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JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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

THE STUDY ON CIUJUNG - CIDURIAN INTEGRATED WATER RESOURCES IN INDONESIA

FINAL REPORT

VOLUME II
MAIN REPORT

FEBRUARY 1995

NIPPON KOEI CO., LTD.
TOKYO, JAPAN

THE STUDY ON CIUJUNG-CIDURIAN INTEGRATED WATER RESOURCES

COMPOSITION OF REPORTS

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Volume II : Main Report

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EXCHANGE RATE

The exchange rates used in this Study are:

Rp.2,177 = US$ 1.00 = ¥ 100

as of August, 1994

PREFACE

Inresponse to a request from the Government of Republic of Indonesia, the Government of Japan decided to conduct a feasibility study on Ciujung-Cidurian Integrated Water Resources and entrusted the study to Japan International Cooperation Agency (JICA).

JICA sent to Indonesia a study team headed by Mr. Katsuyoshi Wada, Nippon Koei Co. Ltd., and members from Nippon Koei Co. Ltd. and Pasco International Inc., 5 times between June, 1993 and December, 1994.

The team held discussions with the officials concerned of the Government of Indonesia, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relation between our two countries.

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

February, 1995

Kimio Fujita

Kimio Fujita
President
Japan International Cooperation Agency

February, 1995

Mr. Kimio Fujita
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Sir,

LETTER OF TRANSMITTAL

We are pleased to submit herewith the Final Report of the Feasibility Study on Ciujung-Cidurian Integrated Water Resources in Indonesia.

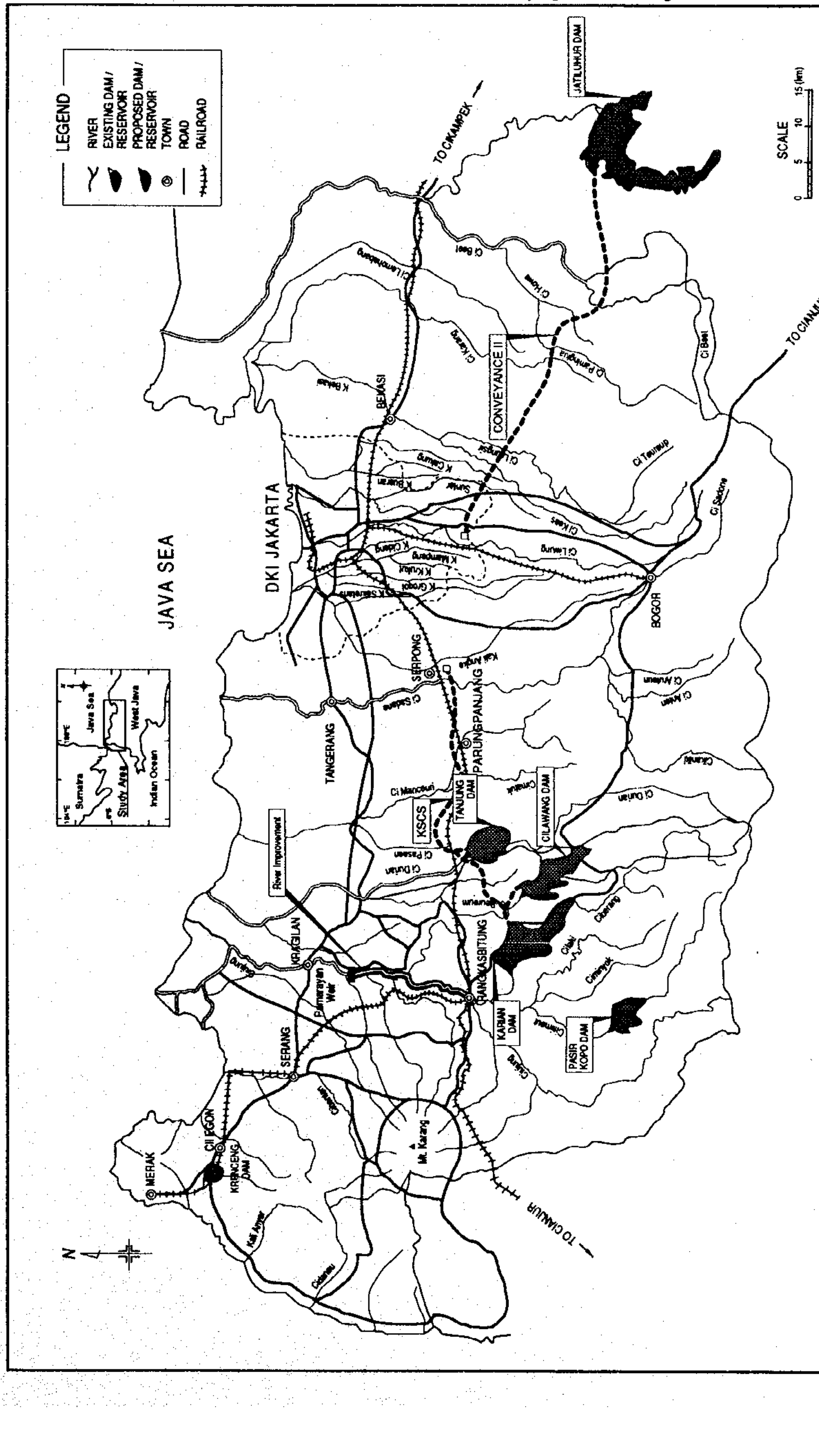
The Report presents the results of the Feasibility Study on Ciujung-Cidurian Integrated Water Resources comprising the Karian, Pasir Kopo, Cilawang, and Tanjung dam schemes, the the Karian-Serpong conveyance system for a municipal and industrial water supply to Jabotabek and the north Banten areas and an irrigation water supply to the existing irrigation areas in the Ciujung and Cidurian river basins, and the river improvement works for the middle reaches of the Ciujung river.

The Report consists of four volumes, the Summary, Main Report, Supporting Report, and Data Book. The Summary presents main outputs of the Study. The Main Report covers all the study results including analysis of the respective disciplines. The Supporting Report gives additional and supporting information, and the Data Book provides data obtained from the basic field survey and investigations carried out in Indonesia.

We would like to express our heartfelt thanks to the personnel of your Agency, the Embassy of Japan in Indonesia, and also to officials and individuals of the Government of Indonesia for the assistance and advice extended to the Study Team. We sincerely hope that the results of this Study will contribute to the national and regional development of the country.

Yours faithfully,

Katsuyoshi Wada
Team Leader
Study on Ciujung-Cidurian
Integrated Water Resources



THE STUDY AREA

THE STUDY
ON
CIUJUNG-CIDURIAN INTEGRATED WATER RESOURCES

VOLUME II : MAIN REPORT

General Location Map of the Project

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ABBREVIATIONS

(1) Organization

DPU (Departemen Pekerjaan Umum)	:	Ministry of Public Works
DPUP (Dinas Pekerjaan Umum Propinsi)	:	Provincial Department Office of Public Works
P3SA (Proyek Perancang Pemgembangan Sumber-Sumber Air)	:	Water Resources Development Planning Project Division
Cipta Karya	:	Directorate General of Housing, Building Planning and Urban Development
DGWRD	:	Directorate General of Water Resources Development
POJ (Perusahaan Umum Otorita Jatiluhur)	:	Jatiluhur Authority Public Corporation
DPMA (Direktorat Penyelidikan Masalah Air)	:	Directorate of Hydraulic Engineering
DEG	:	Directorate of Environmental Geology
DKI Jakarta (Daerah Khusus Ibukota Jakarta)	:	Jakarta Municipal City of Capital = Jakarta Municipality
PDAM (Perusahaan Umum Daerah Air Minum)	:	Regional Water Supply Public Corporation
PDAM or PAM Jaya (PDAM Jakarta Raya)	:	Jakarta Regional Water Supply Public Corporation
JATS	:	JABOTABEK Advisory Team Services
JICA	:	Japan International Corporation Agency
JMDP	:	JABOTABEK Metropolitan Development Plan
JMDPR	:	JABOTABEK Metropolitan Development Plan Review
JWRMS	:	JABOTABEK Water Resources Management Study
BAPPENAS (Badan Prencanaan Pembangunan Nasional)	:	National Development Planning Agency
BAPPEDA	:	Regional Development Planning Agency
BPS (Biro Pusat Statistik)	:	Central Bureau of Statistics
DBPP (Directorat Bina Program Perencanaan)	:	Directorate of Planning and Programming
PMG (Pusat Meteorogi dan Geofisika)	:	Meteorological and Geographycal Center
PT, or P.T (Perusahaan Terbatas)	:	Co. Limited (private firms)

(2) Regional Administration

Propinsi	:	Province
Kab. (Kabupaten)	:	Regency
Kec. (Kecamatan)	:	Subdistrict
Kota	:	City
Kotip (Kota Administratip)	:	Administrative city (Semi municipal city)

Kodya (Kotamadya)	:	Municipal city
Desa	:	Village
Kp. (Kampung)	:	Village (sometimes, smaller administrative community under "Desa" in West Java province, especially in Kab. Lebak)
Kelurahan	:	Village, but belongs to "Kota".
Rw. (Rukun Warga)	:	Small community belongs to "Kampung".
Rt. (Rukun Tetangga)	:	Smallest community belongs yo "Rukung Warga".

(3) Place Name or Geographical Name

G. or Gn. (Gunung)	:	Mountain (or Mount.)
Pr. (Perkebunan Rakyat)	:	Private Plantation (small scale holder plantation)
PTP (Perusaan Terbatas Perkebunan)	:	State owned plantation
Ci- (originated from "Cai = water")	:	River
KCC	:	Kopo-Cikande-Carenang Irrigation System
CJCB	:	Cisadane-Jakarta-Cibeet-Banten Irrigation System
TJC	:	Tarum Jaya Canal
WTC	:	West Tarum Canal

Chapter 1 INTRODUCTION

1.1 Project Background

Urbanization and industrialization in Jakarta, the capital of Indonesia, and its surrounding areas have recently expanded at a higher pace than anticipated. The region so called "Jabotabek", consisting of DKI (special region of the capital city) Jakarta and municipalities of Bogor, Tangerang and Bekasi, has a population of 16.8 million according to the 1990 census, out of which 8.2 million people reside in DKI Jakarta. The future population in the Jabotabek area and its surrounding municipalities are predicted to be about 50 million in 2025.

A number of development projects for housing estates and industrial complexes have been undertaken in the Jabotabek area in recent years. Urbanization and industrialization in the Jabotabek area will induce a rapid increase of the municipal and industrial water demands.

A large number of private wells has also been operating and the over-abstraction of groundwater has caused land subsidence, lowering of the groundwater table and sea water intrusion in DKI Jakarta.

In order to cope with the rapidly increasing water demands, the Directorate General of Water Resources Development (DGWRD), the Ministry of Public Works carried out and accomplished by September 1989 a comprehensive study on water resources development in and around the Jabotabek area. The findings have been compiled in a series of reports titled "Cisadane-Cimanuk Integrated Water Resources Development (BTA-155)". The study concluded that the preferred water supply plan for the water demands in the Jabotabek area until the year 2015 is a balanced supply with the Karian and the Tanjung reservoirs as supply sources from the western area and the Jatiluhur reservoir from the eastern area.

In accordance with the conclusion of the BTA-155 study, the Government of the Republic of Indonesia requested technical assistance of the Government of Japan in December 1991 for a study on integrated water resources in the western area of Jabotabek. In response to the request, the Government of Japan decided to conduct the study on Ciujung-Cidurian Integrated Water Resources. The Japan International Cooperation Agency (JICA) made a preliminary investigation and the scope of work for the assistance was agreed between the Government of the Republic of Indonesia and JICA in December 14th, 1992. In accordance with the scope of work, this Study has been undertaken since June, 1993 in cooperation with counterpart personnel dispatched from the consulting firm, PT. Indra Karya, under contract between DGWRD and the firm, and was completed in February, 1995. The counterpart personnel is listed up in Table 1.1 together with the members of the JICA study team.

While, following to the BTA-155 study, the Government of Indonesia started the Jabotabek Water Resources Management Study (JWRMS) in 1991 in order to establish municipal and industrial water supply master plan for the Jabotabek area as target year of 2025 taking into account rapid economic development since the later part of 1980's. The JWRMS was intended to be completed before the commencement of the study on Ciujung-Cidurian Integrated Water Resources, but it was interrupted and therefore, restarted in February, 1993 and completed in March, 1994.

The Study on Ciujung-Cidurian Integrated Water Resources overlapping the study area and execution period has been carried out with close coordination with the JWRMS and in due consideration of the outputs of the JWRMS.

1.2 Objective of the Study

The objectives of the Study are:

(1) to work out water allocation for the purpose of municipal and industrial water supply in and around the Jabotabek area

(2) to conduct feasible study on a water conveyance system connecting the Karian reservoir and Serpong water treatment plant under construction,

(3) to update the four (4) dam schemes of the Karian , Pasir Kopo, Cilawang and Tanjung dam schemes taking into account the present socio-economic situation, and

(4) to transfer relevant planning and designing technologies to Indonesian counterpart experts in the course of the Study.

Among the aforesaid four (4) dam schemes, the Pasir Kopo dam schemes, which is located in the Ciujung river basin, was identified to be necessary to meet the water demand rapidly increasing during the time horizon till 2025 by the JWRMS and therefore, it was added into the Scope of Work for this Study in the course of the Study.

1.3 Study Area

The Study area as shown in Figure 1.1 covered:

(1) the Ciujung and Cidurian river basins for investigation of surface water resources,

(2) the Jabotabek area and the North Banten area (study area of the Karian Multipurpose Dam Construction Project in 1985) with the total area of 9,489 km^2 for estimation of water demand, and

(3) the area between the Karian damsite and the Serpong water treatment plant for study on a water conveyance system.

CHAPTER 2 THE STUDY AREA

2.1 Topography and River Features

The study area with an area of 9,489 km^2 is situated between the east longitude of 105° 48' and 107° 28' and the south latitude of 5° 50' and 7° 10'. The northern and western parts of the study area are bounded by the Java Sea and the southern part is divided by the mountain range with an altitude of 1,300 m to 2,200 m. The eastern boundary lies on the river course of the Citarum river, which originates in the upstream of Bandung city and is one of the important water sources of the municipal, industrial and irrigation water supply in the downstream areas including DKI Jakarta.

The Ciujung and Cidurian river basins, which are the objective rivers of water resources development by the Study, are located at the western part of the study area and originate in the southern mountainous area with an altitude of about 2,000 m. The Ciujung river with a total catchment area of 1,850 km^2 and a river length of about 100 km has two major tributaries which are the Cisimeut river with a catchment area of 458 km^2 and the Ciberang river with a catchment area of 305 km^2. The main Ciujung river joins with these tributaries at the just upstream of Rangkasbitung and passes through the existing Pamarayan weir which is an irrigation intake of the Ciujung irrigation scheme and re-constructed by the DGWRD. Afterwards, the Ciujung river debauches into the Java Sea. The envisaged Karian and Pasir Kopo damsites are located in the Ciujung river basin.

The Cidurian river has a total catchment area of 865 km^2 and a river length of 95 km. The Cibeureum river with a catchment area of 255 km^2, a major tributary of the Cidurian river, joins at Parigi. The Tanjung and Cilawang damsites are located in the main Cidurian and the Cibeureum river, respectively.

On the other hand, the water conveyance system route envisaged in the study, which will connect the Karian reservoir with the Serpong treatment plant under construction, lies on the southern hilly area with altitude of 30 m to 60 m along the existing railway line. The water conveyance route cross the Cibeureum, Cidurian, Cimatuk, Cimanceuri and Cisadane rivers on the way to Serpong.

2.2 Hydrology

2.2.1 Climate

The study area belongs to typical humid tropical zone and the weather patterns are characterized by the monsoons. The wet season is defined as a period from November to April and the dry season from May to October in general. The monthly mean climatic data for a period from 1971 to 1993 at Serang located in the northern coastal plain are given as follows:

Climatic Data	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
Temperature (°C)	26.2	26.5	26.6	26.9	27.0	26.6	26.3	26.4	26.6	27.1	27.0	26.6	26.7
Relative humidity (%)	85	83	83	82	82	81	79	78	78	77	78	81	81
Wind velocity (knots)	5	5	5	4	4	4	4	5	5	5	5	5	4.7
Sunshine hours (%)	37	44	54	61	64	62	72	72	72	61	52	43	58

The monthly mean temperatures are rather stable throughout a year ranging between 26° and 27°. The monthly mean relative humidity indicates generally high humidity ranging from about 80% in the dry season to 85% in the wet season throughout a year. The monthly mean wind velocity at Serang ranges between 4 knots and 5 knots or 2.1 m/sec and 2.6 m/sec. The monthly mean sunshine duration at Serang ranges between 5 and 6 hours per day in the dry season and 3 to 4 hours per day in the wet season.

The annual rainfalls in the Ciujung and Cidurian river basins range from 4,000 mm in the mountainous area to 1,500 mm in the coastal area. The mean annual basin rainfall at the existing water level gauging stations at Rangkasbitung, Pamarayan and Kragilan in the Ciujung river basin, Kopomaja, Rancasumur and Parigi in the Cidurian river basin are given as follows:

Water Level Gauging Stations	Annual Basin Mean Rainfall
Ciujung river basin	
Rangkasbitung	3,005
Pamarayan	2,970
Kragilan	2,798
Cidurian river basin	
Kopomaja	3,599
Rancasumur	3,488
Parigi	3,143

2.2.2 Low flow analysis

The potential water resources in the Ciujung and Cidurian river basins were evaluated based on the daily discharge records observed at the existing water level gauging stations at Rangkasbitung and Kopomaja, which have been operated since November, 1970 and have the observation period of 24 years. The mentioned runoff data were examined on reliability of discharge rating curve by discharge measurement and consistency between annual runoff and rainfall by means of double mass plotting and runoff coefficient analysis. As a result, the runoff data at the aforesaid gauging stations were judged to be applicable for evaluation of water resources in the respective river basin. The half-monthly discharges at these stations are shown in Table 2.1.

Based on the runoff data at Rangkasbitung and Kopomaja, the runoff at the envisaged damsites and the existing weir sites were estimated by using a ratio of the catchment area and annual rainfall at the Pamarayan weir, Raneasumur weir and the envisaged dam sites to the aforesaid key gauges. The annual mean runoff at these sites are given as follows:

Sites	River Basin	Catchment Area (km^2)	Annual Mean Rainfall (mm)	Annual Mean Runoff (m^3/s)
Pamarayan weir	Ciujung	1,451	2,957	97.8
Rangkasbitung	Ciujung	1,383	2,988	94.2
Karian dam	Ciberang	288	3,498	23.0
Pasir Kopo dam	Cisimeut	172	3,101	12.2
Rancasumur weir	Cidurian	376	3,445	25.3
Kopomaja	Cidurian	304	3,553	21.1
Cilawang dam	Cibeureum	93	3,558	6.5
Tanjung dam	Cidurian	280	3,673	20.1

According to the estimated runoff at the aforesaid sites, the drought discharges were also estimated for 24 years. Among those, the least daily mean discharges are given as follows:

(unit:m^3/s)

Sites	River Basin	Catchment Area (km^2)	1972	1977	1982	1983	1991
Pamarayan weir	Ciujung	1,451	2.39	7.89	3.43	4.46	4.98
Rangkasbitung	Ciujung	1,383	2.30	7.60	3.30	4.30	4.80
Karian dam	Ciberang	288	0.56	1.85	0.80	1.05	1.17
Pasir Kopo dam	Cisimeut	172	0.30	0.98	0.43	0.56	0.62
Rancasumur weir	Cidurian	376	0.96	2.76	0.84	1.80	0.12
Kopomaja	Cidurian	304	0.80	2.30	0.70	1.50	0.10
Cilawang dam	Cibeurcum	93	0.25	0.70	0.21	0.46	0.03
Tanjung dam	Cidurian	280	0.76	2.19	0.67	1.43	0.10

The probable drought discharge with a return period of 10 years were estimated at 3.6 m^3/s at the Pamarayan weir and 1.1 m^3/s at Rancasumur weir by means of statistical analysis as shown in Figure 2.1.

2.2.3 Flood runoff analysis

Flood runoff analysis aimed at providing probable flood discharges for preliminary design of cross drains and river crossing structures along the Karian-Serpong conveyance system (KSCS), and review of spillway capacity of the proposed Pasir Kopo dam at the master plan level.

Design scale of these structures were set at the following probability based on the standard in Indonesia and the following methods are utilized for estimating these floods taking into account the scale of catchment areas and availability of data:

Structures	Standard	Method Applied
a) Cross drain	5-year probable flood peak discharge	The rational formula using rainfall data
b) Aqueduct	Probable flood peak discharge with a return period of 100 years	Equation presenting relationship between probable flood peak discharges and catchment areas established by the statistical analysis for the available flood data.
c) Pasir Kopo dam	Possible maximum flood discharge hydrograph to examine retarding effect in a reservoir.	Storage function model using rainfall data to obtain flood hydrograph flowing into a reservoir

(1) Cross drain of KSCS

Since there is no data on flood discharge from the small drainage area less than 10 km^2 in the study area, the probable flood peak discharges for the drainage basins at the crossing sites with the KSCS were estimated by means of the rational formula, probable rainfall at Maja rainfall gauging station (36A), and relationship between rainfall duration and intensity established by the DGWRD. The probable flood discharges with an excess probability once in 5 years for drainage areas crossing the KSCS are shown in Tables 2.2 and 2.3.

(2) Aqueduct

Probable flood discharge with excess probability once in 100 years at the crossing site of the Cisadane, Cimanceuri, Cimatuk, Cidurian and Cibeureum rivers was estimated in order to select and design the structure type, aqueduct or syphon.

The relationship between catchment area and specific flood peak discharges for the river basins was established through statistical analysis for the annual maximum discharges at Rangkasbitung in the Ciujung river, Kopomaja in the Cidurian river and Batubeulah in the Cisadane river as shown in Figure 2.2. The figure indicates good fitness to the Creager's curve except peak discharges at Kopomaja which has been affected by flood retardation for large scale flood in the upstream flat plane and therefore, the Creager's equation was applied to estimate design discharges at the structure sites with a catchment area more than about 10 km^2. Result is given in the figure.

(3) Pasir Kopo Dam

Probable flood and probable maximum flood (PMF) discharge hydrographs at the Pasir Kopo damsite were generated by using the probable and probable maximum rainfall (PMR) at Cilaki rainfall gauging station (43b) located in the river basin of the Pasir Kopo dam and the flood runoff model in the Cisimeut river basin established by the feasibility study on Karian Multipurpose Dam Construction Project in 1985.

The peak discharge of the PMF at the Pasir Kopo damsite was estimated at 3,300 m^3/s with the Creager's coefficient of 120 and specific discharge of 19.2 m^3/s/km^2. The specific discharge and catchment area for the Pasir Kopo as well as the Karian, Cilawang and Tanjung dam schemes are given as follows:

Description	Karian	Cilawang	Tanjung	Pasir Kopo
Flood Runoff (m^3/s)	3,400	1,700	3,098	3,300
Catchment Area (km^2)	288	93	280	172
Specific Discharge ($m^3/s/km^2$)	11.8	18.3	11.1	19.2

2.3 Regional Geology and Geotechnical Features along the Water Conveyance Route

2.3.1 Regional geology

The geological map covering the study area is given in Figure 2.3 and the stratigraphy of Banten area is shown in Table 2.4. The geological features in the study area are classified into alluvial of Holocene, terrace deposit of Pleistocene, tuffaceous sedimentary rocks of Pliocene to Miocene, and southern volcanoes of Miocene. The sedimentary formations of Miocene to Pleistocene is divided into several formations which are superposed monoclinal from south to north and from lower to upper horizons in order. They are mainly composed of fine to coarse tuffaceous sandstone and pumice tuffs with interbedding of lapili tuffs which belong to the Genteng formation of Pliocene in this study area.

The southern volcanic mountains were formed by basalt, volcanic breccia and andesite, which are erupted and/or intruded along the faulting zones in Miocene. Tectonic activity in this area is reflected in the presence of a large number of folds and faults. In general, beddings are dipping in low angles and gently folded, indicating a relatively minor tectonic activity. Most of lineaments and fault lines with NW-SE and NE-SW directions are found out on aerial photographs.

2.3.2 Karian-Serpong conveyance system

Based on the geological reconnaissance along water conveyance route between the Ciuyah tunnel and Serpong water treatment plant, the geological characteristics is generally divided into the four portions; 1) Genteng formation ; 2) Banten tuff; 3) Bojongmanik formation; 4) Quarternary volcanics; and 5) alluvial plains.

The Genteng formation mainly consists of pumice tuffs with interbedding of lapili tuffs, which are rich in plant remains and silicified wood. The surface of Genteng formation is covered by soil layer consisting of silty clay (decomposed of Quarternary tuffs) with thickness of 1 m to 3 m. The Ciuyah tunnel is located in the hilly area occupied by the Genteng formation.

The water conveyance route between Ciuyah and Maja is planned to run on the boundary of the Genteng formation in the southern part and Banten tuffs in the northern part near Maja.

The Banten tuffs consists of the Lower Banten tuff and the Upper Banten tuff. Out-crops of the Upper Banten tuff composed of tuffaceous sandstone, pumice tuffs and basal conglomerates are seen at or around Maja.

The water conveyance route between Maja and Serpong is planned to be aligned through the Bojongmanik formation, Genteng formation, Quarternary volcanics and alluvial plains. The Bojongmanik formation is composed of marls and clays with brown coal, tuff sandstone, andesite gravel (lower part) and pumice tuffs and is distributed at the southern part in this area. The Quarternary volcanic deposit occupies the northern part of this stretch and is composed of laharic breccia, pillow lava, tuffaceous sandstone and fine tuff. Its exposition is frequently found out in the sand borrow pits at the Cicayur old river channel. These deposits are characterized by well consolidated feature and high bearing capacity. The pillow lava is exposed at the Cimatuk river, which is in slightly weathered condition with flow structure and vesicular. The alluvial deposit composed of unconsolidated and soft sandy-silty clay is found at surrounding areas of river channels and is well developed especially in the Cimanceuri, Cimatuk, Cipayeun and Cidurian rivers.

Serpong water treatment plant is being constructed on the young volcanic deposits with good bearing capacity, which are distributed on the alluvial fans and composed of bedded fine tuff, sandy tuff and interbedded conglomerate tuff.

2.4 Socio-economy

2.4.1 Land use

The study area with an area of 9,489 km^2, comprised of the Jabotabek and north Banten areas is mainly divided into four (4) categories in land use as shown in Figure 2.5; 1) housing area including industrial area currently growing; 2) paddy field; 3) upland crops; and 4) state forest and other areas, based on the statistical data issued by the Kabupatens in 1991. The areas and their percentage distribution are indicated as follows:

(unit : km^2)

Land Use Categories	Jabotabek					North Banten		
	DKI Jakarta	Kab. Bekasi	Kab. Tange-rang	Kota. Bogor	Kab. Bogor	Kab. Serang	Kab. Lebak	Kab. Pande-glang
(1) Housing	271	290	361	18	499	226	81	17
	(41)	(22)	(28)	(27)	(18)	(13)	(6)	(7)
(2) Paddy field	60	751	576	1	867	687	266	128
	(9)	(57)	(44)	(2)	(31)	(39)	(19)	(51)
(3) Upland crops	80	253	326	3	1,212	797	929	89
	(12)	(19)	(25)	(5)	(44)	(45)	(67)	(35)
(4) State forest and others	251	20	38	4	190		110	19
	(38)	(2)	(3)	(67)	(7)	(4)	(8)	(8)
Total	662	1,314	1,301	22	2,770	1,781	1,386	253
	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)

Note : Figures in parenthesis show percentage distribution of areas against total area. Then, figures in Serang, Lebak and Pandeglang indicate an area in the north Banten area.

DKI Jakarta has been mainly developed as an urban area which has a role of political, administrative, and commercial center of the Indonesia. The industrial area is developed along the port at Tanjungpriok, relating to shipbuilding industry. The major industrial estates in DKI Jakarta are Jakarta Industrial Estates at Pulogadung in Jakarta Timur municipality and Kawasan Berikat Nusantara in Jakarta Utara municipality. Also, in the Kabs. Bekasi and Tangerang, urbanization and industrialization has been rapidly expanded along the existing national road and highway and railway line aligned along the foot of hill area, where the water is available along the WTC and the neighboring rivers and from groundwater. Especially, along the envisaged Karian-Serpong water conveyance route, an area of 6,000 ha at Serpong is being developed by the BSD for housing purpose and an area of 3,000 ha at Tigaraksa is scheduled to be further expanded as a new capital city of Kab. Tangerang due to administrative change for the existing capital to Kotip.

While, the north-western part has been developed as a heavy industrial area such as steel, petroleum and chemical centralizing on Cilegon city and its zone is widening toward the coastal area of the northern peninsular of the city. There exist 18 industrial estates with a total area of 4,000 ha including Krakatau Industrial Estate Cilegon. Also, in this area, the Selaraya power plant with an installed capacity of 1,600 MW is under operation and its second stage development with an installed capacity of 1,800 MW is scheduled to be commenced within a few years. In addition, a new harbor construction is going on at the Kec. Bojonegara, of which the first stage is scheduled to be completed in 1997 and the second stage construction will be continued until 1999.

There are large existing systems; 1) Prosijat irrigation area with an area of about 65,845 ha of which irrigation water has been supplied from the Juanda dam in the Citarum river through the existing West Tarum Canal (WTC); 2) Prosida-Cisadane (31,000 ha); 3) Cidurian-Rancasumur (11,000 ha); 4) Cicinta (1,400 ha); 5) Empang-Cisadane (5,791 ha); 6) Katulampa-Ciliwung (3,853 ha); 7) Ciujung (22,988 ha).

Future land use plan including together with transportation development plan is illustrated in Figure 2.6, which was prepared by using the data and information from the local governments related to the Study, and it is noted that target years for these plans are still unclear, subject to determination by further study.

In the Jabotabek and north Banten areas, several new irrigation development schemes were formulated by the previous studies:

Irrigation Scheme	Irrigation Area (ha)	Location	Studies/Projects
Kopo-Cikande-Charenang (KCC)	10,300	Kab. Serang	Karian Multipurpose Dam Construction Project, JICA
Cidurian-Tanjung	5,568	Kab. Tangerang	Cisadane River Basin Development Project
Curug-Legok	2,966	Kab. Tangerang	do above
E6, E8, and E9 areas	6,810	Kab. Bekasi/Bogor	C-J-C project

Most of areas for three schemes of E6, E8, E9, KCC, Tanjung and Curug-Legok irrigation development are presently planned to be developed as industrial and/or settlement areas by the West Java Provincial Government. At present, purpose of land resources development in the aforesaid new irrigation areas is changed from agricultural production to industrial or housing development.

The existing settlement areas in the study area are expected to be largely expanded to support growing population with a high increasing rate. The JWRMS estimated in the draft final report that about 140,000 ha to 160,000 ha which is more than twice of the existing settlement areas in Kabs. Bogor, Bekasi, Tangerang and Serang will be additionally required to accommodate growing population in near future.

2.4.2 Population

According to the result of population census in 1990, the total population of Indonesia was 179 million, and that of the study area were 19 million as broken down below:

Administrative Units	Population	Population Density per km²	Annual Growth Rate between 1980 and 1990 (%)	Average Family Size (person per household)
DKI Jakarta	8,227,746	12,433	2.47	4.71
Kab. Bogor	3,738,868	12,562	4.10	4.80
Kot. Bogor	271,341	1,336	0.94	5.00
Kab.Tangerang	2,703,053	2,063	6.15	4.90
Kab. Bekasi	2,104,392	1,591	6.47	4.61
Jabotabek area	17,045,469	2,809	3.74	4.75
Kab. Serang	1,470,838	808	2.86	4.88
Kab. Lebak	529,295	374	2.52	4.67
Kab. Pandeglang	215,687	684	2.39	5.08
North Banten area	2,167,748	634	2.74	4.84
Total	19,213,148	2,025	3.62	4.76

As indicated above, population in Kabs. Bogor, Bekasi and Tangerang has increased with a high rate of 4 % to 6.5 % against average annual growth rate of the population was 1.97 % in Indonesia, while the population growth rate in other areas was comparative low as less than 3 %. It is noted that some Kecamatans were decreased in population during these 10 years as those in Jakarta Selatan, in Jakarta Timur, in Jakarta Pusat, in Jakarta Barat and Bogor Tengah in Kotamadya Bogor. It seems that the population densities in these areas have almost come near to the limit.

2.4.3 Regional economy

Gross Regional Domestic Products (GRDP) in Indonesia, West Java Province and Kabpatens in the study area are given in the following table:

(trillion Rp.)

Indonesia	West Java	Jabotabek DKI Jakarta	Jabotabek Kota. Bogor	Jabotabek Kab. Bogor	Jabotabek Kab. Tange-rang	Jabotabek Kab. Bekasi	North Banten Kab. Serang	North Banten Kab. Lebak	North Banten Kab. Pande-glang
115	17.8	13.7	0.2	1.4	1.3	0.8	1.1	0.3	0.3
(7.1)	(8.3)	(7.3)	(7.0)	(9.5)	(10.8)	(8.5)	(11.9)	(13.0)	(6.5)

Note : Figure in the parenthesis indicates an average economic growth rate from 1983 based on 1983 constant price level.

As indicated in the aforesaid table, the economic growth rates in the study area excluding Pandeglang was higher than that in the whole Indonesia reflecting the industrialization in these areas as indicated in the following table showing percentage share of each sector in GRDP:

(unit : %)

Industry of Origin	Indo-nesia	West Java	DKI Jakarta	Kab. Bogor	Kodya Bogor	Kab. Tange-rang	Kab. Bekasi	Kab. Serang	Kab. Lebak	Kab. Pande-glang
Agriculture	21.8	21.9	1.1	18.6	1.5	15.8	20.1	10.9	47.0	53.3
Minings	14.5	11.2	0.0	0.7	0.0	0.0	0.5	0.5	0.6	0.1
Manufacturing and industry	19.5	20.7	26.4	29.0	8.0	32.6	36.4	63.5	5.8	5.6
Electricity, gas and water	0.6	1.6	4.1	2.2	5.9	1.9	2.0	0.4	0.1	0.4
Construction	5.5	6.5	7.5	9.6	15.7	7.8	9.7	6.1	7.5	1.6
Trade/commercial	16.3	20.6	20.0	24.2	22.6	21.1	18.6	10.1	21.6	16.2
Transportation and communication	5.6	4.9	10.5	5.2	19.4	13.5	3.4	2.9	2.8	5.3
Financing/banking	4.0	1.4	15.5	0.2	5.0	0.5	0.3	0.5	0.4	1.3
House rent	2.5	1.5	2.8	1.3	0.9	0.9	1.0	0.6	1.3	3.2
Official services	6.5	6.6	3.9	4.2	16.6	3.7	4.4	2.8	9.9	9.1
Services	3.3	3.2	8.5	4.8	4.4	2.1	3.6	1.7	3.0	2.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

2.5 Present Water Use

2.5.1 Existing reservoirs and water conveyance systems

Presently, dam and reservoir are provided only in the Cimanuk river basin; namely the Juanda, Cirata and Saguling dams with a total gross storage volume of 5,354 million m^3; which were constructed in 1969, 1985 and 1988 respectively. Among those dams, the Juanda dam have multi-functions which are i) municipal and industrial water supply to DKI Jakarta and its surrounding areas through the Curug intake weir and the West Tarum Canal (WTC); ii) irrigation water supply to the Prosijat area; iii) hydropower generation with an installed capacity of 183 MW; iv) flood control in the downstream; and v) flushing water supply for DKI Jakarta. While, the later two dams were developed mainly for hydropower generation with a total installed capacity of 1,200 MW. The main features of these dams are as follows:

Main Features	Juanda	Cirata	Saguling
(1) Catchment area (km2)	4,500	4,119	2,100
(2) Gross storage volume (million m^3)	3,000	1,900	888
(3) Effective storage volume (million m^3)	2,100	900	640
(4) Dam height (m)	105	125	99

The major water conveyance system in the study area, which are mainly provided for irrigation water supply, are listed as follows:

Conveyance System	Intake Weir/ River System	Service Area	Length (km)	Max. Design Capacity (m^3/sec)
1) West Tarum Canal	Curug/Citarum	Prosijat irrigation area and DKI Jakarta	69.5	85
2) Cisadane Main Canals	Pasar Baru/ Cisadane	Prosida-Cisadane irrigation area	98.4	30
3) Solokan Barat Main Canal (Empang)	Empang/ Cisadane	Cisadane-Empang irrigation area	22.0	7
4) Katulampa Main Canal	Katulampa/ Ciliwung	Ciliwung-Katulampa Irrigation area	42.7	5
5) Cidurian Main Canal	Rancasumur/ Cidurian	Cidurian-Rancasumur irrigation area	24.8	15
6) Cicinta Main Canal	Cicinta/Cicinta	Cicinta irrigation area		1
7) Ciujung Main Canals	Pamarayan/ Ciujung	Ciujung irrigation area	94.2	30

Since reduction of their capacities due to sedimentation in the canals and slope failure along the canals have been remarkable, the improvement and rehabilitation works were done for some of the canals.

2.5.2 Municipal and industrial water supply system

(1) Municipal water supply

Municipal water has been supplied by PAM system and private groundwater exploitation by providing deep well. According to the PAM Jaya System Improvement Project (PJSIP) funded by the IBRD and OECF, as of 1993, the PAM system covers an area of 300 km^2 and serves drinking water for population of 2 million corresponding to 30 % of a total population in the service area. Unit water consumption is estimated at 200 l/d/capita based on the daily average consumption of 400,000 m^3/day and the aforesaid served population by the PJSIP. Also, the PJSIP identified that rate of distribution loss is presently about 50 % for the whole service area and that it is 60 % to 80 % in Pulogadung pilot area through the project survey. However, these distribution loss is planned to be reduced to 30 % by implementation of the PJSIP, of which first phase will be completed in the fiscal year of 1995/1996 and second phase is scheduled to be continued until 1998/1999.

The existing water treatment plants are listed in Table 2.4 and their location is shown in Figure 2.7. In addition to the above existing treatment plants with the total capacity of about

15 m^3/sec, Buaran II water treatment plant with a capacity of 3,000 l/sec and Serpong water treatment plant with a capacity of 3,000 l/sec are under construction in line with the recommendation of the Jakarta water supply master plan established in 1985. These treatment plants are planned to take water in from the WTC and the Cisadane river.

While, the JWRMS estimated through their simulation analyses that an amount of 7,000 l/sec is abstracted mainly for domestic water use by using shallow wells (less than 40 m) and 3,000 l/sec for industrial and large commercial use by using deep well (40 m to 300 m), though the registered water abstraction is only at about 1,000 l/sec. The later withdrawal of the groundwater significantly causes problems on saline water intrusion into groundwater aquifer and land subsidence with a rate of 4 cm/year especially in the northern part of DKI Jakarta.

The municipal water supply in the surrounding Kabupatens are undertaken by the PDAMs independently organized in each Kabupaten. The existing PDAM's water supply system are shown in Tables 2.5 to 2.7. These water supply systems have mainly been provided by the IKK and BNA projects, using deep groundwater, spring water and/or surface water such as river water and the water in the existing irrigation canals. But, their service factors are between 5 % and 10 % and population served by piped water supply system is rather low. Unit water consumption in the Kabupaten systems ranges between 100 to 125 litter per capita per day (lcd). Most of population presently takes a drinking water mainly through shallow or deep wells.

(2) Industrial and commercial water use

According to the result of investigation data on industrial water use, the total water demands as of 1990 in the Jabotabek area were estimated at 9.61 m^3/sec based on water consumption of the registered manufacturing companies as follows:

	Areas	No. of Companies	Water Consumption (m^3/sec)	No. of Employ.	Water Consumption (l/day/emp.)
(1)	Large scale industry				
	DKI Jakarta	2,351	2.20	338,000	463
	Bogor	864	1.29	180,000	508
	Tangerang	1,159	1.23	269,200	320
	Bekasi	634	0.95	179,700	368
	Sub-total	5,009	5.67	966,900	414
(2)	Small scale industry				
	DKI Jakarta	41,902	3.42	432,400	515
	Bogor	2,021	0.20	18,400	754
	Tangerang	1,039	0.20	12,400	1102
	Bekasi	793	0.12	58,700	1424
	Sub-total	45,756	3.94	552,000	554
	Grand Total	50,764	9.61	1,488,800	491/1

Note : /1 : average water consumption.

In the north Banten area industrialized by the heavy manufacturing enterprises such as the Krakatau Steel, chemical industrial factories, coal thermal power stations and harbors, the water demands is rapidly being increased due to the industrialization. According to the water demand data in 1991/1992 in Kab. Serang, unit water demand per an employment is calculated at about 2.9 m^3/day which is significantly higher than about 0.5 m^3/day in the Jabotabek area. Total water demand in industrial sector in the Kab. Serang was estimated at 19 million m^3/year as of 1990 by the Cidanau-Cibanten water resources development project. Also, the aforesaid project estimated the water demands for hotels and resorts at the 86,000 m^3/year corresponding to 0.2 % of industrial water demands or 2 % of domestic water demands.

The major water source for the above water demands is presently groundwater which covers about 50 % to 80 % of demands in the Kabupatens. Other demands are fulfilled by the surface water, which is directly taken in by the industrial companies, or piped water system of PAM or PDAM.

As for commercial use, there are no sufficient data in order to analyze and grasp present commercial use condition even in Jabotabek area. The JWRMS roughly estimated on the basis of production data provided by the water supply companies in Jabotabek area that total water demands in commercial and service sectors corresponded to about 20 % to 40 % of the municipal water demands.

(3) Irrigation water use

The major existing irrigation systems in the study area are as follows:

Irrigation System	River System/ Water Source	Irrigation Area as of 1990 (ha)	Intake Weir
a) Prosijat area	Citarum	65,845 (WTC)	Curug
b) Prosida-Cisadane	Cisadane	31,156	Pasar Baru
c) Empang	Cisadane	5,791	Empang
d) Cidurian-Rancasumur	Cidurian	10,805	Rancasumur
e) Cicinta	Cicinta	1,371	Cicinta
f) Ciujung	Ciujung	22,988	Pamarayan
g) Katulampa	Ciliwung	3,853	Katulampa
Total		141,809	

These irrigation systems have been operated mainly by the West Java Provincial government and their average intake discharges are summarized as follows:

(unit : m^3/sec)

System	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
Prosijat	16.5	15.7	15.9	16.1	18.2	21.7	27.4	30.6	24.5	20.4	20.4	20.6	20.7
Cisadane	18.0	20.2	21.9	22.1	23.5	23.6	22.2	18.9	17.6	14.2	22.1	23.3	20.6
Empang	11.7	12.0	12.7	12.8	12.5		11.0	10.2	10.7	10.1	11.2	11.8	11.5
Rancasumur	8.1	7.5	7.5	7.3	7.2	8.0	7.1	6.5	5.7	3.3	4.0	4.0	6.3
Ciujung	13.6	12.8	15.5	17.1	16.1	16.4	16.2	15.9	14.4	15.4	15.5	14.9	15.3
Katulampa	7.7	8.1	8.8	8.6	8.1	5.6	4.8	5.5	5.7	2.7	6.6	6.0	6.5
Total	75.6	76.2	82.3	84.0	85.7	87.1	88.7	87.6	78.6	66.1	79.8	80.6	81.0

Cropping patterns in the study area are mainly classified into four patterns; i) paddy-paddy; ii) paddy-palawija; iii) paddy; and iv) palawija. But, intensities of these patterns are depending on availability of water. Presently, large scale irrigation areas such as Prosijat, Cisadane and Ciujung areas have higher intensities than those in other areas where the water availability in both the dry and wet seasons is rather limited comparing with their irrigation areas.

CHAPTER 3

WATER RESOURCES DEVELOPMENT PLAN IN THE CIUJUNG AND CIDURIAN RIVER BASINS

3.1 Water Supply Master Plan Established by the JWRMS

The Jabotabek Water Resources Management Study (JWRMS), which was undertaken from June 1991 to April 1992 and from February 1993 to March 1994, aimed mainly at formulating global plan for raw water supply by developing surface water and groundwater and water resources management plan, during the time horizon till the year of 2025 in the Jabotabek area including its surrounding municipalities, namely the north Banten and Karawang/Purwakarta area.

The JWRMS estimated the future water demands in municipal, industrial and irrigation sectors, using such the latest data as 1990 census and other accumulated statistical data and socio-economic survey result in these years.

The JWRMS predicted that the population in the Jabotabek and surrounding areas increases from 20 million in 1990 to 50 million in 2025 as given in Table 3.1. In estimating future population, the JWRMS used three (3) scenarios for population projection in the Jabotabek area and related areas to the study taking into account long-term economic growth, investment and activities of the government and public in potential economic development. These scenarios have been established by the Jabotabek Metropolitan Development Plan and Review (JMDPR) carried out by the Cipta Karya under financing of IBRD and the JWRMS was carried out the water demand projection in accordance with these scenarios. The concept of the scenarios are described as follows:

Scenario A : a) high economic growth
b) low government involvement in water resources management
c) limited land use planning

Scenario B : a) low economic growth
b) low government involvement in water resources management
c) limited land use planning

Scenario C : a) high/medium economic growth
b) high government awareness in water resources management
c) increased land use planning

The M&I water demands by the water source in the aforesaid areas are given in Table 3.2 and summarized as follows:

(unit:m^3/s)

Year	Serang			Tangerang			DKI Jakarta		
	Surface water	Ground-water	Total	Surface water	Ground-water	Total	Surface water	Ground-water	Total
Scenario A									
1990	2.2	2.6	4.8	2.3	4.4	6.7	9.0	15.1	24.1
2000	4.3	4.0	8.3	4.4	6.4	10.8		16.8	29.0
2010	7.1	6.0	13.1	7.3	8.5	15.8	18.2	17.6	35.8
2025	11.8	8.2	20.0	12.5	10.9	23.4	26.0	17.7	43.7
Scenario C									
1990	2.2	2.6	4.8	2.3	4.4	6.7	9.0	15.1	24.1
2000	4.4	4.0	8.4	4.8	6.7	11.5	18.9	14.8	33.7
2010	9.1	5.0	14.1	11.1	7.9	19.0	36.0	11.1	47.1
2025	17.3	5.3	22.6	22.2	8.4	30.7	42.1	10.1	52.2

The M&I water demands for the surface water in Serang, those in Tangerang excluding water amount of 2 m^3/s to be taken in from the Cisadane river, and 6 m^3/s among those in DKI Jakarta were planned to be supplied by the envisaged dam schemes and water conveyance system in the JWRMS. The water supply to DKI Jakarta also planned to start in 2015 in order to replace the intake water at the on-going Serpong water treatment plant due to predicted significant water pollution in the Cisadane river and to meet additional M&I water demands in DKI Jakarta.

While, irrigation water requirement was estimated based on the existing guidelines issued by the DGWRD referring to those prepared by FAO, using the accumulated data since Cisadane-Cimanuk Integrated Water Resources Development (BTA-155) study. Also, the JWRMS applied the assumption that irrigation area is expected to be reduced due to expansion of residential area for increasing population, and that unit water requirement is be decreased by crop diversification from paddy to vegetables to meet vegetable requirement in the Jabotabek area and to save the limited water resources. The following table indicates the present and future water requirement in the large irrigation schemes in the study area:

Irrigation Area	River Basin	Water Demand (m^3/s)	Water Demand in 2025 (m^3/s)		
			A	B	C
Ciujung	Ciujung	14.0	10.5	11.3	11.1
Rancasumur	Cidurian	4.2	3.7	3.7	3.7
Cisadane	Cisadane	18.9	16.9	17.2	17.2
Empang	Cisadane	1.4	0.7	0.7	0.8
Katulampa	Ciliwung	1.5	0.9	0.9	1.0
West Tarum	Citarum	33.6	28.2	28.7	28.6
North Tarum	Citarum	57.5	48.2	50.1	48.4

(2) Supply criteria

The JWRMS set up priority ranking for water allocation to various water users as follows:

1) The existing irrigation and municipal and industrial water demand
2) Additional municipal and industrial water demand

3) New irrigation development
4) Aqua-culture
5) Flushing water
6) Hydropower

Also, to evaluate the potential water resources, the study established the following supply criteria, describing severity of design drought:

1) M&I	:	failure 1 day in 10 years
2) Irrigation	:	failure 1 half month in 5 years
3) Flushing	:	use of residual water

(3) Water resources development plan

The JWRMS reviewed the potential water resources (refer to Figure 3.1) identified by the previous studies and screened those by comparing the project cost, unit development cost and environmental impacts. The alternative water resources development plans was prepared as shown in Figure 3.2 based on the combination of the following main alternatives:

1) Minimum investment cost,

2) Balanced water supply to DKI from the west (the Ciujung/Cidurian) and the east (the Citarum) to DKI Jakarta,

3) Reservation of the Karian dam only for Kab. Serang,

4) Safe drinking water sources for preventing water pollution along water conveyance system and minimize the use of polluted water in the Cisadane and Bekasi rivers passing through Bogor city area,

5) Multi-objective alternative which was the combined alternative of the four alternatives.

The JWRMS concluded that strategy 5 (multi-objective alternative) was proposed for both scenario A and C through comparison study on ; a) unit cost of raw water and treated water, b) investment cost, c) present value of project cost including operation and maintenance cost, and d) population to be resettled from the proposed reservoir area.

3.2 Procedure for Water Resources Study

The JWRMS was recommended to supply raw water for municipal, industrial and irrigation water uses to the Kabupatens of Serang and Tangerang and DKI Jakarta from the envisaged four (4) dam schemes, that is the Karian, Pasir Kopo, Cilawang and Tanjung dam schemes and the Karian-Serpong conveyance system in the Ciujung and Cidurian river basins.

The water resources study in the Ciujung and Cidurian river basins, specially, focuses on supply capacity of the envisaged dam schemes since the JWRMS used meteorological and hydrological data for a period from 1951 to 1979 but the study area in 1980's experienced several severe droughts in 1982, 1983 and 1991. Therefore, runoff data in these drought years were incorporated to evaluate the water resources in the Ciujung and Cidurian river basins in this Study.

Under the following supply criteria consistent with the master plan, the procedure for review of the water resources in the objective river basins was established as shown in Figure 3.3:

Supply Priority	Water Demand Category		Criteria
(1)	M&I water supply	:	successful supply capacity to meet the water demand even in a drought year with excess probability once in 10 years,
(2)	Irrigation water supply	:	successful supply capacity to meet the water demand even in a drought year with excess probability once in 5 years,
(3)	Flushing water	:	use of remaining water only from the downstream river basin of the envisaged dams,
(4)	Aqua-culture	:	no water allocation in the Ciujung and Cidurian river basins, which means that the aqua-cultural water use is limited into the present situation utilizing return flow of irrigation water supply system.

The above criteria means that the first priority is given to M&I water supply and that the irrigation water supply is restricted in the drought years with return periods more than 5 years in order to maintain the M&I water supply even in such severe drought. In the water balance analysis, a drought year is assumed to be expressed by occurrence rate of water supply failure from the dam/reservoirs for simulation period of 24 years from 1970 to 1993 as follows:

1) Drought once in 10 years : Supply failure once for 24 years is allowed assuming that the second drought corresponds to the drought with the probability once in 10 years.

2) Drought once in 5 years : Supply failures of 4 times for 24 years are allowed assuming that the fifth drought corresponds to drought with the probability once in 5 years.

3.3 Water Demand

(1) Municipal and industrial water demands

The municipal and industrial (M&I) water demand and agricultural water requirement in the north Banten and Jabotabek areas were forecasted by the JWRMS. The applied procedure and data were reviewed by this Study and it was judged that estimation procedures as shown in Figure 3.4 on the basis of the economic data including the latest 1990 census, which have been accumulated and updated since BTA-155 study, is reasonable. From this consideration, the water demands projected by the JWRMS was incorporated into the current water demand and supply balance analysis.

The water demands to be supplied by developing the water resources in the Ciujung and Cidurian river basins are illustrated in Figures 3.5 and 3.6.

(2) Irrigation water requirement

There are two (2) large irrigation areas in the Ciujung and Cidurian river basin; one is the Ciujung scheme with an area of 22,988 ha in the Ciujung river basin, and the other is Cidurian-Rancasumur scheme with an area of 10,805 ha in the Cidurian river basin. The JWRMS suggested that the total irrigation requirement is expected to be reduced due to decrease of irrigation area for housing for increasing population, and that agricultural cropping pattern will gradually change from the paddy to vegetable for supplying necessary vegetable to Jabotabek area with large population.

Based on the above-mentioned, the irrigation requirement was estimated based on agricultural cropping pattern illustrated in Figures 3.7 and 3.8. As indicated in the figures, the irrigation areas of about 4,100 ha in the Ciujung and 1,500 ha to 2,000 ha in the Rancasumur schemes were forecasted to be decreased between the years of 1990 and 2025 by the JWRMS due to population growth.

(unit : ha)

Irrigation Area	River Basin	Area in 1990	Area in 2025 (ha)		Reduced Area from 1990 to 2025 (ha)	
			A	C	A	C
Ciujung	Ciujung	22,988	18,862	18,862	4,126	4,126
Rancasumur	Cidurian	10,805	9,312	8,873	1,493	1,932

Tables 3.3 to 3.6 show the reviewed half monthly irrigation water requirement in the scenarios A and C, which was estimated by the Study with the aforesaid cropping pattern and irrigation areas, the parameters in the PU's guidelines and FAO's standard, and half-month rainfalls observed at the station with code No. 23c for the period from 1970 to 1993.

(3) Flushing water

The JWRMS recommends not to provide flushing water by construction of dam/reservoir since the expensive incremental cost of Rp. 200/m^3 is required to guarantee it and residual water from the downstream basin of damsite is expected to be available for this purpose.

In the downstream river stretch far from the damsite, drastic change of river flow situation is not considered but the just downstream area will be largely affected by storing river water in the reservoir and diversion to Karian-Serpong conveyance system. Especially, no release from the dam will cause no flow situation with significant duration at the just downstream of the damsites, where the inhabitants utilize the river water for their living activities.

In order to cope with these adverse effect to the just downstream area, the minimum released discharge from the dam was considered in this study to maintain their living activities. The minimum discharge was determined based on the specific discharge of 0.3 m^3/sec per 100 km^2 corresponding to drought discharge with excess probability once in 10 years at the damsites.

(4) Fishery

No water was allocated by the water resources development in the Ciujung and Cidurian river basins. But, the water use situation for the brackish fishery will be improved from the present condition with some extent since most of the fish ponds is located at the end of the irrigation canal for use of its return flow and water resources development by providing the Karian and Pasir Kopo dam is planned to fully maintain irrigation water requirement even in the drought with 5 year return period against the present safety level of return periods of 2 or 3 years.

3.4 Water Demand and Supply Balance Analysis

3.4.1 Water demand and supply balance model

(1) Water demand

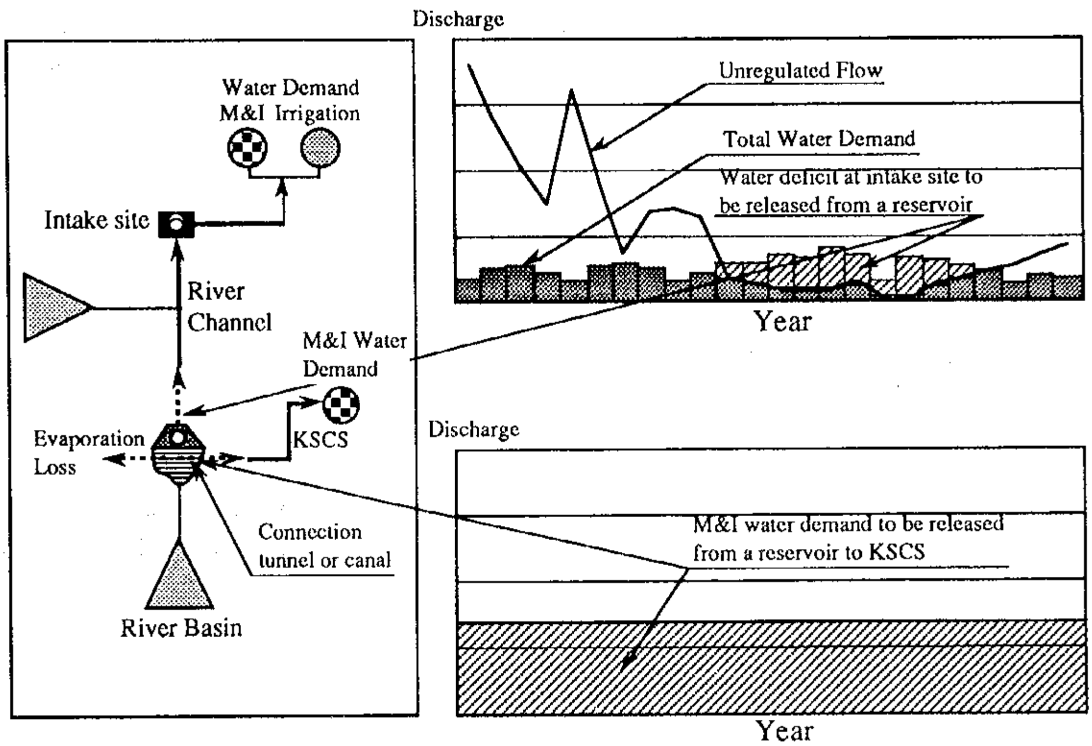
Water demand and supply balance analysis was made for the total M& I water demand of 26.2 m^3/s for the scenario C and 16.5 m^3/s in the scenario A, and irrigation water requirement at 2025 taking into account the seasonal change of the irrigation water requirement. The mentioned water demands were assumed to be taken in at the existing Pamarayan weir for Serang and the Ciujung irrigation area, the existing Rancasumur weir for the Rancasumur irrigation area, and the damsites to be directly connected with the KSCS for M&I water supply in Tangerang and DKI Jakarta.

(2) Dams and reservoirs

The water balance model was prepared taking into account the functions of the dams and reservoirs and Karian-Serpong conveyance system (KSCS) for water resources development and water conveyance to water users as illustrated in Figure 3.9:

Dam/Reservoirs			Functions
(1) Karian	:	a)	M&I water supply to Serang/Tangerang and DKI Jakarta through Ciuyah tunnel and KSCS
		b)	Flood control for a river stretch between Rangkasbitung and Pamarayan weir
		c)	Irrigation water supply to the Ciujung area
(2) Cilawang	:	a)	M&I water supply to Tangerang and DKI Jakarta through KSCS from the Cilawang canal directly connected to the reservoir.
(3) Tanjung	:	a)	M&I water supply to Tangerang and DKI Jakarta through KSCS from the Tanjung canal directly connected to the reservoir.
		b)	Irrigation water supply to Rancasumur area
(4) Pasir Kopo	:	a)	M&I water supply to Serang
		b)	Irrigation water supply to the Ciujung area

The envisaged dams and reservoirs are operated to meet the allocated role in the water balance model. The operation concept of each dam are illustrated as follows:



Dam schemes to be connected with the KSCS by tunnel or canal will constantly release the stored water corresponding to the allocated water amount. While, a dam with irrigation water supply and/or M&I water supply in the downstream area of the dam will release the stored water through river outlet in order to supplement water deficit at an intake site.

(3) Runoff model

The balance model involves sub-basins, which are prepared by dividing the catchment area of the Ciujung and Cidurian river basins taking into account the location of the envisaged dams and the existing intakes as shown in Figure 3.9. The runoffs from these sub-basins are estimated by multiplying a ratio of the catchment area and annual mean rainfall to those at Rangkasbitung for the Ciujung river basin and at Kopomaja for the Cidurian river basin. The catchment area and annual rainfall at Rangkasbitung and Kopomaja are as follows:

Key Gauging Station	River Basin	Catchment Area (km^2)	Annual Rainfall (mm)
Rangkasbitung	Ciujung	1,383	2,988
Kopomaja	Cidurian	304	3,553

The estimated half monthly discharges flowing into these reservoirs are given in Tables 3.7 and 3.8.

(4) Evaporation loss from a reservoir

Evaporation loss from a reservoir was taken into account in the water balance analysis. Since there were no sufficient data on evaporation, potential evaporation was examined by using Penman's method. The results are shown as follows:

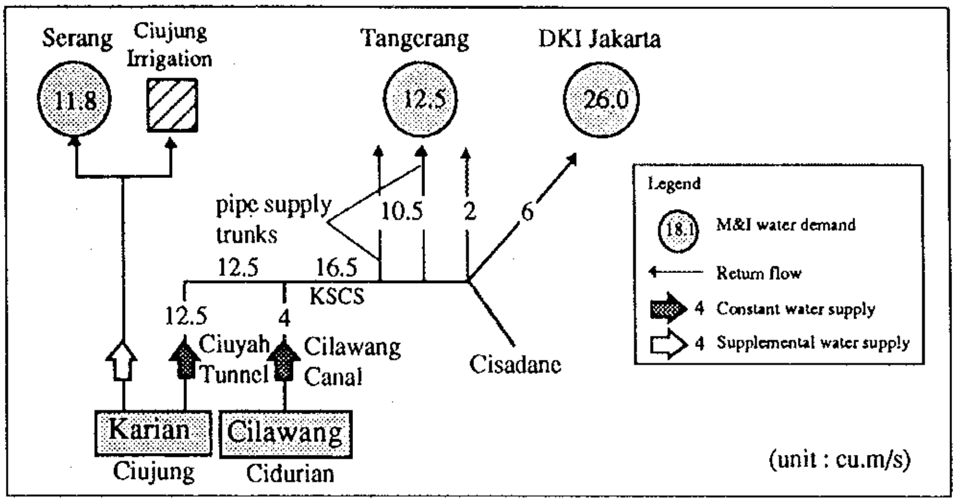
(unit : mm/day)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
4.0	4.3	4.5	4.5	4.1	4.0	4.3	4.7	5.3	5.2	5.0	4.4

3.4.2 Supply capacity of the envisaged dams and reservoirs

(1) Scenario A and Strategy 5 (A5)

The flow capacity of two (2) dams/reservoirs proposed by the water supply master plan by the JWRMS were reviewed through water balance analysis under water demand condition at 2025 as follows:



The Karian dam was planned to supplement water deficit at the Pamarayan weir between unregulated flow and total water demands for M&I sector in Serang and the Ciujung irrigation area. Also, the Karian dam was designed to release water of 12.5 m^3/s through the Ciuyah tunnel to the KSCS to Tangerang and DKI Jakarta. The Cilawang dam was also planned to constantly release the stored water of 4 m^3/s through an intake in the reservoir to be directly connected with the KSCS by the Cilawang canal.

The water demand and supply balance analysis was made for the above supply plan to verify it by using the updated runoff data and as a result, the water supply failure occurs at the Karian reservoir in the severe drought years of 1972, 1977, 1982, 1983 and 1991. While, the Cilawang reservoir is able to supply the allocated water even in the aforesaid drought years without draw-down to the low water level of the reservoir but the surplus at the Cilawang reservoir could not supplement the deficit at the Karian reservoir.

from the above result of the simulation, the above water supply measures in the master plan was judged to be revised to meet the water demands in the scenario A, since it was considered that occurrence of supply failure of 5 times for 24 years corresponds to safety level with excess probability once in 4 years.

It is possible to set up three (3) alternatives; 1) Karian and Tanjung, 2) Karian and Pasir Kopo, and 3) Karian, Cilawang and Pasir Kopo, taking into account the supply capacities of the reservoirs in the master plan.

In the alternative (1), the Karian reservoir is planned to supply water to Serang mainly and the Tanjung to Tangerang and DKI Jakarta. While, in the alternative (2), the Karian reservoir is provided for water supply to Tangerang and DKI Jakarta and the Pasir Kopo reservoir for Serang. This alternative (2) is possible only when the Karian reservoir's capacity sufficiently meets the M&I water demand in Tangerang and DKI Jakarta. The alternative (3) is a countermeasure for the alternative (2) in case that the Karian reservoir is not able to cover the water demand of 16.5 m^3/s in the aforesaid areas.

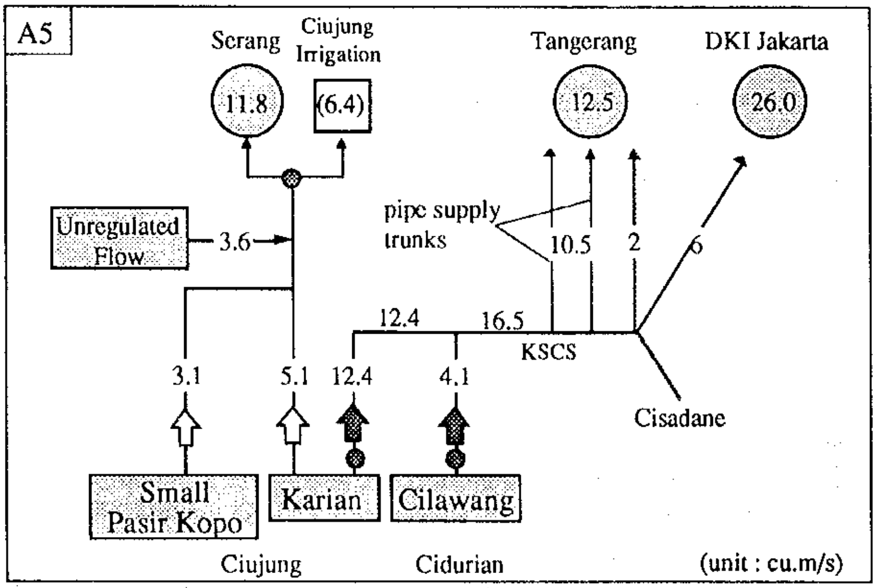
From the above consideration, the Karian reservoir's supply capacity without water supply to Serang was reviewed assuming that the supply to Serang is made by the Pasir Kopo reservoir, and as a result, the Karian reservoir with a storage volume of 219 million m^3 was estimated to have a supply capacity of 14.4 m^3/s less than 16.5 m^3/s of the M&I water demands in Tangerang and DKI Jakarta under the drought condition with excess probability once in 10 years. Consequently, the alternative (2) was not adopted for selecting an optimum measure.

While, the investment costs of alternatives (1) and (3) are compared as follows:

	Alternative (1)		Alternative (3)	
Dam Scheme	Construction Cost (Bil. Rp.)	Population to be Replaced	Construction Cost (Bil. Rp.)	Population to be Replaced
Karian	153	12,124	153	12,124
Cilawang	-	-	71	3,706
Tanjung	417	15,060	-	-
Pasir Kopo	-	-	83	3,810
Total	570	27,184	307	19,640

As shown in the aforesaid table, the alternative (3) has advantages on both the investment cost and resettlement of inhabitants in the planned reservoir areas. Therefore, the alternative (3) was selected as a structural measure for the scenario A.

The water balance analysis was made for the aforesaid alternative (3) based on the procedure and supply criteria established by the Study. Through the simulation, the following M&I water supply plan was established:

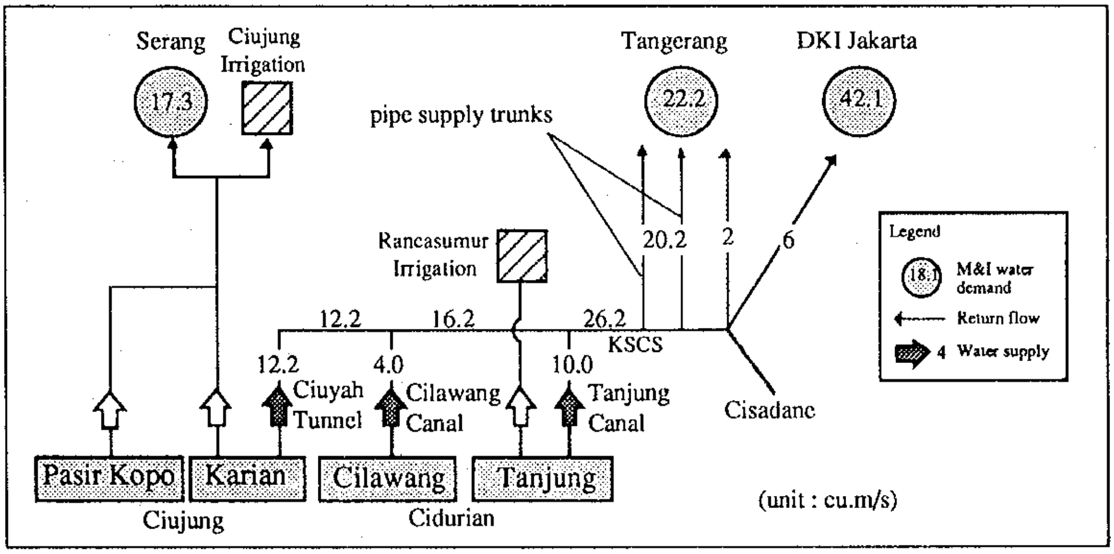


The Karian and Pasir Kopo reservoirs satisfy the M&I water demand of 5.1 m^3/s and 3.1 m^3/s in Serang respectively, and the Karian and Cilawang reservoirs release the discharge of 12.4 m^3/s and 4.1 m^3/s constantly to KSCS even in 10-year drought. Also, scale of the Pasir Kopo dam was optimized to have effective storage volume of 44.5 mil. m^3 and normal high water level of 90.5 m in the scenario A.

While, the irrigation water supply amount for the dry season crops is maintained even in 5-year drought, but it is restricted at about 30 % against full requirement in the 10-year drought. As a result of restriction, water amount supplied to the Ciujung irrigation area is limited to 6.4 m^3/s against the fill requirement of around 11 m^3/s in terms of annual mean discharge.

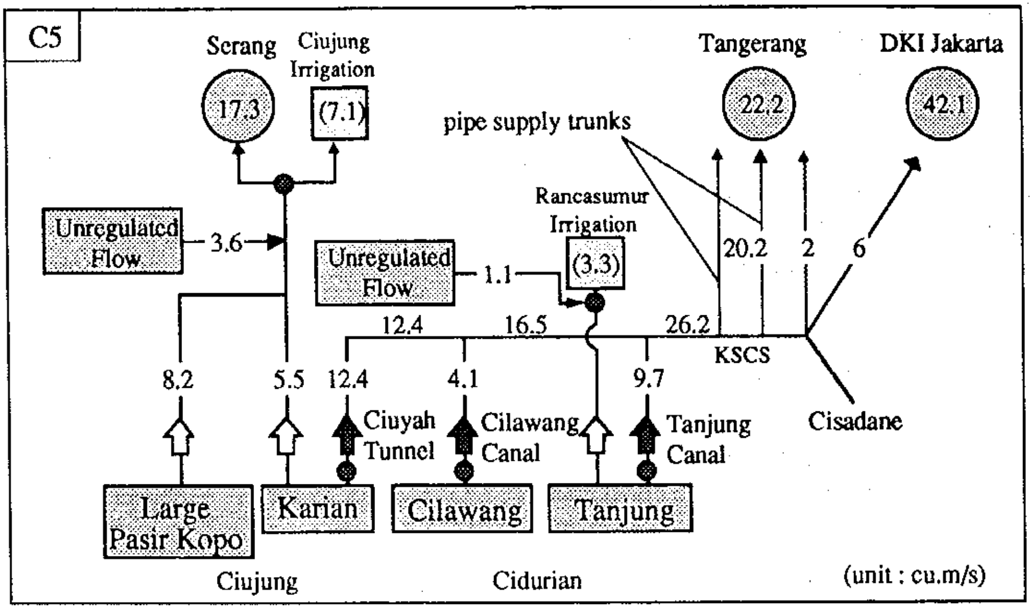
(2) Scenario C and Strategy 5

The four (4) dams were proposed to be constructed in the water supply master plan by the JWRMS and to supply raw water for the M&I and irrigation sectors at 2025 as follows:



The Karian and Pasir Kopo dams were planned to supplement water deficit at the Pamarayan weir between unregulated flow and total water demands for M&I in Serang and the Ciujung irrigation area. The Karian dam, furthermore, was designated to supply water of 12.2 m^3/s through the Ciuyah tunnel to Tangerang and DKI Jakarta. The Cilawang and Tanjung dams constantly release the stored water of 4 m^3/s and 10 m^3/s respectively through the intakes in the reservoirs to be directly connected with the KSCS by the canals. The total water of 26.2 m^3/s released from the reservoirs to the KSCS was planned to be conveyed to the proposed water treatment plants at Tenjo and Parungpanjang and to supply to Balaraja/Tigaraksa and Tangerang areas through pipe trunk lines. On the other hand, raw water of 6 m^3/s is to be conveyed by the KSCS to Serpong water treatment plant.

Through the water balance analysis, the water supply plan above-mentioned was reviewed in accordance with the supply criteria and as a result, the raw water supply plan from the Ciujung and Cidurian river basins for the M&I water demands was revised as follows:



The Karian and Pasir Kopo reservoirs satisfy the M&I water demand of 5.5 m^3/s and 8.2 m^3/s in Serang respectively, and the Karian, Cilawang and Tanjung reservoirs release the discharge of 12.4 m^3/s, 4.1 m^3/s and 9.7 m^3/s constantly to KSCS even in 10-year drought. Also, scale of the Pasir Kopo dam was optimized to have effective storage volume of 112.6 mil. m^3 and normal high water level of 100.5 m in the scenario C.

While, the irrigation water supply amount for the dry season crops in the Ciujung and Rancasumur schemes is maintained even in 5-year drought, but it is necessary to be restricted at about 50 % against the full requirement in the 10-year drought in order to meet the M&I water demands. As a result of restriction, the water amount supplied to the Ciujung and Rancasumur irrigation areas is limited to 7.1 m^3/s and 3.3 m^3/s against the full requirement of 11.7 m^3/s and 4.4 m^3/s in terms of annual mean discharge, respectively.

3.5 Proposed Water Resources Development Plan

3.5.1 Dam schemes

(1) First priority project

The area in Kabs. Serang and Tangerang has been rapidly industrialized and urbanized. Furthermore, it is considered that provision of a new harbor and connection of the national highway between Jakarta and Merak under construction will accelerate these activities. While, the main surface water resources for supporting these economic development are limited into the Ciujung and Cidurian rivers.

The supply capacities without regulation by provision of dam/reservoir were estimated at 3.6 m^3/s at the Pamarayan weir and 1.1 m^3/s at Rancasumur weir by means of statistical analysis using the annual minimum daily mean discharge series for 24 years from 1970 to 1993.

The aforesaid flow discharges were estimated to correspond to the M&I water demands between 1995 and 2000 in Serang and between 1990 and 1995 in Tangerang in both the scenarios A and C. While, the JWRMS recommended not to use the Cidurian-Rancasumur canal for M&I water conveyance due to high possibility of water pollution in the canal and therefore a new water conveyance system is proposed to be directly connected with the Tanjung reservoir. In consideration of the present situation of the areas, both the areas need the earlier construction of dam and reservoir which enable stable water supply.

From the above-mentioned, the Karian dam scheme has large advantage on ability of water supply to both areas and furthermore this scheme can have a flood control function along the middle reach of the Ciujung river rapidly being developed and 1993 flood caused severe damage to the area. Therefore, the first priority for implementation was given to the Karian dam scheme and starting time of the operation is proposed at 2002 as illustrated in Figure 3.10, taking into account the detailed design of two (2) years, financial arrangement and land acquisition of one (1) year and construction period of four (4) years after this Study.

(2) Development scenario : A

It was identified that the Karian reservoir is able to solely satisfy the water demands till 2015 through water balance analysis and that the water supply of 6 m^3/s to DKI Jakarta scheduled to start in 2015 induces supply failure even in a drought year with a return period of 5 years.

From the result of water balance analysis, it is necessary to provide supplemental water supply of 3.1 m^3/s by the Pasir Kopo reservoir to Serang and increase of water supply of the Karian reservoir to Tangerang and DKI Jakarta from 9.1 m^3/s to 12.4 m^3/s by replacing irrigation water supply of 3.3 m^3/s to the Ciujung scheme with the Pasir Kopo dam. In the same year, the Cilawang is also planned to start water supply to Tangerang and DKI Jakarta to fulfill M&I water demands till 2025.

(3) Development scenario : C

The Karian reservoir meets the water demand by 9.1 m^3/s both in Serang and Tangerang including irrigation water supply to the Ciujung irrigation area till 2010. Afterwards, the rapidly increasing water demands in both the areas requires the water supply from the Pasir Kopo reservoir to Serang and increase of water supply to Tangerang from 9.1 m^3/s to 12.4 m^3/s by replacing irrigation water supply of 3.3 m^3/s to the Ciujung irrigation area with the Pasir Kopo dam to meet the water demand till 2014. Furthermore, growing water demands in the aforesaid areas after 2014 and water supply of 6 m^3/s to DKI Jakarta in 2015 need the start of services of the Tanjung reservoir with a large supply capacity of 9.7 m^3/s in 2014 and the Cilawang reservoir with supply capacity of 4.1 m^3/s in 2018.

The JWRMS recommended not to implement the Tanjung scheme because of high construction cost and large population of resettlement. While, the abstraction of large amount of groundwater as a countermeasures for without-Tanjung dam scheme, might induce the problems as similar as in Jakarta and this groundwater resources might not be permanent measure. There is no alternative surface water resources for the Tanjung scheme in the Ciujung and Cidurian river basins and the scheme is indispensable to fulfill the water demand in the scenario C in the study area. Consequently, the Tanjung dam scheme is proposed in case that the M&I water demands increase along or below the scenario C, but above the scenario A.

(4) Development scenario : C'

The future water demands are expected to shift from the growth curve of water demand in the scenario A to that in the scenario C taking into account the rapid industrialization and urbanization, full highway connection between Merak and Jakarta within a few years, provision of a new harbour near Serang city, and diversification of the water source for M&I water supply from groundwater to surface water.

Such situation of the M&I water demands in the study area will require the introduction of the Tanjung dam scheme at 2020 as shown in Figure 4 in addition to the dam schemes proposed for the scenario A. While, the Tanjung dam scheme is predicted to have a significant problem on resettlement in its implementation since the planned reservoir area is well-developed agricultural land and densely populated. Therefore, it is considered that the development series of the Karian, Pasir Kopo, Cilawang and Tanjung dam schemes in the mentioned case (scenario C') is preferable in order to take sufficient time to solve the resettlement problem.

3.5.2 Development scenario for Karian-Serpong water conveyance system

It is recommended that the KSCS should also be developed in line with the water resources development in the Ciujung and Cidurian river basins to cope with increase of M&I water demands in Tangerang and DKI Jakarta, since there are many assumptions in estimating future M&I water demands as shown in Figure 3.4. The significant factors are; 1) necessity of abandonment of intake water of 3.0 m^3/s in the Cisadane river and replacement with other sources due to probable intolerable contamination at 2015, 2) success of diversification of main M&I water source from the groundwater to surface water, and 3) area reduction of the existing irrigation areas and change of agricultural cropping pattern in the Ciujung and Rancasumur areas in future. Taking into account possibility of changes of these factors from those assumed in the Study, the implementation schedule is necessary to be established with flexibility to cope with the changes in the water demand and to minimize over-investment.

From the above-mentioned, a phasing development concept for the KSCS based on the following targets was established:

a) The first phase development aims to supplying the M&I water in Tangerang (Phase I).

b) The second phase development is to be implemented for meeting M&I water demands in Tangerang and DKI Jakarta after around 2015 (Phase II).

Possible phasing development for the trend of M&I water demands in the scenarios A and C are shown in Figure 3.11 based on the above mentioned concepts.

While, the future water demands is judged to be between those of the scenarios A and C. The M&I water demands in the scenario A is the most realistic one between the positive case of the scenario C and the pessimistic case of scenario B assuming the lower economic development by the JWRMS. The scenario C is a preferred case assuming successful diversification of water use from groundwater to surface water in order to solve the problems caused by over-abstraction of shallow and deep groundwater under higher economic growth of Indonesia. While, the scenario A is more aggressive than in the scenario C in using groundwater at high rate against surface use.

In Serang, Tangerang and DKI Jakarta, the industrialization and housing development have been carried out since the later part of 1980's and this development will be further accelerated by the full highway connection between Merak and Jakarta and provision of the new harbor at Bojonegara in Serang. These activities will support the current economic growth in Indonesia and the provision of piped water supply for the M&I uses will be needed to maintain economic development.

While, the Indonesian Government has made efforts to provide safe and stable water supply with piped system and it will take much time and large amount of investment in order to reach such target in the scenario C. Therefore, the future growth trend of the M&I water demands is considered to shift the realistic scenario A to the preferred scenario C.

In consideration of the above situation of the M&I water demands, two (2) implementation scenarios were examined in consideration of the mentioned phasing development options in Figure 3.11:

Scenario 1	:	Phase IA	⇒	Phase IIC-a	⇒	Phase IIC-b
Scenario 2	:	Phase IC	⇒	Phase IIC-a	⇒	Phase IIC-b

The scenario 1 intends to implement small scale Phase IA with the construction of the Karian dam at 2002 as shown in Figure 3.12. While, shifting of water demand curve from scenario A to the scenario C requires earlier implementation of Phase IIC-a with additional capacity of 5.4 m^3/s at around 2010. The introduction of an additional waterway with a capacity of

5.4 m^3/s needs construction of the downstream canals with the full capacity at 2025 before introduction of the Tanjung and Cilawang dam construction as shown in Figure 3.12 since the further division of canals with more than two (2) lanes requires higher cost than two (2) lanes even at the same capacity.

While, the scenario 2, in which phasing development of the water resources and the KSCS is possible at the same time, has advantage on flexible enlargement of the supply capacity in accordance with increase of the M&I water demands in Tangerang and DKI Jakarta since this scenario 2 is able to give the sufficient time of 12 years until the provision of the Tanjung dam after introduction of the Karian dam scheme even though the M&I water demands should increase with an extremely high rate in the scenario C. This advantage in the scenario 2 will enable to make the stable financial arrangement and give sufficient time to review the effect of the investment. Further, the Karian and Pasir Kopo dam schemes, which have total supply capacity of 12.4 m^3/s, are necessary to be constructed in both the scenarios A and C and therefore the KSCS with the supply capacity of 12.4 m^3/s will be able to efficiently meet the M&I water demands in these scenarios.

Comparing the present values of construction cost for the above scenarios, the scenario 2 is considered to be cheaper solution due to appropriate provision of flow capacity against increase of M&I water demands.

Based on the result of selection of the first phase development of the KSCS as mentioned, the phasing development plan of the KSCS consisting of two (2) phases was proposed as illustrated in Figure 3.13 taking into account the possible phasing development scenarios.

Chapter 4

KARIAN-SERPONG WATER CONVEYANCE SYSTEM

4.1 Selection of Prospective Routes

The preliminary study on route of the Karian-Serpong water conveyance system (KSCS) was made by using the existing topographic maps with a scale of 1:10,000 which was produced in 1983, 1984 and 1987 and cover the area of about 80 % of the conveyance route between the Karian reservoir and Serpong water treatment plant (Serpong WTP), and with a scale of 1:50,000 covering all the route. The preliminary study aimed at screening of prospective route(s) comparing the preliminary construction cost of alternative routes due to difference of topographic condition, which significantly affects to the total construction costs of the water conveyance system taking into account that earth work will be the major construction work.

(1) Alternative routes

The topography along the area between the Ciuyah tunnel and Serpong is illustrated in Figure 4.1. The figure indicates that the area is covered with the hills with an altitude from EL. 40 m to 60 m forming many small scale valleys of which the bottom elevation ranges from EL. 20 m to 30 m.

Taking into account the mentioned topography in the area, four (4) alternatives routes were set out as illustrated in Figure 4.2 and topographic characteristics of the alternative routes are described as follows:

Alternative Routes	Topographic Condition	Length from Ciuyah Tunnel to Serpong WTP (km)
N-1	Northern edge of contour line with EL. 50 m till Tenjo and EL. 40 m till IP.2 near Parungpanjang	47.1
N-2	Northern edge of contour line with EL. 50 m till IP.2 near Parungpanjang	47.2
N-3	Similar to N-2 but shortened by running in slightly southern area	46.2
S-1	Along the existing railway line with an elevation of 40 m to 60 m, which is the shortest one among the alternatives.	45.7

In delineating alternative routes, it was further considered not to cause significant land acquisition problems in the existing towns and villages, land acquisition areas along the Cisadane river near Serpong and the areas planned to be developed for industrial and housing uses such as the Bumi Serpong Damai and Tigaraksa New Towns as much as possible.

(2) Options for conveyance method

The low water level of the Karian reservoir and the ground elevation of Serpong water treatment plant is planned to be EL. 46.0 m and EL. 50 m, respectively, which are connected by the envisaged Karian-Serpong conveyance system. Considering these conditions designed by the previous study and on-going projects, provision of pumping-up facilities is necessary to convey the river water in the Ciujung and Cidurian rivers to Serpong WTP and combination of gravity and pumping-up conveyance methods was applied for selection of an optimum route. As for the location of pumping-up of the conveyed raw water through the KSCS, the right bank side of the Cisadane river near the Serpong WTP is proposed taking into account the necessity of operation of pumping facility, consistent with the treatment operation at the Serpong WTP.

From the above, gravity conveyance method was applied for a stretch of the KSCS from the outlet of the Ciuyah tunnel to the right bank side of the Cisadane river and pumping-up method to the Serpong WTP therefrom.

(3) Waterway type

Options on waterway type were also set out and selected prior to the screening of routes. The following options of eight (8) types as shown in Figure 4.3 were considered to be possible:

a) Trapezoidal open channel type
   option 1 : without lining on both slopes
   option 2 : with masonry lining (t = 300)
   option 3 : with concrete lining (t = 100)
b) Rectangular open channel type
   option 4 : with wet rubble masonry
   option 5 : with reinforced concrete
c) option 6 : box culvert type
d) option 7 : steel pipeline
e) option 8 : concrete pipeline

Among the above-mentioned options, a reinforced rectangular channel type of the option 5 was selected for screening of the prospective water conveyance routes, comparing their construction cost, degree of difficulty for operation and maintenance, water conveyance loss, possibility of water pollution, environmental impact especially on resettlement problems, and so on.

Bed slope of the waterway was set at 1/1000, 1/2500, 1/5000, 1/7500, 1/10000 and 1/12500 in screening taking into account the topography in the area between the Ciuyah tunnel and Serpong WTP.

(4) Connection of the Ciuyah tunnel and KSCS

There are broadly the following two (2) alternatives to introduce the water from the Karian reservoir to the KSCS.

Alternative 1 : Karian reservoir ⇒ Ciuyah tunnel ⇒ Cibeureum river ⇒ Buyut weir ⇒ KSCS
Alternative 2 : Karian reservoir ⇒ Ciuyah tunnel ⇒ KSCS

In order to select the preferable one from the aspects of construction and operation costs including treatment cost, a cost comparison was made and as a result, it revealed that the total cost was almost same in both methods as tabulated as follows:

Alternative	Cost Items	Cost (billion Rp.)
1.	a) Construction of Buyut weir	20.0
	b) Construction of sand trap basin	2.0
	c) Water treatment cost	5.0 to 10.0
	Total	27.0 to 32.0
2.	a) Construction of canal between Ciuyah tunnel and KSCS	23.0
	b) Construction of canal between Cilawang dam and KSCS	6.6
	Total	29.6

The alternative 2 directly connecting the Ciuyah tunnel with the KSCS is proposed based on the result of cost comparison and in consideration of particularly clean water supply and also uncertainties to be involved in maintenance works for sedimentation at the Buyut weir and waterway and more complicated operation and maintenance of gates to be required for the Buyut weir connection in the alternative 1.

(5) Screening of alternative routes

A screening study was carried out by comparing construction cost of the alternative routes assuming several water conveyance capacities and waterway bed slopes. As a result, it was indicated that the route of N-2 gave the least construction cost and the second one was the route of N-3 in combination with bed slope of 1: 5,000 in both the routes.

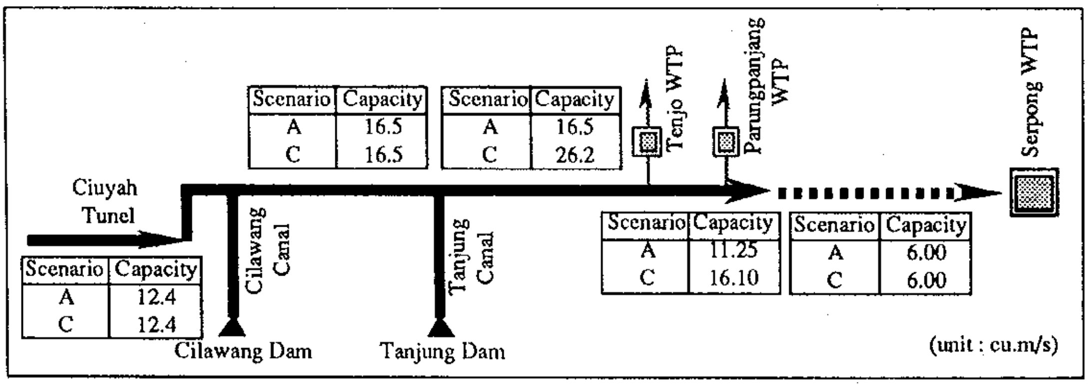
Route	Canal Bed Slope	Present Value (billion Rp.)			
		8 m^3/s	15 m^3/s	20 m^3/s	30 m^3/s
N-1	1/5000	132.7	175.2	192.5	226.4
N-2	1/5000	129.0	163.5	180.2	213.0
N-3	1/5000	135.5	170.2	187.6	221.1
S-1	1/5000	156.7	191.6	209.9	243.5

This result is considered to be reasonable since the southern routes of the existing railway line will need the vast amount of excavation work and the further northern route of the railway line will become rather longer waterway than routes of N-2 and N-3. Taking into account the result of the cost comparison study, the route of N-2 and N-3 was selected as the prospective routes for further studies.

4.2 Optimum Route

Based on the raw water supply plan established by the Study and topographic map with a scale of 1/5,000 produced by the Study covering the entire route of KSCS from the Ciuyah tunnel to the Serpong WTP, the construction cost for the prospective routes of N-2 and N-3 was verified and an optimum route was selected among these prospective two (2) routes.

Construction costs including land acquisition cost of the alternative routes N-2 and N-3 were estimated for the following design discharge proposed in the scenarios A and C, assuming waterway with one lane of concrete rectangular channel:



The present value of construction and operation maintenance costs of the main waterway and pumping-up facilities were estimated as follows:

(unit: billion Rp.)

Scenario	Route N-2	Route N-3
A	245 (1/5,000)	249 (1/10,000)
C	257 (1/5,000)	259 (1/10,000)

Note : Values in parenthesis show the waterway bed slope, giving the least cost among options of bed slopes from 1/1000 to 1/12,500.

From the above verification on the cost for the prospective routes of N-2 and N-3, the route of N-2, which gives the least cost in terms of present value, was proposed to be an optimum route for the KSCS. In addition, the housing development area near Tenjo railway station under planning and acquiring the land for its development in this area overlaps the route of N-3 and therefore, the land acquisition for the route of N-3 becomes difficult soon.

Through the verification of construction cost, it was confirmed that the route of N-2 is the optimum route under the gravity conveyance method from the Ciuyah tunnel to the right bank side of the Cisadane river and pressure flow type conveyance to the Serpong WTP therefrom.

Through the aforesaid cost comparison, it was also identified that construction cost per unit conveyed water amount in the section between Parungpanjang and Serpong was judged to be significantly expensive than that for the upstream route of Parungpanjang due to vast amount of excavation work to form a gravity conveyance waterway, since the waterway is aligned for both the routes of N-2 and N-3 through the hilly area with an altitude of about 60 m against the waterway bed elevation of around 40 m in order to detour the developing area of the Bumi Serpong Damai.

The application of pumping-up method with pipeline conveyance for this section was examined and it was identified that pumping-up conveyance could significantly reduce the construction cost at around 50 % against gravity conveyance method. From this lower cost, the conveyance method from the Karian reservoir to the Serpong WTP were proposed to be the gravity conveyance from the Ciuyah tunnel to Parungpanjang WTP and pressure flow conveyance to Serpong WTP therefrom.

On the other hand, the treated water at the Serpong WTP is planned to be conveyed to two (2) distribution centers through pipeline conveyance system under construction by the PDAM Tangerang; R.4 center and Lebakbelus center in DKI Jakarta.

An optimum route between the Parungpanjang and Serpong water treatment plant was further examined taking into account the routes to the R.4 and Lebakbulus distribution centers for Jakarta area. In the optimization study, five (5) alternative routes to R.4 distribution center through and not through the Serpong WTP, and two routes to Lebakbulus distribution center were studied as shown in Figure 4.4. As a result, the route to both the distribution centers through the pipeline route under construction via the Serpong WTP was selected as the optimum one among the alternatives because of the least cost in terms of the present value including construction cost, operation and maintenance cost, and land acquisition cost as given in Table 4.1 and summarized as follows:

	Alt. Route	Construction (bill. Rp.)	Land (bill. Rp.)	Replacement (bill. Rp.)	O & M (bill. Rp./yr.)	Total (bill. Rp.)
(1)	1S + 0 + 1	104.5	21.7	4.4	3.7	115.6
(2)	1S + 0 + 2	117.3	22.0	5.2	4.4	128.9
(3)	1S + 0 + 3	123.1	19.2	5.2	4.4	131.7
(4)	1S + 0 + 4	124.6	82.7	4.6	4.1	179.6
(5)	1S + 0 + 5	141.8	23.5	5.2	4.6	150.6

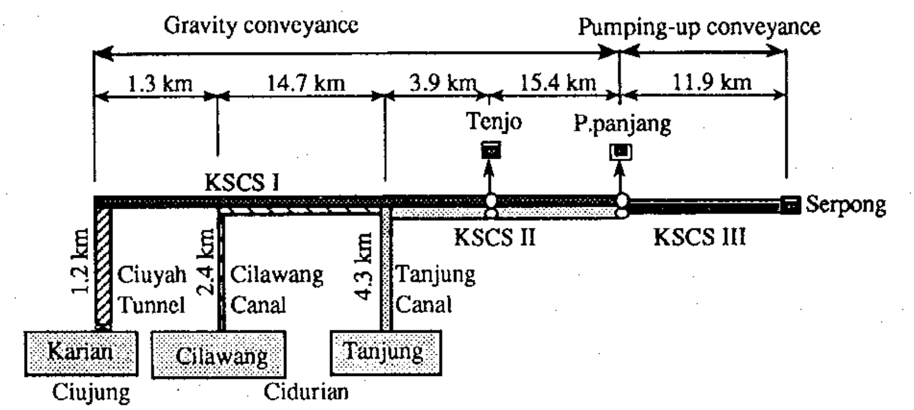
Through the above optimization study, the route of N-2 to Serpong WTP with pipeline conveyance system from Parungpanjang was proved to be the optimum route of the KSCS.

The alignment of the optimum route from the Karian reservoir to the Serpong WTP, the longitudinal profile and cross section of the KSCS are shown in Figures 4.5 to 4.7.

4.3 Preliminary Design of KSCS

The KSCS consists of the main waterway from the Karian reservoir to the Serpong WTP, the Cilawang canal and the Tanjung canal as follows:

Karian-Serpong Conveyance System (KSCS)



Preliminary design of the KSCS was made for such major structures as intake structures in the reservoirs, waterway with a type of concrete rectangular channel or concrete pipeline, river crossing structures, road and railway crossing structures, and cross drains for streams along the proposed route of N-2, taking into account phasing development plan of the KSCS. The location of the major structures is given in Figure 4.8.

4.3.1 Intake structures at the envisaged reservoirs

The KSCS I, Cilawang canal and Tanjung canal is planned to be directly connected with the Karian, Cilawang and Tanjung reservoirs through intake structures in order to take clean water stored in the reservoirs for use of municipal and industrial water supply and to reduce treatment cost at the treatment plant.

The intake for the KSCS I is placed in the Ciuyah tunnel in the Karian reservoir as shown in Figures 4.9 for the design discharge of 12.4 m^3/s. The Ciuyah tunnel consists of inlet portion with a length of 10.0 m, intake shaft with a diameter of 14.5 m and a depth of 45.4 m, tunnel portion with a length of 1,164.8 m and a diameter of 4.0 m and outlet with a length of 5.0 m. The intake shaft was designed to be located in the downstream hill at 110.4 m from the inlet in order to control the discharge from the reservoir to the KSCS I. Dimensions of the intake shaft was determined at an internal diameter of 14.50 m and depth of 45.42 m and a set of sleeve valve and guard valve of 1.40 m in diameter and a set of slide gate and stoplog is to be installed as shown in Figure 4.10.

In the Cilawang reservoir, a steel pipeline with a diameter of 1.20 m and a length of 240 m is aligned along the right guide wall of spillway as shown in Figure 4.11. At the end of the pipeline, a set of guard valve and hollow jet valve with a diameter of 0.90 m is provided to control the discharge. The dimensions of steel pipeline and valve and valve type were determined by comparison of total cost of civil and metal works between a hollow jet valve and a sleeve valve. A stilling basin with a length of 21. 80 m, a width of 3.85 m and a depth of 7.80 m to still the remaining energy of the flow discharged from the hollow jet valve is provided between the valve house and the Cilawang canal as shown in Figure 4.12. A slide gate with a width of 1.00 m and a height of 0.50 m is arranged on the left side wall of the Cilawang canal as a river outlet for release of maintenance flow in the Cibeureum river.

The intake in the Tanjung reservoir is located at the right bank of dam as shown in Figure 4.13. The intake will release the stored water of 9.7 m^3/s between the high water level of 57.5 m and low water level of 50.0 m from the Tanjung reservoir to the Tanjung canal. The intake structure was designed to be equipped with two (2) sets of slide gate with a width of 1.5 m and a height of 2.0 m and one set of stoplogs as shown in Figure 4.14. A stilling basin with a length of 26.0 m and a width of 4.0 m was laid out between the gates and the Tanjung canal.

4.3.2 Waterway

The longitudinal profile of the waterway of KSCS I and II and Tanjung and Cilawang canals was optimized through the cost comparison for several gradient of bed slopes, including construction costs for all the structures such as the Ciuyah tunnel, waterway of KSCS and Cilawang and Tanjung canals, pumping stations at Parungpanjang and Serpong WTP, and operation and maintenance costs.

As a result, the bed slopes of the waterways till the Parungpanjang was determined at 1:5,000 for the KSCS I and II, 1/500 for the Cilawang canal and 1/600 for the Tanjung canal as illustrated in Figure 4.6 and 4.15. Based on the proposed longitudinal, cross sections of the respective waterway was designed as illustrated in Figure 4.16 and 4.17. While, KSCS III including a pump station at Parungpanjang in Figure 4.18 and 4.19. Designed pump up the water of 6.0 m^3/s from the elevation of 37.85 m to 46.0 m through the maximum water level of 60.0 m as show in Figure 4.6. Main features of the waterways are summarized as follows:

Main Features	KSCS I	KSCS II	KSCS III	Tanjung canal	Cilawang canal
1) Length	36.5 km	19.3 km	11.9 km	4.3 km	17.1 km
2) Bed slope	1/5,000	1/5,000	-	1/600	1/500
3) Type of waterway	RC rectangular channel	RC rectangular channel	PC pipe (10.2 km) and steel pipe (1.7 km)	RC rectangular channel	RC rectangular channel
4) Maximum dimension of cross section	(w) 4.85 m (h) 3.05 m	(w) 5.30 m (h) 3.05 m	Ø 2.2 m	(w) 3.00 m (h) 1.95 m	(w) 2.10 m (h) 1.30 m
5) Maximum flow capacity	12.4 m^3/s	13.8 m^3/s	6.0 m^3/s	9.7 m^3/s	4.1 m^3/s
6) Conveyance method	gravity	gravity	pressure flow	gravity	gravity

4.3.3 River crossing structures

River crossing structures are required to cross the rivers of the Cibeureum, Cidurian, Cicinta, Payaheum, Cimatuk, Cibunar, Cimanceuri and Cisadane. Structure type, that is syphon or aqueduct types, were examined based on the following criteria:

a) Syphon type is applied in case that the river water level with a return period of 100 years is higher than the design water level of the KSCS.

b) In case that the river water level with a return period of 100 years is lower than the design water level of KSCS and that difference between the river water level and design water level is larger than free board of 0.6 m, both types are applicable and therefore, a type giving less cost is selected through comparative study on construction cost .

Of the aforesaid rivers, the river crossing structure with syphon type was applied for the rivers of Cibeureum, Cicinta, Payaheum, Cimatuk, Cibunar, and Cimanceuri in accordance with selection criteria (a). While, as for the Cidurian and Cisadane rivers, cost comparison between two (2) types was made and it was concluded that syphon structure for the Cidurian river and the steel pipe aqueduct for the Cisadane river were selected as river crossing structure.

Typical design of syphon and aqueduct structures is illustrated in Figures 4.20 and 4.21.

4.3.4 Railway crossing

Two railway crossing structures are planned at Tenjo in Phases I and Phase II, and at Parungpanjang in Phase II as shown in Figures 4.22 and 4.23.

The railway crossing at Tenjo is proposed to be constructed with special excavation method such as a front-jacking method because it shall be constructed under operation of railway and unfavorable soil condition for the conventional tunnel excavation method to excavate the box culvert of waterway with a height of 2.94 m, a width of 4.85 m and a length of 90.0 m. The railway crossing at Parungpanjang is constructed with an open-cut method by provision of temporary railway.

4.3.5 Road crossing

Box culvert waterway is planned to be provided at locations where the KSCS crosses the existing roads and foot paths. The planned road width are 6 m in standard or more depending on the existing road width, and 3 m for the foot paths. Numbers of the required road crossing structures identified are as follows:

Description	KSCS I	KSCS II	KSCS III	Tanjung canal	Cilawang canal	Total
1) Road	36	17	16	16	4	89
2) Foot path	22	14	8	12	3	59
Total	58	31	24	28	7	148

4.3.6 Cross drain

Cross drains at 92 locations in total will be provided at streams crossing the KSCS. The structure size is determined at a capacity draining out 5-year probable flood peak discharge and its width is designed to be same as that of the existing streams.

The following four (4) kinds of cross drain are planned to be constructed taking into account the design discharge capacity and topography thereat:

Drain Type	Features
Pipe Culvert Type - A	Diameter 0.8 to 1.50 m, horizon type
Pipe Culvert Type - B	Diameter 0.8 to 1.50 m, syphon type
Box Culvert Type	Internal width and height, 2.00 x 2.00 m, 2.50 x 2.50 m
Open Channel Type	Existing stream/river width

Numbers of the required cross drains identified are as follows:

Drain Type	KSCS I	KSCS II	KSCS III	Tanjung canal	Cilawang canal	Total
Pipe Culvert Type -A	22	0	0	3	4	29
Pipe Culvert Type -B	21	0	1	3	3	28
Box Culvert Type	8	0	0	1	0	9
Open Channel Type	12	0	14	0	1	27
Total	63	0	15	7	8	93

Chapter 5
ENVIRONMENTAL IMPACT ANALYSIS

The environmental impact analysis (ANDAL) was undertaken by the JICA study team for the proposed schemes of the Karian, Cilawang and Tanjung dam and reservoir areas and the area along the Karian-Serpong conveyance system and river improvement river stretch of the Ciujung river as shown in Figure 5.1, in accordance with the regulations and guidelines in Indonesia. While, as for the proposed Pasir Kopo dam and reservoir area, the environmentalist of the JICA study team carried out the preliminary investigation work through field reconnaissance and data collection and analysis for them.

Result of the mentioned ANDAL and the preliminary investigation are described as follows:

5.1 Identified Major Environmental Impacts in the Affected Areas

5.1.1 Physical environment

ANDAL investigated on climate, geology, topography, soil characteristics, and hydrological characteristics of water quality and quantity and flooding. Through these investigations, the following problems were identified.

(1) Water quality

Several harmful heavy metals for human health were detected in the Ciujung and Cidurian rivers within the standard in Indonesia for drinking water but the source of heavy metals was not identified. Therefore, water quality in the rivers are recommended to be monitored by periodical sampling of river water as well as riverbed deposit and quality analysis for them for water use for M&I water supply to identify the real source and its future influence.

(2) Flooding

While, the severest flood among the recorded ones for 24 years from 1970 to 1993 occurred in December 1993 in the middle and lower reaches in the Ciujung river basin and lower reach of the Cidurian river basins. Presently, flood damage potential in these areas is being further enlarged by the rapid industrialization and urbanization. For mitigating flood damage and supporting economic development thereat, flood control works are necessary.

5.1.2 Biological environment

According to the result of the field sampling for fauna and flora carried out at twelve (12) sites in the affected areas, no significant natural environment on flora was identified in the affected area, comparing to the endangered species specified by the Indonesian government and other international authorities. While, as for fauna, some species of birds to be endangered were identified through the field survey in the forest area in and around the reservoir areas. The project may reduce a habitat of these birds though the forest area surrounds the reservoirs and the forest area to be inundated is planned to be compensated to adjacent area. Monitoring on these species of birds is proposed in order to confirm a habitat of the birds, to forecast the degree of impact for them and to identify the countermeasures if required.

5.1.3 Socio-economic environment

Of all the components of the project, land acquisition/compensation and resettlement of local residents to be affected by the project is the most important issue dominating the project feasibility.

(1) Population in the areas affected

The identified Kampongs, households, population to be affected by the implementation of the projects are as follows:

Project Components	Scenario A				Scenario C			
	Area (ha)	Kam-pong	House-hold	Popu-lation	Area (ha)	Kam-pong	House-hold	Popu-lation
Karian	1,740	26	2,055	12,124	1,740	26	2,055	12,124
Cilawang	1,056	16	639	3,706	1,056	16	639	3,706
Tanjung	-	-	-	-	2,487	28	2,469	15,060
Pasir Kopo	640	11	846	3,810	920	18	1,781	8,020
KSCS	260	16	117	632	260	16	117	632
River Improvt.	71	16	98	578	71	16	98	578
Total	3,767	85	3,755	20,850	6,534	120	7,159	40,120

Relocation of the households and population to be required for the implementation of the proposed schemes was estimated at 3,755 and 20,850 in the scenario A and 7,159 and 40,120 in the scenario C, respectively.

(2) Land use

Areas planned to be acquired by the construction of the envisaged dam, KSCS and river improvement schemes have been developed as agricultural land, plantation area for coconut and palm oil trees, and housing area and its ownership is categorized into; 1) plantation area of PTP11 (the Estate Company of the Department of Agriculture); 2) forest area of Perum Perhutani (the General Company of National Forest, the Department of Forestry); 3) private land, mainly rice fields and individually owned former estate as termed "Nucleous Estate of Small Holders"; and 4) land owned by the local government. The area by land ownership is shown as follows:

(unit : ha)

Project Components	Scenario A					Scenario C				
	Paddy or Palawija	Forest Area	Private Estate	Housing Area	Total	Paddy or Palawija	Area	Private Estate	Housing Area	Total
Karian	1,190	230	90	229	1,739	1,190	230	90	229	1,739
Cilawang	735	-	298	23	1,056	735	-	298	23	1,056
Tanjung	-	-	-	-	-	1,969	-	-	518	2,487
Pasir Kopo	448	32	102	58	640	644	46	147	83	640
KSCS	133	-	-	4	137	133	-	-	4	137
River Improvt.	104	18	-	3	126	104	18	-	3	126
Total	2,610	280	490	317	3,698	4,775	294	535	860	6,185

5.2 Interview Survey for Local Residents in the Affected Areas

Resettlement of the inhabitants from the present location to the resettlement area gives the most significant impact induced by the Project as it involves:

1) defragmentation of the present social tie of the local communities;

2) re-establishing new community in the relocation area(s);

3) rearrangement of the transportation system for moving agricultural and commercial goods necessary for their life style in the resettlement areas; and

4) psychological and financial strain derived from resettlement and adapting themselves in the relocation areas of new community.

Thus, well organized public hearing for about eleven (11) percent of total local residents to be relocated in the reservoir areas and areas along the KSCS and river improvement stretch was carried out by the Study.

Project Components	Households Interviewed	Total Households to be Relocated	Ratio of the Interviewed to Total (%)
Karian	253	2,055	12.3
Cilawang	90	639	14.1
Tanjung	155	2,469	6.3
Pasir Kopo	183	1,781	10.3
KSCS	103	117	88.0
River Improvt.	24	98	24.6
Total	808	7,159	

(unit : %)

Project Components	Agreed	Not Agreed	No Answer
Karian	90.9	7.9	1.2
Cilawang	88.9	6.7	4.4
Tanjung	80.6	18.7	0.6
Pasir Kopo	89.1	6.6	4.4
KSCS	95.1	2.9	1.9
River Improvt.	87.8	7.1	5.1

As indicated in the above table, the local residents of more than 80 % among those interviewed agreed to their resettlement. Also, it was identified that the local residents who did not agree to their resettlement are anxious about their life when they move to other places, and therefore they could not agree to it. From this point of view, the resettlement plan detailed and acceptable for these local residents is necessary to obtain their consent for resettlement.

Also, the question, which asked the preferable location of resettlement area, was made to local residents and their replies were as follows:

(unit : %)

Project Components	Near-by Village	Within Kecamatan	Within Kabupaten	Within Java	Trans-migration	No Answer
Karian	65.2	22.9	1.6	0.0	0.0	10.3
Cilawang	96.7	2.2	1.1	0.0	0.0	0.0
Tanjung	76.8	10.3	5.2	0.0	0.0	7.7
Pasir Kopo	70.0	0.0	20.0	7.5	2.5	0.0
KSCS	94.2	0.0	0.0	0.0	0.0	5.8
River Improvt.	94.9	0.0	0.0	0.0	0.0	5.1

Most of the residents issued the agreement on the relocation on the assumption to move to adjacent places within kecamatan or kabupaten. This question identified that they do not move to other islands by the transmigration program.

(2) Relocation by the Government resettlement program or to other places

Preferable relocation areas for the local residents were investigated as follows:

(unit : %)

Project Components	Relative's Place	Friends' Land	Own Land	Finding-out Other Land by Oneself	Sub-total	No Answer
Karian	9.1	2.4	6.3	5.5	23.3	76.7
Cilawang	0.0	0.0	0.0	0.0	0.0	100.0
Tanjung	3.9	0.0	7.7	0.0	11.6	88.4
Pasir Kopo	2.5	0.0	53.4	18.4	74.3	25.7
KSCS	2.9	1.9	0.0	0.0	4.8	95.1
River Improvt.	4.1	2.0	0.0	0.0	6.1	93.9

As indicated in the above table, the residents more than 70 % has no idea on preferable relocation area and others wish to move to adjacent places owned by their relative or friends lands after receiving monetary compensation for their own lands. The resettlement area is required to be prepared by the Government for the former residents.

(3) Preferable jobs for local residents after relocation

Large part of local residents replied on the job after relocation that they wish to start new own business or to continue their agricultural activities as shown in the following table. While, it is noted that the several percents of residents living in the Tanjung reservoir area and along the KSCS and river improvement stretch rapidly industrialized in Tangerang and Serang respectively, wish to be factory worker after relocation.

(unit : %)

Project Components	Farmer	Fisher-man	Rearing Livestock	Factory Worker	Starting Own Business	Govt. Job	Office Worker	Others
Karian	8.3	2.0	0.0	0.0	12.6	2.4	0.0	74.7
Cilawang	20.0	0.0	0.0	0.0	13.3	2.2	0.0	64.4
Tanjung	10.3	0.0	0.6	3.9	11.6	1.3	3.2	69.0
Pasir Kopo	11.8	0.0	0.0	0.0	64.7	0.0	0.0	23.5
KSCS	66.0	0.0	0.0	5.8	26.2	0.0	0.0	1.9
River Improvt.	74.5	1.0	2.0	7.1	9.2	0.0	0.0	6.1

5.3 Preliminary Resettlement Plan

5.3.1 Potential resettlement areas for local residents in the reservoir areas

According to the result of the interview survey, a large part of the local residents in the affected areas agreed on their resettlement on the assumption to move to adjacent places. From the survey result, potential areas for resettlement for the dam schemes are identified at the government forest or private estates neighboring the affected area shown in Figures 5.2 to 5.4 and the available areas for resettlement is summarized as follows:

(unit : ha)

Project Components	Settlement Area to be Affected	Agricultural Land to be Affected	Total	Available Area in Adjacent Area	Present Land Use of Potential Area
Karian	229	1,190	1,419	1,550	Estate
Cilawang	23	735	758	570	ditto
Tanjung	518	1,969	2,487	6,639	ditto
Pasir Kopo	83	644	727	4,100	ditto
KSCS	4	133	137	-	-
River Improvt.		104	107	-	-

As indicated in the above table, the potential area for the Karian and Pasir Kopo are sufficient for the required land in terms of land productivity and area. But, as for Cilawang and Tanjung dam schemes, the potential areas located in the mountainous area with high altitude and steep slopes were identified through the reconnaissance survey and therefore, it is judged not to be suitable for compensation area for agricultural land though it is possible to build houses by providing land preparation.

While, since resettlement operation for the local residents on the alignment of KSCS and proposed dyke and short-cut channel of the river improvement works will not be a large scale and there is no area available in Kab. Tangerang and Serang for mass relocation of the local residents, individual arrangement for relocation is necessary. It is therefore considered that there will be essentially no significant social problems caused to any of the local resident subject to relocation or to those of the surrounding areas. It is the local residents' intention that, provided the amount of compensation for individual family is assessed properly in terms of monetary value and sufficient to restore their original life style, there will be no essential problem on the resettlement arrangement.

5.3.2 Basic principles for land acquisition and compensation

Based on result of the interview survey and identification of potential resettlement area for the project components, the basic principles for land acquisition and compensation was established as follows:

(1) Residents' houses and housing plots

Interview survey identified that the residents wish to move to the adjacent places from the present ones. Therefore, resettlement of local residents should be made by provision of resettlement area in the adjacent area, excluding the residents who intend to relocate their houses by their own choice after receiving monetary compensation.

(2) Land compensation

Land compensation for acquisition of the residents' land should be made by provision of land for agriculture and other current purposes in resettlement area to be prepared by the GOI for the residents to be affected by Karian and Pasir Kopo dam schemes. While, monetary compensation is applied for other proposed schemes.

It, however, is noted that the currently applied resettlement concept of "land for land" is not applicable to the Cilawang and Tanjung dam schemes. But, the area near the Tanjung reservoir area has been rapidly urbanized and industrialized. Taking into account the implementation period of these dam schemes after the year 2006, there is a high possibility that life style, living standard and income level of the local residents will be largely changed from the present situation at the implementation stage and that this socio-economic change may need other resettlement concept in future.

5.3.3 Estimate of land acquisition and compensation costs

Land acquisition and compensation costs were estimated by dividing into two (2) categories; 1) monetary compensation; and 2) land preparation of resettlement area. In estimating these costs, price data on land and house were collected from the regional government (PEMDA) and regional development agency (BAPPEDA) in Serang, Tangerang, Bogor and Lebak.

Land acquisition and compensation costs were estimated based on the following criteria:

a) Houses, housing plots and agricultural lands of the local residents, who wish to move out to their own lands, relative land or other places by their own choice, will be compensated by monetary value.

b) House compensation for the residents to the resettlement area to be prepared by GOI is made by monetary compensation. Resettlers will build their houses in the resettlement area by themselves in accordance with their life standard and style, or move out to other places.

c) Housing plot of resettlers to the resettlement area will be compensated by provision of land in the resettlement area.

d) Required infra-structures for water supply, transportation and electric supply and public facilities such as administration office, education facility, mosque, clinic, park and market place will be provided in the resettlement area taking into account the number of resettlers.

e) Forest area in the affected area will be compensated by provision of new forest area in accordance with the latest regulation published by the Ministry of Forest in 1994, but its identification of new area requires the coordination with the related agencies. In the current study, the required cost was estimated as the monetary values without identifying any specific area.

The estimated land acquisition costs based on the mentioned criteria are given in Table 5.1.

5.4 Environmental Monitoring and Management Plan

Prediction of impacts in connection with the implementation of the projects and their overall evaluation in view of the magnitude and duration was conducted through the environmental impacts analysis (ANDAL). When adverse impacts are predicted, mitigation measures or control methods are also studied as definitely as possible in the AMDAL. Besides, unexpected environmental problems may occur during and after implementation of the projects. In this sense, it is very important to monitor and thereby manage the effectiveness and efficiency of the proposed mitigation measures and control methods. Thus, the Environmental Management and Monitoring Plan (EMMP) is required to cope with these matters.

5.4.1 Environmental items for EMMP

The resettlement of local inhabitants to be relocated is assessed to be the most significant impact dominating the viability of the proposed schemes. This might presumably cause some crucial problems to the displaced people from both the socio-economical and socio-cultural aspects unless the well-considered and attractive resettlement and land compensation plan is prepared for a successful implementation and control of the project. Therefore, the resettlement and land compensation plan will have to be formulated focusing on the mitigation and control of the impact. Thus, this program should be managed and monitored by an integrated organization since the institutional support by many governmental agencies is required for minimizing them.

The following items are to be managed and monitored:

(1) Items to be managed

a) Involvement and cooperation of the displaced people to the resettlement plan,
b) Dissemination of necessary and correct information to the displaced people on timely occasions,
c) Consultation with the displaced people,
d) Payment of compensation amount to the displaced people,
e) Full supporting to the displaced people for settling down to self-sustainable level in the resettlement sites, and
f) Coordination of necessary arrangement between related agencies and the displaced people.

(2) Items to be monitored

a) Actual progress of the resettlement and land compensation plan,
b) Socio-economic and socio-cultural conditions in the affected areas and of the local residents to be relocated, and
c) Requirements of the displaced people related to the resettlement, and
d) Other matters related to environment such as water quality and fauna.

The information obtained through monitoring should be used for the purpose of evaluating the actual performance of the plan. It will also be the basis of modifying the resettlement plan for the following schemes to be implemented.

5.4.2 Organizational set-up for EMMP

In order to successfully implement the proposed schemes and carry out resettlement and compensation during time horizon till 2025, establishment of an organization under the executing body is of the paramount importance and required in order to; 1) monitor socio-economic changes and resettlers' requirement in the affected areas continuously; 2) establish the resettlement concept which should be realistic and satisfy resettlers' requirements and socio-economic situation; and 3) carry out resettlement of local residents effectively well in advance of commencement of the respective stage development works.

An organization consisting of appropriate members from the DGWRD, the Local Government and National Land Affairs, and other related agencies shall actually execute the resettlement and land compensation for the projects. A new unit for EMMP should be established in the Project Office at Pandeglang provided by DGWRD. This unit shall handle environmental issues during and after the implementation of the proposed schemes as well as overall management of EMMP for resettlement and land compensation plan under the guidance of the EMMU.

Since the activities of an organization for EMMP may include institutional matters, authorized right or power should be given to this unit for not only effective execution of expected activities but also appropriate collaboration with concerned agencies. The professional staff and assistant staff together with equipment as many as required should also be mobilized.

Chapter 6

PROJECT ORGANIZATION AND MANAGEMENT

6.1 Required Activities for Project Planning, Implementation and Operation and Management

The projects proposed by the current study are; 1) the Karian, Pasir Kopo, Cilawang and Tanjung dam schemes; 2) the Karian-Serpong conveyance system; and 3) the river improvement works along the middle reach of the Ciujung river. These components are proposed to be implemented for significantly long-term period of 30 years in accordance with the increase of water demands in various water sectors. For this long period, the following works are required for successful execution of project planning, implementation and the operation and maintenance works for the phasing development of the water resources in the Ciujung and Cidurian river basins:

(1) Project planning

- preparation of policy and guideline for water resources development,
- modeling and planning of surface water resources development,
- water demand projection,
- establishment of water resources development plan,
- establishment of drought management plan, and
- establishment of environmental monitoring and management plan including resettlement and compensation plan.

(2) Project implementation

- financial arrangement,
- execution of resettlement and compensation plan
- implementation of construction works
- environmental monitoring and management works

(3) Operation and maintenance

- operation and maintenance of facilities to be constructed,
- environmental monitoring and management works,
- drought management, and
- flood disaster preparedness and flood fighting.

Among the necessary works, planning and execution of environmental monitoring and management are identified to be significantly important for the successful execution of the proposed projects taking into account the relocation of local residents reaching about

40,000 persons to be required for implementation of all the proposed schemes. From this point of view, the following is necessary in the works:

(4) Environmental monitoring and management

a) monitoring and management of all the environmental aspects related to the proposed schemes,

b) coordination of institutional matters related to environmental monitoring and management,

c) supervision of the actual resettlement and land compensation,

d) evaluation of the actual performance of resettlement and land compensation,

e) monitoring of change of requirement of resettlers, and

f) establishment of appropriate concept and manner for resettlement.

6.2 Project Organization

Presently, the DGWRD of Ministry of Public Works has organized Directorates of Planning & Programming, Technical Guidance, Water Resources Management and Conservation, Central Region Implementation for the planning and implementation of the project. While, the Environmental Commission provided in the Ministry of Public Works is responsible agency for the environmental matters. Then, the Provincial Government is responsible for the resettlement of local residents and operation and maintenance under cooperation of the DGWRD.

While, the concerned agencies related to the proposed schemes are water supply agencies of PDAM in Tangerang and Serang and PAM Jaya in DKI Jakarta, Ministries of Agriculture and Fishery, West Java Provincial Government, Ministry of Transportation, Bina Marga, Cipta Karya, Ministry of Environment and Population, and so on, as shown in Figure 6.1.

Taking into account the present organization and paramount importance of the environmental monitoring and management works, establishment of environmental monitoring and management unit (EMMU) is proposed in order to undertake the necessary works successfully. Also, provision of coordination committee for drought management is necessary for decision of water allocation in the operation and maintenance stage of the proposed schemes.

6.2.1 Environmental monitoring and management unit (EMMU)

The EMMU is proposed to be comprised of the environmental unit (EU) under the DGWRD and environmental monitoring and management committee (EMMC) to be organized by the related agencies.

The EU is proposed to be provided with well trained stuff of the DGWRD for dealing with wider environmental problems at the project office in Pandeglang in order to monitor all environmental aspects related to the project and to take necessary coordination and activities with the EMMC whenever required because of the timely and continuously operation of environmental monitoring and management for the proposed schemes to be implemented during time horizon till 2025.

The EMMC will be organized with the stuffs of the DGWRD, West Java Provincial Government, Ministry of Forestry, National Land Affair, Ministry of Environment and Population, Ministry of Agriculture and academic authorities concerned so as to make important decision to be required for the necessary works described in the previous section. Furthermore, resettlement and compensation plan will require the coordination with the regional development plan and rural development program established by the Cipta Karya and the Provincial Government.

6.2.2 Coordination committee for drought management

In operation of the existing Jatiluhur dam, a coordination meeting for decision of the water allocation has been provided between agencies such as Jatiluhur Authority, West Java Irrigation Committee, Jakarta Municipality Administration, and PT. PLN (electric supply company).

The proposed dam schemes and Karian-Serpong conveyance system are planned to be provide raw water for M&I water supply to Serang, Tangerang and DKI Jakarta even in the severe drought with a return period of 10 years, sacrificing the irrigation water requirement under such severe drought situation. Therefore, a coordination committee for water allocation is strongly required in order not to induce conflict on water allocation between water users.

Figure 6.2 show the general procedure for drought management. As shown in the figure, the project office will collect the data on hydrology and water requirement and analyze them for establish the draft water allocation plan and a coordination committee will decide the final water allocation plan for coming dry and wet season. Based on the final water allocation plan, the proposed schemes will be operated and when it is necessary to adjust or revise the water allocation plan, the project office will organize a coordination committee and prepare the revised water allocation plan through discussion in a committee.

Chapter 7 PROJECT COST

7.1 Main Feature of the Proposed Schemes

The Study proposes the development of the four (4) dam schemes, that is the Karian, Pasir Kopo, Cilawang and Tanjung dam schemes, and the Karian-Serpong conveyance system in order mainly to supply the municipal and industrial water to Serang, Tangerang and DKI Jakarta.

While, the river improvement works along the middle reach of the Ciujung river was proposed by the feasibility study on the Karian multi-purpose dam construction project, 1985. Unfortunately, the proposed river improvement works has not been implemented and in 1993, the largest flood for the past 24 years occurred and caused the severest flood damages along not only the middle reach but also the lower reach, though the flood dyke with a capacity of 1,100 m^3/s were provided there. In consideration that the area with severe flooding problems are being developed as settlement and industrial areas in the recent years, river improvement works are proposed to be implemented as an urgent works in this project.

The main features of the proposed dams and reservoirs, the Karian-Serpong conveyance system and the river improvement works are summarized as follows:

Main Features	Karian Dam	Pasir Kopo Dam A	Pasir Kopo Dam C	Cilawang Dam	Tanjung
I. Dam scheme					
1) Catchment area (km^2)	288	172	172	93	280
2) Dam type	Rockfill	Rockfill	Rockfill	Rockfill	Rockfill
3) Dam crest level (EL. m)	72.5	97.0	106.5	81.0	60.5
4) Flood high water level (EL.m)	69.9	94.2	103.7	78.5	59.5
5) Normal high water level	67.5	90.5	100.5	75.6	56.5
6) Low water level	46.0	80.0	80.0	66.5	50.0
7) Dam height (m)	60.5	52.0	61.5	36.0	35.5
8) Reservoir area (ha)	1,740	640	920	1,056	2,487
9) Effective storage volume (mil. m^3)	219.0	44.5	112.6	62.0	120.0
10) Embankment volume of main dam (mil. m^3)	1.23	0.42	0.70	0.42	8.39
11) Design flood discharge (PMF)					
a) Inflow	3,400	3,300	3,300	1,700	3,098
b) Outflow	2,670	1,760	1,430	1,230	727
12) Spillway gate					
a) Type	Radial gate	overflow type	overflow type	Radial gate	overflow type
b) Nos.	2			2	
c) Height	12.5			9.5	
d) Width	12.5			9.0	
13) Side overflow spillway weir (m)	50.0	125.0	125.0	20.0	-
14) Flood control volume against 10-year probable flood (mil. m^3)	33.5	-	-	-	-

Main Features	Description
II. Karian-Serpong conveyance system	
1) Length (km)	
a) KSCS I	36.5
b) KSCS II	19.3
c) KSCS III	11.9
d) Cilawang canal	17.1
e) Tanjung canal	4.3
2) Type of conveyance	
a) KSCS I&II and Cilawang & Tanjung Canal	gravity conveyance
b) KSCS III	pumping-up and pipeline
3) Maximum flow capacities (m^3/s)	
a) KSCS I	12.4
b) KSCS II	13.8
c) KSCS III	6.0
d) Cilawang canal	4.1
e) Tanjung canal	9.7
III. River improvement works	
1) River length to be improved (km)	18.20
2) Improvement method	Provision of river dredging, short-cut channel (4 km) and flood dyke
3) Design discharge	
a) Design scale	10-year probable flood discharge
b) Design discharge	1,100 m^3/s with retardation of flood peak discharge in the Karian reservoir
4) Earth work volume	
a) Embankment volume (mil. m^3)	0.60
b) Excavation volume (mil. m^3)	1.40
c) Dredging volume (mil. m^3)	0.67

7.2 Work Quantities of the Projects

The work quantities for the projects are given as follows:

(unit : million m^3)

Projects		Earth Work		Concrete Work
		Excavation	Embankment	
Phase I	: Karian dam	0.26	1.23	0.02
	KSCS I	3.42	1.34	0.16
	River improvement works	2.07	0.60	-
	Total	5.75	3.17	0.18
Phase IIA	: Pasir Kopo dam	0.48	0.50	0.09
	Cilawang dam	0.18	0.40	0.04
	KSCS II&III and Cilawang canal	0.94	0.15	0.12
	Total	1.60	1.05	0.25
Phase IIC	: Pasir Kopo dam	0.55	0.80	0.09
	Tanjung dam	0.58	8.00	0.04
	KSCS II & III and Tanjung canal	1.01	0.25	0.11
	Cilawang dam	0.18	0.40	0.04
	Cilawang canal	0.44	0.11	0.05
	Total	2.76	9.56	0.33

Note : Symbol of "-" means minor work of the project.

Among the dam schemes in the mentioned table, the work quantities for the Karian, Tanjung and Cilawang dam and river improvement works are based on those estimated by the preliminary design of the previous studies as shown in Figures 7.1 to 7.8. While, those for the Pasir Kopo dam was estimated by the preliminary design at the master plan level illustrated in Figures 7.9 to 7.12 and for KSCS at the feasibility study level.

7.3 Implementation Schedule

The aforesaid four (4) dam schemes, the Karian-Serpong conveyance system and the river improvement works are proposed to be implemented by applying phasing development taking into account the urgency of the schemes and trend of increasing municipal and industrial water demand. The proposed implementation schedule are given as follows:

Projects		Period	Duration (years)
Phase I :	Karian dam, KSCS I and River improvement works	1995 to 2002	7 (4)
Phase IIA :	Pasir Kopo dam	2008 to 2015	7 (4)
	Cilawang dam	2008 to 2015	7 (4)
	KSCS II&III and Cilawang canal	2009 to 2015	6 (3)
Phase IIC :	Pasir Kopo dam	2004 to 2011	7 (4)
	Tanjung dam, KSCS II & III and Tanjung canal	2005 to 2014	9 (6)
	Cilawang dam and Cilawang canal	2011 to 2018	7 (4)

Note : Implementation period in the mentioned table were decided taking into account 2 years for detailed design, 1 year for financial arrangement and land acquisition, and construction period in parenthesis in the table.

7.4 Project Cost

7.4.1 Conditions for cost estimate

The construction cost was estimated under the following assumptions and conditions:

(1) Unit prices of material, labor and equipment which constitute unit cost of the civil works are based on a price level in August, 1994.

(2) The exchange rates of foreign currencies are Yen 1.00 to Rp. 21.77 and US dollar $ 1.00 to Rp. 2,177 as of August, 1994.

(3) The estimated unit costs are composed of foreign and local currency portions and both portions are expressed in Rupiah currency.

(4) Land acquisition and compensation cost was made by monetary compensation and preparation of resettlement area.

(5) Engineering services will cover the detailed design and whole construction period. The rates of engineering services to the total construction cost was assumed at 14 % for foreign currency portion and 9 % for local currency portion.

(6) The Government administration cost was set at 5.0 % of the total construction cost.

(7) Value added tax (PPN) as the governmental tax was estimated at 10 % of the total construction cost and engineering service cost.

(8) Physical contingency was provided to cope with the unforeseen physical condition and assumed to be 10 % for each foreign and local currency portion of a sum of total construction cost and costs in items 4 to 7.

(9) Price escalation rate was assumed to be 3 % per annum for foreign currency portion and 8 % per annum for local currency portion till the completion of the first phase development in 2002 and afterwards, a rate of zero was applied for both portions taking into account the uncertainty of escalation rate in future.

(10) The interest during construction was estimated for the a sum of total construction cost and costs in items 4 to 7 in the foreign currency portion assuming the interest rate of 2.6 % per annum which corresponds to the latest rate of Overseas Economic Cooperation Fund (OECF) .

(11) Operation and maintenance cost was estimated at 1 % for cost for civil works and 0.5 % of metal works for the respective project.

7.4.2 Project cost and disbursement schedule

The financial cost for the proposed schemes was estimated as given in Tables 7.1 based on the assumptions in section 7.4.1 and summarized as follows:

(unit : million Rp.)

	Projects	Foreign Currency	Local Currency	Amount
Phase I	: Karian dam and Ciuyah tunnel, KSCS I, River improvement works			
	a) Construction cost including preparatory works	253,074	131,034	384,108
	b) Engineering service	35,430	11,793	47,223
	c) Government administration	0	19,205	19,205
	d) Land acquisition and compensation cost	0	66,906	66,906
	e) Tax	0	43,133	43,133
	Sub-total	288,504	272,072	560,576
	f) Physical contingency	30,014	28,342	58,356
	g) Price escalation	51,173	126,982	178,156
	Sub-total	81,187	155,324	236,511
	h) Interest during construction	33,162	0	33,162
	Total	402,853	427,396	830,249

(unit : million Rp.)

	Projects	Foreign Currency	Local Currency	Amount
Phase IIA	: Pasir Kopo dam, Cilawang dam, KSCS II&III and Cilawang canal			
	a) Construction cost including preparatory works	257,820	112,546	370,366
	b) Engineering service	36,095	10,129	46,224
	c) Government administration	0	18,518	
	d) Land acquisition and compensation cost	0	46,634	46,634
	e) Tax	0	41,659	41,659
	Sub-total	293,915	229,486	523,401
	f) Physical contingency	29,391	22,949	52,340
	g) Price escalation	78,408	195,277	273,685
	Sub-total	107,799	218,226	326,025
	h) Interest during construction	32,804	0	32,804
	Total	434,518	447,712	882,230
Phase IIC	: Pasir Kopo dam, Tanjung dam, KSCS II & III and Tanjung canal, Cilawang dam and Cilawang canal			
	a) Construction cost including preparatory works	587,654	248,544	836,198
	b) Engineering service	82,272	28,484	110,755
	c) Government administration	0	41,810	41,810
	d) Land acquisition and compensation cost	0	149,734	149,734
	e) Tax	0	94,695	94,695
	Sub-total	669,926	563,267	1,233,192
	f) Physical contingency	66,993	56,327	123,319
	g) Price escalation	175,903	472,540	648,443
	Sub-total	242,896	528,867	771,763
	h) Interest during construction	91,481	0	91,481
	Total	1,004,302	1,092,134	2,096,436

As indicated in the above table, total amount of required fund reaches Rp. 1,712 billion in the scenario A or Rp. 2,927 billion in the scenario C for implementation of all the proposed schemes during the time horizon of 30 years till the year 2025. The disbursement schedule of the proposed schemes are given in Tables 7.2 to 7.8

Chapter 8 ECONOMIC EVALUATION

8.1 Economic Analysis

The proposed schemes are planned; 1) to supply the municipal and industrial water to Serang, Tangerang and DKI Jakarta; and 2) to maintain the irrigation water requirement in the existing schemes; and 3) mitigate flood damages along the middle reach of the Ciujung river.

Economic evaluation of the proposed schemes based on economic benefit and cost was made for assessing their economic viability. Economic benefit of the proposed schemes evaluated to be derived from water supply to the aforesaid areas and flood mitigation effect in the area along the river improvement stretches.

As for irrigation benefit, the JWRMS and also the Study expected the increase of cropping intensity by planting palawija and/or vegetables in order to meet the increase of vegetable requirement in the urban areas in Jabotabek and north Banten areas and to save water especially during dry and/or wet seasons. Therefore, the water requirement for the existing irrigation areas was allocated in the Study, incorporating increased cropping intensity under the supply criteria in which the irrigation water requirement is satisfied in droughts with return periods of less than 5 years but restricted in severer droughts.

While, in the current economic evaluation, the incremental benefit due to increase of cropping intensity was not included in the benefit of the proposed schemes since the agricultural diversification from paddy to palawija and/or vegetables is still an idea or expectation and needs the definitive agricultural development plan in the areas.

On one hand, the economic cost differs from the financial cost described in the previous chapter in the sense of value judgment since the former is valued at real resource cost and the later is resource cost at market prices. Thus, in order to estimate the economic costs of the proposed schemes, financial costs were converted by using adjustment factors.

As the method of economic evaluation, economic internal rate of return (EIRR) is utilized as a tool of assessing economic viability.

8.1.1 Conditions for estimate of economic cost and benefit

In estimating the economic cost and benefit., the economic values are estimated applying the following conditions and assumptions:

a) The economic life of the project is taken as 50 years after commencement of the proposed schemes.

b) The price level for cost and benefit is set at the end of August, 1994.

c) The foreign exchange rates of currencies is set at Rp. 21.77 to Yen 1.00 and Rp. 2,177 to US dollar $ 1.00, as of August, 1994.

d) As for transfer payment such as tax and duty, it is assumed that goods and services procured locally and those imported from abroad would include the transfer payment of 10 % of their market prices and that those would exclude any transfer payment.

e) Economic prices of unskilled labor hired locally are assumed to be 75 % of the actual market wages in consideration of the social conditions of (a) the unemployment situation in Indonesia in recent years and (b) social charge included in the wage, which consists of social security and fringe benefit and which accounts for almost 75 % of the total wage payment.

f) Regarding compensation, the following matters to be sacrificed are considered as economic cost from the economic point of view: (a) in the case of farm land, annual production value of paddy is taken as negative benefit and (b) in the case of residences and industrial facilities to be expropriated, prices to be newly built are applied as economic compensation costs.

8.1.2 Economic cost

The financial construction costs consist of the following items:

a) construction cost,
b) land acquisition and compensation cost,
c) government administration cost,
d) engineering service cost,
e) physical contingency,
f) price contingency, and
g) interest during construction period.

Among these costs, price contingency and interest during construction were excluded in the economic construction costs. Other costs were converted into the economic costs by applying the adjustment factors assuming shadow wage rate of 75 % against the actual market wage for labour force and shadow price of equipment and material of 0.97 for local portion and 1.00 for foreign portion.

After going through this conversion procedure on the basis of the financial costs, the total economic capital cost is estimated as follows:

(million Rp.)

Phase	Construction scheme	Cost	Total cost
1st Phase	Karian dam	247,649	
	Ciuyah tunnel	21,543	
	River improvement	44,359	
	KSCS I	224,573	538,124
2nd Phase (Scenario C)	Pasir Kopo dam	152,731	
	Tanjung dam	612,754	
	Cilawang dam	111,755	
	KSCS IIC-a	241,949	
	KSCS IIC-b	67,197	1,186,386
2nd Phase (Scenario A)	Pasir Kopo dam	121,730	-
	Cilawang dam	111,755	-
	KSCS IIA	267,090	500,575

The operation and maintenance (O&M) cost is annually required during the economic life of the project after completion of the project. The O&M cost is also given by making adjustment to economic prices. The O&M cost is estimated as given in the following table, which is assumed to be equivalent to 1.0 % to costs for civil works and 0.5% for metal works.

(million Rp.)

Phase	Economic O/M cost
1st Phase	3,184
2nd Phase (Scenario C)	6,799
2nd Phase (Scenario A)	3,504

While, the economic project life is assumed to be 50 years, some of facilities have shorter life than the civil works. Then, they are assumed to be 25 years for such mechanical equipment as pumps and gates taking into account the existing facilities in the study area. The replacement cost is considered to be 90% for investment value at the end of economic life, taking account of its salvage value of 10%. The economic value of replacement cost is estimated as follows:

(million Rp.)

Phase	Economic Replacement Cost
2nd Phase (Scenario C)	51,208
2nd Phase (Scenario A)	51,278

8.1.3 Economic benefit

(1) Municipal and industrial water supply

Benefit from the municipal and industrial (M&I) water supply was estimated based on the current tariff of the PDAM in Tangerang and Serang and PAM Jaya in DKI Jakarta. The average of the current tariff for non-trading, trading and industrial sectors and public facilities are summarized as follows:

Water Users	Water Tariff (Rp.)	Share Rate (%) in DKI Jakarta in 1992
Non-trading		
House connection	744	40.9
Government institute	1,125	15.5
Trading	2,339	32.3
Industry	2,218	5.4
Public facilities	432	5.9
Weighted Average	1,013	100.0

As indicated in the table, a weighted average of the water tariff for each water users were estimated taking into account the rate of water amount utilized in the sectors in DKI Jakarta. Then, benefit was estimated by excluding the cost for water treatment from the above mentioned weighted mean of Rp. 1,013 since the proposed schemes are planned to be provide raw water for M&I water supply. The estimated water treatment cost is assumed as 40 % of the mentioned tariff based on the result of cost analysis made by JWRMS and value of Rp. 608 per m^3 as of 1994 was judged to be unit raw water benefit per m^3 for M&I water supply in the economic analysis. The mentioned unit benefit was estimated year by year assuming that share rates for water demand of water users will change proportionally year by year.

Annual benefit for the M&I water supply was estimated by multiplying the mentioned unit benefit with the water demands year by year.

(2) Flood mitigation effect

The Ciujung river has a catchment area of 1,850 km^2 at its outfall. It splits into three main tributaries as Upper Ciujung, Ciberang and Cisimeut rivers at Rangkasbitung. Those catchment area comes to 1,383 km^2 or about 75 % of the whole Ciujung river.

In rainy season, the flood flow from those three tributaries coincidentally joins at Rangkasbitung, so that the area in and around of Rangkasbitung and the downstream reaches are frequently inundated by floods and have suffered serious damages.

The Feasibility Study on Karian Multipurpose Dam Construction Project made by JICA, 1985, reported occurrence of the large scale floods in 1981 and 1983. During the current study, a largest flood occurred in December, 1993 and caused the severest flood damage in the middle and lower reaches of the Ciujung river though flood dyke with a discharge capacity of 1,100 m^3/s is provided in the lower reach. The inundated areas caused by these floods were 1,250 ha in 1981, 505 ha in 1983 and 5,563 ha in the area along the middle reach of the Ciujung river. The following table shows the damages caused by these floods:

Damage Items	Flood Damage (million Rp.)		
	1981	1983	1993
a) Houses and buildings, household effects, stored goods	9,016	2,688	57,111
b) Other damages such as crops, suspension of business activities and public facilities	8,912	2,709	15,896
Total	17,928	5,397	73,007

The mentioned floods were estimated to correspond to the probable flood with the return period of 5 years, 2 years and 25 years, respectively. Based on the probability and damages, the annual mean mitigable flood damages for the current river improvement plan against 10-year probable flood was estimated at Rp.7,830 million at the price level in 1994.

8.1.4 Economic evaluation

Based on the cost stream which is distributed in line with the construction schedule and the benefit stream where the annual benefit is generated after completion of the proposed project, EIRR is derived for the proposed schemes as the first phase development consisting of the Karian dam scheme, a part of Karian-Serpong conveyance system (KSCS) and river improvement works in the Ciujung river, and first and second phases comprising of the Pasir Kopo, Cilawang and/or Tanjung dam schemes and other portions of KSCS connecting dams with Serpong water treatment plant. Result is summarized as follows:

(Unit : %)

Works	First Phase Development		Entire Works (1st + 2nd)	
	Scenario A	Scenario C	Scenario A	Scenario C
Water Supply	16.1	20.2	21.7	24.2
River Improvement		13.4		
Water supply + River Improvement	16.0	19.8	21.3	23.7

The EIRR for the entire woks of the proposed schemes indicates the high economic viability as 21.7 % to 24.6 % and that for the first phase development planned to meet the M&I water demand till 2010 in the scenario C and 2015 in the scenario A is worked out at 16.5 % in the scenario A and 20.7 % in the scenario C. While, EIRR for the river improvement works is derived at 13.4 %.

8.2 Financial Analysis

The raw water prices based on the financial cost are evaluated as follows in the condition of discount rate of 9 % for the project life applied in the study of JWRMS:

(Rp. per m^3)

Works	Scenario A	Scenario C
1st Phase	360	267
Entire works (1st + 2nd)	265	283

As indicated above, the raw water prices will be lower than the current tariff of Rp. 608. From this result, it may be said that the proposed schemes is financially viable to water plant authorities because they can get raw water with low price.

8.3 Sensitivity Analysis

In addition to the above-mentioned economic analysis, the sensitivity analysis was made under the following conditions:

(1) The first phase development is proposed to be completed by applying accelerated implementation schedule from fiscal year 1995/1996 to 2001/2002 taking into account urgency of the project works. While, there is a possibility to delay the completion of the construction works including tendering. Therefore, sensitivity analysis assumed that completion of the construction works delays one year from the schedule.

(2) The Study estimated the cost for interest during construction, applying a interest rate of 2.6 % of the Overseas Economic Cooperation Fund (OECF). While, an interest rate of other international funds such as the World Bank and Asian Development Bank is around 6 % to 8 % for Indonesia. The higher rate of 8 % was applied for sensitivity analysis.

The longer construction period of the first phase development will adversely affect the EIRR and unit raw water price because of higher construction cost and delay of obtaining benefit. While, the interest during construction period is a component for the financial construction cost but not for the economic cost and will raise the unit raw water cost.

The estimated EIRR and unit raw water prices are as follows:

Works	EIRR (%)		Unit Raw Water Price (RP./m^3)	
	Scenario A	Scenario C	Scenario A	Scenario C
First Phase Development				
• Water Supply	16.0	20.1	379	284
• Water Supply + River Improvement	15.9	19.6	-	-
Full Development				
• Water Supply	20.9	23.2	286	311
• Water Supply + River Improvement	20.5	22.7	-	-

As indicated in the above table, the proposed schemes indicate the high EIRR even in case of lower benefit induced by the delay of completion of the construction works. Also, the estimated unit raw water prices are lower than Rp. 600 per m^3 of the mentioned raw water price in the current water tariff even in case of the higher construction cost due to the longer construction period and higher interest rate during construction and aforesaid lower benefit.

Chapter 9 PROPOSED ACTION PLAN

9.1 Proposed Action Program

The proposed action plan for the Ciujung-Cidurian integrated water resources development project is illustrated in Figure 9.1, which was prepared based on phasing development plan of the dam schemes and the Karian-Serpong conveyance system established in consideration of the following matters:

(1) advantage on water supply both to Serang and Tangerang by provision of the Karian dam, Ciuyah tunnel and a part of Karian-Serpong conveyance system (KSCS I),

(2) advantage on increase of water supply from the Karian reservoir to Tangerang by replacement of the water supply to Serang by the Pasir Kopo dam schemes, and

(3) water demand and supply balance situation and increasing trend curve of water demand in the scenarios A and C during time horizon till the year 2025.

While, the M&I water demand is predicted to increase shifting the trend curve from the scenario A to scenario C, since the current economic development will be accelerated by the full connection of the existing highway between Jakarta and Merak and provision of a new harbor near Serang city. In such case, the Tanjung dam scheme will be required to be implemented in addition to the dam schemes of the Karian, Pasir Kopo and Cilawang proposed in the scenario A. Assuming that such case will occur after 2015, the introduction of the Tanjung dam will be 2020 in the later case than the scenario C of 2014 in the scenario C' as shown in Figure 9.2.

9.1.1 First step development

The components of the first step development are;

a) Karian multi-purpose dam scheme,

b) KSCS I with the maximum capacity of 12.4 m^3/s including the intake structure and Ciuyah tunnel with length of 1.2 km and concrete type waterway with a length of 36.5 km, and

c) River improvement work for the middle reach of the Ciujung river between Pamarayan weir and Rangkasbitung.

The middle and lower reaches of the Ciujung river are rapidly developed and flood damage potential has been enlarged by industrialization and housing development. In the fact, the flood in 1993 caused large flood damage not only for the middle reach, which is the objective area of river improvement works, but also for the lower reaches. Although a flood control plan was established by the study on the Karian Multi-purpose dam project in 1985 by the the DGWRD, a definitive study is required to review and update the established flood control plan taking into account the present situation of the study area covering the middle and lower reaches and the detailed design is recommended to be carried out based on the result of the definitive study.

9.1.2 Second and third step development

The projected M&I and irrigation water demands are based on the many assumptions. In order to review those and decide the next step development, the updating study for water resources development in the Ciujung and Cidurian river basin is recommended to be made on the basis of performance of the first step development, population census at the year of 2000, data on reduction of the existing irrigation areas, and so on.

This study will propose the necessary scale of the Pasir Kopo dam/reservoir and configuration of the third step development which might be comprised of the other three or less dam schemes and/or provision of additional lane of waterway connecting dam scheme(s) to be developed.

The proposed schemes in the third step development are; the Pasir Kopo dam scheme, Cilawang dam scheme, and/or Tanjung dam schemes, and Phase IIA or IIC in Karian-Serpong conveyance system.

9.2 Recommendations

(1) Through the investigations and analyses made by the Study, it is identified that the first step development consisting of the Karian dam schemes, Karian-Serpong conveyance system (KSCS I) with a length of 36.5 km from the Ciuyah tunnel to the planned Parungpanjang water treatment plant and river improvement works along the Ciujung river has urgency in terms of water demand and supply balance and flooding situation in order to support the current economic development in the study area. It is also revealed that the first step development has high economic viability. Therefore, it is strongly recommended to proceed with necessary procedures for executing these works urgently.

(2) The Karian dam scheme and KSCS I in the first step development are planned to provide raw water for M&I water supply in Serang and Tangerang. In order to supply the treated water to water users in these areas, it is necessary for proceeding the first step development to coordinate with the water supply agencies such Cipta Karya, PDAMs in Tangerang and Serang. Therefore, it is recommended to made necessary coordination system with the related agencies to the M&I water supply.

(3) In order to successfully execute the resettlement of local residents in the affected area by the proposed schemes, it is recommended that the environmental monitoring and management unit (EMMU) consisting of the environmental unit (EU) and environmental monitoring and management committee (EMMC) be established at the project office at Pandeglang under the initiation of the DGWRD.

9.3 Required Engineering Works in the Detailed Design

Basic and Detailed Design

The following works are necessary in the engineering works:

(1) Review of water resources in the Ciujung river basin

In the Ciujung river basin, the severe drought occurred in 1994, of which runoff data was not reflected to the study since the data was under compilation. The water resources in the Ciujung river is needed to be reviewed by adding the runoff data in the river basin.

(2) Review of the proposed route of Karian-Serpong conveyance system

Currently, the area along the Karian-Serpong conveyance system is rapidly developed for housing and industrialization. Updating the data and information on on-going development plans, the proposed route from the outlet of the Ciuyah tunnel to Parungpanjang water treatment plant by the current study have to be reviewed.

(3) Updating the flood control master plan and preparation of definitive plan for detailed design

The flood control master plan in the Ciujung river basin and river improvement plan between the existing Pamarayan weir and Rangkasbitung was established in 1983 and 1985, respectively. While, in the Ciujung river basin, especially in the middle and lower reaches of the river, the current industrialization and housing development is heightening the flood damage potential there in the recent years. Furthermore, the largest flood for the past 24 years occurred and caused the severe flood damage along the middle and lower reaches of the Ciujung river.

Therefore, the above mentioned plans have to be reviewed by updating flood runoff data and socio-economic situation and investigating the existing flood control facilities provided along the lower reach, and definitive flood control plan has to be established through the review studies.

(4) Investigation and studies

a) Detailed geological investigation by core drilling at the dam site, spillway, saddle dams planned at four (4) locations, and quarry site,

b) detailed geological investigation by core drilling at the inlet, intake shaft and outlet of the Ciuyah tunnel,

c) Supplemental geological and geotechnical investigations at the division structure sites at Tenjo and Parungpanjang, and at railway crossing structure near Tenjo,

d) Geotechnical investigation along the river improvement stretch in the middle and lower reach,

e) Construction material survey for dam embankment and concrete aggregate,

e) Photogrammetric mapping for the Karian reservoir, the route of KSCS and the river improvement stretch, topographic survey at the structure sites, and river cross section survey from the river mouth to Rangkasbitung in the Ciujung river,

f) Hydrological study for updating runoff data for evaluation of the water resources in the Ciujung river basin, and

g) Socio-economic study mainly for identification of the present situation of the middle and lower reaches of the Ciujung river, and for economic evaluation of the proposed schemes in the first step development.

(5) Preparation of design criteria and undertaking of basic design for the proposed structures and facilities in the first phase development.

(6) Hydraulic model test for the spillway of the Karian dam

(7) Detailed design for all the proposed structures and facilities

(8) Preparation of inception report, bi-monthly progress report, basic design report, design report including design drawings, implementation program, and technical notes

(9) Preparation of tender documents including pre-qualification documents

(10) Transfer of technical knowledge to counterpart personnel

Environmental Impact Analysis and Resettlement Study

The environmental impact assessment (AMDAL) is necessary to be carried out focusing on the social impacts to be induced by the resettlement of the local residents. Also, the detailed resettlement study is required to be made in order to establish the detailed and acceptable resettlement plan. The following investigation and studies will be covered by the aforesaid AMDAL and resettlement study:

(1) interview survey for all the local residents subject to relocation,

(2) public consultation in order to identify requirements of local residents for resettlement under their sufficient recognition for necessity of the Project and agreement with the implementation of the Project to be discussed,

(3) examination of appropriate manner for resettlement and compensation,

(4) survey on suitability of the potential resettlement area for the Karian dam scheme and prepare frame work plan of resettlement area,

(5) identification of problems after resettlement and necessary countermeasure therefor,

(6) preparation of resettlement and compensation plan, and

(7) institutional study by environmental monitoring and management unit (EMMU).