REPUBLIC OF INDONESIA
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT

JENEBERANG RIVER FLOOD CONTROL PROJECT (PHASE II)

MAIN REPORT

MARCH 1982

JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

In response to the request of the Government of the Republic of Indonesia, the Japanese Government decided to conduct a feasibility study on the Jeneberang River Flood Control Project (Phase II) and entrusted the study to the Japan International Cooperation Agency (JICA). The JICA sent to Indonesia a study team headed by Mr. Katsuhisa Abe, CTI Engineering Co., Ltd. from February to August, 1981.

The team exchanged views with the officials concerned of the Government of the Republic of Indonesia and conducted a field survey in the Jeneberang river basin. After the team returned to Japan, further studies were made and the present report has been prepared.

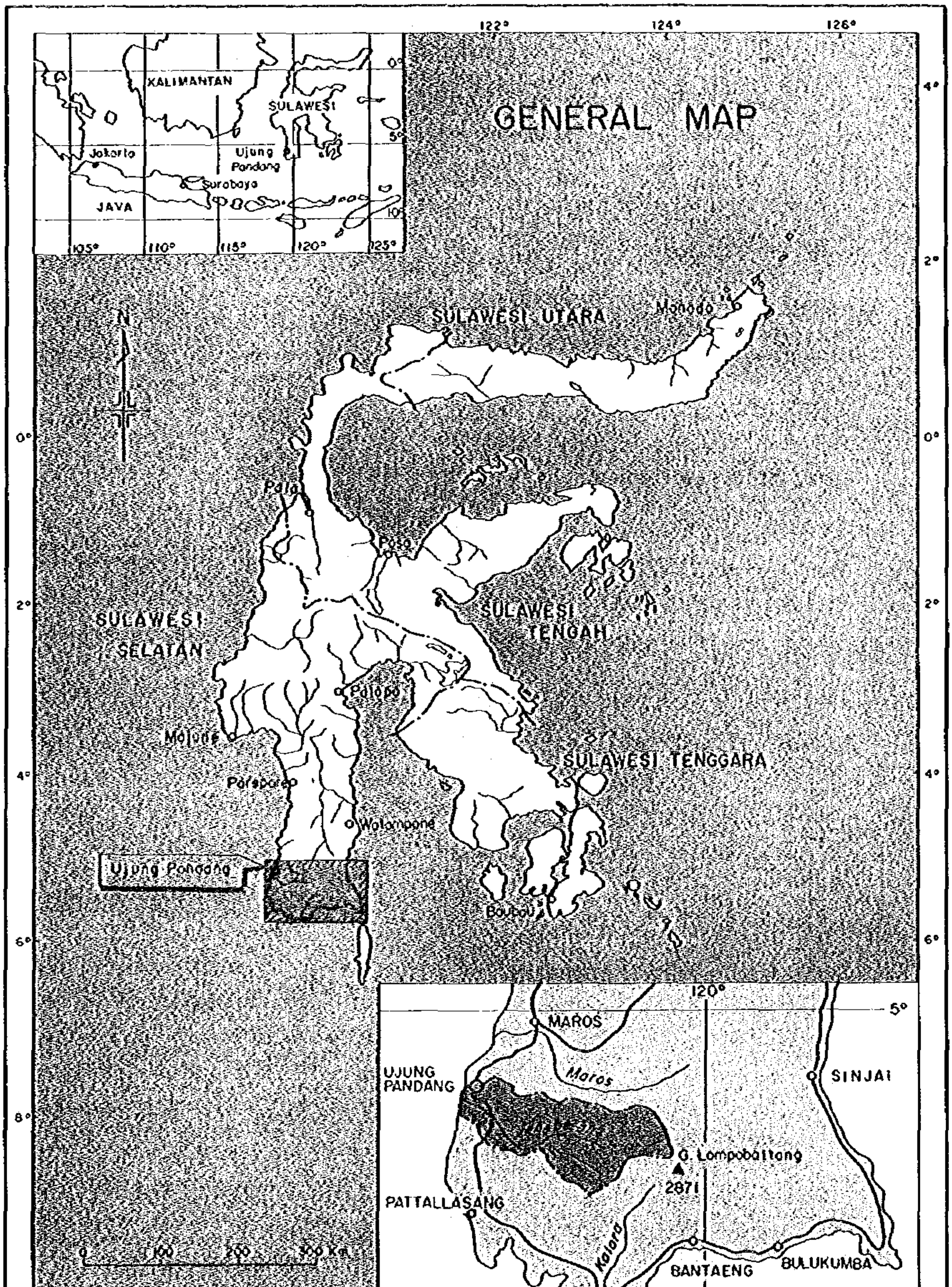
I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Republic of Indonesia for their close cooperation extended to the team.

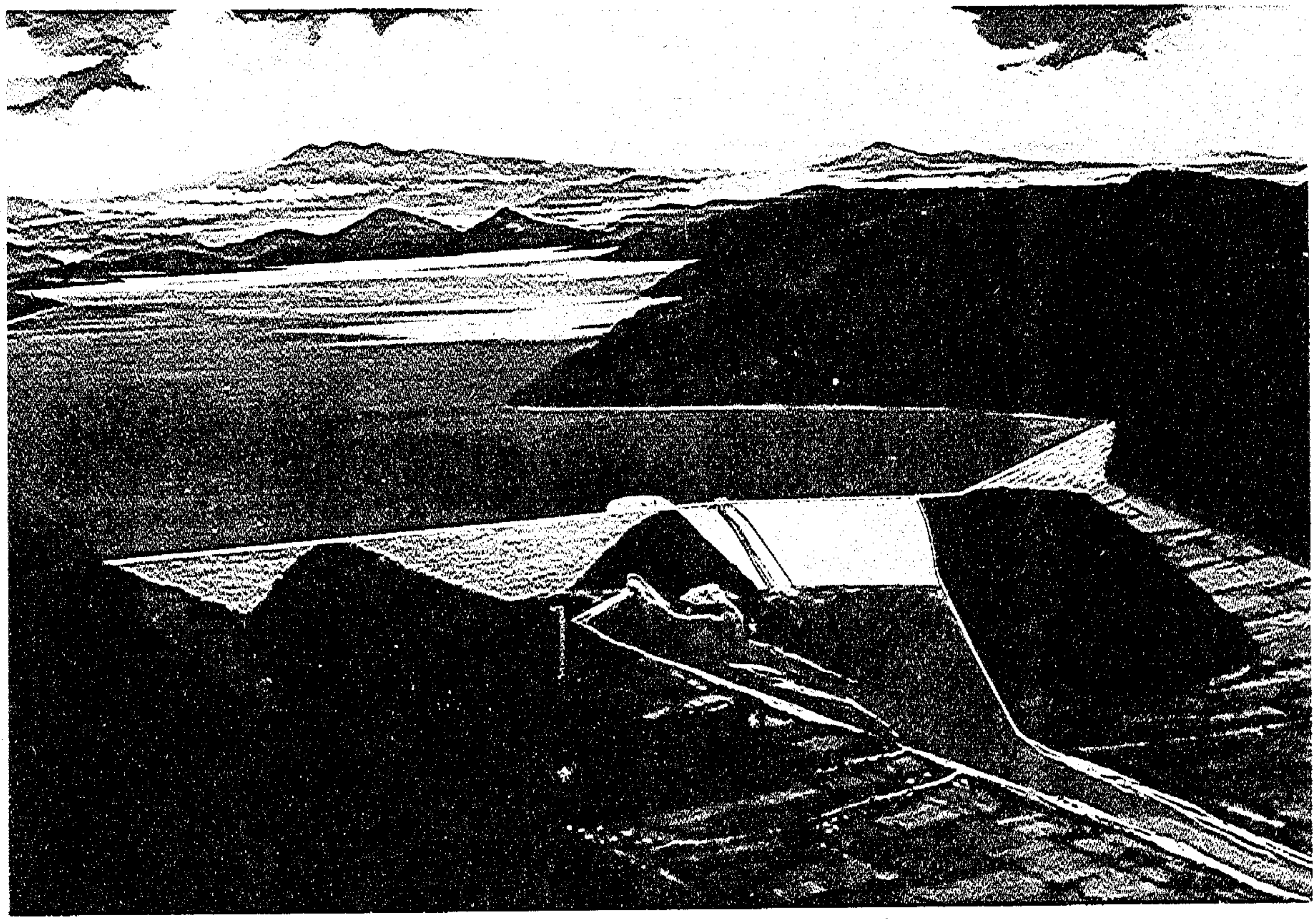
March, 1982

Keisuke Arita

Keisuke Arita
President
Japan International Cooperation Agency



GENERAL MAP
KALIMANTAN
SULAWESI
Jakarta
Ujung Pandang
Surabaya
JAVA
105°
110°
115°
120°
125°
0°
5°
10°
122°
124°
126°
4°
2°
0°
6°
8°
10°
118°
120°
N
SULAWESI UTARA
Manado
Palu
Poso
SULAWESI SELATAN
SULAWESI TENGAH
Palopo
Majene
Parepare
Watampone
SULAWESI TENGGARA
Ujung Pandang
Baubau
0
100
200
300 Km
MAROS
Maros
UJUNG PANDANG
SINJAI
G. Lompobattang
2871
PATTALLASANG
Kalara
BANTAENG
BULUKUMBA
BONTOSUNGGU
0 10 20 30 Km



View of the Bili-Bili Dam and Reservoir

CONCLUSION AND SUMMARY

1. CONCLUSION

The Jeneberang River Flood Control Project (Phase II) has been formulated in order to mitigate flood damage and also to develop water resources toward municipal and industrial water, irrigation as well as hydro power generation.

As a result of this detailed study, it has been concluded that the Project is technically feasible and economically viable with 14.8% of the internal rate of return.

2. SUMMARY

2.1 General

Ujung Pandang city, the capital city of the South Sulawesi Province, has a population of over 700,000, and has been developing as a center of East Indonesia.

Ujung Pandang city and its surrounding area suffer from flood damage every year due in part to an insufficient flow capacity of the Jeneberang river and in part to a poor drainage capacity. On the other hand, they are seriously under shortage of municipal and industrial water, and irrigation water during dry seasons. As for power availability in the project area, its demand is remarkably increasing with the progress of the city development.

To cope with the above-mentioned problems, the project consisting of flood control, municipal and industrial water supply, irrigation water supply and power generation has been formulated in this study.

A multipurpose dam, a core of the project, is planned at the 31 km point (Bili-Bili) away from the Jeneberang river mouth to achieve the desired objectives as mentioned below.

The flooding water will be controlled to protect Ujung Pandang city from flood damage, by the proposed dam and the improved river channel, then safely flown down to the down stream. Municipal and industrial water will be secured by the dam to a satisfactory degree. The proposed dam will also contribute greatly to increment of rice production and power generation.

2.2 Dam and Reservoir

The proposed Bili-Bili dam site is located in the middle reaches of the Jeneberang river. The dam is composed of a main dam and right and left wing dams, all of which are of rock-fill type with a center core.

The Bili-Bili reservoir has a total storage capacity of 362×10^6 m^3 and a total effective capacity of $304 \times 10^6 m^3$. A capacity of 46×10^6 m^3 will be allocated for flood control. This capacity is able to regulate 1,300 m^3/s out of 2,400 m^3/s at the dam site. The remaining capacity of 258×10^6 m^3 can be utilized as water resources of vested right water supply, municipal/industrial water supply and irrigation water supply.

A spillway having a double free flow section with two regular gates will be constructed between the main dam and the left wing dam. In case the discharge happens to surpass 500 m^3/s, they will be completely opened so that the benefitted area may be free from flooding damages due to misoperation of the gate.

An intake is constructed on the bank of the reservoir. The intake water flows down to the power station for generation. The tail water from the station is divided at the division point for the respective supply purposes; municipal and industrial water, irrigation water and vested right water supplies. For suspention of the power operation, a jet flow gate (1.50 m in diameter) will be installed to supply the water for the benefitted area. In addition, an emergency discharge facilities with gate of 2.00 m in a diamter will be installed in order to lower the reservoir water level for inspection and maintenance in case of emergency.

A land of 1,591 ha shall be acquired and 790 houses shall be evacuated due to implementation of the project.

2.3 Flood Control

The flooding water of the river will be controlled by the proposed impounding reservoir and the river improvement work. By using the proposed flood control capacity of the reservoir, the design discharge of 3,700 m^3/s at Kampili and Sungguminasa sites will be regulated to 2,300 m^3/s, which corresponds to a 50-year return period.

The proposed stretch of the river to be improved in this project extends approximately 20 km from the estuary to Kampili. Below Sungguminasa, the improved river channel will be able to confine a discharge of 2,300 m^3/s. Between Sungguminasa and Kampili, only a low water channel will be provided, and the bankful discharge in this section is estimated at 1,300 m^3/s, which corresponds to a 8-year return period.

The proposed longitudinal profiles are 1/1,200 in the upper reaches of the Sungguminasa bridge and 1/1,900 in its lower reaches.

Compound cross-section is employed for the river improvement works below the Sungguminasa brigde. The cross-section has a low water channel with a flow capacity of 900 m^3/s, which corresponds to a 1.5-year return period. River widths above and below Sungguminasa are 162 m and 313 m, respectively.

The low-lying section of Jl. Malino (3 km in distance) in the upper reaches of the Sungguminasa bridge will be raised so as to prevent flood water from flowing into Ujung Pandang city.

The Garassi river which flows into the Jeneberang river at the 0.8 km point will be directly drained to the sea by constructing a diversion channel which runs for about 800 m in parallel to the dike of the Jeneberang.

Riparian structures such as revetments, groynes and groundsills, are proposed in the plan to assure the stability and safety of the proposed river channel.

The land to be acquired and the houses to be evacuated for the river improvement are estimated at 98 ha and 230 nos., respectively.

2.4 Municipal and Industrial Water

Considering the future program of the increasing water demand, the target year of water supply has been fixed in the year of 2000. The water demand in 2000 is estimated at 3,500 l/s, out of which 2,300 l/s has been determined to be secured by the Bili-Bili reservoir.

The municipal and industrial water will be conveyed through a ductile cast-iron pipe with a diameter of 1,500 mm for 25 km from Bili-Bili to the treatment plant. In this stretch, regulating basin and twelve junction wells (at the interval of 1-3 km) will be installed to steadily convey the water.

2.5 Irrigation

The irrigation water developed by the proposed dam will be supplied to the existing irrigation area to achieve the prompt outcome.

In the project area exist two irrigation systems; namely, Bili-Bili system with a benefitted area of 5,000 ha and Kampili system with a benefitted area of 19,000 ha.

The project will enable 19,200 ha out of 24,000 ha to be irrigated even in dry season.

For the purpose of equal distribution of the production output and the resulted wealth, the available irrigation water is distributed to the Kampili and Bili-Bili systems in proportion of its respective area.

Irrigable area, in dry seasons, of the Kampili system is 15,200 ha, while that of the Bili-Bili system is 4,000 ha.

In wet seasons, the irrigation water is steadily be supplied to the benefitted area of 24,000 ha.

In the Kampili system, the narrow section of the main channel of 2,500 m in length, and the secondary and the related facilities are to be improved.

In the Bili-Bili system, a new intake is constructed, and a new connecting channel of 1,500 meters in length will be constructed linking the existing irrigation channel to the intake. The main, secondary and related facilities are also to be improved.

2.6 Hydro Power

The hydro power station is constructed at the immediately down stream toe of the main dam on the left bank. The generation method is of run-of-river type. The generated output is 11,200 KW in power capacity, and the annual generated energy is 69,600 MWH. Power generating equipment consist 2 units of Kaplan type turbine with the installed capacity of 5,600 KW each, and 2 units of 3-phase vertical shaft type generator of 6,600 KVA each.

The transmission line of 30 KV in capacity links Bili-Bili station to Borongloe sub-station over the distance of 15 km along Jl. Malino on the right bank of the Jeneberang river.

2.7 Construction Schedule

The total construction period required for the execution of the project works is 14 years. The construction work will be started in 1982 and terminated in 1995. Construction schedule of each sector including the detailed design phase is given as below;

Sector	Construction Period
Dam	: April of 1983 - March of 1991
River improvement	: April of 1982 - October of 1995
Water supply	: April of 1986 - March of 1991
Irrigation	: April of 1985 - October of 1990
Hydro power	: April of 1987 - March of 1991

2.8 Project Cost

The total project cost is estimated at US$ 603.56 million, on the contract basis by using mid-1981 prices, of which US$ 298.01 million or 49% is foreign currency, and US$ 305.55 million or 51% is local currency. The project cost is classified by work item given as follows.

(x10^6 US$)

Work Item		Foreign currency	Local currency	Total
Dam and reservior	:	151.43	158.76	310.19
The urgent flood control plan and overall river improvement	:	38.77	66.18	104.95
Municipal & industrial water supply	:	56.91	14.79	71.70
Irrigation water supply	:	13.93	48.60	62.53
Power generatrion	:	36.97	17.22	54.19
T o t a l	:	298.01	305.55	603.56

2.9 Project Evaluation

Economic Cost

The total economic cost is estimated at US$ 276.34 million, which is composed of foreign currency portion of US$ 150.95 million and local currency portion of US$ 125.48 million equivalent. These costs are summarized below.

(x10^6 US$)

Work Item		Foreign currency	Local currency	Total
Dam and reservior	:	79.54	67.00	146.54
The urgent flood control plan and overall river improvement	:	17.35	21.81	39.16
Municipal & industrial water supply	:	28.78	6.68	35.46
Irrigation water supply	:	7.20	22.71	29.91
Power generatrion	:	18.08	7.28	25.36
T o t a l	:	150.95	125.48	276.43

Project Benefit

The total annual benefit of the project is estimated at US$ 47.84 million, which can be classified by sector as follows;

Purpose		Annual benefit (x 10^6 US$)
Flood control	:	13.0
Irrigation	:	31.5
Power	:	3.9
Negative benefit	:	- 0.56
T o t a l	:	47.84

Internal Rate of Return

Evaluation of the project was made by means of calculating Internal Rate of Return on the basis of the estimated benefit and economic cost. The Internal Rate of Return of the Jeneberang River Flood Control Project (Phase II) is calculated at 14.8%, assuming a project life of 50 years. This rate shows economic viability of the project.

The Internal Rate of Return has been further calculated for each sector based on cost estimate by purpose, which results in the following percentages.

Sector		IRR (%)
Flood control	:	14.9
Irrigation	:	15.2
Power generation	:	13.3
The Project	:	14.8

FEATURE OF THE PROJECT

1. Dam and Reservoir

Reservoir

Design flood water level (D.F.W.L.)	EL. 102.00 m
Surcharge water level (S.W.L.)	EL. 100.30 m
Normal water level (N.W.L.)	EL. 97.60 m
Low water level (L.W.L.)	El. 74.00 m
Effective water depth (S.W.L.- L.W.L.)	26.30 m
Reservoir surface area at S.W.L.	17.80 km^2
Total storage capacity	362,000,000 m^3
Effective storage capacity	304,000,000 m^3
Flood control capacity	46,000,000 m^3
Water utilization capacity	258,000,000 m^3
Municipal water capacity	17,000,000 m^3
Irrigation water capacity	241,000,000 m^3
Sediment capacity	58,000,000 m^3

Dam

Main dam	
Height above foundation	66.00 m
Crest length	670.00 m
Crest width	10.00 m
Crest elevation	EL. 105.00 m
Dam volume	3,600,000 m^3
Left wing dam	
Height above foundation	40.00 m
Crest length	752.00 m
Crest width	10.00 m
Crest elevation	EL. 105.00 m
Dam volume	1,350,000 m^3
Right wing dam	
Height above foundation	50.00 m
Crest length	440.00 m
Crest width	10.00 m
Crest elevation	EL. 105.00 m
Dam volume	1,330,000 m^3
Spillway	
Free flow section at N.W.L.	100 m wide EL. 97.60 m
Free flow section at S.W.L.	337 m wide EL. 100.30 m
Roller gate	2 nos x 6.5 m wide x 7.2 m high
Chute way	280.00 m in length
Intake and outflow facilities	
Intake water volume	32 m^3/s, Inclined conduit Roller gate 5.0 m wide x 4.0 m high

Municipal and industrial water	Jet flow gate, 0.5 m in diameter
Irrigation and vested right water	Jet flow gate, 1.5 m in diameter
Emergency discharge	Jet flow gate, 2.0 m in diameter
Division works	Control gates 3.5 wide x 2.0 m high x 2 nos

House evacuation and land acquisition

House evacuation	790 nos.
Land acquisition	1,591 ha

Relocation

Road	19,000 m
Pumping station	1 place

2. River Improvement

<u>Discharge</u>

Standard project flood	50-year return period, 2,400 m^3/s at the proposed Bili-Bili dam 3,700 m^3/s at Kampili
Design flood	50-year return period, 1,400 m^3/s at the proposed Bili-Bili dam 2,300 m^3/s at Kampili
<u>Stretch to be improved</u>	20 km from the estuary to the Kampili weir
Flow capacity below Sungguminasa	2,300 m^3/s
Flow capacity above Sungguminasa	1,300 m^3/s in bankful discharge
<u>Diversion Channel of S. Garassi</u>	800 m in total
<u>Road Raising</u>	3,000 m in total
<u>Drainage Ditch</u>	12,000 m in total

<u>Riparian Structures</u>

Groundsill	2 places at the Sungguminasa bridge, and the intake of the paper mill
Revetment	10,300 m in total

Groyne	93 places, 4,700 m in total
Sluice	8 places
Vested right water	0.5 m^3/s

House Evacuation and Land Acquisition

House evacuation	230 houses
Land acquisition	98 ha

3. Water Supply

Intake

Design conveyance volume	2.3 m^3/s
The lowest intake level	EL. 74.0 m

Pipeline Conveyance Facilities

Sand & regulating basin	1 place
Conveyance pipe	Dia. 1,500 mm Ductile cast-iron pipe, 25,000 m in total

4. Irrigation System Improvement

Bili-Bili System

Irrigation area	
Wet season	5,000 ha
Dry season	4,000 ha
Connecting channel	
Flow capacity	6.1 m^3/s
Intake gate	2.0 x 2.0 m x 1 gate
Conduit	200 m in length
Open channel	1,300 m in length
Existing channel	8 km in length
Secondary channel and the related facilities	5,000 ha of improvement area

Kampili System

Irrigation area	
Wet season	19,000 ha
Dry season	15,200 ha
Main channel	23.2 m^3/s in flow capacity, 2,500 m in length
Secondary channel and the related facilities	19,000 ha of improvement area

5. Hydro Power

Power Station

Intake	Inclined conduit
Design intake volume	32 m^3/s
The lowest intake level	EL. 74.0 m
Penstock	1) Dia. 3,500 mm, total length 235 m 2) Dia. 2,400 mm, total length 70 m 3) Dia. 1,800 mm, total length 65 m
Power House	Semi-underground type (floor 38 m x 22 m, 32 m high)

Generating Equipment

Turbine	
Type	Kaplan turbine
Effective head	48.1 m - 24.5 m
Maximum discharge	32 m^3/s
Installed capacity	2 x 5,600 KW
Generator	
Type	3-phase vertical shaft generator
Capacity	2 x 6,600 KVA
Voltage	6 KV
Cycle	50 Hz

Transmission Line

Transmission line	15 km in total
Voltage	30 KV
Conductor	120 mm^2

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GLOSSARY OF TERMS AND ABBREVIATIONS

1. Local Administrative Organizations

Kab. = Kabupaten = Regency
Kec. = Kecamatan = Township
Desa = Village
Kp. = Kampung = Community
DPU = Ministry of Public Works
DGWRD = Directorate General of Water Recources Development
P3SA = Sub-directorate of Planning and Programing
PLN = Perusahaan Umum Listrik Negara
PAM = Perusahaan Air Minum
DOLOG = Provincial Rice Purchasing Agency
KUD = Agricultural Cooperacive Organization
BIMAS/INMAS = Mass Guidance for Self-sufficiency in Food

2. Other Local Terms

Polowijo = Second Crops, Planted after Harvest of Wet Season Paddy
Pelita I = First Five-Year Development Plan
Pelita II = Second Five-Year Development Plan
Pelita III = Third Five-Year Development Plan
Sungai = River
S. = Saluran = Channel
Jl. = Jalan = Street

3. Length

m = meter
cm = centimeter
km = kilometer
K = kilometer point

4. Area, Volume and Weight

m^2 = square meter
ha = hectare = 10^4 m^2
km^2 = square kilometer = 10^6 m^2
l = liter = 1,000 cm^3
m^3 = cubic meter
cm^2 = square centimeter
kg = kilogram
t = ton = 1,000 kg

5. Derived Measures based on the Sam Symbols

m^3/s, m^3/sec = cubic meter per second
t/ha, ton/ha = ton per hectare
m^3/km^2 = cubic meter per squre kilometer
mm/day = millimeter per day
$m^3/km^2/year$ = cubic meter per square kilometer per year
l/s. l/sec = liter per second
m/s, m/sec = meter per second

6. Electric Measures

KW	=	kilowatt
KV	=	kilovolt
MW	=	megawatt
KWH	=	kilowatt-hour
MWH	=	megawatt-hour
KVA	=	kilovolt ampere
Hz	=	hertz

7. Currency

US$	=	United States Dollar
RP, Rp.	=	Indonesian Rupiah
¥	=	Japanese Yen

8. Temperature, Height, etc.

°C	=	degrees in Centigrate
M.S.L.	=	mean sea level
DL	=	datum line
EL.	=	elevation
qc	=	resistance of cone penetration test
PS	=	horse power
%	=	percentage
No.	=	number
Nos.	=	numbers

CHAPTER I - INTRODUCTION

1.1 PROJECT HISTORY

Ujung Pandang City and its surrounding area suffer from flood damage every year due in part to an insufficient flow capacity of the Jeneberang river and in part to a poor drainage capacity. On the other hand, the water resources for municipal, industrial and irrigation water supply are subject to shortage in a dry season.

In 1978, the Government of Indonesia requested the Government of Japan to formulate a flood control plan in the Jeneverang river basin as well as a drainage improvement plan in the Ujung Pandang city. This is named the Lower Jeneberang Flood Control Project.

In response to the request, the Government of Japan dispatched experts in 1979, through Japan International Cooperation Agency (JICA), to perform a feasibility study on the urgent flood control and drainage system improvement plan, and in addition to carry out a preliminary study on a overall flood control and the possibility of developing water resources by means of dam construction.

It was verified that the urgent flood control including drainage system improvement is technically feasible and economically viable. An up-grade flood control and water resources development plan was also recommended to protect the Ujung Pandang city from flood damage as well as to meet the demands for municipal, industrial and irrigation water at present and in the future.

The Government of Japan sent a survey team again in 1981, as requested by the Government of Indonesia, to verify the economic viability of the up-grade flood control and water resources development in continuation to the previous study made in 1979.

1.2 OUTLINE OF THE STUDY

Purpose of the Study

The purpose of the study is to verify the technical feasiblity and economic viablity of the overall flood control plan, which is composed of river improvement and water resources development through the Bili-Bili dam construction.

Study Area

The study area covers the Jeneberang river basin (727 km^2) and the benefitted area of the Kampili irrigation system (19,000 ha.), and the Bili-Bili irrigation system (5,000 ha), which extend on both sides of the Jeneberang river.

Scope of the Study

The scope of the study, agreed upon by and between the governments of Japan and Indonesia, covers the following contents:

1) Terrestrial surveying and mapping of the related area and additional surveying required for the study,

2) Further data collection and review of the data which had been collected through the previous study,

3) Further studies and analysis based on the newly collected data,

4) Planning and preliminary design of the multipurpose dam, the related facilities and the river improvement works, and also preparation of the implementation schedule of the project.

5) Economic and financial analysis of the project, and

6) Transfer of knowledge through the study activities at the project site and through the training in Japan.

The results of the investigation and studies were presented in the report of the following three separate volumes:

1) Main report

2) Supporting report - I

   1. Dam and reservoir
   2. River improvement
   3. Project economy

3) Supporting report - II

   4. Mapping and surveying
   5. Hydrology
   6. Geology
   7. Water supply
   8. Irrigation
   9. Hydro power
   10. Attachment

CHAPTER II - SOCIO-ECONOMIC BACKGROUND

2.1 NATIONAL ECONOMIC BACKGROUND

The Republic of Indonesia is located in the tropical zone and has a territory of 2.03 million km^2 and a population of 142 million.

In the 1960s, the annual growth rate of Gross Domestic Products (hereinafter referred to as GDP) was only about 2%. However, during the period of the First Five-Year Development Plan (Pelita I) starting in the 1970/71 fiscal year, which was aimed at the reestablishment of the national economy, the national economy showed a rapid growth reaching 7% per annum.

During the period of the Second Five-Year Development Plan (Pelita II) which was initiated in the 1974/75 fiscal year, the average annual growth rate reached about 6.9%; although agricultural production, emigration, education and sanitation could not have been improved to a satisfactory degree.

Following the Pelita II, the Third Five-Year Development Plan (Pelita III) was launched out in the 1979/80 fiscal year. Achievement of the targets set out in the Pelita III calls for a rapid development in all the sectors; e.g. infrastructure, industry, agriculture, mining, energy, and so on. The annual incremental rate of GDP is expected to reach 6.5% during this period.

The annual rate of increase of the population is estimated at 2.0% in the period of the Pelita III, while that of the Pelita II was about 2.3%. The present population of 142 million is forecast to reach 151 million at the end of the Pelita III. Per capita GDP is estimated to increase by about 24% during the five years of Pelita III.

2.2 REGIONAL ECONOMIC BACKGROUND

Gross Domestic Product

During the period of Pelita II, the average annual growth rate of the Gross Domestic Product (GDP) in the South Sulawesi Province accounted for 10%, much higher than the national average of 6.9%. The GDP in this province in 1978 reached Rp. 666.8 billion, which corresponds to 3% of the GDP of Indonesia. In making a sectoral review of the growth rate in Pelita II, agriculture sector has grown by 6.9%, mining by 7.8%, industries by 10.2%, transportation and communication by 10.1%, trade by 12.5% and services by 14% annually.

The provincial population has increased at the rate of 1.8% per annum during the five years of the Pelita II.

The growth of per capita GDP during the Pelita II thus shows as high as 40% due to a slight increase of population in this province, although per capita GDP itself is still rather low. The per capita GDP in this province resulted in Rp. 116,500 in 1978, approximately 70% of the national average.

Economic Structure

The regional economy in the South Sulawesi Province highly depends upon the primary economic sector such as agriculture, animal husbandry, fishery and so on. The combined share of these primary sectors accounted for about 55% of the provincial GDP in 1978, which was higher compared with the averaged national dependence on the primary economic sector by 30%. This province is now enjoying surplus production of rice, while Indonesia as a whole has not yet attained self-sufficiency in it. Surplus production of rice contributes toward answering the local demands in other islands.

Fishery, forestry and estate crops are being exported mainly through Ujung Pandang; their combined export value amounted to US$ 36.3 million in 1977, US$ 66.7 million in 1978, and US$ 82.0 million in 1979, corresponding to less than 1% of their total export value from Indonesia. The major items of export are shrimp, timber, and coffee, each sharing the total value in 1978 by 19%, 12% and 10%, respectively.

Mining and quarrying sector is especially underdeveloped in this province, having a share of 9.4% of the provincial GDP. This share is remarkably small in comparison with the national average of 17.6%, although its annual average growth rate reached 7.8% during Pelita II.

Manufacturing and industries likewise contribute slightly to the regional economy by only 3.6% of the GDP. This share is still lower than the national average of 9.9%. The shares of construction and services sectors are also much lower than the national average (refer to Table 2-1).

2.3 *THIRD FIVE-YEAR DEVELOPMENT PLAN*

Indonesia launched out on the Third Five-Year Development Plan (Pelita III) in the fiscal year of 1979/80 with the established aims of : 1) improvement of living standard, technology and welfare, and its equalization, and 2) establishment of the foundation for the subsequent development stage.

To achieve the above goals, the development policy has been set up as follows :

1. Equalization of development degree and an achievement of social justice for the people,

2. Realization of high economic growth, and

3. Stabilization of a healthy and brisk nation.

The Indonesian Government focused on the large scaled development of the economic sectors other than agriculture in the Pelita III. The agricultural sector will be developed to an extent of attaining self-sufficiency in food.

The annual growth rate is expected to reach 6.5% on an average in the Pelita III; 3.5% in agriculture, 4.9% in mining, 11.0% in industry, 9.0% in construction and 8.1% in others (refer to Table 2-2).

To support the above national development policy, the provincial government has likewise set up its own development scheme. The growth rate in South Sulawesi is estimated at 8.5% per annum on an average. The provincial GDP in the final year of the Pelita III (1983/84) is expected to increase to Rp. 972.9 billion. The regional economy will undergo a structural change through which agricultural contribution becomes less important, while industry and trade sectors will assume heavier responsibility for the regional economic development.

Each of the central government, the provincial government and the private sector is expected to increase its investment by an annual rate of approx. 16%, starting from their combined investment amounting to Rp. 147.9 billion in 1979/80. The per capita GDP is estimated to increase at the annual rate of about 6.4%, so that it will be Rp. 154,755 by 1983/84 (refer to Table 2-3).

CHAPTER III - PRESENT CONDITION OF THE PROJECT AREA

3.1 NATURAL RESOURCES

3.1.1 Location and Topography

The project area (latitude 5°4' to 5°25' S and longitude 118°30' to 119°10' E) administratively covers Ujung Pandang city, Kabs. Gowa and Takalar in the South Sulawesi Province, and is topographically made up of the Jeneberang river basin including the agricultural land spreading on the right and left banks of the Jeneberang river, as shown in Fig. 3-1.

The Jeneberang river rises in the Bawakaraeng Mountain, which has an elevation of 2,833 m above M.S.L., and flows to the west. Joining many tributaries and changing its course towards the south-west, it joins the Jenelata river at a distance of 30 km from the rivermouth. After that, it passes through the southern part of Ujung Pandang city, and discharges itself into the Makassar Strait. The total length of the river is about 75 km and the catchment area is 727 km^2. The basin gradient in the upper and lower reaches of the Jenelata confluence is calculated at about 1/65 and 1/800, respectively.

The natural vegetation of the mountainous area is composed of Aran-Aran and a few tall trees. In the top reaches lies a collapse which has been producing the sediments to raise the riverbed level of the Jeneberang river.

Below Bili-Bili, an alluvial fan has developed on the right and left sides. On the right side of these lower reaches lie an urban area and agricultural land which is now under the influence of urbanization.

A flat and fertile agricultural land extends on the left and right sides of the Jeneberang river; 19,000 ha. and 5,000 ha., respectively. The Jeneberang river water is distributed to the left and right sides by the Kampili and Bili-bili irrigation systems, respectively.

3.1.2 Climate

Climate conditions in the project area are dominated by the tropical monsoons. The annual mean rainfall is estimated at 4,000 mm. in the mountainous area and 2,800 mm. at the low-lying area. The climate is divided into two distinct seasons: a rainy season with 75% of the annual rainfall, from November to April, and a dry season, from May to October, as shown in Fig. 3-2.

The monthly mean temperature is about 26°C, slightly fluctuating throughout the year, and the maximum and minimum daily temperature is 30°C and 22°C.

The monthly mean relative humidity is about 85% in the rainy season and 70% in the dry season. The annual mean evaporation range from 1,400 mm. to 1,600 mm., as measured by pan evaporimeters. The rate of sunshine per month is between 40% and 50% in the rainy season and about 80% in the dry season.

3.1.3 Geology and Soils

Geology

Geology in the project area is classified into four groups; namely, 1) Neogene Tertiary sedimentary rocks, 2) Dikes of Neogene Tertiary, 3) Lompobatang volcanic products of Quarternary and 4) Alluvial Deposits (refer to Fig. 3-3).

Neogene Tertiary sedimentary rocks which are being distributed in the middle reaches consist mainly of pyroclastic rocks such as tuff, lapilli tuff and volcanic breccia, and some marine sedimentary rocks such as mudstone, siltstone and sandstone, partly including limestone.

Dikes intruding the Neogene Tertiary sedimentary rocks exist in a width of several hundred meters and a length of several kilo meters. The dikes consist of hard diabase and microdiorite which are having a lot of cracks.

Lompobatang volcanic products distributed in the upper reaches consist of andesite lavas, tuff breccias and mud flows.

Alluvial deposits are distributed on the riverbed as well as on the plain lying in the lower reaches. In the riverbed these unconsolidated deposits consist of sand and gravel, and in the plain area of sand and clay.

Soils

According to the soil map (1:250,000 scale) which was prepared by the Soil Department of the Central Agricultural Research Institute at Bogor in 1969, the project area is mostly made up of the alluvial soil containing deposit clay and sand, which is least unsuitable to paddy cultivation.

3.1.4 Flood, Run-Off, Tide and Sediment

Flood

According to the data collected at Kampili station, the first, second and third biggest floods of the Jeneberang river are recorded as 3,352 m^3/S in 1967, 2,130 m^3/S in 1977, and 1,446 m^3/S in 1974.

Run-Off

The annual run-off volumes at Bili-Bili in the first and second droughtiest years of the decade are estimated at 842 x 10^6 m^3 (in 1976) and 909 x 10^6 m^3 (in 1958), and 355th largest discharge of the year is recorded as 2.2 m^3/s at Bili-Bili and 3.5 m^3/s at Kampili in 1976.

Tidal Stage

Based on the well arranged data recorded at Makassar Port gauging station for 1976, 1977, and 1978, mean high and low water springs have been calculated at 0.56 m above and below the M.S.L., respectively, and a model tidal hydrograph prepared.

Sediment

Sediments are produced by collapse and terrace scarp erosion in the Lompobatang volcanic area which is located in the upper reaches of the Jeneberang and also by bank erosion in the middle reaches.

3.1.5 River

River Basin

The Jeneberang river has a catchment basin of 727 km^2 and a length of 75 km. In its upper reaches, the river runs down through a feather-shaped mountain region with a natural vegetation of a few tall trees and Aran-Aran. In its top reaches, there remains a collapse whose scar has been kept unhealed for unknown period of time. The collapse had produced sediments which had mostly caused to raise the riverbed level of the Jeneberang. The riverbed rising has also been due to terrace scarp erosion in its upper reaches and bank erosion in its middle reaches. After passing Bili-Bili, the river enter its low reaches which is spreading an alluvial fan on both the right and the left banks of the river. On its right bank, the city of Ujung Pandang came to shape itself in the neighborhood of the sea and an agricultural land extends towards the mountaineous area. The left bank consists of an extension of a fertile agricultural land.

Features of the River

The Jeneberang river runs through mountainous and hilly area down to Kampili weir and, then flows on a flat-lying land without heavy meandering until it pours into the Makassar strait. The Jeneberang river considerably narrows down at the site of the Sungguminasa bridge located at about 9.0 km. upstream from its estuary, and is split into two streams at 4.4 km. upstream from its estuary. The stretch extending for 20 km. from its estuary up to Kampili weir is presented in Fig. 3-4.

The Sungguminasa bridge serves as a dividing point of the Jeneberang riverbed gradient into that in the upper reaches (1/1,400) and that in the lower reaches (1/2,000).

Embankment work has so far been completed along the both banks of the Jeneberang river, from 2.0 K to 9.0 K on the left and from 2.6 K to 10.8 K on the right. However, these dikes lack sufficient safety because they are inconsistent in cross-sections and elevation. Moreover, they are non-existent in the section from 5.2 K to 7.2 K on the left and in the section from 7.8 K to 9.0 K on the right.

Flow Capacity

The bankful flow capacities of the Jeneberang river in the lower and upper reaches of the Sungguminasa bridge as well as in the upper reaches of the Kampili weir are estimated at 1,000 m^3/s, 600 m^3/s, and 800 m^3/s, respectively. Fig. 3-5 shows the flow capacity of each section along the Jeneberang river.

The section having the minimum flow capacity in the lower reaches of the Sungguminasa bridge is located near 8.0 K where there has been built no dike on the right side as shown in Fig. 3-6. However, a road lying 1 m. above the ground level near the right bank is serving as a dike. The discharge which would raise the water level to the surface of the road is estimated at 1,800 m^3/s. Water inundating in the right bank area would return to the river after the flood is over.

In the upper reaches of the Sungguminasa bridge, there are a road on the right bank and the Kampili irrigation channel on the left bank, both of which are running higher than the existing ground level. A discharge of 1,800 m^3/s can be confined herein due to this topographic situation. The area between the road and the irrigation channel plays the role of a natural buffer. The discharge, when it exceeds 1,800 m^3/s, will overtop the road and flow into the Bili-Bili irrigation channel on the right bank.

Riverbed Fluctuation

The riverbed has been raised to the present level due to the repeated hillside collapses in bygone years. However, the collapsing phenomenon has been receded to subsidence for a quite sometime in the past. No serious sediment discharge has occurred lately though sediments have been deposited in some parts along the river course. Riverbed materials consist of gravel at Bili-Bili and Kampili, and of fine sand at Sungguminasa.

Transition of Estuary

A sandbar has developed at the Jeneberang estuary due to sediment discharge from its upper reaches. Longtime ago, a great deal of sediment had been flown down through the

Jeneberang river. The total sediment yield since 1900 is estimated at 60,000,000 m^3.

At present, serious sediment deposition has not also been observed at its estuary, since the collapses in the upper reaches are found stable.

River Utilization

The Jeneberang river water is being utilized for various purposes at (or from) different places as follows: water to be used in sericultural center (at 100 m upstream of Bili-Bili dam site) irrigation (Bili-Bili and Kampili intakes); drinking water (point 8.8 K); industry (point 15.3 K), and fish ponds at the estuary.

At a few points, people are ferreid across the river. Fig. 3-7 shows the existing riparian facilities along the river. Quarrying and sand collection is briskly carried on along the river mainly during dry season.

The Jeneberang river water decreases so much during dry season that irrigation water demand for paddy cultivation is available only for about 10% of all the paddy field.

3.2. SOCIO-ECONOMY

3.2.1 Population

The South Sulawesi Province has a population of approx. 6.2 million as of 1980, which is equivalent to 4.3% of the total population of Indonesia. The population density is 79 prs/km^2 on an average, but it ranges widely from 7.2 prs/km^2 in Kab. Manuju at the minimum to 6114.3 prs/km^2 in Ujung Pandang city at the maximum.

Densely populated are Ujung Pandang city, Pare-Pare city, and the southern area such as Kabs. Takalar, Jeneponto, Bantaeng and Bulukumba. These areas, though covering only 3.8% of this province in area, account for as high as 25.9% of the provincial population or 1.5 million persons.

A large number of people are still involved in the primary sectors such as agriculture, husbandary, fishery and so on. According to the 1979's data, about 57% or about one million people of the economic active population are engaged in the primary sectors. Those who are seeking jobs account for 81,367 persons, or 4.5% of the economically active population in this province (refer to Table 3-1). This unemployment rate would be much higher, if the seasonal unemployment of agriculture is taken into account.

Unemployment is one of the major social problems in this province, and insufficient employment opportunities have led to an outflow of population, which is the characteristics of population movement in this province.

The annual population increase rate in Pelita II shows only 1.8%, much less than the national average of 2.4%. The provincial population is forecast to increase at the rate of 1.9% per annum in Pelita III.

On the contrary, the population in Ujung Pandang which assumes an economically important role in the province is now rapidly increasing in these years. According to the 1980's census, its population reached 708,465 persons or 11.5% of the provincial population with an influx from the surrounding areas. This is because Ujung pandang city is now being rapidly urbanized by various kinds of development plans as the capital city of South Sulawesi Province as well as a center for development of the Eastern Indonesia.

Kabs. Gowa and Takalar in which a vast fertile agricultural land extends have populations of 356,484 with a density of 396,2 prs/km^2 and 178,411 with a density of 396,2 prs/km^2, respectively. The population in these Kabs. has been naturally increasing in line with the provincial average in these nine years.

3.2.2 Flood Damage

An extensive flooding from the Jeneberang occurred in 1967 and inflicted great damage on Ujung Pandang city. The dike breached at locations 3.0 K and 9.5 K on the right bank of the Jeneberang river.

The area along the river between Sungguminasa bridge and Kampili has been annually affected by flood. Flooding water would overtop the river bank and flow down on Jl. Malino linking Ujung Pandang city to Malino, often causing traffic stagnation.

The biggest inundation ever observed occurred in January 1976, and this inflicted a great deal of damage on the project area due to the poor drainage system and high water level of the Jeneberang. The total rainfall during that period amounted to 984 mm.

The area which was most severely damaged during the 1976 inundation includes the old urban area along the Panampu channel and the city-side area along Jl. Veteran; in these areas the ponding depth reached 2.1 m. The area sandwiched by Jl. Veteran and Jl. Panakkukang was ponded for three days at the average ponding depth of 60 cm, to a maximum of about 1.0 m. A number of houses in the area were submerged to about floor level.

The inundation area in 1976 is estimated at 35 km^2 as shown in Fig. 3-8. The inundation damage is estimated at 450.0 million Rupiah.

3.2.3 Water Supply

Water Sources

Ujung Pandang is getting its city water from two sources: the one is from the Jeneberang river through the old treatment plant, and the other from the Maros river through the new treatment plant. The old treatment plant with a capacity of 150 l/s pumps up the Jeneberang river water from its right side bank immediately below the Sungguminasa bridge. During dry seasons, water taken in from the Jeneberang drops to about 50 l/s, diminishing the volume available for city water to the bottom; consequently, the city water for Ujung Pandang is largely switched over to that supplied from a new water supply system.

The new water supply system which was built in 1977 treats the river water taken from the Maros, which is flowing in the north of the city, at Lekopancing weir to the amount of 500 l/s which is sent over a distance of some 28 km to the new treatment plant.

The total water supply volume to Ujung Pandang today normally meets about 30% of the total demand of the citizens.

Water Distribution

The water treated at the old plant needs to be pumped up to an elevated tank for distribution among the consumers. As the distribution system was equipped in the 1920's, its facilities are now causing a lot of pipe-loss to make a stabilized supply of city water rather difficult. The new plant sends out pump-pressurized water through distribution pipes with diameter ranging from 1,000 mm to 50 mm.

3.2.4 Agriculture

Available Water Resources

During the dry season, paddy cultivation relies upon irrigation water taken in from the Jeneberang river; however, about 10% of the land is irrigable.

The river discharge falls down to about 4.5 m^3/s on an average during the three months of August, September and October. The detailed figures of the monthly river discharge at Kampili and Bili-Bili intakes are shown in Table 3-2.

Irrigation System

The existing irrigation system prevailing in the project area which is spreading in Kab. Gowa, Kab. Takalar and Ujung Pandang city will be classifiable as shown in Table 3-3. The benefitted area (24,000 ha.) consists of the area fed by

Bili-Bili and Kampili Intakes and is covered by the irrigation system defined by DPU as either technical or semi-technical. However, the benefits expected under each category are not obtained due to such reasons as deterioration of the irrigation facilities, accumulation of sediments in the channels, absolute shortage of water supply, etc.

The maximum intake capacity of Kampili is approx. 25 m^3/sec and the flow capacity of its channel is about 12 m^3/sec in the section with a lowest flow capacity because of numerous bottlenecks along its entire course. The intake capacity of Bili-Bili is estimated at 3.5 m^3/sec when the discharge of the Jeneberang river reaches 30 m^3/sec. The flow capacity of its main channel is about 3.2 m^3/sec at the point where the channel meets Jl. Malino.

Cropping Pattern

The cropping pattern in the project area has, as its nucleus, the paddy cultivation during a wet season (November to April). Other crops being raised include corn, cassava, sweet potato and green beans. Cultivation of paddy during a dry season is restricted according to the availability of irrigation water. The present cropping pattern prevailing in the project area is illustrated in Fig. 3-9.

The area planted in 1980 by different varieties of paddy in Kabs. Gowa and Takalar, in contrast with that in South Sulawesi, is shown in Table 3-4.

Farming Practices

The farming practices having been adhered to in the project area still remain "traditional", and only a limited kinds and number of mechanical equipment have so far been introduced therein.

The improvement program, both varietal and technical, of paddy cultivation has been positively extended in South Sulawesi. While the use of chemical fertilizers and agro-chemicals has been universalized by BIMAS program side by side with wider use of the improved varieties, the per-ha. yield fails to rise as expected. The reasons for such a stagnancy are supposed to be two-fold: an increasing ratio of inferior land on the one hand, and the poor irrigation facilities, on the other. Provision of adequate irrigation facilities and increased supply of irrigation water would, therefore, contribute enormously for an increased production of paddy. Land holdings in the project area will be shown in Table 3-5, for a reference.

Crop and Yield

The crops in the project area are composed mainly of paddy, cassava, maize, soy beans, etc. The annual mean yield of dry stalk paddy is estimated at about 5.03 t/ha. in the wet season and at about 4.31 t/ha. in the dry season.

Livestock Production

Livestock raising does not occupy an important position due to it in agricultural undertaking in the project area. The animals and birds are mostly grazed on small scale in and around paddy fields and yet they consist of the vital source of draught-power in farm operation and transportation, and of protein foods consumable by the inhabitants.

Processing and Marketing

The main farm product for marketing is rice in the project area. Most of the surplus paddy, after consumption of farmers, is generally sold to KUD and/or middle men through brokers. Sub-DOLOG in each Kabupaten purchases rice from KUD. The rice purchased by Sub-DOLOG is distributed for the local government use, and further transferred to the provincial DOLOG. The provincial DOLOG arranges for the provincial consumption and its movement to other provinces. The paddy collected by the middle men is usually sold at the regional market in Ujung Pandang city. Some of the surplus paddy is sold at the local markets in and around the project area directly by farmers or sometime by brokers.

Farm Income

The income and production cost per ha. of the farm products in South Sulawesi Province as identified and reported by the Agricultural Training Center at Batangkaluku in Kab. Gowa through its survey undertaken in 1978 are presented in Table 3-6.

3.2.5 Electric Power

Power Supply and Demand

Electric power supply in the South Sulawesi depends on the services of WILAYAH VIII of PLN, under two systems; i.e., Ujung Pandang system and Pinrang Pare-Pare system.

The annual generated energy (1979/1980) at WILAYAH VIII is approximately 170 GWH while annual energy sold is reaching to approximately 126 GWH in the same period. The percentage of annual increase in energy generated and sold in the last 5 years is reaching to around 20%, and number of consumer in 1980 is 100,000 approximately. Table 3-7 shows annual energy generated, sold and so on in the last 5 years.

With regard to Ujung Pandang system, number of consumers is reaching an approximte 47,000 in 1980, and nearly 20% of households are electrified. The increase of consumers during 1976-1980 is shown in Table 3-8.

In the neighbourhood of Ujung Pandang, there exist various kinds of industry among which ship-building, paper, and cement are the most important ones. 75% of the total installed capacity is thus concentrated in Ujung Pandang and the rest in the rural area. Nevertheless, the large-scale consumers have been experiencing power shortage so much and so often that some of them felt the need to establish their own independent power plants.

The typical daily load curve taken at Tello substation recently (June 1981) gives an indication that a peak time extends for 5 hours from 18:00 to 23:00; during the hours when the industrial and domestic demands for power overlap each other (refer to Fig. 3-10).

Power Station

The major power stations in the Ujung Pandang area have a total generation capacity of 52.1 MW. The independent power stations owned by individual enterprises have a total capacity of 14.3 MW, while the accumulated total of the entire rural electric generating capacity amounts to 22.8 MW.

Transmission Lines

Transmission line system in Ujung Pandang area is fairly well maintained at present. The existing transmission lines are systematized into the following three; 1) Tello ss -Kalukuang ss - Bontoala ss, 2) Tello ss - Mandai ss - Tonasa ss and 3) Tello ss -Sungguminasa ss - Boronglae ss, all of which are linked by 2 lines with a capacity of 30 KV.

Apart from these three, there is only one system connecting Pinrang and Para-Para for rural distribution.

3.2.6 Transportation and Communication

Road Network

The main trunk roads in and around the project area consist of 1) Jl. Sumaharjo Karaeng Patingaloang linking Ujung Pandang city to the domestic air port; 2) Jl. Gowa Raya Malino linking Ujung Pandang City to Sungguminasa city and Bili-Bili, and 3) Jl. Usman Salengkeng linking Sungguminasa city to Kab. Takalar through Kab. Gowa.

Jl. Karaeng Patingaloang is connected to Jl. Maros, which goes to Kab. Maros and further splits towards Pare-Pare city and Kab. Soppeng. All the roads are fully sealed with asphalt. Jl. Malino first goes 11 km to Sungguminasa city, and leads 31 km to the Bili-Bili dam site, and further extends to Malino. The total length of Jl. Malino is 110 km, 90 km out of which has been paved. This road will certainly play an important role for construction of the Bili-Bili dam. The distance between Sungguminasa and Takalar is about 41 km, linked by Jl. Usman Salengkeng, which is fully paved. This road has Sungguminasa bridge which is only one crossing the Jeneberang river, and is quite helpful for transportation of commodities between Kab. Gowa/Takalar and Ujung Pandang city.

Harbour

Makassar harbour has three wharves to which 10,000-ton ships can be anchored. The total length of the wharves is 1,770 m and they have a water depth of 7 or 8 m. This harbour is one of the key points for international and domestic trade as well as sea traffic. The total volume unloaded and loaded at the Makassar harbour in 1979 is 1,352,061 ton (m^3) and 654,415 ton (m^3), respectively. Out of the above volume the harbour handled, 461,320 ton (m^3) was for import and 145,619 ton (m^3) for export.

Airline Network

Garuda Indonesian Airways and Merpati Nusantara provide domestic airline services by the Hasanuddin airport located in Kab. Maros, 25 km east to Ujung Pandang city. They link Ujung Pandang to Jakarta, Surabaya, Ambon and some 20 other places. According to the 1979's records, 764,816 passengers in total utilized this airport in some way : namely, 325,012 passengers for departure, 327,688 for arrival and 112,116 for transit. The loaded and unloaded cargo in 1979 is recorded to be 3,550,509 kg and 3,607,131 kg, respectively.

Telecommunication

An automatic telephone system has been installed in Ujung Pandang city with a capacity of 8,200 lines. As of 1979, 7,138 lines are in use with a diffusion rate of one telephone per 14.8 households. In Kabs. Gowa and Takalar, telephones are diffused at such a low rate as one telephone per 421.7 and 793.8 households, respectively. Communication with a capacity by telex is also available in South Sulawesi with a capacity of 80 lines.

3.2.7 Land Use and Assets

The project area, including Ujung Pandang city, Kabs. Gowa and Takalar, can be classified from the viewpoint of land use as shown in Fig. 3-11.

In Ujung Pandang city, a fully urbanized area (880 ha. approx.) is located in the west side. This area has been provided with electricity, gas and municipal water supply system. On the east side of the city extends an agricultural land (1800 ha. approx.) which lies in a low land with an elevation of 0.3 m to 2.0 m above M.S.L. The area along Jl. Panakkukang, east to the urban area, is now being rapidly urbanized in order to cope with population increase, based on the urbanization plan.

In Kabs. Gowa and Takalar extends a fertile agricultural land (115,300 ha. approx.), 19,000 ha. out of which is an irrigation benefitted area of the Kampili irrigation system. Ujung Pandang city also has an agricultural land of 5,000 ha, which is irrigated by the Bili-Bili irrigation system. The present conditions of land use are described in details in 3.2.4. "Agriculture".

Assets at present concentrate in Ujung Pandang city, especially in the west-side urban area with a relatively high elevation, and mainly consist of residential buildings and their interior effects. For the convenience of flood damage calculation, the flooding area is divided into two parts by Jl. Panakkukang namely; city-side and mountain-side areas. From the view point of ground height, the present assets mostly lie in a range from 2.0 m to 3.0 m above M.S.L. (refer to Table 3-9 and Fig. 3-12). As the regional development goes on, it is unavoidable to expand a residential area into the low-lying land. The agricultural land in the flooding area is also classified by ground height as summarized in Table 3-10.

The value of assets in the prospected flooding area has been remarkably increased, compared with the data collected in 1976, for the following reasons:1) Based on the urbanization plan, a number of buildings have been newly constructed, 2) 1980's national census has revealed the assets which had not been recorded, and 3) The prospected flooding area itself is expanded due to consideration of the over-topped water from the Jeneberang.

The upper reaches of the Sungguminasa bridge, which is another prospected inundation area, are dotted with only small farm houses. There is no notable assets which would be affected by flood.

3.2.8 Urbanization Plan

Ujung Pandang city has a master plan for regional development covering an area of about 4,000 ha. which is situated east to the urban area. This master plan has been prepared in order to deal with a rapid increase of population and to develop Ujung Pandang city as a center of the east Indonesia. The development area is divided into 13 blocks topographically and into 10 stages of construction.

A detailed plan for its first stage has been prepared by the municipal government based on the master plan. This first stage development plan covering an area of 390 ha. along Jl. Panakukang is to be completed by 1985 (refer to Fig. 3-13). The area is zoned in accordance with purposes such as dwelling, industry, public utilities and so on.

According to the detailed plan, buildings are classified into house, market, factory, school, office and mosquse, whose quantity is as follows.

Classification	Quantity (nos.)	
	City side	Mountain side
House :	1,511	1,067
Market :	2	0
Factory :	0	29
School :	9	9
Office :	28	34
Mosque :	2	2

Houses to be built are further classified into large, middle and small size, whose number and location has already been determined. The population density is planned to be in a range from 50 to 100 prs/ha.

The distribution by ground height is summarized in Table 3-9 in quantitative terms and monetary terms.

The value of the proposed buildings in the first stage urbanization area has been estimated to be Rp.72,488 million in the city side area and Rp.33,861 million in the mountain side area. The relation curve between assets value and ground height is illustrated in Fig. 3-14.

CHAPTER IV - FORMULATION OF THE PROJECT

4.1. GENERAL

Ujung Pandang city has long been exposed to the menace of flood damage caused by the Jeneberang river. In promoting the peoples' welfare and enhancing the regional economic activities in this area, it is important to control the flood water of the river.

To attain the above-mentioned purpose, it is essential to construct dam(s) for flood control purpose in the upper reaches of the river basin from technical and economical points of view. If the dam is planned to the maximum extent of development in the aspect of topographic limitation, it can be expected that water supply will be realized in this area which is now suffering from the shortage of the municipal and industrial water and the irrigation water.

The flood control plan of the river is formulated by means of river improvement and dam construction on the ground that there are no adequate places obtainable from the topographical viewpoint for excavation of flood-way nor provision of retarding basin. The dam for the flood control is proposed at Bili-Bili site in this project after a careful comparative study on overall possible dam sites. The proposed Bili-Bili dam will be constructed as a multipurpose dam including water supply purpose taking into account the economical advantage and the effective utilization of the limited water resourses.

In connection to the above, the water utilization capacity developed by the proposed dam will be allocated, in the first priority, for the municipal and industrial water supply in order to support the incremental demand of the water in the project area. The remaining part of the water utilization capacity will be given to the irrigation purpose to raise agricultural productivity in the existing irrigation area; namely, Bili-Bili system and Kampili system areas, though there exists a possible irrigation area for the extension of agriculture. This is because the existing areas are already provided with the main and secondary irrigation channels and its related farming facilities, as the result of which, the supply of the water for the existing irrigation areas has the highest economicality in view of agricultural production and also leads to prompt agricultural outcome.

As for the hydro power generation, it will also be formulated by using the irrigation water and the municipal and industrial water from the proposed reservoir, considering the save of fuel of the thermal power generation.

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The flood control plan involving the dam and the river improvement works has been prepared on the feasibility study level, while the plans dealing with municipal and industrial water supply, irrigation, and hydro power remain at the preliminary study stage. This is because the early implementation of the flood control works, especially dam construction, is expected to be put into execution.

4.2 BILI-BILI DAM AND RESERVOIR

4.2.1 Site Selection

Four possible dam sites were nominated; they are Bili-Bili, Pasaratowaya, Jonggoa, along the Jeneberang river and Pattalikang on the Jenelata river.

The Bili-Bili dam site is regarded as the most advantageous of the four from the considerations mentioned below, while compensation for houses to be evacuated and land to be submerged in the Bili-Bili reservoir is estimated a little bit higher than any other dam sites and this will create social problems.

1) The design discharge of a 50-year return period can be controlled only by the proposed Bili-Bili dam and river improvement works, and

2) The proposed Bili-Bili dam has the highest economicality among four dams in a respect of develeopment of the available reservoir storage capactiy (refer to Table 4-1).

4.2.2 Design Flood Discharge

<u>Design Flood for Spillway</u>

The flood discharge is 4,300 m^3/s which corresponds to the flood discharge of a 1000-year probability has been adopted as Bili-Bili dam's design flood discharge. This shall be equated to the outflow discharge from its spillway without taking into consideration the regulating function of the reservoir. The design flood discharges of the dams existing or under construction in Indonesia are shown in Table 4-2, for reference.

<u>Design Flood for the Benefitted Area</u>

Flood discharge on a 50-year return period basis was employed for the formulation of the flood control plan in due consideration of the improvement scales to other rivers in Indonesia. (More in details refer to 4.3.2 in this report.)

4.2.3 Development Scale of Bili-Bili Dam

The utmost priority is given to safety of a dam where a huge volume of water is impounded. A failure of the proposed dam definitely results immeasurable damage to lives and assets of the downstream inhabitants of the project area including Ujung Pandang with the population of about 700,000.

Under the above situation, the crest elevation and design flood water level have been fixed at EL. 105 m and EL. 102 m respectively, from the viewpoint of safety followed by technical justifications, though from the economic viewpoint a slightly higher crest elevation may be effective (refer to Fig. 4-1).

4.2.4 Bili-Bili Reservoir

The main features of Bili-Bili Reservoir are as follows:

Design flood water level (D.F.W.L.)	EL. 102.00 m
Surcharge water level (S.W.L.)	EL. 100.30 m
Normal water level (N.W.L.)	EL. 97.60 m
Low water level (L.W.L.)	EL. 74.00 m
Effective water depth (S.W.L.- L.W.L.)	26.30 m
Reservoir surface area at S.W.L.	17.8 km^2
Total storage capacity	362×10^6 m^3
Effective storage capacity	304×10^6 m^3
Flood control capacity	46×10^6 m^3
Capacity for water utilization	258×10^6 m^3
Municipal and industrial water capacity	17×10^6 m^3
Irrigation water capacity	241×10^6 m^3
Sediment capacity	58×10^6 m^3

Relation between the reservoir surface area and the storage capacity is shown in Fig. 4-2. Allocation of the reservoir capactiy is illustrated in Fig. 4-3.

<u>Flood Control Capacity</u>

Storage of 46×10^6 m^3, between EL. 97.60 m and EL. 100.30 m, is secured for the purpose of flood control.

<u>Water Utilization Capacity</u>

The allocated 2.3 m^3/s of municipal and industrial water is released from the storage all through the year. Storage of 17×10^6 m^3 is specially earmarked for the supply during a dry season.

Storage of 241×10^6 m^3 is specially secured for the irrigation water during dry season.

The storage capacities mentioned above are computed on the basis of the conditions as shown in the next page.

Evaporation from reservoir surface	:	3.0 mm/day
Discharge loss in river	:	3.0%

Schematics of water utilization and the variation of reservoir water level are shown in Figs. 4-4 and 4-5, respectively.

Sediment Capacity

The sediment capacity is 58×10^6 m^3, corresponding to the 100 year's inflow of sand into the reservoir.

4.2.5 Environmental Assessment

Dam's Neighborhood

1) Natural Environment

Out of sediment discharge of 1,500 m^3/km^2/year, about 90% of the sediments flown down from the upperstream consists of wash load which has mainly originated in the collapse area (0.2 km^2 wide, with an average gradient of 0.95, as shown in Fig. 4-6) as well as the deposits on the banks of the river channel.

Vegetation in the upperstream of the proposed dam site can be described as follows: almost 80% of the basin is covered by Aran-Aran and a few tall trees made up of mango, bamboo, and betel palm, etc., while approximately 13% of the remaining 20% is made up of the grassland, including small denuded area, and the farmland is restricted to the flood prone area along the river channel only.

Wild animals encountered there are mostly sheep or deers and monkeys, with no trace of any other special animals. There is no record available as to the existence of archeological relics or mineral resources in the area concerned.

2) Social Environment

Administratively speaking, the upper stream of the proposed dam site belongs to Kec. Parang Loe, Kab. Gowa in South Sulawesi province. This area is dotted with such villages as Kp. Bujula, Kp. Tonalenasde, and Kp. Pong, etc., in which people are mainly engaged in agriculture and forestry. By religion, they are predominantly Muslim and ethnically, the Makassarese, usually speaking the Makassarese language.

Jl. Malino, a single trunk road connecting Ujung Pandang with Malino is running along the right bank of the Jeneberang river.

Environmental Impacts due to Dam Construction

Major impacts presumed by dam construction may be itemized as follows:

1) Submersion of houses, fields and roads under the reservoir,

2) Deposit of sediments in the reservoir, which may cause the elevation of the riverbed in the upstream of the reservoir and the muddiness of the reservoir water due to wash load,

3) Maintenance water in the downstream during a dry season,

4) Direct impacts due to the dam construction work, which may cause the muddiness of the river water in the downstream and the alteration of topography around the dam site, and

5) Impacts on fauna and flora.

Assessment of and Countermeasure to the Environmental Impacts Due to Dam Construction

Some of the more problematic of the environmental impacts submitted in the above will be individually assessed. Consequently, it has been concluded that there seems to exist no particular reason to suspect occurrence of the serious problems due to construction of the dam as discussed in the below;

1) Submersion of houses, fields and roads under the reservoir.

The transfer of people shall be arranged by paying attention to their ethnical, linguistic and educational aspects so that the existing patterns of their community may not be seriously disturbed thereby.

2) Elevation of the riverbed in the upstream of the reservoir.

The back sand volume in the future of 100 years is estimated at 5.4×10^6 m^3 and the extent affected by back sand is 1.4 km assuming that all sediment of bed material load may be deposited entirely in the upstream of the dam reservoir and cause the back sand.

The water level may possibly be raised by less than 2 m or so due to the above-stated elevation of riverbed caused by the back sand (refer to Fig. 4-7); however, fortunately, there exists no important object to be affected by such an elevation of the water level. It is consequently assessed that the impact of the back sand resulting from dam construction is not serious.

3) Muddiness of the reservoir water due to wash load

It is expected that a majority of muddy water flowing into the reservoir will be swiftly discharged through operation of the movable gates (capacity : 500 m^3/s) or over the free flow section at the spillway without lingering inside the reservoir. Moreover, discharge of muddy water due to rainfall seldom lasts for more than 2 days to be immediately followed by inflow water with fairly high transparency. Accordingly, it is assessed the muddiness of the reservoir water is almost negligible. Again, 258,000,000 m^3 of the utility water which is allocated in the reservoir is expected to dilute muddy water to a great extent.

4) Maintenance water in downstream during the dry season

In this basin, a dry season generally lasts from May to October, with a certain time lag year by year, almost 3 months of which sees low water dischrge at around 3.5 m^3/s at Kampili. The majority of the said low water discharge is currently taken in for the existing Bili-Bili and Kampili irrigation area. Therefore, the river discharge in the downstream of the Kampili intake is reduced to almost 0.5 m^3/s, which is utilized for industrial water for the paper mill, drinking water for Kota Sungguminasa and others. After construction of the proposed Bili-Bili dam, the water discharge of 0.5 m^3/s will be supplied throughout the dry season as the vested right water. Eventually, water conditions of the river will remain almost the same as that at present.

Prevention of Local Disaster in the Area

1) Thought of sediment control

Besides environmental aspects aforementioned, sediment discharge should be discussed in this report. There exists the collapse area spreading 0.2 km^2 in the mountain regions in the upper stream of the Jeneberang river which has produced tremendous amount of sediment in the past and has flown it down into the river.

At present, the collapse area is supposed not to give ill-effects to the river because of less production of the sediment, even if no sediment control facilities be built. It is, however, feared that the sediment discharge from the collapse area, if and when it occurs, may cause local disaster in the immediate downstream of the above-mentioned area. From this point of view, installation of appropriate sediment control facilities will be recommended to mitigate local disaster in the upstream area, though it is not to be included as a part of this project.

2) Location and function of sabo dam

Three sabo dams are proposed as the appropriate sediment control facilities and their locations are shown in Fig. 4-6, in due consideration to the following conditions;

- the active collapse areas in the lower reaches where sediments are currently produced,
- narrowness of the valley which helps saving the total dam volume (and, thereby, saving dam construction cost),
- the place suitable for preventing lateral erosion of terrace and fan scrap through raising the riverbed, and
- the place which is situated in an easy reach of sabo dam construction materials.

The function of the sabo dam is generally as follows.

- to catch sediment discharge,
- to regulate sediment transportation, and
- to prevent producing sediments.

The third function is attainable as Sabo dam will help raising the riverbed at its upper reaches by arresting outflowing sediments and the raised riverbed plays the role of counterweight to check fresh occurence of collapse. Sabo dam will, therefore, be effectively installed in the very area where sediments are being produced.

3) Preliminary standard design and cost estimate

The proposed Sabo dam will be designed as the concrete gravity structure of a floating type on their foundation consisting of thick sand and gravels. The preliminary standard design of the proposed Sabo dam is illustrated in Fig. 4-8 as an example.

Total construction cost of the three sabo dams is estimated at US$1.2 million and its breakdown is presented in the supporting report.

4.3 FLOOD CONTROL

4.3.1 Flood Control Method

As the design scale of flood control, a 50-year return period has been adopted for the project; the project area will be relieved from any lesser flood than a 50-year return period.

There are no adequate places obtainable from the topographical point-of-view for excavation of flood-way nor provision of retarding basin if they were meant for regulation of the flood discharge of the scale of a 50-year return period. It has, therefore, been decided to plan the flood-control project through a combination of dam construction and river improvement works.

4.3.2 Optimum Share of Design Flood Between Dam and River

Standard Project Flood

The decision as to the flood discharge on a 50-year return period has been made on the basis of hydrological analysis in the area and through a careful comparative study with the similar cases so far taken up in other parts of Indonesia. Eventually, the standard project flood discharge has been determined as follows:

Bili-Bili	:	2,400 m^3/s
Jenelata	:	1,400 m^3/s (1,300 m^3/s) *
Kampili	:	3,700 m^3/s
Sungguminasa	:	3,700 m^3/s

* When the Jenelata joins the Jeneberang at the time of the peak discharge of the latter, the former's discharge will be 1,300 m^3/s.

The distribution of standard project flood is shown in Fig. 4-9.

Design Flood for River Improvement

The design flood of the river improvement has been determined at 2,300 m^3/s as tabulated in below, while the Bili-Bili dam is expected to control a discharge of 1,100 m^3/s.

		Peak discharge	Joining discharge
Bili-Bili	:	2,400 m^3/s	1,300 m^3/s
Jenelata river	:	1,400	1,000
Kampili	:	-	2,300
Sungguminasa	:	-	2,300

The following studies have been conducted to arrive at the above shares:

1) Construction Cost

As a result of the study as to the relationship between the construction cost and the discharge at Kampili (refer to Fig. 4-10), it has been arrived at that the Jeneberang river channel should control a discharge of 2,300 m^3/s, in view of striking the most economically balanced combination of dam construction and river improvement works in the total cost.

2) Evacuation and Land Acquisition

The relation between the volume of discharge at Kampili and the evacuation/land acquisition is set forth in Fig. 4-10, according to which the least number of houses and the smallest extent of land would need to be evacuated/acquired when the discharge should be made 2,300 m^3/s at Kampili. In other words, the social problem can be minimized by confining the discharge to be accommodated in the river channel to 2,300 m^3/s.

The distribution of design flood will be made as shown in Fig. 4-9.

4.3.3 General Conception

The river improvement works has been planned with full consideration to the technical, social and economic aspects as mentioned in the below:

1) to control a 50-year return period flood by means of the river improvement and the impounding reservoir;

2) to smoothen the river course alignment in order to stabilize the proposed river channel;

3) in principle, to keep the design high water level and height of the dike as low as possible to reduce the damage potential;

4) to take the stability of the river channel into full consideration;

5) to plan the flood control facilities to the extent possible to mitigate the damage caused by extraordinary flood(s);

6) to minimize land acquisition and evacuation of houses; and

7) to put a priority to protection of the populous and economically significant area in the flooding area along the Jeneberang.

4.3.4 Basic Study for the River Improvement Works

The following studies have been made for the formulation of the river improvement works.

River Improvement Stretch

The stretch which extends from the Jeneberang river estuary up to the Kampili weir has been taken up for the improvement works due to the following reasons:

1) The river course in the upper reaches of Kampili is sandwiched between the hilly lands and has a comparatively higher flow capacity. On the occasion of flooding on both the right and left banks, the inundation water is expected to flow back to the river course immediately after flooding, and

2) Judging from the economic viewpoint, the assets on the area in the upstream of Kampili are of lesser value.

Improvement Scale of the Upper Channel above Sungguminasa

A large scale of improvement of the channel above the Sungguminasa bridge would not have to be planned from the economic viewpoint that the flood damage therein seems to be not serious. Therefore, only a low water channel will be provided in order to assure the channel stability, in a scale of the discharge of 900 m^3/s which corresponds to a 1.5-year flood discharge. The bankful discharge of the channel will reach 1,300 m^3 which corresponds to a 8-year return period.

Stability of the Design River Channel

Study of the river channel stability is made through calculation of tractive force at each cross-section of the existing river channel and the proposed river channel (refer to Fig. 4-11).

In making a comparison of tractive force between the existing and the proposed river channels, as can be seen in Fig. 4-11, it is obvious that there are wide variations in tractive force over the entire length of the existing river channel. On the other hand, tractive force is practically steady all over the entire length of the proposed channel except a slight difference between the upper and lower reaches of the Sumgguminasa bridge.

For keeping better stability of river channels, it is indispensable to manage and maintain the river as much as practically possible.

Once a dam is built in its upper stream, the riverbed might be given a tendency to sink lower due to the decrease in supply of sediments therefrom. The ill-effects upon the existing structures expected from such a sinking of the riverbed should be avoided by installing groundsill at the points where are standing the important structures.

Closing of Right River Course

The existing total assets on the downstream areas of the diversion point at 4.4 k., is estimated at Rp. 2,300 million, approx., while the required construction costs of the closing right river course is broadly at Rp. 4,400 million, as a result of which the construction of the proposed closing right river course at this present may not be economically viable.

It is preferable, however, that the said right river course be closed in the final stage of the river improvement works for the below-mentioned reasons, as long as the main channel of the Jeneberang river can confine a flood discharge after its improvement.

1) It is considerably difficult, if no diversion facilities are provided, to distribute the design flood as designed to the right and left courses which are splitted at 4.4 k;

2) In case the river water splits into two streams, the tractive force on both river courses will decrease; consequently, it is difficult to keep the channel stability;

3) By a closing right river course at the immediate downstream of the point 4.4 k., 370 houses, 293 ha., of farmland including paddy fields and 296 ha., of fish pond will be protected from floods in a scale up to a 50-year probable discharge, and further, more than 70 ha. of land will become available by a land reclamation of right river channel. All the above will contribute greately to the development of the south-western part of the Ujung Pandang city;

4) Makassar port might be affected by extention of sandbar from the Jeneberang river as long as the right course is left open as it is today.

Upon closing the right river course, a sluice gate and a drainage channel will be provided for to ensure drainage function as well as to guarantee the water for livelihood requirements in the area.

Drainage Facilities

Quite a number of drainage facilities are currently located along the existing dike, and most of them are of comparatively small scale, and some are not functioning alright.

Accordingly, they will be unified with necessary scrapping at an interval of 2 km. on an average upon completion of new dike.

Assurance of the Vested Water Rights

The water claimed as the vested rights along the Jeneberang river includes the water for the use of the sericultural center, industrial water used by the paper mill, drinking water for Kota Sungguminasa, raw water for the old treatment plant and others, which are taken in from the Jeneberang river at present.

The total of the above vested right water amounts to 0.5 m^3/s, which will be supplied by the proposed Bili-Bili reservoir.

4.3.5 River Improvement

Upon taking into a careful consideration all the conditions enumerated in the above, the river improvement plan will eventually be comprised of the followings:

Alignment

A new alignment is proposed in the stretch of 20 km., from the estuary to Kampili (however, in the section Sungguminasa bridge upwards will be limited to the low water channel excavation). In principle, the present river course will remain the same since the meandering is slight. The river width is proposed to be 162 m. (low water channel only) in the upper reaches and 313 m. in the lower reaches, the Sungguminasa bridge being their dividing line. Bends of the course will be widened beyond the standard width to flow down the design flood safely. Fig. 4-12 shows the proposed alignment.

Longitudinal Profile

The proposed longitudinal gradient in the upper and the lower reaches of the Sungguminasa bridge is 1/1,200 and 1/1,900, respectively. The ratio of the riverbed gradient between the upper and lower reaches is planned to be less than 1:2, to assure the stability of the river channel. The average excavation depth is about 70 cm in the upper reaches of Sungguminasa bridge and 60 cm in the lower reaches.

The longitudinal profile of the design riverbed is shown in Fig. 4-13.

Desing High Water Level

The design high water level in the target stretch from the estuary up to the Sungguminasa bridge will be fixed within 1.8 m. above the ground level (refer to Fig. 4-13).

Cross-Section

The low water discharge can flow down in the lower water channel, and flood discharge will pass in the whole cross-sectional area. The standard cross-section shown in Fig. 4-14 can confine 900 m^3/s of a 1.5-year return period discharge in the low water channel, and 2,300 m^3/s in the whole cross-sectional area.

In principle, height of dike is fixed within 3.0 m. above the ground level.

4.3.6 Benefit

An urgent flood control project has been formulated in ahead of this project. The urgent flood control project consists of improvements to the down reaches of the Jeneberang river (between 2.0 K and the Sungguminasa bridge) as well as to the drainage system in Ujung Pandang city.

The flood control benefit of this project will be estimated on the base of the present flood control and drainage facilities because the urgent project has not been put into execution yet.

The flood control benefit is defined as the flood damage reduction due to implementation of the project, whose calculation is based on the flooding water stage under the with-and without-the-project conditions (refer to Table 4-3). Therefore, hydrological effectiveness of the project (lowering of the flooding water stage by the project) have to be studied first. Fig. 4-15 illustrates the hydrological calaculation model.

The annual flood control benefit is estimated at US$13.0 million by calculating the total flood damage reduction under with-and without-the-project conditions.

Benefit calculation is discussed in details in the Supporting Report.

The estimated annual damages to buildings and interior effects and to farm crops in the project area are tabulated below:

(unit: x 10^6 US$)

		Without the project	With the project
Building & interior effects	:	18.61	5.65
1) Direct damage	:	16.18	4.91
2) Indirect damage (15%)	:	2.43	0.74
Farm crops (paddy)	:	0.60	0.54
1) Direct damage	:	0.50	0.45
2) Indirect damage (20%)	:	0.10	0.09
T o t a l	:	19.21	6.19
Damage reduction (Benefit)	:	13.02	

The above damage estimation is based on some assumptions (refer to Supporting Report).

4.4 WATER SUPPLY

4.4.1 Future Demand

PAM (Perusahaan Air Minum) is now considering to increase the capacity of the new treatment plant which remains at 500 l/s at present, by 100 l/s in 1982 and further by 500 l/s in 1985 when its total capacity would be 1,100 l/s.

According to the master plan prepared by Pemimpin Proyek Air Bersin Sulawesi Selaten, the future demands of the municipal and industrial water are 2,000 l/s in 1990 and 3,500 l/s in 2000, respectively. The future water demand is presented in Table 4-4.

Considering the future program of the increasing water demand, the target year for water supply has been fixed in the year 2000. Out of 3,500 l/s of the water demand, the water supply of 2,300 l/s has been determined to be secured from the Jeneberang river (proposed Bili-Bili reservoir) in due consideration of the prospective water resources develoment in the area.

The remaining part of the future water demand will have to be supplied from the present water source, that is, the Maros river.

4.4.2 Required Reservoir Storage Capacity

Municipal and industrial water of 2,300 l/s will be taken after power generation. The reservoir storage capacity required for its water supply is estimated at $17 \times 10^6 m^3$ so that it could cover the water requirement in 1976 which is design year for municipal and industrial water supply.

4.4.3 Water Supply Method

There are several methods to supply the raw water for the municipal consumption from Bili-Bili reservoir to Ujung Pandang, and it is broadly classified into two categories from its function; an open channel and a closed channel (pipeline).

Judging from the study results mentioned below, pipe line is proposed for the water supply from the proposed reservoir to the consumption site (refer to Fig. 4-16).

1) Though the construction cost estimated for a new installation of a pipeline will be enormous, the purification cost of the raw water conveyed by means of the open channel is also far bigger than

that of the pipeline. The total construction cost and running cost required for conveyance and purification of raw water are not deemed to have any difference between two cases; open channel and pipeline.

2) To improve the sanitary condition in the site, the raw water is preferable to be conveyed without any deterioration in quality.

4.4.4 Benefit

The municipal and industrial water supply will surely upgrade the living standard, improve the sanitary condition, decrease the frequency of desease, and moreover spur the industrial and commercial activities. In this sense, a great deal of benefit can be expected to accure in the future, although it is quite difficult to quantify the benefit.

4.5 IRRIGATION

4.5.1 Crop and Yield

Selection of the Crop

Irrigation water made available by construction of the proposed dam will primarily be used for crop cultivation during a dry season. Among various kinds of crop to be planted during a dry season, paddy has been selected on the ground of the following reasons:

1) The benefitted area is limited to the existing Bili-Bili and Kampili area for the reason described in 4.5.2, which has already been developed as paddy field in its entirety, with its own irrigation network; in other words, big investment for the land development is not required to increase the paddy production,

2) From the economic point of view, paddy is the most favorable crop among those which have been cultivated during a dry season such as maize, green bean, cassava, etc., as will be easily understood from the comparison given in Table 4-5, and

3) Indonesia as a whole is still in short of rice.

Design Cropping Pattern

Paddy cultivation in the benefitted area can depend on the effective rainfall from November to April and on the river discharge from November to May. Puddling, a process of paddy cultivation during which irrigation water requirement comes to a peak, should preferably fall in the above said period of the year. If so, harvesting of paddy and its drying will have to be performed in a wet season. This will make farmer's activities inconvenient.

Therefore, to avoid the above inconvenience, the design cropping pattern is proposed to be the shape as presented in Fig. 4-17.

This cropping pattern has been worked out on the assumption that the growth period of paddy would be 125 days, (refer to Table 4-6) as recommended by the Agricultural Extension Service in Ujung Pandang under BIMAS/INMAS program (up till 1983).

Expected Crop Yield

The paddy yield expected at the full operation stage of the project has been estimated as below, by taking into consideration 1) the past performance in South Sulawesi province and 2) improvement of appropriate cultivation techniques including proper use of fertilizers and agro-chemicals.

(Unit: ton/ha)

	Paddy	Dry stalk paddy	Gaba
Wet season paddy:	4.59	6.00	3.12
Dry season paddy:	4.59	6.00	3.12

The paddy yield "without the Project" would remain as follows:

(Unit: ton/ha)

	Paddy	Dry stalk paddy	Gaba
Wet season paddy:	3.85	5.03	2.62
Dry season paddy:	3.30	4.31	2.24

4.5.2 Water Requirements

Basic Year for Planning

In Indonesia, it has been customary to select the second droughtiest year in the last 10 years (equivalent to 5-year probability) as the "basic year" for its irrigation projects. It seems appropriate to adopt the second droughtiest year for this project also.

The year 1976 has been the second droughtiest year during the last decade (1971-1980), as evidenced by various data on hand including the past rainfall records (refer to Table 4-7). Hence, this specific year has been adopted as the "basic year" for planning the present Irrigation Plan.

Benefitted Area

It is economically more advantageous to utilize the existing system as it is than to newly construct or extend a system. In this connection, the benefitted area of the irrigation plan under this project has been delineated in the existing irrigation area, based on the volume of irrigation water dependent on the reservoir supply which will be studied in the succeeding sub-section. Since water volume utilizable for the irrigation by the proposed Bili-Bili dam cannot cover the entire area of the existing irrigation during the dry season, the limited utilizable water will be distributed to both Bili-Bili and Kampili irrigation systems in proportion of its respective area for equal distribution of agricultural production output in the both areas. The delineated irrigable areas are as follows;

Wet season paddy

Kampili system	....	19,000
Bili-Bili system	....	5,000
Total	....	24,000 ha

Dry season paddy

Kampili system	....	15,200
Bili-Bili system	....	4,000
Total	....	19,200 ha

Irrigation Requirements

1) Evapotranspiration

Crop evapotranspiration or the plant's water consumption will be computed by the modified Penman method, which suits to a locality which is generally humid and covered by vegetation. The results of computation of monthly evapotranspiration through paddy during 1976 and 1980 are as shown in Table 4-8.

2) Diversion Requirements

Diversion requirements at both Bili-Bili and Kampili intakes during the dry season in the Basic Year (1976) have been computed to be as follows; (for more in details refer to Table 4-9).

	Required water
Kampili irrigation system :	23.2 m^3/s in max.
Bili-Bili irrigation system:	6.1 m^3/s in max.

The items necessary for computation will be as follows:

Water Requirement in Depth (Seepage)

Wet season (November-April) .... 2.5 mm/day
Dry season (May - October) .... 3.0 mm/day

Effective Rainfall

$Re = 0.7 \times Rm$ (mm/month)
Re: effective rainfall
Rm: monthly rainfall

Water required for preparation of paddy field and for puddling

Preparation .... 150 mm
Puddling .... 50 mm

Conveyance Loss

Main and branch channel .... 20 %
Field internal .... 10 %

Thus, the water conveyance efficiency will be $0.80 \times 0.90 = 0.72$.

3) Water Sources

Diversion requirement under the irrigation plan is primarily meant for cultivation of paddy during the dry season, although some amount is required for paddy cultivation during a part of wet season.

Required reservoir storage capacity for dry season paddy is estimated at 241×10^6 m^3. The paddy field which will be benefitted by supply of irrigation water during the dry season will thus depend on the storage capacity provided for the Bili-Bili reservoir, and it will be 19,200 ha in size.

4.5.3 Irrigation System

Irrigation water to be developed will be supplied to the area sown with dry season paddy through the existing Bili-Bili and Kampili systems. The proposed distribution systems and distribution of the irrigation water for Kampili area as well as Bili-Bili area are illustrated in Fig. 4-18.

4.5.4 Benefit

Price of Rice and Production Cost

The price of rice at the full operation stage of the project is estimated at 353,000 RP/ton (refer to Table 4-10).

The corresponding production cost would be as follows:

(Unit: RP/ha)

	Without the project	With the project
Wet season paddy:	180,000	190,000
Dry season paddy:	190,000	200,000

Net Production Value With and Without the Project

The net production value without project would remain at approximately RP 19,319 million (US$30.91 million) or RP 731,780 (US$1,171) per ha in a year. On the other hand, net production value with project in a year would be RP 38,980 million (US$62.37 million) or RP 902,315 (US$ 1,444) per ha.

Consequently, the project would bring about increment of income amounting to RP 19,661 million (US$31.46 million) per year, as detailed in Table 4-11.

4.6 HYDRO POWER

4.6.1 Future Demand and On-going Development Program

Future Demand

The future power demand curve has been chalked out by PLN in order to establish an appropriate Power Project to meet the increasing demand in Ujung Pandang area.

Power Plant

PLN is planning to annually increase the installed capacity to support the increasing demand through the expansion programs.

Fig. 4-19 shows future power demand and the expansion programs at WILAYAH VIII which has been programed by PLN.

Transmission Line

Together with such expansion of the installed capacity, the transmission lines are also planned to be extended to new areas (refer to Fig. 4-20).

4.6.2 Expected Generated Output and Energy

Hydro power generation principally depends on municipal and industrial water, irrigation water and the vested right water which are subject to the requirement of the benefitted area. When the paddy cultivation of the dry season is over at end of September, the reservoir storage will recover to high water level within a few month every year.

For the effective generation of the hydro power, the recovery rule of the reservoir storage is adopted during a period from October to April. As its result, the surplus water for recovery of the reservoir storage will be utilized for the power generation.

The optimum scale of a hydro power station will be decided upon from its IRR values which have been calculated for each maximum available discharge, as shown in Fig. 4-21 and Table 4-12. The optimum generating capacity is determined as follows.

Maximum discharge	:	32.0 m^3/s
Maximum generated output	:	11,200 KW
Annual generated energy	:	69,600 MWH

The result of calculation of generated energy during 5 years (1976-1980), is shown in Table 4-13 and Fig. 4-22.

4.6.3 Transmission Line

A 30 KV transmission line to the nearest Borongloe sub-station will be constructed for a distance of 15 km along Jl. Malino from the switchgear which will be established outside the power station.

4.6.4 Benefit

The benefit of Bili-Bili hydro power station is estimated based on the cost required to produce the equivalent capacity and energy by the most competitive thermal plant.

In this stage, an oil-fired steam station with the capacity of 11,000 KW will be adopted for the alternative.

The capacity value and the energy value are estimated at US$90/KW and US$0.054/KWH respectively. Annual benefit of the proposed power station consisting of capacity benefit, US$0.26 million, and energy benefit, US$3.61 million is estimated at US$3.86 million under the followings conditions.

Dependable peak power	:	2,870 KW, 310th largest generated output in a year.
Transmission loss	:	4 %

CHAPTER V - PRELIMINARY DESIGN

5.1 GENERAL

Based on the optimum size of the proposed facilities which have been studied in Chapter IV, preliminary design has been done. The design discussed in this chapter includes a multipurpose dam at Bili-Bili, river improvement works of the Jeneberang, a municipal/industrial water supply system, irrigation facilities, and hydro power system.

The river improvement works were designed for the urgent flood control in the previous study in 1979, covering the stretch between 2.0 K and 9.0 K below Sungguminasa. However, since its implementation has not been started yet, the design of river improvement works of this Project has been based on the present conditions.

5.2 DAM AND RESERVOIR

5.2.1 Dam

Dam consists of main dam which connects two hills, and two wing dams on the right and left. The main dam will be built to shut down the Jeneberang river, and the right wing dam is to close a saddle through which Jl. Malino is running and the left wing dam is to shut down a saddle which is situated on the watershed dividing the Jeneberang river basin from the Jenelata river basin.

The principal features of each dam are as follows:

	Main dam	Left wing dam	Right wing dam
Height :	66.00 m	40.00 m	50.00 m
Length :	670.00 m	725.00 m	440.00 m
Crest width :	10.00 m	10.00 m	10.00 m
Crest elevation:	EL.105.00 m	EL.105.00 m	EL.105.00 m
Dam volume :	3,600,000 m^3	1,350,000 m^3	1,330,000 m^3

The aggregated total volume of these three dams is estimated at 6,280,000 m^3, including 1,000,000 m^3 which is the coffer dam volume.

Regarding the type of the dams above, rockfill type with a center core is adopted due to the following reasons.

1) Geologic Viewpoint

Though diabase and microdiorite of the foundation rock at the dam site have a sufficient strength to serve as the foundation for a concrete dam, calcareous mudstone/sandstone and tuff which are spreading rather widely in parts of the riverbed and in the neighborhood of the foundations for the both wing dams do not warrant a strong foundation for concrete dam.

2) Topographic Viewpoint

The ratio of crest length to crest height is larger, accordingly fill type dam is more suitable to its topography.

3) Material Viewpoint

The geological survey conducted at and in the vicinity of the dam site made it clear that the materials for fill type dam are available.

4) Technical Viewpoint

Among the dams, homogeneous earth dam is given the upper limit of 30 m in dam height, while an inclined core type is out of choice in the case of Bili-Bili dam which will then require a huge dam volume. This is because the upstream slope of the dam with inclined core is required to be very gentle, as the valley opens extremely wide towards upper stream.

The dams and their related facilities are shown in Figs. 5-1, 5-2 and 5-3.

5.2.2 Spillway

Spillway will be installed on an elevated ground standing between the main dam and the left wing dam. The principal features of the overflow part of spillway are mentioned below.

Free flow section	:	1) 100 m wide, EL.97.60 m
		2) 337 m wide, EL. 100.30 m
Regular gate	:	2 gates x 6.5 m wide x 7.2 m high

These features are determined based on the undermentioned conditions:

1) In case the discharge at the dam site happens to be below 500 m^3/s, the spillway gates will be operated to discharge surplus water in order to maintain the reservoir water at the normal water level (N.W.L.);

2) In case the discharge happens to be over 500 m^3/s at the dam site, the flooding water will be naturally regulated without operating spillway gates. Accordingly, design flood for downsteam area will be discharged at the surchage water level (S.W.L.) so as it will be regulated to 2,300 m^3/s at Kampili point;

3) The flood discharge designed at 4,300 m^3/s will be made an outflow discharge at the design flood water level (D.F.W.L.).

5.2.3 Diversion Channel

The design discharge for the temporary diversion channels is 1,850 m^3/s which corresponds to a flood of 20-year probability.

A tunnel type is adopted as the temporary diversion works in this project.

The sizes of the diversion tunnel and coffer dam are decided from the economical comparison (refer to Fig. 5-4) and engineering aspects, as follows.

Diversion channel	:	9 m in diameter, 2 units
Main coffer dam	:	31m in length

<u>Diversion Tunnel</u>

The diversion tunnels are located below the left abutment of the main dam. One tunnel, to be located along the riverside, and the other, to be located near to the mountain, are 260 m and 280 m in length, respectively.

<u>Main Coffer Dam</u>

The main coffer dam is located on the proposed sites of main dam and the right wing dam. The volume of the main coffer dam is estimated at 1,000,000 m^3.

5.2.4 Intake Facilities

The intake facilities should be designed to allow the intake volume of 32 m^3/sec, at the low water level of the reservoir.

For the intake, an inclined conduit is constructed above the No. 2 temporary diversion tunnel running through the abutment of the left bank of the main dam.

The inclined conduit of reinforced concrete construction is 11.0 m in width and 36.0 m in height with an inclined angle of 45 degrees.

The temporary diversion tunnel, after completion of the dam, will be re-used for the purpose of the intake channel instead of the construction of a new intake for the utility water to save the project cost.

Accordingly, the intake water runs through the temporary diversion tunnel and, then lead to the power plant through a steel pipe, from the plugged section in the diversion tunnel.

5.2.5 Outlet Facilities

The outlet facilities for the respective purposes as mentioned below are located in the power plant housing.

For the outlet facilities, the gates of the specifications below are installed.

1) Municipal and industrial water

Jet-flow gate: 0.5 m dia.

2) Irrigation water

Jet-flow gate: 1.5 m dia.

Normally, these gates are closed, and the required water is supplied through the tailrace. The gates are opened only when the power plant is not in operation.

Besides the outlet facilities as mentioned above, one jet-flow gate, 2.0 m dia., has to be installed in the No.1 temporary diversion tunnel in order to lower the reservoir water stage for inspection and maintenance in case of emergency. The gate and its operating room will be placed in the temporary diversion tunnel.

5.2.6 Division Works

Tail water from the power station is divided for the required supply purposes while flowing in the tail water channel.

For a steady control of the intake water for the respective purpose, the control gates are installed at the end of the tailrace channel.

Two intakes with the sluice gate are provided on the side wall of the tail water channel above the control gate.

Major features of the diversion gates are as follows:

Item	Width	Height	Number	Remarks
Control gate	3.5 m	2.0 m	2	Kampili irrigation & vested right water
Intake gate	1.0 m	1.0 m	1	Municipal water & sericulture water
Intake gate	2.0 m	2.0 m	1	Bili-Bili irrigation water

5.2.7 Land Acquistition and Relocation

A land of 1,591 ha shall be acquired and 790 houses shall be evacuated for implementation of the project. The pump station belonging to the sericultural center which is drawing the river water at dam site will need to be replaced.

Jl. Malino which is running along the right bank side upstream of the dam site will have to be relocated for a distance of 19 km. Construction of new bridge is limited to small ones less than 5 m in width, simply to cross over brooks, in the number of 4. The details of land acquisition and relocation related to the project implementation are set forth in Table 5-1.

5.3 RIVER IMPROVEMENT

5.3.1 Earthwork Required

The earthwork for the river improvement consists of the followings;

(Unit: m^3)

	Below Sungguminasa	Above Sungguminasa	Drainage ditch	Road raising
Excavation	2,040,000	870,000	72,400	-
Embankment	630,000	-	-	20,000
Filling	-	360,000	-	-

Borrow Pit

Since no appropriate materials for dike embankment are obtainable from the riverbed, its materials will be conveyed from a borrow pit which is located in the right bank near Sungguminasa (see Fig. 5-5). The available volume of the soil material in the proposed borrow bit is estimated at 1.2×10^6 m^3.

Spoil Bank

There exists a low elevation area, 0.3 m above M.S.L. in a part of Ujung Pandang city which will be planned to urbanize in the future. For the urbanization of the low elevated area, it will be required that the area be filled up to prevent flooding due to land side water. It is, therefore, recommendable that the area will be utilized as the spoil bank.

The expected volume of the spoil bank is estimated at 3.5×10^6 m^3 when the area is reclaimed up to a elevation of about 1.1 m above M.S.L..

5.3.2 Riparian Structures

The riparian structures which will be installed under the present improvement plan along the Jeneberang river will include dike, drainage ditch, revetment, groyne, sluice, and groundsill. The excavation of a diversion channel of S. Garassi, and the raising of the existing road running on the right bank in the upper reaches of Sungguminasa bridge, will be also included as the part of the project.

Fig. 4-12 will show the location of the riparian structures referred to the above.

Dike

It is proposed, as a principle, to keep the height of dike no more than 3.0 m above ground level, including a 1.2 m freeboard. The proposed dike will have a crest width of 3.0 m, so that vehicles can pass along it for river management. The side slope gradient on the river side and land side will be 1 : 2, to assure the stability of the dike (refer to Fig. 5-6).

Fig. 5-6 shows the standard cross-section of the dike.

Drainage Ditch

In the present design, drainage ditches will be excavated along the both banks of the downstream of Sungguminasa bridge, extending for 3,000 m on the right and 9,000 m on the left. Along the right bank, the drainage ditch will be designed in 3 systems so that they can also serve as drainage channels of the municipal waste water. On the left bank, 4 systems of drainage ditch will be provided. At its terminal, the drainage ditch will be connected to a sluice gate.

Revetment

Revetment whose structure is of wet masonry will be constructed in the vicinity of a bridge as well as along the concave side of bends of the river, for a total distance of 10,300 m (on the upper reaches of Sungguminasa bridge, only low water revetment will be constructed for a length of 3,800 m), as shown in Figs. 4-12 and 5-6.

Groyne

The purpose of a groyne is to prevent erosion at the foot of the river bank by slowing down flow velocity and by accelerating sediment deposit.

The structural details are shown in Fig. 5-6. The total length of the sections where groynes are to be provided is 4,700 m, and their number counts 94.

Sluice

The existing sluices in the lower reaches of Sungguminasa will be unable to be used due to the construction of the proposed dikes and the drainage ditches. In this connection, 7 sluices in total, will be newly installed, whose scale depends on the drainage discharge of each ditch. After the closure of the right course of the Jeneberang river, a sluice will be established at its closing point so that the river water can be taken in, as a flush water, the drainage ditch on the right course which is reclaimed in this project.

Fig. 5-6 illustrates the structure of the sluice.

Groundsill

The groundsill is installed to prevent the reparian structures from erosion of the riverbed, as a majority of sediment will be deposited in Bili-Bili reservoir after completion of Bili-Bili dam. The groundsill will be installed at 30 m downstream of Sungguminasa bridge to protect its foundation. The groundsill, as shown in Fig. 5-6, will be placed over the full width of the channel.

Groundsills of smaller dimensions will also be placed in the downstream of the intake for the paper mill's water to prevent the lowering of their intale capacity due to a sinking of riverbed.

Diversion Channel of S. Garassi

Construction of dike along the Jeneberang river will necessitate a change of the course of S. Garassi which is joining the Jeneberang in the neighborhood of the estuary from the left bank side. At the present stage of designing, it is proposed to construct a diversion channel which runs for about 800 m in parallel to the dike (refer to Fig. 4-12).

Road Raising

The road which is running to Jl. Malino on the right bank in the upper reaches of Sungguminasa bridge, has some portions which are subject to overflowing of flooding water due to the lower elevation. Accordingly, the lower section of the existing road will be raised by about 1.5 m in maximum for a distance of some 3,000 m, to confine flooding water in river side area. The section of the road proposed for such raising is shown in Fig. 5-5.

5.3.3 Land Acquisition and House Evacuation

The land to be acquired and the houses to be evacuated for implementation of the river improvement works will be tabulated in the below:

Land Acquisition

(Unit: ha)

	Right bank side	Left bank side
Above Sungguminasa	12	6
Below Sungguminasa	43	37

House Evacuation

(Unit: nos.)

	Right bank side	Left bank side
Below Sungguminasa	180	50

5.4 WATER SUPPLY

5.4.1 Water Intake Facilities

A preliminary design of the intake facilities for the municipal/industrial water will be done for common use with the irrigation water which are more economical than those for exclusive use of the municipal water.

Intake Volume

The common intake will be designed to draw the design volume of 32 m^3/s which is almost equal to the maximum demand of the municipal/industrial water, the irrigation and the vested right water.

Intake volume for the municipal and industrial water is fixed at the required municipal/industrial water of 2,300 l/s all through the year.

Intake Facilities

The water from the reservoir will be sent through the hydro power facilities and, after generation, will distribute to the municipal/industrial water with a part of the vested right water for the sericultural center.

The municipal/industrial water will be supplied to the sand basin and the regulating basin on the right bank of the river through the conduit buried under the river. The principal facilities in regard to the intake are as follows:

Gate-controlled division works	:	1 L.S.
Conduit	:	200 m
Sand basin	:	1 place
Regulating basin	:	1 place

The outline of the water supply facilities is shown in Fig. 5-7.

5.4.2 Conveyance Facilities

Conveyance of the municipal/industrial water will be made through a pipeline. The water taken from the reservoir will be deposited for sometime in the regulating basins nearby the dam, thence sent to the treatment plant through a pipeline extending for approximately 25 km. Ductile cast-iron pipe with 1,500 mm diameter is proposed. This pipeline will be generally buried underground along the road between Ujung Pandang and Malino.

Again, to ensure conveyance of a well-stabilized volume of water through the pipeline, it is desirable to install the junction well, regulating valve, flow meter, air vent, etc., with an interval of every 1 - 3 km. The principal features of the proposed pipelines are as follows:

Design conveyance volume	:	2.3 m^3/s
Conveyance pipe	:	1,500 mm dia. Ductile cast-iron pipe
Junction well, regulating valve, flow meter, air vent	:	12 sites

5.5 IRRIGATION

5.5.1 Bili-Bili Irrigation System

Intake

The maximum intake discharge of Bili-Bili irrigation is 6.1 m^3/s.

The existing Bili-Bili takes in the river water without weir, and the intake capacity is about 3.5 m^3/s, when the river discharge at the intake site is about 30 m^3/s.

It is, therefore, requested that a new intake be installed in tailrace of the power station and a new irrigation channel linking the new intake to the existing channel be located in the downstream of Bili-Bili intake.

In the downstream of the existing channel, the present irrigation facilities will be utilized after the required improvements.

Construction of Connecting Channel

The intake water would be conveyed by conduit and open channel.

The conduit will be embedded below the Jeneberang river and the open channel will be installed on the right bank of the river. The connecting channel runs in parallel with the municipal water pipeline. The route of and the cross section of the connecting channel are shown in Fig. 5-8.

The lengths of the proposed conduit and the open channel are as follows;

Conduit	:	200 m
Open Channel	:	1,300 m

Improvement of Existing Channel

The channel between Bili-Bili intake and Pakatto weir extending 8 km makes use of natural river channel. Irregular sections and bottlenecks of the natural channel requires to be improved in a scale of required capacity in this project.

Secondary Channels and Relevant Facilities

For a steady supply of irrigation water to the extreme tips of farm lands, improvements of the secondary and tertiary channels and other appurtenant facilities are required. The improvements consist of the widening of bottlenecks of the channel, inspection roads, and appurtenant facilities such as deteriorated diversion works, bridges, etc.

The area subject to this improvement work corresponds to the benefitted area in a wet season, which is 5,000 ha.

As for the cost of improvement per ha, the reference was made to the program implemented by the Ministry of Public Works with indication of Rp.427,700 /ha (US$683/ha). Considering the price escalation, the cost of improvement per ha in this project is determined to be US$900.

5.5.2 Kampili Irrigation System

The maximum intake discharge for Kampili system is set at $Q = 23.2\ m^3/s$. The present intake capacity of the Kampili intake is approximately $25\ m^3/s$, making available the continued use of such facilities as intake and settling basin. Bottlenecks in some sections of main channel (flow capacity: approximately 12 m^3/s) will be expanded.

Improvement of Main Channel

The narrow sections in the main channel (approximately 2,500 m in length) will be expanded to allow a water volume of Q = 23.2 m^3/s. Fig. 5-8 shows the improved stream of main channel and its cross section.

Secondary Channels and Relevant Facilities

The area subject to this improvement work corresponds to the benefitted area in a wet season, which is 19,000 ha. As for the cost of improvement, US$900/ha is adopted which equals the cost for Bili-Bili system.

5.6 HYDRO POWER

5.6.1 Power Station

Intake

The common intake designed as an inclined conduit type, is laid on the slope immediate downstream of the mouth of a temporary diversion channel.

The water from the intake will be controlled with the intake gate and sent to the turbine through the steel pipe which will be installed in the diversion tunnel of the dam. The principal specifications in regard to the intake are follows.

Design intake volume	:	32 m^3/s
The lowest intake level	:	EL. 74.00 m
Intake type	:	Inclined conduit
Penstock	:	Dia. 3,500 mm, L = 120 m
		Dia. 2,400 mm, L = 70 m
		Dia. 1,800 mm, L = 65 m

Power House and Waterway

A power house is to be constructed at a flat ground on the left bank downstream of the outlet of the temporary diversion channel.

Two generators are accommodated in the power house which is built with reinforced concrete, 38.0 m in length, 22.0 m in width, 12.0 m above and 20.0 m below the ground levels.

After the water being branched off in two penstocks immediately before the power house, it will operate each one of the turbines. A draft gate will be installed at the outlet of the turbine.

The waterway and power house are illustrated in Fig. 5-9.

5.6.2 Generating Equipment

Each one of the proposed hydraulic turbines which has been designed under conditions of 16 m^3/s of discharge at 42.0 m design head, will be of vertical shaft, Kaplan type with an elbow-type draft tube. The selection of the turbines has been made by considering the undermentioned items:

High water level	:	EL. 97.60 m
Low water level	:	EL. 74.00 m
Normal tail water level	:	EL. 47.0 m
Effective head	:	48.1 m - 24.5 m

Two generators to be provided for the power station will be 3-phase vertical shaft revolving field type and rated at 6,600 KVA, 6 KV, 50 Hz. The generators will be directly coupled with the water turbines.

5.6.3 Transmission Line

The steel poles for the 30 KV transmission line will be constructed in every 100 m of 15 km distance between Bili-Bili power station and Borongloe sub-station (refer to Fig. 5-9).

The conductor will be selected as 120 mm^2 ACSR considering corona discharge.

CHAPTER VI - CONSTRUCTION SCHEDULE AND COST ESTIMATE

6.1 GENERAL

In working out the construction plans, careful consideration of and evaluation with such items as the availability of construction machinery and material in the local, their prices, the construction capacity of the local contractors, the facilities and capacity for repairing of the machinery and equipment to be mobilized for construction works, the conveniences of their transport to the job sites, and other necessary items relevant to construction work has been made.

Cement, steel bars, lumbers, bricks, stones, fuels and oils which are necessary as the construction materials in general are almost entirely obtainable locally, but the structural steel, iron/steel pipes, water gates, valves and some other materials which need to be of high precision and good quality plus machinery and equipments will have to be imported.

The construction cost of each sector to be mentioned below has been estimated on the contract basis and on 1981 prices.

6.2 BILI-BILI DAM

6.2.1 Construction Schedule

Work Order

Dam construction work will follow the stages as mentioned below:

1.	Temporary diversion work	1986-1987
2.	Coffer dam work	1987
3.	Left wing dam embankment	1987
4.	Main dam embankment	1988
5.	Right wing dam embankment	1988
6.	Commencement of impounding of the reservoir	1990

An entire construction period will last for 5 years, from April 1986 to March 1991. The construction schedule covering all the stages is shown in Fig. 6-1.

While the excavation and concrete works will be continuously done all through the year, filling work will be suspended during a wet season that is from November to March.

Construction Machinary

Excavation of hard rocks will be performed by drilling and explosion. Bulldozers will be used for excavation of soft rocks.

Compaction of core material and filter zone which will be involved in the embankment work of dam will be carried out by tamping roller and vibration roller, respectively.

Concrete placing will relay on concrete pump cars and truck cranes. Temporary plants and machinery which will be required for the dam construction are set forth in details in Table 6-1.

6.2.2 Cost Estimate

Construction Cost

The total construction cost of Bili-Bili dam comprise civil works, gates and equipment, road relocation, land acquisition, engineering cost and plus 15% physical contingencies.

The total cost will be US$157.2 million, out of which US$79.5 million is of foreign currency and US$77.7 million of local currency.

The breakdown of the construction cost is shown in Table 6-2.

Operation, Maintenance and Replacement Cost

The dam operation and maintenance cost will comprise the personnel cost, operational machinery and equipment, vehicles, boats, administrative cost and miscellaneous. As an annual operation and maintenance cost for the whole period of the project life, US$0.08 million is estimated. Replacement cost of the gates after 35 years from the initial dam operation has been estimated at US$1.47 million.

6.3 RIVER IMPROVEMENT

6.3.1 Construction Schedule

Work Order

The river improvement for the urgent flood control is scheduled to be implemented from the biginning of 1982 under the financial assistance of Overseas Economic Cooperation Fund. The construction schedule for the river improvement works in this report has been planned on a basis of the completed conditions of the urgent flood control, and the works will be implemented after completion of the dam construction to avoid concentration of the construction works.