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REPUBLIC OF INDONESIA
MINISTRY OF PUBLIC WORKS (DPU)
DIRECTORATE GENERAL OF
HUMAN SETTLEMENT (CIPTA KARYA)

UJUNG PANDANG
WATER SUPPLY DEVELOPMENT PROJECT

VOLUME I

EXECUTIVE SUMMARY

NOVEMBER 1985

JAPAN INTERNATIONAL COOPERATION AGENCY

SDS
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国際協力事業団	
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P R E F A C E

In response to the request of the Government of the Republic of Indonesia, the Government of Japan decided to conduct a Master Plan and Feasibility Study on Ujung Pandang Water Supply System and entrusted the Study to the Japan International Cooperation Agency (JICA).

JICA sent to Indonesia a preliminary survey team headed by Mr. Tsunao USAMI, Deputy Director of Planning Div. of Kanagawa Water Supply Authority, March 1984. The team had a series of discussions with the officials concerned of the Government of Indonesia, in particular with those of the Ministry of Public Works (CIPTA KARYA), and has agreed on the Scope of Work for the Study.

After a preliminary survey was conducted, JICA dispatched a full-scaled study team led by Mr. Fumihiro TABU, Nihon Suido Consultants Co., Ltd., made further field survey and analysis work based upon the Scope of Work, from July 1984 to November 1985, and the present report has been prepared.

I hope that this report will serve for the development of the Project and thereby 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 Indonesia for their close cooperation extended to the team.

November, 1985

Keisuke Arita

Keisuke ARITA
President
Japan International Cooperation Agency

SYNOPSIS

1) The scope of the Master Plan study, included a review of all the related regional planning in Kotamadya Ujung Pandang to 2005 and the National Guidelines prepared by Cipta Karya.

2) The total population of Kotamadya Ujung Pandang is forecast to increase from 0.7 million to 1.3 million by 2005, and the serviced population from 0.3 million to 1.2 million in the same period.

3) The present water supply conditions are far behind the targets envisaged in the National Guidelines. The majority of the people utilize shallow well groundwater supplies, many of which are in an unsanitary condition.

4) The long term water supply plan to 2005 is separated into two parts: Stage I Project (1985-1995) and Stage II Project (1990-2005). Each Project is further divided into a two phased programme.

5) The long-term water source for the stage II Project is the Bili-Bili dam to be constructed by 1995, while the Stage I Project relies on the irrigation water source from the existing Bili-Bili intake in addition to the other present water sources.

6) A new treatment plant will be constructed at Mangngasa with a capacity of 500 l/sec under each Phase of Stage I Project and 1,000 l/sec under Phases 1 and 2 of the Stage II Project for a total capacity of 3,000 l/sec. Phase 1 of the Stage I Project proposes rehabilitation of the existing Ratulangi and Panaikang treatment plants and distribution network.

7) Both phases of the Stage I Project comprise the scope of work for the Feasibility Study.

8) The Study also formulates a loss reduction program. Urgent implementation of this program will give a significant increase of the revenue water from 50 % at present to 80 % by 1990, to meet the target of Cipta Karya.

9) The total project costs of Stage I are estimated at Rp. 80.1 billion including construction cost, administrative and engineering fees, physical and price contingencies. The foreign and local portions have been estimated at US$ 37.1 million and 37.4 billion Rupiah respectively.

10) The new 500 l/sec treatment plants of Phases 1 and 2 are scheduled to be in operation by October, 1990 and February, 1993 respectively.

11) The financial analysis verifies the feasibility of Stage I Project. The financial rate of return is at a favourable level of 6.0% for Phase 1 and 12.3% for Phase 2.

M A S T E R P L A N

A N D

F E A S I B I L I T Y S T U D Y

M A S T E R P L A N

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EXECUTIVE SUMMARY

1. Introduction

In response to the request by the Government of the Republic of Indonesia, the Government of Japan decided to undertake Master Plan and Feasibility Study of Ujung Pandang Water Supply Development Project through the Japan International Cooperation Agency (JICA) within the frame of the international technical cooperation programme.

The present Master Plan, prepared in accordance with the contract between JICA and Nihon Suido Consultants, identifies a long range water supply project targetted at the year of 2005. This executive summary describes briefly all salient points planned and recommended in the said Plan.

2. Description of the Area

2.1 Location and Topography: The city is located at the south-western end of South Sulawesi Province facing the Makassar Strait. Its topography is generally flat and the elevation is several meters above sea level. The area consists of alluvial deposits. In the area two major rivers flow from east to west, namely, the Tallo River and the Jeneberang River.

2.2 Climate: The temperature is rather high, 25 °C to 27 °C on average throughout the year. Annual rainfall reaches as high as 3,000 mm. During the period from July to September, however, rainfall is scarce.

2.3 Socio-economic Conditions: Economic activities of the area are characterized by agriculture and commerce. Major farm product is rice. The city is a commercial center in Sulawesi, collecting various agricultural products from the

hinterland and distributing goods transported from other areas of the country, and also the area prospers as a center of fishery. On the other hand, industries are now increasingly developing, stimulated by the government policy, and an industrial estate is presently under construction.

2.4 Infrastructure: The city is well provided with transportation facilities, such as airport, harbor and road; domestic airlines connect with major cities in the country, and public roads run to north and south. The old town area of the city has a complete electric network.

2.5 Public Health: Incidences of eye disease and digestive organ disease are rather high. In the city there are nine hospitals and 48 drugstores. Sewerage system has not been constructed yet, and collection and disposal of domestic solid waste is practiced but still insufficient.

3. Existing Water Supply

3.1 The Existing Water Supply: The existing water supply is as follows:

Panaikang System

Water source	: The Maros River
Water intake	: Leko Pancing
Treatment plant	: Panaikang
Production capacity	: 600 l/sec (51,800 cum/day)

Ratulangi System

Water source	: The Jeneberang River
Water intake	: Sungguminasa
Treatment plant	: Ratulangi
Production capacity	: 50 l/sec (4,320 cum/day)

The general plan of the existing water supply systems and its illustration are shown on Figures 1 and 2 respectively.

3.2 Water Source: The Jeneberang River, presently tapped for the Ratulangi plant, is the biggest river in South Sulawesi. It has a catchment basin of 727 sq km and its main stream has a length of 75 km. The flow is abundant only except for the short dry period of July to September. Once in several years, the flow in the dry period barely meets the demand of the Ratulangi plant.

The Maros River supplies raw water to the Panaikang treatment plant. The river, having a similar catchment basin and river length to the Jeneberang, has more or less same flow conditions as the latter.

Groundwater is widely available in the area, but its quality is not necessarily good for domestic use, and besides in the northern area the water table drops to the extent that shallow wells cannot take water in the dry season. Presently, a large number of people rely on groundwater for domestic use.

3.3 Ratulangei Treatment Plant: The plant was constructed in 1924, more than half century ago, and since then some improvement works have been added. The present production capacity is estimated at not more than 50 l/sec. As all the facilities are deteriorated and some are left unrepaired, it may not be appropriate to renovate the plant.

3.4 Panaikang Treatment Plant: The plant was constructed in 1977 with a capacity of 500 l/sec, and later it was uprated by 100 l/sec with some improvement works. Further, an expansion of the production by 500 l/sec has been planned with completion in a few years. The plant suffers water shortage once per several years in the dry season. Distribution of treated water was originally designed to be by pumpage, but presently it is made by gravity, resulting in low water pressure throughout the served area.

3.5 Distribution System: The existing pipelines total 404 km, including cast iron, galvanized steel and ductile cast iron pipes. Recently PVC pipe is being used for the service mains.

Water pressure in the service area is generally very low, and many customers have pumps installed on their service connections. Abundant leakage seems to be occurring on the pipelines, especially from the connecting part of service connections with the mains.

Regarding valves, many of them are lost under the pavement of the road. Fire hydrants do not work because of low water pressure of the mains, and water is transported by fire engines in case of fire.

3.6 House Connections and Public Standpipes: There are 26,676 service connections, the majority of which are for house connections. Major losses from leakage are taking place from service connections, due to unattended repair works and improper material and workmanship. As to public standpipes, their installation is made by not only PDAM but also other agencies, and as a result, maintenance thereof is quite insufficient.

3.7 Water Production and Consumption: Estimated maximum production is about 59,000 cu m/day, while consumption is recorded at about 25,100 cu m/day. The weakest point of the existing water supply is the lack of correct and reliable records of measuring. Bulk meters at the treatment plants are out of order or lacking, and besides there are many house connections with meters defective without meters.

4. Population and Water Requirements

4.1 Population: To project future population, the following procedures are taken, namely, 1) To analyze characteristics of the past population growth, 2) To build models for projection consistent with the characteristics, and 3) To simulate future population growth, taking into account the development plans related to population growth.

Remarkable features of the past population growth are that 1) migration from other areas have been taking place, and 2) younger generation have a rather higher share in the total population.

The present served population is 269,000 against total population of 789,000. The coverage is 34 %. Results of projection of total population and served population are shown on Table 1.

4.2 Water Requirements: The present per capita consumption is estimated at 97 l/c/d for house connection and 30 l/c/d for standpipe. On the other hand, the national guideline has the following target, i.e., 170 l/c/d for house connection and 30 l/c/d for standpipe to be accomplished by 1990. The present planning projects future water requirements based on the national guideline and also taking into consideration the present usage. Further, non-domestic water requirements are projected taking into account the industrial development plan of the area.

Results of the projection are shown on Figure 3. As is shown thereon, served population and water production in 1990 will be 695,000 persons and 121,000 cu m/day respectively.

5. Proposed Water Supply System

5.1 Target Year and Service Area: The whole water supply development is divided into two stages, namely, Stage I up to 1995 and Stage II up to 2005, considering that the proposed Bili Bili Dam is scheduled for completion in 1995. Further, each Stage is divided into two phases considering the convenience of implementation.

Area to be served by each phase stage are shown on Figure 4. Priority in extending the service area is given on areas where groundwater is difficult to obtain and where urbanization is to take place.

5.2 Water Source: Diversion from the Bili Bili intake for the irrigation use is planned for Stage I, and the impounded water at the Bili Bili Dam for Stage II.

5.3 Proposed Water Supply System: The proposed water supply system is shown on Figure 5, and its particulars are shown on Table 2. Planned quantity of each facility is schematically portrayed on Figure 6. The water treatment plant to be constructed in Stage I is planned to supplement the probable decrease of production of the existing plants in dry periods.

6. Implementation Schedule and Cost Estimate

6.1 Implementation Schedule: The proposed implementation schedule is presented on Figure 7, which shows water demand and production, construction periods and disbursement, and total population and served population.

6.2 Estimated Costs: Estimated costs are shown on Table 3. Estimated costs for Stage I project are US$ 33 million in foreign currency, Rp. 37 billion in local currency, and Rp. 73 billion (US$ 66 million) in total, and for Stage II, US$ 81 million in foreign currency, Rp. 96 billion in local currency and Rp. 185 billion (US$ 165 million in total),as of December 1984.

6.3 Project for Feasibility Study: The Stage I project (including Phases 1 and 2) is recommended for feasibility study, the target year of which is set on 1995 and its major works are to be completed by 1993. Major components of the project are rehabilitation of raw water transmission channel, Ratulangi Plant, meters and old pipelines, and construction of a new treatment plant with a capacity of 500 l/sec together with other necessary facilities under Phase 1 and its expansion work to increase the production capacity up to 1,000 l/sec under Phase 2. By this project, the served population will be more than tripled, up to 840,000.

7. Organization, Operation and Management Plan

7.1 Present Organization and Management: PDAM Ujung Pandang was established, separated from the local government, as a public enterprise in 1974. It has a board of directors as an organ for policy making and supervision; under this the executive organization headed by the President Director manages the water supply enterprise. Since the establishment, there have been modifications of the organization, and presently there are five Divisions, with a total staff of 388 persons.

Insufficiencies are observed in the following: 1) Training of staff and personnel, 2) Staff distribution, 3) Provision of inventory, and 4) Public relations with the customers.

7.2 Future Organization and staffing Requirement: The number of present staff is not necessarily small, but considering the work load of leakage abatement, meter installation, expansion of the water supply system, and other imperative necessity of public relations and education, training of the staff and recruitment of additional staff is recommended. In addition, some improvement in the organization is suggested. The number of staff will be increased by 50 % under Stage I project.

7.3 Financial Management and Stability: Out of the present connections, 25,000, 86 % are metered. With the metered connections, there are defective meters and some connections with meters removed. 18 meter readers read the meters every month. The rate of delinquency for water bills is rather high, 10 to 15 %.

The past income statements show that there have been surpluses every year, but the balance sheets show that vast amounts remain as accounts receivable.

8. Benefits of the Project

8.1 Benefits: Major benefits of the project are 1) 24-hour continuous water supply will be secured, 2) Safety of water will be assured, 3) Industries will be promoted by provision of water, and others.

9. RECOMMENDATIONS

For successful implementation of the project proposed in the master plan, and accomplishing the target aimed at, there are some important issues that must be carried out or realized. If not, it may not be expected that the project will produce satisfactory results as desired.

In consideration of the above, recommendations, deemed necessary, are prepared herein under the following three headings: 1) for PDAM, 2) for Kotamadya Ujung Pandang, and 3) for other Authorities concerned.

1. PDAM

The following are desired to be carried out of PDAM's own accord.

1) Periodical Review of Master Plan

In preparing the present water supply master plan, some assumptions were inevitably made owing to insufficiency of necessary data, and furthermore, the projected development of the area, together with water consumption, may possibly differ from the actual future development. Therefore, review and revision of the present report is recommended to be made from time to time, at least once a year after the commencement of the operation of Phase 1, and before implementation of the subsequent Phases.

The following items, among others, are to be reviewed every year.

- Total population
- Population served
- Production and consumption
- Per capita consumption

2) Measure to be Taken Immediately

Reduction of leakage and wastage is the most effective measure to substantially increase water supply. As water shortage in the service area is presently acute, it is recommended that PDAM concentrates its efforts on reduction of leakage and wastage and starts the work immediately. Water thus saved can alleviate the suffering of the customers. Besides, the financial position of the enterprise will accordingly be improved.

Measures to be taken are as follows:

(1) To repair leaks in no time, as found; to this end to patrol the service area.
(2) To install meters at all connections, and replace defective meters.
(3) To procure tools and equipment necessary for the above works.
(4) To mobilize, organize and train staff to be assigned for the above tasks.
(5) To establish regulations to define the responsibility of the customers in maintaining their service systems.
(6) To conduct public education on conservation of piped water, sanitary water use and others.

3) Recruitment of Engineers and Technicians

The present population served is relatively small compared with the total population, and further the target of future water supply is set rather high in accordance with the intention of the National Guidelines. Hence, substantial expansion of the water supply system is planned in the master plan. When PDAM is reviewed from the above viewpoint, its staffing is considered not sufficient to cope with the anticipated increase of work load to result from the execution of the proposed project.

Therefore, it is advised to strengthen the staff by recruiting engineers and technicians qualified in technology and skill, in due course.

4) Financial and Administrative Support

The present project requires a huge amount of funds in local and foreign currencies. Regarding the financing of the local portion, in particular the central and local governments' financial assistance in loan/equity is pre-requisite for successful implementation of the project. In this connection, PDAM has to make every effort in getting thorough understanding and full support thereof.

On the other hand, it is time-consuming to get through all the complicated formalities of the above financing, and also the implementation procedures such as inviting bids, awarding contracts, etc. Therefore, PDAM has to endeavor to obtain full support of the central government for expeditious processing.

2. Kotamadya Ujung Pandang

Considering that both drinking water and living environment are to be improved side by side to achieve the purpose of enhancing public health, it is desired that the Municipality take adequate measures for the following.

1) Maintenance of Shallow Wells

Households as many as 90% of the total are currently relying on shallow wells for a part of their domestic use. The present field survey indicates that the location of wells is often so close to the pit latrines or refuse dumps that there are many cases of well water contamination by coliform organisms. This could result in infectious water borne diseases, spreading through the community.

To protect shallow wells from contamination, the division of the municipal government responsible for public health is advised to take the following measures:

(1) To monitor water quality of shallow wells, and to disinfect them as required.
(2) To prepare a standard design of shallow wells for the use of the public.
(3) To undertake public education on use of the shallow well and construction of sanitary shallow wells.

3. Authorities Concerned

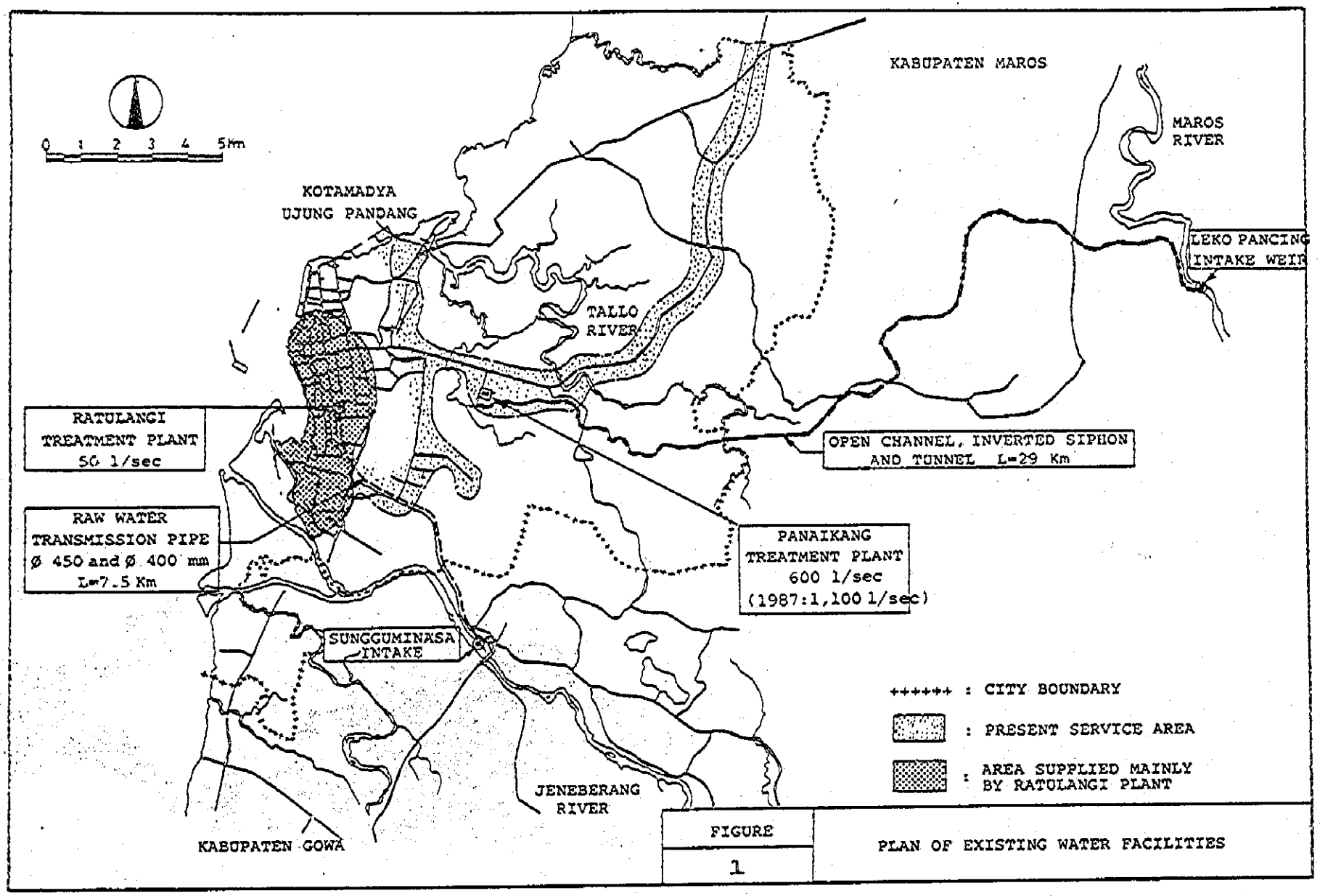
Since PDAM/Municipality is not in a position to manage the water source for the water supply, it is desired that the Authorities concerned extend their cooperation to PDAM/Municipality in the following matters.

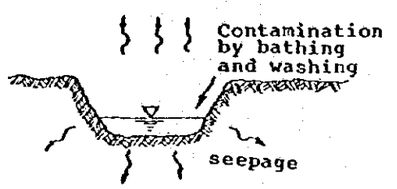
1) Construction of Bili-Bili Dam

Without the construction of Bili-Bili Dam, a sole future water source for Ujung Pandang, the problem of water shortage cannot be solved, nor the planned development of the Municipality be realized. It is, therefore, strongly wished that the Authorities concerned give due consideration to this problem and expedite the construction of the Dam. On the other hand, in the detailed design of the Dam to be shortly undertaken, it is also wished that the raw water demand of 2.8 m3/sec in 2005 of Ujung Pandang, estimated by the present study, be counted in the dam capacity, if technically and financially possible.

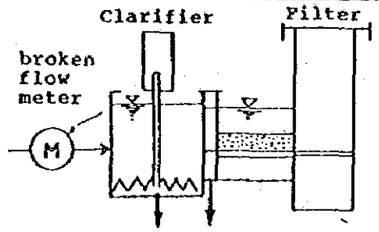
2) Water Management

If withdrawal of the Jeneberang river water is possible at Sungguminasa, as it is today and in the future as well, a vast amount of saving in the construction cost of the water supply system will be realized to the benefit of PDAM and the local/central governments. This will be practicable, only when a comprehensive water management of the said river is established to enable all the water users with water right to take in water as permitted. From the above standpoint, the Authority in charge of water resources is hoped to establish such institution of water management.


0 1 2 3 4 5Km
KABUPATEN MAROS
MAROS RIVER
KOTAMADYA UJUNG PANDANG
LEKO PANCING INTAKE WEIR
TALLO RIVER
RATULANGI TREATMENT PLANT 50 l/sec
OPEN CHANNEL, INVERTED SIPHON AND TUNNEL L=29 Km
RAW WATER TRANSMISSION PIPE Ø 450 and Ø 400 mm L=7.5 Km
PANAIKANG TREATMENT PLANT 600 l/sec (1987:1,100 l/sec)
SUNGGUMINASA INTAKE
++++++ : CITY BOUNDARY
: PRESENT SERVICE AREA
: AREA SUPPLIED MAINLY BY RATULANGI PLANT
JENEBERANG RIVER
KABUPATEN GOWA
FIGURE 1
PLAN OF EXISTING WATER FACILITIES

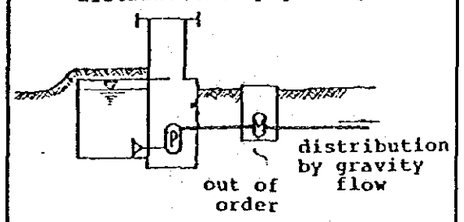


Water losses at existing channel

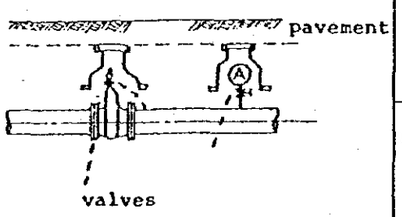


Inplant losses as drain and backwashing water

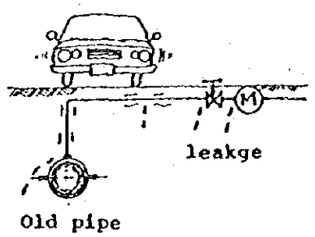
Defective bulk meter and distribution by gravity

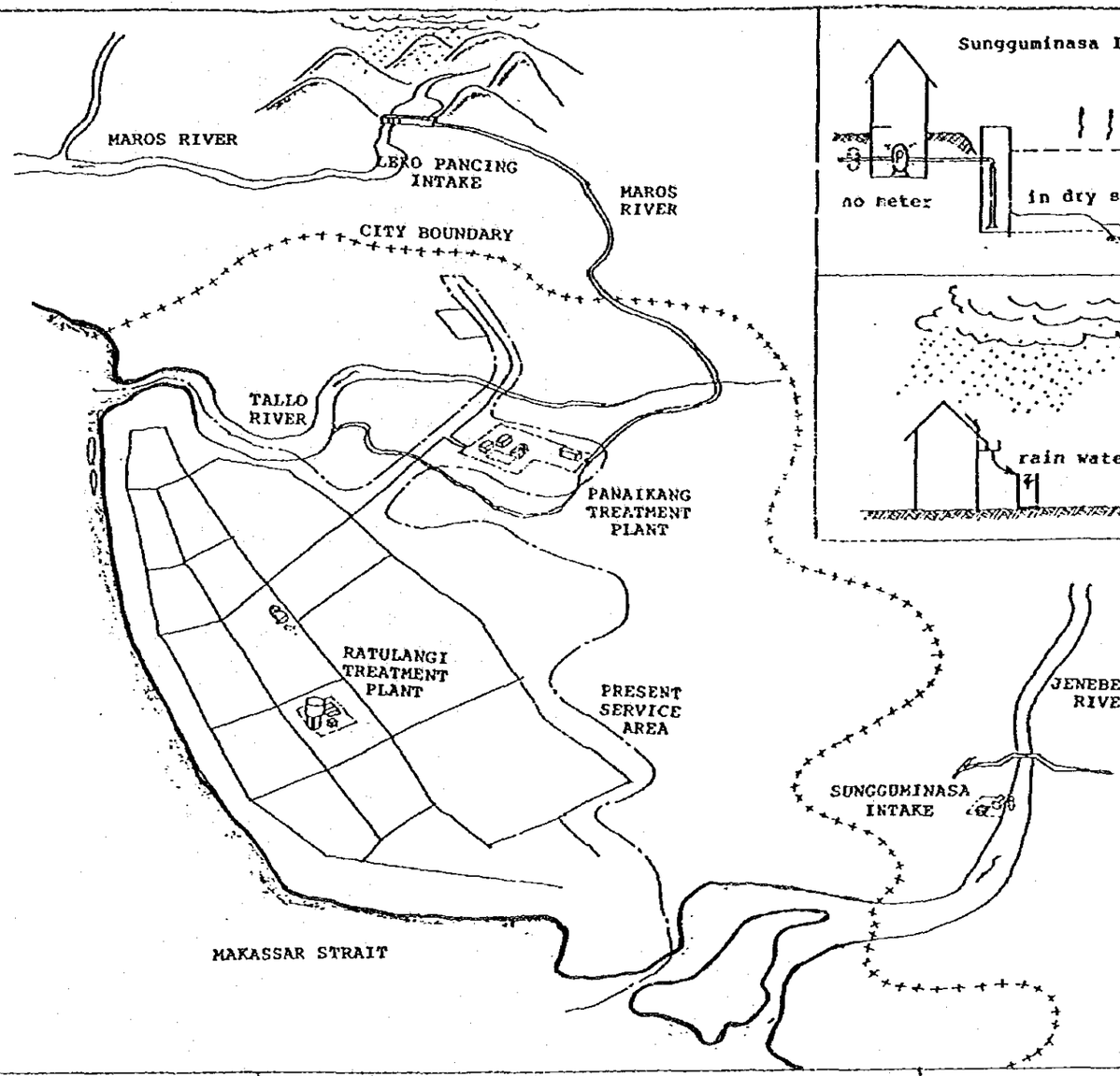


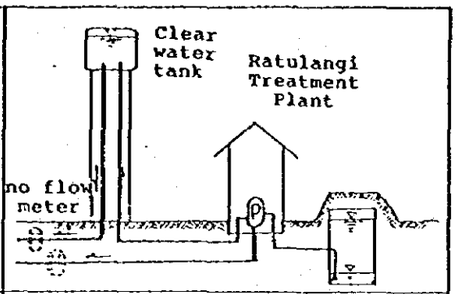
Valves covered by pavement

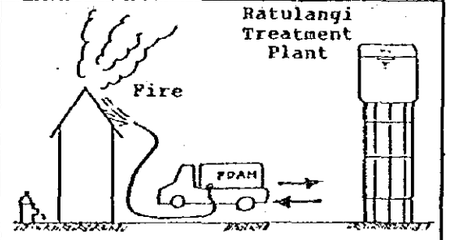


Water leakage at the service pipe

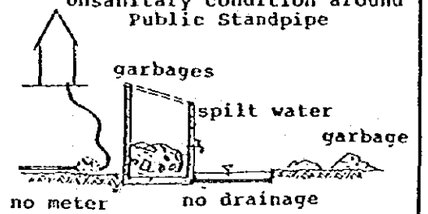




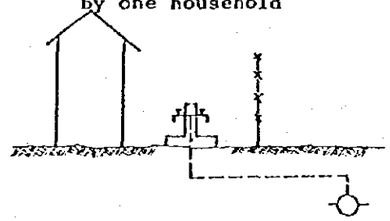




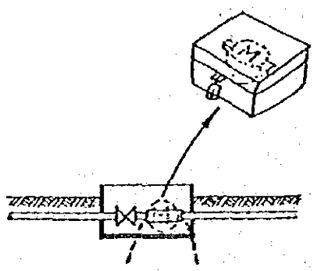
Unsanitary condition around Public Standpipe



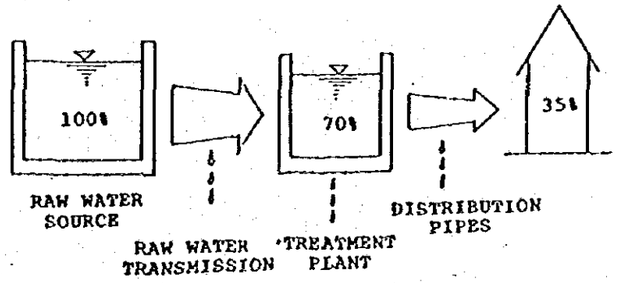
Public standpipes owned by one household

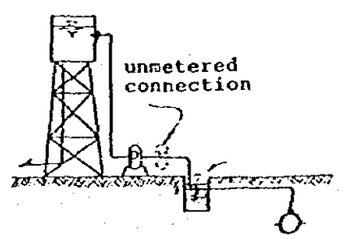


Meters removed by consumers



Raw water and water sold





Service pipe installed in the ditch and without meter

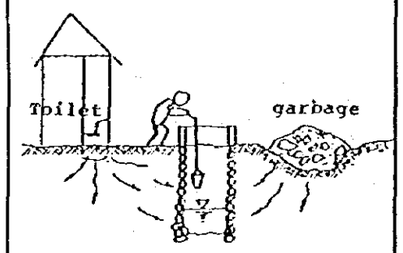


FIGURE	ILLUSTRATION
2	EXISTING WATER SUPPLY SYSTEM

TABLE 1 TOTAL POPULATION AND SERVED POPULATION

DESCRIPTION	1983	1990	1992	1995	2000	2005
1) Total population	768,000	927,000	976,000	1,050,000	1,171,000	1,286,000
2) Population in service area	642,000	827,000	909,000	995,000	1,117,000	1,267,000
3) Served population	262,000	695,000	752,000	840,000	995,000	1,157,000
4) Population coverage (3)/(1)	34 %	75 %	77 %	80 %	85 %	90%

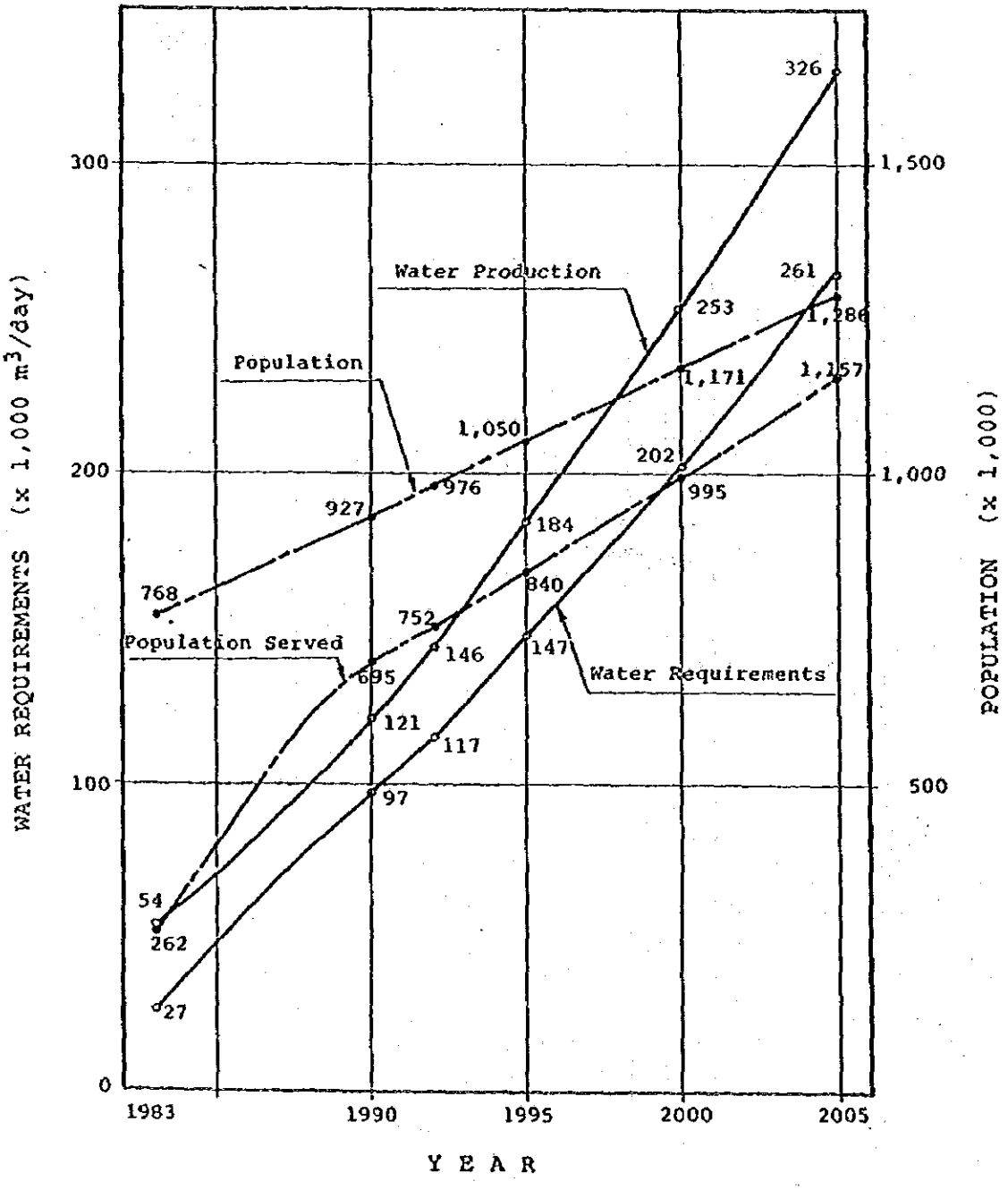


FIGURE	WATER REQUIREMENTS AND POPULATION
3	

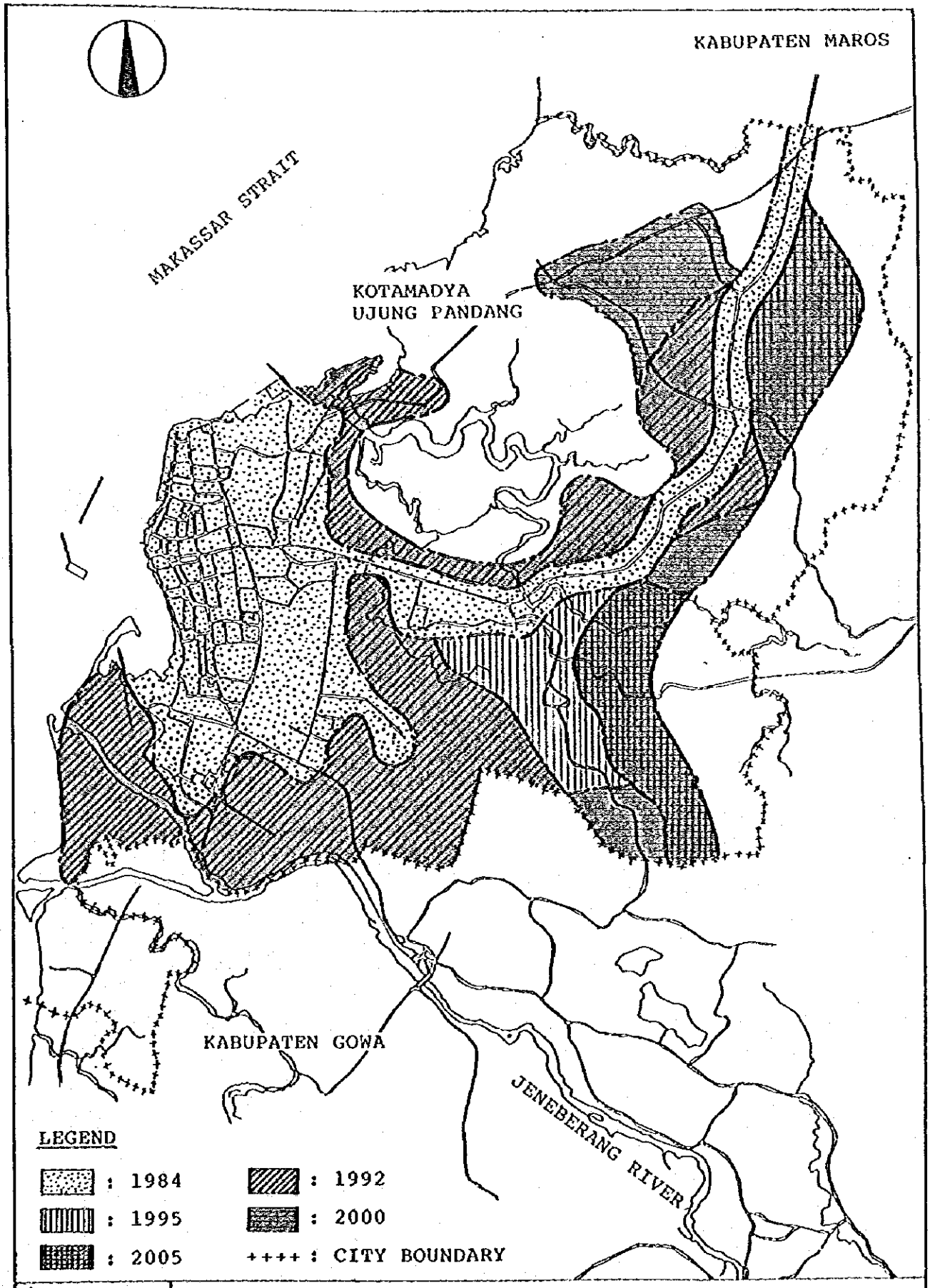


FIGURE	PLANNED SERVICE AREA
4	

0 1 2 3 4 5Km

KOTAMADYA
UJUNG PANDANG

STRAIT

MAKASSAR

KABUPATEN MAROS

MAROS
RIVER

RAW WATER
TRANSMISSION CANAL

LEKO PANCING
INTAKE

RATULANGI TREATMENT PLANT

STAGE I: 50 l/sec
STAGE II: To be abandoned

PANAIKANG TREATMENT PLANT

STAGE I : 1,200 l/sec (total capacity)
STAGE II : 1,200 l/sec (total capacity)

DISTRIBUTION PIPES

STAGE I

Phase 1: Rehabilitation
Ø 75 - Ø 350 mm
L = 55 Km

Phase 1: Ø 75 - Ø 1,000 mm
L = 115 Km

Phase 2: Ø 75 - Ø 800 mm
L = 111 Km

STAGE II

Phase 1: Ø 75 - Ø 900 mm
L = 142 Km

Phase 2: Ø 75 - Ø 800 mm
L = 84 Km

SUNGGUMINASA
INTAKE
STAGE II:
To be abandoned

NEW TREATMENT PLANT AND CLEAR WATER RESERVOIR AT MANGNGASA

STAGE I

Phase 1 : 500 l/sec and 4,000 m³
Phase 2 : 500 l/sec and 4,000 m³

STAGE II

Phase 1 : 1,000 l/sec and 7,500 m³
Phase 2 : 1,000 l/sec and 7,500 m³

LEGEND:

xxxxxx: Boundary of distribution zone

------: Existing trunk main

——— : Trunk main laid in future

Ø 500^{I} : In Stage I

Ø 500^{II} : In Stage II

——.——: Raw water transmission pipes for new treatment plant

	HOUSE CONNECTION	PUBLIC STANDPIPE
	STAGE I	
Phase 1	40,000	1,800
Phase 2	12,000	100
	STAGE II	
Phase 1	31,000	100
Phase 2	37,000	100

RAW WATER TRANSMISSION PIPES

STAGE I : Ø 1,100 mm L = 20.5 Km
STAGE II : Ø 1,350 mm L = 2.9 Km
Ø 900 mm L = 20.5 Km

JENEBERANG
RIVER

KABUPATEN GOWA

KAMPILI

BILI-BILI DAM

BILI-BILI INTAKE

FIGURE 5

GENERAL PLAN
OF
PROPOSED WATER SUPPLY SYSTEM

TABLE 2 FACILITIES TO BE CONSTRUCTED

Facilities	Stage I		Stage II	
	Phase 1	Phase 2	Phase 1	Phase 2
Rehabilitation Work	- Leakage Reduction Work of Transmission Channel of Panaikang System - Filter sand, Chlorinator, etc. of Ratulangi System - Leakage Reduction Work	-	-	-
Intake and Transmission Facilities	- Intake Facilities at Bili-Bili irrigation Channel (1,000 l/sec) - Transmission Pipes Dia.1,100 x 20.5 km	-	- Intake Facilities at Dam Site (3,000 l/sec) - Transmission Pipes Dia.1,350mm x 2.9 km Dia.900mm x 20.5 km	-
Treatment Facilities	- Upgrading of Panaikang System (100 l/sec) - New Treatment Plant (500 l/sec)	- Extension of New Treatment Plant (500 l/sec)	- Extension of New Treatment Plant (1,000 l/sec)	- Extension of New Treatment Plant (1,000 l/sec)
Distribution Facilities and House Meters	- Clear Water Reservoir (4,000 m^3) - Distribution Pumps (170 kw x 3 sets) - Distribution Pipes Dia.75mm to 1,000 mm x 115 km - Standpipes 1,800 nos. - House Meters 40,000 nos.	- Clear Water Reservoir (4,000 m^3) - Distribution Pumps (340 kw x 2 sets) - Distribution Pipes Dia.75mm to 800mm x 111 km - Standpipes 100 nos. - House Meters 12,000 nos.	- Clear Water Reservoir (7,500 m^3) - Distribution Pumps (340 kw x 2 sets) - Distribution Pipes Dia.75mm to 900mm x 142 km - Standpipes 100 nos. - House Meters 31,000 nos.	- Clear Water Reservoir (7,500 m^3) - Distribution Pumps (340 kw x 2 sets) - Distribution Pipes Dia.75mm to 800mm x 84 km - Standpipes 100 nos. - House Meters 37,000 nos.

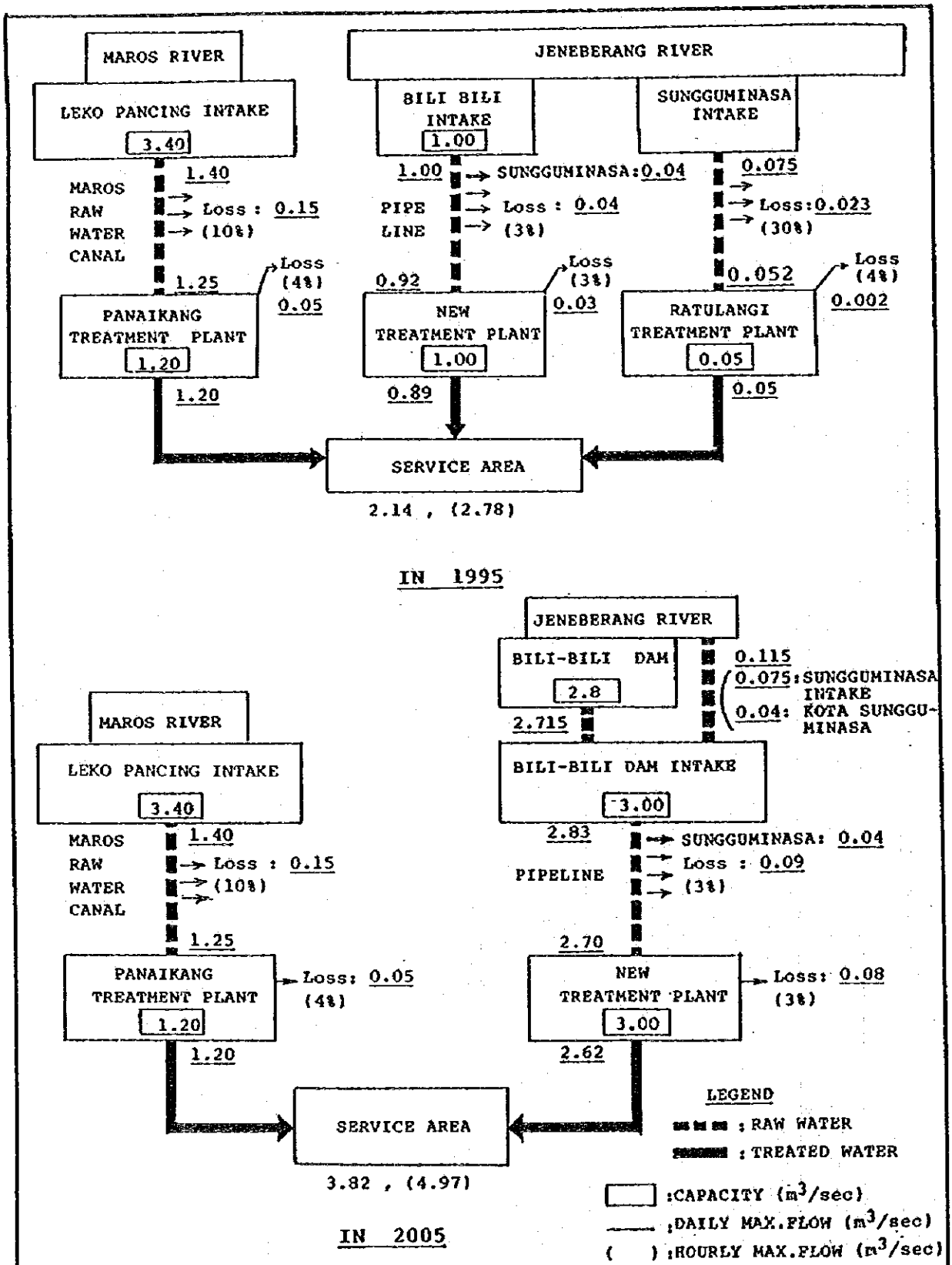
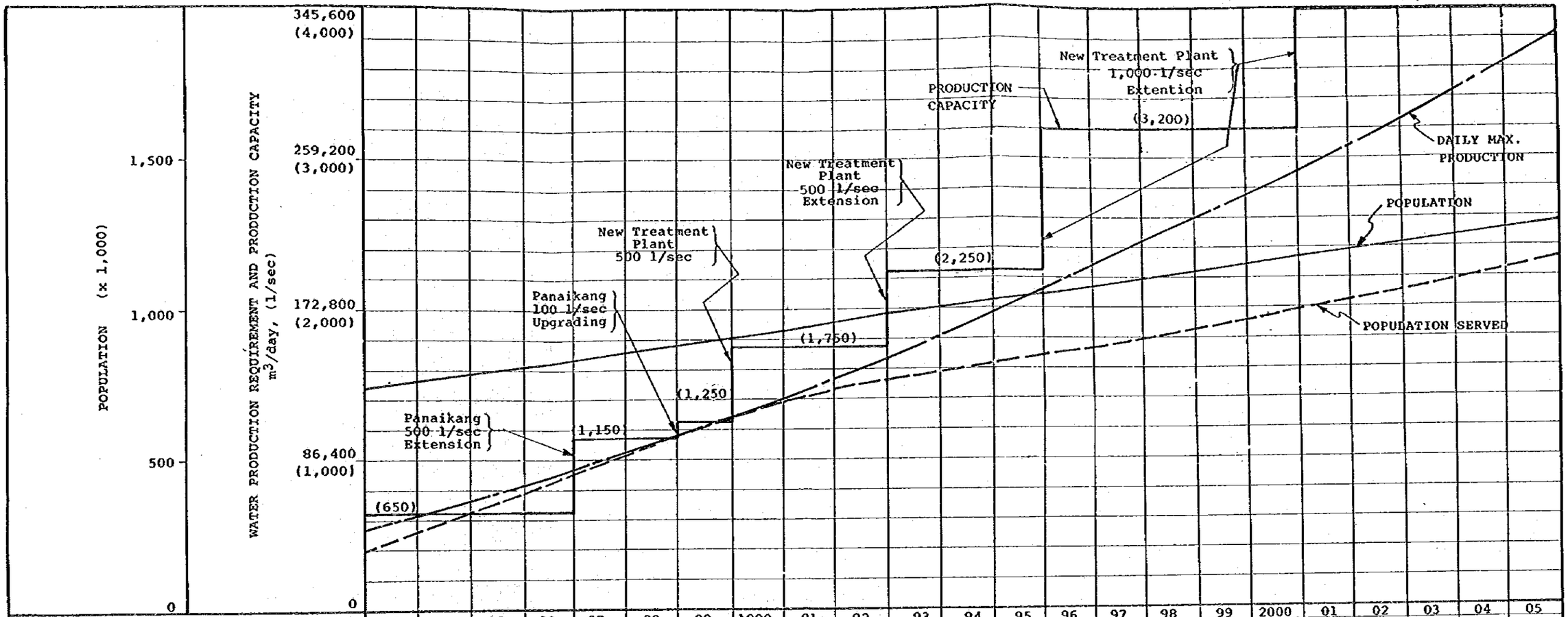


FIGURE	DAILY FLOW REQUIREMENTS FOR 1995 AND 2005
6	



YEAR	83	84	85	86	87	88	89	1990	91	92	93	94	95	96	97	98	99	2000	01	02	03	04	05
CONSTRUCTION AND DISBURSEMENT SCHEDULE (Billion Rp.)			0.5	2.0	8.0	9.0	9.0	8.1	0.5			72.7						14.6					
				STAGE I Phase 1						STAGE I Phase 2				STAGE II Phase 1						STAGE II Phase 2			
STAGING AND PHASING			STAGE I Phase 1							STAGE I Phase 2				STAGE II Phase I						STAGE II Phase 2			
POPULATION (x 1,000)	768							927		976			1,050					1,171					1,286
POPULATION COVERAGE (%)	34.1							75.0		77.0			80.0					85.0					90.0
POPULATION SERVED (x 1,000)	262							695		752			840					995					1,157
PER CAPITA DEMAND (DOMESTIC USE) (l/c/d)	65							100		113			127					147					162
TOTAL WATER REQUIREMENT (x 1,000 m³/day)	27							97		117			147					202					261
ACCOUNTED-FOR WATER (%)	50							80		80			80					80					80
PRODUCTION (Daily Max. x 1,000 m³/day)	54							121		146			184					253					326
RAW WATER REQUIREMENT m³/sec)	0.94							1.64		1.92			2.44					3.24					4.19

FIGURE 7

WATER SUPPLY PLAN TO 2005

TABLE 3 COST ESTIMATE SUMMARY (MASTER PLAN)

Description	Stage I - Phase 1			Stage I - Phase 2			Stage II - Phase 1			Stage II - Phase 2		
	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	F/c	L/C	Total
Rehabilitation, leakage reduction and upgrading of Panaikang Plant	380 (420)	3,345 (3,700)	3,725 (4,150)	0	0	0	0	0	0	0	0	0
New Water Supply System	11,520 (12,670)	11,238 (12,530)	22,758 (25,200)	5,590 (6,150)	3,677 (4,100)	9,267 (10,250)	25,520 (28,072)	26,399 (29,435)	51,919 (57,507)	6,300 (6,930)	4,143 (4,620)	10,433 (11,550)
Physical Contingency (15 %)	1,601 (1,761)	2,370 (2,642)	3,971 (4,403)	559 (651)	828 (923)	1,387 (1,538)	3,136 (3,450)	4,641 (5,175)	7,777 (8,625)	630 (693)	993 (1,040)	1,563 (1,733)
Engineering Services (10 %)	2,148 (2,363)	908 (1,012)	3,056 (3,375)	750 (825)	317 (354)	1,067 (1,179)	4,208 (4,629)	1,779 (1,984)	5,987 (6,613)	845 (930)	357 (398)	1,202 (1,328)
Subtotal	15,649 (17,214)	17,861 (19,914)	33,510 (37,128)	6,899 (7,590)	4,822 (5,377)	11,721 (12,967)	32,864 (36,151)	32,819 (36,594)	65,683 (72,745)	7,775 (8,553)	5,433 (6,058)	13,208 (14,611)
Price Contingency	4,721 (5,193)	7,163 (7,987)	11,884 (13,180)	5,571 (6,128)	3,683 (4,106)	9,254 (10,234)	28,195 (31,014)	37,112 (41,380)	65,307 (72,394)	11,760 (12,936)	10,623 (11,845)	22,383 (24,781)
Grand Total	20,370 (22,407)	25,024 (27,901)	45,394 (50,308)	12,470 (13,718)	8,505 (9,483)	20,975 (23,201)	61,059 (67,165)	69,931 (77,974)	130,990 (145,139)	19,535 (21,489)	16,056 (17,903)	35,591 (39,392)

Note: The above costs based on the rate as of 1984 will be further reviewed in the course of the Feasibility Study.

Unit : 1,000 US$ (million Rp.)

F E A S I B I L I T Y S T U D Y

TABLE OF CONTENTS

EXECUTIVE SUMMARY

1. Introduction

Ujung Pandang has been suffering from general water shortage, especially in dry seasons, and on the other hand the Municipality is facing unprecedented water requirements due to industrial and commercial developments as the central city in the East Indonesia. To alleviate the citizens' suffering and cope with the increasing water demand, the long term water supply master plan has already been prepared. For implementing the initial stage of the long term project as early as possible, the present feasibility study is carried out covering the Stage I project consisting of Phases 1 and 2 together with rehabilitation work.

With this project, the water supply capacity is to be increased by 1,100 l/sec and the served population will be increased from the present 314,000 to 840,000 in 1995, and the planned development of industries, housing estates and others will be materialized without impediment due to water shortage. Further, even with the investment of 80,131 million Rp. in total, the water tariff can be maintained within the paying ability of the consumers.

2. Population and Water Requirements

2.1 Service Area and Population Projected

Proposed service area is shown in Figure 1. The service area will extend to 7,530 ha in Phase 1 and 8,150 ha in Phase 2.

Population served is shown in Table 1. In the target year of Phase 1, the total population and served population will be 976,000 and 752,000 respectively; the service coverage being 77 %. In the target year of Phase 2, the figures will rise to 1,050,000, 840,000 and 80 % respectively.

2.2 Water Requirements

Projected water requirements are shown in Table 2 and Figure 2. In the Figure, the supply capacity, which is to be attained by the present project, is also illustrated.

3. Water Supply System of Stage I Project

3.1 General

Stage I Project will be executed in two phases, namely Phase 1 with a capacity of 500 l/sec and Phase 2 with a capacity, also, of 500 l/sec. In addition to the above expansion projects, a rehabilitation program is included in Phase 1 project. The proposed water source is the irrigation water at the Bili Bili intake.

For the project, realistic design criteria are established, and then based on the design criteria a preliminary design is made with all the facilities to be constructed. With regard to the operation of the completed facilities a suitable operation method is provided, taking into due consideration the present operation conditions.

3.2 Design Criteria

Most basic design criteria adopted are as follows:

1) The transmission pipeline to include an additional quantity of 40 l/sec for Sungguminasa.

2) The ratio of daily maximum/daily average demand, 1.2.
3) The ratio of hourly maximum/daily average, 1.6.
4) Water loss from Maros transmission canal to be reduced to less than 15%.
5) Ratulangi treatment plant to be rehabilitated so as to be operable until the completion of Stage 1 project.
6) Panaikang treatment plant to be uprated by 100 l/sec.
7) Leakage from the pipelines to be reduced to 20 % of production.
8) Filtration rate, 120 m/day.
9) Water storage, 5 hour distribution.
10) Water pressure, maximum 50 m and minimum 15 m at the end of trunk mains.

3.3 Rehabilitation Work

To reduce leakage from the Maros transmission canal, a span of 4 km upstream of Panaikang will be changed to pipeline, replacing the present open canal. The pipe will be concrete pipe or corrugated steel pipe with a diameter of 1.8 m.

As regards Ratulangi Plant, replacement of filter sand, installation of flow measuring equipment and other major repairs will be carried out. As the plant is over deteriorated, it will be abandoned when the project of stage I is completed.

Panaikang plant will be uprated by 100 l/sec with some minor additions of equipment, and in addition waste water generated during treatment will be reclaimed. To this end, a thickener and other necessary equipment will be installed.

A total of 65,000 m length of distribution pipelines will be replaced to reduce leakage, and replacement of service connections and installation of house meters are included in the project to raise revenue of water sales.

3.4 Facilities to be Constructed

Facilities to be constructed for the project are shown in Figures 3 and 4.

A weir to extract the raw water will be constructed at the existing Bili Bili intake. The existing canal transmits the raw water to a grit chamber where the required quantity for water supply will be diverted into a transmission pipeline. It conveys raw water to a treatment plant to be constructed at Mangngasa. The treatment plant that has a capacity of 1,000 l/sec consists of a receiving well, mixing chambers, flocculation and sedimentation basins, filters and clear water reservoirs.

The treatment plant to produce clear water of 500 l/sec will be constructed under Phase 1 and the remaining 500 l/sec under Phase 2.

The planned distribution network divides the service area into two zones, i.e., areas to be served from Panaikang and Mangngasa treatment plants. The length of pipelines to be installed under Phases 1 and 2 totals to 280 km and 100 km respectively.

4 Cost Estimate and Project Implementation

4.1 Labour and Materials

Contractors experienced in water supply construction are available locally, since there have been numerous water supply projects in Sulawesi in these years. In addition labourers are abundantly available in the project area, as Ujung Pandang is attracting migrants from all over the Island as the center of industrial and commercial activities in the East Indonesia.

As regards materials for the water supply construction, all basic materials such as cement, aggregates, timber and others, and pipe materials are locally available, except some mechanical and electrical equipment which are to be imported from abroad.

4.2 Project Cost

The breakdown of project cost is given in Table 3. The total project cost of each phase is summarized below:

Phase	Foregin Currency (1,000 US$)	Local Currency (Million Rp.)	Total (Million Rp.)
Phase 1 Project	28,361	28,873	60,496
Phase 2 Project	8,778	9,848	19,635
Total	37,139	38,721	80,131

The above project cost includes a physical contingency of 10 percent, and price contingencies as tabulated below:

Currency	1984	1985	1986 onward
Foreign Component (%)	7.5	7.0	6.0
Local Component (%)	15.0	11.0	7.0

4.3 Project Implementation

Cipta Karya takes charge of all implementation of the project. After completion of the construction, all facilities are to be turned over to PDAM of Ujung Pandang for operation.

Supply and installation of mechanical and electrical equipment of the treatment plant and pumping stations will be made by open international tender, and civil and architectural works will be executed by local tender.

The proposed implementation schedule is schematically shown on Figure 5.

5. Financial Analysis and Socio-Economic Benefits

The proposed Stage I project is examined with its financial feasibility and the benefits thereof are appraised as summarized hereunder.

5.1 Financing Plan

For financing the fund requirement of Rp. 80 billion, as earlier described, there are several possible fund sources, such as foreign loan, government loan, equity and own fund of PDAM. As a result of financial analsis assuming these fund sources, the following financing plan is concluded as most preferable and also practicable.

Loan/ Equity	Amount	Composition Ratio of Funds	Requirement	
Foreign Aid Fund (BLN)	US$37,139 thousand	51.7 %	Repayment period Grace period Interest rate	30 years 6 years 9 %
Domestic Loan at Normal Interest (DLNI)	Rp.27,687 million	34.6 %	Repayment period Grace period Interest rate	20 years 6 years 9 %
Interest-free Government Loan (IFGL)	Rp.8,211 million	10.2 %	Repayment period Grace period Interest	20 years 6 years free
PDAM's Own Funds	Rp.2,823 million	3.5 %	-	

5.2 Water Rate and Affordability

Based on the above financing plan and setting the average water rate as 211 Rp./m3 in 1992, 223 Rp./m3 in 1995 and 240 Rp./m3 in 2000, which is an annual rise of about 2 %, the

project is financially feasible. The above rates are appropriate comparing the average unit cost calculated by the average incremental cost method.

Further, regarding the water rate for domestic consumption, the cost is allocated to domestic use and non-domestic use in accordance with the national guidelines and the current practice of PDAM, and the result obtained is 128 Rp./m3 in 1992, 138 Rp./m3 in 1995 and 149 Rp./m3 in 2000. These rates for domestic use is well within the affordable range; even with the lower income class, the water charge calculated by these rate is lower than 4 % of the household income.

As for non-domestic use, the average rate is more than three times the domestic water rate, and this is in compliance with the national guidelines.

5.3 Financial Projection

The financial projection, based on the estimated cost and the above financing sources and average water rate, is summarized in Table 4. As shown in the Table, a reasonable amount of net income is produced in almost every year during the calculated period. Regarding cash surplus, during the initial period, some deficit will be inevitable, but its amount is not significant and can be managed with by temporary borrowing. The calculated rate of return is acceptable ranging from 2.0 % to 6.0 % (historic cost basis). Conclusively, the project is financially sound and viable.

Further, the results of sensitivity analysis on cost variation and risk analysis on work delay reveal that the project remains viable even against such unforeseeable changes in project implementation.

5.4 Socio-economic Benefits

Socio-economic benefits, to be noted among others, are as follows:

1) Present coverage of water supply is about 30 % of the total population. The remaining population are dependent on unsanitary water sources for their daily water use. By the project, the coverage will increase to 80 %, and in terms of population, from the present 260 thousand to 840 thousand in 1995.

2) The above increase of population served will greatly contribute to public health promotion, reducing water-borne diseases and heightening amenity of the living environment.

3) On the other hand, water supply will be made possible to the ongoing projects of industries and housing schemes, thus contributing to the general development of the Municipality.

6. Organization and Management

Developing the recommendations made in the master plan, revision of organization and recommendation of staff training are made in more concrete terms as described in the following.

6.1 Future Organization

In line with the expansion of the water supply system, a staffing plan is provided as shown in Table 5. The present staff of 400 will have to be strengthened within the next decade by an addition of 200 members. In consideration of the present weakness in the customer division and technical division, more staff than averager are planned for these division.

6.2 Strategy to Develop Organization's Ability

To heighten the overall capability of the organization, most important is to develop each individual's capability, not to mention the necessity of organizating all the staff in pertinent positions. From this standpoint, the following are recommended and the cost required for this is included in the estimated cost of the project.

1) Water supply management for directors and section chiefs.
2) Water treatment and maintenance of the plant for operators.
3) Accounting and management for staff involved in finance and budget.
4) Pipelaying for staff concerned.
5) Water supply technology for directors and section chiefs.

6.3 Public Relations

To establish good public relations and obtain support from the public, it is suggested to carry out campaign on the following:

1) Ways of protecting water from contamination at the house connections and public standpipes,
2) Ways of reducing waste and re-using water,
3) Standard design of house connections,
4) Water treatment plant and its process, and
5) Necessity of the public supports and understandings.

7. RECOMMENDATION

The following are matters, as found by the Team, to be practiced to achieve the project smoothly or make the project more effective.

1) Equipment of the new treatment plant with a capacity of 500 l/sec at Panaikang has already been delivered to the construction site, but its civil works is not yet started. Considering the suffering from water shortage of the people down town of the Municipality, the work should be commenced as early as possible. In this connection, improvement and replacement works of deteriorated pipelines in the afflicted areas are included in the present project under feasibility study.

2) Presently the account receivable reached to a huge amount of Rp. 1.6 billion, endangering the financial stability of the enterprise. One of the causes for this poor collection results is considered to be the inadequate supply condition under extraordinarily low pressure in most part of the served area resulting in delinquency in payment of bills. To rectify this condition, the pumping station which is at present put out of service should be operated in the early stage of the project implementation.

3) It is indispensable to implement the project as planned that provision of necessary local funds is available in time all through the project implementation. Especially the local fund required for rehabilitation work should be provided even before the loan agreement with international financing sources concerned, since a larger portion of the rehabilitation is planned solely under local financing. Considering the present financial capability of PDAM, fund should be sought from the City and/or the central Government.

4) Construction costs of Bili Bili dam allocated to the water supply sector proposed in the 'Feasibility Study on the Jeneberang River Flood Control Project' are US$27.49 million, namely around Rp.35/m3 as of 1983. In comparison with the present water rate, this raw water charge would be a heavy burden on PDAM finance unless some measure be undertaken by Cipta Karya to minimize it.

5) The detailed design of Bili Bili dam is expected to start within 1985. According to the 'Feasibility Study on the Jeneberang River Flood Control Project', the impounded water is planned to divert directly into the transmission pipeline. On the other hand, the Team's preliminary survey reveals that it is more economical if the impounded water be once flushed out from the dam and be extracted at Bili Bili irrigation intake after flowing down the Jeneberang River. It is therefore recommended that these alternatives should be studied further in the course of the detailed design of the above project.

6) Study on water resource made so far by the Team suggests that Kotamadya Ujung Pandang and its surrounding area are not necessarily benefited with water resources. The regional development plan defines Ujung Pandang to develop as a national industrial, educational and administrative center of the eastern Indonesia. It is, therefore, recommended to prepare urgently comprehensive water resources development plan including water supply, irrigation, flood control, industry, etc.

7) Reforestation at the upstream of the Maros River is being undertaken by agencies concerned. In this connection, it is recommended that an authority responsible for monitoring the river flow and managing water use among sectors concerned should be established at the earliest possible date.

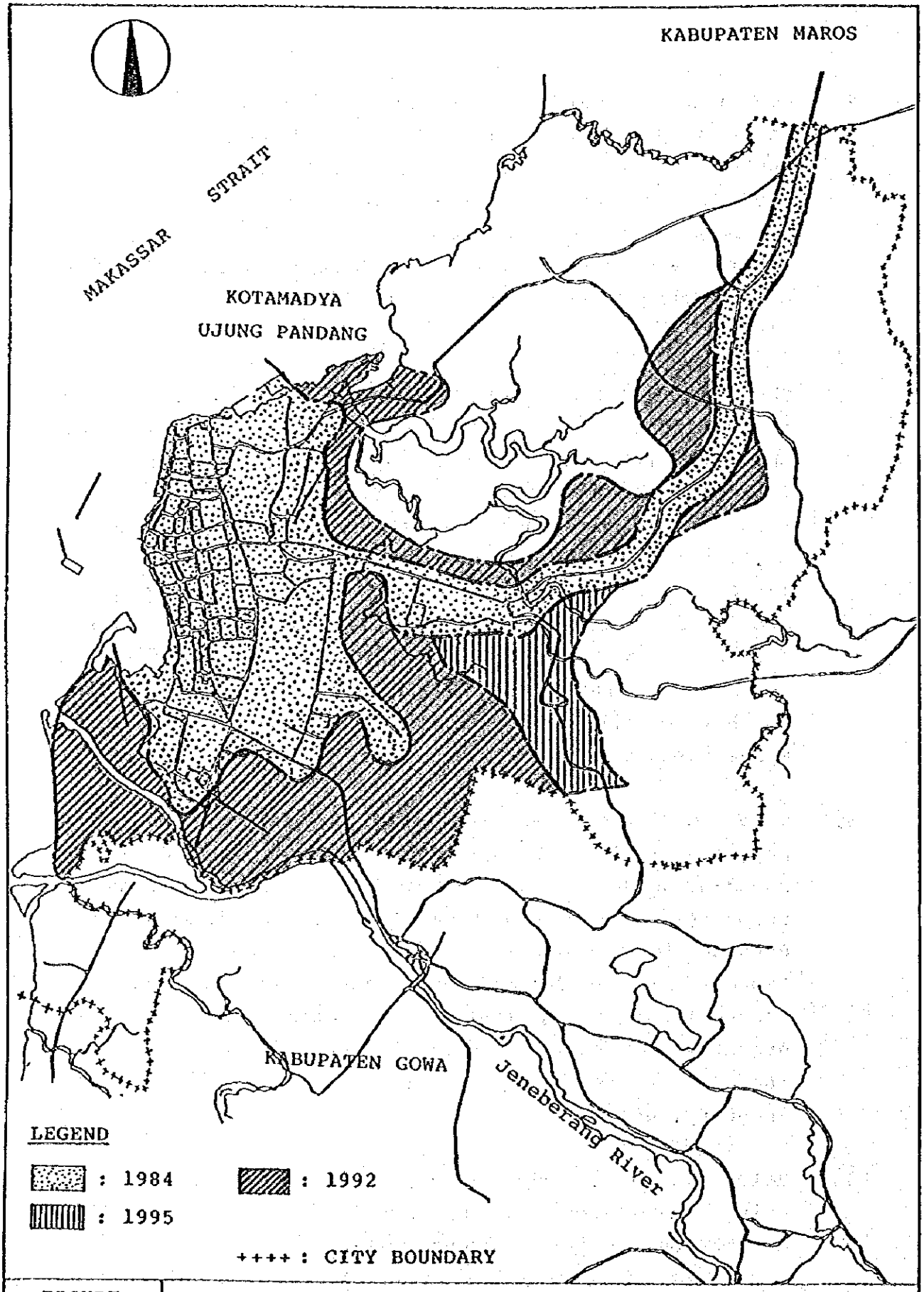


FIGURE	PLANNED SERVICE AREA
1	

TABLE 1 POPULATION SERVED BY YEAR

Year	Population (x1,000)	Coverage (%)	Composition of Types (%) House Connect.	Public Standpipes	Neighbors Supply,etc	Population Served (x1,000) Total	House Connect.	Public Standpipes	Neighbours Supply,etc
1983	768	34.1	58.4	12.6	29.0	262	153	33	76
1984	790	36.3	58.6	13.9	27.5	287	168	40	79
1985	812	38.7	59.2	15.3	25.5	314	186	48	80
1986	834	44.0	62.0	17.0	21.0	367	228	63	76
1987	856	50.0	65.0	20.0	15.0	428	278	86	64
1988	879	57.0	67.0	24.0	9.0	501	336	120	45
1989	903	66.0	69.0	28.0	3.0	596	411	166	19
1990	927	75.0	70.0	30.0	-	695	487	208	-
1991	951	76.0	71.0	29.0	-	723	514	209	-
1992	976	77.0	72.0	28.0	-	752	542	210	-
1993	1,000	78.0	73.0	27.0	-	780	570	210	-
1994	1,025	79.0	74.0	26.0	-	810	600	210	-
1995	1,050	80.0	75.0	25.0	-	840	630	210	-

TABLE 2 WATER REQUIREMENTS BY USE AND YEAR

Year	Daily Maximum (x1,000 m3/day)					Daily Average (x1,000 m3/day)				Unaccounted-for Water (x1,000m3/day)	Accounted-for Water (x1,000m3/day)
	Domestic					Domestic					
	House Conne.	Public St.pipes	Neighbors Supply,et	Non-domestic	Total	House Connect.	Public Standpipes	Non-domestic	Total		
1983	16	1	1	10	28	14	1	8	22	12	11
1984	18	1	2	11	32	17	1	9	26	13	14
1985	21	1	2	12	36	19	1	10	29	14	16
1986	26	2	2	14	44	23	2	12	35	15	22
1987	33	3	2	16	54	29	3	13	42	16	29
1988	41	4	1	19	65	35	3	16	51	16	38
1989	52	5	0	23	80	44	4	19	63	17	50
1990	64	6	0	27	97	53	5	23	76	16	65
1991	71	6	0	30	107	59	5	25	84	18	71
1992	79	6	0	32	117	66	5	27	93	20	78
1993	86	6	0	35	127	62	5	29	91	21	85
1994	93	6	0	38	137	77	5	32	109	23	91
1995	101	6	0	40	147	84	5	33	117	24	98

As for the unit consumption by public standpipes, 30 liters per capita is employed constantly.
Unit demand of 20 liters (1983-1984) growing annually by 5 liters up
to 30 liters is tentatively applied to estimate water requirements of consumers supplied by neighbours.

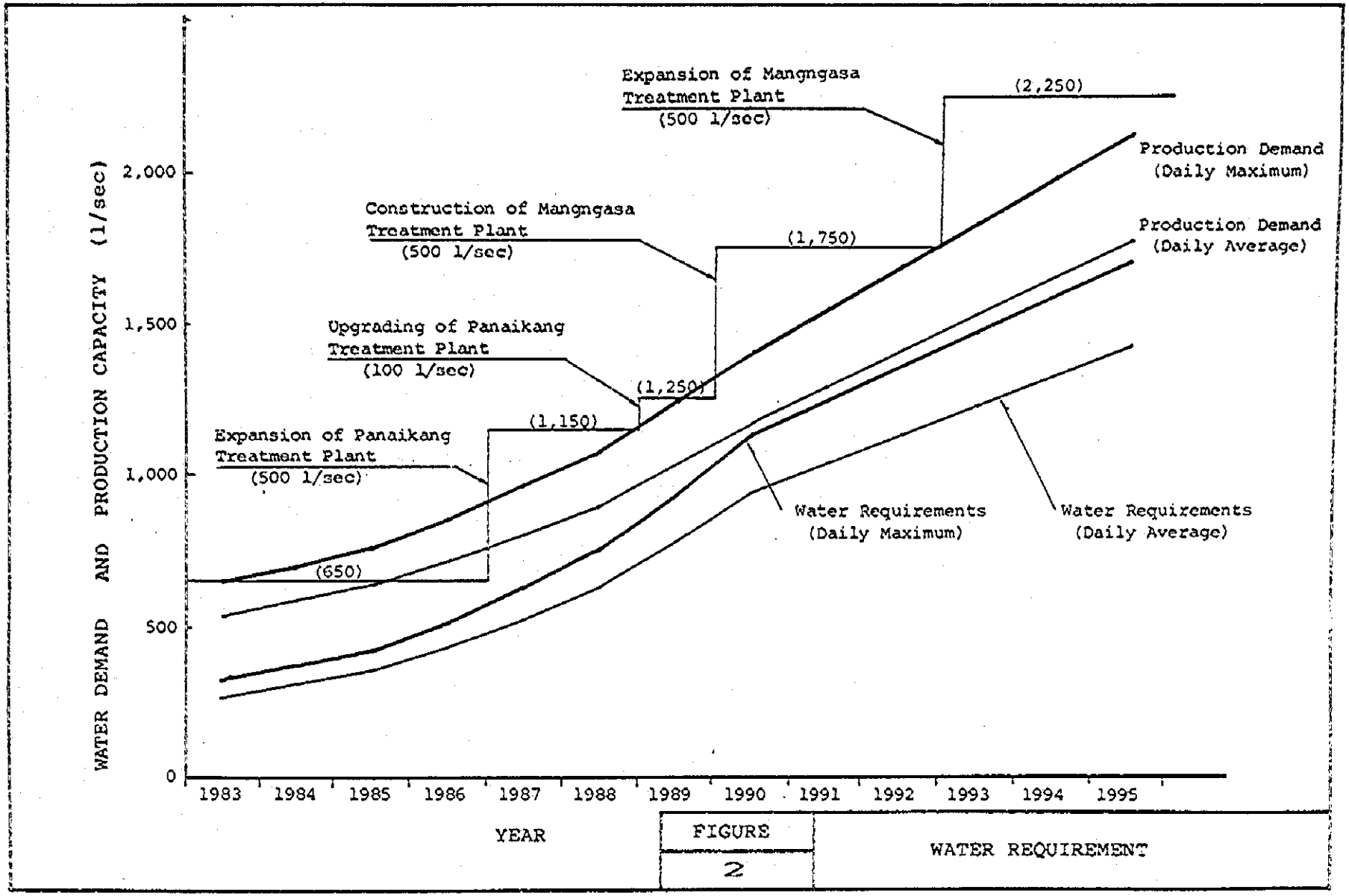
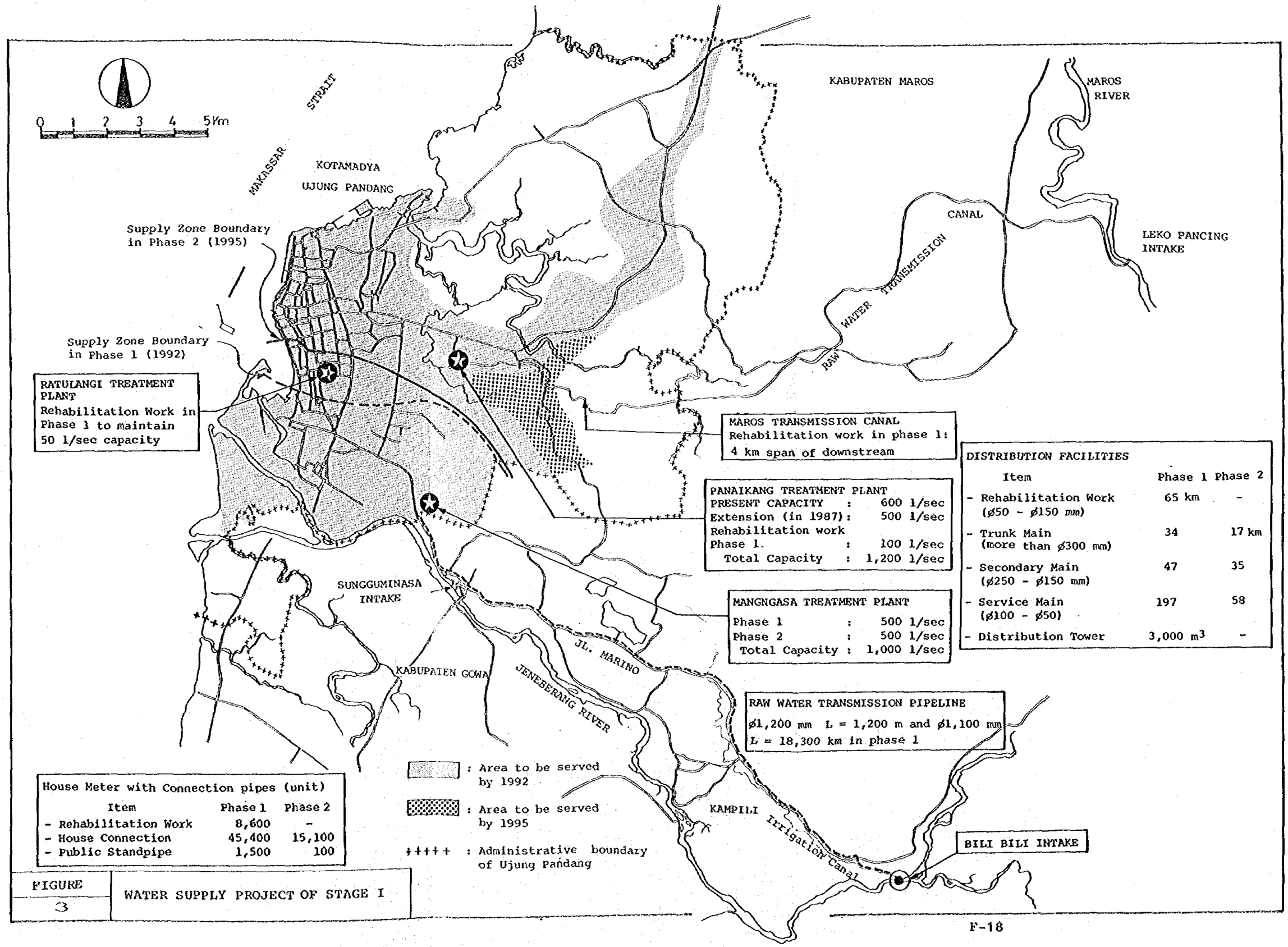


FIGURE 2 WATER REQUIREMENT



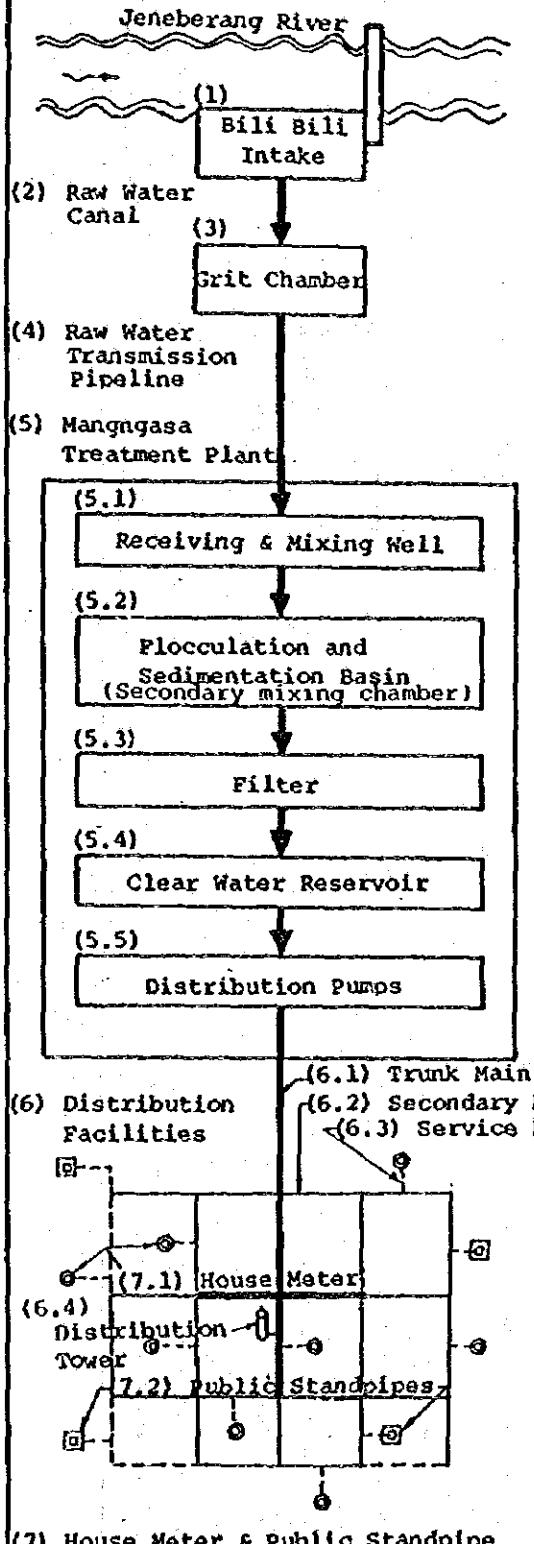
DISTRIBUTION FACILITIES

Item	Phase 1	Phase 2
- Rehabilitation Work (ø50 - ø150 mm)	65 km	-
- Trunk Main (more than ø300 mm)	34	17 km
- Secondary Main (ø250 - ø150 mm)	47	35
- Service Main (ø100 - ø50)	197	58
- Distribution Tower	3,000 m³	-

House Meter with Connection pipes (unit)

Item	Phase 1	Phase 2
- Rehabilitation Work	8,600	-
- House Connection	45,400	15,100
- Public Standpipe	1,500	100

FIGURE 3 WATER SUPPLY PROJECT OF STAGE I



Item	Phase 1	Phase 2
	Intake Facilities	
(1)	1 unit	-
(2)	1,500 m	-
(3)	1 Basin(2units)	-
	Raw Water Transmission Pipeline	
(4)	L = 19,500 m	--
	Mangngasa Treatment Plant	
(5)	0.5 m3/sec	0.5 m3/sec
(5.1)	1 Basin(2units)	-
(5.2)	1 Basin(2units)	1 Basin(2units)
(5.3)	6 Filter Beds	6 Filter Beds
(5.4)	9,000 m3	9,000 m3
(5.5)	Large Pumps 3units (1 standby)	Large and Small Pumps 1 large 2 small (1 standby)
	(6) Distribution Facilities	
(6.1)	34 Km	17 Km
(6.2)	47 Km	35 Km
(6.3)	197 Km	58 Km
(6.4)	3,000 m3	-
	(7) House Meter & Public Standpipes	
(7.1)	45,400	15,100
(7.2)	1,500	100

FIGURE	OUTLINE OF STAGE I PROJECT
4	

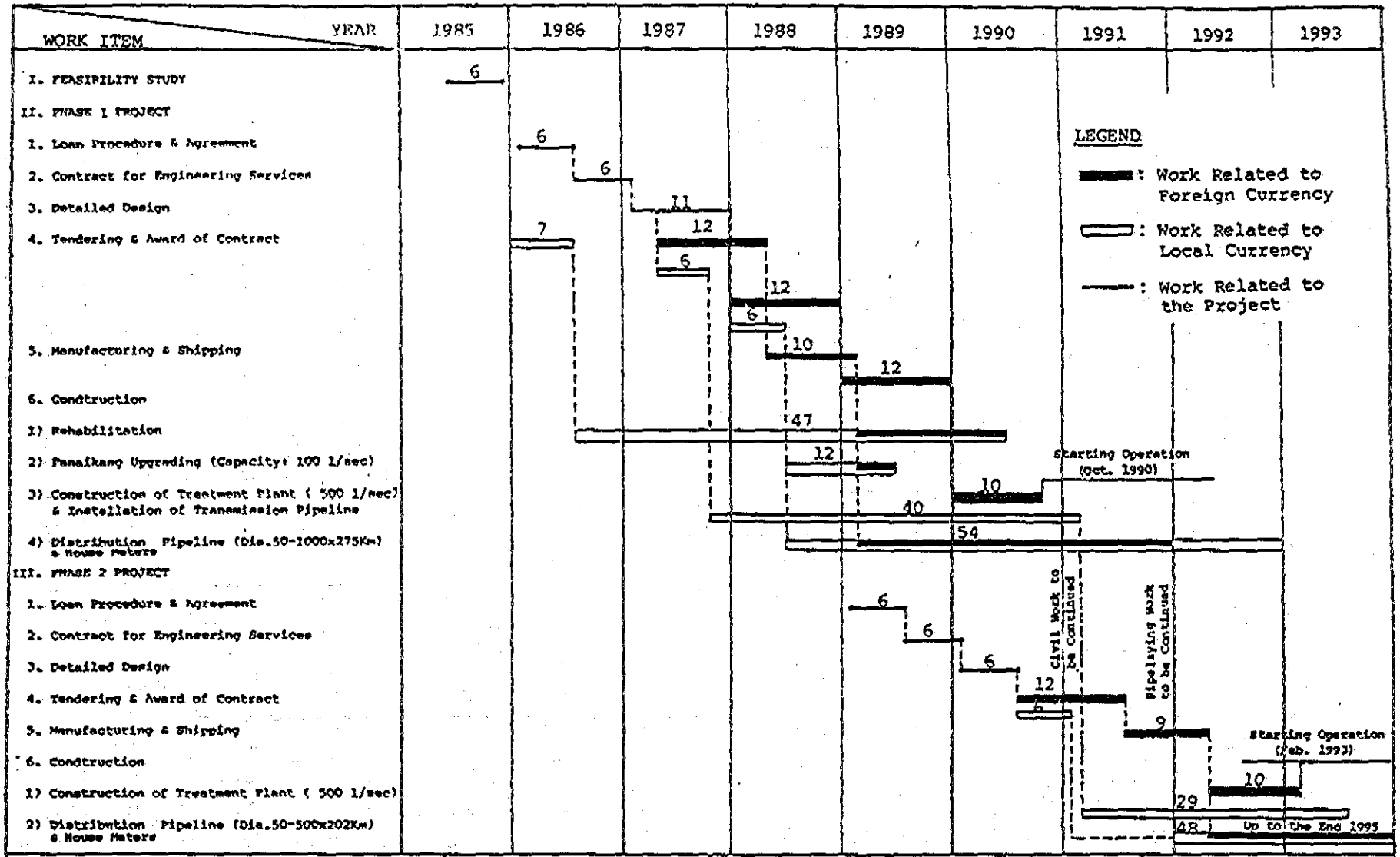


FIGURE 5

IMPLEMENTATION SCHEDULE

Table 3 COST ESTIMATE FOR STAGE I PROJECT

DESCRIPTION	Foreign Currency 1,000 US$	Local Currency million rupiah	Total million rupiah
I. PHASE 1 PROJECT			
1) Rehabilitation			
-Maros Transmission Canal	1,348	937	2,440
-Ratulangi Treatment Plant	0	19	19
-Panaikang Treatment Plant	17	48	67
-Distribution Pipelines & House Meters	588	1,778	2,434
SUBTOTAL OF 1)	1,953	2,782	4,960
2) Mangngasa System			
-Land Acquisition	0	1,166	1,166
-Intake Facilities	0	826	826
-Transmission Pipelines	3,212	2,228	5,809
-Treatment Plant	3,793	3,871	8,100
-Power Receiving	0	48	48
-Distribution Pipelines & House Meters	6,889	6,708	14,389
-Distribution Tower	1,040	0	1,160
SUBTOTAL OF 2)	14,934	14,847	31,498
3) Administration (2%)	0	353	353
4) Engineering Services	2,526	1,360	4,176
5) Physical Contingency (10%)	1,942	1,934	4,099
SUBTOTAL OF 1)-5)	21,355	21,276	45,087
6) Price Contingency	7,006	7,597	15,409
Total of Phase 1 Project	28,361	28,873	60,496
II. PHASE 2 PROJECT			
1) Treatment Plant	1,681	1,793	3,667
2) Distribution Pipelines & House Meters	2,537	2,860	5,689
3) Administration (2%)	0	93	93
4) Engineering Services	875	469	1,445
5) Physical Contingency (10%)	509	520	1,088
SUBTOTAL OF 1)-5)	5,602	5,735	11,981
6) Price Contingency	3,176	4,113	7,654
Total of Phase 2 Project	8,778	9,848	19,635
III. PHASE 1 + PHASE 2			
TOTAL of STAGE I PROJECT	37,139	38,721	80,131

TABLE 4 SUMMARY OF FINANCIAL PROJECTION

(Unit: million Rp.)

Item	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Operating Revenues	2.073	2.890	4.306	5.598	7.337	10.066	11.712	13.431	16.152	18.581	21.283	25.555	28.923	32.361	35.441	38.633
Operating Expenses	1.356	1.643	2.232	2.684	3.264	3.840	4.488	5.187	5.947	6.990	8.180	9.570	11.178	12.989	15.000	17.472
Depreciation (Revalued)	755	854	1.108	1.263	1.509	3.066	4.043	4.754	5.913	6.702	7.413	8.038	8.632	9.273	9.962	10.704
Interests	0	0	0	97	97	97	93	89	85	5.728	5.411	5.094	7.034	6.581	6.128	5.676
Tax	0	132	332	538	857	1.066	1.075	1.185	1.467	0	92	993	722	1.225	1.517	1.667
Net Income	-38	261	634	1.016	1.609	1.997	2.014	2.217	2.742	-840	188	1.860	1.358	2.293	2.834	3.114
Change in Cash	335	240	-2.159	1.914	1.632	4.158	5.043	5.226	3.146	647	2.327	1.485	1.748	3.001	4.050	4.689
Rate of Return (%) 1/																
Historic Cost :	1.5	3.4	4.2	4.6	6.0	3.3	2.1	2.0	2.2	0.4	1.0	2.1	2.0	2.8	3.3	3.8
Revalued Cost :	-0.2	1.2	2.4	3.2	4.6	3.4	2.2	2.1	2.2	-0.6	0.1	1.2	0.9	1.4	1.7	1.8
Working Ratio (%) 2/	65.4	56.9	51.8	48.0	44.5	38.1	38.3	38.6	36.8	37.6	38.4	37.5	38.6	40.1	42.3	45.2
Operating Ratio (%) 3/																
Historic Cost :	80.3	68.7	64.3	58.6	54.5	59.3	62.5	62.5	61.4	60.6	59.3	55.3	54.6	54.6	55.7	57.6
Revalued Cost :	101.6	86.4	77.6	70.5	65.1	68.6	72.8	74.0	73.4	73.7	73.3	68.9	68.5	68.8	70.4	72.9
Debt/Debt & Equity 4/ Ratio (%)	4.7	6.9	18.1	26.6	44.7	55.4	58.0	57.1	55.0	52.5	49.0	44.8	40.3	35.9	31.7	27.8
Debt Service Coverage 5/	-	-	-	30.1	42.1	44.0	52.6	11.5	2.4	1.2	1.4	1.5	1.4	1.6	1.7	1.9

Note:
Ratios and index as from 1/ to 5/ is defined as :

1/ Rate of Return = $\frac{\text{Net Income after Tax}}{\text{Average Net Fixed Assets in Operation}} \times 100\ (\%)$

2/ Working Ratio = $\frac{\text{Operating Expenses}}{\text{Operating Revenues}} \times 100\ (\%)$

3/ Operating ratio = $\frac{\text{Operating Expenses + Depreciation}}{\text{Operating Revenues}} \times 100\ (\%)$

4/ Debt/Debt & Equity Ratio = $\frac{\text{Long-Term Debt}}{\text{Long-Term Debt + Equity}} \times 100\ (\%)$

5/ Debt Service Coverage = $\frac{\text{Internal Cash Generation}}{\text{Total Debt Service}}$ (times)

TABLE 5 STAFFING PLAN

Year	Accouting Division		Book keeping Division		Finance Division		Customer Division		Personnel Division		Technical Division		O & M Division		Total
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	2)	(1)	(2)	
1985	4	41	3	12	7	78	3	42	3	18	4	20	5	160	400
1986	4	44	4	13	7	81	3	45	3	19	5	21	5	166	420
1987	4	46	4	13	8	84	4	48	3	19	5	21	5	176	440
1988	5	49	4	14	8	86	4	51	3	20	6	22	6	182	460
1989	5	51	5	14	8	89	4	54	3	21	6	22	6	192	480
1990	5	54	5	15	9	92	4	57	4	22	7	23	6	197	500
1991	5	56	5	16	9	95	5	60	4	22	7	24	7	205	520
1992	6	59	6	16	10	98	5	63	4	23	7	24	7	212	540
1993	6	61	6	17	10	100	5	66	4	24	7	25	8	221	560
1994	6	64	6	17	11	103	5	69	4	24	7	25	8	231	580
1995	6	66	6	18	11	106	5	72	4	25	7	26	8	240	600

Note ;

(1) : Engineer / Technician (Director, Division & Section Chiefs)

(2) : Office Staff

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