	0.4	0.2	0.0	14.9	70.7	
1988	28.5	110.7	34.2	6.8	8.3	2.2	1.3	1.4	0.7	0.2	28.1	114.1	
1989	120.2	79.6	39.5	64.8	22.4	31.9	5.4	2.7	1.7	2.1	2.5	20.1	
1990	27.5	17.2	19.4	7.5	13.6	6.6	2.1	0.9	2.0	3.6	2.2	40.3	*
1991	53.7	46.3	15.3	35.0	8.2	1.9	1.3	0.5	0.4	0.1	1.5	19.5	*
1992	25.4	27.8	29.3	19.6	3.9	4.7	1.7	0.5	0.9	2.0	7.7	13.1	*
1993	31.3	50.7	17.0	28.0	16.5	10.6	3.8	1.7	0.9	1.2	6.4	49.4	*
1994	37.4	40.4	44.3	25.5	12.1	3.5	1.5	0.5	0.3	0.3	1.5	12.4	*
1995	48.0	23.0	47.3	21.4	11.2	17.2	3.5	1.8	0.8	1.5	17.8	35.8	*
1996	25.9	56.7	30.3	12.7	4.2	4.0	3.2	2.4	1.4	7.5	16.1	49.9	*
1997	28.1	31.3	27.0	6.7	4.5	2.2	2.0	0.8	0.5	0.4	2.7	8.6	*
1998	10.4	8.5	14.4	32.6	15.5	8.7	6.4	4.6	3.2	2.4	17.9	23.4	
1999	35.2	38.7	29.1	17.6	8.6	5.8	4.0	2.9	2.3	2.5	12.0	31.2	
2000	34.4	48.5	32.2	25.2	12.3	14.7	9.7	6.5	4.6	3.8	7.5	26.8	
2001	37.1	71.9	29.9	20.7	11.4	8.2	5.8	4.2	3.2	2.9	13.9	53.2	
Ave.	43.3	43.1	30.2	23.2	11.3	7.4	3.9	1.8	1.9	3.1	12.4	33.9	

Note : * the figures are obtained from the discharge converted from gaugied water level

Table D4.3 Railfall and Runoff Depth at each Station

Bili-Bili Dam Site

C.A. = 384.4 km^2

Hydrological Year (Jun.-May)	Rainfall (mm)	Runoff Depth (mm)	Ratio (%)	loss
1972	2594	1806 *	70	788
1973	4782	4034	84	747
1974	4511	3677	82	834
1975	3979	2952	74	1027
1976	4669	3733	80	936
1977	3353	2568	77	785
1978	4916	3405 *	69	1510
1979	5334	4260 *	80	1073
1980	4518	3185 *	70	1333
1981	5784	3554 *	61	2230
1982	2988	833 *	28	2155
1983	4672	3339 *	71	1333
1984	4488	2540 *	57	1947
1985	4075	2610 *	64	1465
1986	4134	2761 *	67	1374
1987	4721	2834 *	60	1887
1988	7445	3288 *	44	4156
1989	3325	2052 *	62	1273
1990	3220	3299 *	102	-78
1991	2595	1366 *	53	1229
1992	3932	2726	69	1205
1993	4128	3054	74	1074
1994	3254	2315	71	939
1995	4435	3248	73	1187
1996	4951	3607	73	1344
1997	2241	1344	60	897
1998	3971	2683	68	1289
1999	3768	2609	69	1159
2000	4130	2947	71	1183
Ave.	4169	2849	68	

Jenelata Station

C.A. = 226.3 km^2

Hydrological Year (Jun.-May)	Rainfall (mm)	Runoff Depth (mm)	Ratio (%)	loss
1972	2635	1174	45	1461
1973	5075	2861	56	2214
1974	4784	2482	52	2302
1975	4597	2371	52	2226
1976	4716	2695	57	2021
1977	3671	1893	52	1778
1978	5119	2630	51	2489
1979	5955	3589	60	2366
1980	5045	2870	57	2175
1981	6458	3773	58	2685
1982	3306	1645	50	1661
1983	4842	2604	54	2238
1984	4981	2573	52	2408
1985	4280	2327	54	1953
1986	4263	2152	50	2111
1987	5190	3189	61	2001
1988	8623	5488	64	3135
1989	3444	1759	51	1685
1990	2800	2489 *	89	311
1991	2810	1524 *	54	1287
1992	3919	1986 *	51	1934
1993	4195	2702 *	64	1493
1994	3170	1985 *	63	1186
1995	4181	2403 *	57	1778
1996	4541	2108 *	46	2432
1997	2300	1142 *	50	1157
1998	3636	2254	62	1382
1999	3817	2450	64	1367
2000	4144	2796	67	1348
Ave.	4362	2480	57	

Note : * the figures are obtained from the discharge converted from gaugied water level

Table D5.1 Half Monthly Rainfall in the Irrigation Area for Calcuration of Net Field Requirement (NFR)

Average Rainfall for seven (7) Stations

(Kampili, Bontosunggu, Mandalle, Kalabajeng, Bontosallang, Barembeng, Sandro Bone) Unit : mm

Year	Jan.		Feb.		Mar.		Apr.		May		Jun.		Jul.		Aug.		Sept.		Oct.		Nov.		Dec.		Total
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	
1972	784	38	106	328	216	120	0	61	13	0	0	0	0	0	0	4	0	0	0	0	24	106	78	120	1,998
1973	109	212	76	10	170	89	228	217	72	51	16	3	107	0	10	7	60	176	48	32	111	380	68	398	2,647
1974	192	11	219	196	402	182	126	40	22	47	8	26	27	79	0	4	78	4	137	41	71	216	183	214	2,528
1975	163	156	193	111	178	94	38	285	48	24	41	3	4	53	16	2	62	41	64	147	94	249	421	215	2,698
1976	592	101	226	192	202	250	33	10	55	2	17	17	8	0	0	0	0	0	5	47	105	154	277	147	2,438
1977	366	618	475	577	112	155	133	2	24	15	63	12	0	0	11	0	0	3	0	0	3	97	157	156	2,979
1978	274	198	289	194	95	174	136	43	132	130	48	37	87	9	7	14	43	10	32	8	72	105	159	477	2,774
1979	651	180	237	261	288	56	21	44	87	28	109	3	1	0	5	0	2	2	1	7	33	61	410	129	2,618
1980	365	306	294	192	198	117	86	86	16	11	0	9	1	0	2	0	0	5	4	11	40	44	358	306	2,451
1981	297	298	207	130	47	123	64	33	59	19	2	25	113	14	1	4	13	1	15	10	77	316	393	281	2,543
1982	287	313	412	53	205	137	12	52	34	1	12	0	0	0	0	0	0	0	0	0	1	4	14	185	1,721
1983	165	72	65	36	8	70	85	101	65	4	10	13	10	8	0	0	0	1	19	54	56	361	149	349	1,698
1984	201	389	339	179	189	56	76	70	114	33	7	6	0	13	0	1	55	8	30	30	40	132	186	381	2,536
1985	162	276	164	183	435	10	120	47	70	27	29	0	12	18	0	5	0	35	2	24	54	112	80	98	1,961
1986	534	308	186	155	170	144	109	21	29	1	42	9	8	14	0	0	0	7	52	39	72	115	101	121	2,237
1987	376	566	207	121	82	250	75	9	72	1	2	0	0	0	0	0	0	1	0	5	37	33	290	913	3,040
1988	122	236	682	146	74	274	128	16	103	44	10	6	2	3	11	10	48	35	59	71	150	201	389	204	3,025
1989	57	627	282	278	297	23	84	221	59	4	31	47	15	32	0	9	3	23	41	83	103	94	199	59	2,671
1990	373	299	176	91	172	17	35	31	62	114	7	0	4	3	0	1	0	2	0	50	65	56	80	315	1,953
1991	205	534	244	127	30	76	56	121	0	4	0	1	1	0	0	0	0	0	0	1	25	49	236	48	1,760
1992	258	79	88	94	265	188	86	19	8	3	26	17	26	0	10	1	52	39	9	17	34	111	154	172	1,755
1993	75	346	178	173	86	90	136	42	59	19	28	6	0	0	0	0	0	0	17	5	20	58	147	501	1,987
1994	205	497	175	132	288	210	40	59	36	0	0	11	0	0	0	0	0	0	4	10	41	99	124	127	2,057
1995	305	289	216	190	266	106	285	23	68	12	32	17	8	0	0	0	2	8	5	19	66	177	433	122	2,649
1996	172	432	641	210	104	181	42	38	20	3	8	7	2	2	4	0	4	2	51	24	125	74	470	476	3,092
1997	290	183	209	412	130	5	48	35	12	4	0	1	5	0	0	0	0	2	2	0	0	27	72	172	1,609
1998	65	19	56	11	5	211	226	95	105	57	36	75	32	118	26	30	2	57	45	124	263	204	241	430	2,532
1999	716	583	270	270	183	109	61	113	61	1	2	19	15	0	0	0	0	0	132	95	178	89	290	233	3,419
2000	233	441	453	188	141	231	110	92	36	46	85	46	12	5	1	0	0	0	8	60	12	190	258	121	2,766
2001	498	148	715	101	283	121	47	22	8	10	51	6	0	0	0	0	1	1	3	20	76	112	466	193	2,882
Mean	303	292	269	178	177	129	91	68	52	24	24	14	17	12	3	3	14	15	26	34	68	134	229	255	2,434

Note : Jan.-May 1972, Sep.74-Mar.75 : R(Project Area) = 0.879xR(Kampili)
Jun.1972-Aug.74 : R(Project Area) = 0.879x(0.723xR(Bili Bili))

Missing data :

Sandro Bone	Jan. and Feb. 1998
Kampili	Jan. and Feb. 1999
Bontosunggu	Aug. and Sep. 1999
Bontosallang	Jan. - Mar. 2000
Mandalle	Feb. 2000

Source : 1972 - 1997 obteined from Supporting Report for Detaile Design on Bili-Bili Irrigation Project in Dec.1999
: 1998 - 2001 Newly Collecting from Balai PSDA Jeneberang

Table D5.2 (1/2) Projected Municipal Water Demand and Diversion Requirement

Supplier	Present Condition in 2003								
	All Supply Area				from the Jeneberang River				
	WTP		Intake		WTP		Intake		
					Wet Season	Dry Season	Wet Season	Dry Season	Amount
	(m^3/s)	(MCM)	(m^3/s)	(MCM)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(MCM)
PDAM Makassar	**2.36** *1	74.30	unknown	unknoun	1.34	1.84	1.47	1.97	54.18
PDAM Gowa	**0.19** *1	5.99	unknown	unknoun	0.18	0.18	0.19	0.19	6.10

Supplier	in 2010								
	All Supply Area				from the Jeneberang River				
	WTP		Intake		WTP		Intake		
					Wet Season	Dry Season	Wet Season	Dry Season	Amount
	(m^3/s)	(MCM)	(m^3/s)	(MCM)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(MCM)
PDAM Makassar	**2.74** *1	86.25	unknown	unknown	1.65	unknown	1.80	2.30	64.71
PDAM Gowa	uknown	unknown	0.37	**11.82** *2	unknown	unknown	0.36	0.36	11.50

Supplier	in 2018								
	All Supply Area				from the Jeneberang River				
	WTP		Intake		WTP		Intake		
					Wet Season	Dry Season	Wet Season	Dry Season	Amount
	(m^3/s)	(MCM)	(m^3/s)	(MCM)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(MCM)
PDAM Makassar	**4.11** *1	129.48	unknown	unknown	3.02	unknown	3.31	3.81	112.26
PDAM Gowa	unknown	unknown	0.72	**22.81** *3	unknown	unknown	0.71	0.71	22.50

Supplier	in 2019								
	All Supply Area				from the Jeneberang River				
	WTP		Intake		WTP		Intake		
					Wet Season	Dry Season	Wet Season	Dry Season	Amount
	(m^3/s)	(MCM)	(m^3/s)	(MCM)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(MCM)
PDAM Makassar	**4.25** *1	134.11	unknown	unknown	3.16	unknown	3.47	3.97	117.30
PDAM Gowa	unknown	unknown	0.77	**24.19** *3	unknown	unknown	0.76	0.76	23.87

Supplier	in 2020								
	All Supply Area				from the Jeneberang River				
	WTP		Intake		WTP		Intake		
					Wet Season	Dry Season	Wet Season	Dry Season	Amount
	(m^3/s)	(MCM)	(m^3/s)	(MCM)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(MCM)
PDAM Makassar	**4.40** *1	138.90	unknown	unknown	3.31	unknown	3.63	4.13	122.33
PDAM Gowa	unknown	unknown	0.81	**25.56** *2	unknown	unknown	0.80	0.80	25.24

*1: Refer to Water Supply Section
*2: Refer to Main Report on Consulting Engineering Services for Comprehensive Water Management Plam Stud
for MAROS-JENEPONTO River Basin, Sector 10
*3: estimated to interpolate linear between 2010 and 2020

WTP : Requirement of Water Treatment Plant
Intake : Diversion requirement from the intake

Table D5.2 (2/2) Projected Municipal Water Demand and Diversion Requirement from the Jeneberang River

Facility Name	Originally Programmed		Present Condition				in 2010			in 2018			Intake Point
			Plant Capacity	Actual[*5]	Intake		Actual	Intake		Actual	Intake		
	(m^3/s)	(MCM)	(m^3/s)	(m^3/s)	(m^3/s)	(MCM)	(m^3/s)	(m^3/s)	(MCM)	(m^3/s)	(m^3/s)	(MCM)	
[*1] Somba Opu WTP	3.30	104.07	1.00	1.19	1.31	41.33	1.50	1.64	51.86	2.87	3.15	99.42	Bili-Bili[*3]
[*1] Ratulangi WTP	-	-	0.05	0.06	0.07	2.07	0.06	0.07	2.07	0.06	0.07	2.07	Ujung Pandang
[*1] Maccini Sombala WTP	-	-	0.20	0.09	0.09	2.90	0.09	0.09	2.90	0.09	0.09	2.90	Malingkeli-1
[*1] the growth[*4]	-	-	-	-	-	-	0.00	0.00	0.00	0.00	0.00	0.00	Downstream
[*1] Panaikang WTP (for dry season)	-	-	1.00	unknown	0.50	7.88	unknown	0.50	7.88	unknown	0.50	7.88	Malingkeli-2
[*2] Bajeng WTP	-	-	0.02	0.02	0.02	0.66	0.02	0.02	0.66	0.02	0.02	0.66	Kampili Weir
[*2] Borong Loe WTP	-	-	0.02	0.01	0.01	0.44	0.02	0.02	0.69	0.02	0.02	0.69	Bili-Bili[*3]
[*2] Tompo Balang WTP	0.10	3.15	0.04	0.03	0.03	0.83	0.04	0.04	1.32	0.04	0.04	1.32	Sungguminasa
[*2] Pandang-Pandang WTP	-	-	0.20	0.13	0.13	4.17	0.20	0.21	6.62	0.20	0.21	6.62	Padang-Pandang
[*2] the growth[*4]	-	-	-	-	-	-	0.07	0.07	2.20	0.40	0.42	13.19	Downstream

Facility Name	in 2019			in 2020			Intake Point
	Actual	Intake		Actual	Intake		
	(m^3/s)	(m^3/s)	(MCM)	(m^3/s)	(m^3/s)	(MCM)	
[*1] Somba Opu WTP	2.98	3.28	103.38	2.98	3.28	103.38	Bili-Bili[*3]
[*1] Ratulangi WTP	0.06	0.07	2.07	0.06	0.07	2.07	Ujung Pandang
[*1] Maccini Sombala WTP	0.12	0.13	3.98	0.20	0.21	6.62	Malingkeli-1
[*1] the growth[*4]	0.00	0.00	0.00	0.07	0.08	2.39	Downstream
[*1] Panaikang WTP (for dry season)	unknown	0.50	7.88	unknown	0.50	7.88	Malingkeli-2
[*2] Bajeng WTP	0.02	0.02	0.66	0.02	0.02	0.66	Kampili Weir
[*2] Borong Loe WTP	0.02	0.02	0.69	0.02	0.02	0.69	Bili-Bili[*3]
[*2] Tompo Balang WTP	0.04	0.04	1.32	0.04	0.04	1.32	Sungguminasa
[*2] Pandang-Pandang WTP	0.20	0.21	6.62	0.20	0.21	6.62	Padang-Pandang
[*2] the growth[*4]	0.44	0.46	14.57	0.48	0.51	15.94	Downstream

*1 : Operated by PDAM Makassar
*2 : Operated by PDAM Gowa
*3 : Intake point between Bili-Bili MultipurposeDam and Bili-Bili Wei
*4 : Water Demand Increament which cannot be provided from existing WTP capacity and Somba Opu reinforcemen
*5 : Refer to Water Supply Sector
Actual : actual requirement of Water Treatment Plan
Intake : estimated diversion requiremenr from the intake

Table D5.3 Result of Bili-Bili Reservoir Simulation

Year	Minimum Water Level (m)				Minimum Volume (MCM)			
	Present (2003)	2018	2019	2020	Present (2003)	2018	2019	2020
1972	64.9	64.9	64.9	64.9	12.0	12.0	12.0	12.00
1973	87.2	86.3	86.2	86.2	142.5	132.7	131.9	131.57
1974	91.1	88.9	88.7	88.5	190.2	162.4	160.0	157.62
1975	89.7	87.3	87.0	86.8	171.9	143.0	140.3	137.57
1976	73.0	64.9	64.9	64.9	35.5	12.0	12.0	12.00
1977	82.5	76.2	75.7	75.1	96.1	54.7	51.1	47.64
1978	98.6	96.6	96.4	96.2	304.1	271.3	267.3	263.86
1979	83.8	79.1	78.4	77.9	108.1	71.7	68.4	65.19
1980	81.4	75.7	75.3	74.8	87.3	51.5	48.5	45.64
1981	90.3	87.5	87.2	87.0	179.5	145.4	142.5	139.90
1982	64.9	64.9	64.9	64.9	12.0	12.0	12.0	12.00
1983	67.4	64.9	64.9	64.9	17.2	12.0	12.0	12.00
1984	89.2	86.0	85.7	85.4	165.4	129.1	126.0	123.20
1985	89.8	87.4	87.1	86.9	173.0	144.3	141.7	139.38
1986	84.2	80.3	79.6	78.9	111.2	77.2	73.9	70.57
1987	75.1	65.9	64.9	64.9	47.6	13.9	12.0	12.00
1988	87.9	84.5	84.2	83.9	150.3	114.7	111.6	108.55
1989	98.5	97.9	97.8	97.7	301.4	291.4	290.4	289.43
1990	93.4	91.8	91.7	91.5	221.6	199.8	198.0	196.01
1991	76.1	66.4	64.9	64.9	53.9	15.0	12.0	12.00
1992	72.8	64.9	64.9	64.9	34.8	12.0	12.0	12.00
1993	86.1	83.0	82.9	82.9	130.6	100.6	100.1	99.97
1994	76.8	68.2	66.7	65.0	58.5	19.1	15.7	12.32
1995	86.3	81.5	81.1	80.6	132.3	88.3	84.6	81.27
1996	79.4	73.3	72.6	71.8	73.4	36.8	33.7	30.46
1997	64.9	64.9	64.9	64.9	12.0	12.0	12.0	12.00
1998	81.0	77.8	77.6	77.4	83.9	65.0	63.4	62.17
1999	82.1	76.6	76.2	75.7	93.3	57.6	54.5	51.39
2000	95.5	94.0	93.8	93.7	253.1	230.3	228.3	226.28
2001	95.5	94.0	93.8	93.7	138.5	104.6	101.7	98.72

: beyond Bili-Bili reservoir capacity

Table D5.4 Areal Average Rainfall in Lower Reaches of Jeneberang River below Bili-Bili Dam in the Drought Year

Year	Occurrence of Drought				Areal Average Raindall				
	Present	2018	2019	2020	Apr.	May	Jun	Total	Annual
1972	*	*	*	*	61	13	0	74	1,998
1973					444	123	19	586	2,647
1974					166	69	34	269	2,528
1975					323	72	44	438	2,698
1976		*	*	*	42	58	34	134	2,438
1977					135	39	75	249	2,979
1978					178	263	86	527	2,774
1979					65	115	112	292	2,618
1980					172	27	9	208	2,451
1981					97	79	27	203	2,543
1982	*	*	*	*	64	34	12	110	1,721
1983		*	*	*	186	69	23	277	1,698
1984					146	148	13	306	2,536
1985					166	97	30	293	1,961
1986					130	29	51	211	2,237
1987			*	*	84	73	2	158	3,040
1988					144	147	16	307	3,025
1989					305	63	77	446	2,671
1990					66	176	7	249	1,953
1991			*	*	177	5	1	183	1,760
1992		*	*	*	105	11	43	159	1,755
1993					178	79	34	291	1,987
1994					99	36	12	146	2,057
1995					308	80	48	436	2,649
1996					79	23	15	117	3,092
1997	*	*	*	*	83	16	1	100	1,609
1998					321	162	111	595	2,532
1999					174	62	21	257	3,419
2000					202	83	130	415	2,766
2001					69	17	57	144	2,882
Average					159	76	38	273	2,434

* : The year during which the storage volume of Bili-Bili dam reservoir drops to zero.

Figures

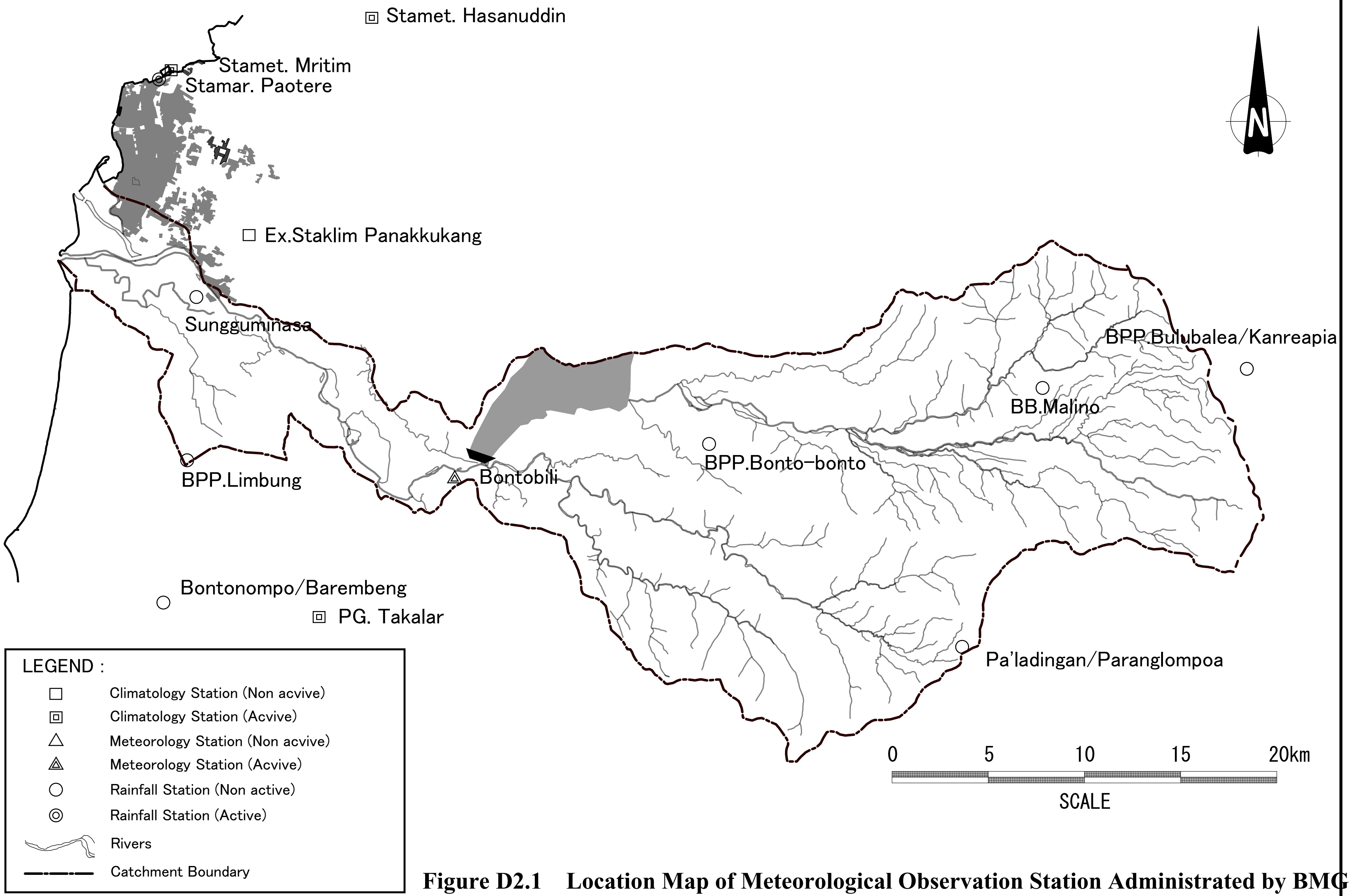


Figure D2.1 Location Map of Meteorological Observation Station Administrated by BMG

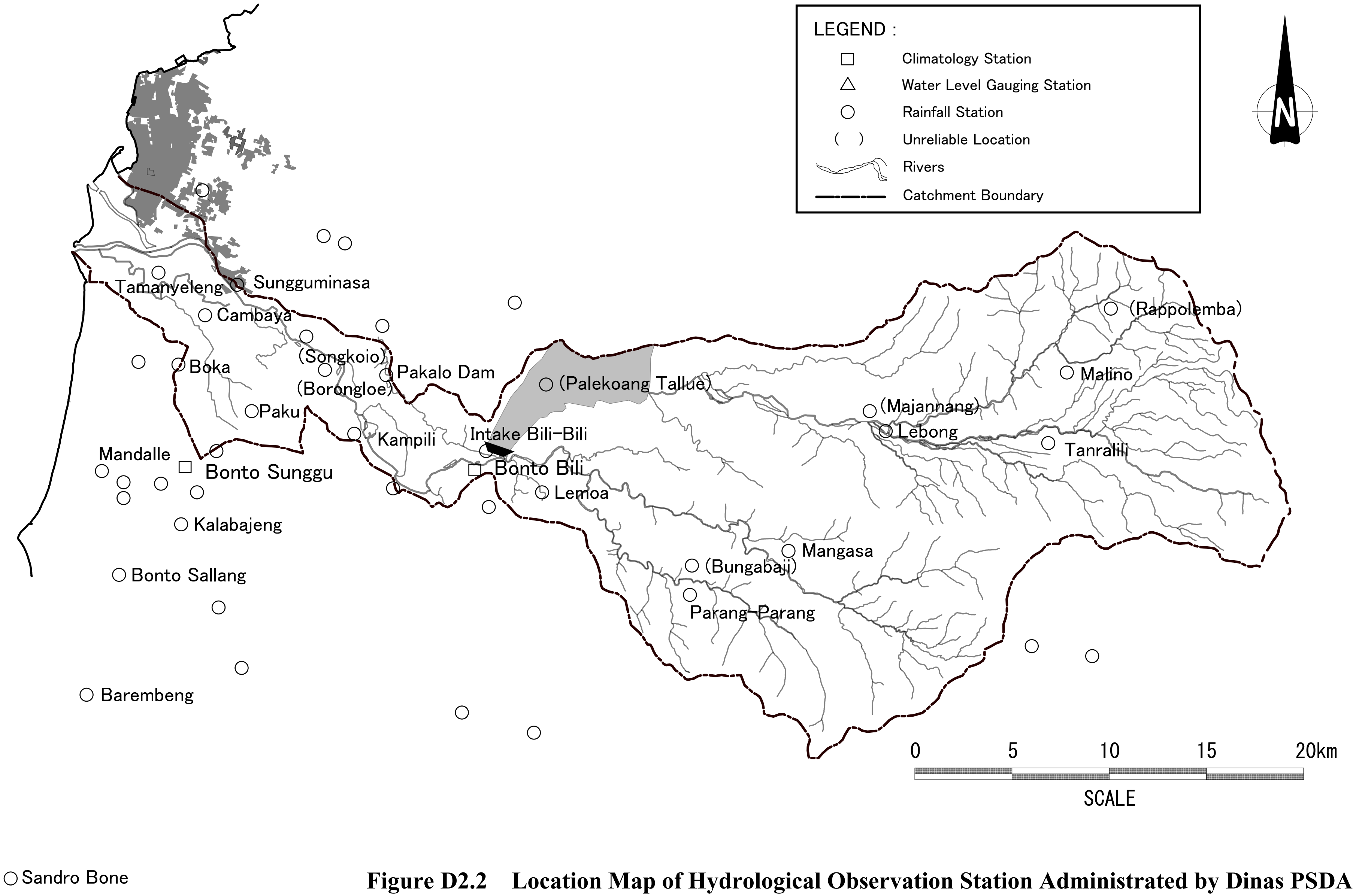


Figure D2.2 Location Map of Hydrological Observation Station Administrated by Dinas PSDA

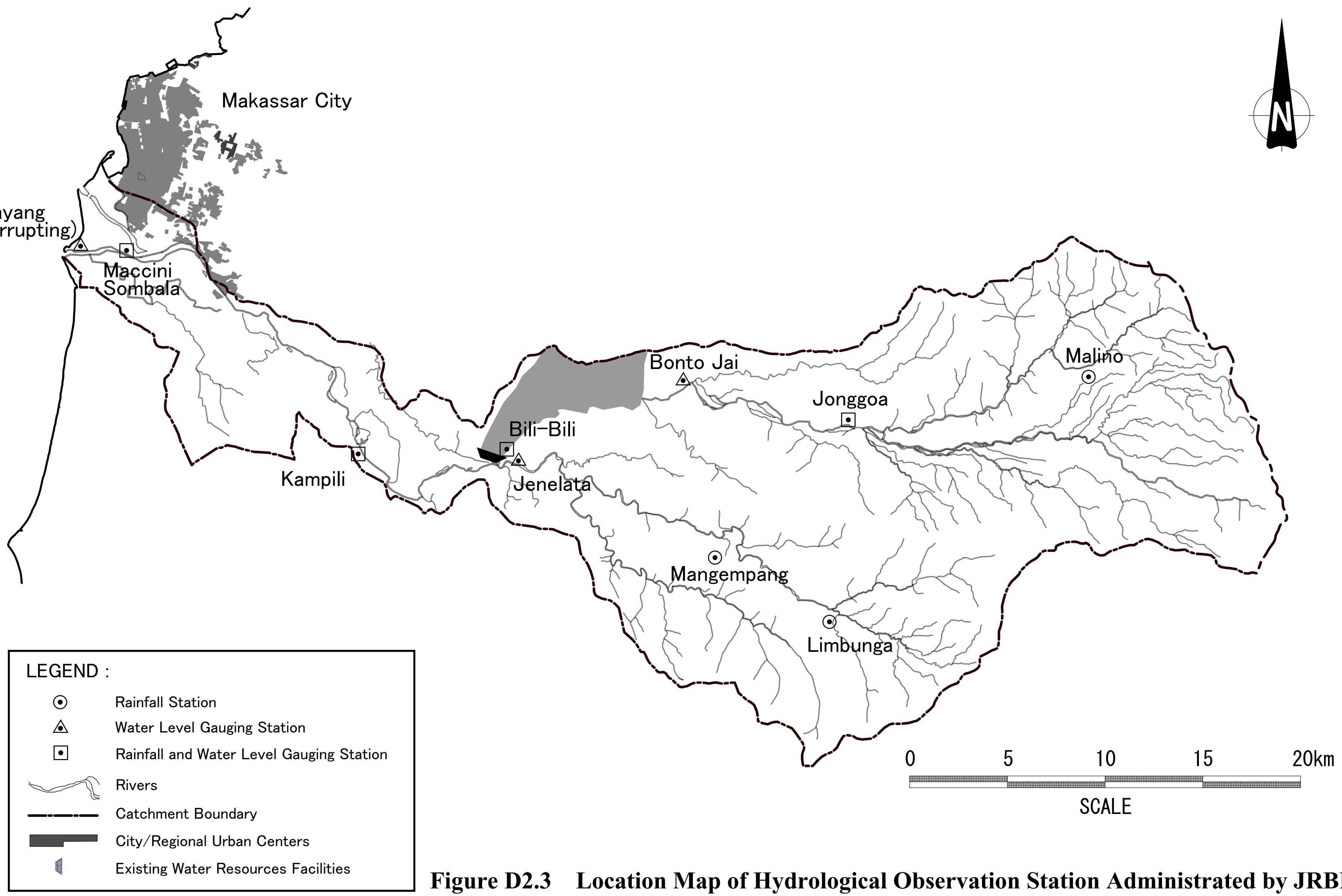


Figure D2.3 Location Map of Hydrological Observation Station Administrated by JRBDP

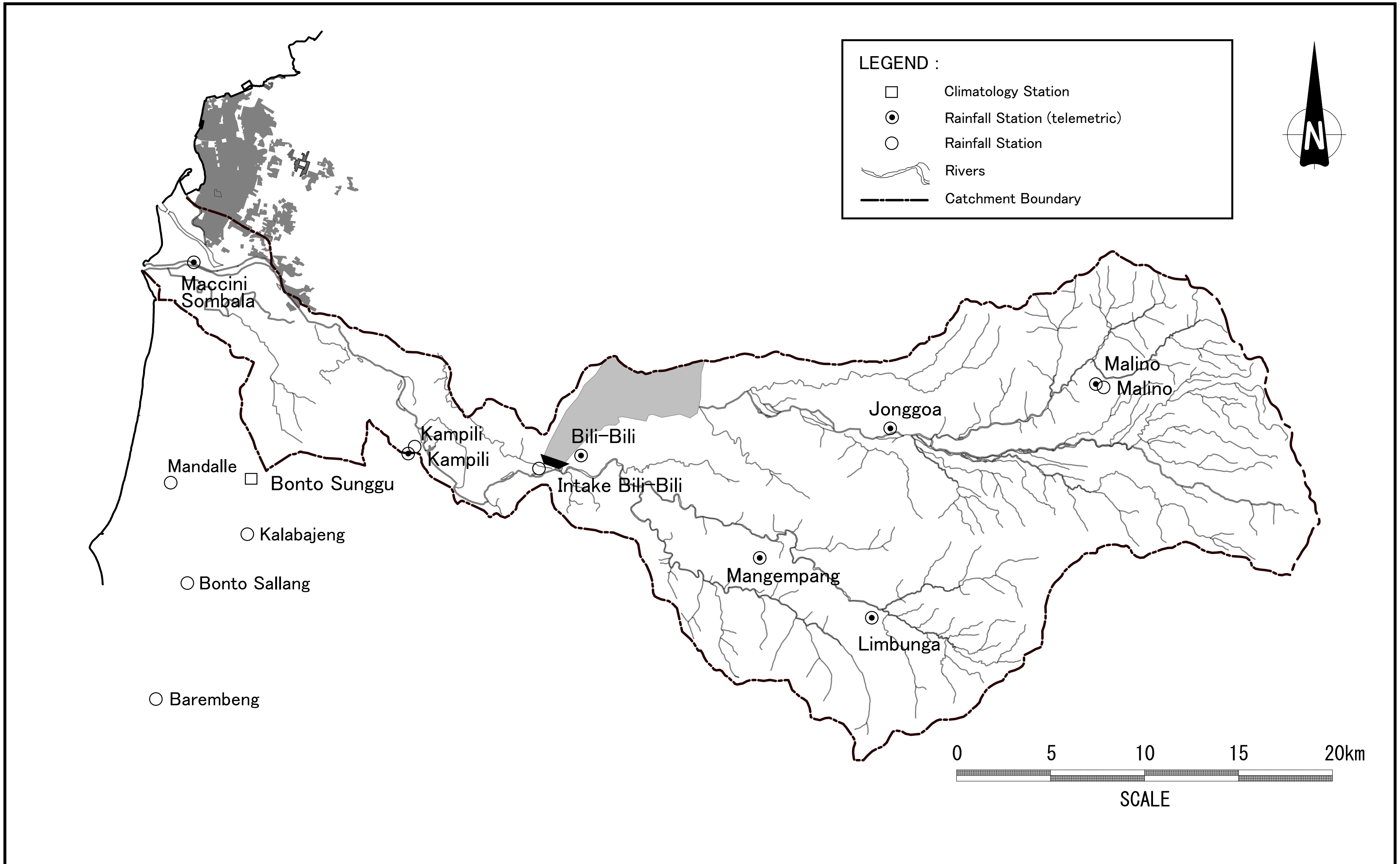


Figure D3.1 The Location of Rainfall Station Collected Data in this Study

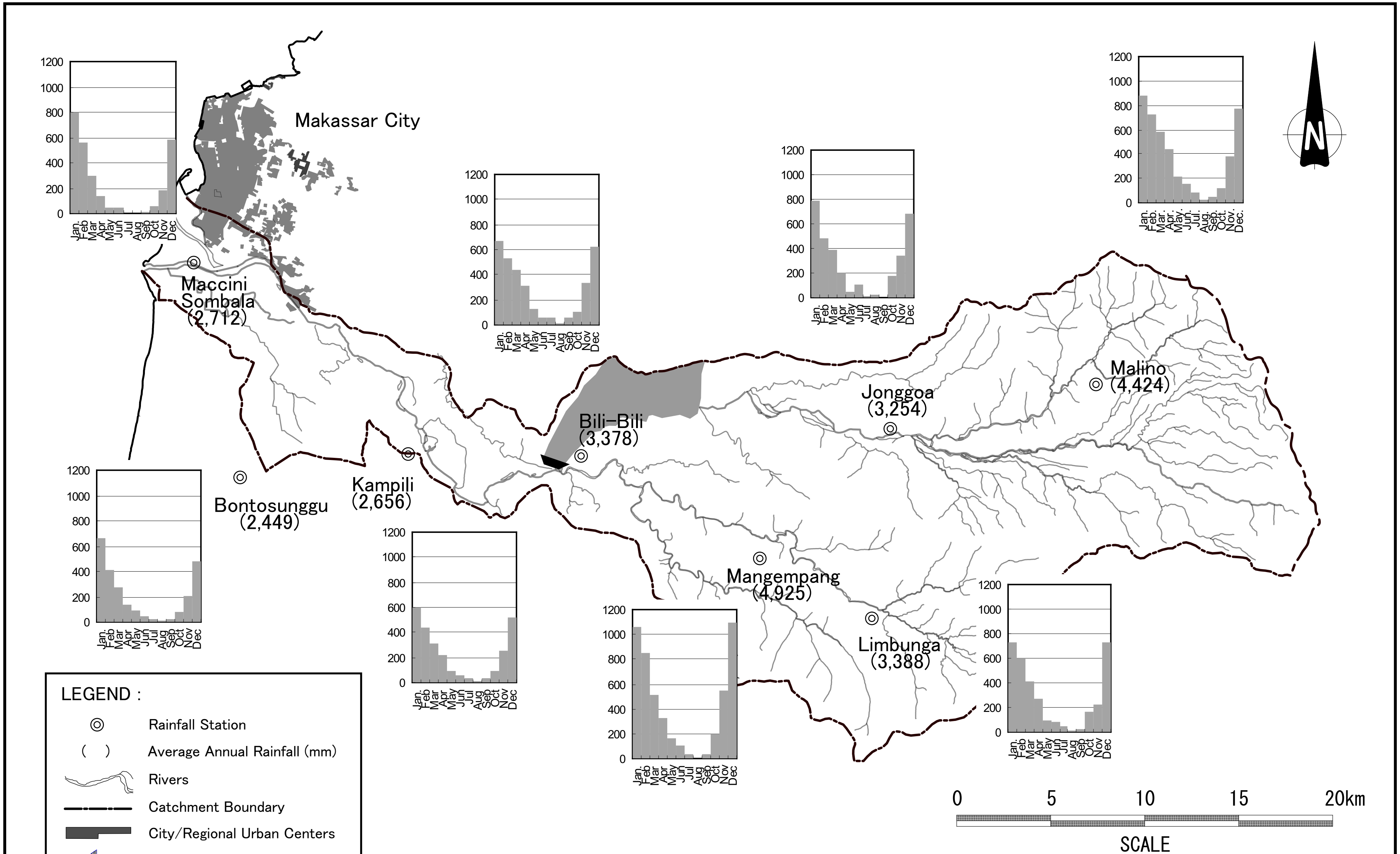
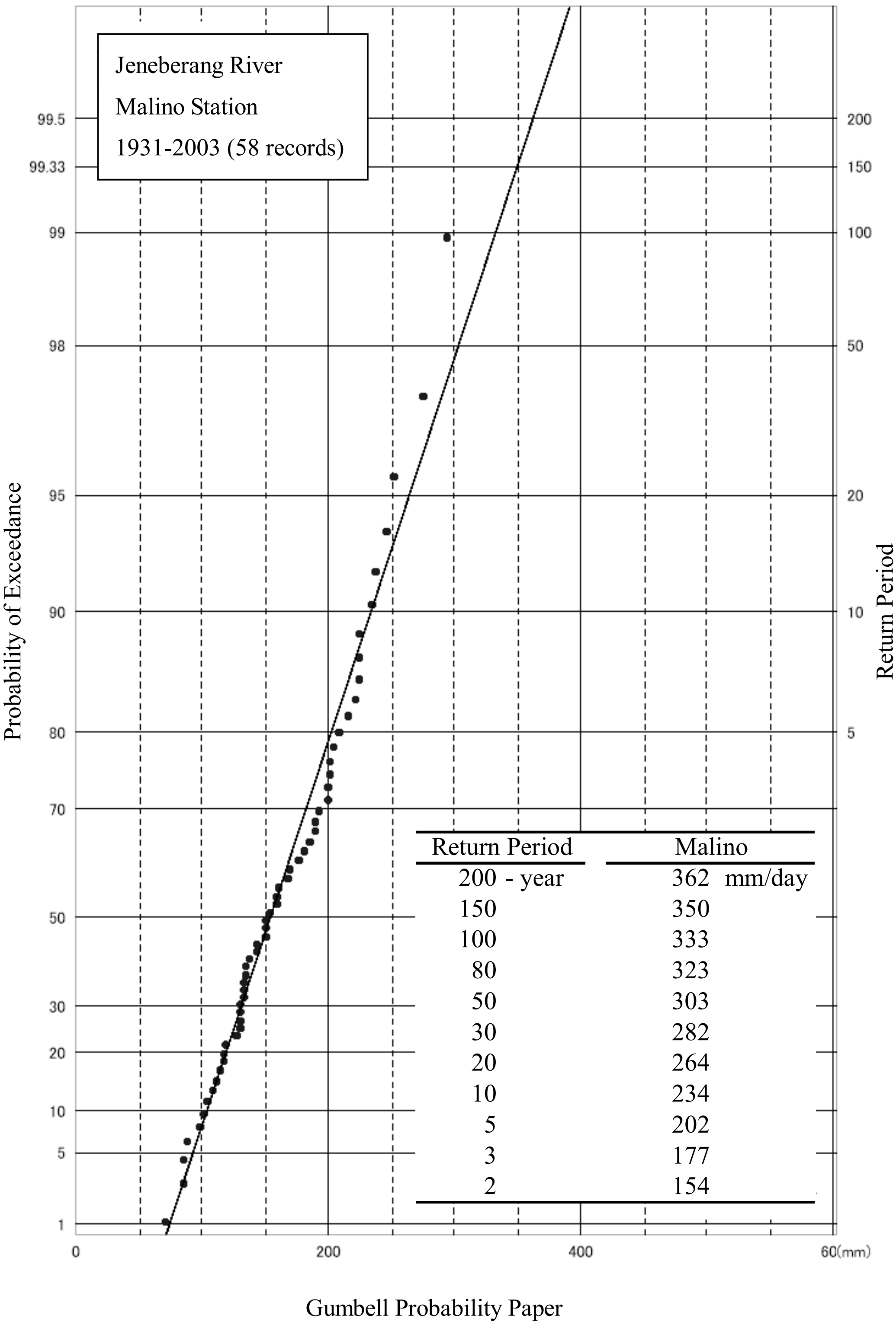
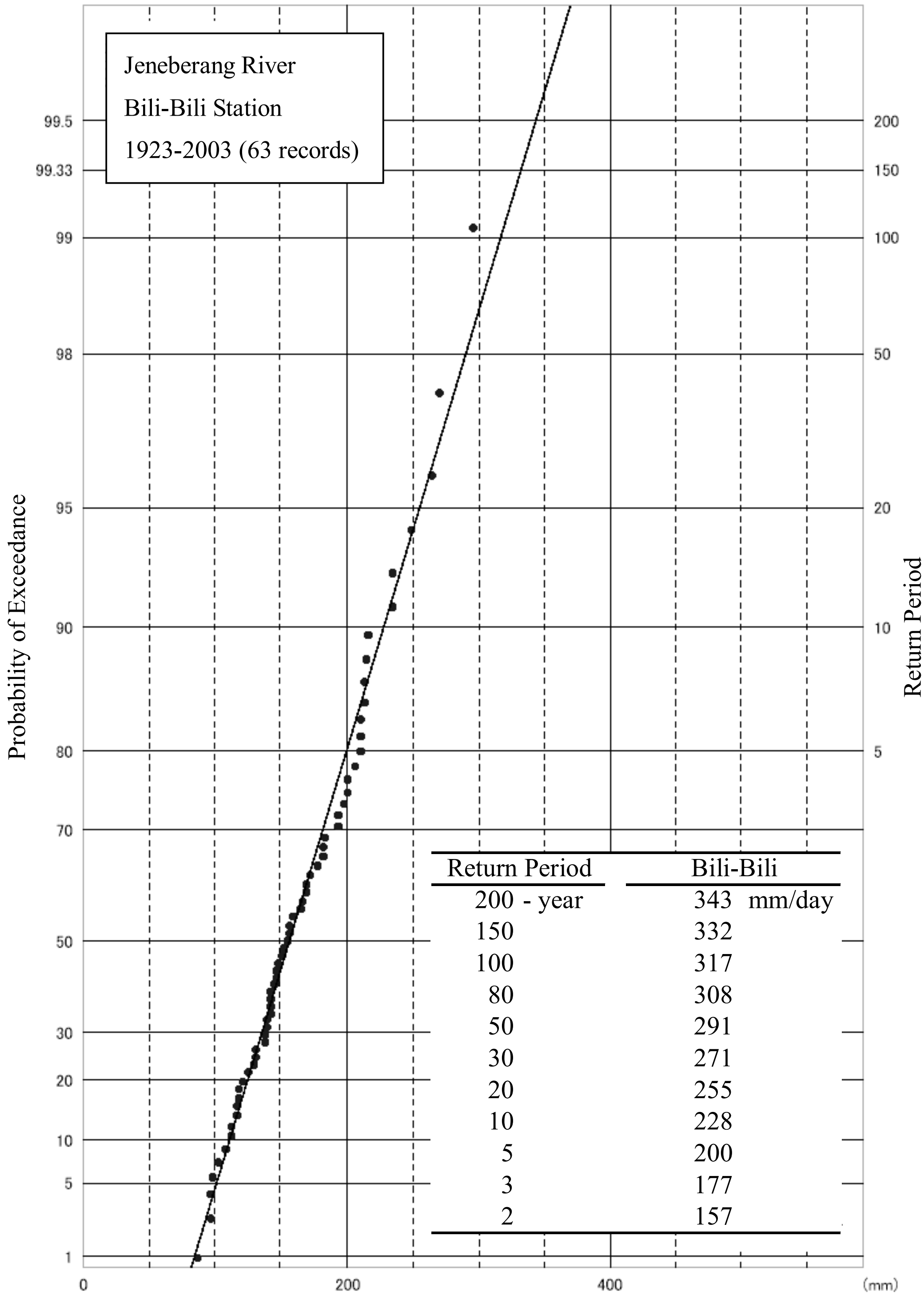


Figure D3.2 Seasonal Rainfall in the Jeneberang River Basin



Return Period	Malino
200 - year	362 mm/day
150	350
100	333
80	323
50	303
30	282
20	264
10	234
5	202
3	177
2	154

Figure D3.3 (1/2) Probable Maximum One-day Rainfall (Malino)



Return Period	Bili-Bili
200 - year	343 mm/day
150	332
100	317
80	308
50	291
30	271
20	255
10	228
5	200
3	177
2	157

Gumbell Probability Paper

Figure D3.3 (2/2) Probable Maximum One-day Rainfall (Bili-Bili)

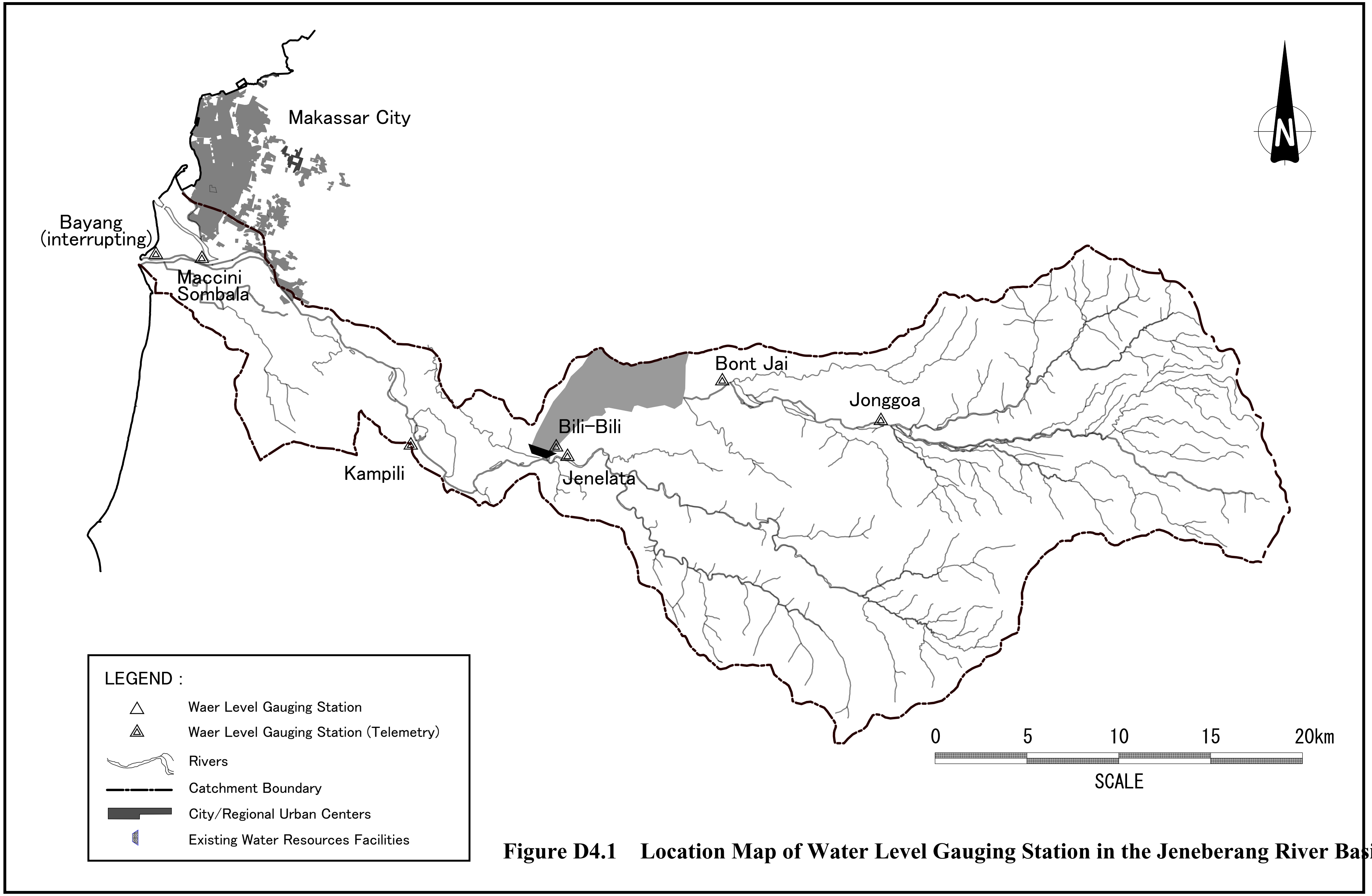
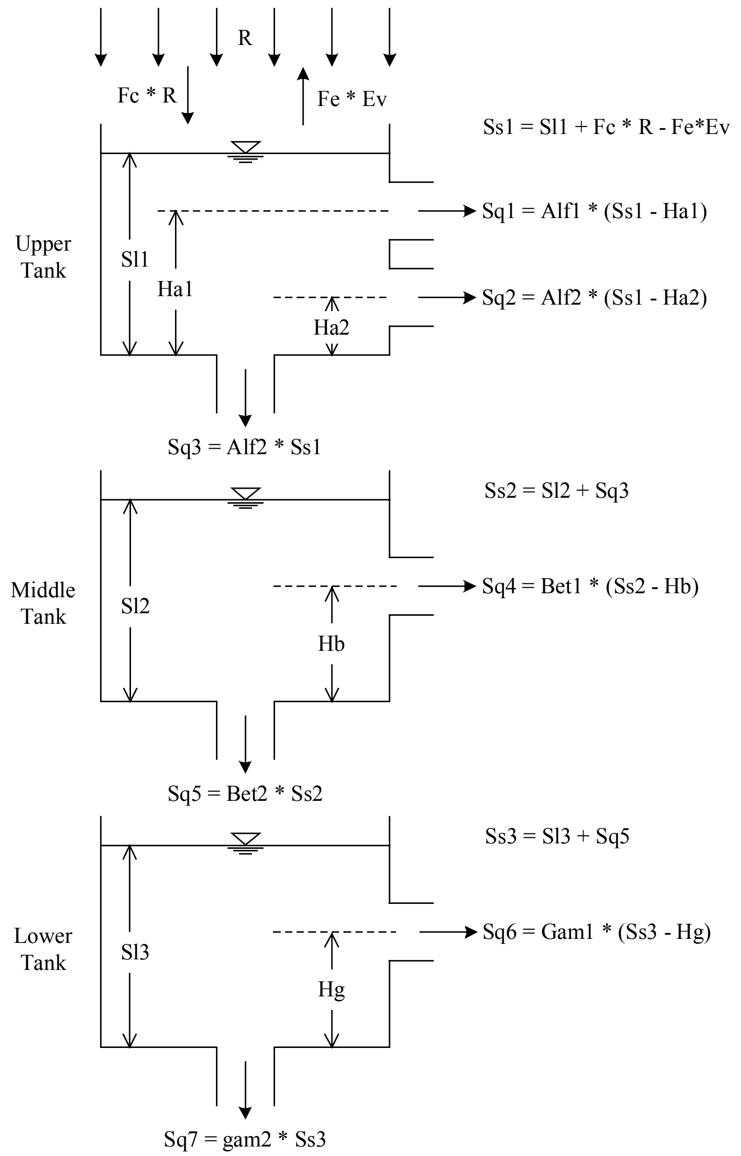
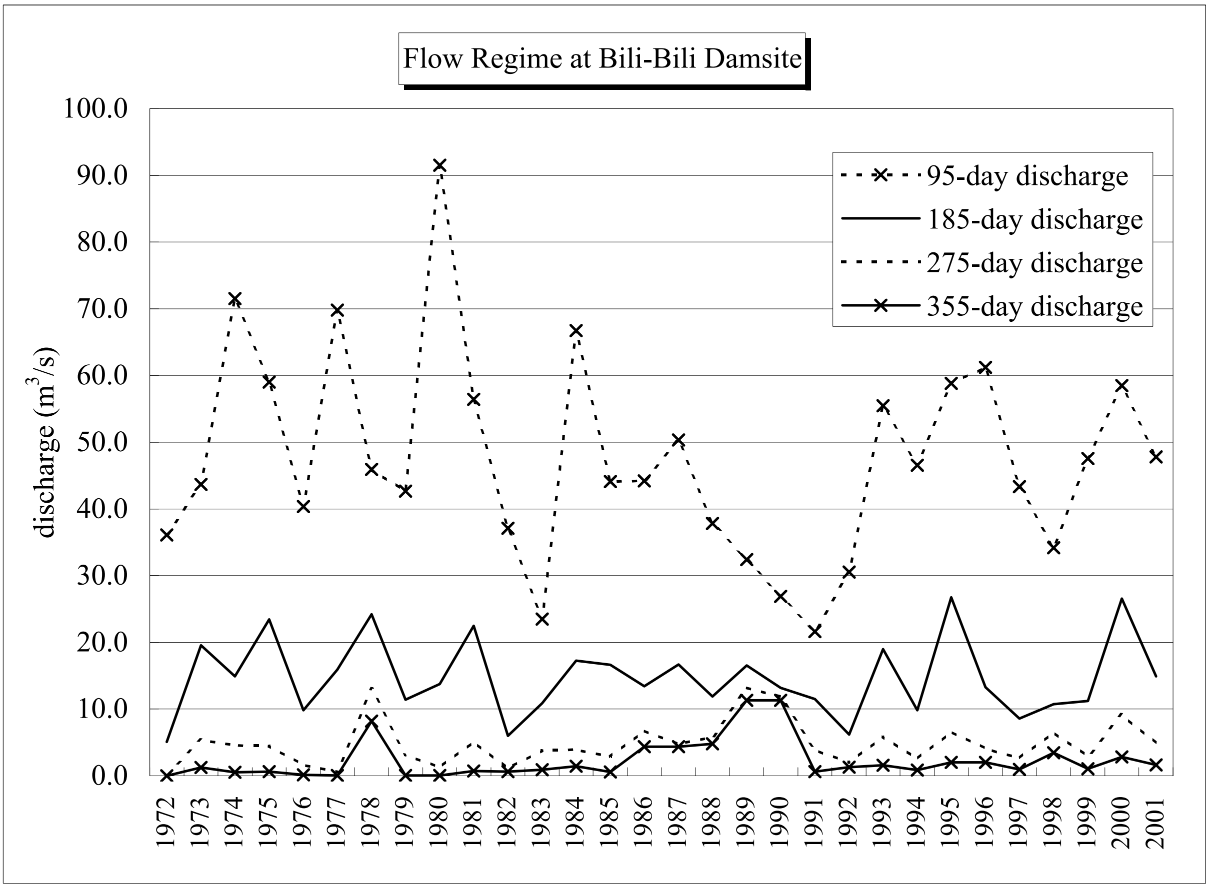


Figure D4.1 Location Map of Water Level Gauging Station in the Jeneberang River Basin



Parameter	Jeneberang River			Jenelata River		
Catchment Area (km^2)	384.4			226.3		
Multiplying Constant of Outlet (mm)						
- Upper Tank	0.900	0.600	0.200	0.700	0.260	0.130
- Middle Tank	0.050	0.030		0.060	0.020	
- Lower Tank	0.004	0.015		0.008	0.001	
Height of Outlet (mm)						
- Upper Tank	50	10		90	20	
- Middle Tank	10			20		
- Lower Tank	10			20		
Evaporation Factor	0.55			0.65		
Effective Rainfall Ratio	1.00			0.93		

Figure D4.2 Structure and Parameter of Tank Model in this Study



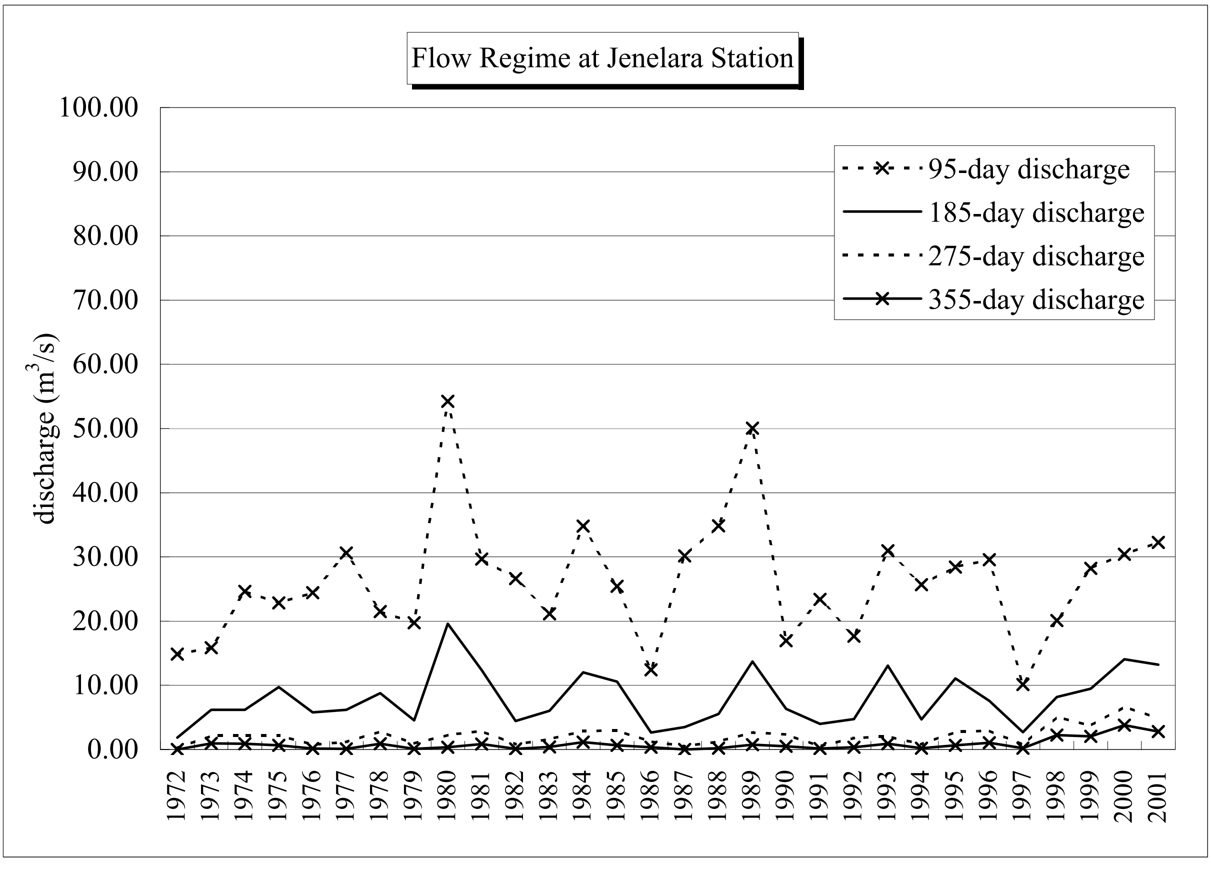


Figure D4.3 Flow Regime in the Jeneberang River Basi

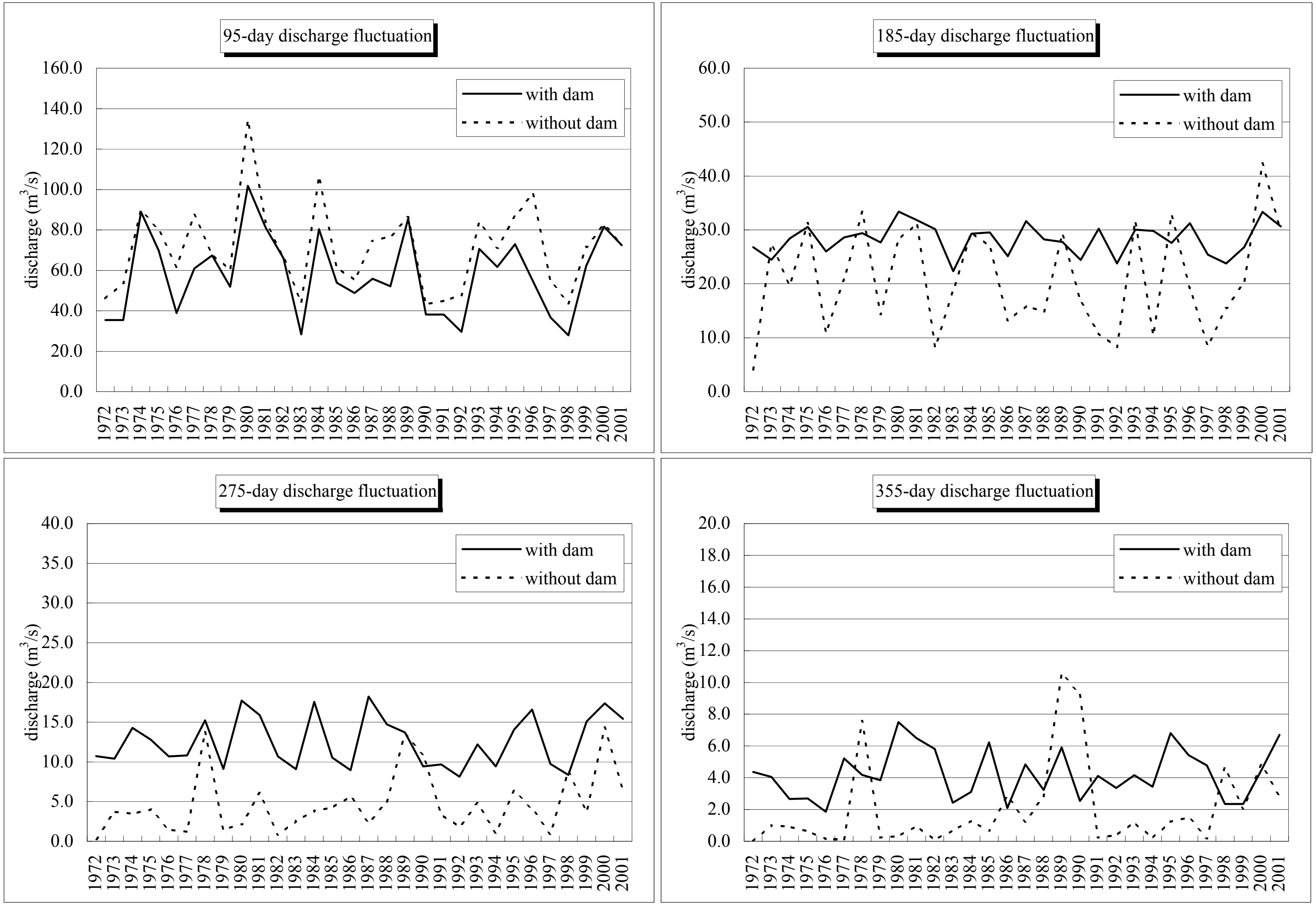
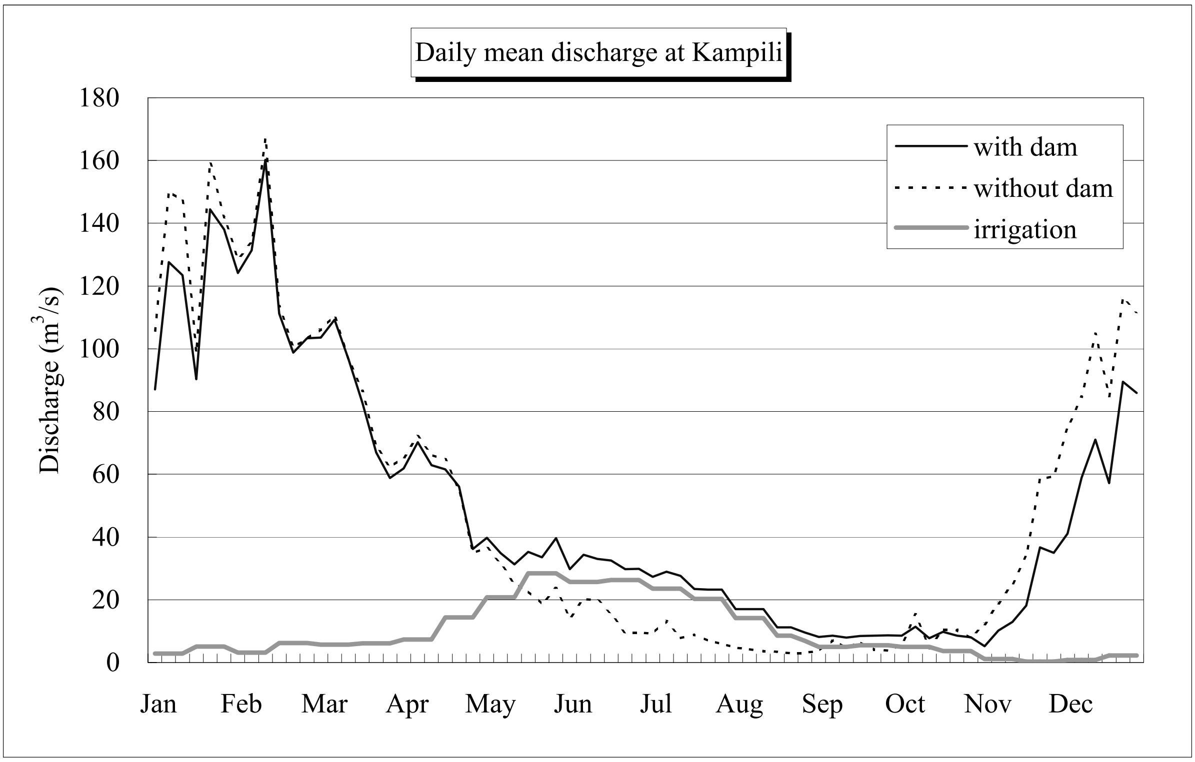
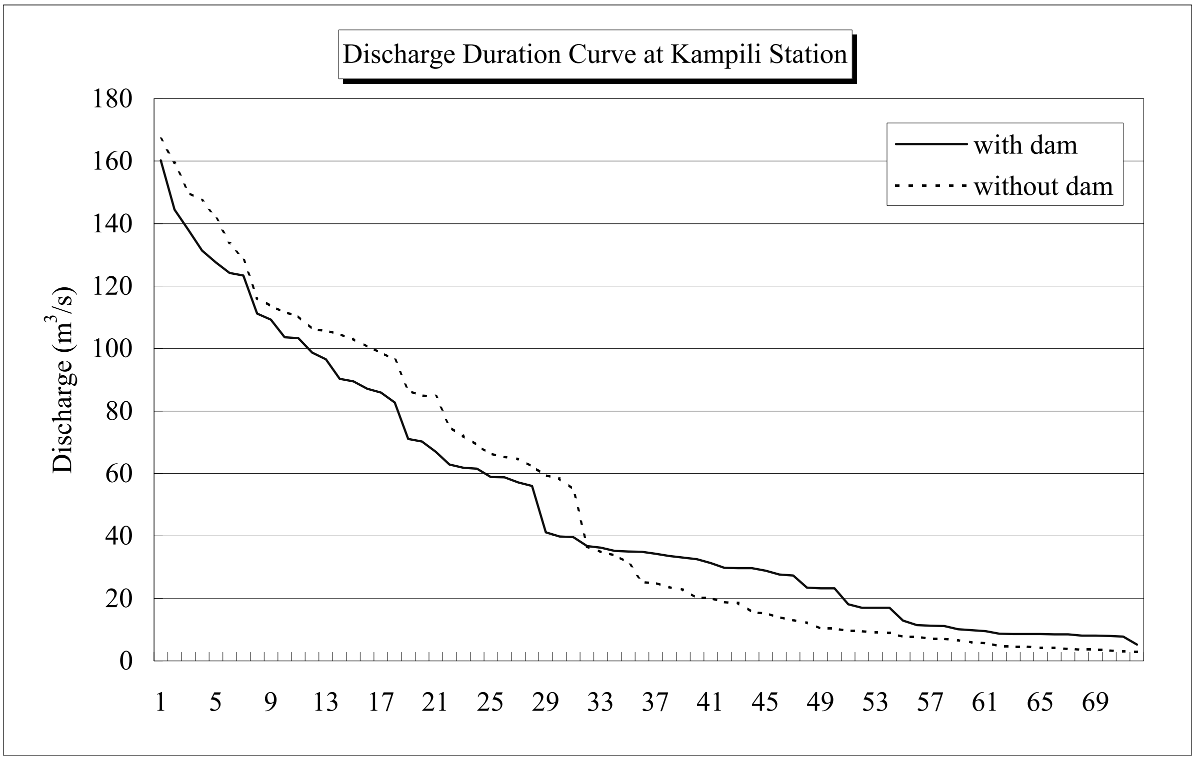


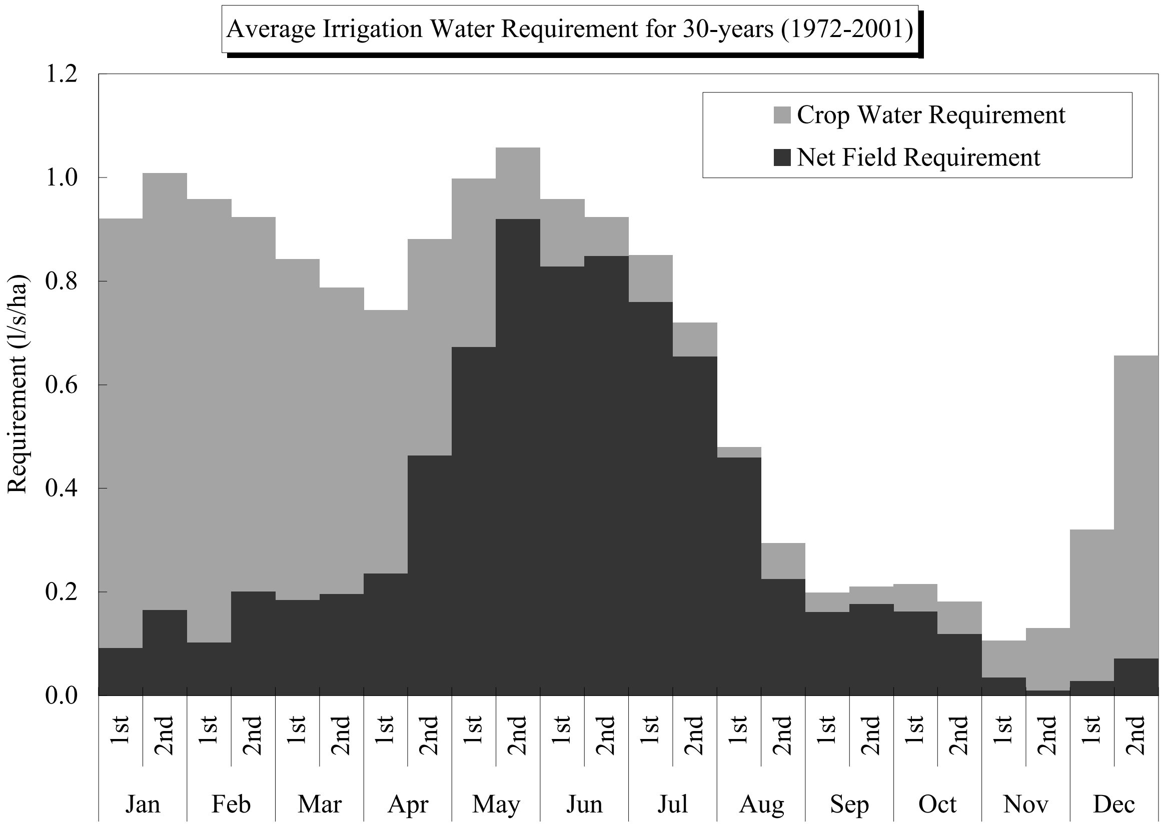
Figure D4.4 Flow Regime at Kampili Station





Data : Averaged from 1972 to 2001based on 5-days discharge

Figure D4.5 Flow Regime Improvement by Bili-Bili Multipurpose Dam



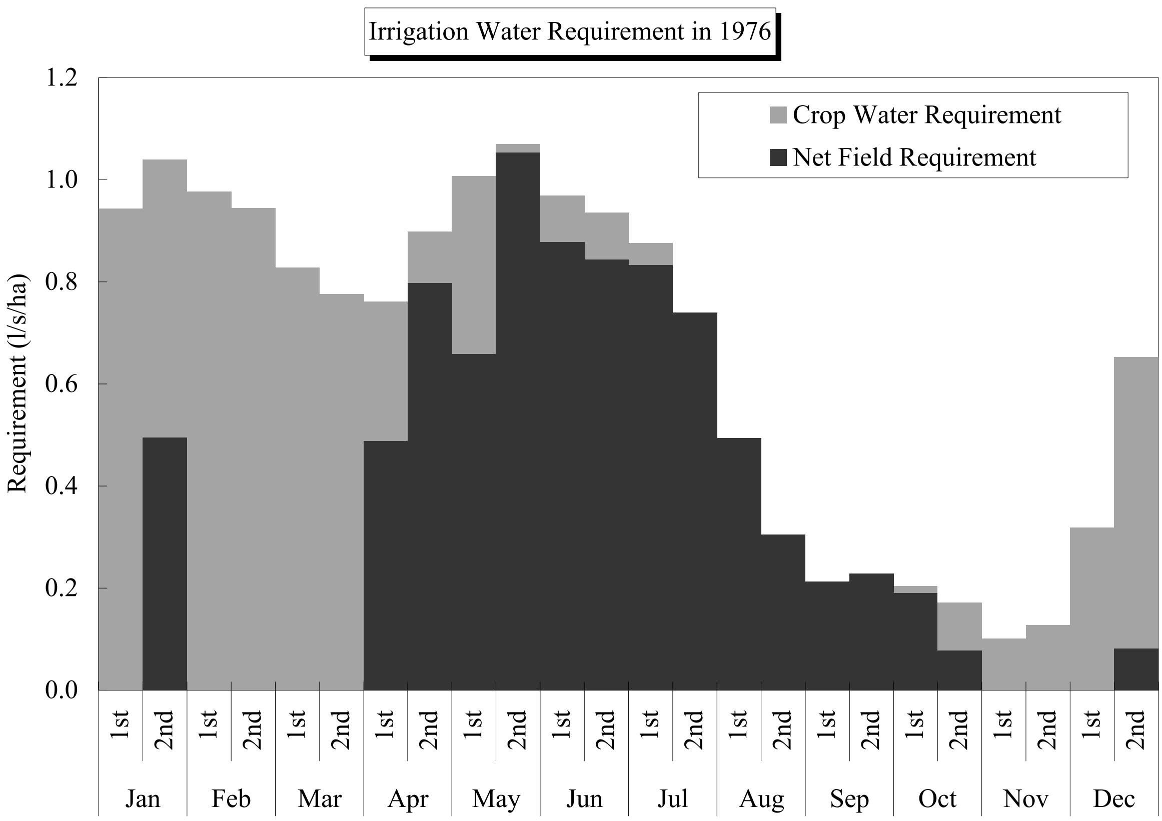
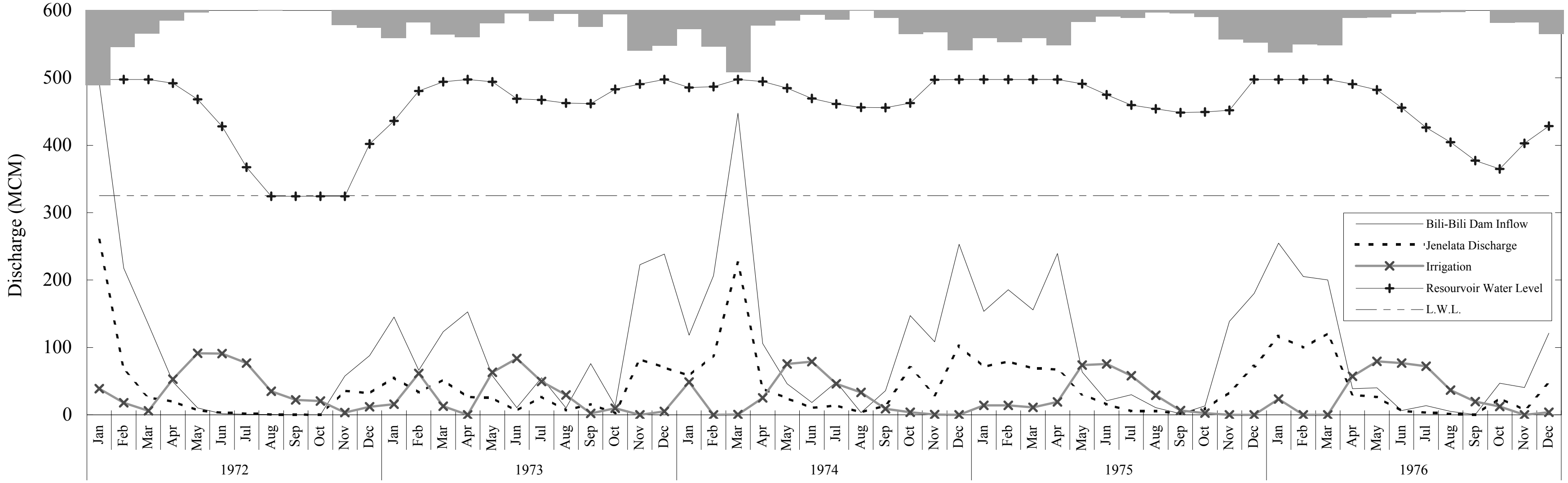


Figure D5.1 Irrigation Water Requirement



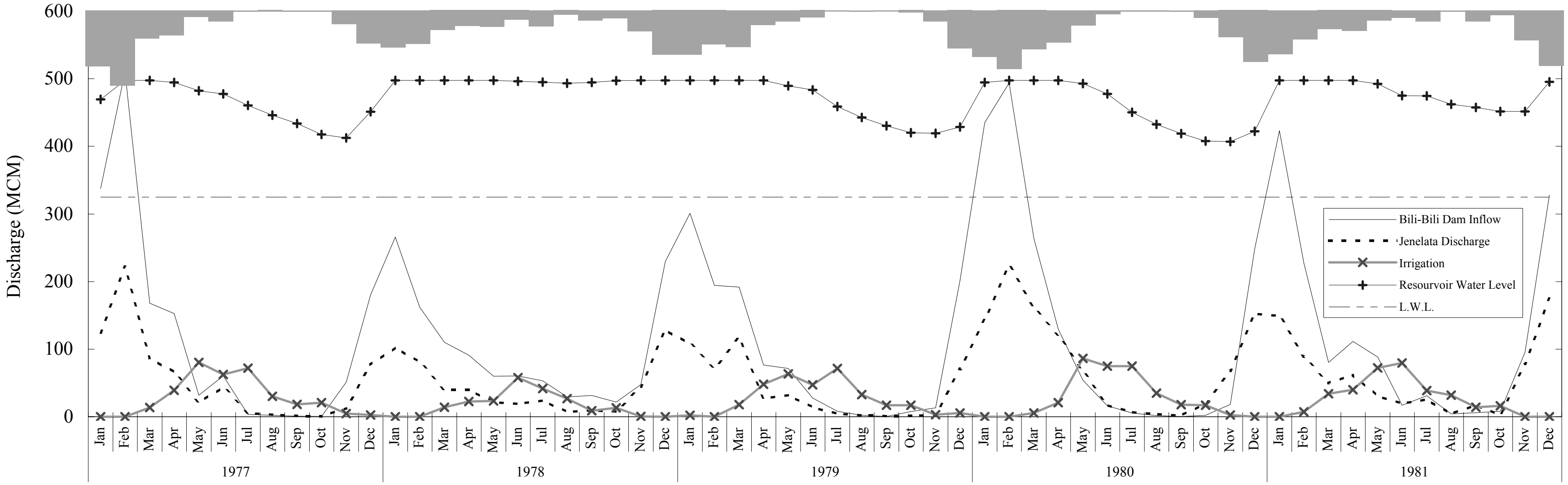


Figure D5.2 (1/3) Result of Water Balance Calculation

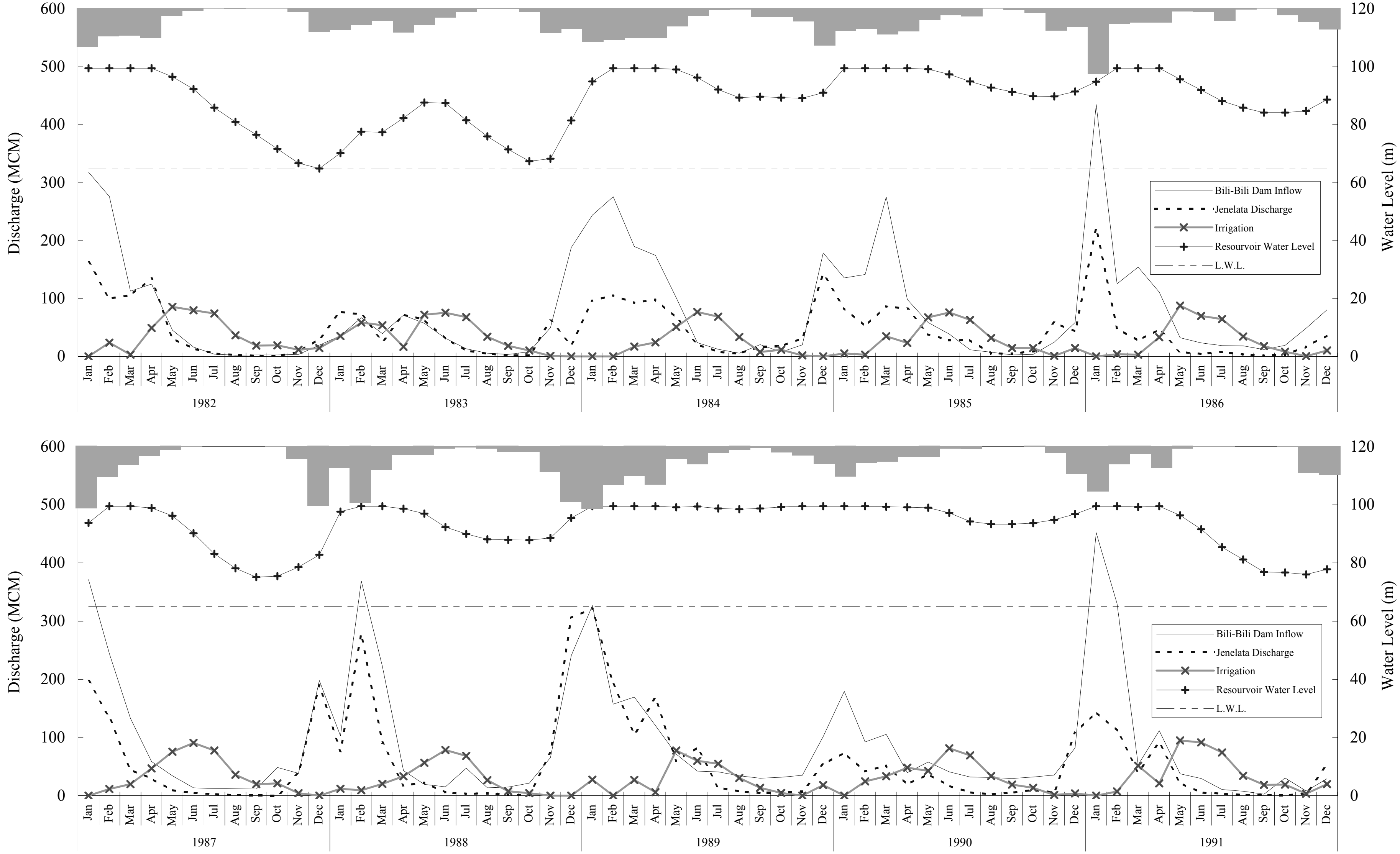


Figure D5.2 (2/3) Result of Water Balance Calculation

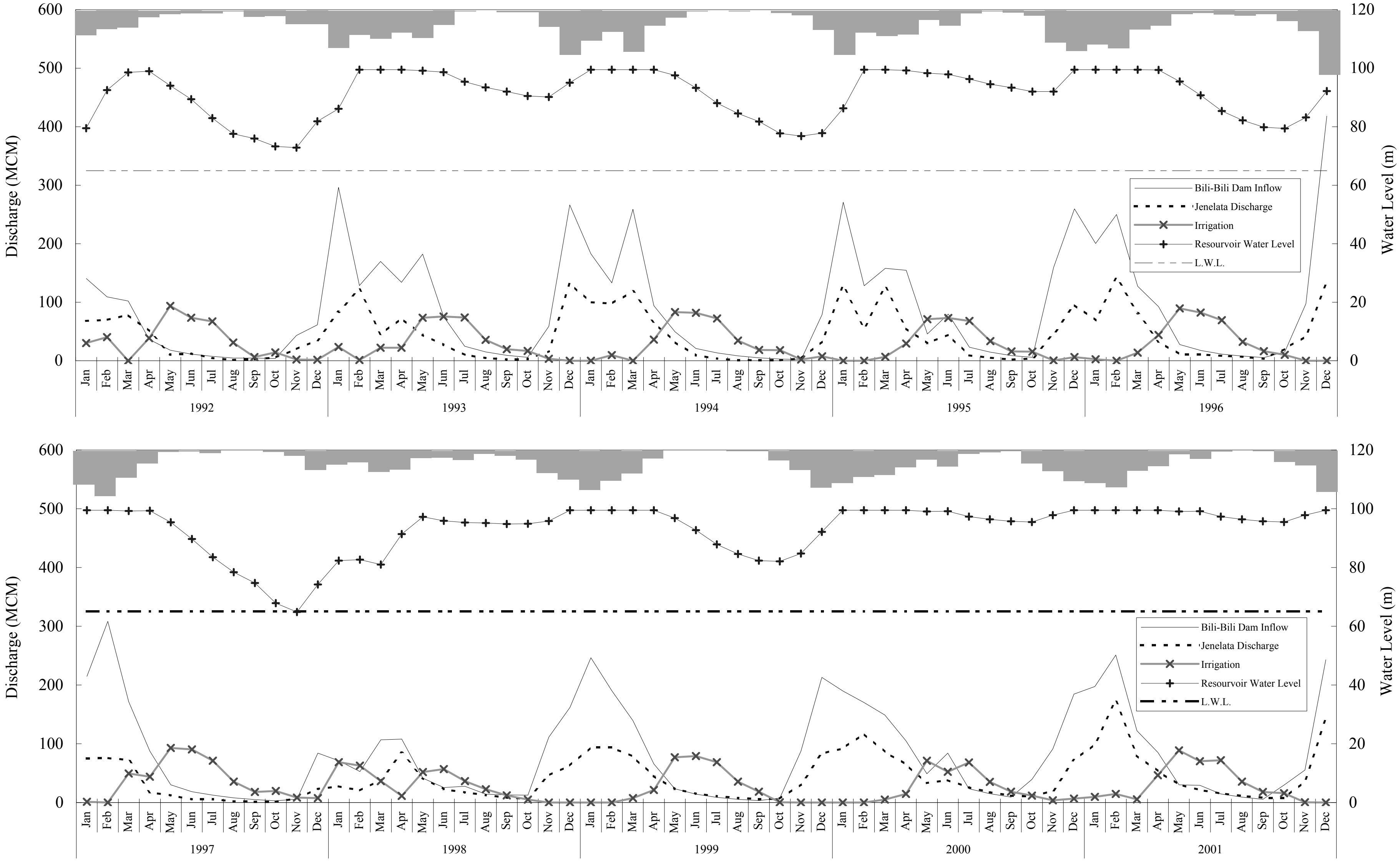


Figure D5.2 (3/3)   Result of Water Balance Calculation

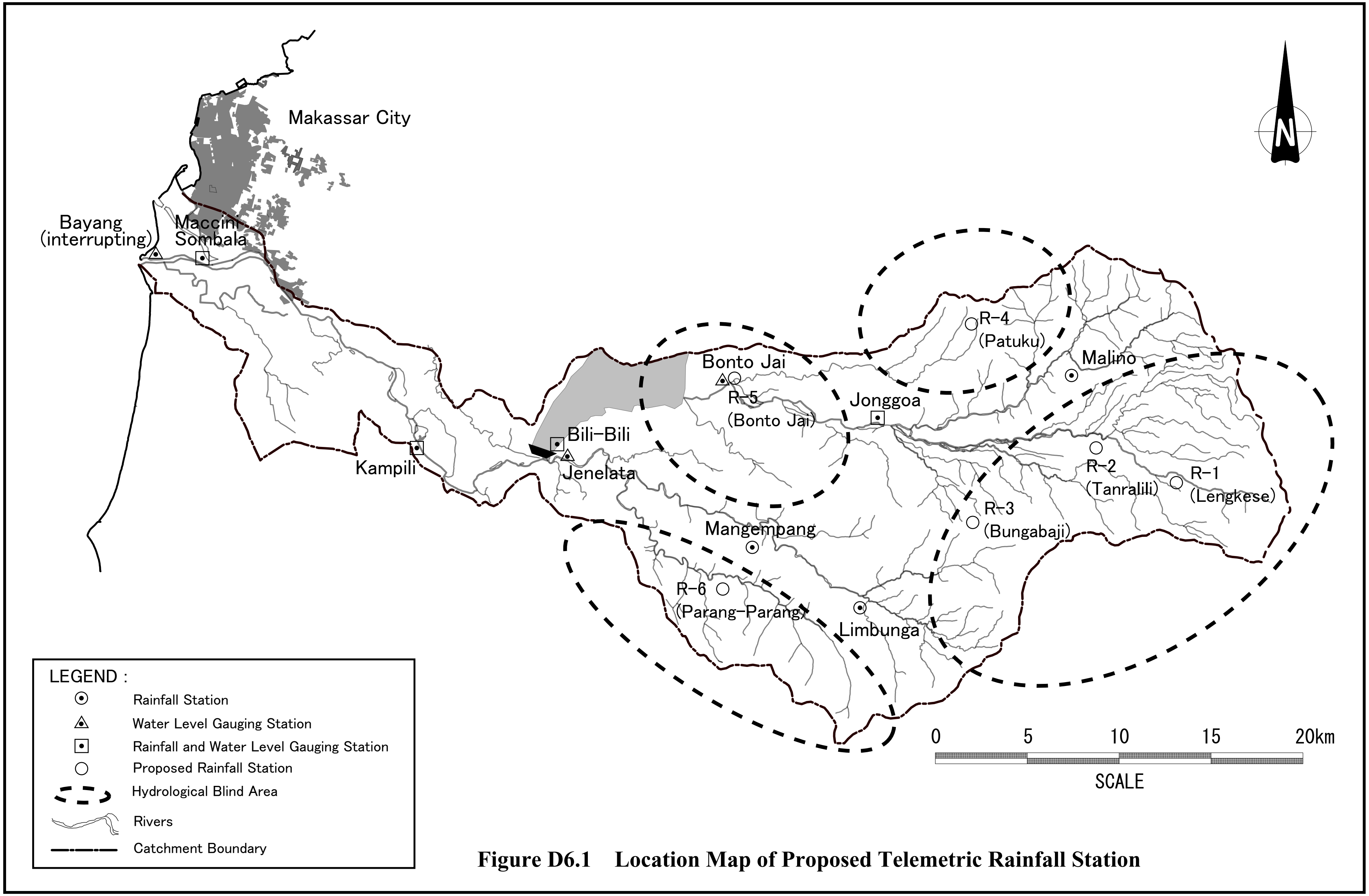


Figure D6.1 Location Map of Proposed Telemetric Rainfall Station

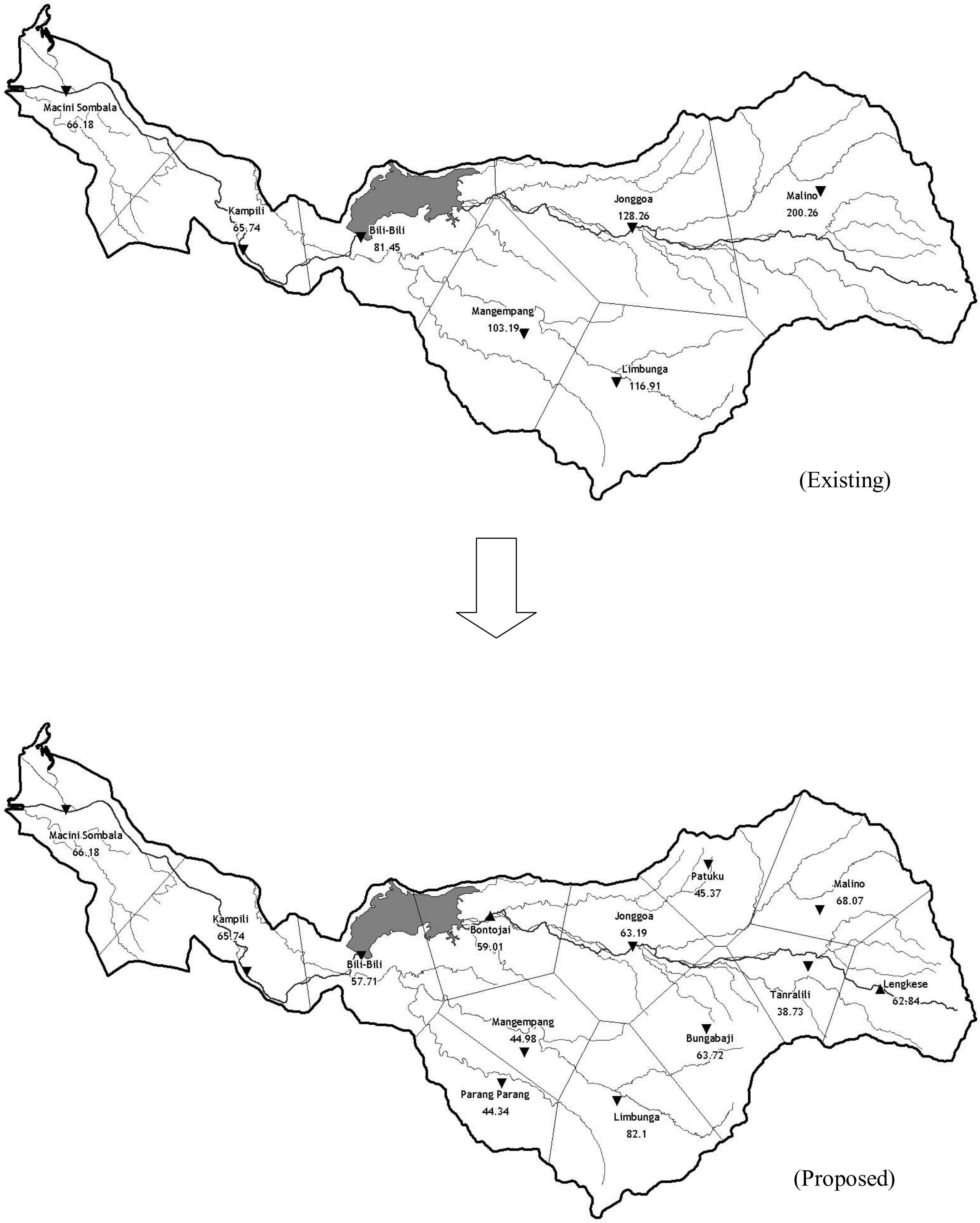


Figure D6.2 Comparison of Existing and Proposed Rainfall Station Area

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RIVER AND INFRASTRUCTURE MANAGEMENT

E1 Physical Features of Jeneberang River Basin

E1.1 Geography and Present Land Use in Jeneberang River Basin

Jeneberang River originates from Mt. Bawakaraeng (EL. 2,830 m) running westward and finally pours into Makassar Strait. The whole extent of the river basin and the channel length of the mainstream are about 762 km^2 and 85.5 km, respectively. There are fourteen first order tributaries (or second order river), which join or branch off from the mainstream as listed below (refer to Figures E1.1 and E1.2).

First Order Tributaries of Jeneberang River

	Name of Tributary	Channel Length (km)	Catchment Area (km^2)
1	Long Storage*	15.8	5.3
2	Garassi	16.5	42.3
3	Salo Tebeatu	6.6	6.2
4	Bantimurung	11.9	14.6
5	Jenelata	38.5	232.7**
6	Jene Bontomalangngrere	7.9	8.8
7	Binanga Jajang	9.7	22.4
8	Jene Rakikang	19.2	41.2
9	Binanga Bengo	6.6	14.2
10	Salo Bengo	8.5	22.6
11	Salo Malino	18.7	85.9
12	Angasia	5.6	5.4
13	Salo Kauusik	18.9	37.5
14	Takapala	11.5	37.5

*: The channel branches off from the mainstream.
**: The catchment area of Jenelata includes the second order tributary (or third order river), Binanga Tokka of 77.5km^2.

The principal tributary called Jenelata with a catchment area of 233 km^2 joins the mainstream about 29.4 km upstream from the river mouth. The lower reaches from confluence of the Jeneberang and Jenelata Rivers are the extremely flat alluvium plain, which was formed by lateral erosion of the river. In contrast, the upper reaches from confluence of the Jeneberang and Jenelata Rivers are the mountainous/hilly area, which has the rather steep ground slope of about 15 % (refer to Figure E1.3). The mountainous/hilly area forms the foot of Mt. Bawakaraeng and Mt. Lompobatang, which have calderas of about 3 to 5 km in diameter showing the notable volcanic geological features. Due to the steep ground slope and the volcanic type of geology, the upper reaches of the Jeneberang River tend to produce a large quantity of sediment and debris runoff.

Due to these contrastive geographies, Jeneberang River as well as its tributaries tend to have the gentle channel slope in the lower reaches and steep in the upper reaches (refer to Figure E1.4). That is, the mainstream of Jeneberang River has a gentle channel slope of about 1/2,400 along the downstream of about 20 km in length, while its upper channel has the steeper channel slope of about 1/600 below Bili-Bili dam, and more than 1/300 above the dam. Among the above first tributaries, those in the upper mountainous area such as Salo Takapla, Salo Keoenisik and Salo Malino have also very steep channel slope in a range of 1/40 to 1/100. On the other hand, those in the middle and lower reaches of Jeneberang River, such as Garassi and Salo Tebeatu have the rather gentle channel slope of more than 1/500.

The above two contrastive geographies also leads to the quite different patterns of land use between the upper and lower reaches of the confluence of the Jeneberang and Jenelata river basin. The paddy field is the principal land use item in the lower reaches of the Jeneberang River, while more than 80 % in the upper reaches is left behind as the non-cropping area as listed below (refer to Figure E1.5).

Land Use in the Jeneberang River Basin

(Unit: ha)

Classification of Land Use	Lower Reaches from Confluence of Jenelata	Upper Reaches from Confluence of Jenelata	Basin Total
Forest Area	1716 (11.7 %)	32,929 (53.4 %)	34,646 (45.3 %)
Grass Land	2668 (18.1 %)	18,193 (29.5 %)	20,861 (27.3 %)
Mixed Estate Crop Field	3284 (22.3 %)	2,280 (3.7 %)	5,564 (7.3 %)
Paddy Field	6035 (41.0 %)	3,892 (6.3 %)	9,927 (13.0 %)
Dry Crop Field	548 (3.7 %)	3,227 (5.2 %)	3,775 (4.9 %)
Dam Reservoir Area	0 (0.0 %)	1,170 (1.9 %)	1,170 (1.5 %)
Urban Area	465 (3.2 %)	0 (0.0 %)	465 (0.6 %)
Total	14,716 (100.0 %)	61,691 (100.0%)	76,408 (100.0 %)

Source: Department of Forestry Service, South Sulawesi Province.

E1.2 Administrative Boundaries in the Jeneberang River Basin

The Jeneberang River basin is administratively divided into Kabupaten Gowa, Kabupaten Takalar and Makassar City in South Sulawesi Province. The shares of the river basin by each Kabupaten and City are as below (refer to Figure E1.6):

(1) 730.0 km^2 (96.0 % of the basin) in Kabupaten Gowa;
(2) 9.5 km^2 (1.2 % of the entire basin) in Kabupaten Takalar; and
(3) 21.3 km^2 (2.8 % of the entire basin) in Makassar City.

As listed above, the substantial part of the river basin belongs to Kabupaten Gowa, while Kabupaten Takalar and Makassar City take extremely small share of area. Thus, almost all of the river basin apparently belongs to Kabupaten Gowa covering the whole extent of Bili-Bili Dam reservoir and its catchment area. Nevertheless, an extensive irrigation area of about 7,400 ha in Kabupaten Takalar receives its irrigation water supply from the Jeneberang River. Makassar City also relies its major part of municipal water use on the source of Jeneberang River. Thus, both of Kabupaten Takalar and Makassar City are the major water users of the Jeneberang River, although they do not topographically take a substantial share of the basin.

The river basin is further divided into the following eleven Kechamatans, out of which two in Makassar City, one in Takalar Regency and eight are in Gowa Regency: (refer to Table E1.1 and Figure E1.6).

Kechamatans overlapped with Jeneberang River Basin

Name of City or Kabupaten	Kechamatans
Makassar City	1. Mariso 2. Tamalate
Kabupaten Takalar	3. Polombankeng Utra
Kabupaten Gowa	4. Bajeng 5. Bontomarannu 6. Bungaya 7. Mamajang 8. Palangga 9. Prangloe 10. Somba Opu 11. Tinggimoncong

E2 Existing Water Use and River Channel

E2.1 Use of River Water

The river water is currently used as the water sources for the municipal water use, the irrigation water use, and other various water demands. The present major water users such as the PDAM, the large irrigation schemes of Bili-Bili, Bissua, and Kampili and the Takalar Sugar Factory have been substantially registered as the customary water use right and their full supply is promised by the reservoir operation of Bili-Bili dam. Detailed of these major water users are as described in Chapters 4 and 5.

In addition to these major water users, however, there are several minor water users. The details of these minor water users have never been known, and thereby, a survey on them was made through this Study. As the results of the survey, it was clarified that the users could be classified into (1) small irrigation schemes, (2) factories/commercial shops and (3) fishponds. Among others, the small irrigation schemes are called “the village irrigation”, which are dotted in the upper reaches of Jeneberang River and its tributary, Jenelata River, and the following village irrigation schemes were confirmed through this study (refer to Figure E2.1):

Village Irrigation Preliminarily Confirmed in the Study

No	Name of Irrigation Scheme	Name of Village	Name of River	Area (ha)
V1	Tanralili	Lengkesek/Manimbahoi	Kunisi	360.25
V2	Kaciping	Manimbahoi	Kunisi	226.00
V3	Kalolo	Manimbahoi	Kunisi	305.00
V4	Bontote”ne	Buluttana	BL.Manappa	105.00
V5	Takapala	Buluttana	Takapala	175.00
V6	Batulapisi	Malino	Bongko	105.00
V7	Tujuang	Malino	Bongko	74.00
V8	Karangpuang	Malino	Karangpuang	70.00
V9	Lembangbata	Gantarang	BL.Bulang	155.00
V10	Lambangmanai	Gantarang	BL.Bulang	232.00
V11	Je”ne Kampala	Sapaya	Tattumbu	50.00
V12	Tallanggatarang	Sapaya	Nyulu	50.50
V13	Leang Panyikiang	Sapaya	Danggang	58.00
V14	Manggunturu	Bonto Manai	Manggunturu	55.00
Total				2020.75

It was also confirmed that there are nine factories/commercial shops, which abstract the water from the Jeneberang River and/or release its effluent into the River (refer to Table E2.1). Among them, two factories abstract the water from Jeneberang River with a rate of 40 and 200 m^3/day, respectively. Other seven factories do not directory abstract the water from Jeneberang River, but their effluent is discharged to the River. Two fishing ponds were also confirmed as the water users of Jeneberang River, but their details could not been clarified.

E2.2 River Sand Mining

There are several sand mining sites along Jeneberang River as shown in Table E2.2 and Figure E2.2. The annual average sediment runoff volume from the Jeneberang River basin before 2004 (i.e., before the recent gigantic collapse of Mt. Bawakaraeng) is estimated at 890 thousand m^3/year, which is divided into 690 thousand m^3/year from the upper reaches of Bili-Bili Dam and 200 thousand m^3/year from the Jenelata River basin as listed below.

Annual Average Sediment Runoff Volume in Jeneberang River Basin before Collapse of Mt. Bawakaraeng

Watershed	Catchment Area (km^2)	Annual Sediment Run-off Volume (m^3/year/km^2)	Annual Sediment Run-off Volume (1000 x m^3/year)
Upper Reaches of Bili-Bili Dam*	384.4	1,800	690
The Jenelata River Basin**	226.3	890	200
Total	610.7	1,460	890

Source: * Supporting Report Vol. IV Sediment an Erosion Control, 1994
** Detailed Design for Jeneberang River Improvement Works

On the other hand, the annual average sand mining volume from the Jeneberang River from 1995 to 2001 was recorded at 1,749 thousand m^3/year, which divided into 1,316 thousand m^3/year mined in the downstream of Bili-Bili dam and 433 thousand m^3 /year in the upper stream of the dam as listed below.

Annual Volume of Sand Mining from Jeneberang River

(unit: 1000 x m^3/year)

River Stretch	'95/'96	'96/'97	'97/'98	'98/'99	'99/'00	'00/'01	Ave.
1. Downstream from Bili-Bili Dam	**1,537**	**1,787**	**1,790**	**1,476**	**703**	**604**	**1,316**
(1) Estuary–Sungguminasa Br.	88	451	348	285	290	286	291
(2). Sungguminasa Br.-Kampili Weir	1,301	906	1,026	843	88	42	701
(3). Kampili Weir-Bili-Bili Dam	148	430	416	348	325	276	324
2. Upstream from Bili-Bili Dam	**177**	**475**	**701**	**301**	**585**	**360**	**433**
Total	**1,714**	**2,262**	**2,491**	**1,777**	**1,288**	**964**	**1,749**

Source: Annual Monitoring Report 1995/1996-1999/2000, "Environmental Management and Monitoring (EMM), The Bili-Bili Multipurpose Dam Project (Phase II")

As listed above the annual average sand mining volume is more than two times of the basin annual sediment runoff volume. Moreover, the mining volumes as listed above are the figures registered in the license list by Gowa Dinas Mining & Energy. There exist other non-licensed mining activities, and therefore, the actual difference between the mining volume and the sediment runoff discharge should be larger than that the above values estimated from the license record. Moreover, after completion of Bili-Bili dam reservoir in 1999, a substantial part of the sediment runoff volume from the upper reaches of the dam are trapped by the dam reservoir, and the excess of sand mining over the sediment runoff volume from the upper reaches had been further aggravated. As the results, the serious river channel erosion has occurred along the downstream of Jeneberang River, and the serious damage on the existing river infrastructures are likely to be attributed to this river erosion (refer to subsection E4.4.3). The riverbed elevation dropped by 5.2 m at Sungguminasa Bridge and 8.1m at Kampili Weir during a period of 22 years from 1979 to 2001 as listed below (refer to Figure E2.3):

River Bed Elevation of Jeneberang River

Location	Distance from River Mouth (km)	River Bed Elevation (EL. m) 1979*	1983*	2001**	Depth of River Bed Lowed from 1979 to 2001 (m)
River Mouth	0.0	-2.3	-1.9	--5.6	3.3
Sungguminasa Bridge	9.6	+4.2	+0.3	-1.0	5.2
Kampili Weir	21.0	+16.5	+16.5.	+8.4	8.1

Source: * Annual Monitoring Report 1999/2000, "Environmental Management and Monitoring (EMM), The Bili-Bili Multipurpose Dam Project (Phase II")
** Results of river channel survey by JRBDP

E2.3 Land Use along River Channel

As described in subsection E4.3, the river and its adjacent river corridor is designated as the river area to be managed by the river administrator, and all development, and/or utilization of water and land resources within the river area should be under jurisdiction of the river management body. The outside boundaries of the river corridor are assumed as:

(a) Until 3 m from the edge of the existing river dike from the river mouth up to Sungguminasa Bridge located 9.5 km upstream from the river mouth:
(b) Until 100 m from the existing natural riverbank upstream from Sungguminasa Bridge.

The present land use states within the above river area from the river mouth up to Bili-Bili Dam were preliminarily estimated based on the Ortho-photo Maps developed under the "Bili-Bili Irrigation Project in 2000. As the results, it was clarified that a considerable part of the river utilization area is occupied by the settlement area and the agricultural cropping land as enumerated below (refer to Tables E2.3 and E2.4).

Share of Settlement Area and Agricultural Cropping Area in the Designated River Utilization Area

River Stretch		Settlement Area	Agricultural Cropping Area	Total
(1) Left bank along the dike section	Inside of Dike	38.5 %	43.5 %	82.0 %
	Outside of Dike	0.0 %	26.2 %	26.2 %
(2) Right bank along the river dike section	Inside of Dike	6.2 %	20.1 %	26.3 %
	Outside of Dike	58.3 %	9.6 %	67.9 %
(3) Left bank along the non-dike section		9.1 %	60.7 %	69.8 %
(4) Left bank along the non-dike section		8.1 %	41.9 %	50.0 %

A particular attention in the above list is given to the settlement area inside of the dike (i.e., the area of the flood high water channels), which is exposed to the high risk of flood damage. The settlement areas inside of the dike concentrates to the following extents:

(a) The stretch along right bank 2 to 3 km upstream from river mouth (just downstream of Rubber Dam); and
(b) The stretch along left bank 5 to 6 km upstream from river mouth (adjacent to the existing groundsill).

E2.4 Ground Water

The low-lying area in the lower reaches of Jeneberang River is formed by river alluvium sediment, beach sediment and swamp, which contains rather abundant shallow groundwater conveyed through the layer of the sediment rock of Camba Formation from the mountainous area to the flat plain area. The upland in the basin also contains the plentiful and good quality groundwater in its thick sand-gravel layers of the Quaternary deposits.

Due to the above basin conditions, the shallow wells of less than 10 m in depth are extensively exploited by the individual households especially in the low land area. The exploited shallow well is the indispensable water source for household use in the non-PDAM service area. At the same time, a large number of population even in PDAM service area use water from the private tap only for drinking, but also use the private well for secondary water uses such washing and bathing. According to the results of the previous Study, out of the total annual consumption for household use, about 70 % is fulfilled by the source of ground water as listed below:

Annual Water Consumption of PDAM System for Household Use

(Unit: Thousand m^3/year)

	Classification of Water Use	Makassar	Gowa	Total
1.	Use of water supplied from PDAM system	16,239	348	16,587 (31.5 %)
2.	Use of ground water			
	(1) Use of households served by PDAM supply	2,716	81	2,797
	(2) Use of household not served by PDAM supply	22,469	10,839	33,308
	Sub-total of 2	25,185	10,920	36,105 (68.5 %)
	Total of 1 and 2	41,424	11,268	52,692 (100.0%)

Source: Consulting Engineering Services for Comprehensive Water Management Plan Study for Maros-Jeneponto River Basin

The deep wells of about 50 to 250 m in depth are also exploited especially for the irrigation use of paddy field, which is out of the technical irrigation system of Kampili, Bissua and Bili-Bili. There exist 90 units of deep wells for the upland irrigation area of 972 ha. The groundwater is lifted up by pump under operation and management of each water user's association. There are also 40 locations of spring water in Kabupaten Gowa. Most of the spring water has been exploited as clean water source for the surrounding houses. The large discharge spring is on the Lompobatang volcanic lock, where a water of 75 liter/sec gushes out.

E3 Existing River Infrastructures

E3.1 Overview of Facilities

The intensive water resources development in the Jeneberang River basin has been made since 1970's in line with the national economic development policy, and many relevant infrastructures have been constructed (refer to Table E3.1 and Figures E3.1 and E3.2). The total cost invested for water resources development is about Rp.935 billion, which includes Rp.668 billion for water source and distribution, Rp.166 billion for flood control and Rp.101 billion for watershed management represented by sabo works as listed below:

Investment Cost and Completion Year of Existing River Infrastructures

Purpose	Project/Facility	Investment Cost (Rp. Million))	Completion Year
Water Source and Distribution	Bili-Bili Dam and Raw Water Transmission Main	442,815 /1	Dec. 1999
	Rubber Dam	61,045	Dec. 1996
	Long Storage	12,158	Nov. 2001
	Diversion Weirs for Irrigation /2	152,216	Nov. 2004 /3
	Sub-total	668,234	
Flood Control	River Improvement & Drainage Improvement-I /4	96,469	Feb. 1992
	Drainage Improvement-II /5	69,577	Dec. 2001
	Sub-total	166,046	
Watershed Management	Sand Pocket Dam and Sabo Dam	101,185	Jan. 2001
	Sub-total	101,185	
Ground Total		935,465	

/1 : Excludes cost for the on-going hydropower plant
/2 : Bili-Bili, Bissua and Kampili Diversion Weirs
/3 : Scheduled
/4 : For Drainage System of Jongaya-Panampu-Sinrijala
/5 : For Drainage System of Pampang

E3.2 Structural Features of the Facilities

E3.2.1 Bili-Bili Multipurpose Dam

Bili-Bili Dam was constructed during a period from 1992 to 1999 for the sake of flood control, municipal water supply, irrigation water supply and preservation of sustainable river maintenance flow. The Dam has a catchment area of 384.4km^2, which occupies the almost half of the entire catchment area (762 km^2), and the effective storage capacity of 346 million m^3, which is divided into 41 million m^3 for flood control of the downstream of Jeneberang river and, 305 million m^3 as the water sources for irrigation and municipal water and river maintenance flow in the lower reaches of the Jeneberang River. The salient structural features of Bili-Bili dam are as enumerated below:

(1) Dam Reservoir

- Design Flood Water Level (DFWL) : EL. 103.0 m
- Surcharge Water Level (SWL) : EL. 101.6 m
- Normal Water Level (NWL) : EL. 99.5 m

- Low Water Level (LWL) : EL. 65.0 m
- Effective Water Depth (SWL-LWL) : 36.6 m
- Reservoir Surface Area at SWL : 18.50 km^2
- Total Storage Capacity : 375,000,000 m^3
- Effective Storage Capacity : 346,000,000 m^3
- Flood Control Capacity : 41,000,000 m^3
- Water Utilization Capacity : 305,000,000 m^3
- Sediment Capacity : 29,000,000 m^3

(2) Main Dam Body

- Type of Dam : Rockfill Type with Central Core
- Height Above Foundation : 73 m
- Crest Length : 750 m
- Crest Width : 10 m
- Crest Elevation : EL. 106.0 m
- Dam Body Volume : 2,760,000 m^3

(3) Left Wing Dam body

- Height Above Foundation : 42 m
- Crest Length : 646 m
- Crest Width : 10 m
- Crest Elevation : 106 m
- Dam Body Volume : 1,470,000 m^3

(4) Right Wing Dam body

- Height Above Foundation : 52 m
- Crest Length : 412 m
- Crest Width : 10 m
- Crest Elevation : 106 m
- Dam Body Volume : 1,060,000 m^3/s

(5) Spillway

- Elevation of Free Flow Crest : EL. 99.5 m
- Width of Free Flow Crest : 70 m
- Elevation of Gated Spillway Crest : EL. 91.8 m
- Width of Gated Spillway Crest : 14 m
- Regular Gate : 7.0 m wide x 7.7 m high x 2 units
- Chute way : 225 m long x 99.5 to 55.0 m wide
- Stilling Basin : 65 m long x 75 m wide
- Outlet Channel : 100 m wide x 400 m long

(6) Outlet Works

- Intake Structure	:	Inclined intake, 51.5 m high
- Bulkhead Gate	:	Roller gate, 3.7 m wide x 5.2 m high
- Steel Conduit	:	285 m long x 3.7 m dia.
- Control Gate	:	Jet flow gate, 2.0 m dia.
- Guard Gate	:	Gate valve, 2.0 m dia.
- Dissipater Basin	:	4.0 m wide x 74.1 m long

(7) Monitoring and Control System

- Control Center	:	Dam Control Station INDUK Monitoring Station
- Hydrological Gauge Station	:	Four rainfall stations Three rainfall/water level stations Four water level gauge stations One repeater station
- Gage Flow Meter/ Opening Gauge	:	One flow meter for Control Gate Two flow meters for Raw Water Transmission Main (One at inlet point and another at outlet point) One gate opening gauge for Regular gate
- Data processing and display unit	:	One set at Dam Control Station One set at Monitoring Station

E3.2.2 Raw Water Transmission Main (RWTM)

The RWTM is a single pipeline of 17.61 km in length to transmit the raw water of 3.3 m^3/s as the maximum from Bili-Bili Dam reservoir to the downstream Soma Opu Water Treatment Plant for the municipal water supply. The principal structures of RWTM are broadly divided into the Intake, the Pipes and the Chambers. The Chambers are further divided into the Flow Meter Chamber, Blow-Off Chamber and Air Valve Chamber, all of which are used for operation and maintenance of the pipelines.

(1) Intake

The intake of RWTM is located at the right side of the aforesaid the Diversion Work just downstream of the Control Gate of Bili-Bili Dam. The intake is composed of screen, intake gate and inlet pipe. Among others, the diversion gate is the slide gate with manual actuator having the maximum opening height of 1.4 m, which is in equivalent to the diameter of the main intake pipes.

(2) Pipe

The pipes to convey the raw water are composed of (i) the upstream pipe of 1,650 mm in diameter and 6.63 km in length and (ii) the downstream pipe of 1,500 mm in diameter and 10.38 km in length. The pipes laid underground are made of the precast concrete, while those in the chambers are steel pipe.

(3) Flow Meter Chamber

There are two flow meter chambers, namely Chamber No.1 at the inlet of RWTM beside the above intake gate and Chamber No. 2 at the outlet of RWTM located within a compound of Somba Opu Water Treatment Plant. The Chambers are used as the space for operation and maintenance of the valves the flow meters and other relevant devices in the Chambers.

(4) Blow-off Chamber

There are five chambers at the lower ground level along the pipeline. The chambers are used as the space to close/open the main water conveyance pipes and drain the water from the main conveyance pipes to the surrounding outside water channels (such as the river channel and irrigation channel) through the drainage pipe for sake of the maintenance of the main conveyance pipes. Each of chambers is equipped with one unit of butterfly valve to close/open the pipes and one unit of sluice valve to drain the water from the pipes.

(5) Air Valve Chamber

There are the fifteen air valve chambers at the higher ground level along the pipeline. Each of the chambers are equipped with air valves to let air out of the pipes in case of inletting of water into pipes or to let air into pipes in case of draining of water from the pipes. Further, out of the fifteen chambers, three are equipped with sluice valve to divert the water into local water users.

E3.2.3 Rubber Dam

An inflatable rubber dam with a width of 210 m and a height of 2.0 m was constructed across the Jeneberang River 3.65 km upstream of the river mouth. The principal function of the rubber dam is to prevent the salinity water from intruding into the Jeneberang River, and at the same time, to stabilize the riverbed fluctuations. The structural features of the Rubber dam are as enumerated below:

- Gate Type : Inflatable rubber-made dam
- Width of Dam : 210m
- Gate Sharing : Five Spans, which are composed of the following Dam Numbering stating from the right bank side
  Sub-gate No. 1 of 9.5 m in width
  Main-gate No. 2 of 59 m in width
  Main-gate No. 3 of 59 m in width

Main-gate No. 4 of 59 m in width
sub-gate No. 5 of 9.5 m m in width

- Gate Crest Level : EL. 1.8 m (2 m above the bottom slabs).

E3.2.4 Long Storage

An old channel of about 4 km in length from river mouth was isolated at the right-bank side of the Jeneberang River by the under-mentioned "Lower Jeneberang River Channel Improvement Project". The isolated channel is called "Long Storage", which is connected with the mainstream of the Jeneberang River having an effective storage capacity of 1.6 million m^3 to store the water diverted from Jeneberang River. Long Storage is used as: (a) the water supply source for municipal water demand in Makassar City, (b) the water source to dilute the water in the primary drainage channels in Makassar City and (c) the amenity space.

Long Storage is equipped with one inlet and two outlet gates, namely: (a) Intake Gate to inlet the water from Jeneberang River into Long Storage, (b) Flush Gate to release the discharge from Long Storage into the urban drainage channels in Makassar City and (c) Outlet Sluice Gate (Tidal Gate) to release the water stored in Long Storage into the sea. The principal features of these facilities as well as storage channel are as enumerated below

(1) Long Storage

- Channel Length & Width : 5,260 m long x 150 m in average.
- Lowest Water Level : EL.1.0 m
- Normal High Water Level : EL.1.8 m
- Dike Crown Level : EL. 2.5 m
- Effective Water Depth : EL. 1.2 m
- Effective Storage Volume : 1,600,000 m^3
- Revetment : 4,900 m long

(2) Intake Sluice Gate and Culvert (from Jeneberang River to Long Storage)

- Invert Level : EL. 0.20 m
- Gate : Steel slide gate with electric drive actuator
  (2.0 m wide x 2.0 m high x 2 units x 2 sides)
- Culvert : Box Culvert (2 m wide x 2 m high x 2 cells)

(3) Outlet Sluice Gate (from Long Storage to Sea)

- Invert Level : EL. –1.5 m
- Gate : Steel slide gate with electric drive actuator
  (2.0 m wide x 2.0 m high x 2 units)

(4) Flush Gate (from Long Storage to Urban Drainage Channel in Makassar City)

- Invert Level : EL. 0.2 m

- Gate : Manually operated steel slide gate
  (1.0 m wide x 1.6 m high x 2 units)

E3.2.5 Diversion Weirs for Bili-Bili Irrigation System

As a part of Bili-Bili Irrigation Project, the following three diversion weirs were completed October 2004: (a) Bili-Bili Weir placed just downstream of Bili-Bili Dam, (b) Bissua Weir 7 km downstream of Bili-Bili Dam, and (c) Kampili Weir 11 km downstream of Bili-Bili Dam. These weirs aim at diverting the necessary water for the following irrigation areas:

Intake Discharge through Intake Weirs of Bili-Bili Irrigation

Name of Weir	Intake Discharge (Annual Maximum) (m^3/s)	Irrigation Area (ha)
Bili-Bili	4.7	2,360
Bissua	25.0	10,758
Kampili	17.5	10,545

Each of the weirs consists of fixed weir, scoring sluice gates and intake gate together with the flow measuring devices. Bissua and Kampili Weir are further provided with the sediment trap basin just downstream of the intake gate in order to minimize the sediment inflow into the irrigation canal. The salient structural features of these intake facilities are as enumerated below:

(1) Bili-Bili Weir

- Maximum Intake Discharge : 3.90 m^3/s
- Irrigation Area : 2,360 ha
- Fixed Weir : Dam up height of 1.7 m
  Crest Length of 66 m
- Scoring Sluice Gate : 1.4 m wide x 2.5 m high x 2 units (Fixed roller gate with electric drive actuator)
- Intake gate : 2.5 m wide x 1.2 m high x 2 units (Fixed roller gate with electric drive actuator)

(2) Bissua Weir

- Maximum Intake Discharge : 21.5 m^3/s
- Irrigation Area : 10,785 ha
- Fixed Weir : Dam up height of 8.2 m
  Crest Length of 223.2 m
- Scoring Sluice Gate : 2.5 m wide x 4.3 m high x 4 units (Fixed roller gate with electric drive actuator)
- Intake gate : 3.0 m wide x 1.9 m high x 4 units (Fixed roller gate with electric drive actuator)
- Sediment Trap Basin : 5.85 m wide x 4 lanes x 120 m long
  Settling capacity of 3,900 m^3
  Sediment flush gate of 2.6 m wide x 1.86 m high x

		4 gate (Fixed roller gate with electric drive actuator) Overflow spillway of 40 m
- Diversion Gate	:	To Bissua Primary Canal: 1.8 m wide x 2.0 m high x 3 units (Fixed roller gate with manual actuator) To Mattoagin Primary Canal: 2.35 m wide x 2.0 m high x 2 units (Fixed roller gate with manual actuator)

(3) Kampili Weir

- Maximum Intake Discharge	:	17.40 m^3/s
- Irrigation Area	:	10,545 ha
- Fixed Weir	:	Dam up height of 2.0 m Crest Length of 117 m
- Scoring Sluice Gate	:	3.0 m wide x 3.5 m high x 2 units (Steel slide gate with electric drive actuator)
- Intake Gate	:	2.05 m wide x 3.5 m high x 2 units (Steel slide gate with electric drive actuator)
- Sediment Trap Basin	:	7.5 m wide x 250 m long Settling capacity of 3,750 m^3 Sediment flush gate of 1.6 m wide x 2.09 m high x 4 gate (Manually operated steel slide gate)

E3.2.6 Riparian Structure

The river channel improvement of about 9.5 km in length from river mouth to Sungguminasa Bridge was implemented during a period from 1988 to 1992 through “Lower Jeneberang River Improvement Project” in order to cope with a design flood discharge of 50-year return period together with flood control effect by Bili-Bili Dam. The major structural components of the Project are river dikes of about 21 km in total for both of right and left bank, revetment of 8,786 km, two groundsills, one jetty of about 300 m in length at the river mouth and 14 sluices. The salient structural features of these facilities are as enumerated below:

(1) Earth Dike

The following earth dike was constructed along the downstream of Jeneberang River from the river mouth to Sungguminasa Bridge in 1992.

- Length: 21.3 km in to total, which is divided into right dike of 11.7 km and left dike of 9.6 km.
- Crown width: 3.5 m (covered with gravel pavement).
- Dike Slope: 1 to 2 for both of the land and riversides.

(2) Revetment

The following revetment was constructed to prevent scoring and erosion of the above earth dike in 1992 and 1993:

- Revetment for low water channel with random masonry of 425 m in length,
- Revetment for low water channel with dry masonry of 996 m in length,
- Revetment for low water channel with wet masonry of 3,592 m in length, and
- Revetment for high water channel with wet masonry of 6,384 m in length.

(3) Groyne

The following groyne was constructed to maintain the designed depth of river channel and protect the river dike and revetment.

- Structural type: Permeable pile groyne;
- Number of groyne: 43 units in total;
- Standard dimension of one unit of groyne: 2 m (W) x 2.3 m (L) x 1.2 m(H);
- Depth of pile driving: 2.5 m; and
- Foot protection: by Gabion.

(4) Groundsill

Two units of groundsill were constructed 5.97 km and 9.00 km upstream from the river mouth to minimize the fluctuations of the riverbed level. The salient features of the groundsill are as enumerated below:

- Main concrete body: 1.3 m in crown width x 1.8 m in height x 200 m in length;
- Concrete apron: 3.7 m in width x 200 m in length x 0.8 m in thickness; and
- Foot protection by gabion mattress: 15 m in width x 200 m in length.

(5) Drainage Sluice Gate

Eleven drainage sluice gates were constructed along the downstream of Jeneberang River from the river mouth to 11 km upstream in 1992 to 1993. The salient features of the drainage sluice gates are as enumerated below:

- Number of gate leaves at each of drainage gate: 1 or 2 units;
- Gate type and power source: Roller gate to be lifted by man-power;
- Size of gate leaf: 1.5 to 2 m in width x 1.5 to 2 m in height
- Length of drainage culvert: 16 to 19 m

E3.2.7 Sand Pocket and Sabo Dam

Five sand pocket dams and three sabo dams were constructed in the upper reaches of Bili-Bili dam in a period from 1997 to 2001 in order to mitigate the sediment inflow into the Bili-Bili dam reservoir and at the same time to contribute to prevention of the local sediment disaster. Among others, however, one sand pocket dam (called "Sand Pocket No.4") and one sabo dam (called "Sabo Dam No.4") were damaged by the extra-ordinary flood in January 2002. Sabo Dam No.4, which is located most upstream among the existing sand pocket dams and sabo dams, in particular, were seriously damaged and abandoned. On the other hand, Sand Pocket No.4 is to be rehabilitated in 2005. The salient features of the existing sand pocket and sabo dams are as listed below:

Salient Features of Main dam Body of Sand Pocket Dam and Sabo Dam

Name of Facility	Dam body material	Distance from End of Bili-Bili Reservoir (km)	Length (m)	Crest Width (m)	Height (m)	Sediment Capacity (m^3)	Year Comple-tion
Sand Pocket No.1	Ruble-concrete	1.8	620	3	7.5	164,000	1997
Sand Pocket No.2	Ruble-concrete	8.0	465	3	7.0	202,000	1997
Sand Pocket No.3	Wet stone masonry	15.0	336	3	7.0	129,000	1998
Sand Pocket No.4	Wet stone masonry	28.0	644	3	7.0	444,000	2000
Sand Pocket No.5	Wet stone masonry	32.0	441	3	7.0	142,300	2000
Sabo dam No.6	Wet stone masonry	42.0	230	3	10.0	74,400	2001
Sabo dam No.8	Wet stone masonry	64.0	104	3	10.0	122,400	2001

Note: Concrete apron, sub-dam, and floor protection by gabion mattress are placed downstream of the main dam.

E3.2.8 Urban Drainage Facilities in Makassar City

The storm rainfall in the lowland area of about 64.3km^2 in Makassar City is drained through four primary drainage channels of about 33km in length, namely Jongaya, Panampu, Sinrijala and Pampang (refer to Figure E3.1). Among others, Jongaya, Panampu and Sinrijala were completed through the above "Lowe Jeneberang River Improvement Project" during a period from 1992 to 1993, and Pampang was suceedingly constructed during a period from 1997 to 2000.

All of these drainage channels were designed to cope with the rainfall intensity of 20-year return period. Among others, Pampang drainage channel adopts pumping drainage with a capacity of 6m^3/s, while other three drainage channels adopt the gravity drain.

Jongaya channel is connected to the aforesaid "Long Storage" through a flush gate, and also connected to other two primary channels of Panampu and Sinrijala channels (refer to Figure E3.1). During a dry season, the flush gate is occasionally opened to release the water stored in the Long Storage into Jongaya channel. After the flush gate is opened, the control gates on the drainage channels are opened one after another so that the solid wastes as well as the polluted water in the drainage channels could be diluted through the water released from the Long Storage.

E3.3 Power Supply System to River Infrastructures in Jeneberang River Basin

E3.3.1 PLN Power Supply System in South Sulawesi Province

The PLN is the State Electric Company undertaking the commercial electric power supply in the whole of Indonesia, and a most of the river infrastructures in Jeneberang river basin relies on the PLN system as their main power supply source. The PLN power supply systems in South Sulawesi as well as in Makassar area are as shown in Figure E3.3 and their particular features are as described hereinafter:

(1) Power Balance

According to the power balance plan in Makassar for 2003-2013 formulated by PLN, the total installed capacity for Makassar would keep a margin of more than 26 % in the next ten years (refer to Table E3.2). Moreover, PLN has formulated and implemented several plans to reinforce their power supply capacity, and in line with the reinforcement plans, Bili-Bili Hydro Electric Power Plant (Bili-Bili HEPP) is scheduled to complete on November 2005. Total installation capacity of Bili-Bili HEPP is 20 MW (6 MW x 1 unit, 14 MW x 1 unit, vertical shaft, Kaplan type) and annual energy output is 77 GWh.

(2) Electric Power Failure

Water resources development facilities for Jeneberang River is connected to following three PLN Feeders of 20 kV (refer to Figure E3.3):

PLN Feeders Connected to Water Resources Facilities in Jeneberang River Basin

Name of Feeder	Number of Circuit	Water Resources Facilities Connected to Feeder
Kampili Feeder	Single Circuit	– Kampili Irrigation Weir
Rindam Feeder	Single Circuit	– Bissua Irrigation Weir
GMTDC feeder	Double Circuit	– Rubber Dam – Intake Gate for Long Storage – Tidal Gate for Long Storage – Pampang Pumping Station

The electric power failures have occasionally occurred in South Sulawesi. Number of trips and duration of electric power failures of the above three feeders in these three years are as listed below:

Electric Power Failure in Jeneberang River Basin

Year	Name of Feeder	Trip of Power Failures (times)	Duration of Power Failure (min.)	Unsupplied Power (kWh)
2001	Kampili	3	86	60
	Rindam	145	1,101	14,192
	GMTDC	15	94	1,125
2002	Kampili	26	461	609
	Rindam	193	2,911	36,342
	GMTDC	57	200	6,784
2003	Kampili	9	306	387
	Rindam	190	1,452	23,349
	GMTDC	81	365	10,542
Ave.	Kampili	13	284	352
	Rindam	176	1,821	24,628
	GMTDC	51	220	6,150

Source : PLN's information dated October 2004

As listed above, Rindam Feeder in particular is estimated to have failed its power supply ever two days in average (=365 days/176 trips), and each of failures continued about 10 minutes (=1,821 minutes/176 times). On the other hand, the failures of power supply by other two feeders are far less than that of Rindam Feeder.

(3) Energy Tariff System

Energy tariff system of PLN is divided into 6 classes by the consumer that is official, social, industry, business, housing and temporary. The river infrastructures of Jeneberang River basin are classified into industrial consumer, whereby the following tariff system is applied to the facilities:

Energy Tariff System for Industrial Consumer of PLN

No.	Installed Capacity	Unit Cost (Burden) (Rp./kVA/month)	Unit Cost (Usage) (Rp./kWh)
1	Less than 450 VA	26,000	Less than 30 kWh : 160 More than 30 kWh : 395
2	450 to 900 VA	31,500	Less than 72 kWh : 310 72 kWh - : 405
3	900 to 1,300 VA	31,800	Less than 104 kWh : 450 104 kWh - : 460
4	1,300 to 2,200 VA	32,000	Less than 196 kWh : 455 196 kWh - : 460
5	2,000VA to 14 kVA	32,200	Less than 80 hour : 455 80 hour - : 460
6	14 to 200 kVA	32,500	Peak Load : K x 440 Off Load : 440
7	200kVA to 30,000 kVA	29,500	Peak Load (Less than 350 hour) : K x 439 Peak Load (More than350 hour) : 439 Off Load : 439
8	More than 30,000 kVA	27,000	For all users : 434

Source: PLN's information dated October 2004

Note: (1) 1.4 ≤ K ≤ 2, this value will be decided by PLN. At present, "K" is set up as 1.5.
(2) Peak Load is 5 hours from 17:00 to 22:00 everyday.

E3.3.2 Electrical Power Supply System for River Infrastructures

The following water resources facilities are operated by the electric power supply; (i) Bili-Bili Dam, (ii) Rubber Dam, (iii) three irrigation diversion facilities (i.e., Bili-Bili, Bissua and Kampili); (iv) Intake Gate and Tidal Gate for Long Storage; and (v) Pampang Pumping Station. These facilities other than Bili-Bili Dam and Bili-Bili irrigation Weir apply the PLN system as the main power supply source. As for Bili-Bili Dam and Bili-Bili Irrigation weir, the main power source is currently the Micro-hydro Power Plant but would be sifted to PLN system upon completion of the aforesaid Bili-Bili HEPP. In addition to these main power supply sources, most of the facilities are equipped with the engine generator as the emergency power supply source (refer to Table E3.3). The details of these power supply systems are as described below:

(1) Bili-Bili Dam

The present main power source for all electrical equipment is the Micro-hydro Power Plant with an install capacity of 325 kVA, which is managed by JRBDP as the dam operator. The diesel engine generator of 200 kVA is also used as the emergency power supply source, when Micro-hydro Power Plant stops by accident. The Micro-hydro Power Plant is, however, not equipped with the discharge adjustment mechanism, and therefore, it hardly keeps a stable frequency and voltage to the actual power demand, which is changeable time to time. In order to cope with such problem, the Micro-hydro Power Plant is equipped with a ballast load governor system, which functions to control a constant power load on the Plant. However, this governor system currently does not function well, and the frequency and voltage supplied by Micro-hydro Power Plant is not stable, which could leads to damage of electric equipment.

Due to the above defects of the existing Micro-hydropower Plant, the Bili-Bili Dam is scheduled to receive the power supply directory from the Bili-Bili HEPP upon its completion in November 2004. Bili-Bili Dam has been already equipped with the switchgear equipment such as transformer and circuit breaker to receive the power supply from Bili-Bili HEPP.

(2) Irrigation Weir

The main power source of Bissua Irrigation Weir is PLN Rindam feeder of 20 kV from Borongloe substation. Bissua weir is also equipped with an engine generator with an install capacity of 75 kVA as the emergency power source. Rindam feeder is single circuit and it tends to cause frequent failures of power supply as described above. Accordingly, diesel engine generator would make more important role as the emergency power supply source than other irrigation weirs.

The main power source for Kampili Irrigation Weir is Kampili feeder of 20 kV from Borongloe substation and also equipped with an engine generator of 75 kVA as the emergency power source. Kampili feeder is single circuit but it causes less frequent power failure. Accordingly, less use of the emergency power source is expected.

The main power source for Bili-Bili Irrigation Weir is currently the aforesaid Micro-hydro Power Plant at Bili-Bili dam but would change to Bili-Bili HEPP upon its completion in November 2004. The emergency power supply for Bili-Bili Irrigation would also receive from the engine generator installed at Bili-Bili dam. Accordingly, Bili-Bili Irrigation Weir itself is not equipped with emergency power source.

(3) Others

PLN GMTDC feeder of 20 kV from Sungguminasa substation is used as the main power source for the facilities other than the aforesaid Bili-Bili dam and Irrigation Weirs (i.e., Intake/Tidal Gate for Long Storage, Rubber Dam and Pampang Pumping Station). The GMTDC feeder has the double circuits and it causes less frequent failures of power supply. Nevertheless, Tidal Gate for Long Storage, Rubber Dam and Pampang Pumping Station are equipped with the engine generators as the emergency power supply source with the following install capacities as the emergency power source.

- Tidal Gate : 10 kVA
- Rubber Dam : 40 kVA
- Pampang Pumping Station : 660 kVA

E4 Present River and Infrastructure Management in Jeneberang River Basin

E4.1 Present Water Quantity and Drought Management

E4.1.1 Water Allocation

Almost whole of the water demand for the source of the Jeneberang River currently depends on the stable water supply through the river flow control by Bili-Bili dam reservoir. Only the upstream village irrigation and other minor water intakes are out of the dam control. The water use for the village irrigations is managed by traditional leaders through general community agreement and could be regarded as the customary water use although the water use has not been officially registered yet. Nevertheless, the abstraction volume of village irrigations is presumed to be far smaller than those of large-scale irrigation schemes in the lower reaches, and a substantial part of the abstracted irrigation water return to the river due to the hilly/mountainous topography in the area of the village irrigation. Accordingly, the village irrigation would not have a subsistent influence to the downstream flow regime as well as the inflow regime to the Bili-Bili Dam reservoir.

The water supply capacity of Bili-Bili Dam (i.e. 305 million m^3) was designed to promise full supply for the diversion water requirement of about 541 million m^3/year from Jeneberang River against a 5-year drought. However, some of the water requirement programmed at the time of the dam design has not taken place yet. As the results, the updated water requirement to the source of Bili-Bili dam reservoir is limited to about 490 million m^3/year. The updated water requirement includes even the water demand of about 382 million m^3/year for the on-going Bili-Bili Irrigation Project. Due to the less updated water demand than the programmed value, full supply of the updated water requirement could be promised through reservoir operation of Bili-Bili Dam against a 10-year drought, which is far higher than the design supply level of a 5-year drought (refer to Supporting Report D). The detailed breakdown of the water requirement originally programmed and the updated value are as listed below:

Annual Diversion Water Requirement Dependent of Water Source of Bili-Bili dam

Item of Water Demand	Original Program		Updated	
	(m^3/s)	(m^3 million/year)	(m^3/s)	(m^3 million/year)
1. Municipal Water Demand				
1.1 PDAM Makassar	3.30	104.07	1.97	54.30
1.2 PDAM Gowa	0.10	3.15	0.19	6.00
2. Demand for Private Factory				
2.1 Takalar Sugar Factory	0.40	12.61	0.50	15.77
2.2 Gowa Paper Mill	0.25	7.88	0.00	0.00
3. Irrigation Water Demand*2	Variable	381.70	Variable	381.70
4. Maintenance Flow	1.00	31.54	1.00	31.54
Total		540.95		489.31

Note *1: Out of the WTP owned by PDAM Makassar, Panaikang WTP takes the whole raw water of 1,000 liter/sec from Lekopancing weir on throughout a rainy season, but have a half of it (500 liter/sec) from Jeneberang River for a dry season.

*2: The irrigation water demand occurs upon completion of the on-going Bili-Bili Irrigation Project. The target completion time is set at November 2004.

The Provincial Regulation of South Sulawesi on November 8, 1991 prescribes that all surface water abstraction is subject to the formal permit of Governor of South Sulawesi Province. According to Dinas PSDA, however, any formal document/list on the permitted water abstraction is likely not to exist, and the above updated water demand is substantially handled as the customary use right and, its requirement is fulfilled through dam reservoir operation based on the agreement between JRBDP as the dam operator and the water users. This would be attributed to a particular background such that Bili-Bili Dam still reserves enough supply capacity for the updated water demand, and there has been little need to introduce the formal permit.

E4.1.2 Water Distribution

JRBDP currently distributes the necessary water for the downstream water demand through operation of Bili-Bili Dam reservoir, and other water distribution facilities such as Raw Water Transmission Main, the intake for Long Storage and Rubber Dam. The water distribution is, however, currently not appropriately made due to the following background and/or the defects of monitoring devises:

(a) Bili-Bili Irrigation Project, which is the largest water user of Jeneberang River, has not started its substantial operation. Therefore, Bili-Bili Dam still reservoirs enough supply capacity for the downstream water demand, and there has been little need to introduce the precise water distribution system.

(b) The existing telemetry gauging network for the river water level is essential to monitor the natural flow discharge and to decide the necessary water to be distributed for the downstream requirement. The telemetry gauging monitoring is, however, currently not operational due to defects of one of the telemetry gauging station (refer to subsection E4.4.3).

(c) H-Q rating curves at the existing telemetry water level gauging stations are also essential to estimate the natural river flow discharge from the gauged river water level. However, the curves have never been updated since it was originally developed in 1993, and its present reliability is judged to be extremely low.

(d) There does not exist any definite institutional-setup to coordinate and decide the daily water distribution volume among JRBDP as the operator of facilities for water distribution, the various water users and the relevant coordination committees such as PTPA and PPTPA. The downstream water requirement is informed to JRBDP with very irregular intervals and by the indefinite water users.

E4.1.3 Drought Management

As described above, Bili-Bili Dam still reservoirs enough supply capacity for the downstream water demand, and Jeneberang River has not experienced any serious drought since Bili-Bili dam started its reservoir operation in 2000. Due to these backgrounds, the definite drought management system for Jeneberang River including the following items has not been established yet and the drought management has never been implemented since Bili-Bili dam was completed in 1999:

(a) Priority of water supply during drought period;
(b) Updating of the Reservoir Operation Curve, which is the ruled daily reservoir water level during the drought period; and
(c) Definite procedures to coordinate and decide reduction rate of water supply during the drought period.

E4.2 Present Flood Management

The low-lying flood plain area spreads out in the densely populated areas of Makassar and Sungguminasa City along the downstream of Sungguminasa Bridge. In order to reduce the risk of flood overflow from the Jeneberang River to the flood plain area, the river channel improvement has been made along the stretch of 9.5 km in length from the river mouth up to Sungguminasa Bridge. The improved river section currently has a flow capacity of 2,300 m^3/s.

Succeeding to the river channel improvement, Bili-Bili dam was constructed in 1999 having a flood control capacity of 41,000,000 m^3 between the Normal Water Level (EL. 99.5 m) and the Surcharge Water Level (EL. 101.60 m). The flood control capacity of Bili-Bili dam was planned to confine the flood discharge of 50-year return along the above river improvement section within the river flow capacity of 2,300 m^3/s (refer to the Flood design Discharge as shown in the right Figure).

The flood control of Bili-Bili dam reservoir is made through the following functions of the gate and non-gated structures:

(a) Gate Structures: Two roller gates (7.0 m in width x 7.7 m in height x 2 gates) called “Regulation Gates” are placed at the center of the non-gated spillway. The jet flow gate of 2m in diameter called “Control Gate” is also at tail of the dam body. Both of the Regulation Gates and the Control Gate start partial open of their gates, when the reservoir water level reaches to EL. 95.4 m (= 0.1 m below NWL). The gates further fully open to release the discharge of 642.4 m^3/s (i.e., 600 m^3/s through the regular gate and 42.4 m^3/s through the control gate), when the reservoir water level reaches to NWL (EL. 95.5 m). Through these gate operations, the small-scale flood discharge of less than 642.3 m^3/s, which occur approximately once for one year, is released without storing into the reservoir so as to maximize the flood storage capacity against the design flood discharge of 50-year return period.
(b) Non-gate Structure: The non-gated spillway of 70 m in length is placed at NWL and starts to releases the overflow discharge, when the reservoir water level reaches NWL. The non-gate structure together with the above gate structures further release the discharge of 1,200 m^3/s in total together so as to maintain the reservoir water level (RWL) at SWL (EL. 101.6 m), when the dam inflow discharge reaches the probable runoff discharge of 50-year return period (i.e., 2,200 m^3/s).

As stated above, the rather complex gate operation is required to maximize the effect of flood control capacity of Bili-Bili dam reservoir. According to the records of dam reservoir operation, however, the present gate operation during a flood is well performed, whereby any serious flood damage has never occurred since completion of Bili-Bili Dam reservoir.

Two large floods have occurred in February 2000 and February 2002, after completion of Bili-Bili dam reservoir. The flood in February 2000 brought out the peak dam inflow discharge of 1,670 m^3/s. The gauged data of dam inflow discharge and flood runoff discharge of Jenelata River shows that if no flood control were made by Bili-Bili dam reservoir, the peak discharge at Sungguminasa Bridge was supposed to reach to 2,560 m^3/s, which exceeds the channel river flow capacity of 2,300 m^3/s. The actual flood control by Bili-Bili dam was properly executed in accordance with the above gate operation procedures so that Bili-Bili dam released the peak discharge of only 900 m^3/s with using a flood control capacity of 14,600,000 m^3. As the results, the actual peak discharge at Sungguminasa Bridge was controlled to be 1,650 m^3/s (refer to Figure E4.1).

As for another the flood in February 2002, Bili-Bili dam recorded the dam peak inflow discharge of 1,960 m^3/s (this corresponds to about 25-year return period), which is much bigger than that of the above flood in 2000. During this flood, the water level gauging station on Jenelata River was washed away, and therefore the peak runoff discharge from the river is unknown. Nevertheless, the peak discharge released from the Bili-Bili dam is limited to 850 m^3/s, and any flood overflow of the Jeneberang River was not reported.

Judging from the operation records of Bili-Bili dam as described above, the present flood control operation of dam reservoir is properly executed, and the existing flood operation rule could be evaluated applicable without any revision on it. This operation rule is, however, only available to the flood scales of less the design levels of 50-year return period, and it is indispensable to setup the emergency flood warning and evacuation plan against the extra-ordinary flood scale.

E4.3 Present River Management

"Government Regulation No. 35/1991" and "Provincial Regulation of Government of South Sulawesi No.5/1999" stipulated that the "River Borderline" as the outward bound of jurisdiction of the river administrator should cover the following areas:

Legal Outward Boundary of Jurisdiction by River Administrator

English Term	Indonesian Term	Definition
River Utilization Area	Daerah Manfaat Sungai	The area including: - **Water Body**: Whole extent of river, lake, and dam reservoir; - **River Corridor**: A certain extent of land along the water body, which has been acquired by the river administrator for the sake of river management; and - **River Retention Area**: A certain extent of land, which has been acquired by the river administrator for the specific purpose of flood control.
River Control Area	Daerah Penguasaan Sungai	The area including: - **River Corridor**: A certain extent of land along the water body, which is important for river management but has not been acquired by the river administrator; - **River Retention Area**: A certain extent of land, which is retained as the future flood control work but has not been acquired by the river administrator. - **Flood Plain**: The potential flood inundation area in a certain scale of flood*.

* A probable flood of 50-year return period was applied in south Sulawesi Province

Among the above terms, the “Flood Plain” under the “River Control Area” is hardly defined due to difficulties in estimating the extent of the potential extent flood inundation area. Moreover the “Flood Plain” in Jeneberang river basin would extends over a substantial part of Makassar City, whereby it is virtually difficult to demarcate the administrative authorities of the local government and the river administrator. Due to these backgrounds, JRBDP, Dinas PSDA and any other present river administrator currently possess no administrative authority over the flood plain in Jeneberang river basin.

It is further noted that there does not exist any “River Retention Area” under both of River Utilization Area and River Control Area in Jeneberang River. As the results, the current potential area under jurisdiction of the river administrator is limited to the Water Body and the River Corridor both for the River Utilization Area and River Control Area.

The border of River Corridor (i.e., the cross-sectional borders of the river area) is defined in accordance with the above Government and Provincial Regulations as listed below (refer to Figure E4.2):

Borderline of River Corridor

Type of Water Body	Borderline of River Corridor
River with dike in urban area	3 m from edge of dike
River with dike in non-urban area	5 m from edge of the dike
Major river ($A>500km^2$) without dike in non-urban area	100 m from the river bank
Minor river ($A<500km^2$) without dike in non-urban area	50 m from the river bank
Bili-Bili dam reservoir	Both of: – The land around the reservoir, which has a ground level between NWL and SWL of Bili-Bili Dam*, and – The land around the reservoir 50 m in distance from the shoreline of reservoir at NWL**

* : The land acquired by JRBDP as the dam operator.
** : The land as specified in the Provincial Government Regulation.

As described in Subsection E3.2.6, the river dike of about 9.5 km in length was constructed along the mainstream of Jeneberang River from the river mouth to Sungguminasa. The hinterland along the river dike is situated as the urban area of Makassar and Sungguminasa. Accordingly, the extent of 3 m from the edge of the river dike should be defined as the outward bound of the River Corridor. Likewise, the upstream of the river channel improvement section is classified as the “major river without dike in non-urban area”, and the extent of 100 m from the riverbank could be regarded as the outward bound of the River Corridor.

JRBDP is currently responsible as the affix of MSRI to control these river corridors as well as the extent between the right and left dikes/banks. However, the regular inspection on the land use activities in the river utilization area is hardly implemented. As the results, illegal activities such as sand mining without permit license and construction of houses in the river corridor are often seen along Jeneberang River.

E4.4 Present Operation and Maintenance of River Infrastructure

E4.4.1 Jurisdiction for O&M Works of Facilities

JRBDP has been the implementation body for construction of all the existing river infrastructures in Jeneberang river basin over 14 years and accumulated knowledge on the structures and/or their relevant mechanical facilities. Due to these backgrounds, preparation of O&M manuals for the facilities have been made by JRBDP and a substantial part of O&M works are currently being made by JRBDP. JRBDP is, however, the affix of Ministry Public Works (the former MSRI), and, therefore, O&M works in the Jeneberang River basin is apparently now under jurisdiction of the central government. These states lead to the inconsistent relationship between the water service supplier and its corresponding beneficiaries. As the typical case of the inconsistency, it is pointed out that the beneficiaries of the drainage system is limited to only Makassar City, while all O&M works are undertaken by JRBDP. This situation could be attributed to non-existence of agreement for handover of the drainage facilities from the central government to Makassar City.

Due to the current national policy of decentralization, however, Dinas PSDA as the affix of the provincial government has began to partially take a supervisory authority of JRBDP, although the boundary of supervisory authority for JRBDP is not clear between the Ministry of Public Works and Dinas PSDA. The responsibility of O&M works will further shift to the provincial and the local government.

E4.4.2 Present Activities of JRBDP for O&M of Facilities

As stated above, the O&M for all river infrastructures in the Jeneberang River is being undertaken by JRBDP. The O&M works for the existing river infrastructures are currently made by 52 staffs, who belong to two (2) sections of JRBDP, namely “Jeneberang Water Resources Development and Management (PPSA)” and “Raw Water Development (PAB)”.

The annual budget of JRBDP in 2004 was Rp. 88 billion, out of which Rp. 78 billion (89 %) is allocated to water resources development. Thus, the present works by JRBDP is oriented to development work rather than O&M work. The budget of JRBDP for these five years are as enumerated below:

Budget of JRBDP for its Whole Administration Area in 2000 to 2004

(Unit: Rp. million)

Item	2000	2001	2002	2003	2004
Administration	853	897	1,633	1,181	1,483
Guidance/Planning	0	0	4,000	2,656	2,160
Development	80,177	18,601	4,728	16,662	78,465
Maintenance/Management	1,551	1,768	4,315	7,586	6,136
Total	82,582	21,266	14,676	28,085	88,245

The budge for maintenance/management for the whole jurisdiction area of JRBDP has gradually increased from Rp. 1,551 million in 2000 to 7,586 million in 2003, although the budget slightly reduced from 2003 to 2004. Out of these maintenance/management cost, the cost for Jeneberang is as summarized below:

Budget of JRBDP for O&M Works in Jeneberang River Basin in 2000 to 2004

(Unit: Rp. million)

Item	2000	2001	2002	2003	2004
O&M for Bili-Bili Dam	0	0	114	857	798
Rehabilitation of River Embankment	144	168	0	0	0
O&M for Rubber Dam/Drainage System	26	38	50	70	118
O&M for Raw Water Transmission Main	30	36	50	102	38
O&M for Long Storage	31	27	0	300	0
Total	230	268	214	1,329	954

As listed above, the cost for O&M works in Jeneberang river basin had the significant increment in 2003 due to commencement of O&M of Bili-Bili dam. The O&M cost for Bili-Bili dam takes about 65 % of the total O&M cost in 2003 and 84 % in 2004. A rather substantial and continuous O&M cost has also been allocated to Rubber Dam/Drainage System (Pampang Pumping Station) and RWTM. In contrast to these river infrastructures, however, the sand pocket dam /sabo dams and the riparian structures such as river revetment, groyne and groundsill are likely to have been left behind without any notable O&M work. Thus, the present O&M works are deemed to be inadequate.

According to interview survey from JRBDP, the present O&M works by JRBDP tend to be biased to three (3) major facilities Bili-Bili Dam, the Pampang Pumping Station, and Rubber Dam, where the permanent staff for O&M are assigned at the sites. However, the regular inspection is hardly implemented for the sand pocket dams/sabo dams, the drainage channels and the riparian structures such revetment, groyne, intakes which have spatially wide distribution.

E4.4.3 Evaluation on Present O&M of River Infrastructures

The present states of O&M of the facilities in Jeneberang river basin are evaluated through field reconnaissance and interview survey with O&M staffs in charge. The results of evaluation are as described the below:

(1) Bili-Bili Dam

As stated above, Bili-Bili Dam takes the largest O&M Cost of JRBDP (64 % of the whole O&M cost in 2003 and 84 % in 2004), whereby the dam bodies as well as all mechanical and electrical facilities are rather well maintained. A few defects on the facilities are, however, detected, as enumerated below:

- As described in the fore-going subsection E3.3.1, the current main power source for operation of Bili-Bili dam is the internal Micro-hydro Power Plant, but the ballast load governor system for the Micro-hydro Power Plant does not work well. As the results, the frequency and voltage of power supplied from the Micro-hydro power plant is not stable, which could lead to the damage of the electric equipment installed at Bili-Bili dam. In order to cope with this problem, the main power source of Bili-Bili Dam is scheduled to shift to the Bili-Bili Electric Power Plant, upon its completion in November 2005.
- The telemetry water level gauging station at Bayang (placed at river mouth) has not been operational, since its telemetry equipment was stolen in 2001. The defect of Bayang gauging station further extended to standstill of the entire telemetry gauging system due to the present software for system control, which was programmed to cease the whole system operation, when even one of the gauging telemetry gauging station stops to work. JRBDP now intends to restores the Bayang gauging station and at the same time to improve the software for entire system control through contact with its supplier.
- The diesel engine generator installed at the Induk Monitoring Station is out of order, and only the UPS is used as the sole emergency power supply device.

(2) Raw Water Transmission Main (RWTM)

The RWTM is now under operation. However some of PC pipes was previously damaged and replaced. Moreover, RWTM currently has the following defects:

- The RWTM is equipped with two flow meters at the inlet and outlet of the pipelines in order to monitor the flow of the pipeline and detect any leakage of water from the pipes. However, the flow meter at the inlet is now out of order, whereby the pipe leakage is hardly detected.
- Some of blow chambers are inundated with the water, which is apparently attributed to be seepage of either the groundwater or rainfall but not leakage from the pipes.

(3) Irrigation Weir

All of Bili-Bili, Bissua and Kampili Irrigation Weirs have been just completed, and their full-scale operation has not started yet. Accordingly any damage as well as deterioration of the facilities has not taken place. It is, however, noted that the main electric power for Bissua Irrigation Weir is supplied through Rindam Feeder of PLN, which has frequently caused failures of power supply as described in the subsection E3.3.1. Accordingly, Bissua Irrigation Weir would need frequent use of diesel engine generators as its emergency power supply.

(4) Rubber Dam

Out of the five-span rubber dams, the first and second spans had burst in January 2004, and since then the spans are not workable. JRBDP has started to replace the damage spans, and it is scheduled to resume operation of Rubber dam during the dry season in 2005. It is further noted that a considerable dust and dirt has accumulated in the local control panels and other various mechanical devices, and periodical lubrication for them are required.

(5) Long Storage

Long Storage could be evaluated to be under the operational condition but the following particular attentions are given.

- JRBDP entrusted maintenance and operation of both of Intake Gate and Outlet Gates (i.e., Tidal Gate and Flush Gate) for Long Storage to the local residents as the gatekeepers, whereby the gates are now operational. However, the dirt is stuck to both of the gates, and there are minor damages on their gate leafs
- The water hyacinth is seen on the water surface of Long Storage during a dry season. However, the area of the water hyacinth is limited to a rather small extent (about 5% of the entire water surface), and therefore. the growth of water hyacinth would be not great hindrance for environment of Long Storage.
- Moreover, Tidal Gate has the following troubles on its electrical power control system: (i) mechanical trouble of diesel engine generator, (ii) failure of push button, (iii) failure of ammeter and (iv) lamps burned out.

(6) Riparian Structures

The earth dike as well as revetment is rather well maintained, although a very limited part of face of revetment (made of by wet-masonry) is detached, and over-growth of weed is seen at a part of the flood high water channel. The serious damage, however, occurred at the groundsill located 5.95 km upstream of the river mouth in December 2003. Sliding of bank initially occurred at the right abutment of the groundsill and the damage further has spread to the main body. Out of the entire length of 240 m of the main body, the damage has already extended up to 100 m. In order to retrieve the damage, JRBDP has commenced the rehabilitation works with the target completion date on the end of 2004.

The existing eleven drainage gates along the earth dike are also in the critical conditions. These gates have been left without any maintenance by any gatekeeper for almost 10 years. As the results, all of the gates are not operational. All of gate leafs are currently fully or half opened and could not be closed down due to damage of gate hoist. Such unfavorable conditions would cause flood reverse flow from the river channel leading to the serious flood inundation in the hinterland during a rainy season. Accordingly it is urgently required to repair and/or replace all sluice gates. The major defects of the gates as enumerated below:

- Almost all of the mechanical parts of the gates including gate leafs are rusted and not workable,
- Some of the spindle shafts for gate leaf operation are missing;
- Gate seal rubber is badly worn; and
- Approach bridges to the spindle shaft from the dike are seriously damaged.

The summary of the present states of each drainage gate is as listed below:

Damages of Existing Drainage Gate

Drainage Gate		Location	Condition*			
No.	Name		Gate Hoist	Gate Leaf/Flame	Seal Rubber	Civil Structure
R-1	Bayang	K1.220－R	C	B	B	A
L-1	Taeng	K5.473－L	C	A	A	A
R-2	K7.00	K7.012－R	C	A	A	A
R-3	Bili-Bili	K7.722－R	C	A	A	A
R-4	Sungguminasa	K8.392－R	C	A	A	A
L—2	Lambengi	K8.776－L	C	A	A	A
R-5	K9.10	K9.135－R	C	A	A	A
R-6	K9.60	K9.563－R	C	B	A	A
R-7	Batang Kaluku No.1	K9.816－R	C	A	A	A
R-8	Batang Kaluku No.2	K10.333－R	C	A	A	A
R-9	Batang Kaluku No.3	K10.862－R	C	A	A	A

*: A = Not damaged
B = Damaged and necessary to repair
C= Seriously damaged and necessary to be replaced

(7) Sand Pocket Dam and Sabo Dam

Out of eight existing sand pocket dams and sabo dams, Sand Pocket No.4 and Sabo dam No.4 were damaged by an extraordinary intensive storm rainfall in January 2004. During the storm, the rainfall station at Malino in the upper reaches of Bili-Bili Dam recorded a two-day rainfall of 660 mm, which badly exceeded the recorded maximum rainfall of 440mm. Sabo Dam No.4 in particular has lost a substantial part of the dam body, and judging from such serious damage, it is virtually difficult to restore the structure, and JRBDP decided to abandon Sabo dam No.4.

As for Sand Pocket Dam No.4, on the other hand, the damaged portion is on the non-over flow portion, and no significant difficulty in rehabilitating the damaged portion is foreseeable. The Dam has a sediment trap capacity of 440 thousand m^3, which is the largest among those of the existing sand pocket dams and sabo dams. Moreover, the dam site has the spacious vacant land at the left bank and, the access road to the dam site is rather well maintained, which leads to easy excavation of sediment deposit at the dam. Accordingly, the Dam is expected to take an important role to check and store the sediment runoff from the collapse of Mt. Bawakaraeng. From these viewpoints, JRBDP has started to rehabilitate Sand Pocket No.4 with its target completion date at the end of dry season in 2005.

(8) Urban Drainage

The Pampang drainage system in including a pumping station is well maintained and operational. The existing three control gates placed at each of Jongaya, Panampu, and Sinrijala drainage system are also rather well maintained by the gatekeepers, whom JRBDP entrusted to the local residents. Less maintenance works have been, however, given to the drainage channels of Jongaya, Panampu, and Sinrijala drainage system including diluting of drainage channels by releasing water from the flush gate. As the results, the drainage channels are clogged by the sediment deposit and solid waste dumped into the channels, and the water quality of the drainage channels is seriously deteriorated.

E5 Present River Management by PJT I and PJT II in Brantas and Citarum Basin

E5.1 Overview of Management

PJT I and PJT II currently undertake the river basin management within the following working areas:

Working Area of PJT I and PJT II

Item	PJT-I	PJT-II
Name of Objective river basin	Brantas and Bengawan Solo	Citarum and Ciliwung-Cisadane
Extent of catchment area	32,125 km^2	12,000 km^2
Number of rivers managed	64	74

Both of PJT I and PJT II currently undertake the comprehensive river basin management in the above working area including (1) management of river infrastructures, (2) management for water allocation, (3) water quality management, (4) flood control management, and (5) river environmental management. However, there exists a distinct difference in the major concerns of river basin management by PJT I and PJT II.

PJT II directly undertakes management of hydropower generation and irrigation, which includes management for all primary, secondary and the tertiary canales. On the other hand, PJT I takes a role to supply the raw water but management of hydropower plant as well as irrigation facilities (except intake weirs on the river) are made by PLN and Balai PSDA, respectively. PJT I also takes an important role for control of negative impact such as flood, sediment runoff and water pollution. Thus, the principal scope of river basin management by PJT I is oriented to more comprehensive river basin management, while that by PJT II is to increment of efficiency and effectivity of the existing production infrastructures for hydropower generation and irrigation.

The major issues for river basin management in Jeneberang river basin would be placed on the raw water supply rather than management of hydropower generation and irrigation. From this viewpoint, the actual guidelines, procedures and/or manuals used for river basin management by PJT I serves more as a reference for management by the water corporation in Jeneberang river basin.

E5.2 Procedures and Job Instructions for River Basin Management

PJT I has prepared the basic procedures and job instructions certifies by ISO 2000 for the river basin management. The procedures and job instructions contains 66 items of categories related to river basin management including the following procedures for O&M works:

(1) Management of River Facilities

- General procedures for management of infrastructure
- Procedures for inspection for sediment in dam reservoir;
- Planning procedures for technical maintenance
- Procedures for O&M of equipment;

(2) Water Allocation

- Planning procedures for water allocation;

(3) Flood Management

- General procedures of flood control;
- Job instruction for O&M of FFWS equipment;

(4) Water Quality Management

- Procedures for monitoring of water quality;
- Procedures for daily water quality control;
- Procedures for water quality analysis in laboratory;
- Job instruction for cleaning of waterweeds and garbage in dam reservoir;
- Job instruction for water sampling for water quality test;

(5) Hydrological Measurement and Gauging

- General procedures for monitoring and measurements;
- Procedures for compiling and monitoring of hydrological data;
- Job instruction for water level gauge;
- Job instruction for current velocity and river discharge measurement;
- Jon instruction for measurement of reservoir cross-section;

Among the above items, those of items (2) to (5) have not been furnished nor used in the current practice of Jeneberang river basin, and could be useful as the reference for preparation of O&M manuals for water cooperation of Jeneberang River.

E5.3 Management of River Infrastructures

Both of PJT I and PJT II operate and maintain a full variety of river infrastructures including dam reservoirs, diversion weirs, intake facilities, check dams, and river structures such as groundsill, groyne and levee. Among others, PJT I operates eight dam reservoirs as represented by Wonogi dam reservoir (storage capacity of 440 million m^3) in Bengawan Solo river basin, and Karankates dam reservoir (storage capacity of 232.5 million m^3) in Brantas river basin. These dams promise raw water of about 390 million m^3 for municipal use. As for the facilities operated by PJT II, there exist three (3) major dam reservoirs, namely: Jatiluhur (storage capacity of 3 billion m^3), Cirata (2.2 billion m^3) and Saguling (1 billion m^3). These dam reservoirs contribute the hydropower generation of 1,888 MW in install capacity.

O&M manuals written in Indonesia for all of the major river infrastructures have been prepared and updated through several revisions. The revisions are based on the difficulties encountered and the countermeasures taken in the actual O&M works, which could serve references for O&M of water resources facilities in Jeneberang river basin. The following are enumerated as the actual difficulties and countermeasures in O&M works by PJT I:

(1) The check dams in the downstream of Mt. Kuld in Brantas river basin were filled up by lahars flow from the mountain. In order to cope with the problem, the dredging work was undertaken and, at the same time, a by-pass of lahars flow has been constructed.

(2) Due to the above lahars flow from Mt. Kuld, a considerable volume of sediment has also accumulated in the reservoirs of Wlingi Dam and Lodoyo Dam, (after bay of Wlingi Dam). According to PJT I, it is virtually difficult to restore the reservoir capacity, although dredging of works was undertaken.

(3) Reservoir operation of Sengguruh dam located on the mainstream of Brantas River is seriously affected by overgrowth of water hyacinth during a dry season. Removal of hyacinth by manpower was adopted only as the practical solution for this issue.

(4) The water quality of drainage channels in Surabaya City is seriously deteriorated due to damping of solid waste and inflow of non-treated wastewater. PJT I monitors the water quality of the drainage channel as well as effluent from the principal point pollutant sources. At the same time, the river maintenance flow is provided to drainage channel to flush the solid waste and polluted water. In spite of these activities by PJT I, this issue has not been substantially solved yet.

E5.4 Water Quantity Management

In accordance with the basic procedures as described in the above subsection E5.2, PJT I prepare the draft of Annual Operation Plan for water allocation at the ends of every dry and rainy seasons. PJT II also prepares the similar Annual Operation Plan, but it is not based on the written basic procedure.

PJT I simulates the water supply capacity of water source facilities based on the updated water requirement in the year and the gauging record on the reservoir water levels and dam inflow discharges in the last six months. Based on the results of simulation, PJT I prepares a water allocation plan, which is submitted to PTPA and Dinas PSDA, and finally approved by Vice Governor.

In the drought year, the water demand is not fully supplied and curtailed to a certain level in accordance with the water allocation plan. In fact, Brantas river basin has been suffered from the critical drought and water demand has not been fully supplied for these five (5) years.

The priorities of water supply in a drought year are given, in accordance with the “Gov. Law No. 11 in 1974”, to the following water uses:(1) First priority for domestic & municipal water use, (2) Second priority for water use for agriculture, animal husbandry, plantation, fishery, and (3) Third priority for water use for energy, industry, mining, navigation, recreation.

E5.5 Flood Management

In accordance with the basic procedures as described in the above subsection E5.2, PJT I prepares the “Annual Emergency Action Plan for Flood” once a year and submitted to Dinas PSDA, Kabupatens and Committee for Flood Fighting chaired by Governor at the end of every dry seasons. The plan contains the following items, which cold be used for flood evacuation and flood fighting:

(1) Areas and residents in danger of flood, which are identified through inspection of the river structures as well as land use in the floodplain;
(2) Available communication measures to the residents in danger of flood;
(3) Procedures for flood forecasting and issuance of flood warning, and
(4) Procedures for flood evacuation and flood fighting.

E5.6 Water Quality Management

Both of PJT 1 and II sample river discharge as well as effluent from factories and analyze the water quality at their own laboratory. They also monitor the water quality of effluent from factories and collect monitoring fee from the factories. Based of the results of water quality monitoring, PJT I and II implement improvement works of water quality through releasing the river maintenance flow and/or de-clogging of solids wastes accumulated in the river channels. Nevertheless, they do not possess any legal capacity of enforcement to control the effluent from the factories as the point pollutant sources.

E6 Proposed Water Quantity Management Plan for Jeneberang River Basin

E6.1 Water Allocation Plan

As described in the foregoing subsection E4.1.1, any formal document/list on the permitted water abstraction from Jeneberang River is likely not to exist, and the water abstraction from Jeneberang River is substantially controlled by JRBDP as the operator of river infrastructures.

E6.2 Water Distribution Plan

JRBDP has granted the annual diversion water requirement of 489.39 million m^3/year in total to be dependent on the source of Jeneberang River. This granted diversion water requirement could be regarded as the customary water use right and adopted to the base of water quantity management by the Public Water Corporation. The breakdown of this granted water requirement is as listed below (refer to Table E6.1 and Figure E6.1).

Granted Annual Diversion Water Requirement from Jeneberang River

Month	Municipal Water Demand[*1]		Irrigation Water Demand [*2]		Takalar Sugar Factory Demand		River Maintenance. Flow		Monthly Total	
	10^6m^3	m^3/s	10^6m^3	m^3/s	10^6m^3	m^3/s	10^6m^3	m^3/s	10^6m^3	m^3/s
Jan.	4.45	1.66	23.56	8.80	1.34	0.50	2.68	1.00	32.03	11.96
Feb.	4.02	1.66	0.00	0.00	1.21	0.50	2.42	1.00	7.65	3.16
Mar.	4.45	1.66	0.00	0.00	1.34	0.50	2.68	1.00	8.47	3.16
Apr.	4.31	1.66	57.36	22.13	1.30	0.50	2.59	1.00	65.56	25.29
May	5.79	2.16	79.46	29.67	1.34	0.50	2.68	1.00	89.27	33.33
Jun.	5.60	2.16	76.74	29.61	1.30	0.50	2.59	1.00	86.23	33.27
Jul.	5.79	2.16	72.33	27.01	1.34	0.50	2.68	1.00	82.14	30.67
Aug.	5.79	2.16	36.53	13.64	1.34	0.50	2.68	1.00	46.34	17.30
Sep.	5.60	2.16	19.66	7.59	1.30	0.50	2.59	1.00	29.15	11.25
Oct.	5.79	2.16	12.21	4.56	1.34	0.50	2.68	1.00	22.02	8.22
Nov.	4.31	1.66	0.00	0.00	1.30	0.50	2.59	1.00	8.20	3.16
Dec.	4.45	1.66	3.86	1.44	1.34	0.50	2.68	1.00	12.33	4.60
Total	60.35		381.70		15.79		31.54		489.39	

According to results of water demand-supply balance simulation, the supply capacity of Bili-Bili Dam reservoir would barely meet the water demand in the year 2018, and since then, shortage of water supply capacity to the water demand occurs in a 5-year drought year due to increment of the municipal water demand (refer to Supporting Report-D). Hence, in order to establish more effective and fair rules over water allocation, the water use right (WUR) is necessary for Jeneberang River, and the WUR should be granted to the above updated diversion water requirement of 489.39 m^3 million/year, since it prevails over the general community recognition and therefore, it could be accepted as the customary water use. The proposed WUR would be based on the following concepts:

(a) The reservoir capacity of Bili-Bili Dam could currently promise full supply of the WUR both for municipal and irrigation water against a 10-year drought. However, the marginal drought safety level for the WUR of irrigation water use in particular should be set at 5-year return period, and therefore, Bili-Bili dam reservoir capacity still possesses the excessive supply capacity for the present WUR.

(b) The excessive supply capacity of Bili-Bili dam reservoir should be reserved to secure the future incremental municipal water demand as the essential social need. According to the water supply-demand simulation, the reservoir capacity of Bili-Bili Dam would still promise full supply of the future municipal water demand of 133.5 million m^3 (a maximum of 4.52 m^3/s) in the year 2018 on the premises of the aforesaid marginal drought safety level of 5-year return period for irrigation water use (refer to Supporting Report-D);

(c) Water requirement for irrigation use is variable every year depending on rainfall depth. Moreover, the cropping schedules occasionally change, which also influences the variation of the water requirement for irrigation. Thus, the actual water requirement for irrigation use is changeable. In due consideration of these particular variations, the WUR for irrigation water is provisionally proposed on the premises of the following conditions:
   - The WUR should be limited to the above diversion water requirement of 38.17 million m^3/year granted by JRBDP.
   - The seasonal values of WUR should follow the standard cropping schedules for Bili-Bili, Bissua and Kampili irrigation schemes. and
   - The actual water distribution for irrigation requirement should be decided every year through coordination with the irrigators taking the above WUR granted into account.

E6.2.1 Monitoring Plan on Water Distribution

The river management authority has an obligation to distribute the water for the requirement of the above WURs. In order to ensure the obligation, it is indispensable to precisely monitor the seasonal variations of both river flow discharge and requirement of water users, and decide to the appropriate water distribution based the monitoring results. Such monitoring works would become more crucial issues especially upon completion of the on-going Bili-Bili irrigation project.

From the above viewpoints, the following monitoring system for the river flow and water intake discharge is proposed. The proposed system is used to monitor (1) inflow/outflow of dam reservoir, (2) unregulated flow discharge from the Jenelata River, (3) river flow discharge below the major water intake points and (4) water abstraction volume at all intake points, where the WUR is granted. Among these monitoring items, those of items (1) to (3) should be monitored by the river administrator, while the item (4) by the water users.

Proposed Monitoring System for River Flow Discharge and Water Use

		Objectives of Monitoring	Device for Monitoring	Monitored by
Monitoring of Flow Discharge	(1)	Inflow discharge to Bili-Bili dam reservoir	Dam Control and Monitoring System at Dam Control Office (Existing)	River administrator
	(2)	Outflow discharge from Bili-Bili Dam reservoir	Dam Control and Monitoring System at Dam Control Office (Existing)	River administrator
	(3)	PDAM Intake to Somba Opu WTP	Dam Control and Monitoring System at Dam Control Office (Existing)	River Administrator
	(4)	Runoff discharge from Jenelata River	Dam Control and Monitoring System at Dam Control Office (Existing)	River administrator
	(5)	Flow discharge from Kampili Weir	Dam Control and Monitoring System at Dam Control Office (Existing)	River administrator
	(6)	Overflow discharge of the lower groundsill (at K5.97)	Staff gauge	River administrator
	(7)	Inflow discharge to Long Storage	Off-line gate opening gauge (exist)	River administrator
	(8)	Overflow discharge of Rubber Dam	Water level gauge at Rubber Dam (Existing)	River administrator
Monitoring of Water Use	(9)	PDAM Intake other than that for Soma Opu	Flow mete (To be newly installed)	PDAM Makassar and Gowa
	(10)	Bili-Bili Irrigation System	Staff gauge (Existing)	Dinas PSDA
	(11)	Bissua Irrigation System	Staff gauge (Existing)	Dinas PSDA
	(12)	Kampili Irrigation System	Staff gauge (Existing)	Dinas PSDA
	(13)	Takalar Sugar Factory	Flow meter (to be newly installed)	Takalar Sugar Factory
	(14)	River Maintenance Flow	Estimate from the above (6), (7) and (8)	River Administrator

The above-proposed monitoring network includes the water level gauging stations at Patarikan Gauging Station on the Jenelata River and Kampili Gauging Station on the Jeneberang River. In order to acquire the precise information on the discharge from these water level gauging points, it is indispensable to renew the H-Q rating curves at the end of every rainy season.

E6.2.2 Proposed Procedures of Water Distribution

In order to achieve the sustainable water distribution throughout a year, the following work procedures for daily water distribution is proposed with referring to the procedures currently applied by PJT I:

(1) Preparatory Works

The river administrator should undertake the following preparatory works for formulation of semiannual water allocation plan and operation plan of the daily water distribution at the end of May (the end of rainy season) and at the end of November (at the end of dry season):

a) To check the updated water supply capacities/workability of water supply facilities, which include the following items,
   - Bili-Bili dam Reservoir,
   - PLN hydropower station,

- Raw Water Transmission Main (RWTM);
- Three irrigation intake weirs, namely, Bili-Bili, Bissua, and Kampili weir.
- Rubber dam and intake/outlet facilities for Long Storage; and
- PDAM intake facilities.

b) To check and repair all flow meters and hydrological gauging devices to be used for monitor the daily operation of water allocation,

c) To update the H-Q rating curves to be used for monitor the under-mentioned operation of the daily water allocation, and

d) To forecast the meteorological conditions for the succeeding six months based on the information from Meteorology and Geophysics Agency.

(2) Formulation of Water Allocation Plan

The river administrator should prepare a draft of the semiannual water allocation plan at the end of May (the end of the rainy season) and at the end of November (the end of dry season). The draft of the plan should stipulate the updated water users and the seasonal variations of their water abstraction volumes for the next six months.

The draft of plan is submitted to, evaluated and finalized by the Water Resources Coordination Committee (PTPA). PTPA would distribute the finalized SEMIANNUAL WATER ALLOCATION PLAN within four (4) days at least before commencement of the daily operation for water allocation to the following relevant agencies:

a) The river administrator
b) Dinas PSDA
c) Balai PSDA
d) PDAM Makassar
e) PDAM Gowa
f) Takalar Sugar Factory
g) PLN and
h) Other agencies as required

(3) Daily Operation for Water Distribution

Based on the above semiannual water allocation plan, the river administrator should formulate the daily operation plan for water distribution, which stipulates the time schedule of operation, the necessary personnel in charge and their duties, at the end of November (at the end of dry season). The river administrator is further required to undertake the following works:

a) To prepare assignment schedules of the staffs to be engaged (including the gate operator, observer/inspector, security force, telecommunication operator, etc.) every month;

b) To collect the half-monthly water requirement from the following water users:

- Balai PSDA, which estimates the water volume to be taken from three

irrigation weirs (Bili-Bili, Bissua, and Kampili) to their respective irrigation areas taking the cropping schedules and the effective rainfall depth into account;
- Takalar Sugar Factory, which estimates the half-monthly water requirement taking the necessary water for sugar plantation and refining; and
- PDAM Makassar and Gowa, which estimate the necessary water intake volumes for their municipal water supply.

c) To estimate the possible discharge to be released from Bili-Bili dam reservoir to the downstream water demand, every half month, based on the above water requirement, the water storage volume stored in the reservoir and the necessary river maintenance flow:

d) To instruct PLN to release the discharge passing through the turbines of Bili-Bili Electric Hydropower Plant in accordance with the above estimation;

e) To monitor and measure the results of daily water allocation:

f) To rearrange the water allocation in accordance with the Step 1 to Step3 for the drought management on the premises of approval by PTPA as described in the following subsection E6.3, if difficulties arise in fulfilling the requirement of water users as programmed in THE SEMIANNUAL WATER ALLOCATION PLAN due to the drought.

g) To compile the following records
   - Daily reservoir operation record including daily water supply volumes to each of water users;
   - Records of collection of water service fee from the users.

h) To review the daily water allocation executed for the foregoing six months, and to make the necessary revisions on the procedures for the daily water allocation, as required.

E6.3 Drought Management Plan

Bili-Bili dam reservoir is operated, in the normal-drought years, to fulfill the whole requirement for the downstream water use. However, should the dam unconditionally releases its storage water in accordance with the downstream water requirement, the available supply capacity of the dam reservoir possibly drops to zero during an extra-ordinary drought year causing sudden and drastic reduction of available water supply for the whole water use.

In order to avoid such unfavorable conditions, the dam reservoir needs to gradually reduce the water supply in the extra-ordinary drought year. At the same time, the dam reservoir needs to promise less reduction of water supply for priority water use even in the extra-drought year. However, the present reservoir operation plan of Bili-Bili dam does not prescribe such reservoir operation procedures in case of the extra-ordinal drought.

According to the results of water demand-supply simulation, out of 30 years from 1972 up to 2001, three hydrological years[1] of 1972/1973, 1982/1983 and 1997/1998 were identified as the extra-ordinal drought years over the recurrence probability of 10-year (refer to Figure E6.2). During these three years, the dam supply capacity could not fulfill the whole requirement of the allocated water demand.

The year of 1972/1973 in particular is recognized as the most severe drought year having a less rainfall throughout the rainy season. On the other hand, 1982/1983 and 1997/1998 cause drought, only because the dry season lasted about one-month longer than usual. Should the Bili-Bili Dam have kept full supply to the allocated water demand in the year of 1972/1973, the vacancy of dam reservoir storage continued from the later half of June to the end of November. On the other hand, in 1982/1983 and 1997/1998, the period of the vacant reservoir storage is limited to less than one month.

During the above three drought years of 1972/1973, 1982/1983 and 1997/1998, the allocated water demand could not be fully supplied, and a certain reduction of water supply is required. In this connection, the priority of water supply and the procedures to reduce water supply in the drought years are proposed as the essential issues for drought management.

(1) Priority of Water Supply in Drought Years

The priority of water supply during the drought years of more than 10-year return period should be given to municipal water supply and supply for river maintenance flow. These priority water supplies are the basic need for community, and objective of reduction of water supply in the drought year should be addressed to the irrigation water supply.

(2) Reservoir Operation Curve

The Reservoir Operation Curve (RC) is the ruled lowest daily reservoir water levels, and the dam operator is required to always maintain the reservoir water level (RWL) above RC so as to facilitate the under-mentioned drought management.

The RC is developed as a curve, which envelops the whole lowest daily reservoir water levels (RWLs) estimated through water supply-demand simulation under the past low flow regimes from a period from 1972 to 2001 except those in the above extra-ordinary drought years of 1972/1973, 1982/1983 and 1997/1998.

Thus, the RC is closely related to the allocated water demand and should be updated according to every renewal of water allocation. However, the present Bili-Bili dam reservoir operation is based on the RC established in 1993, and since then, any updating of RC has never been made in spite of change of the downstream requirement of water use. In this connection, the RC is newly developed based on the new water allocation as proposed in the above subsection E6.1

[1] The hydrological year is herein defined as a hydrological cycle of a year from the beginning of the dry season (June 1st) to the end of the next rainy season (May 31st).

and the past low flow regime from 1972 to 2001 (refer to Figure E6.3). The present and the newly estimated RCs are as listed below, and the detailed reservoir operation plans based on the newly developed RC are as described in the under-mentioned item (3).

Present and Proposed Reservoir Operation Rule Curve

Month	RC on the beginning of the Month (EL. m)	
	Existing	Newly Proposed
May	99.0	84.0
Jun.	95.0	88.5
Jul.	88.0	84.0
Aug.	81.0	79.5
Sep.	74.0	75.0
Oct.	66.0	70.5
Nov.	65.0	66.0
Dec.	67.0	66.0

Note: The daily RCs are defined as the values interpolated from the above RCs at the beginning of each month.

(3) Procedures to Reduce Supply to Allocated Water Demand in Drought Years

The operator of dam reservoir needs to firstly reduce the irrigation water supply in advance before RWL drops below RC. In order to facilitate the appropriate reduction of water supply, the basic concepts on the necessary procedures were provisionally delineated as below:

Basic Concept on Procedures for Reduction of Water Supply

Step1: (Stand by)	A particular dam operation team against drought should be organized, when the RWL and/or daily descending rate of RWL reach a certain designated level showing an initial incident of drought. And the team should undertake the following tasks: (a) to estimate the expected dam inflow discharge based the long-term weather forecast, (b) to inform the relevant water council and water users about possibility reduction of irrigation water supply.
Step2: (Coordination)	When the RWL continues to drop with the critical rate, the dam operation team should estimate the necessary reduction of irrigation water supply and proposed the estimated value to the water council and water users.
Step3: (Reduction of Irrigation Water Supply)	When the RWL reaches a certain critical level, the dam operation team should execute the necessary reduction of irrigation water supply as estimated in Step2.
Step4: (Stop of Irrigation Water Supply	When the RWL reaches RC, the dam operation team should stop the whole water supply of irrigation water supply.

Based on the above concept, the definite procedures for reduction of water supply was further examined through trial simulation for the low flow regime in the extra-ordinary drought year of 1972/1973, 1982/1983 and 1997.1998. As the results, the following drought management procedures are proposed:

Proposed Procedures to Reduce Water Supply in Drought Years

Steps	Approx. Leading Time to Next Step	Flood Discharge/Water Level to Commence the Steps	Necessary Activities
Step1: Standby	10days	• {RWL < RC +2.0m} and • The dairy descending rate of RWL >0.25 m/day	• Setup a dam operation team against drought • Estimate the expected dam inflow discharge based the long term weather forecast • Inform the relevant water councils/committees and water users about possibility reduction of irrigation water supply
Step2: Coordination	5days	• {RWL < RC + 1.0m} and • The dairy descending rate of RWL >0.25 m	• Estimate and the necessary reduction of irrigation water supply • Proposed the above estimated value to the water council and water users
Step3: Reduction of Water Supply for Irrigation	2days	• {RWL < RC + 0.5m} and • The dairy descending rate of RWL >0.25 m	• Execute the above estimated necessary reduction of irrigation water supply
Step4: Stop of Irrigation Water Supply	-	• When RWL = RC	• Reduce 100% of irrigation water supply
Step4 Stop of Whole Water Supply	-	• When RWL = LWL	• Reduce a certain volume of municipal water supply from dam reservoir

According to results of water supply-demand balance simulation, the above-proposed procedures for reservoir operation would require the following reductions of irrigation water supply for the dry paddy, the wet paddy and Palawija in case of the drought year as experienced in 1972/1973, 1982/1983 and 1997/1998 (refer to Figures E6.4).

Simulated Necessary Reduction Rates of Irrigation Water Supply in Drought Year

Drought Year	Reduction Rate Rates of Irrigation water		
	For Dry Paddy	Palawija	Wet Paddy
1972/1973	55%	100%	0%
1982/1983	0%	0%	20%
1997/1998	0%	100%	0%

Note: Irrigation Period for Dry Paddy = from June to September for Dry Paddy
Irrigation Period for Palawija = from July to December
Irrigation Period for Wet Paddy = from November to May

E7 Proposed Flood Management Plan for Jeneberang River Basin

E7.1 Plan for Flood Warning

As described in the foregoing subsection E4.2, the flood control capacity of Bili-Bili dam reservoir as well as the river channel flow is within a limit to cope with the flood 50-year return period, and once the flood over the design capacity occurs, the disastrous flood damage including death of people is expected due to flood overflow from the river. In spite of this, there does not exist any flood warning and evacuation plan against the extra-ordinary floods over and/or out of the design flood. Hence, the plan was preliminarily delineated in this Study.

E7.1.1 Setup of Flood Warning Levels and Necessary Activities

The flood warning and its relevant activities should be made based on the appropriate hydrological gauging data. Judging from the existing available hydrological gauging network, it is proposed to issue the flood warning based on the following three existing telemetry-gauging stations:

(a) Bili-Bili dam to gauge dam inflow/outflow discharge,
(b) Patarikan Bridge on Jenelata to gauge the unregulated flood runoff discharge from the Jenelata River,
(c) Kampili Weir on the mainstream of the Jeneberang River to gauge sum of discharge from Bili-Bili dam and the Jenelata river basin.
(e) Maccini Sombala on the downstream of Jeneberang River to gate the river water level:

The warning activities are also proposed to have the following steps to facilitate the smooth execution: (1) Standby, (2) Warning, and (3) Evacuation/Flood Fighting. The flood discharge/water level to commence each of the steps and the necessary activities to be taken in the steps are proposed as below:

Proposed Flood Warning and Evacuation Plan

Steps	Occurrence Probability and Flood Lag Time	Flood Discharge/Water Level to Commence the Steps	Necessary Activities
Step1: Standby	Occurrence: Once for 1 to 2 years	Any of the following is detected: • RWL of Bili-Bili Dam is over NWL (EL. 99.5) and tends to rise. At the same time, dam inflow discharge exceeds 642.3m^3/s (=maximum discharge from the regular gates and control gate when RWL is NWL); • Discharge of Jenelata River at Patarikan Bridge exceeds 400 m^3/s; • Discharge of Jeneberang River at Kampili Weir exceeds 1,150m^3/s; or • Water level of Jeneberang River at M. Sombala reaches 1.5m below the crown level of river dike	• Start flood control operation of dam reservoir: • Standby a team for patrol along the potential flood area along the river course: • Standby a term to disseminate the flood evacuation to the residents
Step2: Warning	Occurrence: Once for about 20-years Flood Lag Time: About 4hours from Step 1	Any of the following is detected: • RWL of Bili-Bili Dam reaches EL101m or the dam outflow discharge exceeds 1000m^3/s; • The river flow discharge at Patarikan Bridge exceeds 900 m^3/s; • The River flow discharge at Kampili Weir exceeds 1,800m^3/s; or • Water level of Jeneberang River at M. Sombala reaches 1.0m below crown level of river dike	• Continue flood control operation of dam reservoir: • Start patrol along the potential flood area: • Start to disseminate the flood evacuation to the residents • Standby a term to carry out the emergency protection works against flood
Step3: Evacuation /Flood Fighting	Occurrence: Once for about 50-years Flood Lag Time: About 2hours from Step 2	Any of the following is detected: • RWL of Bili-Bili Dam reaches EL101.6 m or the dam outflow discharge exceeds 1,200m^3/s; • Discharge of Jenelata River at Patarikan Bridge exceeds 1,100 m^3/s; • Discharge of Jeneberang River at Kampili Weir exceeds 2,300m^3/s; or • Water level of Jeneberang River at M. Sombala reaches 0.6m below the crown level of the river dike	• Continue flood control operation of dam reservoir: • Continue patrol along the potential flood area along the river course: • Continue to disseminate the flood evacuation to the residents • Start to carry out the emergency protection works against flood overflow

E7.1.2 Center for Flood Forecasting, Warning and Fighting

The principal center should be placed at the existing Monitoring Station for Bili-Bili Dam in Makassar City, where the Operation Director of Public Corporation should station during a flood and make all determination and issuances for flood warning, evacuation and fighting. The secondary center should be further placed to the Dam Control Office at Bili-Bili dam site having functions to undertake the necessary flood control operation of gate facilities at Bili-Bili Dam based on the flood conditions (flood discharge, rainfall intensity and dam inflow discharge).

E7.1.3 Flood Monitoring Points

The flood forecasting and warning based on the discharge/water level gauged by the following four principal telemetry stations as described above (refer to Figure E7.1). The gauged discharges/water levels are automatically transmitted to the Dam Control Office placed at

Bili-Bili dam site and the Monitoring Office in Makassar City on real time base, and used to judge the flood conditions.

Principal Hydrological Gauging Stations for Flood Warning and Evacuation

Name of Gauging Station	Hydrological Data to be Gauged	Critical Discharge to Initiate Each of Steps for Flood Warning and Evacuation		
		Step 1	Step 2	Step 3
Bili-Bili Dam	Bili-Bili Dam Inflow Discharge	642.3m^3/s	1,000.0m^3/s	1,200.0m^3/s
Patarikan bridge	Discharge of Jenelata River	400.0m^3/s	900.0m^3/s	1,100.0m^3/s
Kampili Weir	Discharge of Jeneberang River	1,150.0m^3/s	1,800.0m^3/s	2,300.0m^3/s
Maccini Sombala	Water Level of below Crown Level	1.5m (EL. 4.7m)	1.0m (EL. 5.2m)	0.6m (El. 5.6m)

In addition to the above principal gauging stations, there also exist the following several water level and rainfall telemetry gauging stations, which transmit their gauging data to the Dam Control Office and the Monitoring Office (refer to Figure E7.1). These should be used as the supporting gauging stations and their gauged date should be taken into consideration as the reference for forecasting of the succeeding flood conditions:

Sub Hydrological Gauging Stations for Flood Waning and Evacuation

Name of Gauging Station	Hydrological Data to be Gauged	Use of Gauged Data
Jonggoa Bonto Jai	Water level of the upstream of Jeneberang River from Bili-Bili Dam	Evaluate the succeeding tendency of the increase/ decrease of dam inflow based on rise/drop of the gauged water level
Bayang	Tidal level at river mouth of Jeneberang River	Evaluate the succeeding tendency of the rise/drop of the downstream water level of Jeneberang River on rise/drop of the gauged tidal level.
Malino Jonggoa	Rainfall in upper reaches of Bili-Bili Dam	Evaluate the succeeding tendency of the increase/ decrease of dam inflow based on the increase/ decrease of the gauged rainfall.
Limbua Mangepang	Rainfall in Jenelata River Basin	Evaluate the succeeding tendency of the increase/ decrease of the downstream discharge of Jeneberang River based on increase/decrease of the gauged rainfall.

E7.2 Development and Dissemination of Flood Risk Map

Earth embankment was constructed in 1993 along the right and left bank of Lower Jeneberang River 9.6km long from the river mouth to Sungguminasa Bridge. The embankment together with the flood storage capacity of Bili-Bili Dam was designed to cope with the probable flood discharge of 50-year return period. However, once an extreme flood with a recurrence probability above 50-year return period occurs, the river flow would overtop the embankment and flow into the hinterland. The flood could further possibly wash a substantial part of the embankment away, since the crown level of the embankment is higher than the ground level of the hinterland. Hence, in order to minimize the disastrous flood damage, which may involve death of the resident, dissemination of flood risk map is proposed.

Dissemination of the flood risk map has been broadly adapted throughout the world as one of the useful non-structural flood mitigation measures. Through dissemination of the flood risk map, the residents are made aware of the extent of the potential flood inundation area and the available evacuation routes during a flood. The flood risk map can also provide the guidance for appropriate urban planning and land development.

The movement of flood overflow discharge is highly influenced by the topographic conditions (i.e., undulations and ground levels) in the hinterland. The movement is also varied by the uncertain factors such as location of flooding over embankment, and flood hydrological conditions in the river basin (i.e., the spatial and temporal variation of the storm rainfall and the variations of flood runoff hydrograph). Despite of these complex and uncertain factors on the movement of flood overflow, the available information on them is limited to the following items in case of Jeneberang river basin:

(a) The counter maps of ground levels with 1.0 m intervals in the Ortho-Photo Maps, which were developed under the "Bili-Bili Irrigation Project in 2000",
(b) The existing dike levels and/or design high water levels of Jeneberang River against the design discharge of 50-year return period; and
(c) The actual inundation area in the Flood 1976 estimated through interview survey to the residents in the Study on "Jeneberang River Flood Control Project (Phase II), by JICA in 1983".

The low-lying areas with the ground levels below the design high water channel were firstly outlined as the maximum extent of the potential flood area. Then, the area, where the flood overflow could be interrupted by the roads, the dikes of drainage channels and other boundaries with high ground levels, were identified based on the actual flood inundation area in 1976, and such areas were excluded from the potential flood inundation area.

As the results, the potential flood inundation area was preliminarily estimated to cover an extent of about 58.5km^2 spreading out a substantial part of Makassar and Sungguminasa City at the left side bank of the Jeneberang as shown in Figure E7.2. The areas not to be inundated would be the east part of Makassar City surrounded by the dike alignments of Jongaya, Panampu drainage channels, the north of the Jl. Urip Sumoharjo, and the slightly elevated area in and around Kel. Tibung and Bontomakkio. In contrast to the area at the right bank, the possible inundation area at the left bank is confined into a rather limited area between the dikes of the Jeneberang River and the Garassi River.

In addition to the above flood inundation areas, a particular attention should be given to the illegal dwellers living in the flood high water channels. The areas of illegal dwellers are designated as the river area and exposed to the high risk of flood damage. Accordingly, the river administrator should exert his maximum effort to evacuate the illegal dwellers during a non-flood period and at the same time, record the location of all illegal dwellers in advance so at to issue the early flood warning to them during a flood time. The dominant areas of illegal dwellers are as enumerated below:

(a) The stretch along left bank 2 to 3 km upstream from river mouth (just downstream fro Rubber Dam); and

(b) The stretch along right bank 5 to 6 km upstream from river mouth (adjacent to the existing groundsill).

The evacuation centers as well as evacuation routes would be placed in to West side on the Sinrijala-Panampu, or East of Central Ring Road. However, their detailed locations could not be specified in this Study due to the limited information, and should be designated, in the future, by the relevant local government agencies based on the base flood risk map. The flood risk map thus prepared should be disseminated to the public through a bulletin, an information board and other available information tools.

E7.3 Institutional Set-up Plan for Flood Warning Evacuation and Fighting

The Public Corporation would undertake the major task of flood forecasting, warning and fighting as the river administrator of Jeneberang River and at the same time as the operator of Bili-Bili dam reservoir, the principal flood control facility in the river basin. Nevertheless, it is indispensable to involve the external organizations other than the Public Corporation to the task of flood evacuation as well as flood fighting in particular, which has to be executed in response to the flood forecasting and warning. The internal working groups of the Public Corporation and the external organizations to be involved to the objective tasks are as described below (it is herein noted that the specific designations of the Public Corporation described below are derived from the proposed organization set-up of the Public Corporation in Volume 3, Supporting Report-I):

(1) Internal Working Groups of Public Corporation

During a rainy season from December to May, the Public Corporation should organize a team for flood forecasting and warning. The team should include the following staffs:

(a) Head of Operations Directorate

The Operations Director (the top of the Public Corporation for Jeneberang River as proposed in this Study) would stay at the Monitoring Office and take the following roles as the head of the team for flood forecasting and warning:

- To announce commencement of operation for flood warning, evacuation and fighting;
- To deploy a team for operation for flood warning, evacuation and fighting;
- To issue the flood warning to the external relevant organizations as required;
- To issue the flood evacuation to the external relevant organization as required;
- To request the external relevant organization to participate to the flood fighting works;
- To announce the end of operation when the flood is judged to have subsided based on comprehensive evaluation on the hydrological information given from the telemetry

gauging stations and the metrological information furnished from the Meteorology and Geophysics Agency.

(b) Dam O&M Staff

The Dam O&M Staff should execute the tasks related to telemetry hydrological gauging works as well as dam operation under supervision by the Head of the Sub-division I-1:

(c) Downstream River O&M Staff

The following tasks related to monitoring of the river water level as well as inspection of the conditions of riparian structures should be executed under the supervision by the Head of Service Division II-2:

- To maintain workable conditions of the riparian structures for flood control such as river dike, revetment and groyne through usual inspection and maintenance:
- To patrol the river utilization area when the occurrence of flood is announced by the Head of Service Division II-2;
- To monitor the risk of flood overflow along the downstream of Jeneberang River:

(2) External Organization Setup (out of Public Corporation)

The following external organizations would be related for the tasks of flood forecasting, warning and evacuation:

(a) Meteorology and Geophysics Agency (BMD)

The meteorological information should be provided from Meteorology and Geophysics Agency (BMD) as the basic information for flood forecasting.

(b) Implementation Unit for Disaster Management (SATLAK PB)

Upon receipt of request from the Operations Director of the Public Corporation, the SATLAK PB would mobilize their personnel, heavy equipment and materials as required to execute the necessary prevention works against flood overflow under technical instruction from the Public Corporation and the necessary rescue works in case of occurrence of flood overflow. The SATLAK PB is composed of the following members:

- Mayor of Makassar City and/or the Head of Gowa Regency as the head of SATLAK PB
- The territorial military commander (PALGDAM) and/or the commander of regional military administrative unit (DANREM) as the deputy head of SATLAK PB;
- The head of provincial police (KAPOLDA) and/ot the head of regional police (/KAPOLWIL) as the another deputy head of SATLAK PB;

- The heads of relevant provincial and regional government agencies such as Water Resources Management Services of Public Works and Housing, Planning and Urban Development Service of Public Works; and.
- The relevant regional communities.

(c) Governor of South Sulawesi Province

Upon receipt of request from the Operations Director of the Public Corporation the Governor of South Sulawesi Province would undertake the necessary coordination for the works to be undertaken by the above SATLAK PB and the technical/financial support from the central government as the member of National Coordination Board of Disaster management (BOKORNAS PB).

E8 Proposed Management Plan of River Area in Jeneberang River Basin

E8.1 Extent of River Area to be Managed by River Administrator

E8.1.1 River Stretch Managed by Public Corporation

As described in the foregoing subsection E4.3, the cross-sectional extent of the river area to be managed by the Public Corporation would cover the water body and the river corridor with a certain width along the water body. On the other hand, there does not exist any clear definition on the longitudinal extent of river area to be managed by the Public Corporation.

JRBDP is the present principal river administrator for Jeneberang River, and its authority is likely to prevail over the mainstream of Jeneberang River from the river mouth up to Bili-Bili Dam at least. As for the upstream of Jeneberang River and/or the tributaries of Jeneberang River, however, there does not exist a clear definition on the administrative boundary between JRBDP and other possible administrative entities such as Dinas PSDA and Local governments at Kabupaten level. Moreover, when a certain extent of authority for river management is handed over to the Public Corporation, it is virtually difficult for the Corporation to administrate the whole river systems due to the limited manpower and budgetary capacity.

From these points of view, it is proposed that the Public Corporation would initially administrate the following river stretches of Jeneberang River and their associated river utilization/control areas and river structures (refer to Figures E8.1 and E8.2). These proposed river stretches contain the principal river infrastructures and/or possess the significant hydrological/ hydraulic effects on the flood management and the water quantity management.

Longitudinal Extent of

River	Stretch	Length	Classification*	Remarks
Mainstream (1)	From river mouth to Sungguminasa Bridge	9.60	A	1st order River
Mainstream (2)	From Sungguminasa Bridge to Lengkese Village	75.90	B	1st order River
Long Storage	From river mouth to confluence with the mainstream	4.50	A	2nd order River (old channel of Jeneberang River
Jenelata River	Between the confluences with the mainstream and Sapaya Village	38.45	B	2nd order River (the largest tributary)
Binanga Tokka	From the confluence with the mainstream to Sapakeke Village	24.26	B	3rd order Ricer (tributary of Jenelata River)
Salo Malino	From the confluence with mainstream to Sabo Dam No.6	18.67	B	2nd order River
Kausis	From the confluence with mainstream to Sabo Dam No.8	18.91	B	2nd order River
Total		190.29		

*: Classification of River A = The land of the river corridor has been acquired by the river administrator.
Classification of River B = The land of the river corridor has not been acquired by the river administrator

E8.1.2 Extent of Authority of Public Corporation for Watershed Management

The river administrator would possess the direct authority to manage the aforesaid river area, while it hardly prevails the watershed management over the entire river basin. Instead, the principal function of the watershed management should be delegated to the organizations relevant to forest management and soil conservation as represented by the Watershed Management Center (Balai Pengelolaan Daerah Aliran Sungai), and the function of the river administrator is oriented to just collaboration with those organizations.

E8.2 Development of Inventory of River Area

In order to facilitate the management of the river area, it is proposed that the Public Corporation should develop the inventory of the river stretches and river corridors in its responsible river area. The inventory should be made by the following unit of river stretches/corridors:

(a) An approximately uniform morphology for a river and river corridor of about 500m in longitudinal length;
(b) A shorter length of river and river corridor displaying a particular problems, if exist, such as severe bank erosion; and
(c) A shorter length of river containing a particular structure of interest such as a bridge.

It is further proposed that the following information should be recorded into the inventory list with using a fixed format.

(1) Classification of River Corridor:

The following classification should be made:

- A unique identity number (ID) should be assigned to each of entities (i.e., each reach of river corridor, section of levee and structure).
- Date of inspection
- Name of river basin
- Code number and name of river
- Type of river corridor (to be classified into four types, namely without-levee on both left and right bank, with-levee on both left and right banks, with-levee only on left bank and, with-levee along right levee);
- Name of adjacent village, if any (useful to identify the location);
- List of all structures, which are under jurisdiction of river administrator, contained in the river corridor
- Definition of the upstream and downstream of river corridor (recorded as GPS coordinates, channel length from a standard point (such as river mouth),

(2) Land Use States of River Corridor

The following land use sates in the river corridor should be inventoried and updated.

- Photographic record number,
- Land ownership,
- Land use of floodplains and 5m wide strips of land outside the levee together with evaluation whether or not the land use results in a significant obstruction of flood flows
- Type and densities of vegetation together with evaluation whether or not the vegetation results in a significant obstruction of flood flows;
- Sand mining activity, if any, together with evaluation on whether or not the activity could cause danger to the levee;

E8.3 Plan of Land Use Control in River Area

The land use and construction of structures in the river area should not hamper the river channel flow nor cause any degradation of river environment. In order to maintain the appropriate land use in the river area, the following items should be checked and controlled through the river patrol:

- Official permission is granted to the land use.
- Purpose and location of land use is within the allowable limits of the official permission.
- Land reformation including land excavation and banking follows the permitted specification.
- Illegal construction and/or renovation work is being made in the river corridor.
- River facilities such as the sluice gate, bridge and water intake facilities have the officially permitted structural features and they are located at the permitted site.
- River facilities are used for the sake of the official permitted purposes.
- Construction is in progress in accordance with the officially permitted schedule.
- River Park and other structures in the river control, which is judged to hamper the flood flow, have been removed.

As described subsection E4.3, the river area could be classified into the following three categories: (a) the river utilization area, where the land of the river corridor had been acquired by the river administrator, (b) the circumference of Bili-Bili dam reservoir, where the land of ground levels of less than SWL (EL.101.6m) had been acquired by the river administrator; and (c) the river control area, where the land belongs to the private. These three kinds of river areas would differ in criteria of land use control as described below:

(1) Land Use Control in River Utilization Area

JRBDP as the river administrator had constructed river dike of 9.6km in length along the left and right bank of the downstream of Jeneberang River from the river mouth up to Sungguminasa Bridge. The hinterland of the river dike is the densely populated area of Makassar City and its outskirts, and therefore, the river dike takes a role as the important flood control facility.

In order to keep the design river flow capacity, the JRBDP had also acquired the whole land of river corridor along the river dike as the flood high water channel. The average width of flood high water channel (the river corridor) is about 200m in total of the right and left bank.

Land use in the above high water channel should be subject to approval by the river administrator, and any illegal land use therein should be strictly prohibited. The existing illegal dwellers in the flood in particular would be the great hindrance against the safety flow of flood discharge, and at the same time, they are exposed to the high risk of flood damage. Accordingly, the major effort for land use control should be oriented to evacuation of these illegal dwellers.

The allowable land use in the flood high water channel should be limited to those for the public interests such as the river-park and public ground. Moreover, the structures in the flood high water channel should be limited to those not to hamper the flood flow and/or riparian structures such as water level gauging stations and drainage sluice, which need to be unavoidably constructed with in the river corridor.

(2) Land Use Control in River Authority Area

The river corridor of 100m in width along both of the right and left river bank of the upstream channel from the above river utilization area could be specified as the river authorized area. The land of this river corridor belongs to the private land, and therefore, the authority of land control by the river administrator would hardly prevail over the river corridor. Nevertheless, the river administrator should monitor the progress of land exploitation in the river corridor, and control the excessive exploitation, whenever it is judged to cause the significant effect on the river morphology, river flow conditions, and/or river environment.

(3) Circumference of Bili-Bili dam Reservoir

Any removal of grass/trees and/or logging activities in the administration area around the dam reservoir (its extent is as designated in Sub-section E4.3) should be subject to approval of the river administrator so as to preserve the existing green belt around the dam reservoir. Moreover all construction works in the subject area should be subject to approval by the river administrator on the premises that construction of structures except those for the public interests such road and riparian structures should be prohibited in the area.

E8.4 Plan for Control of Sand-mining

As described in the subsection E2.2, the current excessive sand mining activities cause the serious degradation of the downstream riverbed of Jeneberang River below Bili-Bili dam. In order to minimize such serious degradation of riverbed, any sand mining activities below Bili-Bili Dam should be preferably prohibited, and the sand minor should be guided to transfer their mining sites to the upstream of Bili-Bili Dam. The potential sand mining sites upstream of the Bili-Bili dam would be placed at the upstream of the reservoir area and the sabo pocket dams No.1 to 4 as shown in Figure E8.3. Many difficulties in putting an end to the downstream mining are, however, foreseeable taking accessibility to the upstream mining site and dispute on conventional territories of each of sand minors into account. From these viewpoints, it is proposed that the river administrator should stop any renewal of mining license for the downstream channel below Bili-Bili dam and at the same time to undertake the following activities:

(1) To carry out the river channel survey at the every end of rainy season and clarify the tendencies of degradation of riverbed at each of the major river structures based on the results of the river channel survey;
(2) To estimate the sediment deposit on the riverbeds at each of the major river structures after stop of renewal of mining license;
(3) To estimate the allowable sand mining volume and the available mining sites on the downstream of Jeneberang River based on the results of clarification on the above.
(4) To carry out the river patrol to confirm the following items:
    - Official license is issued to the mining activities.
    - Mining is not too deeply and/or too disorderly made.
    - Mining location and volume is being made within the allowable limits of the official permission.
    - Mining equipment follows the permitted specification.
    - Ex-mining site has been properly cleared and leveled.
    - Mined sand is placed at the specified temporary stockyard and in the specified shape.
    - No serious turbidity due to cleaning of the mined sand occurs and the sand accumulated in the drainage channel is properly removed.
    - Mined sand is transported through the officially permitted route and in accordance with the specified manners.
    - Road for transportation of the mined sand is properly maintained.

E8.5 Plan for Control of Illegal Water Abstraction and Illegal Effluent/Garbage Dumping

The water abstraction should be made within a limit of water use right and/or customary water use right granted by the river administrator. The illegal effluent and dumping of garbage into the river should be also controlled through the river patrol so as to preserve the appropriate river environment. The major items to be checked by the river patrol are as enumerated below:

(1) Control of Illegal Water Abstraction

    - Official permission is granted to the water abstraction.
    - Purpose and period of water abstraction is within the allowable limits of the official permission.
    - Volume of and facilities used for water abstraction is with the extent of the official permission.

(2) Control of Illegal Effluent and Garbage Dumping

- River water shows a particular color of turbidity, the bubbles, the oil flow and/or the death of fish on the surface of water.
- Effluent into the river causes a particular color of turbidity, the bubbles, the oil flow and/or the death of fish on the surface of water.
- Garbage is dumped into the river.

E8.6 Prevention Plan against Sediment Runoff from Collapse of Mt. Bawakaraeng

On 26 March 2004, a gigantic-scale of collapse of quay occurred in the caldera of Mt. Bawakaraeng (EL. 2,870 m), which is located upstream end of the Jeneberang River basin and/or about 40 km upstream from the Bili-Bili dam reservoir. The collapse brought about a tremendous volume of sediment runoff to the downstream of the Jeneberang River and caused disastrous damages as enumerated below:

(1) Ten persons have been found dead and twenty-two are still missing;
(2) Agricultural land of 1,500 ha was buried, and 635 cows were dead; and
(3) 6,333 persons have evacuated.

In accordance with the request by MSRI (the present Ministry of Public Works), JICA dispatched a survey team called “JICA Sabo Urgent Investigation Team” (hereinafter referred to as “JSUIT”) to clarify the mechanism of collapse and the necessary countermeasure against the possible disasters by the collapse.

According to the field investigation by the aforesaid JSUIT, there exist two collapses, and the volume of these collapses is estimated at about 235 million m^3 in total. Out of this volume of collapses, about 14 million m^3 has already been eroded and transported as the sediment runoff to the downstream of Jeneberang River during a period of 3-month from the time of collapse in March until the end of last rainy season in May 2004. JSUIT further suggest that judging from the conditions experienced in the previous similar collapse, the sediment runoff would reach peak in the next year and its runoff volume would be about two times of what have flow out so far. Then, sediment volume would exponentially reduce and subside in five years after collapse. In due consideration of these conditions into account, JSUIT estimated the sediment runoff and deposit volumes caused by the collapse of Mt. Bawakaraeng as listed below:

Sediment Runoff and Deposit Volumes Caused by Collapse of Mt. Bawakaraeng

Year of rainy Season (Nov. to May)	Annual Runoff Mil. m^3/year	1st Annual Deposit on River Bed Mil. m^3/year	2nd Movement of Sediment from River Bed Mil. m^3/year	Annual Inflow to Dam Reservoir Mil. m^3/year	Annual Deposit in Dam Reservoir Mil. m^3/year
Up to Present	14.00 [*1]	8.70 [*4]	0.00 [*6]	5.30 [*7]	2.65 [*8]
2004/2005	28.00 [*2]	17.00 [*5]	5.00 [*6]	16.00 [*7]	8.00 [*8]
2005/2006	17.00 [*3]	11.00 [*5]	5.00 [*6]	11.00 [*7]	5.50 [*8]
2006/2007	10.00 [*3]	6.00 [*5]	5.00 [*6]	9.00 [*7]	4.50 [*8]
2007/2008	6.00 [*3]	4.00 [*5]	5.00 [*6]	7.00 [*7]	3.50 [*8]
2008/2009	3.00 [*3]	2.00 [*5]	5.00 [*6]	6.00 [*7]	3.00 [*8]
	78.00	48.70	25.00	54.30	27.15

Note: *1 Estimated through the field reconnaissance

*2: Assumed as the volume of up to present of 8.7 million m^3 (for 3 months since collapse) x 2 times (for an entire rainy season of 6 months)

*3. Assumed to exponentially decreases from the annual volume of 28 m^3 in 2005/2006

*4: Estimated through the field reconnaissance (Sediment deposit length of 29km x Average sediment depth of 1m)

*5: {Sediment Deposit up to Present (8.7 mil.m^3)}/{Sediment Runoff up to Present(14mil.m^3)} = 0.62. The annual sediment deposit from 2004/2005 onward is assumed to be the annual sediment runoff x 0.62

*6: Estimated by "Brown-Formula"

*7: Estimated as the Volume (="Annual Runoff " - "Annual Deposit on River Bed" + "2nd Movement of Sediment from River Bed")

*8: Assumed as 50% of the accumulated annual inflow volume to Bili-Bili dam reservoir

Source: "Recommendation on Urgent Measures Plan against the Gigantic Collapse of Mt. Bawakaraeng in Indonesia, June 20th - 29th, 2004"by JICA Sabo Urgent Investigation Team.

As estimated above, the collapse of Mt. Bawakaraeng would produce the sediment runoff volume of about 78 million m^3 in total for five years from the occurrence of collapse until the subsidence of runoff. Out of this total sediment runoff volume, 54.30 million m^3 is expected to flow into Bili-Bili Dam reservoir and half of it (i.e., 27.15 million m^3) would accumulate in the reservoir.

Bili-Bili dam reservoir has a dead storage capacity of 29 million m^3. This dead storage capacity was design to accommodate the sediment deposit for a period of 50 years, but the above sediment deposit by the collapse of Mt. Bawakaraeng would fulfill about 90 % of the dead storage capacity within five years.

Another critical issue is also addressed to the several natural ponds in the caldera of Mt. Bawakaraeng. Should these ponds break out, a tremendous volume of water impounded in ponds would flow down with debris causing the intensive damage to the residents and houses in the lower reaches of the pond.

In order to reduce the sediment accumulation in the dam reservoir and at the same time to prevent the water impounded in the natural ponds from flowing down, the following countermeasures are preliminarily recommended by the JSUIT:

(1) To increase sand trap capacity of sand pocket dams and sabo dams by the following measures: (a) excavation of the sediment deposits at the existing sand pocket dams/sabo dams, (b) rising of height of the existing sand pocket dams and sabo dams, (c)

construction of the new sabo dams[2] and (d) rehabilitation of the existing damaged sand pocket dams and sabo dams;

(2) To construct a waterway (such as drainage channel and siphon) to drain the water impounded in the ponds;

(3) To establish the monitoring system including assigning of the watchman and setting of the telemetry hydrological gauging stations at the critical points;

(4) To establish mudflow warning system including (a) organizing of the community network[3], (b) setup of the warning siren and (c) use of the radio broadcast system for early warning; and

(5) To disseminate the hazard map.

[2] Eleven sabo dams are proposed. One is about 1.2 km downstream from Daraha Bridge and other ten dams about 1.5 km upstream from the Bridge.

[3] The community named "Komunitas Sabo Jeneberang" has already been established for the sake of early dissemination and evacuation against the mad-flow.

E9 Operation and Maintenance Plan of River Infrastructures

E9.1 Objective River Infrastructures for O&M by Public Corporation

E9.1.1 Entire Infrastructures Managed by Public Corporation

The existing water resources facilities administrative by JRBDP are broadly classified into the flowing six groups in terms of their different functions and locations:

(1) Structures attached to Bili-Bili dam such as the dam body, the dam reservoir, gates, and hydrological gauging stations;
(2) Structures attached to the Rubber dam and Long Storage such as rubber dam body, control facilities of rubber dam; the channel of Long Storage and intake/outlet gates of Long storage;
(3) Riparian structures such as embankment, revetment, groyne, and groundsill, and sluices which were constructed along the downstream of Jeneberang river from the river mouth up to the Sungguminasa Bridge;
(4) Three irrigation intake weirs namely, Bili-Bili, Bissua and Kampili weirs located between the above river improvement section and Bili-Bili dam reservoir;
(5) Four sand pocket dams and three sabo dams located upper reaches of Bili-Bili dam reservoir excluding the Sabo dam No.4, which was abandoned due to damage by the storm in January 2002; and
(6) Urban drainage facilities under Jongaya, Sinrijala, Panampu, and Pampang system including drainage channels, sluices, control gate, and drainage pumps.

Among the above structures, the items (1) to (5) are indispensable for the consistent management of Jeneberang River functioning as important water source/water distribution facilities as well as flood mitigation facilities for a wide range of beneficiaries. On the other hand, the urban drainage facilities under item (6) contribute to the beneficiary of Makassar City and their function is less related to the consistent river management. Due to these particular functions of facilities, Public Corporation should undertake O&M for the facilities of the items (1) to (5), while O&M for the urban drainage facilities should be handed over directly to Makassar City from JRBDP. The limits of O&M by Public Corporation should be until the Flush Gate placed at the outlet of Long Storage, and O&M of all drainage facilities located downstream of the Flush Gate should be under authority and responsibility of Makassar City.

E9.1.2 Expansion Program of O&M by Public Corporation

Due to the limited potential human resources and budgetary constraint, it deemed to be difficult for new Public Corporation to initially undertake O&M for the all of river infrastructures as proposed in the above subsection, and the following expansion program of O&M is proposed:

(1) O&M during First Two-year Operation Period

It is proposed that O&M by Public Corporation should focus on the following facilities during its first two-year operation period in 2007 and 2008;

- Bili-Bili Dam and its associated Raw Water Transmission Main (RWTM);
- Rubber Dam and Long Storage; and
- Three irrigation weirs of Bili-Bili, Bissua, and Kampili.

All of these river infrastructures are indispensable to promise the sustainable water supply for the specific water users such as PLN, PDAM and the farmers, and the higher priority of O&M should be given to them. Moreover, Public Water Corporation could collect its water service fee from the water users other than farmers, which would take a substantial part of the revenue for Public Corporation. It is herein noted that difficulties are foreseeable in colleting the water service from the farmers according to the new water law4. Nevertheless, out of the whole water abstraction volume from Jeneberang River, that for the irrigation requirement takes about 80%. Accordingly operation of irrigation weirs is influential in managing the entire water distribution of Jeneberang River and indispensable for the consistent river management of Jeneberang River.

(2) O&M after First-Two-year Operation Period

Public Corporation should add the following facilities as the additional objectives of their O&M works after the aforesaid first two-year operation period (i.e., from 2009 onward):

- Four sand pocket dams and three sabo dams (other than Sabo Dam No.4) located upper reaches of Bili-Bili dam reservoir, and
- Riparian structures such as embankment, revetment, groyne, and groundsill, and sluices along the downstream of Jeneberang River from the river mouth up to the Sungguminasa Bridge.

Both of the sand pocket dams and the sabo dams could reduce the sediment inflow into Bili-Bili dam reservoir contributing longer durable life of the reservoir and preservation of the suitable river channel morphology. The riparian structures also take an important role for flood mitigation in the low-laying area along the downstream of the Jeneberang River. Thus, all of these facilities are important for river management, but rather independent from the daily water distribution, and Public Corporation could hardly get the revenue through O&M of these facilities. Accordingly, O&M of the facilities should be preferably undertaken by JRBDP during the initial operation stage of Public Corporation and turned over from JRBDP to Public Corporation, after Public Corporation could secure the rather stable revenue from other service sources.

[4] The new water law in 2004 prescribes that the necessary O&M cost only for the tertiary irrigation channel would be charge to the farmer but the farmer is not the subject of collection of any irrigation service fee.

E9.1.3 Development of Inventory and Location Map of Water Resources Facilities

There exist neither the detailed inventory nor the detailed location maps for all of the existing river infrastructures. In order to achieve the effective inspection and maintenance, inventory of all major river infrastructures in Jeneberang river basin should be developed and updated containing the following information:

(1) A unique identity number (ID) should be assigned to each of entities (i.e., each reach of river corridor, section of levee and structure),
(2) Name and number of each entity,
(3) Location of the entity and name of river, where the entity is located; and
(4) Structural size, type and quantities of the river infrastructures.

The inventory of river infrastructures as 2004 as well as the location maps of the river infrastructures for the river section from the river mouth to Sungguminasa were preliminarily developed in this Study as shown in Table E9.1 and Figure E9.1.

All river infrastructures in the river area including those as selected the objectives of O&M by Public Corporation should be inventoried. The detailed assessment should be, however, made for the following structures, which have a direct river function:

(1) Structures to convey and/or conserve the river water, as represented by Bili-Bili Multipurpose Dam, Rubber Dam, Long Storage, and three intake weirs for irrigation, namely Kampili, Bissua and Bili-Bili,
(2) Structures to mitigate and/or control flood discharge such as levee, and drainage sluice gate, and
(3) Structures to protect integrity of river channel as well as other river structures such as revetment, groundsill, groyne, and sand pocket and sabo dams.

The structures not to be provided with the detailed assessment in the inventory list are the bridges, the intakes for municipal water supply, the urban drainage facilities, the facilities for hydropower generation and others, which are supposed not to be under jurisdiction of the river administrator.

E9.2 O&M Plan for River Infrastructure

E9.2.1 Classification of Maintenance of River Infrastructures

The Maintenance aims at detecting and rehabilitating deterioration in function of facilities including fatigue/decrepitude of facilities and mechanical troubles. The works are broadly classified into the following three categories:

(1) Preventive Maintenance: This aims at keeping the originally designed function of the river infrastructure through the following three kinds of activities.

- Routine Maintenance, which includes all repetitive activities to be performed throughout a year such as lubrication of mechanical facilities, removal of weed/garbage, and removal of sediment deposit,
- Periodical Maintenance, which includes all activities such as overhaul of mechanical facilities and re-painting of substantial part of metal parts to be performed at intermittent intervals in accordance with a schedule programmed beforehand, and
- Small Repair Work, which includes works of small-scale necessary for restoration of a facility such as repair of small cracks, holes or detachment on structures and replacement of damaged facilities.

(2) Corrective Maintenance: This aims at more substantial repair/replacement works than the Preventive Maintenance to restore a facility, which has considerably reduced its function originally designed due to over-period of durability service and/or destructive damages. The ongoing rehabilitation works for the under-mentioned damaged Rubber Dam, Groundsill No.2 and Sand Pocket dam No.4 are as enumerated as the typical cases of the Corrective Maintenance. It is herein preliminarily proposed that the repair works with more than about Rp. 500 million should be classified as the Corrective Maintenance, while those of less than Rp. 500 million are as the small repair.

(3) Emergency Maintenance: This is executed against the imminent failures of infrastructures by extensive scales of disasters such as flood, landslide and earthquake.

E9.2.2 Maintenance Plan

Among others, the Preventive Maintenance could be performed based on the definite and consistent maintenance plan. On the other hand, both of the Corrective and Emergency Maintenance is ad-hoc work in nature, and it is virtually difficult to formulate the consistent annual plan for them in advance. Moreover, when the Preventive Maintenance is adequately achieved, the Corrective Maintenance could be minimized at least. From these points of views, the maintenance plan should be formulated for Preventive Maintenance, and in due consideration of the present states of river infrastructures, the following maintenance are proposed as the standard maintenance works (refer to detailed maintenance works as described in Volume4.A-“Guidelines and Manuals - River Infrastructure and Manual”):

Proposed Work Items for Preventive Maintenance

Work item	Objective Facility	Time interval of Work	Standard Annual Work Volume
Removal of garbage in river corridor	- River corridor in management area of Public Corporation	As required	The whole extent of river corridor
Removal of garbage twining around riparian structures	- Riparian structures such as groyne, groundsill, drainage sluice gate along river channel - Trash boom in Bili-Bili dam reservoir - Regular and control gates of Bili-Bili Dam - Intake and outlet gates of Long Storage - Intake and sluice gates of irrigation weirs	As required	As required
Removal of sediment deposit	- Sediment sand trap of irrigation weir - Sand pocket dams and sabo dams	As required	10% of sediment trapping capacity
Removal of water hyacinth	- Water surface of Long Storage	Once a year	About 5% of the water surface
Removal of grass in river corridor	- River corridor in management area of Public Corporation - Green belt around dam reservoir	Once a year 4times a year	Entire area of river corridor
Small repair for earth dike	- Earth dike	As required	About 0.5% of the entire surface
Small repair for structures other than earth dike	- Revetment of all river structures - Foundation works of all riparian structures	As required	About 0.1% of the entire surface
Land slide protection work	- River management area of Public Corporation around Bili-Bili dam reservoir	As required	As required
Lubrication of mechanical facilities	- All mechanical facilities	As required	As required
Small-scale re-painting for detachment of metal parts	- All mechanical facilities	As required	As required
Test and repair of pipe leakage	- Raw Water Transmission Main	Once a year	1% of the whole pipes
Supply of spare parts to the electric facilities	- Telemetry gauging equipment attached to Bili-Bili dam control office - Monitoring and control system at Bili-Bili dam control office - Control devices for Rubber dam	Once a year	As required
Supply of consumables to the electric facilities	- All mechanical facilities	As required	As required
Overhaul of mechanical facilities	- All gate facilities - Valves of RWTM - Control device for Rubber Dam	Once for 2 years	Whole mechanical parts
Greasing of whole movable part of mechanical facilities	- All movable parts of mechanical facilities	Once for 3 years	Whole mechanical part
Cross-sectional river channel survey	- River channel along mainstream of about 70.6km in length from river mouth to Daraha Bridge.	Once year	With an interval of 500 to 1000m
Echo-sounding survey for Bili-Bili dam reservoir	- Bili-Bili dam reservoir	Once a year	Whole reservoir area

The above maintenance works except the relevant inspection works would be hardly executed on the force account of Public Corporation especially during its initial operation stage, because of difficulties in effective use of heavy equipment and machines for the objective maintenance works. It is commercially better to spend the budget for maintenance directly to actual implementation by contracts through the following measures[5]:

(1) Direct appointment of small Class C2 contractors with contract values up to Rp. 50 million using highly standardized contracts, and

(2) Award of large proportion of the work to large contractors of more than one year based on “period contract”, where the unit prices are tendered for and fixed, and there is flexibility in directing actual work items packages and quantities during the course of the contract.

(3) The small repair work would be executed based on the sketch drawing of the area, and the standard typical drawing together with brief work instruction and technical specification

5 Recommended in “Guideline Manual for River Infrastructure Maintenance (RIM) by SMEC in 1997.

but without detailed design. It is desirable, whenever possible, to implement the works by labor-intensive means using local labor.

E9.2.3 Operation Plan

The operation procedures for all objective river infrastructures are described in the existing O&M manuals and currently applied by JRBDP. The list of the available O&M manuals is as shown in Table E9.2. All of these O&M manuals other than those for irrigation intake facilities had been prepared in 1994 to 2001, but any updating on the contents of the manuals have never been made. As the results, some of instructions for operation in the manuals are not compatible to the present water demand, the present land uses and other present relevant conditions. Moreover, the manuals contain no definitive technical instructions against emergency cases such as occurrences of extra-ordinary drought and flood over design capacity. Due to backgrounds behind, the necessary revisions and updating on the contents of the existing manuals was made in this Study based on the under-mentioned O&M plan of the relevant river infrastructures, and its results are compiled Volume IV, A - "Guidelines and Manuals - River Infrastructure and Manual". The principal revisions and/or renewals on the existing operation rules and procedures in the Manual are as enumerated below

(1) Bili-Bili Dam

The operation rules of the regular gates/control gate for Bili-Bili dam and the guide vane for Bili-Bili HEPP were newly revised. The detailed guidance was also made on the configuration and the operation method of the remote monitoring and control system. These renewal of operation rules and the detailed guidance are required due to the following backgrounds:

- After Bili-Bili Electric-hydro Power Operation (Bili-Bili HEPP) starts its operation in November 2005, the integrated gate operation for the above three gates is required.
- The Rule Curve (RC) for Bili-Bili was revised in accordance with the updated water demand allocated to Bili-Bili Dam in this Study. The drought management rules were also newly developed based on the revised RC. In accordance with the revision of RC and the new drought management rules, the operation rules of the control gate for Bili-Bili dam as well as the guide vane for Bili-Bili HEPP were revised.

(2) Rubber Dam and Long Storage

The following contents are compiled in the Manual:

- Detailed guidance on the synchronized operation rules and procedures for Rubber Dam and the Inlet/Outlet gates of Long Storage;
- Temporary operation rules of the Inlet Gate of Long Storage to control the salinity intrusion during the non-operational period of Rubber Dam (the current non-operational conditions of rubber dam is expected to continue until the mid-term of the dry season in 2005); and

- Operation rules of the Flush to dilute the stagnant water in the drainage channels of Jongaya, Sinrijala and Panampu.

(3) Raw Water Transmission Main

The operation rules for butterfly valves, sluice valves and air valves for replacement of pips are not described in the present manual and therefore supplemented in the Manual of this Study.

(4) Bili-Bili, Bissua and Kampili Irrigation Weirs

Operation rules for the following gate structures were abstracted from the existing manual ("Bili-Bili Irrigation Project, Operation & Maintenance Manual by CTI Engineering Co. LTD. in 2001", and the supplementary explanation on them were given:

- Intake Gate; for three weirs
- Scoring Sluice Gate for three weirs;
- Sand Flush Gate for Bissua and Kampili weirs, and
- Diversion Gate for Bissua weir.

(5) Drainage Sluice Gates along the Lower Jeneberang River

The operation rules for the existing eleven sluice gates were newly established on the premises that the local residents would undertake the operation as the gatekeepers entrusted by Public Corporation, and their operation works would be under supervision and control of Bili-Bili Dam Control Office.

E9.3 Required Rehabilitation Works for Existing River Infrastructures

JRBDP currently undertakes rehabilitation of the damaged river infrastructures including Rubber Dam, Groundsill and Sand Pocket Dam no.4. In addition these structure, however, there still exist other damaged facilities, which are left behind without any rehabilitation and/or replacement as described in the foregoing subsection E4.4.3. The damages of the facilities contain a potential to cause significant adverse effects to the river management, and therefore, JRBDP would be required as the present administrator of the structures to repair and/or replace them before hand-over of O&M works of the structures to Public Corporation. The major required rehabilitation works together with their rehabilitation costs are summarized as below (refer to Tables E9.3 and E9.4):

Required Rehabilitation Works for Existing River Infrastructures

Objective Facilities	Required Rehabilitation Works	Required Cost (Rp. million)
Telemetry gauging system for monitoring and operation for Bili-Bili Dam	- To replace whole telemetry gauging equipment at Bayang, which were stolen in Nov. 2005	503.8
	- To revise the present software system for control of entire telemetry gauging system	200.0
Flow meter placed at inlet of RWTM	- The flow meter should be replaces	7.5
Eleven drainage gate along the downstream of Jeneberang River	- To replace the gate hoists for all of the gates; - To repair the gate leaf/flame for two gates namely, Bayang (K.1.220-R) and K9.60 (K9.663-R); and - To replace the seal rubber at Bayang Gate (K1.22-R).	1,250.0
Total		1,961.3

E10 Cost Estimation for O&M of River Infrastructure and River Management

E10.1 Cost Borne by Public Corporation

The present conditions of river infrastructures were clarified in detail through:

(1) Field reconnaissance,
(2) Interview survey from JRBDP,
(3) Review on the actual budget allocated to O&M by JRBDP, and
(4) Review on the relevant documents such as O&M manuals/completion drawings.

Based on these clarifications, the necessary full-scale O&M cost of the river infrastructures and the relevant river basin management is estimated at Rp.4,054 million. This corresponds to more than three times of the actual budget disbursed by JRBDP (JRBDP had disbursed O&M cost of Rp. 1,329 million in 2003 and Rp. 954 million in 2004 as described in the subsection E4.4.2). The break down of the estimated cost is as listed below:

Summary of Cost for O&M of River Infrastructures and Cost for River Management

(Unit: Rp. million)

Item	Facility/management Field	2007-2008*	From 2009 onward
O&M of River Infrastructures	Bili-Bili Dam/RWTM	933	996
	Irrigation Intake Weir	566	593
	Rubber Dam/Long Storage	353	437
	Riparian Structure	0	428
	Sand Pocket Dam and Sabo Dam	0	463
	Sub-total	1,852	2,917
River Management	Water Quantity management	188	259
	Flood Management	229	278
	Drought Management	227	267
	River Conservation Management	209	334
	Sub-total	854	1,137
Total		2,706	4,054

*: In accordance with the proposed expansion Program of O&M as described in subsection E9.1.2, Public Corporation would not undertake O&M for the sand pocket dam/sabo dam and riparian structures during the first operation period in 2008 and 2008.

The above cost is divided into (1) routine and periodical maintenance of river infrastructures, (2) overhaul of mechanical facilities, (3) operation cost of river infrastructures, (4) overhead for O&M of river infrastructures and (5) cost for the relevant river management activities as listed in Table E10.1. Estimation basis of these cost component are as below:

(1) Routine and Periodical Maintenance Cost of River Infrastructure: The actual field maintenance works were assumed to be executed on the contract basis, and the unit cost for each work item is estimated based on the current prevailing contract price as listed in Table E10.2. The annual work volume for each work quantity was further estimated based field reconnaissance, and the necessary maintenance cost was finally derived as listed in Table E10.3.

(2) Overhaul of Mechanical Facilities: The annual cost for overhaul of mechanical facilities were estimated based on the necessary time interval of overhaul, work quantity, and unit cost as listed in Table E10.4. All of the necessary information was derived from the contract price of the facilities, the supplier's instruction manual and the standards on the overhaul of mechanical facilities prepared by Ministry of Land and Transportation in Japan.

(3) Operation Cost of River Infrastructures: The operation cost includes the cost for power supply, spare parts, materials (such as grease and oil), consumables and personnel expenditures for gatekeepers as listed in Tables E10.5 to E10.7. The operation of infrastructures is assumed to be by the internal staffs of Public Water Corporation in principal and, its necessary personnel expenditure as well as other overhead was separately estimated under the following item (4). The exceptional case of this principal is, however, given to the gatekeepers for eleven drainage sluice gate along the downstream of Jeneberang River and three inlet/outlet gates for Long Storage. It is assumed that these gatekeepers should be entrusted to the local residents, and their necessary costs were included as a part of the operation cost.

(3) Overhead of O&M: The annual salary for the permanent staff of Public Work Corporation to be involved to O&M was firstly estimated as shown in Table E10.8. Then, the whole overhead of O&M was estimated with adding the incidental cost such as material cost, equipment cost, and duty trip cost as shown in Table E10.9.

(4) Cost for the Relevant River Management Works: The objective river management herein includes water quantity management, flood management, drought management and river conservation management. The annual salary for the permanent staff to be involved to these river management works was firstly estimated as shown in Table E10.8. Then, the whole necessary cost for the river management works were estimated with adding the incidental cost such as material cost, equipment cost, and duty trip cost as shown in Table E10.10.

E10.2 Cost for Corrective and Emergency Maintenance

The maintenance cost as estimated above is limited to the preventive maintenance cost. In addition to the preventive maintenance, however, the maintenance may cover the corrective and emergency maintenance as described in the foregoing subsection E10.2.1.

The ongoing repair of the damaged Rubber Dam, Groundsill No.2 and Sand Pocket dam No.4 are as enumerated as the typical cases of the Corrective Maintenance (refer to subsections E4.4.2 and E10.2.1). Moreover, there still exist other damaged facilities, which are regarded as the objectives of corrective maintenance but left behind without any rehabilitation and/or replacement (refer to subsections E4.4.2 and E8.3). The whole necessary cost for these corrective maintenance works are added up to Rp. 13,411 million as summarized below:

Corrective Maintenance Cost for River Infrastructures in Jeneberang River Basin

Objective Facilities of Corrective Maintenance	Year of Completion	Occurrence of Damage	Present States of Corrective Works	Required Corrective Cost (Rp. million)
Sand Pocket Dam No.4	2000	2002	On-going	908
Rubber Dam	1996	2004	On-going	5,343
Groundsill No.2	1992	2003	On-going	5,407
Eleven Drainage Sluice Gates	1992	Unknown	Suspended	1,250
Telemetry gauging system	1997	2002	Suspended	503
Total				13,411

As described in subsection E8.6, the gigantic caldera-wall collapse at Mt. Bawakaraeng has occurred on 26 March 2004, and Bili-Bili dam reservoir is now in danger to substantially reduce its reservoir capacity by the huge volume of the sediment discharge (refer to subsection E8.4). In order to cope with this problem, JRBDP is going to implement the urgent sediment control project with the financial assistance from JBIC. The sediment control project could be regarded as a sort of the emergency maintenance. The cost for the urgent sediment control project is estimated at Rp. 87,000 million.

As described above, both for the corrective maintenance and emergency maintenance require huge implementation cost within a rather short period, and the budgetary arrangement for them is deemed to be far beyond capacity of Public Corporation. Thus, the corrective and emergency maintenance would not be hardly within the scope of Public Corporation but need to be implemented as a part of the national projects.

Moreover, both of the corrective and emergency maintenance is oriented to replacement of the assets (river infrastructure), which have the over-period of durability service and/or the destructive damages by the extensive scales of natural disasters such as flood, land slide and earthquake. Such replacement of the assets is deemed to be under responsibility of JRBDP as the possessor of the assets but not by Public Corporation as the executer of O&M of the assets. From these viewpoints, the cost for both of corrective and emergency maintenance was excluded from the budgetary burden on the Public Corporation.

Tables

Table E1.1 Area of Kecamatan in Each of Sub-River Basin

(unit: km^2)

Regency / Kechamatan / Name of River	Gowa							Takalar	Makkasar			Total
	Bajeng	Bontomarannu	Bungaya	Palangga	Parangloe	Somba Opu	Tinggimoncong	Polombangkeng Utara	Mamajang	Mariso	Tamalate	
Jeneberang	0.19	22.60		26.53	60.85	9.01	47.44	6.48	1.18	0.36	16.14	190.78
Garassi	9.88			27.64							4.79	42.31
Salo Tebebatu				6.22								6.22
Bantimurung		14.58										14.58
Jenelata			199.69		29.94		0.04	3.01				232.68
Jene Bontomalangngrere					8.78							8.78
Binanga Jajang					22.43							22.43
Jene Rakikang					19.29		21.96					41.25
Binanga Bengo			0.24		13.98							14.22
Salo Bengo			0.62		11.77		10.16					22.55
Salo Malino					0.55		85.34					85.89
Angasia			0.15				5.19					5.34
Salo Keoenisik			0.84				36.65					37.49
Takapala							37.46					37.46
Total	10.07 (1.3%)	37.18 (4.9%)	201.54 (26.4%)	60.39 (7.9%)	167.59 (22.0%)	9.01 (1.2%)	244.24 (32.1%)	9.49 (1.2%)	1.18 (0.2%)	0.36 (0.0%)	20.93 (2.7%)	761.98 100.0%

Table E2.1 Inventory of Factories Related to Jeneberang River

No	Location	Name of Factory	Kind & Production	Source of Water Supply	Abstraction Vol.
F1	Tanjung Bunga	Pt.GMDT	Property		
F2	Jl.Pelita Raya, Desa Bontoala, Kec.Pallangga	UD.Cahaya Indra Mulia	Ice Factory	Jeneberang River	
F3	Jl.Pallangga Raya 8, Gowa	UD.Tulungagung	Roof tile factory	Deep Well	5 m^3/day
F4	Jl.Raya Palangga, Gowa	UD.Adinata	Taste & Saus Factory	Deep Well	2 m^3/day
F5	Jl. Raya Pallangga, Gowa	UD.Cahaya Terbit	Fry oil Factory	PDAM	5 m^3/day
F6	Jl.Kacong Dg.La'lang, Gowa	UD.Kian Jaya	Drinking Factory	PDAM/Deep Well	5 m^3/day
F7	Jl.Kacong Dg.La'lang, Gowa	CV.DHT	Syrup Drinking	PDAM	5 m^3/day
F8	Jl.Poros Malino Km.22 Gowa	PT.Ketelindo Tulus, Sejahtera	Tapioca flour Factory		200 m^3/day
F9	Desa Bontoramba, Kec.Pallangga	PT.Uma Pelita Abadi	Tapioca flour Factory		40 m^3/day

Table E2.2 Inventory of Mining Sites as of 2004

No	Location	Objectives of Mining	Mining Equipment	Estimated Mining Volume (m^3/day)	Name of Mining Firm
S 1	Kec.Barombong Desa Bayang	Sand	Pump and Excavator	80	Wirabuana CV.Ansar
S 2	Kec.Tamalate/Bayang Bayang Caddi	Sand	Traditional by Boat	40	
S 3	Kec.Tamalate/Bayang	Sand	Traditional by Boat	60	Dg.Nuntung,DgMambang,Dg,lalo
S 4	Kec.Sombaopu	Sand	Traditional by Boat	12	Dg.Nuntung,DgMambang,Dg,lalo
S 5	Parangtambung/Malengkeri	Sand	Traditional by Boat	40	Dg.Naba,Dg Tayang, Dg.Tawang, Dg.Gasing,Dg.Nai.
S 6	Parangtambung	Sand	Pump	16	H.Tampak CV.Buana Jaya
S 7	Desa Balang-Balang Kec.Botomaranu	Sand	Pump	32	DG.Kio, Kamaruddin
S 8	Desa Borongloe	Sand	Pump	48	Dg.tata,Dg Bahar
S 9	Desa Songkolok	Stone, Sand, Gravel	Excavator	40	Kamaruddin
S 10	Desa Songkolok	Stone, Sand, Gravel	Excavator	200	H.Awing.
S 11	Desa Pattiro	Sand	Pump	40	Dg.Basir
S 12	Desa Pattiro	Sand	Pump	40	Ir.Amir
S 13	Desa Patiro	Sand	Pump	16	Dg.Mansur
S 14	Desa Songkolok	Sand	Pump	28	Tayyep
S 15	Desa Songkolok	Sand	Pump	28	Dg.Paik
S 16	Desa Songkolok	Sand	Pump	24	Dg.Liwung
S 17	Lebong/Parangloe, Sand Pocket 4	Sand	Excavator	Unknown	Perusda Kab.Gowa
	Total			744	

Note: The above mining sites are only those, which the Study Team could confirm through the field reconnaissance.

Table E2.3 Land Use in River Administration Area along River Dike Section (1/2)

Left Bank from River Mouth to Sungguminasa Bridge

Inside of Dike

No.	Distance (m)	Length (m)	Land Use Type
1	0-1072	1072	Water Body
2	1072-1500	428	Bare Land
3	1500-2127	627	Paddy Field
4	2127-2298	171	Bare Land
5	2298-2848	550	Settlement
6	2848-3792	944	Paddy Field
7	3792-3878	86	Settlement
8	3878-4595	717	Paddy Field
9	4595-5421	826	Settlement
10	5421-5698	277	Paddy Field
11	5698-5820	122	Settlement
12	5820-6255	435	Estate Crop Field
13	6255-6990	735	Settlement
14	6990-7479	489	Estate Crop Field
15	7479-7554	75	Settlement
16	7554-7931	377	Paddy Field
17	7931-8473	542	Settlement
18	8473-8545	72	Paddy Field
19	8545-8609	64	Settlement
20	8609-8704	95	Paddy Field
21	8704-9272	568	Settlement
Total	Water Body	1,072	(11.6%)
	Bare Land	599	(6.5%)
	Paddy Field	3,109	(33.5%)
	Settlement	3,568	(38.5%)
	Estate Crop Field	924	(10.0%)
	Bush	-	(0.0%)
	Dry Farm Land	-	(0.0%)
	Grass Land	-	(0.0%)
	Forest Area	-	(0.0%)
	Scrub Land	-	(0.0%)
	Grand Total	9,272	(100.0%)

Outside of Dike

No.	Distance (m)	Length (m)	Land Use Type
1	0-3160	3,160	Bare Land
2	3160-3327	167	Rubber Dam
3	3327-4958	1,631	Bush
4	4958-5041	83	Dry Land Farm
5	5041-5420	379	Bush
6	5420-5792	372	Dry Land Farm
7	5792-5888	96	Bush
8	5888-6086	198	Dry Land Farm
9	6086-6350	264	Bush
10	6350-7066	716	Dry Land Farm
11	7066-7319	253	Bush/Bare Land
12	7319-7584	265	Dry Land Farm
13	7584-7851	267	Bush/Bare Land
14	7851-8223	383	Dry Land Farm
15	8223-9028	794	Bush/Bare Land
16	9028-9272	244	Dry Land Farm
Total	Water Body	-	(0.0%)
	Bare Land	3,160	(34.1%)
	Paddy Field	167	(1.8%)
	Settlement	-	(0.0%)
	Estate Crop Field	-	(0.0%)
	Bush	3,684	(39.7%)
	Dry Farm Land	2,261	(24.4%)
	Grass Land	-	(0.0%)
	Forest Area	-	(0.0%)
	Scrub Land	-	(0.0%)
	Grand Total	9,272	(100.0%)

Note:

Water Body	Area that covered by water e.g. river, canal
Bare Land	Empty Area from plants or artificial activities e.g. river deposit bar
Paddy Field	Area that planted by paddy
Settlement	Housing Area and it surrounding, including front yard, back yard, plantation between houses
Estate Crop Field	Area that dominated by estate trees, usually around settlement
Bush	Area that dominated by bushes
Dry Farm Land	Farm area that dominated by dry farm e.g. non-irrigated agricultural field, sugar cane field, corn field, etc.
Grass Land	Area that dominated by grass for livestock's
Forest Area	Area that dominated by forest trees, commonly in hilly or mountainous area
Scrub Land	Area that dominated by scrubs plants

Table E2.3 Land Use in River Administration Area along River Dike Section (2/2)

Right Bank from River Mouth to Sungguminasa Bridge

Inside of Dike

No.	Distance (m)	Length (m)	Land Use Type
1	0-1045	1045	Bare Land, Bush
2	1045-1976	931	Bush, Bare Land
3	1976-2000	24	Settlement
4	2000-3427	1427	Bush, Bare Land
5	3427-3440	13	Settlement
6	3440-3752	312	Bush
7	3752-4573	821	Bare Land, Bush
8	4573-5118	545	Bush, Bare Land
9	5118-5526	408	Estate Crop Field
10	5526-5624	98	Bush
11	5624-5745	121	Settlement
12	5745-6023	278	Bush
13	6023-6426	403	Settlement
14	6426-6759	333	Bush
15	6759-6871	112	Water Pond
16	6871-7188	317	Bush
17	7188-8402	1214	Dry Farm Land
18	8402-10040	1638	Bush, Bare Land
19	10040-10460	420	Dry Farm Land
20	10460-10670	210	Bare Land, Bush
21	10670-11020	350	Dry Farm Land
22	11020-11510	490	Bush
23	11510-11680	170	Settlement
24	11680-11880	200	Bare Land, Bush
Total	Water Body	112	(0.9%)
	Bare Land	2,276	(19.2%)
	Paddy Field	-	(0.0%)
	Settlement	731	(6.2%)
	Estate Crop Field	408	(3.4%)
	Bush	6,369	(53.6%)
	Dry Farm Land	1,984	(16.7%)
	Grass Land	-	(0.0%)
	Forest Area	-	(0.0%)
	Scrub Land	-	(0.0%)
	Grand Total	11,880	(100.0%)

Outside of Dike

No.	Distance (m)	Length (m)	Land Use Type
1	0-342	342	Bush, Bare Land
2	342-770	428	Dry Farm Land
3	770-912	142	Bush
4	912-1145	233	Water Body
5	1145-1287	142	Bush
6	1287-1532	245	Dry Farm Land
7	1532-1813	281	Bush
8	1813-1989	176	Paddy Field
9	1989-2134	145	Settlement
10	2134-2539	405	Paddy Field
11	2539-2984	445	Settlement
12	2984-3167	183	Paddy Field
13	3167-3426	259	Grass Land
14	3426-3440	14	Rubber Dam
15	3440-4456	1016	Bush
16	4456-10190	5734	Settlement
17	10190-10290	100	Paddy Field
18	10290-10670	380	Settlement
19	10670-11020	350	Paddy Field
20	11020-11290	270	Estate Crop Field
21	11290-11510	220	Settlement
22	11510-11680	170	Paddy Field
23	11680-11880	200	Dry Farm Land
Total	Water Body	233	(2.0%)
	Bare Land	-	(0.0%)
	Paddy Field	1,398	(11.8%)
	Settlement	6,924	(58.3%)
	Estate Crop Field	270	(2.3%)
	Bush	1,923	(16.2%)
	Dry Farm Land	873	(7.3%)
	Grass Land	259	(2.2%)
	Forest Area	-	(0.0%)
	Scrub Land	-	(0.0%)
	Grand Total	11,880	(100.0%)

Note:

Water Body	Area that covered by water e.g. river, canal
Bare Land	Empty Area from plants or artificial activities e.g. river deposit bar
Paddy Field	Area that planted by paddy
Settlement	Housing Area and it surrounding, including front yard, back yard, plantation between houses
Estate Crop Field	Area that dominated by estate trees, usually around settlement
Bush	Area that dominated by bushes
Dry Farm Land	Farm area that dominated by dry farm e.g. Non-irrigated agricultural field, sugar cane field, corn field, etc.
Grass Land	Area that dominated by grass for livestock's
Forest Area	Area that dominated by forest trees, commonly in hilly or mountainous area
Scrub Land	Area that dominated by scrubs plants

Table E2.4 Land Use in River Administration Area along Non-dike River Dike Section (1/2)

Left Bank from Sungguminasa Bridge to Bili-Bili Dam

No.	Distance (m)	Length (m)	Area (ha)	Land Use Type
1 -1	9270-10490	1220	12.85	Settlement
1 -2			0.14	Paddy Field
2 -1	10490-11240	750	2.92	Bare Land
2 -2			4.19	Settlement
2 -3			0.65	Paddy Field
3 -1	11240-11430	1190	13.32	Paddy Field
3 -2			1.76	Settlement
4 -1	11430-13470	1040	6.15	Bare Land
4 -2			3.68	Dry Land Farm
4 -3			1.21	Paddy Field
4 -4			0.09	Estate Crop Field
5 -1	13470-15560	2090	10.14	Dry Land Farm
5 -2			8.46	Estate Crop Field
5 -3			2.02	Paddy Field
6 -1	15560-16220	660	3.02	Bare Land
6 -2			0.85	Dry Land Farm
6 -3			2.91	Paddy Field
7 -1	16220-16490	270	2.39	Paddy Field
7 -2			0.70	Estate Crop Field
7 -3			0.07	Settlement
8 -1	16490-17760	1270	7.11	Bare Land
8 -2			6.03	Paddy Field
8 -3			1.44	Dry Land Farm
8 -4			2.29	Estate Crop Field
9 -1	17760-17880	120	0.67	Estate Crop Field
9 -2			0.48	Paddy Field
9 -3			0.02	Bare Land
10 -1	17880-18860	980	2.95	Bare Land
10 -2			8.52	Estate Crop Field
10 -3			0.02	Settlement
11 -1	18860-18920	60	0.58	Estate Crop Field
11 -2			0.04	Dry Land Farm
12 -1	18920-19060	140	1.28	Dry Land Farm
12 -2			0.01	Estate Crop Field
13 -1	19060-19660	600	4.50	Bare Land
13 -2			2.32	Dry Land Farm
13 -3			0.08	Water Body
13 -3			1.33	Estate Crop Field
14 -1	19660-19970	310	2.66	Estate Crop Field
14 -2			0.34	Water Body
14 -3			1.29	Paddy Field
15 -1	19970-20150	180	1.88	Paddy Field

No.	Distance (m)	Length (m)	Area (ha)	Land Use Type
16 -1	20150-20830	680	3.56	Bare Land
16 -2			0.61	Estate Crop Field
16 -3			1.01	Paddy Field
16 -4			1.90	Dry Land Farm
17 -1	20830-20940	110	1.19	Dry Land Farm
17 -2			0.05	Water Body
18 -1	20940-23740	2800	6.84	Bare Land
18 -2			17.86	Dry Land Farm
18 -3			1.50	Estate Crop Field
18 -4			3.50	Paddy Field
19 -1	23740-23910	170	1.87	Paddy Field
20 -1	23910-24900	990	7.03	Bare Land
20 -2			4.32	Estate Crop Field
20 -3			1.74	Dry Land Farm
20 -4			0.73	Paddy Field
20 -5			1.10	Forest Area
20 -6			0.02	Scrub Land
21 -1	24900-25330	430	3.50	Dry Land Farm
21 -2			0.87	Forest Area
22 -1	25330-27340	2010	6.30	Bare Land
22 -2			9.36	Dry Land Farm
22 -3			5.25	Grass Land
22 -4			1.04	Scrub Land
23 -1	27340-27450	110	0.46	Scrub Land
23 -2			0.82	Grass Land
24 -1	27450-29110	1660	11.97	Bare Land
24 -2			1.57	Dry Land Farm
24 -3			0.05	Grass Land
24 -4			0.13	Scrub Land
24 -5			3.60	Estate Crop Field
24 -6			0.01	Paddy Field
24 -7			0.57	Settlement
25 -1	29110-30110	1180	11.44	Estate Crop Field
25 -2			2.22	Settlement
25 -3			1.83	Paddy Field
Total	Water Body	-	0.47	0.2%
	Bare Land	13,440	62.37	26.1%
	Paddy Field	1,810	41.27	17.3%
	Settlement	1,220	21.68	9.1%
	Estate Crop Field	1,670	46.78	19.6%
	Bush	-	-	0.0%
	Dry Farm Land	2,770	56.87	23.8%
	Grass Land	-	6.12	2.6%
	Forest Area	-	1.97	0.8%
	Scrub Land	110	1.65	0.7%
	Grand Total	21,020	239.18	100.0%

Note:

Water Body	Area that covered by water e.g. river, canal
Bare Land	Empty Area from plants or artificial activities e.g. river deposit bar
Paddy Field	Area that planted by paddy
Settlement	Housing Area and it surrounding, including front yard, back yard, plantation between houses
Estate Crop Field	Area that dominated by estate trees, usually around settlement
Bush	Area that dominated by bushes
Dry Farm Land	Farm area that dominated by dry farm e.g. non-irrigated agricultural field, sugar cane field, corn field, etc.
Grass Land	Area that dominated by grass for livestock's
Forest Area	Area that dominated by forest trees, commonly in hilly or mountainous area
Scrub Land	Area that dominated by scrubs plants

Table E2.4 Land Use in River Administration Area along Non-dike River Dike Section (2/2)

Right Bank from Sungguminasa Bridge to Bili-Bili Dam

No.	Distance (m)	Length (m)	Area (ha)	Land Use Type
1 -1	11440-11700	260	1.49	Bare Land
1 -2			1.09	Settlement
2 -1	11700-11880	180	1.58	Bare Land
2 -2			0.08	Settlement
3 -1	11880-12110	230	2.33	Paddy Field
3 -2			0.10	Bare Land
4 -1	12110-12390	280	3.18	Bare Land
4 -2			0.28	Paddy Field
5 -1	12390-12480	90	0.89	Paddy Field
5 -2			0.23	Bare Land
6 -1	12480-13140	660	5.44	Bare Land
6 -2			1.86	Paddy Field
7 -1	13140-13500	360	2.60	Paddy Field
7 -2			1.05	Estate Crop Field
8 -1	13500-14310	810	7.08	Estate Crop Field
8 -2			1.12	Paddy Field
8 -3			0.23	Settlement
8 -4			0.01	Dry Land Farm
9 -1	14310-15930	1620	12.79	Dry Land Farm
9 -2			3.61	Settlement
9 -3			0.09	Water Body
10 -1	15930-16430	500	5.23	Settlement
11 -1	16430-16820	390	2.23	Dry Land Farm
11 -2			0.63	Settlement
11 -3			0.59	Paddy Field
11 -4			0.49	Estate Crop Field
12 -1	16820-16890	70	0.45	Paddy Field
12 -2			0.38	Estate Crop Field
13 -1	16890-17640	750	2.31	Bare Land
13 -2			4.33	Estate Crop Field
13 -3			1.36	Paddy Field
13 -4			0.66	Settlement
14 -1	17640-18210	570	5.42	Paddy Field
14 -2			0.77	Estate Crop Field
14 -3			0.01	Bare Land
15 -1	18210-18380	170	1.41	Dry Land Farm
15 -2			0.52	Paddy Field
15 -3			0.01	Bare Land
16 -1	18380-18920	540	6.90	Bare Land
16 -2			0.77	Dry Land Farm
16 -3			0.10	Estate Crop Field
17 -1	18920-19250	330	2.50	Dry Land Farm
17 -2			0.38	Paddy Field
17 -3			0.52	Estate Crop Field
18 -1	19250-19350	100	0.87	Estate Crop Field
18 -2			0.09	Dry Land Farm
18 -3			0.01	Paddy Field
19 -1	19350-20430	1080	4.03	Bare Land
19 -2			5.54	Settlement
19 -3			2.76	Estate Crop Field
19 -4			0.47	Paddy Field
20 -1	20430-20600	170	0.41	Estate Crop Field
20 -2			1.32	Dry Land Farm
20 -3			0.01	Paddy Field
21 -1	20600-20900	300	1.65	Dry Land Farm
21 -2			1.27	Estate Crop Field
21 -3			0.08	Settlement
22 -1	20900-21020	120	1.29	Estate Crop Field
22 -2			0.06	Settlement
23 -1	21020-21080	60	0.21	Paddy Field
23 -2			0.94	Estate Crop Field
24 -1	21080-21300	220	1.43	Estate Crop Field
24 -2			1.11	Paddy Field

No.	Distance (m)	Length (m)	Area (ha)	Land Use Type
25 -1	21300-21580	280	3.14	Paddy Field
25 -2			0.03	Estate Crop Field
26 -1			1.08	Paddy Field
26 -1	21580-21730	150	0.49	Estate Crop Field
27 -1	21730-21820	90	1.20	Paddy Field
27 -2			0.02	Estate Crop Field
28 -1	21820-22260	440	4.38	Dry Land Farm
28 -2			0.04	Paddy Field
29 -1	22260-22490	1230	1.23	Estate Crop Field
29 -2			1.16	Dry Land Farm
30 -1	22490-23730	240	5.30	Bare Land
30 -2			5.77	Dry Land Farm
30 -3			1.27	Estate Crop Field
30 -4			0.52	Water Body
31 -1	23730-23910	180	1.72	Dry Land Farm
31 -2			0.10	Paddy Field
32 -1	23910-24370	460	5.22	Paddy Field
33 -1	24730-25380	1010	7.93	Bare Land
33 -2			2.57	Dry Land Farm
33 -3			0.31	Paddy Field
34 -1	25380-25570	190	1.39	Dry Land Farm
35 -1	25570-26160	590	6.78	Bare Land
35 -2			0.94	Estate Crop Field
35 -3			0.87	Dry Land Farm
36 -1	26160-27050	890	1.24	Grass Land
36 -2			0.31	Bare Land
37 -1	27050-27210	160	3.91	Bare Land
37 -2			3.30	Grass Land
37 -3			0.90	Estate Crop Field
37 -4			0.02	Dry Land Farm
38 -1	27210-27450	240	0.59	Estate Crop Field
38 -2			0.78	Dry Land Farm
38 -3			0.45	Paddy Field
39 -1	27450-27530	80	0.26	Bare Land
39 -2			1.42	Dry Land Farm
39 -3			0.87	Paddy Field
39 -4			0.03	Estate Crop Field
40 -1	24530-30450	2920	0.16	Estate Crop Field
40 -2			0.62	Paddy Field
40 -3			0.09	Scrub Land
41 -1	30450-30760	310	21.77	Bare Land
41 -2			6.65	Estate Crop Field
41 -3			1.14	Scrub Land
41 -4			0.21	Paddy Field
41 -5			2.05	Dry Land Farm
41 -6			0.33	Grass Land
41 -7			0.62	Settlement
42 -1	30760-31520	760	2.99	Scrub Land
42 -2			56.27	Bili-Bili Dam Complex
42 -3			0.05	Scrub Land
43 -1	31520-32110	590	4.44	Settlement
43 -2			1.57	Paddy Field
43 -3			0.10	Bili-Bili Dam Complex
Total	Water Body	-	0.61	0.2%
	Bare Land	6,140	127.91	46.5%
	Paddy Field	2,210	34.42	12.5%
	Settlement	1,090	22.27	8.1%
	Estate Crop Field	5,960	36	13.1%
	Bush	-	0	0.0%
	Dry Farm Land	3,620	44.9	16.3%
	Grass Land	890	4.87	1.8%
	Forest Area	-	0	0.0%
	Scrub Land	760	4.27	1.6%
	Grand Total	20,670	275.25	100.0%

Water Body	Area that covered by water e.g. river, canal
Bare Land	Empty Area from plants or artificial activities e.g. river deposit bar
Paddy Field	Area that planted by paddy
Settlement	Housing Area and it surrounding, including front yard, back yard, plantation between houses
Estate Crop Field	Area that dominated by estate trees, usually around settlement
Bush	Area that dominated by bushes
Dry Farm Land	Farm area that dominated by dry farm e.g. non-irrigated agricultural field, sugar cane field, corn field, etc.
Grass Land	Area that dominated by grass for livestock's
Forest Area	Area that dominated by forest trees, commonly in hilly or mountainous area
Scrub Land	Area that dominated by scrubs plants

Table E3.1 Principal River Structures in Jeneberang River Basin (1/2)

Project/Purpose	Components of Structures	Quantity/Structural Size: Description	Quantity/Structural Size: Quantity/Size	Time of Completion	River	Agencies Responsible
Bili-Bili Dam for Water Supply and Flood Control	Main Dam	Type	Rock fill	Aug. 1999	Jeneberang	PPSA*
		Height	76 m			
		Crest Length	750 m			
		Crest Width	10 m			
		Dam Volume	3,559,000 m^3			
	Left Wing Dam	Height	42 m	Aug. 1999	Jeneberang	PPSA*
		Crest Length	646 m			
		Crest Width	10 m			
		Dam Volume	1,515,000 m^3			
	Right Wing Dam	Height	52 m			
		Crest Length	412 m			
		Crest Width	10 m			
		Dam Volume	1,153,000 m^3			
	Reservoir	Catchment Area	384.4 km^2	Aug. 1999	Jeneberang	PPSA*
		Effective Water Depth	36.6 m			
		Reservoir Area	18.5 km^2			
		Total Storage	375,000,000 m^3			
		Effective Storage Vol.	346,000,000 m^3			
		Flood Control Vol.	41,000,000 m^3			
		Water Utilization Vol.	305,000,000 m^3			
		Municipal Water Vol.	35,000,000 m^3			
		Irrigation Water Vol.	270,000,000 m^3			
		Sediment Deposit	29,000,000 m^3			
	Telemetry System			May 1999	Jeneberang	PPSA*
	Control Station	Number	1 Sta.			
	Monitoring Station	Number	1 Sta.			
	Rainfall Gauging Sta.	Number	7 Sta.			
	Water Level Gauging Sta.	Number	7 Sta.			
	Warning Station	Number	2 Sta.			
	Bridges	Number	2 units	Nov. 1994	Jeneberang	PPSA*
River Improvement for Flood Control	River Dike	Length	20,970 m	Dec. 1993	Jeneberang (River Mouth to Sungguminasa)	PPSA*
	Revetment	Length	8,786 m			
	Groyne	Number	40 units			
	Groundsill at K5.96	Width	265.0 m			
	Groundsill at K9.00	Width	204.5 m			
	Sluice	Number	12 units			
	Intake	Number	2 units			
	Drainage ditch	Length	5,700 m			
	Jetty	Length	300 m			
Jongaya-Panampu-Sinrijala Drainage System for Flood Control	Drainage Channel	Length	13,870 m	Dec. 1993	Jongaya-Panampu-Sinrijala	PPSA*
	Control Gate	Number	4 units			
	Sluice (Box Culvert)	Number	34 units			
	Sluice (Pipe Culvert)	Number	291 units			
	Bridges	Number	23 units			
	Fence	Length	14,995 m			
	Inspection Road	Length	13,870 m			
	Jetty	Length	50 m			
Pampang Drainage System for Flood Control	Pump (Submersible)	Capacity	6 m^3/s	Dec. 2001	Pampang	PPSA*
	Regulation Pond	Storage Capacity	1,100,000 m^3			
		Area	39 ha			
	Sluice	Number	2 units			
	Bridges	Number	4 units			
Long Storage for Water Supply and Channel Cleaning	Reservoir	Length	4 km	Nov. 2001	Jeneberang (Old Estuary Channel)	PAB**
		Width	200 to 300 m			
		Effective Storage Vol.	1,600,000 m^3			
	Intake Sluice	Number	1 unit			
	Outlet Sluice	Number	1 unit			
	Tidal Barrage	Number	1 unit			

* PPSA = Jeneberang Water Resources Developmernt & Management, Jeneberang River Basin Development Project

** PAB = Raw Water Development, Jeneberang River Basin Development Project

Table E3.1 Principal River Structures in Jeneberang River Basin (2/2)

Project/Purpose	Components of Structures	Quantity/Structural Size			Time of Completion	River	Agencies Responsible
		Description	Quantity/Size				
Rubber Dam for Water Supply	Dam	Width	210	m	Dec. 1996	Jeneberang	PAB**
		Height	2	m			
	Main body	Length	10	m			
	Upstream Apron	Length	5	m			
	Downstream Apron	Length	12	m			
	Revetment	Length	336	m			
	Control house	Number	1	unit			
Raw Water Transmission System for Water Supply	Pipeline	Design Discharge	3.3	m^3/s	Mar. 1999	-	PAB**
	Pipe of 1600mm dia	Length	6,630	m			
	Pipe of 1,500mm dia	Length	10,380	m			
	Valve	Number	30	units			
	Fire Hydrant	Number	15	units			
	Flow-meter Chamber	Number	2	units			
	Blow-off Chamber	Number	5	units			
	Air Valve Chamber	Number	15	units			
	Fire Hydrant Chamber	Number	3	units			
Sand Pocket and Sabo Dam	Sand Pocket Dam No.1	Dam Volume	31,800	m^3	Oct. 1997	Jeneberang	PAB**
		Length of Dam Crest	620	m			
		Dam Height	7.5	m			
		Sediment Capacity	164,000	m^3			
		Mining Capacity	113,000	m^3			
	Sand Pocket Dam No.3	Dam Volume	16,100	m^3	Oct. 1997	Jeneberang	PPSA*
		Length of Dam Crest	336	m			
		Dam height	7	m			
		Sediment Capacity	129,000	m^3			
		Mining Capacity	93,000	m^3			
	Sand Pocket Dam No.2	Dam Volume	28,000	m^3	Sep. 2000	Jeneberang	PPSA*
		Length of Dam Crest	465	m			
		Dam height	7	m			
		Sediment Capacity	202,000	m^3			
		Mining Capacity	153,000	m^3			
	Sand Pocket Dam No.4	Dam Volume	35,800	m^3	Nov. 2000	Jeneberang	PPSA*
		Length of Dam Crest	644	m			
		Dam height	7	m			
		Sediment Capacity	444,000	m^3			
		Mining Capacity	359,000	m^3			
	Sand Pocket Dam No.5	Dam Volume	26,800	m^3	Nov. 2000	Jeneberang	PPSA*
		Length of Dam Crest	441	m			
		Dam height	7	m			
		Sediment Capacity	142,000	m^3			
		Mining Capacity	106,000	m^3			
	Sabo Dam No.4	Dam Volume	8,400	m^3	Jan. 2001	Jeneberang	PPSA*
		Length of Dam Crest	150	m			
		Dam height	8	m			
		Sediment Capacity	129,000	m^3			
		Mining Capacity	92,000	m^3			
	Sabo Dam No.6	Dam Volume	8,400	m^3	Jan. 2001	Marino	PPSA*
		Length of Dam Crest	230	m			
		Dam height	10	m			
		Sediment Capacity	74,400	m^3			
		Mining Capacity	62,000	m^3			
	Sabo Dam No.8	Dam Volume	28,000	m^3	Jan. 2001	Salo Bengo	PPSA*
		Length of Dam Crest	104	m			
		Dam height	10	m			
		Sediment Capacity	122,400	m^3			
		Mining Capacity	73,150	m^3			

* PPSA = Jeneberang Water Resources Developmernt & Management, Jeneberang River Basin Development Project
** PAB = Raw Water Development, Jeneberang River Basin Development Project

Table E3.2 Power Balance System in Makassar

Item	Unit	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Demand												
Energy Generation	GWh	2,191	2,244	2,389	2,559	2,743	2,941	3,155	3,385	3,634	3,901	4,190
Peak Load	MW	421	432	458	488	520	555	593	633	675	722	771
Lad Factor	%	59	59	60	60	60	60	61	61	61	62	62
Supply												
Installed Capacity	MW											
Power Station of PLN	PLTA	126	126	126	126	126	126	126	126	126	126	126
	PLTD	56	56	56	56	56	0	0	0	0	0	0
	PLTG	126	126	126	126	126	70	70	70	70	70	70
	PLTU	25	25	25	25	25	0	0	0	0	0	0
Power Station of Private												
Sengkang	PLTG	136										
Pare-pare	PLTG	60										
Project of PLN												
Bili-Bili	PLTA			20								
New PLTG	PLTG					50	50	50				50
Takalar	PLTU					65	65					
Malea	PLTA								182			
Project of IPP												
Sengkang	PLTG		65									
Total Capacity	***MW***	***529***	***594***	***614***	***614***	***729***	***707***	***757***	***939***	***939***	***939***	***989***
Reserve Margin	%	26	37	34	26	40	27	28	48	39	30	28

Source: Planning of Electric Power Supply outside Jawa-Madura-Bali 2004-2013, PLN, February 2004

Note: Categories of power station are as follows;
PLTA: Hydro, PLTD: Diesel, PLTG: Gas, PLTU: Thermal

Table E3.3 Engine Generator as Emergency Power Supply Installed at River Infrastructures

River Infrastructure	Type	Voltage (V)	Frequency (Hz)	Power Factor	Capacity (kVA)	Manufacturer	Year of manufacture	Operating Time (Season)	Major Failure	Agencies Responsible
1. Bili-Bili Dam										
(1) Generator for Micro-hydro	3phase4wire	AC 380	50	0.8	325	PT. Newage	1999	34,343 h (all the year)	-	PPSA
(2) Diesel Engine Generator	3phase4wire	AC 380	50	0.8	200	PT. Newage	1997	863 h (all the year)	-	PPSA
(3) Emergency Diesel Engine Generator	3phase4wire	AC 380	50	0.8	50	PT. Newage	1999	60 h (all the year)	Oil Pressure	PPSA
2. Rubber Dam										
(1) Emergency Diesel Engine Generator	3phase4wire	AC 400	50	0.8	40	Generac	1996	(all the year)	-	PAB
3. Bissua Irrigation Weir										
(1) Emergency Diesel Engine Generator	3phase4wire	AC 380	50	0.8	75	Perkin Olympiam	2004	(all the year)	-	PIRASS
4. Kampili Irrigation Weir										
(1) Emergency Diesel Engine Generator	3phase4wire	AC 380	50	0.8	75	Perkin Olympiam	2004	(all the year)	-	PIRASS
5. Tidal Gate										
(1) Emergency Diesel Engine Generator	3phase4wire	AC 400	50	0.8	10	Mindong Electric	1993	(all the year)	Mechanical Failure	PAB
6. Pampang Pumping Station										
(1) Diesel Engine Generator	3phase4wire	AC 380	50	0.8	660	Mitsubishi	2000	490 h (all the year)	-	PPSA

Note: Diesel engine generators in Induk Monitoring Office and Tidal Gate are now out of order

Table E6.1 Diversion Water Requirement Granted by JRBDP for the Source of Jeneberang River

(unit: m^3/s)

Water User			Water Requirement											
Sector	Name of User	Intake Point	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Irrigation	Bili-Bili Irrigation	Bili-Bili Weie	0.88	0.00	0.00	2.20	2.96	2.95	2.69	1.36	0.76	0.45	0.00	0.14
	Bissua Irrigation	Bissua Weir	4.00	0.00	0.00	10.07	13.51	13.48	12.29	6.21	3.45	2.08	0.00	0.66
	Kampili Irrigation	Kampili Weir	3.92	0.00	0.00	9.85	13.20	13.18	12.02	6.07	3.38	2.03	0.00	0.64
	Sub-total		8.80	0.00	0.00	22.13	29.67	29.61	27.01	13.64	7.59	4.56	0.00	1.44
Municipal	PDAM Makassar	Somba Opu	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31
		Ratulangi	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
		Macchini Simbala	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
		Panaikang	0.00	0.00	0.00	0.00	0.50	0.50	0.50	0.50	0.50	0.50	0.00	0.00
	PDAM Gowa	Bajeng	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
		Borong Loe	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
		Tompo Balang	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
		Pandang-Pandang	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
	Sub-total		1.66	1.66	1.66	1.66	2.16	2.16	2.16	2.16	2.16	2.16	1.66	1.66
Industry	Takalar Sugar Factory	Bissua Weir	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
River Maintenance	None	None	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Total			11.96	3.16	3.16	25.29	33.33	33.27	30.67	17.30	11.25	8.22	3.16	4.60

(unit: 10^6m^3)

Water User			Water Requirement												
Sector	Name of User	Intake Point	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Irrigation	Bili-Bili Irrigation	Bili-Bili Weie	2.35	0.00	0.00	5.71	7.92	7.64	7.21	3.64	1.96	1.22	0.00	0.38	38.03
	Bissua Irrigation	Bissua Weir	10.72	0.00	0.00	26.11	36.17	34.94	32.93	16.63	8.95	5.56	0.00	1.76	173.77
	Kampili Irrigation	Kampili Weir	10.49	0.00	0.00	25.53	35.37	34.16	32.20	16.26	8.75	5.43	0.00	1.72	169.91
	Sub-total		23.56	0.00	0.00	57.36	79.46	76.74	72.33	36.53	19.66	12.21	0.00	3.86	381.70
Municipal	PDAM Makassar	Somba Opu	3.51	3.17	3.51	3.40	3.51	3.40	3.51	3.51	3.40	3.51	3.40	3.51	41.31
		Ratulangi	0.18	0.17	0.19	0.18	0.19	0.18	0.19	0.19	0.18	0.19	0.18	0.19	2.20
		Macchini Simbala	0.25	0.22	0.24	0.23	0.24	0.23	0.24	0.24	0.23	0.24	0.23	0.24	2.84
		Panaikang	0.00	0.00	0.00	0.00	1.34	1.30	1.34	1.34	1.30	1.34	0.00	0.00	7.95
	PDAM Gowa	Bajeng	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.63
		Borong Loe	0.04	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.33
		Tompo Balang	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.94
		Pandang-Pandang	0.35	0.31	0.35	0.34	0.35	0.34	0.35	0.35	0.34	0.35	0.34	0.35	4.11
	Sub-total		4.45	4.02	4.45	4.30	5.79	5.60	5.79	5.79	5.60	5.79	4.30	4.45	60.30
Industry	Takalar Sugar Factory	Bissua Weir	1.34	1.21	1.34	1.30	1.34	1.30	1.34	1.34	1.30	1.34	1.30	1.34	15.77
River Maintenance	None	None	2.68	2.42	2.68	2.59	2.68	2.59	2.68	2.68	2.59	2.68	2.59	2.68	31.54
Total			32.03	7.64	8.46	65.55	89.26	86.23	82.14	46.33	29.15	22.01	8.19	12.33	489.31

Table E6.2 Water Abstraction Volume Granted by JRBDP for the Source of Jeneberang River

(unit: m^3/s)

Water User			Water Abstaraction Volume											
Sector	Name of User	Intake Point	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Irrigation	Bili-Bili Irrigation	Bili-Bili Weie	0.88	0.00	0.00	2.20	2.96	2.95	2.69	1.36	0.76	0.45	0.00	0.14
	Bissua Irrigation	Bissua Weir	4.00	0.00	0.00	10.07	13.51	13.48	12.29	6.21	3.45	2.08	0.00	0.66
	Kampili Irrigation	Kampili Weir	3.92	0.00	0.00	9.85	13.20	13.18	12.02	6.07	3.38	2.03	0.00	0.64
	Sub-total		8.80	0.00	0.00	22.13	29.67	29.61	27.01	13.64	7.59	4.56	0.00	1.44
Municipal	PDAM Makassar	Somba Opu	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31
		Ratulangi	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
		Macchini Simbala	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
		Panaikang	0.00	0.00	0.00	0.00	0.50	0.50	0.50	0.50	0.50	0.50	0.00	0.00
	PDAM Gowa	Bajeng	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
		Borong Loe	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
		Tompo Balang	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
		Pandang-Pandang	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
	Sub-total		1.66	1.66	1.66	1.66	2.16	2.16	2.16	2.16	2.16	2.16	1.66	1.66
Industry	Takalar Sugar Factory	Bissua Weir	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
River Maintenance	None	None	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Total														

(unit: $10^6 m^3$)

Water User			Water Abstaraction Volume												
Sector	Name of User	Intake Point	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Irrigation	Bili-Bili Irrigation	Bili-Bili Weie	2.35	0.00	0.00	5.71	7.92	7.64	7.21	3.64	1.96	1.22	0.00	0.38	38.03
	Bissua Irrigation	Bissua Weir	10.72	0.00	0.00	26.11	36.17	34.94	32.93	16.63	8.95	5.56	0.00	1.76	173.77
	Kampili Irrigation	Kampili Weir	10.49	0.00	0.00	25.53	35.37	34.16	32.20	16.26	8.75	5.43	0.00	1.72	169.91
	Sub-total		23.56	0.00	0.00	57.36	79.46	76.74	72.33	36.53	19.66	12.21	0.00	3.86	381.70
Municipal	PDAM Makassar	Somba Opu	3.51	3.17	3.51	3.40	3.51	3.40	3.51	3.51	3.40	3.51	3.40	3.51	41.31
		Ratulangi	0.18	0.17	0.19	0.18	0.19	0.18	0.19	0.19	0.18	0.19	0.18	0.19	2.20
		Macchini Simbala	0.25	0.22	0.24	0.23	0.24	0.23	0.24	0.24	0.23	0.24	0.23	0.24	2.84
		Panaikang	0.00	0.00	0.00	0.00	1.34	1.30	1.34	1.34	1.30	1.34	0.00	0.00	7.95
	PDAM Gowa	Bajeng	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.63
		Borong Loe	0.04	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.33
		Tompo Balang	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.94
		Pandang-Pandang	0.35	0.31	0.35	0.34	0.35	0.34	0.35	0.35	0.34	0.35	0.34	0.35	4.11
	Sub-total		4.45	4.02	4.45	4.30	5.79	5.60	5.79	5.79	5.60	5.79	4.30	4.45	60.30
Industry	Takalar Sugar Factory	Bissua Weir	1.34	1.21	1.34	1.30	1.34	1.30	1.34	1.34	1.30	1.34	1.30	1.34	15.77
River Maintenance	None	None	2.68	2.42	2.68	2.59	2.68	2.59	2.68	2.68	2.59	2.68	2.59	2.68	31.54
Total			32.03	7.64	8.46	65.55	89.26	86.23	82.14	46.33	29.15	22.01	8.19	12.33	489.31

Table E9.1 Inventory of River Infrastructures (1/3)

River		Structure			Location (Sta. No.)			Number of Units	Structural Type	Structural Size	Year of Completion	Investment (Rp. Million)	Agencies Responsible	Remarks
Name of River	River Order	Classification	Name	ID No.	Right or Left Bank	From	To							
Jeneberang	1st	Jetty		JET -1	Both	K0.000 (River Mouth)		1	Rubble Aggregate	4.5 m (B) x 3.5m (H) x 100m (L)	1993	2,675	PPSA	
Jeneberang	1st	River Dike	Right Lower Dike	RD -1	R	K0.310	K5.203	1	Earth Dike	4,920 m	1993	3,842	PPSA	
Jeneberang	1st		Right Upper Dike	RD -2	R	K5.200	K11.500	1	Earth Dike	6,740 m	1992	5,263	PPSA	With Maintenance Road
Jeneberang	1st		Left Lower Dike	RD -3	L	K0.050	K5.000	1	Earth Dike	4,950 m	1993	3,865	PPSA	
Jeneberang	1st		Left Upper Dike	RD -4	L	K5.000	K9.600	1	Earth Dike	4,700 m	1992	3,670	PPSA	With Maintenance Road
			Sub-total							21,310 m		16,639		
Jeneberang	1st	Revetment	Low Water Dike (1)	RVT -1	R	K2.350	H2.775	1	Random Masonry	425 m	1993	337	PPSA	
Jeneberang	1st		Low Water Dike (2)	RVT -2	R	K2.775	K3.762	1	Dry Masonry	996 m	1993	1,000	PPSA	
Jeneberang	1st		Low Water Dike (3)	RVT -3	R	K3.762	K3.968	1	Wet Masonry	250 m	1993	251	PPSA	
Jeneberang	1st		Low Water Dike (4)	RVT -4	R	K5.918	K6.659	1	Wet Masonry	927 m	1992	930	PPSA	
Jeneberang	1st		Low Water Dike (5)	RVT -5	R	K8.200	K9.586	1	Wet Masonry	1,370 m	1992	1,375	PPSA	
Jeneberang	1st		Low Water Dike (6)	RVT -6	L	K8.797	K9.332	1	Wet Masonry	1,045 m	1992	1,049	PPSA	
Jeneberang	1st		High Water Dike (1)	RVT -7	R	K0.310	K4.800	1	Wet Masonry	1,990 m	1993	1,997	PPSA	
Jeneberang	1st		High Water Dike (2)	RVT -8	R	K6.398	K6.632	1	Wet Masonry	305 m	1992	306	PPSA	
Jeneberang	1st		High Water Dike (3)	RVT -9	R	K8.259	K10.589	1	Wet Masonry	2,305 m	1992	2,313	PPSA	
Jeneberang	1st		High Water Dike (4)	RVT -10	L	K0.050	K0.730	1	Wet Masonry	680 m	1993	682	PPSA	
Jeneberang	1st		High Water Dike (5)	RVT -11	L	K0.751	K1.180	1	Wet Masonry	420 m	1993	422	PPSA	
Jeneberang	1st		High Water Dike (6)	RVT -12	L	K8.720	K9.387	1	Wet Masonry	684 m	1992	686	PPSA	
			Sub-total							11,397 m		11,349		
Jeneberang	1st	Rubber Dam		RDM -1		K3.650		1	Inflatable rubber-dam	210m (B) x 2m(H) with main dam (3 spans x 59m) and sub-dam (2 spans x	1996	61,045	PAB	
Jeneberang	1st													
Jeneberang	1st	Groundsill	Lower Groundsill	GRS -1		K5.970		1	Concrete Apron and Bed Protectior with Gabion Mattress	Approx. 200m (B)	1992	1,035	PPSA	
Jeneberang	1st		Upper Groundsill	GRS -2		K9.000		1			1992	1,035	PPSA	
			Sub-total					2				2,069		
Jeneberang	1st	Groyne	Groyne (R-1)	GRN -1	R	K0.350	K0.450	3	Pile Groyne of Permeable Type	6m (B) x 1.5m (H) x 5 to 29m (L)	1993	68	PPSA	
Jeneberang	1st		Groyne (R-2)	GRN -2	R	K2.000	K2.300	7			1993	159	PPSA	
Jeneberang	1st		Groyne (R-3)	GRN -3	R	K5.200	K5.300	3			1993	68	PPSA	
Jeneberang	1st		Groyne (R-4)	GRN -4	R	K6.000	K6.700	8			1992	182	PPSA	
Jeneberang	1st		Groyne (R-5)	GRN -5	R	K7.800	K8.300	5			1992	114	PPSA	
Jeneberang	1st		Groyne (L-1)	GRN -6	L	K1.150	K1.300	3			1993	68	PPSA	
Jeneberang	1st		Groyne (L-2)	GRN -7	L	K4.700	K4.950	4			1993	91	PPSA	
Jeneberang	1st		Groyne (L-3)	GRN -8	L	K7.900	K8.200	4			1992	91	PPSA	
Jeneberang	1st		Groyne (L-4)	GRN -9	L	K8.850	K9.350	6			1992	137	PPSA	
			Sub-total					43				979		
Jeneberang	1st	Drainage Sluice Gate	Bayang	DSG -1	R	K1.220		1	Box Culvert with Steel Slide Gate	2.0m(B) x 2.0m(H) x 2units x 19.0m (L)	1993	467	PPSA	
Jeneberang	1st		Taeng	DSG -2	L	K5.473		1		2.0m(B) x 2.0m(H) x 2units x 16.5m (L)	1992	153	PPSA	
Jeneberang	1st		Lambengi	DSG -3	L	K8.776		1		1.5m(B) x 1.5m(H) x 1unit x 16.0m (L)	1992	153	PPSA	
Jeneberang	1st		K7.00	DSG -4	R	K7.012		1		1.5m(B) x 1.5m(H) x 1unit x 16.5m (L)	1992	153	PPSA	
Jeneberang	1st		Bili-Bili	DSG -5	R	K7.722		1		1.5m(B) x 1.5m(H) x 1unit x 16.0m (L)	1992	153	PPSA	
Jeneberang	1st		Sungguminasa	DSG -6	R	K8.392		1		1.7m(B) x 1.7m(H) x 1unit x 16.3m (L)	1992	153	PPSA	
Jeneberang	1st		K9.10	DSG -7	R	K9.135		1		1.5m(B) x 1.5m(H) x 1unit x 16.5m (L)	1992	153	PPSA	
Jeneberang	1st		K9.60	DSG -8	R	K9.563		1		1.5m(B) x 1.5m(H) x 1unit x 16.0m (L)	1992	153	PPSA	
Jeneberang	1st		Batang Kaluku No.1	DSG -9	R	K9.816		1		1.7m(B) x 1.7m(H) x 2units x 17.5m (L)	1992	153	PPSA	
Jeneberang	1st		Batang Kaluku No.2	DSG -10	R	K10.333		1		1.7m(B) x 1.7m(H) x 2units x 17.5m (L)	1992	153	PPSA	
Jeneberang	1st		Batang Kaluku No.3	DSG -11	R	K10.862		1		1.7m(B) x 1.7m(H) x 2units x 17.5m (L)	1992	153	PPSA	
			Sub-total					11				1,992		
Jeneberang	1st	PDAM Intake	Malingkeli-1	PDAM -1	R			1	Intake Pump	Pump Capacity = 100 l/s			PDAM	To Machini Sombala WTP
Jeneberang	1st		Malingkeli-2	PDAM -2	R			1	Intake Pump	Pump Capacity = 500 l/s			PDAM	To Panaikang WTP (for dry season)
Jeneberang	1st		Pandang-Pandang	PDAM -3	R			1	Intake Pump	Pump Capacity = 200 l/s			PDAM	To Pandang-Pandang WTP
Jeneberang	1st		Ujung Pandang	PDAM -4	R			1	Intake Pump	Pump Capacity = 200 l /s			PDAM	To Ratulangi WTP
Jeneberang	1st		Sungguminasa	PDAM -5	R			1	Intake Pump	Pump Capacity = 40 l/s			PDAM	To Tompo Balang WTP

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Table E9.1 Inventory of River Infrastructures (2/3)

River		Structure			Location (Sta. No.)			Number	Structural Type	Structural Size	Year of	Investment	Agencies	Remarks
Name of River	River Order	Classification	Name	ID. No.	Right or Left Bank	From	To	of			Completion	(Rp. Million)	Responsible	
Jeneberang	1st		Bissua Weir	IRRW -1				1			2004		PIRASS	Irrigation area of 3,850 ha
Jeneberang	1st		(1) Diversion Weir						Concrete gravity	239.3m (L) x 8.2m (H)				
Jeneberang	1st		(2) Intake Structure		L				Fixed wheel	3.0m (B) x 1.9m (H) x 4gates		93,424		
Jeneberang	1st		Kampili Weir	IRRW -2				1			2004		PIRASS	Irrigation area of 17,480 ha
Jeneberang	1st	Irrigation Intake	(1) Diversion Weir						Masonry	91.0m (L) x 9.0m (H)				
Jeneberang	1st		(2) Intake Structure		L				Steel slide	2.05m (B) x 1.5m (H) x 4 gates				
Jeneberang	1st		Bili-Bili Weir	IRRW -3				1			2004		PIRASS	Irrigation area of 2,360 ha
Jeneberang	1st		(1) Diversion Weir						Concrete gravity	69.0m (L) x 2.0m (H)		10,116		
Jeneberang	1st		(2) Intake Structure		R				Fixed wheel	2.5m (B) x 1.2m (H) x 2 gates				
Jeneberang	1st		Sub-total									103,539		
Jeneberang	1st	Bridge	Bili-Bili	BR -1				1		5.0m (B) x 30.6m (L) (6 spans)	1994	222		
Jeneberang	1st		Pattalikang	BR -2				1		5.0m (B) x 30.4m (L) (6 spans)	1994	220		
Jeneberang	1st		Bili-Bili	Dam -1									PPSA	
Jeneberang	1st		(1) Main Dam					1	Center core type rockfill	10m (B) x 73m (H) x 750m (L)	1999			
Jeneberang	1st		(2) Left Wing Dam					1	Center core type rockfill	10m (B) x 42m (H) x 646m (L)	1999			
Jeneberang	1st		(3) Right Wing Dam					1	Center core type rockfill	10m (B) x 52m (H) x 412m (L)	1999			
Jeneberang	1st		(4) Spillway					1	Concrete Chute-way	99.5 to 55m (B) x 225m (L)	1999	174,797		
Jeneberang	1st	Multipurpose Dam	(5) Intake					1	Inclined	47m (H) with	1999			
Jeneberang	1st		(6) Outlet					1	Jet Flow Gate	Control Gate: 2m in dia	1999			
Jeneberang	1st								Gate Valve	Guard Gate: 3.0m in dia.				
Jeneberang	1st		(7) Building					1	RC Building	1,141 m2, 1-storey	1999			
Jeneberang	1st		(8) Micro-power Plant					1	Cross Flow Type of Turbine	Generator: 380v, 50hz	2005			
Jeneberang	1st									Gate Valve: 600mm in dia x 2units				
Jeneberang	1st		(9) Diversion Tunnel					2	Circular section type	9.3m (dia.) X 290m (L) & 300m (L)	1994	23,346		
Jeneberang	1st	Water Transmission Pipe	Raw Water Trasmission Main (RWTM)	RWTM -1		Bili-Bili Dam to Smba Opu-WTP		1	Single Pipe Line	6.63km (L) with 1,650mm in dia., 10.38km (L) with 1,500mm in dia.	1996	84,135	PAB	Trasmission Capacity = 3.3 m3/s
Jeneberang	1st		Bayang	HYGS -1				1			1997		PPSA	
Jeneberang	1st		Maccinni Sombala	HYGS -2				1			1997			
Jeneberang	1st	Hydrological Gauging Sta.	Kampili	HYGS -3				1			1997	1,500		
Jeneberang	1st		Bont Jai	HYGS -4				1			1997			
Jeneberang	1st		Jonggoa	HYGS -5				1			1997			
Jeneberang	1st		Sand Pocket Dam	SD -1				1	Gravity dam by wet stone masonry	3m (B) x 620m (L) x 7.5m (H)	1997	13,035	PPSA	
Jeneberang	1st		Sand Pocket Dam No.3	SD -2				1	Gravity dam by rubble-concrete	3m (B) x 336m (L) x 7.0m (H)	1997	5,887		
Jeneberang	1st	Sand Pocket/Sabo Dam	Sand Pocket Dam No.2	SD -3				1	Gravity dam by wet stone masonry	3m (B) x 465m (L) x 7.0m (H)	1998	13,035		
Jeneberang	1st		Sand Pocket Dam No. 4	SD -4				1	Gravity dam by wet stone masonry	3m (B) x 644m (L) x 7.0m (H)	2000	14,725		
Jeneberang	1st		Sand Pocket Dam No. 5	SD -5				1	Gravity dam by wet stone masonry	3m (B) x 441m (L) x 7.0m (H)	2000	12,900		
Jeneberang	1st		Sabo Dam No. 4	SD -6				1	Gravity dam by wet stone masonry	3m (B) x 150m (L) x 8.0m (H)	2000	5,880		
Salo Kausisi	2nd	Sabo Dam	Sabo Dam No. 8	SD -7				1	Gravity dam by wet stone masonry	3m (B) x 104m (L) x 10.0m (H)	2001	6,620	PPSA	
Jenelata	2nd		Jenelata	HYGS -6				1			1999		PPSA	
Jenelata	2nd	Hydrological Gauging Sta.	Mangempang	HYGS -7				1			1997	900	PPSA	
Jenelata	2nd		Limbunga	HYGS -8				1			1997		PPSA	
Salo Malino	2nd	Sabo Dam	Sabo Dam No. 6	SD -8				1	Gravity dam by wet stone masonry	3m (B) x 230m (L) x 10.0m (H)	2001	8,977	PPSA	
Salo Malino	2nd	Hydrological Gauging Sta.	Malino	HYGS -9				1			1997		PPSA	
Garassi	2nd	Bridge	Panakkukang	BR -3	L	K1.247		1	T-Beam	4.0m (B) x 29.8m (L)	1993	336		
Panampu		Jetty		JET -2	Both	K0.000 (River Mouth)		1	RC Boxes/Rubble Stones	5.0 m (B) x 3.0m (H) x 50m (L) x 2 unit	1991	1,338	PPSA	
Panampu	3rd	Revetment		RVT -13	R			1		4,940 m	1991	1,187	PPSA	
Panampu	3rd			RVT -14	L			1		4,940 m	1991	1,187	PPSA	
Panampu	3rd		BR. No.1	BR -4		K0.174		1	Hollow	7.8m (B) x 17.0m (L)	1991	193		
Panampu	3rd		BR. No.3	BR -5		K0.796		1	Hollow	18.6m (B) x 17.0m (L)	1991	460		
Panampu	3rd		BR. No. D	BR -6		K1.295		1	Hollow	7.8m (B) x 19.0m (L)	1991	216		
Panampu	3rd		BR. No. 4	BR -7		K2.318		1	Hollow	7.8m (B) x 17.0m (L)	1991	193		
Panampu	3rd		BR. No. 5	BR -8		K2.548		1	Hollow	19.8m (B) x 19.0m (L)	1991	547		
Panampu	3rd	Bridge	BR. No. 6	BR -9		K2.926		1	Hollow	21.8m (B) x 17.0m (L)	1991	539		
Panampu	3rd		BR. No. 7	BR -10		K3.251		1	Hollow	7.8m (B) x 17.0m (L)	1991	193		
Panampu	3rd		BR. No. 8	BR -11		K3.504		1	T-Beam	18.8m (B) x 11.5m (L)	1991	314		
Panampu	3rd		BR. No. 10	BR -12		K4.048		1	T-Beam	11.6m (B) x 12.0m (L)	1991	202		
Panampu	3rd		BR. No. A	BR -13		K4.390		1	T-Beam	11.6m (B) x 11.5m (L)	1991	194		
Panampu	3rd		Pedestrian Bridge	BR -14				6	T-Beam	1.5 to 3.0m (B) x 12.0 to 17.1 m (L)		262		

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Table E9.1 Inventory of River Infrastructures (3/3)

River		Structure			Location (Sta. No.)			Number	Structural Type	Structural Size	Year of	Investment	O&M Cost	Remarks
Name of River	River Order	Classification	Name	ID. NO	Right or Left Bank	From	To	of			Completion	(Rp. Million)	(Rp.	
Panampu	3rd	Drainage Sluice Culvert	One-box Culvert	SCV -1	R	Variable		6	Box Culvert		1991	68	PPSA	
Panampu	3rd		One-box Culvert	DSC -2	L	Variable		6			1991	68	PPSA	
Panampu	3rd		Two-box Culvert	DSC -3	R	K2.015		1		1.5 m (B) x 1.2m (H) per Box	1991	23	PPSA	
Jongaya	3rd	Revetment		RVT -15	L			1		6,565 m	1991	1,577	PPSA	
Jongaya	3rd			RVT -16	R			1		6,565 m	1991	1,577	PPSA	
Jongaya	3rd	Bridge	BR. No. B	BR -15		K1.000		1	T-Beam	11.6m (B) x 10.5m (L)	1991	177		
Jongaya	3rd		BR. No. 11	BR -16		K4.496		1	T-Beam	11.6m (B) x 10.5m (L)	1991	177		
Jongaya	3rd		BR. No. 12	BR -17		K4.916		1	T-Beam	7.8m (B) x 10.5m (L)	1991	119		
Jongaya	3rd		BR. No. C	BR -18		K5.720		1	T-Beam	18.8m (B) x 10.5m (L)	1991	287		
Jongaya	3rd		BR. No. 13	BR -19		K6.163		1	T-Beam	21.8m (B) x 11.0m (L)	1991	349		
Jongaya	3rd		BR. No. 14	BR -20		K6.772		1	Hollow	12.8m (B) x 17.0m (L)	1991	316		
Jongaya	3rd		BR. No. 18	BR -21		K7.235		1	Hollow	7.8m (B) x 19.0m (L)	1991	216		
Jongaya	3rd		BR. No. 15	BR -22		K7.773		1	Hollow	12.8m (B) x 19.0m (L)	1991	354		
Jongaya	3rd		BR. No. 16	BR -23		K7.982		1	Hollow	12.8m (B) x 19.0m (L)	1991	354		
Jongaya	3rd		BR. No. 17	BR -24		K8.153		1	Hollow	7.8m (B) x 19.0m (L)	1991	216		
Jongaya	3rd		BR. No. E	BR -25		K8.469		1	Hollow	9.8m (B) x 19.0m (L)	1991	271		
Jongaya	3rd		BR. No. F	BR -26		K9.126		1	Hollow	7.8m (B) x 19.0m (L)	1991	216		
Jongaya	3rd		BR. No. H	BR -27		K10.147		1	Hollow	7.8m (B) x 19.0m (L)	1991	216		
Jongaya	3rd		Pedestrian Bridge	BR -28		K11.086		1	T-Beam	2.5m (B) x 20.9m (L)	1991	76		
Jongaya	3rd	Drainage Sluice Culvert	One-box Culvert	DSC -4	L			1	Box Culvert	1.5 m (B) x 1.2m (H) per Box	1991	23	PPSA	
Jongaya	3rd		One-box Culvert	DSC -5	R	Variable		2			1991	79	PPSA	
Jongaya	3rd		Two-box Culvert	DSC -6	L	Variable		7			1991	91	PPSA	
Jongaya	3rd		Two-box Culvert	DSC -7	R	Variable		4			1991	91	PPSA	
Sinrijala	4th	Revetment		RVT -17	L	Variable		4		2,366 m	1991	569	PPSA	
Sinrijala	4th			RVT -18	R	Variable		1		2,366 m	1991	569	PPSA	
Sinrijala	4th	Drainage Sluice Gate	Sluice No. 1	DSG -12	L	K0.820			Box culvert with movable gates	3.3m(B) x 2.4m(H) x 2units x 48.0m (L)	1991	284	PPSA	Intersection with Jl. A.P. Pettarai
Sinrijala	4th		Sluice No. 2	DSG -13	L	K2.105		1	Box culvert with movable gates	3.3m(B) x 2.4m(H) x 1unit x 12.0m (L)	1991	142	PPSA	Intersection with Jl. S. Saddang Baru
Sinrijala	4th	Drainage Sluice Culvert	One-box Culvert	DSC -8	R	K0.795		1	Box Culvert	1.5 m (B) x 1.2m (H) per Box	1991	11	PPSA	
Sinrijala	4th		One-box Culvert	DSC -9		K8.835		1			1991	11	PPSA	
Sinrijala	4th	Fall		Fall -1		K2.350		1	RC Structure/Gabion Mattress	3.5m (Upper B) , 5.0m (Lower B), 1.76m (H)	1991	2	PPSA	
Sinrijala	4th	Pedestrian Bridge		BR -29				1	T-Beam	1.5 to 3.0m (B) x 10.4m (L)	1991	151		
Pampang	5th	Drainage Pump Station		DRP -1							2000	52,470	PPSA	
Pampang	5th	(1) Pump						1	Submersible Pump	2m3/s, (100kw, dia 1m x 3 units)	2000			
Pampang	5th	(2) Regulation Pond						1		360,000m2 (Area) x 3.5m (Depth)	2000			
Pampang	5th	(3) Spillway						1	Concrete Fix Weir	4.3m (H) x 150m (L)	2000			
Pampang	5th	Drainage Sluice Gate	Pampang	DSG -1				1	Gate with motor drive hoist	5.0m (B) x 3.1m (H) x 2 gates	1998	17,107	PPSA	
Pampang	5th		Anotong	DSG -2				1	Gate with manual operation	1.5m (B) x 1.5m (H) x 2 gates	1998			
Pampang	5th	Revetment		RVT -19				1	Wet Masonry	1,000m (L)	1998		PPSA	
Pampang	5th	Bridge	Pettarani II	BR -30				1	PC girder bridge	L = 33.7 m	1998			
Pampang	5th		Antong	BR -31				1	PC girder bridge	L = 22.7 m	1998			
Pampang	5th		Sari I	BR -32				1	PC girder bridge	L = 22.7 m	1998			
Pampang	5th		Sari II	BR -33				1	PC girder bridge	L = 22.7 m	1998			
Pampang	5th		Banca	BR -34				1	PC girder bridge	L = 22.7 m	1998			
Long Storage	2nd	Tidal Barrage		TB -1		K0.004	to K1.792	5			1993	11,917	PAB	
Long Storage	2nd	(1) Barrage							Earth dike	200m (B) x 200m (L) x 3.5m (H)	1993			
Long Storage	2nd	(2) Outlet Sluice							Box culvert		1993			
Long Storage	2nd	(3) Revetment							Wet Masonry	400m in length	1993			
Long Storage	2nd	(4) Tidal Gate							Steel Slide Gate	2.0m(B) x 2.0m(H) x 2 gates	1993			
Long Storage	2nd	Flushing Gate	Gate (A)	FG -1				1	Steel Gate	1.0m(B) x 1.6m(H) x 2 gates.	2001	11,158	PAB	
Long Storage	2nd		Gate (B)	FG -2				2	Steel Gate	1.1m(B) x 1.3m(H) x 2 gates	2001		PAB	
Long Storage	2nd	Revetment		RVT -19	R			1	Wet Masonry	2300m in length	2001		PAB	
Long Storage	2nd			RVT -20	L			1	Wet Masonry	2600m in length	2001		PAB	
Long Storage	2nd	Intake Sluice Gate		ISG -1	R	K4.054		1	Box culvert with movable gates	2.0m(B) x 2.0m(H) x 2units x 42.74m (L)	1993	1,051	PAB	To supply to Long Storage
Long Storage	2nd	PDAM Intake	Maccini Sombala	PDAM -6					Intake Pump	Pump Capacity = 200 l/s			PDAM	Closed (To Maccini Sombala WTP)

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Table E9.2 Existing Operation and Maintenance Manuals of River Structures

Name of Project	Principal Structures in the Project	Principal Contents of O&M Manuals	Prepared in
Bili-Bili Dam	– Bili-Bili Dam	– Dam operation rule – Water control plant – Dam control and monitoring system – Telecommunication system – Micro hydropower plant – Dam instrumentation – Power supply system – Instruction manual of end suction volute pumps	Dec. 1999
Sand Pocket and Sabo Dam	– Sand Pocket and Sabo Dam	– List of structures and structural features – Institutional setup for O&M – Budgetary arrangement for O&M – Guideline for monitoring on progress of sedimentation – Operation guideline for mining of sand trapped in the Structures – Maintenance manual of structures	Nov. 2001
Pampang River Improvement Project	– Pampang Drainage Pump – Regulation Pond – Pampang Drainage Channel	– List of structures and structural features – Institutional setup for O&M – Budgetary arrangement for O&M – Guideline for the necessary inspection works – Guideline for gate and pump operation, – Maintenance manual of structures and facilities	Dec. 2001
Lower Jeneberang River Urgent Flood Control Works	– Lower Jeneberang – Drainage Channel	– List of structures and structural features – Institutional setup for O&M – Budgetary arrangement for O&M – Guideline for the necessary inspection works – Guideline for operation of drainage sluices – Maintenance manual of river channel, structures and facilities	Mar. 1994
Construction of Long Storage	– Long Storage	– List of structures and structural features – Organization for O&M – Budgetary arrangement for O&M – Guideline for the necessary inspection works – Guideline for operation of reservoir operation and gate operation – Maintenance manual of river channel, structures and facilities	Jan. 2002
Bili-Bili Irrigation Project (Draft)	– Bili-Bili Weir – Bissua Weir – Kampili Weir	– List of structures and structural features – Organization for O&M – Guideline for the necessary inspection works – Guideline for operation of Weirs – Maintenance manual of structures and facilities – Guideline for data collection and evaluation on maintenance works	Aug. 2003
Rubber Dam Construction	– Rubber Dam	– List of structures and structural features – Organization for O&M – Budgetary arrangement for O&M – Guideline for the necessary inspection works – Guideline for operation of rubber dam – Maintenance manual of structures and facilities	Mar. 1997
Raw Water Transmission Main	– Pipe Line	– List of Structures – Operation of gates – Maintenance Guideline of gates	Mar. 1999

Table E9.3 Cost for Flow Meter at Inlet of RWTM and Telemetry Equipment at Bayang Gauging Station

Description			Q'ty	F/C (Yen)		L/C (Rp.)	Total (Rp.)	Remarks
				FOB Japan	CIF Mkssr			
I	Flow Meter at Inlet of RWTM							
	(1)	Flow Meter	1 set	52,000	76,541	6,888,703	6,888,703	To be purchased in Indonesia
	(2)	Installation Cost	L.S.			561,600	561,600	12% of FOB Japan of (1)
		Subtotal for I				7,450,303	**7,450,303**	
II	Telemetry Gauging at Bayang gauging Station							
	(1)	Coaxial arrester with fixture	1 set	62,500	91,997	0	8,279,691	Inport material (CIF Makassar)
	(2)	Yagi type anntena (3-element folded)	1 set	218,750	321,988	0	28,978,920	Inport material (CIF Makassar)
	(3)	Telemetary equipment	1 set	1,592,500	2,344,073	0	210,966,539	Inport material (CIF Makassar)
	(4)	Float type water level gauging equipment	1 set	1,280,000	1,884,090	0	169,568,081	Inport material (CIF Makassar)
	(5)	DC 12 V power supply equipment with solar arr	1 set			7,300,000	7,300,000	To be purchased in Indonesia
	(6)	Portable enging generator	1 set			5,840,000	5,840,000	To be purchased in Indonesia
	(7)	Installation materials	L.S.			31,316,995	31,316,995	To be purchased in Indonesia
	(8)	Installation of equipment	L.S.			34,060,500	34,060,500	12% of FOB Japan of (1) to (7)
		Subtotal II		3,153,750	4,642,147	78,517,495	**496,310,727**	
Total for I and II				3,153,750	4,642,147	85,967,798	**503,761,030**	

Note : *1) Conversion Rate as of Oct. 2004 1yen = Rp.90.00

*2) Ocean fleight and insurance is included in the unit price of equipment.

Table E9.4 Cost for Rehabilitaion of Drainage Gate

Nos.	Item	Location	Q'ty	Rehabilitation Cost (Rp/unit)	Amount (Rp)
1	Drainage Gate R-1 (Bayang)	K1.220－R	2	70,000,000	140,000,000
2	Drainage Gate L-1 (Taeng)	K5.473－L	2	50,000,000	100,000,000
3	Drainage Gate R-2 (K7.00)	K7.012－R	1	50,000,000	50,000,000
4	Drainage Gate R-3 (Bili-Bili)	K7.722－R	1	50,000,000	50,000,000
5	Drainage Gate R-4 (Sungguminasa)	K8.392－R	1	50,000,000	50,000,000
6	Drainage Gate L-2 (Lambengi)	K8.776－L	1	50,000,000	50,000,000
7	Drainage Gate R-5 (K9.10)	K9.135－R	1	50,000,000	50,000,000
8	Drainage Gate R-6 (K9.60)	K9.563－R	1	50,000,000	50,000,000
9	Drainage Gate R-7 (Batang Kaluku No.1)	K9.816－R	2	50,000,000	100,000,000
10	Drainage Gate R-8 (Batan Kaluku No.2)	K10.333－R	2	70,000,000	140,000,000
11	Drainage Gate R-9 (Batang Kaluku No.3)	K10.862－R	2	50,000,000	100,000,000
Total					**1,250,000,000**

Table E10.1 Summary of O&M Cost of River Infrastructures and Cost for River Management

Item	Structure/Management Filed	Work Item	Cost in Million Rp. in 2007	Cost in Million Rp. in 2011
O&M	Bili-Bili Dam/RWTM	Routine & Periodical Maintenance	372	372
		Overhaul	75	75
		Operation	193	193
		Overhead	293	356
		Sub-total	933	996
	Irrigation Intake Weir	Routine & Periodical Maintenance	78	78
		Overhaul	21	21
		Operation	230	230
		Overhead	238	265
		Sub-total	566	593
	Long Storage/Rubber Dam	Routine & Periodical Maintenance	103	103
		Overhaul	36	36
		Operation	132	132
		Overhead	82	166
		Sub-total	353	437
	Riparian Structure	Routine & Periodical Maintenance	-	173
		Overhaul	-	41
		Operation	-	84
		Overhead	-	130
		Sub-total	-	428
	Sabo Dam	Routine & Periodical Maintenance	-	274
		Overhaul	-	-
		Operation	-	-
		Overhead	-	189
		Sub-total	-	463
	Total for O&M		1,852	2,917
River Management	Water Quantity management		188	259
	Flood Management		229	278
	Drought Management		227	267
	River Conservation Management		209	334
	Total for River Management		854	1,137
Grand Total			2,706	4,054

Table E10.2 Unit Cost of Routine and Periodical Inspection and Maintenance (1/2)

Work Item	Description	Unit	Quantity	Unit Cost (Rp.)	Cost (Rp.)
Removal of on-land garbage per 1000m^2		M/D	0.02	33,600	672
	Common Labor	M/D	0.51	16,800	8,568
	Dump truck (2ton)	day	0.10	505,300	50,530
	Total				59,770
	Removal of on-land garbage per 1m ^{2} =				***60***
Removal of garbage twining around riparian structures (such as groyne and gate) per 100m	Common Labor	M/D	0.04	16,800	700
	Dump truck (2ton)	day	0.02	505,300	10,527
	Total				11,227
	Removal of garbage twining around riparian structure per 1m =				***110***
Cutting of grass (weed) in river corridor per 1000m^2	Foreman	M/D	0.04	33,600	1,344
	Common Labor	M/D	0.36	16,800	6,048
	Gasoline	liter	5.70	1,810	10,317
	Oils (25% of Gasoline)	L.S.	1		2,063
	Tools (weeding machine, etc)	day	0.36	238,000	85,680
	Total				105,452
	Cutting of Grass on embankment per 1m ^{2} =				***100***
Removal of floating materials in Dam reservoir per time	Common Labor	M/D	0.38	16,800	6,300
	Tools (net, boat, etc)	day	0.13	10,000	1,250
	Dump truck (2ton)	day	0.08	505,300	42,108
	Total				49,658
	Removal of floating materials in Dam reservoir per time =				***50,000***
Small repair for cracks, holes & other minor failures of embankment per 1m^2	Foreman	M/D	0.13	33,600	4,200
	Skilled Labor	M/D	0.17	25,600	4,267
	Tools (grader, etc)	day	0.17	75,000	12,500
	Total				16,767
	Minor rehabilitation on embankment per 1m ^{2} =				***17,000***
Small repair of cracks, holes & other minor failures of concrete structure per 1m^2 (assuming crack of 0.15m in depth)	Foreman	M/D	0.04	33,600	1,400
	Concrete Worker	M/D	0.17	33,600	5,600
	Skilled Labor	M/D	0.17	25,600	4,267
	Common Labor	M/D	0.33	16,800	5,600
	Non-shrinkage Mortal	m^3	0.15	2,000,000	300,000
	Tool (mortal spray, etc.)	day	0.17	150,000	25,000
	Total				341,867
	Minor rehabilitation on concrete structure per 1m ^{2} =				***342,000***
Re-painting of metal parts and tightening/ replacement of bolts/nuts per 5m^2	Foreman	M/D	0.20	33,600	6,720
	Skilled Painter	M/D	0.13	35,000	4,375
	Assistant. Painter	M/D	1.00	30,000	30,000
	Lead Paint	kg	0.9	5,000	4,500
	Cover Paint	kg	0.9	21,500	19,350
	Paint Remover	liter	0.2	5,000	1,000
	Thinner	liter	0.2	5,000	1,000
	Bolts/Nuts	kg	0.3	7,500	2,250
	Total				69,195
	Painting of metals per 1m ^{2} =				***14,000***
Removal of Sediment Deposit at Sand Pocket and sabo dam per 30m^3	Foreman	M/D	0.06	33,600	2,100
	Operator	M/D	0.25	30,000	7,500
	Common Worker	M/D	0.38	16,800	6,300
	Hydraulic Excavator (30m^3)	day	0.13	994,400	124,300
	Damp Truck (8ton)	day	0.25	111,500	27,875
	Fuel (Diesel)	liter	25	1650	41,250
	Oils (35% of Fuel Cost)	L.S.			14,438
	Miscellaneous (10% of the above	L.S.			22,376
	Total				244,039
	Removal of Sediment Deposit at Sand Pocket and sabo dam per 1m ^{3} =				***8,100***

Note: Man-power cost of permanent staff and its incidental cost is excluded from the above annual cost.

Table E10.2 Unit Cost of Routine and Periodical Inspection and Maintenance (2/2)

Work Item	Description	Unit	Quantity	Unit Cost (Rp.)	Cost (Rp.)
Replacement of pipe per piece (for 1,500mm in dia. and 6m in length per peace)	Foreman	M/D	0.50	33,600	16,800
	Mechanics	M/D	0.50	33,600	16,800
	Skilled Labor	M/D	2.00	25,600	51,200
	Operator	M/D	2.00	30,000	60,000
	Backhoe (0.35m^3)	hour	2.00	134,000	268,000
	Truck Crane (4.9t)	hour	2.00	129,000	258,000
	Dump Truck (8t)	hour	2.00	84,000	168,000
	PC Pipe	m	6.00	3,780,000	22,680,000
	Miscellaneous (10% of the above)				23,518,800
	Total				47,037,600
	Replacement of Pipe per Piece =				***47,000,000***
Removal of floating aquatic grass such as water hyacinth in Long Storage per 100m^2	Foreman	M/D	0.06	33,600	1,915
	Common Labor	M/D	0.57	16,800	9,576
	Tool (Grass cutter, boat, etc.)	day	0.57	250,000	142,500
	Dump Truck (2t)	day	0.04	505,300	21,054
	Miscellaneous (10% of the above	L.S.			17,505
	Total				192,550
	Removal of aquatic grass in river channel per 1m^2 =				***1,900***
Cross-sectional river channel survey per section	Chief Surveyor	M/D	0.08	33,600	2,800
	Assistant Surveyor	M/D	0.17	25,600	4,267
	Common Labor	M/D	0.25	16,800	4,200
	Tool (transit, boat, echo-sounder	hour	2.00	6,500,000	13,000,000
	Drawings/Reporting	section	1.00	600,000	600,000
	Miscellaneous (10% of the above	L.S.			1,361,127
	Total				14,972,393
	Cross-sectional river channel survey per section =				***15,000,000***
Echo-sounding survey for Bili-Bili dam reservoir per section of 500m in length	Chief Surveyor	M/D	0.08	33,600	2,800
	Assistant Surveyor	M/D	0.42	25,600	10,667
	Common Labor	M/D	0.50	16,800	8,400
	Tool (transit, boat, echo-sounder	hour	2.00	8,600,000	17,200,000
	Drawings/Reporting	section	1.00	600,000	600,000
	Miscellaneous (10% of the above	L.S.	1.00		1,782,187
	Total				19,604,053
	Echo-sounding survey for Bili-Bili dam reservoir per 500m =				***19,600,000***

Note: Man-power cost of permanent staff and its incidental cost is excluded from the above annual cost.

Table E10.3 Annual Cost of Routine and Periodical Inspection and Maintenance

Structure	Part of Structure	Work Item	Unit	Unit Cost (Rp.)	Annual Work	Annual Cost (Rp.)	Estimation base for Annual Work Volume
Riparian Structure	Embankment	Cutting of grass (weed) in River Corridor	m^2	100	775,684	77,568,400	Earth Dike Portion
		Removal of garbage	m^2	60	288,000.0	17,280,000	Once from river Mouth to Sungguminasa Bridge
		Small repair	m^2	17,000	3,878.4	65,933,140	0.5% of existing high-water channel
	Revetment	Small repair	m^2	342,000	32.1	10,972,386	0.1% of existing revetment
	Groyne	Removal of garbage	m	110	1,032.0	113,520	12times in average for 43 existing groyne
	Groundsill	Removal of garbage	m	110	4,800.0	528,000	2 existing groundsills
		Small repair	m^2	342,000	2.5	861,840	0.1% of main concrete body
	Sluice Gate and Pipe	Removal of garbage	m	110	132.0	14,520	12times in average. for 11 sluice gates
		Re-painting (Limited Part)	m^2	14,000	11.0	154,000	$1m^2$ for each of 11 existing gates in a year
	Sub-total					173,425,806	
Rubber Dam	Whole	Removal of garbage	m	110	2,520.0	277,200	12 times in average.
	Upstream/Downstream	Small repair	m^2	342,000	6.4	2,192,562	0.1% of Investment cost required once for every two years
	Sub-total					2,469,762	
Long Storage	Channel	Cutting of grass (weed) in River Corridor	m^2	100	157,800.0	15,780,000	30m in width x 5,260m in length
		Removal of water hyacinth	m^2	1,900	39,450.0	74,955,000	Once a year at the middle of dry season
	Intake Sluice	Re-painting (Limited Part)	m^2	14,000	1.0	14,000	$1m^2$ in average. in a year
	Tidal Gate	Re-painting (Limited Part)	m^2	14,000	1.0	14,000	$1m^2$ in average. in a year
	Flush Gate	Re-painting (Limited Part)	m^2	14,000	1.0	14,000	$1m^2$ in average. in a year
	Revetment	Small repair	m^2	342,000	29.4	10,054,800	0.1% of the revetment
	Sub-total					100,831,800	
Dam	Reservoir Area	Echo-sounding survey	section	2,000,000	70.0	140,000,000	Once a year, 500m interval
		Removal of floating materials	time	50,000	48.0	2,400,000	Every week
		Trash boom maintenance	m	100,000	105.0	10,500,000	As required
		Land slide protection works	m^2	7,500	1,000.0	7,500,000	Once a year
		Reforestation around the reservoir	Nos.	7,500	800.0	6,000,000	Once a year
	Surrounding Area	Cutting of grass (weed) in River Corridor	m^2	100	240,000.0	24,000,000	$60,000m^2$ x 4 times
		Removal of dead decorative plant	nos	2,500	1,000.0	2,500,000	Once a year
		Removal of the clump of plants	m^2	3,000	500.0	1,500,000	Once a year
		Improvement of undulating land	L.S.	300,000	1.0	300,000	Once a year
	Spillway	Re-painting (Limited Part)	m^2	14,000	10.0	140,000	For Regular Gates
		Small repair	m^2	342,000	0.8	287,280	0.1% of flow crest
	Outlet Sluice	Re-painting (Limited Part)	m^2	14,000	15.0	210,000	For Control Gate, Bulkhead Gate & Guard Gate
	House	Maintenance of Control Office	m^2	65,000	1,141.0	74,165,000	For whole floor
	Sub-total					269,502,280	
RWTM	Gate	Re-painting (Limited Part)	m^2	14,000	15.3	213,500	For Intake gate and other metal parts
		Removal of garbage	m	110	120.0	13,200	12 times in average. in a year
	Transmission Pipe & Blow Off	Test and repair for leakage	km	500,000	17.0	8,500,000	Once a year
		Repair/replacement	piece	47,000,000	2.0	94,000,000	Once a year (replacement of 0.1% of whole number of pipe)
	Sub-total					102,726,700	
Irrigation Intake Weir	Bili-Bili Diversion Weir	Small repair	m^2	342,000	0.1	36,115	0.1% of crown area
	Bili-Bili Scoring Sluice	Re-painting	m^2	14,000	9.0	126,000	Whole metal part once a year
	Bili-Bili Intake Gate	Re-painting (Limited Part)	m^2	14,000	35.4	495,079	Whole metal part once a year
	Bili-Bili Intake Gate	Removal of garbage on Screen	m	110	336.0	36,960	Every week
	Bissua Diversion Weir	Small repair	m^2	342,000	1.5	504,033	0.1% of crown area
	Bissua Scoring Sluice	Re-painting (Limited Part)	m^2	14,000	64.5	903,000	Whole metal part once a year
	Bissua Intake Gate	Re-painting (Limited Part)	m^2	14,000	34.2	478,800	Whole metal part once a year
	Bissua Intake Gate	Removal of garbage on Screen	m	110	2,064.0	227,040	Every week
	Bissua Sediment Trap	Removal of sediment	m^3	8,100	2,340.0	18,954,000	10% of trapping capacity
	Kampili Diversion Weir	Small repair	m^2	342,000	0.2	52,018	0.1% of crown area
	Kampili Scoring Sluice	Re-painting (Limited Part)	m^2	14,000	45.0	630,000	Whole metal part once a year
	Kampili Intake Gate	Re-painting (Limited Part)	m^2	14,000	18.5	258,300	Whole metal part once a year
	Kampili Intake Gate	Removal of garbage on Screen	m	110	2,016.0	221,760	Every week
	Kampili Sediment Trap	Removal of sediment	m^3	8,100	6,750.0	54,675,000	30% of trapping capacity
	Sub-total					77,598,105	
Sabo Dam	Sand Pocket Dam	Small repair	m^2	342,000	1.9	636,120	0.1% of crown area of main dam body
		Removal of Sand Deposit	m^3	8,100	1,640.0	13,284,000	1% of trapping capacity
	Sand Pocket Dam No.2	Small repair	m^2	342,000	1.4	477,090	0.1% of crown area of main dam body
		Removal of Sand Deposit	m^3	8,100	2,020.0	16,362,000	1% of trapping capacity
	Sand Pocket Dam No.3	Small repair	m^2	342,000	1.0	344,736	0.1% of crown area of main dam body
		Removal of Sand Deposit	m^3	8,100	1,290.0	10,449,000	1% of trapping capacity
	Sand Pocket Dam No.4	Small repair	m^2	342,000	1.9	660,744	0.1% of crown area of main dam body
		Removal of Sand Deposit	m^3	8,100	4,440.0	35,964,000	1% of trapping capacity
	Sand Pocket Dam No.5	Small repair	m^2	342,000	1.3	452,466	0.1% of crown area of main dam body
		Removal of Sand Deposit	m^3	8,100	1,423.0	11,526,300	1% of trapping capacity
	Sabo Dam No. 6	Small repair	m^2	342,000	0.7	235,980	0.1% of crown area of main dam body
		Removal of Sand Deposit	m^3	8,100	744.0	6,026,400	1% of trapping capacity
	Sabo Dam No. 8	Small repair	m^2	342,000	0.7	235,980	0.1% of crown area of main dam body
		Removal of Sand Deposit	m^3	8,100	1,224.0	9,914,400	1% of trapping capacity
	New Sabo Dams (11 dams) proposed in the on-going Project for Collapse of Mt. Bawakaraeng	Small repair	m^2	342,000	14.0	4,782,039	0.1% of crown area of main dam body
		Removal of Sand Deposit	m^3	8,100	20,084.4	162,683,871	1% of trapping capacity
	Sub-total					274,035,127	
Grand Total						**1,000,589,580**	

Note: Man-power cost of permanent staff and its incidental cost is excluded from the above annual cost.

Table E10.4 Cost for Overhaul of Mechanical Facilities (1/2)

Facility		Item	Work Interval (year)	Unit	Quantity	Unit Cost (Rp.)	Annual Cost (Rp.)
(1) Bili-Bili Dam	Regulating Gate	Grease	3	kg	50	800,000	13,333,333
		Oil	3	liter	50	20,000	333,333
		Overhaul of limit switch for gate operation	5	unit	2	1,000,000	400,000
		Overhaul of Gate motor	10	unit	2	5,000,000	1,000,000
		Overhaul of Control panel	10	unit	2	3,000,000	600,000
		Overhaul of Operation equipment	10	unit	2	30,000,000	6,000,000
		Overhaul of Miscellaneous equipment	10	L.S.	-	10,000,000	10,000,000
		Sub-total					31,666,667
	Bulkhead Gate	Grease	3	kg	20	800,000	5,333,333
		Oil	3	liter	20	20,000	133,333
		Overhaul of limit switch for gate operation	5	unit	1	1,000,000	200,000
		Overhaul of Gate motor	10	unit	1	5,000,000	500,000
		Overhaul of Control panel	10	unit	1	5,000,000	500,000
		Overhaul of Operation equipment	10	unit	1	30,000,000	3,000,000
		Overhaul of Miscellaneous equipment	10	L.S.	-	10,000,000	10,000,000
		Sub-total					19,666,667
	Guard Gate (Gate Valve) & Control Gate (Jet Flow Gate)	Grease	3	kg	10	800,000	2,666,667
		Oil	3	liter	10	20,000	66,667
		Overhaul of Gate motor	10	unit	2	3,000,000	600,000
		Overhaul of Control panel	10	unit	2	3,000,000	600,000
		Overhaul of Operation equipment	10	unit	2	3,000,000	600,000
		Overhaul of Miscellaneous equipment	10	L.S.	-	1,000,000	1,000,000
		Sub-total					5,533,333
	Total						***56,866,667***
(2) Raw Water Transmission Main	Raw Water Transmission Main	Grease	3	kg	20	16,000	106,667
		Oil	3	liter	20	20,000	133,333
		Overhaul of Operation equipment (Intake Gate)	10	unit	2	2,000,000	400,000
		Overhaul of Operation equipment (butterfly valve)	10	unit	12	10,000,000	12,000,000
		Overhaul of Sluice Valve	10	unit	16	2,000,000	3,200,000
		Overhaul of Air Valve	10	unit	15	1,000,000	1,500,000
		Overhaul of Miscellaneous equipment	10	L.S.	-	1,000,000	1,000,000
	Total						***18,340,000***
(3) Irrigation Weir	Bili-Bili Irrigation Weir Intake Gate	Grease	3	kg	10	16,000	53,333
		Oil	3	liter	10	20,000	66,667
		Overhaul of limit switch for gate operation	5	unit	2	1,000,000	400,000
		Overhaul of Gate motor	10	unit	2	1,500,000	300,000
		Overhaul of Control panel	10	unit	2	3,000,000	600,000
		Overhaul of Operation equipment	10	unit	2	5,000,000	1,000,000
		Overhaul of Miscellaneous equipment	10	L.S.	-	1,000,000	1,000,000
		Sub-total					3,420,000
	Bili-Bili Irrigation Weir Sand Flush	Grease	3	kg	10	16,000	53,333
		Oil	3	liter	10	20,000	66,667
		Overhaul of limit switch for gate operation	5	unit	2	1,000,000	400,000
		Overhaul of Gate motor	10	unit	2	1,500,000	300,000
		Overhaul of Control panel	10	unit	2	3,000,000	600,000
		Overhaul of Operation equipment	10	unit	2	5,000,000	1,000,000
		Overhaul of Miscellaneous equipment	10	L.S.	-	1,000,000	1,000,000
		Sub-total					3,420,000
	Bissua Irrigation Weir Intake Gate	Grease	3	kg	10	16,000	53,333
		Oil	3	liter	10	20,000	66,667
		Overhaul of limit switch for gate operation	5	unit	2	1,000,000	400,000
		Overhaul of Gate motor	10	unit	2	1,500,000	300,000
		Overhaul of Control panel	10	unit	2	3,000,000	600,000
		Overhaul of Operation equipment	10	unit	2	5,000,000	1,000,000
		Overhaul of Miscellaneous equipment	10	L.S.	-	1,000,000	1,000,000
		Sub-total					3,420,000
	Bissua Irrigation Weir Sand Flush	Grease	3	kg	10	16,000	53,333
		Oil	3	liter	10	20,000	66,667
		Overhaul of limit switch for gate operation	5	unit	2	1,000,000	400,000
		Overhaul of Gate motor	10	unit	2	1,500,000	300,000
		Overhaul of Control panel	10	unit	2	3,000,000	600,000
		Overhaul of Operation equipment	10	unit	2	5,000,000	1,000,000
		Overhaul of Miscellaneous equipment	10	L.S.	-	1,000,000	1,000,000
		Sub-total					3,420,000
	Kampili Irrigation Weir Intake Gate	Grease	3	kg	10	16,000	53,333
		Oil	3	liter	10	20,000	66,667
		Overhaul of limit switch for gate operation	5	unit	2	1,000,000	400,000
		Overhaul of Gate motor	10	unit	2	1,500,000	300,000
		Overhaul of Control panel	10	unit	2	3,000,000	600,000
		Overhaul of Operation equipment	10	unit	2	5,000,000	1,000,000
		Overhaul of Miscellaneous equipment	10	L.S.	-	1,000,000	1,000,000
		Sub-total					3,420,000
	Kampili Irrigation Weir Sand Flush	Grease	3	kg	10	16,000	53,333
		Oil	3	liter	10	20,000	66,667
		Overhaul of limit switch for gate operation	5	unit	2	1,000,000	400,000
		Overhaul of Gate motor	10	unit	2	1,500,000	300,000
		Overhaul of Control panel	10	unit	2	3,000,000	600,000
		Overhaul of Operation equipment	10	unit	2	5,000,000	1,000,000
		Overhaul of Miscellaneous equipment	10	L.S.	-	1,000,000	1,000,000
		Sub-total					3,420,000
	Total						20,520,000
Total of (1) to (3)							**95,726,667**

Note: Man-power cost of permanent staff and its incidental cost is excluded from the above annual cost.

Table E10.4 Cost for Overhaul of Mechanical Facilities (2/2)

Facility		Item	Work Interval (year)	Unit	Quantity	Unit Cost (Rp.)	Annual Cost (Rp.)
(4) Rubber Dam	Rubber GateNo.1 & No.5	Grease	3	kg	10	800,000	2,666,667
		Oil	5	liter	20	20,000	80,000
		Overhaul of Compressor & Motor	5	unit	2	3,000,000	1,200,000
		Overhaul of Control panel	10	unit	2	1,500,000	300,000
		Overhaul of Valve equipment	10	unit	2	2,000,000	400,000
		Overhaul of Miscellaneous equipment	10	L.S.	-	1,000,000	1,000,000
		Sub-total	1				5,646,667
	Rubber GateNo.2 to No.4	Grease	3	kg	10	800,000	2,666,667
		Oil	5	liter	20	20,000	80,000
		Overhaul of Compressor & Motor	5	unit	3	3,000,000	1,800,000
		Overhaul of Control panel	10	unit	3	1,500,000	450,000
		Overhaul of Valve equipment	10	unit	3	2,000,000	600,000
		Overhaul of Miscellaneous equipment	10	L.S.	-	1,000,000	1,000,000
		Sub-total	1				6,596,667
	Total						***12,243,333***
(6) Long Storage	Long Storage Inlet Gate	Grease	3	kg	30	800,000	8,000,000
		Oil	3	liter	50	20,000	333,333
		Overhaul of Gate motor	10	unit	4	1,500,000	600,000
		Overhaul of Control panel	10	unit	4	1,500,000	600,000
		Overhaul of Operation equipment	10	unit	4	3,000,000	1,200,000
		Overhaul of Miscellaneous equipment	10	L.S.	-	1,000,000	1,000,000
		Sub-total	1				11,733,333
	Long Storage Outlet Gate	Grease	3	kg	30	800,000	8,000,000
		Oil	3	liter	50	20,000	333,333
		Overhaul of Gate motor	10	unit	2	1,500,000	300,000
		Overhaul of Control panel	10	unit	2	1,500,000	300,000
		Overhaul of Operation equipment	10	unit	2	3,000,000	600,000
		Overhaul of Miscellaneous equipment	10	L.S.	-	1,000,000	1,000,000
		Sub-total	1				10,533,333
	Long Storage Flushing Gate	Grease	3	kg	10	16,000	53,333
		Oil	3	liter	-	-	-
		Overhaul of Operation equipment	10	unit	2	2,000,000	400,000
		Overhaul of Miscellaneous equipment	10	L.S.	-	1,000,000	1,000,000
		Sub-total	1				1,453,333
	Total						***23,720,000***
(7) Riparian	Drainage Gate R-4, R-7, R-8, R-9	Grease	3	kg	20	800,000	5,333,333
		Oil	3	liter	20	20,000	133,333
		Overhaul of Operation equipment	10	unit	7	3,000,000	2,100,000
		Overhaul of Miscellaneous equipment	10	L.S.	-	7,000,000	7,000,000
		Sub-total	1				14,566,667
	Drainage Gate R-2, R-3, R-5, R-6 & L-2	Grease	3	kg	15	800,000	4,000,000
		Oil	3	liter	15	20,000	100,000
		Overhaul of Operation equipment	10	unit	5	3,000,000	1,500,000
		Overhaul of Miscellaneous equipment	10	L.S.	-	7,000,000	7,000,000
		Sub-total	1				12,600,000
	Drainage Gate L-1 & R-1	Grease	3	kg	20	800,000	5,333,333
		Oil	3	liter	20	20,000	133,333
		Overhaul of Operation equipment	10	unit	4	3,000,000	1,200,000
		Overhaul of Miscellaneous equipment	10	L.S.	-	7,000,000	7,000,000
		Sub-total	1				13,666,667
	Total						***40,833,333***
Total of (4) to (7)							**76,796,667**
Grand Total of (1) to (7)							**172,523,333**

Note: Man-power cost of permanent staff and its incidental cost is excluded from the above annual cost.

Table E10.5 Annual Operation Cost of Mechanical Facilities (1/2)

Facility		Description	Unit	Quantity	Unit Cost (Rp.)	Cost (Rp.)
(1) Bili-Bili Dam	Gate	Grease	kg	40	800,000	32,000,000
		Oil	liter	40	20,000	800,000
		Spare Parts	L.S.			20,000,000
		Consumables	L.S.			6,000,000
		Miscellaneous (10% above)	L.S.			5,880,000
		Fuel (Bili-Bili Dam)	liter	2,574	2,000	5,148,000
		Fuel (Monitoring Room)	liter	32	2,000	63,000
		Sub-total				69,891,000
	Telemetry Gauging System	Recording Chart (Water Level)	roll	30	290,000	8,700,000
		Recording Chart (Rainfall)	roll	35	240,000	8,400,000
		Recording Pen (Water Level)	set	30	620,000	18,600,000
		Recording Pen (Rainfall)	set	35	295,000	10,325,000
		Spare parts	L.S.			42,500,000
		Miscellaneous (10% of above)	L.S.			8,852,500
		Sub-total				97,377,500
	Total					***167,268,500***
(2) RWTM	Intake Gate and Valve	Grease	kg	10	800,000	8,000,000
		Oil	liter	10	20,000	200,000
		Spare Parts	L.S.	-	-	10,000,000
		Consumables	L.S.	-	-	5,000,000
		Miscellaneous (10% above)	L.S.	-	-	2,320,000
	Total					***25,520,000***
(3) Rubber Dam	Rubber Gate	Grease	kg	10	800,000	8,000,000
		Oil	liter	20	20,000	400,000
		Spare Parts	L.S.			10,000,000
		Consumables	L.S.			3,000,000
		Miscellaneous (10% above)	L.S.			2,140,000
		Power Supply (Base)	KVA	23	390,000	9,009,000
		Power Supply (Peak rime)	kwh	5,760	660	3,801,600
		Power Supply (Off-peak Time)	kwh	5,760	440	2,534,400
		Fuel (Monitoring Room)	liter	32	2,000	63,000
	Total					***38,948,000***
Total of (1) to (3)						***231,736,500***

Note: Man-power cost of permanent staff and its incidental cost is excluded from the above annual cost.

Table E10.5 Annual Routine Operation Cost of Mechanical Facilities (2/2)

Facility		Description	Unit	Quantity	Unit Cost (Rp.)	Cost (Rp.)
(4) Irrigation Intake Weir	Kampili, Bissua and Bili-Bili Irrigation Intake	Grease	kg	36	16,000	576,000
		Oil	liter	20	56,000	1,120,000
		Spare Parts	L.S.			120,000,000
		Consumables	L.S.			35,000,000
		Miscellaneous (10% above)	L.S.			15,669,600
		Power Supply (Base) for Bissua	KVA	33	390,000	12,870,000
		Power Supply (Peak rime) for Bissua	kwh	10,800	660	7,128,000
		Power Supply (Off-peak Time) for Bissua	kwh	41,040	440	18,057,600
		Power Supply (Base) for Kampili	KVA	16	390,000	6,240,000
		Power Supply (Peak rime) for Kampili	kwh	5,400	660	3,564,000
		Power Supply (Off-peak Time) for Kampili	kwh	20,520	440	9,028,800
		Fuel	liter	364	2,000	***728,000***
	Total					***229,982,000***
(5) Downstream Riparian Structure	11 Drainage Sluice Gates	Gate Keeper (Entrusted to residents)	person-day	4,015	10,000	40,150,000
		Grease	kg	12	800,000	9,600,000
		Oil	liter	12	20,000	240,000
		Spare Parts	L.S.	0	0	14,000,000
		Consumables	L.S.	0	0	12,000,000
		Miscellaneous (10% above)	L.S.	0	0	7,599,000
	Total					***83,589,000***
(6) Long Storage	3 gates (Intake Gate, Flash Gate and Tidal Gate)	Gate Keeper (Entrusted to residents)	person-day	1,080	10,000	10,800,000
		Grease (for Intake and Tidal gate)	kg	40	800,000	32,000,000
		Grease (for Flush gate)	kg	2	160,000	320,000
		Oil	liter	100	20,000	2,000,000
		Spare Parts	L.S.			15,000,000
		Consumables	L.S.			4,500,000
		Miscellaneous (10% above)	L.S.			6,462,000
		Power Supply (Base)	KVA	8	772,800	6,182,400
		Power Supply (Peak rime)	kwh	960	455	436,800
		Power Supply (Off-peak Time)	kwh	33,600	460	15,456,000
		Fuel (Monitoring Room)	liter	32	2,000	63,000
	Total					***93,220,200***
Total of (4) to (6)						***406,791,200***
Grand Total of (1) to (6)						***638,527,700***

Note: Man-power cost of permanent staff and its incidental cost is excluded from the above annual cost.

Table E10.6 Breakdown of Energy Charge

No.	Facilities	Installed Capacity	Operation Time	Unit Cost Burden (Rp./kVA)	Unit Cost Usage (Rp./kWh)	Cost (Rp.)	Note
1	Bili-Bili Dam	325 kVA	12 month	-	-	0	supplied by Micro-hydro
			350 hour	-	-	0	0-350h, Peak time (17-22)
		288 kW	1,475 hour	-	-	0	350h-, Peak time (17-22)
			6,935 hour	-	-	0	Off-peak time
	Sub-total					0	
2	Rubber Dam	23 kVA	12 month	32,500	-	9,009,000	
		16 kW	360 hour	-	660	3,801,600	Peak time (17-22)
			360 hour	-	440	2,534,400	Off-peak time
	Sub-total					15,345,000	
3	Bili-Bili Irrigation Weir	6 kVA	12 month	-	-	0	supplied from Bili-Bili dam
		6 kW	80 hour	-	-	0	0-80h
			2,800 hour	-	-	0	80h-
	Sub-total					0	
4	Bissua Irrigation Weir	33 kVA	12 month	32,500	-	12,870,000	
		18 kW	600 hour	-	660	7,128,000	Peak time (17-22)
			2,280 hour	-	440	18,057,600	Off-peak time
	Sub-total					38,055,600	
5	Kampili Irrigation Weir	16 kVA	12 month	32,500	-	6,240,000	
		9 kW	600 hour	-	660	3,564,000	Peak time (17-22)
			2,280 hour	-	440	9,028,800	Off-peak time
	Sub-total					18,832,800	
6	Long Storage Intake	8 kVA	12 month	32,200	-	3,091,200	
		6 kW	80 hour	-	455	291,200	0-80h
			2,800 hour	-	460	7,654,400	80h-
	Sub-total					11,036,800	
7	Tidal Gate	8 kVA	12 month	32,200	-	3,091,200	
		6 kW	80 hour	-	455	291,200	0-80h
			2,800 hour	-	460	7,654,400	80h-
	Sub-total					11,036,800	
8	Pampang Pumping Station	33 kVA	12 month	32,500	-	12,870,000	
		21 kW	1,800 hour	-	660	24,948,000	Peak time (17-22)
			2,520 hour	-	440	23,284,800	Off-peak time
	Sub-total					61,102,800	
9	RWTM	5 kVA	12 month	32,200	-	1,932,000	
		4 kW	80 hour	-	455	182,000	0-80h
			640 hour	-	460	1,140,800	80h-
	Sub-total					3,254,800	
	Total	-	-	-	-	155,409,800	

Note:
(1) Installed Capacity is estimated based on result of interview and design documents.
(2) Operation time is applied to following table.

No.	Facilities	hour/day	day/month	month/year	total hour
1	Bili-Bili Dam	24	30	12	8,760
2	Rubber Dam	2	30	12	720
3	Bili-Bili Irrigation Weir	24	30	4	2,880
4	Bissua Irrigation Weir	24	30	4	2,880
5	Kampili Irrigation Weir	24	30	4	2,880
6	Long Storage Intake	24	30	4	2,880
7	Tidal Gate	24	30	4	2,880
8	Pampang Pumping Station	24	30	6	4,320
9	RWTM	2	30	12	720

Table E10.7 Breakdown of Fuel Cost for Diesel Engine Generator

Facilities	Capacity (kVA)	Operation Time (hour/year)	Fuel Consumption (liter/hour)	Fuel Unit Cost (Rp./Liter)	Total Cost (Rp.)	Note
Bili-Bili Dam	200	110	23.4	2,000	5,148,000	DG was operated 863 hours from 1997 to 2004.
Induk Office	50	5	6.3	2,000	63,000	The facility is connected to GMTDC feeder of PLN.
Rubber Dam	50	5	6.3	2,000	63,000	The facility is connected to GMTDC feeder of PLN.
Bissua Irrigation Weir	75	35	9.1	2,000	633,500	The facility is connected to Rindam feeder of PLN.
Kampili Irrigation Weir	75	5	9.1	2,000	91,000	The facility is connected to Kampili feeder of PLN.
Tidal Gate	5	5	1.6	2,000	16,000	The facility is connected to GMTDC feeder of PLN.
Pampang Pumping Station	660	98	73.6	2,000	14,425,600	DG was operated 490 hours from 2000 to 2004.
Total	-	-	-	-	20,440,100	

Note:
(1) Fuel consumption is applied to the value from Japanese manufacture's catalogue.
(2) Operation time is applied to the value of operation record or electric power failure of PLN.
(3) Average for the last 3 years of annual electric power failure on GMTDC feeder is 220 minutes.
(4) Average for the last 3 years of annual electric power failure on Rindam feeder is 1,821 minutes.
(5) Average for the last 3 years of annual electric power failure on Kampili feeder is 284 minutes.

Table E10.8 Annual Salary of Permanent Staff for O&M Works and Management Works (1/2)

In 2007

Bureau/Section	Designation	Annual Salary (Rp/year)	Number of Staff	Personnel Cost for O&M and management Works									
				For O&M Works					For Management Works				Total
				Bili-Bili Dam	Sabo	Rubber/Long Storage	Downstream River	Irrigation Weir	Water Quantity	Flood	Drought	River Conservation	
	Head of Operations Directorate	138,456,000	1	0	0	0	0	0	6,922,800	6,922,800	6,922,800	6,922,800	27,691,200
Administration & Finance Bureau	Head of Adm. & Finance Bureau	65,699,506	1	0	0	0	0	0	0	0	0	0	0
	Legal Advisor	44,288,580	0	0	0	0	0	0	0	0	0	0	0
	Public Relations Coordinator	23,307,240	0	0	0	0	0	0	0	0	0	0	0
	Head of HR Section	50,473,512	0	0	0	0	0	0	0	0	0	0	0
	Head of Finance Section	50,473,512	1	0	0	0	0	0	0	0	0	0	0
	Head of General Affairs Section	50,473,512	1	0	0	0	0	0	1,009,470	1,009,470	1,009,470	1,009,470	4,037,881
	Administration Staff (2)	12,213,997	2	0	0	0	0	0	0	0	0	0	0
	Finance/Accounting Staff	12,213,997	1	0	0	0	0	0	0	0	0	0	0
	Office Boy/Girl	12,712,065	1	0	0	0	0	0	0	0	0	0	0
	Security [[subcontracted; numbers not correct]]	12,712,065	0	0	0	0	0	0	0	0	0	0	0
	Computer Operator/Typist (Admi)	12,368,728	1	0	0	0	0	0	0	0	0	0	0
	Drivers	12,213,997	2	0	0	0	0	0	0	0	0	0	0
	Sub-total		10	0	0	0	0	0	1,009,470	1,009,470	1,009,470	1,009,470	4,037,881
Technical Bureau	Head of Technical Bureau	65,699,506	1	6,569,951	0	3,284,975	0	3,284,975	6,569,951	3,284,975	3,284,975	6,569,951	32,849,753
	Head of Program Section	50,473,512	0	0	0	0	0	0	0	0	0	0	0
	Head of OM & Environment Section	50,473,512	0	0	0	0	0	0	0	0	0	0	0
	Survey & Equipment Staff	20,104,349	0	0	0	0	0	0	0	0	0	0	0
	Water Quality Analyst / Hydrologist	23,500,143	0	0	0	0	0	0	0	0	0	0	0
	Engineering Staff for Program Section	23,500,143	1	2,350,014	0	2,350,014	0	2,350,014	4,700,029	4,700,029	2,350,014	2,350,014	21,150,129
	Structural Engineer	20,104,349	0	0	0	0	0	0	0	0	0	0	0
	Mechanical/Electrical Enginner	12,213,997	1	4,885,599	0	4,885,599	1,221,400	1,221,400	0	0	0	0	12,213,997
	Gelogist/Soil Mechanical Engineer	20,104,349	0	0	0	0	0	0	0	0	0	0	0
	Sampling Staff	12,213,997	0	0	0	0	0	0	0	0	0	0	0
	Computer Operator/Typist (Admi)	12,368,728	1	0	0	0	0	0	3,710,618	3,710,618	2,473,746	2,473,746	12,368,728
	Sub-total		4	13,805,564	0	10,520,588	1,221,400	6,856,389	14,980,597	11,695,622	8,108,735	11,393,710	78,582,606
Sub-section I-1 (For Dam O&M)	Head of Water Service Division I	65,699,506	1	26,279,802	0	0	0	0	6,569,951	6,569,951	3,284,975	3,284,975	45,989,654
	Head of General Affairs Section	50,473,512	1	20,189,405	0	0	0	0	5,047,351	5,047,351	2,523,676	2,523,676	35,331,458
	Computer Operator/Typist (Div I)	12,368,728	1	3,710,618	0	0	0	0	6,184,364	1,236,873	1,236,873	0	12,368,728
	Drivers (Head of Water Service Div)	12,213,997	1	4,885,599	0	0	0	0	1,221,400	610,700	610,700	1,221,400	8,549,798
	Head of Sub-Division I-1	50,473,512	1	25,236,756	0	0	0	0	7,571,027	5,047,351	2,523,676	0	40,378,810
	Hydrologist/Water Quality Expert	23,500,143	0	0	0	0	0	0	0	0	0	0	0
	Telecommunication Engineer	20,104,349	1	10,052,175	0	0	0	0	4,020,870	4,020,870	2,010,435	0	20,104,349
	Computer Engineer	20,104,349	0	0	0	0	0	0	0	0	0	0	0
	Gate Operator Sub I-1 (Dam)	12,213,997	4	48,855,989	0	0	0	0	0	0	0	0	48,855,989
	Field Inspector/Warning Crew Sub-I-1 (Dam)	12,213,997	1	9,771,198	0	0	0	0	610,700	1,221,400	610,700	0	12,213,997
	Computer Operator/Typist Sub Div I-1 (Dam)	12,368,728	1	3,710,618	0	0	0	0	6,184,364	1,236,873	1,236,873	0	12,368,728
	Drivers Sub I-1 (Dam)	12,213,997	2	21,985,195	0	0	0	0	1,221,400	1,221,400	0	0	24,427,994
	Sub-total		14	174,677,355	0	0	0	0	38,631,425	26,212,768	14,037,907	7,030,051	260,589,505
Sub-section I-2 (Upstream O&M)	Head of Sub-Division I-2	50,473,512	0	0	0	0	0	0	0	0	0	0	0
	Field Inspector	12,213,997	0	0	0	0	0	0	0	0	0	0	0
	Computer Operator/Typist Sub Div I-2 (Sabo)	12,368,728	0	0	0	0	0	0	0	0	0	0	0
	Drivers Sub I-2 (Sabo)	12,213,997	0	0	0	0	0	0	0	0	0	0	0
	Sub-total		0	0	0	0	0	0	0	0	0	0	0
Sub-division II-1 (For Irritation Weir O&M)	Head of Water Service Division-II	65,699,506	1	0	0	0	0	32,849,753	13,139,901	0	6,569,951	0	52,559,605
	Computer Operator/Typist	12,368,728	1	0	0	0	0	8,658,109	3,092,182	0	618,436	0	12,368,728
	Drivers Div.	12,213,997	2	0	0	0	0	2,442,799	6,106,999	0	1,221,400	2,442,799	12,213,997
	Head of Sub-Division II-1	50,473,512	1	0	0	0	0	25,236,756	10,094,702	0	5,047,351	0	40,378,810
	Irrigation Engineer	12,213,997	0	0	0	0	0	0	0	0	0	0	0
	Gate Operator	12,213,997	6	0	0	0	0	73,283,983	0	0	0	0	73,283,983
	Drivers for Sub.Div. II-1	12,213,997	1	0	0	0	0	12,213,997	0	0	0	0	12,213,997
	Sub-total		12	0	0	0	0	154,685,398	32,433,784	0	13,457,138	2,442,799	203,019,120
Sub-division II-2 (For Downstream O&M)	Head of Sub-Division II-2	50,473,512	0	0	0	0	0	0	0	0	0	0	0
	Hydraulic Engineer	12,213,997	0	0	0	0	0	0	0	0	0	0	0
	Hydrologist/Water Quality Analyst	23,500,143	0	0	0	0	0	0	0	0	0	0	0
	Field Inspector (River)	12,213,997	0	0	0	0	0	0	0	0	0	0	0
	Computer Operator	12,368,728	0	0	0	0	0	0	0	0	0	0	0
	Gate Operator Sub II-2	12,213,997	4	0	0	48,855,989	0	0	0	0	0	0	48,855,989
	Sub-total		4	0	0	48,855,989	0	0	0	0	0	0	48,855,989
	TOTAL		45	188,482,918	0	59,376,577	1,221,400	161,541,787	93,978,077	45,840,660	43,536,050	28,798,831	622,776,301

Table E10.8 Annual Salary of Permanent Staff for O&M Works and Management Works (2/2)

In 2011

Bureau/Section	Designation	Annual Salary (Rp/year)	Number of Staff	Personnel Cost for O&M an management Works									
				For O&M Works					For Management Works				Total
				Bili-Bili	Sabo	Rubber/Long Storage	Downstream River	Irrigation Weir	Water Quantity	Flood	Drought	River Conservation	
	Head of Operations Directorate	138,456,000	1	0	0	0	0	0	6,922,800	6,922,800	6,922,800	6,922,800	27,691,200
Administration & Finance Bureau	Head of Adm. & Finance Bureau	65,699,506	1	0	0	0	0	0	0	0	0	0	0
	Legal Advisor	44,288,580	1	0	0	0	0	0	885,772	885,772	885,772	885,772	3,543,086
	Public Relations Coordinator	23,307,240	1	0	0	0	0	0	466,145	466,145	466,145	466,145	1,864,579
	Head of HR Section	50,473,512	1	0	0	0	0	0	1,009,470	1,009,470	1,009,470	1,009,470	4,037,881
	Head of Finance Section	50,473,512	1	0	0	0	0	0	0	0	0	0	0
	Head of General Affairs Section	50,473,512	1	0	0	0	0	0	1,009,470	1,009,470	1,009,470	1,009,470	4,037,881
	Administration Staff (2)	12,213,997	2	0	0	0	0	0	0	0	0	0	0
	Finance/Accounting Staff	12,213,997	1	0	0	0	0	0	0	0	0	0	0
	Office Boy/Girl	12,712,065	2	0	0	0	0	0	0	0	0	0	0
	Security [[subcontracted; numbers not correct]]	12,712,065	0	0	0	0	0	0	0	0	0	0	0
	Computer Operator/Typist (Admi)	12,368,728	1	0	0	0	0	0	0	0	0	0	0
	Drivers	12,213,997	3	0	0	0	0	0	0	0	0	0	0
	Sub-total		15	0	0	0	0	0	3,370,857	3,370,857	3,370,857	3,370,857	13,483,427
Technical Bureau	Head of Technical Bureau	65,699,506	1	6,569,951	3,284,975	3,284,975	3,284,975	3,284,975	6,569,951	3,284,975	3,284,975	6,569,951	39,419,704
	Head of Program Section	50,473,512	1	5,047,351	0	5,047,351	0	5,047,351	10,094,702	5,047,351	5,047,351	5,047,351	40,378,810
	Head of OM & Environment Section	50,473,512	1	5,047,351	5,047,351	2,523,676	5,047,351	2,523,676	5,047,351	5,047,351	5,047,351	15,142,054	50,473,512
	Survey & Equipment Staff	20,104,349	1	8,041,740	2,010,435	0	0	0	3,015,652	1,005,217	1,005,217	1,005,217	16,083,479
	Water Quality Analyst / Hydrologist	23,500,143	1	0	0	0	0	0	2,350,014	2,350,014	1,175,007	12,925,079	18,800,114
	Engineering Staff for Program Section	23,500,143	1	2,350,014	1,175,007	2,350,014	1,175,007	2,350,014	4,700,029	4,700,029	2,350,014	2,350,014	23,500,143
	Structural Engineer	20,104,349	1	6,031,305	4,020,870	4,020,870	4,020,870	2,010,435					
	Mechanical/Electrical Enginner	12,213,997	1	4,885,599	0	4,885,599	1,221,400	1,221,400					
	Gelogist/Soil Mechanical Engineer	20,104,349	1	6,031,305	10,052,175	0	2,010,435	2,010,435					
	Sampling Staff	12,213,997	2	0	0	0	0	0	0	0	0	24,427,994	24,427,994
	Computer Operator/Typist (Admi)	12,368,728	1	0	0	0	0	0	3,710,618	3,710,618	2,473,746	2,473,746	12,368,728
	Sub-total		12	44,004,615	25,590,813	22,112,485	16,760,038	18,448,286	35,488,318	25,145,556	20,383,662	69,941,406	277,875,179
Sub-section I-1 (For Dam O&M)	Head of Water Service Division I	65,699,506	1	26,279,802	6,569,951	0	0	0	6,569,951	6,569,951	3,284,975	3,284,975	52,559,605
	Head of General Affairs Section	50,473,512	1	20,189,405	5,047,351	0	0	0	5,047,351	5,047,351	2,523,676	2,523,676	40,378,810
	Computer Operator/Typist (Div I)	12,368,728	1	3,710,618	0	0	0	0	6,184,364	1,236,873	1,236,873	0	12,368,728
	Drivers (Head of Water Service Div)	12,213,997	2	9,771,198	7,328,398	0	0	0	2,442,799	1,221,400	1,221,400	2,442,799	24,427,994
	Head of Sub-Division I-1	50,473,512	1	25,236,756	0	0	0	0	7,571,027	5,047,351	2,523,676	0	40,378,810
	Hydrologist/Water Quality Expert	23,500,143	1	7,050,043	0	0	0	0	2,350,014	2,350,014	2,350,014	9,400,057	23,500,143
	Telecommunication Engineer	20,104,349	1	10,052,175	0	0	0	0	4,020,870	4,020,870	2,010,435	0	20,104,349
	Computer Engineer	20,104,349	1	10,052,175	0	0	0	0	4,020,870	4,020,870	2,010,435	0	20,104,349
	Gate Operator Sub I-1 (Dam)	12,213,997	4	48,855,989	0	0	0	0	0	0	0	0	48,855,989
	Field Inspector/Warning Crew Sub-I-1 (Dam)	12,213,997	1	9,771,198	0	0	0	0	610,700	1,221,400	610,700	0	12,213,997
	Computer Operator/Typist Sub Div I-1 (Dam)	12,368,728	1	3,710,618	0	0	0	0	6,184,364	1,236,873	1,236,873	0	12,368,728
	Drivers Sub I-1 (Dam)	12,213,997	3	32,977,792	0	0	0	0	1,832,100	1,832,100	0	0	36,641,992
	Sub-total		18	207,657,768	18,945,700	0	0	0	46,834,409	33,805,051	19,009,056	17,651,507	343,903,492
Sub-section I-2 (Upstream O&M)	Head of Sub-Division I-2	50,473,512	1	0	25,236,756	0	0	0	2,523,676	2,523,676	0	10,094,702	40,378,810
	Field Inspector	12,213,997	1	0	9,771,198	0	0	0	0	0	0	2,442,799	12,213,997
	Computer Operator/Typist Sub Div I-2 (Sabo)	12,368,728	1	0	9,894,982	0	0	0	0	0	0	2,473,746	12,368,728
	Drivers Sub I-2 (Sabo)	12,213,997	3	0	36,641,992	0	0	0	0	0	0	0	36,641,992
	Sub-total		6	0	81,544,927	0	0	0	2,523,676	2,523,676	0	15,011,247	101,603,526
Sub-division II-1 (For Irritation Weir O&M)	Head of Water Service Division-II	65,699,506	1	0	0	0	0	32,849,753	13,139,901	0	6,569,951	0	52,559,605
	Computer Operator/Typist	12,368,728	1	0	0	0	0	8,658,109	3,092,182	0	618,436	0	12,368,728
	Drivers Div.	12,213,997	3	0	0	0	18,320,996	3,664,199	9,160,498	0	1,832,100	3,664,199	36,641,992
	Head of Sub-Division II-1	50,473,512	1	0	0	0	0	25,236,756	10,094,702	0	5,047,351	0	40,378,810
	Irrigation Engineer	12,213,997	1	0	0	0	0	1,832,100	3,664,199	0	610,700	0	6,106,999
	Gate Operator	12,213,997	6	0	0	0	0	73,283,983	0	0	0	0	73,283,983
	Drivers for Sub.Div. II-1	12,213,997	2	0	0	0	0	24,427,994	0	0	0	0	24,427,994
	Sub-total		15	0	0	0	18,320,996	169,952,895	39,151,483	0	14,678,538	3,664,199	245,768,110
Sub-division II-2 (For Downstream O&M)	Head of Sub-Division II-2	50,473,512	1	0	0	15,142,054	10,094,702	0	5,047,351	2,523,676	2,523,676	5,047,351	40,378,810
	Hydraulic Engineer	12,213,997	1	0	0	3,053,499	3,053,499	0	0	0	0	0	6,106,999
	Hydrologist/Water Quality Analyst	23,500,143	1	0	0	4,700,029	4,700,029	0	4,700,029	1,175,007	1,175,007	0	16,450,100
	Field Inspector (River)	12,213,997	1	0	0	0	6,106,999	0	0	0	0	6,106,999	12,213,997
	Computer Operator	12,368,728	1	0	0	6,184,364	6,184,364	0	0	0	0	0	12,368,728
	Gate Operator Sub II-2	12,213,997	4	0	0	48,855,989	0	0	0	0	0	0	48,855,989
	Sub-total		9	0	0	77,935,934	30,139,593	0	9,747,380	3,698,683	3,698,683	11,154,350	136,374,622
	TOTAL		76	251,662,384	126,081,440	100,048,419	65,220,627	188,401,181	144,038,921	75,466,623	68,063,595	127,716,366	1,146,699,556

Table E10.9 Overhead for O&M Works

For the Year 2007

(unit: 1,000 Rp.)

Description	Unit	Unit Cost	Work Quantity					Cost				
			Bili-Bili Dam	Sabo	Rubber/Long Storage	Riparian Structure	Irrigation Weir	Bili-Bili Dam	Sabo	Rubber/Long Storage	Riparian Structure	Irrigation Weir
1. Direct Personnel Cost								188,483	0	59,377	1,221	161,542
2. Material and Supplies												
(1) Maps	LS							10,000	0	0	0	0
(2) Consumable	LS							3,000	0	1,000	0	1,000
(3) Miscellaneous (20%)	LS							2,600	0	200	0	200
Sub-total								15,600	0	1,200	0	1,200
3. Equipment												
(1) Vehicle	car/day	100.0	360.0	0.0	360.0	0.0	360.0	36,000	0	0	0	36,000
(2) Computer	No./mo.	1,000.0	6.0	0.0	6.0	0.0	6.0	6,000	0	6,000	0	6,000
(5) Miscellaneous (20%)								8,400	0	1,200	0	8,400
Sub-total								50,400	0	7,200	0	50,400
4. Duty Trip and Field Allowance												
(1) Duty trip to Jakarta												
- Travel Cost	No.	1,500.0	3.0	0.0	1.0		3.0	4,500	0	1,500	0	4,500
- Per-diem and lodging	day	550.0	6.0	0.0	2.0		6.0	3,300	0	1,100	0	3,300
(2) Duty trip to Malang												
- Travel Cost	No.	1,200.0	3.0	0.0	1.0		3.0	3,600	0	1,200	0	3,600
- Per-diem and lodging	day	400.0	6.0	0.0	2.0		6.0	2,400	0	800	0	2,400
(3) Field Allowance												
Field allowance for staff	M/D	30.0	300.0	0.0	0.0	0.0	0.0	9,000	0	0	0	0
Field Allowance for drivers	M/D	10.0	150.0	0.0	0.0	0.0	0.0	1,500	0	0	0	0
Lodging allowance	M/D	200.0	10.0	0.0	0.0	0.0	5.0	2,000	0	0	0	1,000
Miscellaneous (20%)								2,500	0	0	0	200
Sub-total								28,800	0	4,600	0	15,000
5. Other Direct Cost												
(1) Report printing cost	LS							3,000	0	3,000	0	3,000
(2) Leaflets for public relation	LS							5,000	0	5,000	0	5,000
(3) Miscellaneous (20%)								1,600	0	1,600	0	1,600
Sub-total								9,600	0	9,600	0	9,600
Total								**292,883**	**0**	**81,977**	**1,221**	**237,742**

For the Year 2011

(unit: 1,000 Rp.)

Description	Unit	Unit Cost	Work Quantity					Cost				
			Bili-Bili Dam	Sabo	Rubber/Long Storage	Riparian Structure	Irrigation Weir	Bili-Bili Dam	Sabo	Rubber/Long Storage	Riparian Structure	Irrigation Weir
1. Direct Personnel Cost								251,662	126,081	100,048	65,221	188,401
2. Material and Supplies												
(1) Maps	LS							10,000	0	0	0	0
(2) Consumable	LS							3,000	0	1,000	0	1,000
(3) Miscellaneous (20%)	LS							2,600	0	200	0	200
Sub-total								15,600	0	1,200	0	1,200
3. Equipment												
(1) Vehicle	car/day	100.0	360.0	360.0	360.0	360.0	360.0	36,000	36,000	36,000	36,000	36,000
(2) Computer	No./mo.	1,000.0	6.0	2.0	6.0	6.0	6.0	6,000	2,000	6,000	6,000	6,000
(5) Miscellaneous (20%)								8,400	7,600	8,400	8,400	8,400
Sub-total								50,400	45,600	50,400	50,400	50,400
4. Duty Trip and Field Allowance												
(1) Duty trip to Jakarta												
- Travel Cost	No.	1,500.0	3.0	1.0	1.0	1.0	3.0	4,500	1,500	1,500	1,500	4,500
- Per-diem and lodging	day	550.0	6.0	2.0	2.0	2.0	6.0	3,300	1,100	1,100	1,100	3,300
(2) Duty trip to Malang												
- Travel Cost	No.	1,200.0	3.0	1.0	1.0	1.0	3.0	3,600	1,200	1,200	1,200	3,600
- Per-diem and lodging	day	400.0	6.0	2.0	2.0	2.0	6.0	2,400	800	800	800	2,400
(3) Field Allowance												
Field allowance for staff	M/D	30.0	300.0	50.0	0.0	0.0	0.0	9,000	1,500	0	0	0
Field Allowance for drivers	M/D	10.0	150.0	5.0	0.0	0.0	0.0	1,500	50	0	0	0
Lodging allowance	M/D	200.0	10.0	5.0	0.0	0.0	5.0	2,000	1,000	0	0	1,000
Miscellaneous (20%)								2,500	510	0	0	200
Sub-total								28,800	7,660	4,600	4,600	15,000
5. Other Direct Cost												
(1) Report printing cost	LS							3,000	3,000	3,000	3,000	3,000
(2) Leaflets for public relation	LS							5,000	5,000	5,000	5,000	5,000
(3) Miscellaneous (20%)								1,600	1,600	1,600	1,600	1,600
Sub-total								9,600	9,600	9,600	9,600	9,600
Total								**356,062**	**188,941**	**165,848**	**129,821**	**264,601**

Table E10.10 Operation Cost for Water Quantity Management, Flood Management, Drought Management and River Channel Management

For the Year 2007

(unit: 1,000 Rp.)

Description		Unit	Unit Cost	Management Work Quantity				Management Cost			
				Water Quantity	Flood	Drought	River Conservation	Water Quantity	Flood	Drought	River Conservation
1.	Direct Personnel Cost							93,978	45,841	43,536	28,799
2.	Labor Cost										
(1)	Field Inspector	M/D	20.0					0	0	0	0
(2)	Labor for discharge measurement	M/D	16.8		32.0	32.0		0	538	538	0
(3)	Miscellaneous (20%)	LS						0	108	108	0
	Sub-total							0	645	645	0
3.	Material and Supplies										
(1)	Maps	LS						10,000	10,000	10,000	10,000
(2)	Consumable	LS						3,000	3,000	3,000	3,000
(3)	Miscellaneous (20%)	LS						2,600	2,600	2,600	2,600
	Sub-total							15,600	15,600	15,600	15,600
4.	Equipment										
(1)	Vehicle (fuel, consumables, repair)	car/day	100.0	360.0	360.0	360.0	360.0	36,000	36,000	36,000	36,000
(2)	Computer	No./mo.	1,000.0	6.0	1.0	1.0	3.0	6,000	1,000	1,000	3,000
(3)	Current meter (for discharge measurement)	No./mo.	500.0	0.0	12.0	12.0	0.0	0	6,000	6,000	0
(4)	Communication tool (for river patrol)	No./mo.	250.0	0.0	0.5	6.0	0.0	0	125	1,500	0
(5)	Miscellaneous (20%)							8,400	8,625	8,900	7,800
	Sub-total							50,400	51,750	53,400	46,800
5.	Duty Trip and Field Allowance										
(1)	Duty trip to Jakarta										
	- Travel Cost	No.	1,500.0	3.0	3.0	3.0	3.0	4,500	4,500	4,500	4,500
	- Per-diem and lodging	day	550.0	6.0	6.0	6.0	6.0	3,300	3,300	3,300	3,300
(2)	Duty trip to Malang										
	- Travel Cost	No.	1,200.0	3.0	3.0	3.0	3.0	3,600	3,600	3,600	3,600
	- Per-diem and lodging	day	400.0	6.0	6.0	6.0	6.0	2,400	2,400	2,400	2,400
(3)	Field Allowance										
	Field allowance for staff	M/D	30.0	50.0	20.0	20.0	50.0	1,500	600	600	1,500
	Field Allowance for drivers	M/D	10.0	20.0	10.0	10.0	20.0	200	100	100	200
	Lodging allowance	M/D	200.0	10.0	5.0	0.0	10.0	2,000	1,000	0	2,000
	Miscellaneous (20%)							740	340	140	740
	Sub-total							18,240	15,840	14,640	18,240
6.	Other Direct Cost										
(1)	Report printing cost	LS						3,000	3,000	3,000	3,000
(2)	Leaflets for public relation	LS						5,000	5,000	5,000	5,000
(3)	Miscellaneous (20%)							1,600	1,600	1,600	1,600
	Sub-total							9,600	9,600	9,600	9,600
7.	Contract Work (River Channel Survey)	Section	1,500.0		60.0	60.0	60.0	0	90,000	90,000	90,000
	Total							**187,818**	**229,276**	**227,421**	**209,039**

For the Year 2011

(unit: 1,000 Rp.)

Description		Unit	Unit Cost	Quantity				Cost			
				Water Quantity	Flood	Drought	River Conservation	Water Quantity	Flood	Drought	River Conservation
1.	Direct Personnel Cost							144,039	75,467	68,064	127,716
2.	Labor Cost										
(1)	Field Inspector	M/D	20.0		180.0		48.0	0	3,600	0	960
(2)	Labor for discharge measurement	M/D	16.8		32.0	32.0		0	538	538	0
(3)	Miscellaneous (20%)	LS						0	108	108	0
	Sub-total							0	4,245	645	960
3.	Material and Supplies										
(1)	Maps	LS						10,000	10,000	10,000	10,000
(2)	Consumable	LS						3,000	3,000	3,000	3,000
(3)	Miscellaneous (20%)	LS						2,600	2,600	2,600	2,600
	Sub-total							15,600	15,600	15,600	15,600
4.	Equipment										
(1)	Vehicle (fuel, consumables, repair)*	car/day	100.0	360.0	360.0	360.0	360.0	36,000	36,000	36,000	36,000
(2)	Computer	No./mo.	1,000.0	12.0	2.0	2.0	6.0	12,000	2,000	2,000	6,000
(3)	Current meter (for discharge measurement)	No./mo.	500.0	0.0	12.0	12.0	0.0	0	6,000	6,000	0
(4)	Communication tool (for monitoring)*	No./mo.	250.0	0.0	0.5	6.0	24.0	0	125	1,500	6,000
(5)	Miscellaneous (20%)							9,600	8,825	9,100	9,600
	Sub-total							57,600	52,950	54,600	57,600
5.	Duty Trip and Field Allowance										
(1)	Duty trip to Jakarta										
	- Travel Cost	No.	1,500.0	6.0	6.0	6.0	6.0	9,000	9,000	9,000	9,000
	- Per-diem and lodging	day	550.0	12.0	12.0	12.0	12.0	6,600	6,600	6,600	6,600
(2)	Duty trip to Malang										
	- Travel Cost	No.	1,200.0	6.0	6.0	6.0	6.0	7,200	7,200	7,200	7,200
	- Per-diem and lodging	day	400.0	12.0	12.0	12.0	12.0	4,800	4,800	4,800	4,800
(3)	Field Allowance*										
	Field allowance for staff	M/D	30.0	50.0	20.0	20.0	50.0	1,500	600	600	1,500
	Field Allowance for drivers	M/D	10.0	20.0	10.0	10.0	20.0	200	100	100	200
	Lodging allowance	M/D	200.0	10.0	5.0	0.0	10.0	2,000	1,000	0	2,000
	Miscellaneous (20%)							740	340	140	740
	Sub-total							32,040	29,640	28,440	32,040
6.	Other Direct Cost										
(1)	Report printing cost	LS						3,000	3,000	3,000	3,000
(2)	Leaflets for public relation	LS						5,000	5,000	5,000	5,000
(3)	Miscellaneous (20%)							1,600	1,600	1,600	1,600
	Sub-total							9,600	9,600	9,600	9,600
7.	Contract Work										
(1)	River Channel Survey	Section	1,500.0		60.0	60.0	60.0	0	90,000	90,000	90,000
(2)	Monitoring of sediment runoff from Mt. Bawakaraeng	LS									50,000
	Sub-total							0	90,000	90,000	140,000
	Total							**258,879**	**277,502**	**266,949**	**333,516**

* Including monitoring works for sediment discharge from Mt. Bawakaraeng