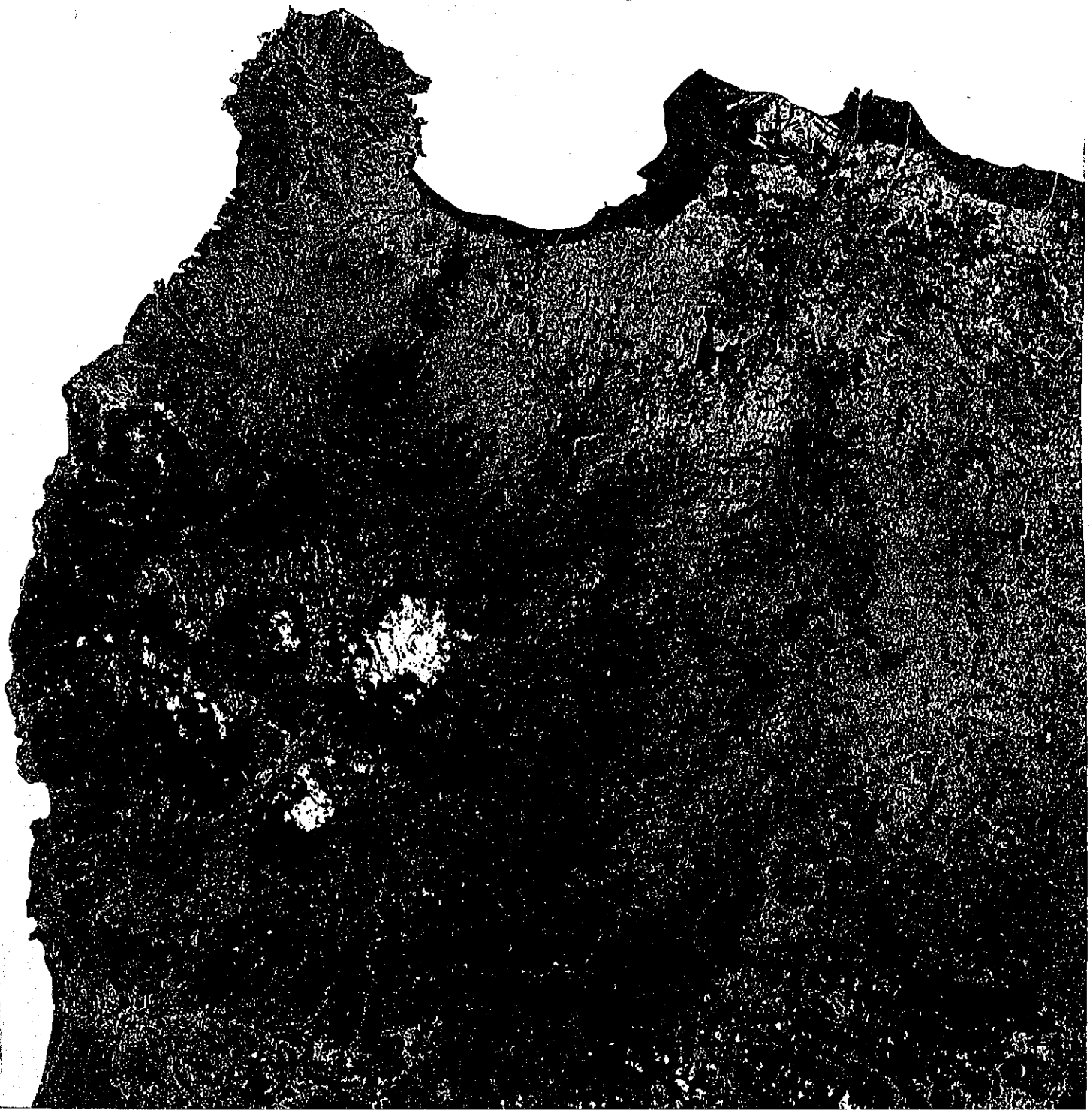
REPUBLIC OF INDONESIA
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT

MASTER PLAN STUDY ON NORTH BANTEN WATER RESOURCES DEVELOPMENT

MAIN REPORT



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July 1983

JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO, JAPAN

MASTER PLAN STUDY
ON
NORTH BANTEN
WATER RESOURCES DEVELOPMENT

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PREFACE

It is with great pleasure that I present to the Government of the Republic of Indonesia a report entitled "Master Plan Study on North Banten Water Resources Development".

This report embodies the results of the study which was carried out from July 1982 to July 1983 by a team organized by the Japan International Cooperation Agency in response to the request of the Government of the Republic of Indonesia to the Government of Japan.

The study team, headed by Mr. Takao Ichimiya of the Nippon Koei Co., Ltd., had a series of discussions with the officials concerned of the Government of the Republic of Indonesia, conducted a wide scope of survey and formulated the present report.

I hope that this report will serve for the development of the project.

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

July 1983

Keisuke Arita
President
Japan International
Cooperation Agency

July, 1983

Mr. Keisuke Arita
President
Japan International
Cooperation Agency
Tokyo

Dear Sir,

LETTER OF TRANSMITTAL

We have the pleasure of submitting to you a Final Report of Master Plan Study on North Banten Water Resources Development prepared for the consideration by the Government of Indonesia in implementing water resources development in nation's socio-economic development objective.

Volume 1, Main Report, contains a master plan of the future water resources development in the North Banten Area based on the national development policy. The plan indicates that it is the time to expedite water resources development to a great deal to attain the declared goal of the socio-economic development in the North Banten Area. Volume 2, Appendix, contains preliminary analyses and discussions in twelve sectors to support the master plan presented in the Main Report.

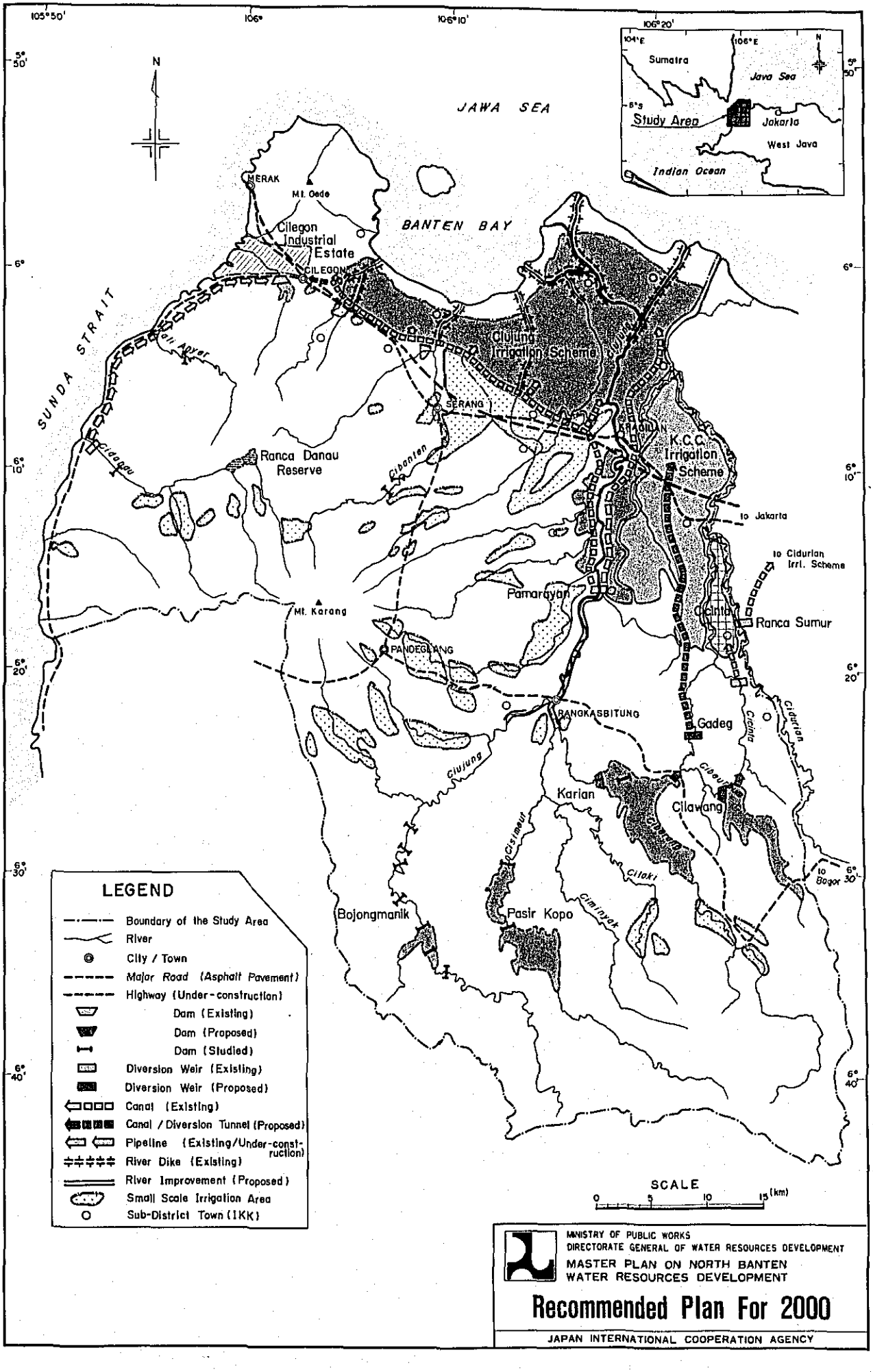
All members of the Study Team wish to express grateful acknowledgement to the personnel of your Agency, Advisory Committee, Ministry of Foreign Affairs, Ministry of Construction, Embassy to Indonesia and Japanese Colombo Plan Expert Team as well as officials and individuals of Indonesia for their assistance extended to the Study Team.

In conclusion, the Study Team sincerely hopes that the study results would contribute to socio-economic development and well-being in general and to the future water resources development in particular in the North Banten Area.

Yours sincerely,

T. Ichimiya

Takao Ichimiya
Team Leader
Master Plan Study Team
on North Banten
Water Resources Development



MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN ON NORTH BANTEN WATER RESOURCES DEVELOPMENT

Recommended Plan For 2000

JAPAN INTERNATIONAL COOPERATION AGENCY

SUMMARY

BACKGROUND

S001 The North Banten area (the Study Area) is located in the northwestern corner of the Province of West Java. It is situated near Jakarta and bridges Sumatra to the capital. Despite such favourable location, the average income is below that of the Province of West Java. There are also depressed areas in the income distribution in the Study Area. It is the main objective of the present study to level the income both within the Study Area and in the Province.

STUDY AREA

S002 The Study Area is 3,550 km^2 in area with irregular shape bordered by the sea in the north and west, by mountains in the south and by the Cidurian river in the east. The Study Area is mostly mountainous to hilly except the northeastern part where low and flat lands are concentrated. Geology is predominated by tuffaceous sedimentary rocks. Precipitation is rich ranging from 5,000 mm in the south to 1,500 mm in the north. Many rivers drain the Study Area. The Ciujung river drains more than one half of the Study Area, and many rivers, middle to small in size, drain the rest of the Study Area.

S003 Administratively, the Study Area consists of four Kabupatens, namely entire Serang and a part of Lebak, Pandeglang and Bogor. Population in 1980 was 1.65 million and population density was 455 person/km^2. Notable towns are Serang, Rangkasbitung, Pandeglang and Cilegon. Employment by agriculture, forestry and fishery occupies 70% of total of all sectors. Mainstay of the Study Area is paddy based agriculture. The Cilegon area is an industrial area with existing factories and on-going industrial estate.

S004 Almost entire arable lands in the Study Area have been cultivated for paddy, upland crops and mixed crops. Wet paddy fields of 93,000 ha are existing, of which 62,700 ha are provided with irrigation facilities of various grades and the rest is rainfed.

WATER RESOURCES AND PRESENT USE

S005 The Study Area has an annual runoff of 4.56 billion m^3 in total, comprising 3.35 billion m^3 from the Ciujung river basin and 1.21 billion m^3 from other river basins.

S006 Of the existing irrigated area, 19,200 ha receive irrigation water during the dry season from the natural run-off of the source rivers. However, there is no storage reservoir for seasonal flow regulation, hence more irrigation in the dry season is impossible at present. There exist five notable irrigation schemes of which commanding areas are more than 1,000 ha. The largest one is the Ciujung irrigation scheme of 24,200 ha which was completed in 1918, withdrawing river flow through an intake constructed on the Ciujung river at Pamarayan, and is under rehabilitation and improvement by the assistance of IBRD. The annual water consumption by all the existing irrigation schemes in the Study Area is 1.06 billion m^3.

S007 The four notable towns and many Kecamatan towns are provided with urban water which depends on springs and deep wells. Rural water use has no special water supply system except hand-operated pump facilities installed by the aid of the Department of Health. The existing factories in Cilegon own individual water sources.

WATER DEMAND

S008 To achieve the main objective of the present study, it is needed to provide new irrigation water sources for the wet season paddy cultivation area of 8,000 ha in the

Kopo-Cikande-Carenang (K-C-C) area and for the dry season paddy cropping area of 19,600 ha in the Ciujung, K-C-C and Cicinta areas. The additional irrigation water demand in the target year 2000 will be 286 million m^3.

S009 The Ciujung river generally carries floods in the wet season and gives damages to the lower reaches especially to Rangkasbitung. Such damages need to be lessened. On the other hand, towns including Kecamatan towns need to meet growing demands for water supply. Also the industrial area near Cilegon will need to meet growing demands for industrial water supply.

S010 Thus, there are increasing demands for water in the Study Area for irrigation, domestic and industrial water supply purposes. Also the mitigation of flood damages is needed. They also need reservoirs.

DEVELOPMENT STRATEGY

S011 The strategy of the master plan of the water resources development in the Study Area is to overcome two conditions. One condition is that the outflow of surface water source for further use is biased in the wet season. The other is the condition of location that the possible water sources are located in the southern part of the Study Area whereas the demand areas are located in the northern and northeastern parts of the Study Area.

S012 To meet the growing water demands, as the natural outflow of surface water in the dry season has been exhausted for the existing irrigation in the Study Area, it is necessary to provide the storage reservoirs by which rich wet season flow is stored and used in the dry season.

PLANS FOR WATER RESOURCES DEVELOPMENT,
USE AND MANAGEMENT

S013 The present study is made to find the storage reservoirs to meet the needs. Sixteen candidate dam sites on seven rivers are found and studied. The study is made to find the most suitable reservoir or combination of reservoirs in view of the available amount of water to meet the demands, method of conveying water and the costs to develop. As a result of the comparison, it is found that the best solution is a combination of two reservoirs such as the Karian and Cilawang sites. These reservoirs are provided by dams.

S014 The Karian dam site is located on the Ciberang river, a tributary of the Ciujung river, about 10 km upstream from Rangkasbitung. Height of dam will be 52 m. The dam will be of fill type, and the fill volume will be 1.1 million m^3. Available effective capacity is 218 million m^3 of which 30 million m^3 is used for flood control and 188 million m^3 is used for the storage. These values of capacity are measured on new map 1/5,000 in scale.

S015 The Cilawang dam site is located on the Cibeureum river, a tributary of the Cidurian river, about 15 km to the southeast of Rangkasbitung. Height of dam will be 28 m. The dam will be of concrete gravity type, and the dam volume will be 70,000 m^3. Available effective capacity is 54 million m^3 for use of storage. This capacity, measured on general topographic map 1/50,000 in scale, is hence subject to review upon completion of new map 1/5,000 in scale.

S016 For the full use of stored water in two reservoirs, two tunnels are necessary; one is to connect the Karian reservoir to the Cibeureum river and the other is to connect the Cilawang reservoir to the Cicinta river, a tributary of the Cibeureum river.

S017 Benefited irrigation areas by the said two dams and two tunnels are the existing Ciujung irrigation scheme of 24,200 ha, the proposed K-C-C irrigation scheme of 8,000 ha and the existing Cicinta irrigation scheme of 1,435 ha. Two existing schemes do not need additional structures and will receive almost full irrigation water for paddy in the dry season. Proposed K-C-C irrigation scheme needs new irrigation facilities and a Gadeg weir on the Cibeureum river, then 8,000 ha will receive full irrigation water for paddy both in the wet and dry seasons.

S018 Town of Rangkasbitung and 17 Kecamatan towns are located in an area where the water for domestic use can be served by using the said irrigation system. Regulated water in the two reservoirs includes sufficient amount to meet the demand for domestic water supply in these towns. Especially, water for Rangkasbitung will be taken directly from the Karian reservoir and sent through a pipeline by gravity.

S019 Water supply for Cilegon and vicinity consists of the domestic water supply to the urban areas and the industrial water supply to the Cilegon industrial estate. There is an existing water supply system from the Cidanau river to Krenceng near Cilegon with an average capacity of 2.0 m^3/s. Since the water demand in the Cilegon area will reach 3.2 m^3/s by 2000, the deficit will be supplied from the Karian reservoir. Conveyance of water will be made through the existing left bank primary canal of the Ciujung irrigation scheme, and therefrom through a proposed pipeline to Krenceng.

S020 By the effect of the Karian dam, the peak flood of the Ciberang river will be cut remarkably. However, the flood at Rangkasbitung consists not only the outflow of the Ciberang river but also those of the Cisimeut and upper Ciujung rivers which join together near Rangkasbitung.

Hence, the river improvement works are proposed to be made on the Ciujung river for the section between the Pamarayan weir and Rangkasbitung with the total length of 17.0 km. These works will be made mainly by dredging the riverbed and short cutting of the river course where the meandering are heavy. Further, the upper Ciujung river will be improved for the section of 5.5 km near Rangkasbitung. By the proposed river improvement works, the flood under 10 years return period will turn to harmless discharge, and the flood damages will be largely mitigated.

EFFECT

S021 The total construction cost of the proposed plan is estimated to be Rp 151 billion including the physical and price contingencies. The cost comprises Rp 95 billion for the Karian and Cilawang dams, Rp 39 billion for the K-C-C irrigation scheme, Rp 15 billion for the river improvement works and Rp 2 billion for the domestic and industrial water supply facilities. The foreign currency portion will occupy about 43% of the total construction cost, corresponding to approximately US$94 million at the 1982 official exchange rate.

S022 Provisional economic evaluation is tried. Economic cost includes those for the Karian dam, Cilawang dam, tunnels, irrigation facilities on the K-C-C area of 8,000 ha and river improvement. Major economic benefits are the irrigation benefits consisting of the dry season cropping in the Ciujung and Cicinta areas and the two cropping in the K-C-C area, as well as the benefit by flood control. The results are that the economic internal rate of return (EIRR) is 13.8%, the benefit-cost ratio (B/C) at 12% discount rate is 1.18 and the difference of benefit and cost (Net Present Value) is Rp 9.62 billion at 12% discount rate. The results show that the proposed plan is economically sound.

S023 By the effect of irrigation, 116,600 tons of paddy will be produced every year in addition to the present paddy production. This increment corresponds to 40% of the present production. The Study Area occupies 6% of the population of the Province of West Java, while it currently produces 4% of the Province's paddy production. With the said increment, the future paddy production in the Study Area will exceed 6% of the Province's paddy production. These facts show that the proposed plan is efficient to level up the living standard of the Study Area and beneficial to the socio-economy of the Study Area.

RECOMMENDATION

S024 The proposed plan is recommended to be formed in a project of which name is tentatively referred to as the Karian Dam Multipurpose Project. This project will consist of the following items:

- Karian dam;
- Cilawang dam as auxiliary storage;
- a tunnel to divert water from the Karian reservoir to the Cibeureum river;
- a tunnel to divert water from the Cilawang reservoir to a tributary of the Cicinta river;
- river improvement works of the Ciujung river around Rangkasbitung for 22.5 km;
- irrigation facilities to cover 8,000 ha of net irrigation area over the K-C-C area including the Gadeg weir and a main irrigation canal therefrom to the K-C-C area; and
- a pipeline from the end of existing left bank primary canal of the Ciujung irrigation scheme to the existing Krenceng reservoir.

S025 As the present study is still on the master plan level, it is necessary to carry out the feasibility study on the project. It is recommended to make effort towards the realization of the feasibility study.

MASTER PLAN STUDY
ON
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WATER RESOURCES DEVELOPMENT

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FIGURES

ABBREVIATIONS

(1) Local Terms

BAPPENAS	= Badan Perencanaan Pembangunan Nasional	:	National Development Planning Agency
BIMAS	= Bimbingan Massal	:	Mass Guidance for Self-sufficiency in Food
BKPM-D		:	Investment Coordination Board of the Province of West Java
BPAM		:	Provincial Water Management Unit
BPS	= Biro Pusat Statistik	:	Central Bureau of Statistics
BULOG	= Badan Urusan Logistik	:	National Food Logistics Agency
BUUD	= Badan Usaha Unit Desa	:	Village Unit Executive Body
CIPTA KARYA		:	Directorate General of Housing, Building, Planning and Urban Development
Danau		:	Lake
Desa		:	Village
DGWRD		:	Directorate General of Water Resources Development
DIPERTA	= Dinas Pertanian Pakyat	:	Ministry of Agriculture
DOLOG	= Depot Logistik	:	Provincial Food Depot of BULOG
DPMA	= Direktorat Penyelidikan Masalah Air	:	Directorate of Hydraulic Engineering
DPU	= Departmen Pekerjaan Umum	:	Ministry of Public Works
DPUP	= Dinas Pekerjaan Umum	:	Provincial Department Office of Public Works
DSE		:	Directorate of Sanitary Engineering
Gunung		:	Mountain
IKK	= Ibu Kota Kecamatan	:	Sub-district town
INMAS	= Intensifikasi Massal	:	Mass Intensification
Kabupaten		:	Regency
Kampung		:	Settlement
K-C-C area		:	Kopo-Cikande-Carenang area
Kecamatan		:	Sub-district
Kotamadya		:	Municipality

KUD	= Koperasi Unit Desa	:	Village Unit Cooperative
Lama		:	Old
LEKNAS-LIPI		:	National Institute of Economic and Social Research
Palawija		:	Upland Crops
P3SA	= Proyek Perancang Pengembangan Sumber-Sumber Air	:	Water Resources Development Planning Project Division
PDAM		:	Regional Water Supply Enterprise
PELITA	= Pembangunan Lima Tahun	:	Five Year Development
PLN	= Perusahan Listrik Nagara	:	Public Cooperation of Electricity
PMA	= Penyelidikan Masalah Air	:	Hydraulic Engineering (Sub-division)
PMG	= Pusat Meteorogi Dan Geofisika	:	Meteological and Geophysical Center
PPA		:	Nature Conservation and Wildlife Management
PPL	= Penyuluh Pertanian Lapangan	:	Agricultural Field Extension Worker
PPM	= Penyuluh Pertanian Madya	:	Agricultural Extension Officer
PPS	= Penyuluh Pertanian Spesialis	:	Agricultural Extension Specialist
PROSIDA	= Proyek Irigasi IDA	:	IDA Irrigation Project Division
P.T.	= Perusahaan Terbatas	:	Private Estate Enterprise
REPELITA	= Rencana Pembangunan Lima Tahun	:	Five Year Development Plan
Wilayah		:	Region

(2) International or Foreign Organization

ADB	:	Asian Development Bank
FAO	:	Food and Agriculture Organization of the United Nations
IBRD	:	International Bank for Reconstruction and Development
IDA	:	International Development Association
JICA	:	Japan International Cooperation Agency

UK	:	United Kingdom
UNESCO	:	United Nations Educational, Scientific, and Cultural Organization
US or USA	:	United States of America

(3) Others

B	:	Benefit
C	:	Cost
EIRR	:	Economic Internal Rate of Return
El.	:	Elevation above mean sea level
GDP	:	Gross Domestic Product
GNP	:	Gross National Product
GRDP	:	Gross Regional Domestic Product
NPV	:	Net Present Value
O&M	:	Operation and Maintenance
PVC	:	Polyvinyl Chloride
TSP	:	Triple Super Phosphate

ABBREVIATIONS OF MEASUREMENT

Length

mm = millimeter
cm = centimeter
m = meter
km = kilometer

Area

cm^2 = square centimeter
m^2 = square meter
ha = hectare
km^2 = square kilometer

Volume

cm^3 = cubic centimeter
lit = liter
m^3 = cubic meter

Weight

mg = milligram
g = gram
kg = kilogram
ton = metric ton

Time

s = second
min = minute
h = hour
d = day
y = year

Electrical Measures

V = Volt
A = Ampere
W = Watt
kW = Kilowatt
MW = Megawatt
GW = Gigawatt

Other Measures

% = percent
PS = horsepower
° = degree
' = minute
" = second
°C = degree centigrade
10^3 = thousand
10^6 = million
10^9 = billion (milliard)
ppm = parts per million
pH = scale for acidity

Derived Measures

m^3/s = cubic meter per second
micromhos/cm = scale for electrical conductivity
kWh = kilowatt hour
MWh = Megawatt hour
GWh = Gigawatt hour
kWh/y = kilowatt hour per year
kVA = kilovolt ampere

Money

Rp = Rupiah
US$ = US dollar (US$1 = Rp 690)
¥ = Japanese Yen (¥100 = Rp 280)

1. INTRODUCTION

1.1 Objectives of Master Plan Study

1101 The area to be studied under the present master plan study is an area so-called the North Banten Area (hereinafter referred to as the Study Area). The Study Area is located near and to the west of Jakarta forming a part of the capital's hinter land. The Study Area also bridges the capital and the Sumatra island. Despite such favourable conditions, the Study Area still remains on a level lower than the average of the Java island. This fact is attributable mainly to the delay in the water resources development.

1102 The Government of Indonesia, considering that the development of the Java island is preferable to that of the other islands, divides the Java island into 15 blocks and intends to carry out the water resources master plan study on each of such blocks. Some of such master plans were completed, some are under way and the remainder is on the waiting list. The Study Area falls on one of the 15 blocks.

1103 As water is a limited item, the water resources have to be developed based on correct plans. Intended purpose under the present master plan study are to clarify the demands for water, quantity of available water and the means of development, and to find the priority of the development. The present study is to cover the entire potential of water resources. However, the target year of development is set to be the year 2000.

1104 Demands for water in the Study Area consist largely of irrigation and partly of the domestic and industrial water supply. The irrigation requirement is partly for the existing irrigated areas which receive water mostly in the wet season only, and partly for the area which has not been

irrigated as yet. Principal areas are the Ciujung irrigation scheme for the former category and the Kopo-Cikande-Carenang area (the K-C-C area) for the latter category. Hydroelectric power potential is to be studied if any. On the other hand, the flood protection or mitigation is to be considered duly.

1.2 Background

1201 The Directorate of Planning and Programming of the Directorate General of Water Resources Development (DGWRD), through its project division, the Proyek Perancang Pengembangan Sumber-Sumber Air (P3SA), has been in study activities on the water resources development of the Study Area since 1977. A network of station was established to provide meteorological and hydrological data.

1202 From December 1978 through September 1979, a reconnaissance study on the water resources development in the Study Area was performed by P3SA assisted by the UK technical cooperation, and the report entitled "Banten Water Resources Development Reconnaissance Study" was prepared. By the way, the area to the east of the Study Area was studied under the Cisadane-Jakarta-Cibeet Water Resources Development Study assisted by the French technical cooperation, and the area to the south of the Study Area has been studied and being developed under the Teluk Lada Irrigation Project assisted by the Asian Development Bank.

1203 The present study on the water resources development in the Study Area, commenced by the Japanese technical cooperation, was firstly carried out by the Team on the North Banten Water Resources Development Project (the First M/P Study Team). This team consisting of six members was organized by the Government of Japan through the Japan International Cooperation Agency (JICA) and sent to the Study Area from July to September 1982. As a result, the

report entitled "Inception-and-Progress Report" was prepared in September 1982.

1204 Present team for further study (called the Master Plan Study Team on North Banten Water Resources Development and referred to as the Second M/P Study Team) was organized through JICA. The executive agency of the Government of Indonesia is P3SA of DGWRD of the Ministry of Public Works (DPU).

1205 The Second M/P Study Team consists of almost entire members of the First M/P Study Team and new members to complete necessary work items of the study, totalling 12 members. After about one and a half month's study in Japan, the Second M/P Study Team prepared a report entitled "Interim Report on Master Plan Study on North Banten Water Resources Development". Then the Second M/P Study Team was sent to the Study Area from November 1982 through January 1983. This Team further continued the study works up to February 1983 in Japan and prepared a Draft Final Report summarizing the results of studies. The Draft Final Report entitled "Master Plan Study on North Banten Water Resources Development" was submitted to the Government of Indonesia in March 1983.

1206 In parallel with the works by the First and Second M/P Study Teams, two separate activities were carried out by P3SA assisted by the Japanese technical cooperation. The air-photo mapping was conducted to draw a map of such areas for the possible dams and reservoirs as Karian, Pasir Kopo, Bojongmanik and Cibanten in 1/5,000 scale with 5 m contour intervals. Longitudinal profile survey and cross sectional survey of principal portions of main rivers in the Study Area were also performed. As for mapping, other areas like the K-C-C area were mapped separately by P3SA at its own expense.

1207 The other activity is the feasibility study of the K-C-C area on condition that the irrigation on this area is to be made only by the flow of the Cibeureum river, which flows through this area, without discharge regulation nor additional water diversion from other neighbouring rivers. A draft final report of this study was prepared keeping pace with that of the master plan study and also submitted to the Government of Indonesia in March 1983.

1208 The Final Report which is submitted herein comprises one main volume and one supporting volume. It is prepared in due consideration of the comments made by the Government of Indonesia for the Draft Final Report.

1.3 Study Works

1301 Activities of the First M/P Study Team covered (1) to establish the basic concept of the master plan, (2) to formulate basic master plan by finding the demands for water and flood protection and by conceiving countermeasures to cope with such demands, and (3) to collect data, documents and information for use of the studies by the First M/P Study Team and also for the succeeding study.

1302 Work categories covered by the First M/P Study Team were the water resources planning, hydrology, dam engineering, geology and groundwater. As the results of the First M/P Study, it was concluded that further study was to be continued in succession, that the important items in the master plan were the new irrigation facilities for the K-C-C area, and that such items would have to be studied with a precision of feasibility study.

1303 In line with the conclusion of the preceding study, the Second M/P Study Team was organized. The work categories covered by the new team were the entire work categories of the foregoing team except for groundwater,

with such categories added as the river engineering, hydraulics, domestic and industrial water supply, agro-economy, agronomy cum environment, irrigation and drainage, hydro-electric power generation, and socio-economy.

1.4 Personnel

1401 The 12 members of the Second M/P Study Team are listed in Annex 1401.

1402 The Second M/P Study Team during its stay in Indonesia received the counterparts services from the Government of Indonesia through P3SA. Services provided were vehicles, office with working accommodations and counterparts personnel. List of the counterparts personnel is also shown in Annex 1401.

1.5 Acknowledgement

1501 In undertaking the present study, the Second M/P Study Team has attached great importance to the incorporation of the views of departments and agencies of the Government of Indonesia relating to the various aspects covered by the present study. The contribution to the present study by the officials of Government who have provided information and data, participated in discussions, given valuable advices and provided other forms of assistance to the present study are greatfully acknowledged. A heartiful gratitude is also made to the officials of the Ministry of Foreign Affairs, Ministry of Construction, Embassy to Indonesia of the Government of Japan, JICA Jakarta Office and Japanese Colombo Plan Expert Team who have given advices and provided various supports in performing the present study. In reality, the present study can be regarded as a joint effort by the Indonesian and Japanese officials concerned and the Second M/P Study Team. The Second M/P Study Team sincerely hopes that this joint effort would contribute to the future

water resources development in the North Banten Area in particular and its socio-economic development and well-being in general.

2. ECONOMIC BACKGROUND

2.1 National Economic Background

2101 Indonesia is located in a tropical zone which extends from 6° north latitude to 11° south latitude and from 95° to 141° east longitude. The total land area of the country is about 1.9 million km^2 comprising 13,667 islands. Of the numerous islands, Java is the fifth largest island and covers an area of 134,044 km^2 corresponding to about 7% of Indonesia. It is divided into three provinces, West Java, Central Java and East Java, and two special cities, Jakarta and Yogyakarta.

2102 Indonesia has a population of 147 million according to the 1980 census, corresponding to the density of 77 person/km^2. The increase in population was about 28 million compared with the 1971 census, and the average growth rate was 2.37% per annum during the period from 1971 to 1980. This growth rate is high by 0.27% compared with that for the period from 1961 to 1971. The population projection, which was carried out in 1976 by the National Institute of Economic and Social Research (LEKNAS-LIPI), showed that the population of Indonesia in the year 2000 would reach between 210 and 260 million. Using the 1961 and 1980 censuses, if the average annual growth rate of 2.23% for the period from 1961 to 1980 may be applied to the forecast of population in the future, the population of Indonesia is expected to reach some 230 million by 2000.

2103 As for population, Indonesia is at present ranked as the fifth largest country in the world after China, India, the Soviet Union and the United States, and Java has a population of some 91 million corresponding to 62% of the total population of Indonesia. The ratio of the population in Java to the total population of Indonesia has decreased

year by year owing to the promotion of transmigration policy by the Government, nevertheless, Java, with a density of 690 person/km^2, is still one of the most densely populated areas in the world at present.

2104 The population of 10 years and over of age was 105.4 million in 1980, increasing by about 24 million from the 1971 census. Among them, the labour force was 52.3 million corresponding to 49.6% of the population of 10 years and over of age. Comparing these figures with the 1971 figures, though the labour force increased by 10.5 million, the participation rate of the labour force decreased from 51.3% to 49.6% due to the increase in the population of school attendance.

2105 Percentage of workers employed in the agricultural sector in Indonesia was about 55% of the number of the whole workers in 1980 or decreased by about 10% compared with the 1971 percentage. Share of the agricultural sector to the whole industry has a tendency to decrease. On the contrary, there is an observable tendency to increase in shares of manufacturing industries, trade and service sectors. Such a change in the industrial structure is also seen in the difference between urban and rural on the growth in population. The average growth rate of population in Indonesia was 2.8% per annum for the urban area and 1.8% for the rural area during the period from 1971 to 1980. In view of the present socio-economic conditions in Indonesia, such a tendency is expected to continue for quite some time.

2106 The Indonesian economy has achieved a remarkable development in the last decade based on the First, Second and Third Five Year Development Plans (REPELITA I, REPELITA II and REPELITA III). The gross domestic production (GDP) in Indonesia increased from Rp 11.2 trillion in 1973 to Rp 18.1 trillion in 1980 at the 1975 constant price. The per capita GDP reached US$400 in 1980, corresponding to

about five times of that in 1973. Such a high growth is largely due to the expansion of the mining sector including petroleum production. The change in industrial structure is clearly appeared in share of GDP among industries; the share of agricultural sector to the total GDP decreased from 37% to 31% between 1975 and 1980, while the share of manufacturing industries sector increased from 11% to 14% during the same period.

2107 Persons more than a half of the whole worker in Indonesia are engaged in the agricultural sector which is a basic industry of the country. However, rice, the most important staple food, has been being imported at 2 million tons per annum on the average during the recent five years in spite of the increase in production of 3.8% yearly during the same period. To achieve self-sufficiency in rice in the near future, the expansion of productive capacity should be promoted mightily. In this context, the water resources development is regarded as one of the most important factor for increasing the rice production.

2108 In Indonesia, REPELITA III (1979/80 to 1983/84) is under execution at present and its major objectives are:

(1) to raise living standards, knowledge levels and welfare of people, and to strive for equitable distribution of them to the whole nation; and

(2) to establish a solid foundation for the next development stage.

Through REPELITA III, the Government expects to achieve the average economic growth rate of 6.5% per annum, composing of 3.5% in agriculture, 4.0% in mining, 11.0% in manufacturing, 9.0% in construction, 10.0% in transportation and communication, and 8.1% in other sectors. In view of the economic growth rate of nearly 10% in GDP from 1979 to 1980, REPELITA III is regarded as being on the fair way to success.

2109 At present, the agricultural sector is the lowest of all industrial sectors in terms of the economic growth rate and the per capita income. To expect the equitable distribution of the fruits of economic growth which is one of the major objectives of REPELITA III, the further economic growth is to be desired in the agricultural sector in which the majority of the Indonesian people are engaged. On the other hand, the expansion of manufacturing industrial sector has the noticeable effects to raise GDP and to maintain the balance of international payments. The water resources development is an indispensable factor to the increase in agricultural production and to the expansion of manufacturing industries.

2.2 Regional Economic Background

2201 The Province of West Java covers an area of 46,300 km^2 and its administrative units are formed of 20 regencies (Kabupaten) which are further divided into four municipalities (Kotamadya) and 390 sub-districts (Kecamatan).

2202 The Province has a population of 27.5 million based on the 1980 census and its population density is 593 person/km^2. The population increased by 5.8 million between 1971 and 1980 with the average growth rate of 2.66% per annum. This growth rate is high by 0.57% compared with that for the period from 1961 to 1971. Based on the forecast of future population made in the present study, the Province of West Java is expected to reach a population of some 44 million in 2000 with the average annual growth rate of 2.38% being equivalent to the rate for the period from 1961 to 1980.

2203 The population of 10 years and over of age in the Province increased from 14.4 million in the 1971 census to 19.2 million in the 1980 census. The labour force was 8.67 million in total in the 1980 census, corresponding to 45% of the population of 10 years and over of age.

2204 The number of employed people in the Province was 8.47 million as of 1978. Among them, 4.79 million persons were engaged in agricultural sector of which share in employment was 56.5%.

2205 The gross regional domestic product (GRDP) for the Province of West Java grew from Rp 1,501 billion in 1973 to Rp 2,596 billion in 1980 at the 1975 constant price. In GRDP in 1980, the share by main sector was 29.8% for agriculture, 22.4% for wholesale and retail trade, 9.9% for manufacturing industries and 9.3% for mining and quarrying.

2206 The Province is the main rice bowl in the country, producing 6.34 million tons of dry paddy in 1980 and covering 23% of the whole production in Indonesia. However, this production is slightly below the domestic consumption at present. The increase in rice production through expansion of dry season irrigation area is needed to realize the self-sufficiency in the Province.

3. STUDY AREA

3.1 Present Condition

3.1.1 Land

3111 The Study Area is situated in the northwest corner of the Province of West Java. It is bordered by the Java Sea in the north, by the Sunda Strait in the northwest, by the boundary of the Teluk Lada Irrigation Project in the southwest, by the watershed of the Ciujung river system in the south, by the watershed of the Cidurian river in the southeast, and by the Cidurian river in the northeast. The Study Area is 3,550 km^2 in area with irregular shape. Its approximate measure is 70 km wide in the eastwest direction and 100 km in the northsouth direction.

3112 Topography is complicated. It is flat in the northeast corner, but hilly to mountainous in the rest of the Study Area. The highest peak is the Gunung Karang, El. 1,778 m, on the southwestern border of the Study Area. There are two independent mountains which have the same name of Gunung Gede, El. 744 m high and El. 595 m low. The latter forms a peninsula in the north of the Study Area. Between the Gunung Karang and the higher Gunung Gede, there lies a swamp of Ranca Danau formed on caldera.

3113 The geology of the Study Area consists of tuffaceous sedimentary rocks of Miocene to Pleistocene and volcanic rocks such as andesites and basalts which are intruded and/or erupted in the age of late Tertiary to Quaternary.

3114 The formations of Miocene to Pleistocene are divided into several formations which are superposed monoclinically from south to north and from lower to upper horizons in order. They are mainly composed of fine to coarse tuffs and pumice tuffs with interbedding of lapilli

tuffs in places. In the lower to middle Miocene and in the Pleistocene horizons, limestones are intercalated. The lower Pliocene formations include plant remains and silicificated wood remains.

3115 The igneous rock located in the southern mountains consists of volcanic breccias and andesite lavas of Pliocene and overlying quaternary andesites. The quaternary igneous rock of the northwestern mountains is possible to divide into old and young volcanoes at the event of the Danau Caldera. These old volcanic activities developed a dome and block-faulting. The center of the dome has subsequently collapsed forming a collapse caldera which has the distance of 13.5 km across in eastwest and 15 km across in northsouth. After the appearance of the caldera, vital activities of the young volcano have arised again in the south area of the caldera and its surroundings.

3116 Most of soils in the Study Area are formed of materials directly derived from volcanic and sedimentary rocks except in bayside tidal marshes, alluvial plains and river terraces. Along the bay shore, tidal marshes range from 0.7 to 1.5 km wide and are affected regularly by the ebb and flow of the tides. The tidal marshes with an elevation of less than 2 m are covered with deep, fine textured Grey Hydromorphic Alluvial Soils. Alluvial Soils extending over low terraces behind the marshes are affected by water table which comes to or near the ground surface during the wet season. The Alluvial Soils are medium to fine in texture, very slow to moderately slow in permeability and rather high in inherent fertility. Gently sloping to undulating hills with an elevation ranging from Els. 50 to 150 m are covered with Podzolic Soils which are generally deep in effective soil depth, fine to medium in texture and moderately permeable. Rendzinas mainly occur in slopes locating in the northwestern part of the Study Area, being, in general,

rather shallow or stony. Mountain areas having steep slope and undulating topography are covered with Latosol characterized by the low cation exchange capacity. In addition, Vertisols and Luvisols are identified in a small extent of the mountain area occupying the southernmost corner of the Study Area.

3117 Most of the vegetations in the Study Area are affected by man's activities. In a few places westward of the Study Area, typically on elevated land, montane forests have been naturally regenerated toward the successional process to mature primary forest ecosystem, which comes into the category of tropical rainforest.

3118 In the Study Area, there are three reserve areas such as Ranca Danau, Pulau Dua and Tukung Gede. The Ranca Danau Reserve has been authorized since 1921, the Pulau Dua Reserve since 1937 and the Tukung Gede Reserve since 1979. All of them are located in the Kabupaten of Serang and occupy 4,208 ha in total. The Ranca Danau Reserve covering 3,791 ha is the most attractive of the three in terms of size and unique freshwater swamp condition, but it has been encroached by illegal farming. According to the list of reserve/park published in 1981, the Ranca Danau Reserve has an extent of approximately 2,500 ha consisting of freshwater swamp of 1,300 ha and montane forest of 1,200 ha.

3.1.2 Climate

3121 Climate in the Study Area is generally characterized as a tropical monsoon climate. As the topography is complicated, the local climatic patterns vary accordingly. In December, the west monsoon from the Java Sea starts and brings abundant rain in January to March in the Study Area. The period from April to May is the first transition between the two monsoons. The east monsoon season from the Indian Ocean starts in June and lasts until September. As it brings

rainfall only the outside of the Study Area, the period of the east monsoon is the minimum rainfall season throughout the year in the Study Area. The second transition period is between October and November before the west monsoon. From the agronomic viewpoint, the first transition period and the east monsoon season are called the dry season, and the second transition period and the west monsoon season are called the wet season in the Study Area.

3122 Precipitation in the Study Area is rich. Annual precipitation is richer in the southern part and less richer in the northern part. In the southeastern corner of the Study Area, the annual precipitation is 5,000 mm, decreases going to the north, and becomes 1,500 mm along the coast. Areal average precipitation in the Study Area is estimated to be 2,500 mm per annum.

3123 Monthly mean air temperature little varies throughout the year ranging between 26 and 27°C. Relative humidity is uniformly high, ranging from 80% to 85%, throughout the year except for two months of June and July during which it falls to 75%.

3124 Average wind velocity ranges between 1.6 and 2.1 m/s throughout the year. The sunshine hours in the dry season are five to six hours, while those range between three and four hours in the wet season. The monthly open water evaporation is 100 to 140 mm and the annual mean is 1,200 to 1,800 mm. The maximum usually occurs in August, while the minimum occurs in the period from November to January.

3.1.3 Rivers

3131 The rivers in the Study Area are categorized into two; one those to drain generally from the south to the north to the Java Sea, and the other those to drain from

the east to the west to the Sunda Strait. Many rivers belong to the former category, and notable ones are, from the east in order, the Cidurian, Ciujung and Cibanten rivers. Rivers in the latter category are rather small. Notable ones are the Kali Anyer and Cidanau rivers, the latter originating in the swamp of Ranca Danau.

3132 The Ciujung river is the largest river in the Study Area. It joins such tributaries as the Ciberang and Cisimeut rivers. The catchment area is 1,850 km^2 at the estuary, occupying 52% of the Study Area and having an annual runoff of 3,350 million m^3.

3133 The Cidurian river has similar size as the Ciujung river, but only the catchment area of the Cibeureum river, one of the tributaries, is included in the Study Area. The Cibeureum river has a catchment of 255 km^2 and an annual runoff of 482 million m^3. The Cibanten river has a catchment area of 183 km^2 and its annual runoff is 153 million m^3. The Kali Anyer river, 50 km^2 in catchment area, has an annual runoff of 53 million m^3. The Cidanau river has a catchment area of 222 km^2 and an annual runoff of 521 million m^3. This river, as it originated in the swamp of Ranca Danau, has richer flow in the dry season in comparison with other rivers of the second category. The total catchment area of these rivers mentioned above occupies 72% of the Study Area. The rest of the Study Area is drained by many minor rivers.

3134 Bank erosion is observed in many rivers, but it is only local and to a minor extent except for the confluence of the Ciberang and Cisimeut rivers. Estuaries facing the Java Sea are affected by drift sand.

3135 Flood occurs in the west monsoon period in general. During the past 10 years, the maximum flood experienced occurred in November 1981 for the Ciujung river. Another

notable flood occurrence was seen in Rangkasbitung to Pamarayan along the Ciujung river in January 1979.

3136 Channel improvement works are on-going under the Ciujung irrigation and rehabilitation program executed by the Irrigation Project Financed by International Development Agency (PROSIDA) aiming at the increase in the discharge capacity of river by reshaping the river channel and constructing levees. Up to date, levees have been constructed for the Ciujung river with a length of 9 km and for the Cibanten river with a length of 6 km.

3.1.4 Springs and groundwater

3141 There are many springs on the foot slope of the Gunung Karang. They are perennial and gushing on similar elevation between El. 200 and 300 m.

3142 Springs emerge from the layers of sand, gravel and pebbles as well as from the pyroclastic sediments which have a total thickness of several meters. Occasionally springs emerge from andesitic boulder sediments or andesitic lava flow.

3143 The depth to water table in the Study Area varies from less than one to about 12 m below the ground surface. The Study Area gets groundwater recharge from the Gunung Karang in the south. Groundwater flows from the Gunung Karang northward and eastward, and gradient varies from 1/500 to 1/50.

3144 The groundwater in the unconfined aquifer has a good quality in the foot of the Gunung Karang. However, the unconfined groundwater in the lowland is not potable. The deep confined aquifers are distributed in a few limited locations around Rangkasbitung.

3.2 Socio-economy

3.2.1 Administration

3211 The Study Area consists of four Kabupatens which include all of Serang except for islands and a part of Lebak, Pandeglang and Bogor. The Study Area totals 3,550 km^2, comprising 1,876 km^2 for Serang, 1,290 km^2 for Lebak, 239 km^2 for Pandeglang and 145 km^2 for Bogor. The Study Area is nearly 8% of the gross area of the Province of West Java.

3212 The Kabupaten of Serang consists of 26 Kecamatans and is administered from the town of Serang. Besides, the Study Area includes 10 Kecamatans, whole or partly, in the Kabupaten of Lebak, and whole and part of each three Kecamatans in the Kabupaten of Pandeglang. The administrative center is the town of Rangkasbitung for the Kabupaten of Lebak and the town of Pandeglang for the Kabupaten of Pandeglang. Kecamatans are subdivided into Desas or villages being composed of one or several Kampungs or small settlements. Administration division is illustrated in Annex 3212.

3.2.2 Population

3221 Population censuses in Indonesia were taken in the years 1961, 1971 and 1980 recently. Population figures for these years are given in Annex 3221 for the whole Indonesia, Java island, the Province of West Java, four Kabupatens of Serang, Lebak, Pandeglang and Bogor, and the Study Area. The total population of the Study Area in 1980 was 1.65 million, out of which 1.10 million distributed in Serang, 0.34 million in Lebak, 0.17 million in Pandeglang and 0.04 million in Bogor.

3222 The average growth rate of per annum in the Study Area is estimated to be 1.88% for the period of 1961 to 1971 and 2.72% for that of 1971 to 1980. Such a tendency that the growth rate is increasing in recent years is also in

evidence throughout the whole of Indonesia. The growth rate in the Study Area is close to that in the Province of West Java and just higher than that in the whole of Indonesia as shown in Annex 3222.

3223 The population in the Study Area is relatively dense in the northern part and sparse in the southern part. The average population density of the Study Area was 455 person/km^2 in 1980. This figure is low compared with the Province of West Java of 593 person/km^2 and the Java island of 690 person/km^2.

3224 In the Study Area, eight Kecamatans have urban areas in which commercial, industrial and administrative activities concentrate. These are the Kecamatans of Serang having urban population share of 69% to the total population in 1980, Cilegong of 33%, Pandeglang of 28%, Rangkasbitung of 25%, Pulomerak of 17%, Ciruas of 17%, Kramatwatu of 15% and Ciomas of 13%. The urban population of the Study Area in 1980 amounted to 0.16 million, corresponding to 9.7% of the total population. Except a little population in the urban area, therefore, most of population, 1.49 million, were distributed in the rural area.

3.2.3 Labour force

3231 The population of 10 years and over of age in the Study Area was 1.11 million in 1980, corresponding to 67% of the total population. Among them, total number of labour force was estimated to be 0.49 million which comprised 0.34 million for male and 0.15 million for female.

3232 Employment by agriculture, forestry and fishery sector in 1980 was estimated to be 0.33 million, being equivalent to approximately 70% of employees in all the sectors.

3.2.4 Infrastructure

3241 Transportation in the Study Area depends mainly on the road traffic by a national road and a number of provincial roads. The national road runs through the Study Area from Jakarta to Merak passing Serang and Cilegon. This road as a main route connecting Sumatra and Java is well maintained, though the construction works are being carried out for increasing the traffic capacity. There are also provincial roads linking among Serang, Pandeglang and Rangkasbitung, connecting Rangkasbitung and Bogor, and connecting Pandeglang and Labuan. These roads are asphalt paved and well maintained. There are many other smaller roads, and some of them are asphalt or metal paved. However, roads in the southern part of the Study Area are generally poor.

3242 The railway with single line runs from Jakarta to Merak through the Study Area. There is a railway junction at Rangkasbitung, a major station on this line, and the other line from Rangkasbitung runs to Labuan on the west coast. These railways are at present one of the important facilities to transport daily passengers and cargoes to and from Jakarta.

3243 Port facilities in the Study Area are concentrated on the northwest coast between Anyer and Merak. A terminal of ferry running between Java and Sumatra is located in Merak. Other than the Merak ferry terminal, five ports perform an important function in importing raw materials for industrial factories in Cilegon.

3244 Among the four major towns in the Study Area, Serang, Pandeglang and Rangkasbitung are supplied by pipes from water sources of dug wells and springs. Cilegon is supplied by pipes from the nearby Krakatau Steel Complex. In rural areas, there is no special water supply system except for hand-operated pump facilities installed for each

Desa in the Study Area. The groundwater taken out from these dug wells is used for cooking and drinking purposes, while the water of rivers and irrigation canals is used for washing and laundry works by inhabitants in Desas.

3245 At present, main industries working in the Study Area are P.T. Krakatau Steel Works at Cilegon, P.T. Satya Raya Indah Woodbased Industries at Anyer and P.T. Statomer PVC Resin Factory near Merak. Others are of small scale factories such as bricks and tiles, bamboo products, coconut products and so on. Since there is no public industrial water supply system in the Study Area, most of the small scale industries have their own shallow wells with low yield.

3246 The water supply source for P.T. Krakatau Steel Works is the river water taken from the Cidanau river. A diversion structure has been built on the river and the river water is fed to an intake pumping station adjacent to the river. The river water is taken in the intake pumping station and is transmitted through a steel pipeline with a diameter of 1,400 mm and a total length of 27 km to Krenceng treatment plant near P.T. Krakatau Steel Works. Adjacent to the said treatment plant, Krenceng raw water reservoir with a capacity of 2.5 million m^3 in gross and 1.45 million m^3 in effect is constructed for emergency use.

3247 The electric power supply service in the Study Area is presently limited in major towns and those vicinities. The towns of Rangkasbitung, Pandeglang and Serang are linked by a 70-kV power transmission system of the Public Corporation of Electricity (PLN), being fed from outside of the Study Area, and provided with power through 20-kV and 6-kV high tension distribution lines. In the Study Area, there are six diesel power plants of 120 kW in total operated by the PLN Wilayah. These are located in Karanghantu, Kragilan, Petir, Warunggunung, Batubantar and

Cipanas. Besides, P.T. Krakatau Steel Works have own power plant of 150 MW and some industries also operate small to medium size generators for their own consumption. At Suralaya on the northernmost coast of peninsular at the foot of the lower Gunung Gede, the Suralaya thermal power station is now under construction with a schedule of the final output of 3,100 MW.

3248 In the Kecamatans of Sajira and Maja in the Kabupaten of Lebak, located in the east-southeastern part of the Study Area, a military training field covers an area of 26 km^2 along the Cibeureum river. Inhabitants of villages nearby the military training field can be allowed to utilize this field for crop growing purpose except for the training period. Further, there is an airstrip which is reserved by the airforce and covers 6 km^2 in gross. It is located in the Kecamatan of Carenang, the Kabupaten of Serang, occupying a flat land between the Cidurian river and its tributary called the Cimandaua in the northeastern part of the Study Area.

3249 There are two tourism areas in the Study Area. Banten Lama (old Banten) is located near the estuary of the Cibanten river. This area has historical buildings of which preservation priority is high alike Borobudur and Prambanan. On the western side of the Study Area, there is a tourism belt as a coastal resort called the Anyer beach area. These two tourism resources have development potential to suit the one-night stop tour from Jakarta or Bandung.

3.2.5 Land use

3251 Based on the land use map prepared by the Directorate of Agrarian, the Province of West Java, in 1977/78 and the latest statistics available in the Kabupaten Offices of Serang, Lebak and Pandeglang, areal distribution of land use patterns by Kecamatan within the Study Area was examined.

Out of the Study Area of 3,550 km^2, a total of 2,950 km^2 is used for agricultural purpose at present, which comprises 930 km^2 for wet paddy fields, 1,780 km^2 for upland and mixed crop fields, 184 km^2 for plantation and estate, and 56 km^2 for fish pond.

3252 Among 93,000 ha of wet paddy field in the Study Area, about 62,700 ha are provided with irrigation facilities and the rest is rainfed. Further, 19,200 ha or 31% of the irrigated paddy field can expect dry season paddy cropping by withdrawing natural flow of river. Cultivation of palawija crops such as vegetables, chillies and peanuts prevails locally in the Study Area. Half of wet paddy fields, therefore, lie usually fallow during the dry season due to lack of irrigation water.

3253 Besides wetland paddy, there are many upland crops grown on dryland. In the Study Area, dryland paddy, cassava, peanuts, sweet potatoes, maize and soybeans are popular, but most of them are cultivated for self consumption. In 1981, peanuts had the largest planted area of 17,700 ha followed by dryland paddy of 15,900 ha and cassava of 7,500 ha in the Study Area.

3254 In some parts of the upper catchment of the Ciujung river system and on the higher slopes of the Gunung Karang, a semi-shifting cultivation type of farming still remains. In the Kecamatans of Maja, Sajira and Rangkasbitung, private estates have converted their crops from rubber to coconut with a total area of about 4,000 ha. Other tree crops prevailing in the Study Area are cloves, kapok, coffee, pepper and vanilla. Among those, cloves have markedly increased especially in the Kecamatans of Ciomas, Padarincang and Cadasari because advance farmers have earned a comfortable income from cloves.

3255 Along the coast of the Banten Bay in the north of the Study Area, there are numerous brackish water fish ponds of which main products are shrimp and milkfish called "ikan bandeng".

3.2.6 Agricultural production

3261 According to crop production statistics prepared by the Kabupaten Offices, the average yield of wetland paddy in the Study Area is 2.8 ton/ha as dry paddy for wet season and 3.2 ton/ha for dry season and that of dryland paddy is 1.7 ton/ha. The yield still varies depending on availability of water resources for irrigation water use, though a package of agricultural inputs has been provided to farmers with coordination of all the efforts of agricultural support services in the Study Area through the agricultural intensification program called BIMAS and INMAS. Under well-irrigated or drained condition supported by such program, the average yield goes up to 4.2 ton/ha for the wet season and 4.5 ton/ha for the dry season. The total dry paddy production in the Study Area was estimated to be around 380,000 tons in 1981.

3262 The yield of upland crops is generally low due to little application of fertilizers and chemicals. The annual production in 1980 totaled 80,300 tons for cassava, 26,200 tons for dryland paddy and 15,300 tons for peanuts in the Study Area.

3263 The production of tree crops in the Study Area was 1,820 tons for rubber, 14,200 tons for coconut, 370 tons for cloves and 140 tons for vanilla. Prevailing fruit trees in the Study Area are bananas, producing 22,000 tons in 1980.

3264 The fish production in the Study Area totaled 3,613 tons in 1981, the breakdown of which was 3,265 tons from brackish water ponds, 141 tons from fresh water ponds and 207 tons from wet paddy field, cage, river and swamp.

3.2.7 Self-sufficiency of rice

3271 Farmers sell marketable paddy surplus to farmers' village cooperative units (KUD) or a private middleman sometimes including a private miller after meeting their self-consumption and paying rental and hired labour charges in kind.

3272 The National Logistic Agency (BULOG) purchases rice from the KUD and private rice mills through its branch office (DOLOG) in Serang to stabilize rice price in a local market. The DOLOG in Serang is capable of storing about 7,000 tons of milled rice in the town of Serang and 15,000 tons of unhusked rice in mills and KUDs elsewhere in the Kabupaten of Serang. Although, in general, total rice production fluctuates considerably from year to year, a rice surplus is observed in the Kabupaten of Serang, while a rice deficit is as usual in the Kabupatens of Lebak and Pandeglang. The preliminary estimate of self-sufficiency rate in 1981 shows 103% based on the total dry paddy production of 380,000 tons against the consumption of 370,000 tons assuming that the per capita consumption of milled rice is 120 kg/y for urban people and 145 kg/y for rural people, a milling rate is 65% and population growth rate between 1980 and 1981 is 2.9% for urban population and 1.2% for rural population.

3.2.8 GRDP and income distribution

3281 According to the income statistics of Indonesia, GRDP of the Banten region comprising the Kabupatens of Serang, Lebak and Pandeglang was about Rp 320 billion in 1980 at current price. During the period from 1973 to 1980, the average annual real growth rate of GRDP was 6.8% at the 1975 constant price. This figure is fairly less than that of the Province of West Java, 8.1%, and the whole country, 7.1%.

3282 The per capita income of the Banten region was about Rp 130,000 in 1980 at current price. This income is equivalent to about half of that of the whole country and 63% of that of the Province of West Java. The average real growth rate of per capita income in the Banten region was 4.5% per annum during the period from 1973 to 1980 at the 1975 constant price. This growth rate is close to that of the whole country, 4.0%, and slightly lower than that of the Province of West Java, 5.6%.

3283 The low income of the Banten region is mainly caused by a fact that about 70% of the whole workers are engaged in the agricultural sector of which per capita income is relatively low among all industries. In the cases of the whole country and the Province of West Java, number of workers engaged in the agricultural sector are below 60%. Among Kecamatans in the Study Area, there is a disparity in the income distribution. Generally, the income in the urban area is higher than that in the rural area. One of the lower income areas is the K-C-C area which remains in the rainfed condition of agriculture. The average per capita income of the K-C-C area is estimated to be about 65% of that of the Kabupaten of Serang.

3284 Mainstay in the Study Area is agriculture in which farmers are predominating. It is, therefore, necessary to enhance the agriculture so that the farms' income could increase. The full-equipped irrigation system is the most important measure for the enhancement of agriculture. Besides the agriculture, an important development in connection with water resources in the Study Area is the expansion of industrial estate in the Cilegon-Merak area and water supply system to urban areas as well as flood control of the Ciujung river.

4. WATER RESOURCES AND PRESENT USE

4.1 Surface Water

4.1.1 Watershed

4111 The Study Area is composed of seven major river basins and many minor river basins. Major basins are, from east in order, the Cibeurem of the Cidurian river system having an area of 255 km^2, the Ciujung river basin of 1,850 km^2, the Cibanten river basin of 185 km^2, the Cidanau river basin of 216 km^2, the Kali Kedungingas river basin of 149 km^2, the Kali Anyer river basin of 50 km^2 and the lower Gunung Gede watershed of 123 km^2. Minor river basins occupy 722 km^2, corresponding to 20% of the Study Area. The Ciujung river basin is further divided into the Ciberang watershed of 331 km^2, the Cisimeut watershed of 458 km^2, the upper Ciujung watershed of 594 km^2 and the lower Ciujung watershed of 467 km^2.

4112 Natural forests cover at present only 221 km^2 or 6.2% of the whole Study Area. The natural forest cover in each river basin varies reflecting the land use condition for the agricultural purpose. The natural forest cover is concentrated in four river basins such as Ciberang, Cidanau, Kali Anyer and Cisimeut ranging from 6.8% to 22.6% in share and totalling 182 km^2 in area. The remaining natural forest of 39 km^2 as scattered in other minor river basins. Besides the natural forest, there extend plantation and scrub forest occupying 547 km^2 in total and 15.4% of the Study Area. These are found in the Ciberang, Cisimeut, upper Ciujung and Kali Anyer river basins. Except for the Ranca Danau Reserve and other two reserves, however, there are no significant natural forest for conservation and reserve.

4113 The result of preliminary evaluation regarding soil erosion hazard points out that there is a high risk of surface soil loss in the Ciberang, Cisimeut and upper Ciujung watersheds of the Ciujung river basin if the existing forests are cleared to large extent.

4.1.2 Precipitation

4121 Rainfall observation in and around the Study Area has been carried out since 1870's. Presently, about 100 rainfall gauging stations are operated under the management of P3SA and the Meteorology and Geophysics Center (PMG). Of them, 19 stations are equipped with automatic rain recorders and the others are equipped with accumulative type rain gauges which are observed once a day. Taking the availability of observation data into account, 85 stations are extracted and their locations are shown in Annex 4121.

4122 The data-keeping situations for these 85 stations are examined and the result is listed up in Annex 4122. Most of them are found to be comparatively useful for the arrangement of daily and monthly rainfall data. Besides these stations, two groups of rain gauge stations have been installed at 2-km mesh intervals in the upper and lower catchments of the Ciujung river to study the rainfall distribution patterns in limited areas. Though the observation work has been undertaken since 1978, the data accumulated to date are yet insufficient for the processing of data. Accordingly, these data are not employed in arranging the daily and monthly rainfall data for the present study.

4123 Through the review of rainfall data arranged for 85 stations, nine main points are selected which represent the typical monthly rainfall patterns in the Study Area. Illustrations are shown in Annex 4123.

4124 An isohyetal map of annual rainfall is drawn as portrayed in Annex 4124, taking account of the average annual rainfall data from 1942 through 1980 at gauging stations selected in and around the Study Area. The isohyetal lines are almost parallel within the Ciujung river basin, however, the Gunung Karang affects the isohyetal lines in the central western part of the Study Area, namely, richer rainfall on its western slope and lesser rainfall on its eastern slope of the mountain.

4.1.3 River flow

4131 The existing 10 water level gauging stations in the Study Area are listed in Annex 4131. Presently, eight gauging stations are working and the remains at Curugbetung on the Cidanau river and at Cileuksa on the Ciberang river were already abandoned. P3SA has been operating five stations at Serut on the Cibanten river since 1977, at Sajira on the Ciberang river and at Cileles on the Ciujung river since 1978, at Leuwidamar on the Cisimeut river since 1979 and at Kubang Baros on the Cidanau river since 1980. Two gauging stations on the main stem of the Ciujung river, at Kragilan and Rangkasbitung, are under operation managed by the Directorate of Hydraulic Engineering (DPMA) since 1969 and 1969/70, respectively. The available gauging data at the Pamarayan weir on the Ciujung river, since 1975, are kept by the Serang Regional Office, DPUP. As water level recorders installed at the Rangkasbitung, Sajira and Leuwidamar gauging stations were washed away by the flood in November 1981, the gaugings have been carried out by staff gauge observation three times a day since then.

4132 On the DPMA gauging stations at Rangkasbitung and Kragilan on the Ciujung river, discharge rating curves have already been arranged and daily discharge tables are also ready to use. The Rangkasbitung gauging station will play a role of a key gauging station in the catchment of the

Ciujung river, which gives well arranged discharge data for a fairly long observation period from 1972 through 1982. At the P3SA gauging stations, a series of discharge measurement has been carried out since the year of installation to date and these measurement data are available for drawing up discharge rating curves. After some checkings on the original data processed by P3SA, newly revised discharge rating curves and corresponding formulae are prepared by the Second M/P Study Team for the estimation of daily and monthly mean discharges at each gauging station. The monthly mean discharge and annual runoff at each gauging station are summarized in Annex 4132. Detailed discussions are presented in Appendix B. However, as the observation periods of P3SA gauging stations are relatively short, the obtained data are considered to be insufficient for the present study. Besides, it is very difficult to grasp clearly the relation between discharge and water level at the Sajira gauging station on the Ciberang river, which has been affected by simple intake facilities immediately downstream from the gauging station. Therefore, a new gauging station on the Ciberang river will have to be selected somewhen elsewhere it cannot be affected by similar facilities.

4133 The monthly mean discharge and the annual runoff at each potential dam site are estimated as follows and the results are summarized in Annex 4133:

(1) For the potential dam sites on the upper catchment of the Ciujung river system and on the catchment of Cibeureum river, the discharges are estimated based on the discharge data at the Rangkasbitung gauging station, taking account of the catchment areas, the annual catchment rainfalls and the annual catchment losses of such potential dam sites as Karian, Pasir Kopo and Bojongmanik of the Ciujung river system and Cilawang on the Cibeureum river.

(2) The discharge at a potential dam site on the Cibanten river is estimated based on the discharge data at the Serut gauging station on the Cibanten river.

(3) The discharge at a potential dam site on the Cidanau river is estimated based on the discharge data at the Curugbetung and Kubang Baros gauging stations on the Cidanau river.

(4) As the Kali Anyer river has no gauging station, the discharge at a potential dam site on the Kali Anyer river is estimated based on the discharge data of the Cibanten river which is expected to have a similar runoff pattern.

4134 The probable monthly mean discharge and annual runoff at each potential dam site are estimated by the Thomas plotting. The estimated results are summarized in Annex 4134.

4135 The standard project flood is a basic standard hydrograph at the specific projected sites along the river, which is used as the basis for the flood control planning. Generally, the standard project flood is derived from the design storm rainfall of a probability of exceedance corresponding to the required safety of flood control. An estimation of the standard project flood is supposed to be done under the condition of no flood regulation measures and no flooding or inundation along the river course.

4136 The peak discharge of the estimated standard project flood is generally larger than the flood peak discharge obtained from the flood discharge data at the gauging station, which may be affected by the natural flooding or inundation along the river course. Based upon the estimated standard project flood, the flood control plan will be established with the optimum distribution of projected flood discharge

into the river channel improvement and the flood regulation measures such as dam, retarding basin and diversion channel.

4137 The standard project floods of the Ciujung river system are estimated by the process mentioned below. Detailed discussions are given in Appendix B.

(1) The rain gauging stations which have well arranged data for long observation periods are selected for the study and the probable daily rainfalls at the rain gauging stations are estimated by the Thomas plotting.

(2) The commanding area of each rain gauging station is obtained by drawing the Thiessen polygons.

(3) The catchment rainfall at each potential dam site and of each tributary is obtained by applying the commanding area of rain gauging station to each catchment and by applying the conversion ratio of point rainfall to area rainfall on each catchment.

(4) The flood hydrograph at each potential dam site and of each tributary is obtained by applying the Rational formula. A detailed process is presented in Annex 4137.

(5) The flood hydrograph at Rangkasbitung, located downstream from the confluence of the three upper tributaries of the Ciujung river, is obtained by superposing the flood hydrograph of each tributary taking account of the difference of time of concentration.

4138 The standard project flood distribution illustrated is presented in Annex 4138. The standard project floods at the principal points on the Ciujung river system are as follows:

River	Site	1/50 Flood	1/10 Flood
Ciberang	Karian	740 m^3/s	600 m^3/s
Cisimeut	Pasir Kopo	850 m^3/s	610 m^3/s
Upper Ciujung	Bojongmanik	590 m^3/s	450 m^3/s
Ciujung	Rangkasbitung	1,800 m^3/s	1,400 m^3/s
Ciujung	Pamarayan weir	1,800 m^3/s	1,400 m^3/s
Ciujung	Kragilan	2,000 m^3/s	1,600 m^3/s

4139 The spillway design flood is estimated on the basis of the calculation of peak flood discharge by the Rational formula. The daily rainfall of 340 mm at the Sampan Peundeuy gauging station in the upper Ciujung basin in August 1921 is adopted for the calculation of peak flood discharge, which is the experienced highest rainfall within the Ciujung river basin. Giving an allowance of 20% to the calculated discharge, the spillway design flood for each proposed dam is estimated as follows:

Site	Catchment	Design Flood	Specific Discharge
Karian	288 km^2	1,600 m^3/s	5.56 $m^3/s/km^2$
Pasir Kopo	172 km^2	1,700 m^3/s	9.88 $m^3/s/km^2$
Bojongmanik	159 km^2	1,200 m^3/s	7.55 $m^3/s/km^2$
Cilawang	93 km^2	780 m^3/s	8.39 $m^3/s/km^2$

4.1.4 Water quality

4141 The water quality test was conducted on the water samples collected in August and December 1982 at Pamarayan and Rangkasbitung on the Ciujung river, Cileles on the upper Ciujung river, Leuwidamar on the Cisimeut river, Karian on the Ciberang river, Gadeg on the Cibeureum river and Serut on the Cibanten river. The additional sampling for the water quality test was done in December 1982 at Kragilan on the Ciujung river, Sajira on the Ciberang river, Cinangka on the Cidanau river, Bedeng on the left bank primary canal of the Ciujung irrigation scheme and Pos on the right bank

primary canal of the Ciujung irrigation scheme. In total, 19 samples were analyzed by the Water Quality Laboratory, DPMA.

4142 The results of water quality analysis show that the water has no problem for agricultural use and can be used as the raw water for drinking purpose with corresponding purification process. The analytical data are given in Appendix B.

4143 The salinity survey was carried out along the downstream reaches of the Ciujung river. The observed records of salinity in December 1982 were around 1,000 ppm at Tirtayasa located about 5 km from the estuary and very low at Kragilan located about 18 km from the estuary. Through this observation, the saline water intrusion is considered to be terminated near the Kragilan bridge and the effect of saline water intrusion is small upstream from the Kragilan bridge.

4.2 Groundwater

4.2.1 Present condition

4211 Groundwater in the Study Area is in both unconfined and confined conditions. The depth to water table in the Study Area varies from less than 1 m to about 12 m below the ground surface. Groundwater is recharged from the Gunung Karang in the south. Groundwater flows from the Gunung Karang northward and eastward, and gradient varies from 1/500 to 1/50.

4212 Most of the shallow wells are made by digging the subsurface with 60 to 120 cm in diameter and 2 to 17 m in depth. Yields of the shallow wells are not sufficient for the domestic use in the dry season. Groundwater in the unconfined aquifer has a good quality in the foot of the Gunung Karang. However, the unconfined groundwater in the lowland is not potable.

4213 Most of the wells have been drilled in the northern coastal region, ranging from 50 to 200 m in depth. Several aquifers are recognized in the fine to medium sandy beds within 5 m in thickness. The maximum yields of these aquifers are expected to be 3 lit/s.

4214 The deep confined aquifers are distributed in a few limited locations. They have small specific yields except a well for water supply to Rangkasbitung. This well, which is drilled down to the depth of 150 m from the ground surface, is tapping the water bearing formations of 25.5 m and has a specific capacity 2.44 lit/s/m.

4215 Three boreholes, 58 m in depth, were drilled at Warunggunung for the purpose of evaluating the potential of the unconfined aquifer of the Quaternary volcanic sediments. By the results of the pumping test, the production of groundwater has smaller yield than that in the coastal region.

4216 Quality of groundwater in the deep confined aquifers is poor in the coastal area, meaning that the aquifers are affected by salt water intrusion. On the foot slope of the Gunung Karang, however, there exist aquifers which consist of pyroclastic sediments and have a good quality of water with electrical conductivity values of 140 to 470 micromhos/cm.

4217 Springs are concentrated between Els. 200 and 300 m at northern and southern flanks of the Gunung Karang. Even when the small streams near the Gunung Karang are dried up in the dry season, yet the springs gush out from the slopes of mountain throughout the year. The quality of water is generally good and suitable for drinking purposes.

4218 Springs emerge from the layers of sand, gravel and pebbles as well as from the pyroclastic sediments which have a total thickness of several meters. Occasionally springs emerge from andesitic boulder sediments or andesitic lava flow.

4219 Springs are divided into two groups on the basis of the water yield, quality and recharge area. One is springs gushing from the northern and southern foots of the Gunung Karang with moderate to large yield, good quality and large recharge area. The other is springs distributing in the foots of the Gunungs Parakasa and Pulasari adjacent to the Gunung Karang, having rather limited recharge area and no large yield.

4.2.2 Groundwater potential

4221 Groundwater in the unconfined aquifers is not expected for domestic and industrial use because of small yield and effect of sea water intrusion in the coastal plain and also less potential in the foot of the Gunung Karang. Groundwater in the confined aquifers are found over the Study Area, however, the groundwater development potential is anticipated to a very slight extent taking into consideration the limited location of the deep confined aquifers with marginal yield.

4222 As the existing springs have already been fully used for the domestic and irrigation purposes and there is little undeveloped spring in the Study Area, it is considered that yields of springs are not enough for additional water requirement.

4.3 Present Use of Water Resources

4.3.1 Irrigation water

4311 Among the whole wet paddy fields of 93,000 ha in the Study Area, 62,700 ha are irrigated and the rest is

rainfed. Cropping patterns prevailing in the irrigated and rainfed areas vary depending on local conditions of rainfall pattern and stream flow as illustrated in Annex 4311.

4312 The irrigation area under the control of DPU totals 44,900 ha at present, comprising a technical irrigation area of 33,600 ha, a semi-technical irrigation area of 7,000 ha and a simple irrigation area of 4,300 ha. The remaining irrigation area of 17,800 ha is managed by Desa and called Non-DPU irrigation. There are 71 DPU irrigation schemes which are composed of 13 technical, 35 semi-technical and 23 simple irrigation schemes. Among them, the largest one is the Ciujung irrigation scheme with a net irrigated area of 24,200 ha. The other notable technical ones are the Cibanten irrigation scheme of 2,200 ha, the Ciwaka irrigation scheme of 1,560 ha, the Cicinta irrigation scheme of 1,435 ha and the Cisangu irrigation scheme of 1,440 ha. The average size of DPU scheme except for the Ciujung irrigation scheme is estimated to be 297 ha. The location of DPU scheme is shown in Annex 4312.

4313 All the irrigation schemes, DPU and Non-DPU, depend their irrigation water sources on river water and their water intakes are gravity system. The main water source for the existing irrigation schemes in the Study Area is the surface water of the Ciujung river. As shown in Annex 4313, a total of 46,200 ha takes irrigation water from the Ciujung river, the main stem and its tributaries, during the wet season. Other water sources are the Cibeureum, Ciwaka, Cibanten and Cidanau rivers, irrigating 8,300 ha in total for the wet season cropping. Due to decrease in the dry season river flow, irrigation water supply for the dry season cropping is limited to about 19,200 ha annually, corresponding to 31% of the whole irrigation area.

4314 Presently, the annual irrigation water use by all the existing irrigation schemes in the Study Area is estimated on the basis of assumption that the present irrigation efficiency is 55% on an average and the average monthly

rainfall records from 1972 to 1982 are used for obtaining effective rainfall. The estimated results show that the annual irrigation water use amounts to 1,055 million m^3 in the Study Area comprising 768 million m^3 or 73% for water sources depending on the Ciujung river and 287 million m^3 for other rivers as summarized in Annex 4314.

4.3.2 Domestic and industrial water

4321 The main domestic water consumers in the Study Area are people living in the towns of Serang, Pandeglang, Rangkasbitung, Cilegon and Kecamatan towns (IKKs), which are provided with urban water, and such industries as P.T. Satya Raya Indah Woodbased Industries, P.T. Statomer PVC Resin Factory, Port and Ferry Installations, P.T. Krakatau Steel Works, P.T. Suralaya Power Stations and Cilegon Industrial Estate, having each own industrial water source.

4322 Urban water use by most municipalities in the Study Area depends on springs and deep wells as mentioned below.

(1) In the town of Serang, the water supply system is now served with sufficient amount of springs. The Sukacai spring with a yield of 114 lit/s and Citaman spring having a yield of 189 lit/s are the major sources.

(2) In the town of Pandeglang, the newly developed Karan Tanjung spring acts as the main water source for urban water supply, but its yield of 20 lit/s is insufficient and the further development of springs to cope with the urban water demand is proceeded.

(3) In the town of Rangkasbitung, deep well groundwater yielding 35 lit/s in total is used for urban water supply and other deep wells yielding 40 lit/s in total are now under development.

(4) In the town of Cilegon, the potable water up to the amount of 50 lit/s is agreed to be served directly from the private Krenceng water treatment plant of P.T. Krakatau Steel Works. This water supply is scheduled to be started from May 1983.

(5) In IKKs, the water sources are of spring, shallow-well, deep-well, river and irrigation canal reflecting the location of each town. The planned capacity of each town is limited to the standard types of 2.5, 5 and 10 lit/s from the administrative reason.

4323 Rural water use has no special water supply system except hand-operated pump facilities of which installation is promoted by the aid of the Department of Health and it will be continued until 2000. In dry season of 1982, most dug wells were dried up and only the hand-operated pumps met the water demand of villagers.

4324 Industrial water use by main industries in the Study Area depends on their own water supply systems, being grouped in four classes such as P.T. Krakatau Steel Works, P.T. Suralaya Power Station, Cilegon Industrial Estate and Anyer/Merak area including P.T. Satya Raya Indah woodbased industries, P.T. Statomer PVC Resin Factory, and Port and Ferry Installations.

4325 P.T. Krakatau Steel Works, for its domestic and industrial water supply, has the private Krenceng water treatment plant of which potable water supply capacity is 2.0 m^3/s. The Krenceng intake pumping station has the capacity of 2.5 m^3/s as raw water which is transmitted from the Cidanau river to the Krenceng water treatment plant through the pipeline system. The Krenceng water treatment plant presently serves P.T. Krakatau Steel Works alone with the treated water and will provide for water to meet

the domestic use in the town of Cilegon and P.T. Suralaya Power Station together with its housing colony each having demand of 0.05 m^3/s.

4326 P.T. Suralaya Power Station is now under construction and will be equipped with a desalinization plant consisting of two units having a capacity of 130 m^3/h each for its industrial water use. However, the domestic water for its plant and housing colony is scheduled to be directly sent from the Krenceng water treatment plant.

4327 The Cilegon Industrial Estate has a total area of 550 ha and its development for secondary steel based industries is scheduled to be commenced by 1985. Although no definite plan on water supply system has been formed yet, the Krenceng water treatment plant is located in the nearest place.

4328 Present water use in Anyer/Merak area is briefed as follows:

(1) P.T. Satya Raya Indah Woodbased Industries privately consume industrial water of 250 m^3/d pumped up from the Kali Anyer river and supply domestic water of 350 m^3/d for its employees by pumping up groundwater from their own deep wells.

(2) P.T. Statomer PVC Resin Factory has a private industrial water supply system consisting of a deep well of 270 m^3/month and a clean water producing system from sea water of 5.5 m^3/h. The domestic water demand is 2.8 m^3/d.

(3) Port and Ferry Installations at Merak own their private industrial water supply system with shallow dug wells yielding 50 m^3/d in total. The shortage of amount of 15 m^3/d is bought from the private companies in Cilegon including a small amount of domestic water for the workers.

4.4 Water Balance under Present Condition

4.4.1 Ciujung river system

4411 The entire catchment area of the Ciujung river occupies about two thirds of the Study Area. This river is used as the sole water source for the Ciujung irrigation scheme. There is no storage reservoir on this river, and water is diverted from the Pamarayan intake weir to command 24,200 ha of wet paddy field. In the wet season, water is sufficient to irrigate the whole commanding area, whereas, in the dry season, the flow decreases below the level of requirement for full irrigation. Almost all the inflow to the Pamarayan weir is diverted in the dry season, but the amount of water only meets to irrigate at most one third to half of the commanding area. Except the irrigation water diversion for the Ciujung scheme, there is no existing intake weir on the Ciujung river.

4412 There are a few tributaries which originate on the eastern slope of the Gunung Karang and join the Ciujung river from the east at points downstream from the Pamarayan weir. There are many small existing irrigation schemes in the basins of these tributaries. Flows of these tributaries are almost exhausted in the dry season. However, as they join the main stem downstream from the Pamarayan weir, any development of water resources on the upper reaches of the Ciujung river can be made, independent of such small irrigation schemes.

4413 Situation of use of natural flow as such, it is comprehended that the use of water of the Ciujung river has been made fully under the present condition that there is no storage reservoir. Hence, one or more storage reservoirs which can tap the wet season flow and release in the dry season are needed for the purpose of withdrawing more water from this river.

4.4.2 Cibeureum river

4421 The Cibeureum river is a tributary of the Cidurian river which forms the eastern boundary of the Study Area. The Cicinta river is a tributary of the Cibeureum river. These two rivers join and from the confluence downward flow along the eastern side of the K-C-C area. On the Cicinta river, there is an existing intake weir for the Cicinta irrigation scheme. This intake is located before the Cicinta river joins the Cibeureum river. Further, there is an existing intake weir at Ranca Sumur on the Cidurian river for the Cidurian irrigation scheme which is located outside the Study Area. This intake is situated before the Cibeureum river joins the Cidurian river.

4422 Flow of the Cicinta river is used for the Cicinta irrigation scheme effectively. This scheme commanding 1,435 ha receives sufficient water in the wet season, while only 100 ha or less are irrigated in the dry season, exhausting the dry season flow of the Cicinta river. On the Cibeureum river, there is no existing diversion facility, hence, entire flow of the Cibeureum river has not been used. Any development of water resources on the Cibeureum and the Cicinta rivers can be made without hindering the diversion to the Cidurian irrigation scheme.

4.4.3 Other river systems

4431 Flow of the Cibanten river is used fully for the existing Cibanten irrigation scheme. This scheme, however, receives irrigation water for only a part of the commanding area in the dry season, although the dry season flow of the Cibanten river is exhausted.

4432 There are many small tributaries of the Cidanau river which flow northwards either to the swamp of Ranca Danau or the main stream. Flow of these streams are widely used for the existing Non-DPU small irrigation schemes.

4433 Near the estuary of the Cidanau river, there is an existing intake weir for the sole use of P.T. Krakatau Steel Works. Diverted water from this intake weir is pumped up to the pipeline with a diameter of 1,400 mm and a length of 27 km, and sent to the purification plant located near the town of Cilegon. This pipeline has a capacity of 2.5 m^3/s and a reservoir by the dam having 2.5 million m^3 in gross capacity is built on the Kali Berung river for the emergency use.

4434 In case this water intake system is fully used, the dry season flow of the Cidanau river would be exhausted. However, this system has not been used fully as yet. Present amount of intake is constantly 0.3 m^3/s.

4435 Other small rivers including the Kali Anyer river are seldom used as water resources mainly for Non-DPU small scale irrigation schemes.

4.5 Existing Water-related Problems and Needs

4501 In the existing irrigation area totaling 62,700 ha in the Study Area, irrigation water demand for the wet season cropping has been fully met by diverted natural flow of rivers. The excess of natural flow available in the wet season runs to the sea, sometimes as flood. However, transplanting works seldom forfeits a proper occasion caused by delay of the opening of wet season.

4502 During the dry season, rainfall reduces to large extent and surface runoff varies every year. Although irrigation water for the dry season cropping can be withdrawn from rivers, its quantity is far below the demand for full cropping of paddy. At present, the dry season cropping area of the Ciujung irrigation scheme is scheduled to be 9,600 ha or 40% of the whole area before starting cultivation work of every dry season, but the average actual

planted area for the recent five years from 1977 to 1981 is estimated to be 7,000 ha, corresponding to approximately 30% of the entire scheme. The total paddy cropping area in the dry season in the Study Area has fluctuated between 10,000 ha under a dry spell and 30,000 ha with abundant rain.

4503 The limitation of dry season irrigation area forms the determining cause that the existing irrigation water management system called Golongan in the Ciujung irrigation scheme is hardly functioning in proper manner. As a result, wet paddy fields located along the main canal and also the upper reaches of secondary canals can only take irrigation water for the dry season paddy cropping, prior to other wet paddy fields distributed along the lower reaches of secondary canals. Thus, farmers who grow wetland paddy on the latter fields in the dry season are always forced to do very risky farming.

4504 In the K-C-C area, the elevation of existing wet paddy fields, totaling 8,000 ha in net, is high compared with the water level of the Pamalayan weir and the Cibeureum river. Up to date, therefore, no intake facility of irrigation water has been developed for the K-C-C area. Rainfed cultivation of wetland paddy still predominates in the K-C-C area of the Study Area so that the average farm income is limited to a considerable extent due to low cropping intensity.

4505 To expand the irrigation area and to stabilize the wetland paddy cropping in the dry season for the Ciujung irrigation scheme, and also to provide the K-C-C area with year-round irrigation water, it is needed to create new water resources by regulating natural flow of rivers.

4506 The towns of Rangkasbitung and Cilegon depend their urban water supply on groundwater at present. Groundwater potential which can be newly developed around these

two towns is very limited. Although the private water supply system is scheduled to support the existing urban water supply system of Cilegon from May 1983, additional water sources are necessitated to meet the increasing water demand and to be developed as an important component of public supply system for urban water use in the both towns.

4507 In the lower part of the Ciujung river basin, domestic water supply to IKKs and rural areas depends on shallow wells, rivers and irrigation canals. Inhabitants are seriously suffering from shortage of water for domestic use when a long spell of dry weather lasts. Provision for potable water supply is indispensable for these areas to better the living standard of villagers.

4508 Industrial water use in Cilegon, Merak and Anyer presently relies upon private water supply systems under which river water is treated and sea water will be desalinized. In the Cilegon Industrial Estate, land totaling 550 ha is being sold in lots for the development of secondary steel based industries. There is no more water sources which have large potential and can be developed by own investments of water users around Cilegon. To accelerate industrial development in this area, incorporation of social infrastructural development including the public water supply system for domestic and industrial purposes is necessary.

4509 Notable floods have recently been experienced in January 1979 and November 1981. The latter is the largest in the past. About 2,400 houses in Rangkasbitung and 3,600 houses along the lower reaches of the Ciujung river were seriously affected by the latter flood. In addition, agricultural land of 3,800 ha mainly comprising wetland paddy fields in the Ciujung irrigation scheme area was flooded at the same time. Inhabitants in the flooded area of Rangkasbitung wait for flood mitigation works to reduce damages to their properties.

5. WATER DEMAND

5.1 Basic Concept for Water Demand Projection

5101 In projecting the future water demand in the Study Area, items to be described in the following paragraphs are taken into consideration as the basic concept.

5102 The target year in formulating development plans in each sector is set to be the year 2000.

5103 The projection of future population is to be conducted principally based on the results of population censuses in 1961, 1971 and 1980.

5104 The irrigation water demand is to be projected on the basis of planning criteria taken by DPU.

5105 The domestic water demand is to be forecasted based on per capita daily use which is prepared in due consideration of the recent consumption trend in Indonesia. This per capita daily use includes unaccounted for water demand and treatment plant use.

5106 The alternative study on water supply facilities for domestic and industrial use is to be done for making such an economical plan as to incorporate the existing private water supply system into the future public system.

5.2 Population Projection

5201 Population projection for Indonesia to the year 2005 was carried out by LEKNAS-LIPI in 1976, putting use of the 1961 and 1971 censuses and population statistics in the preceding years till 1976. The projection was made, assuming two conditions of the high and the low for each factor of fertility, migration and urbanization. As a result, the forecast shows that, in the year 2000, the

population of Indonesia will reach between 210 and 260 million, and 235 million on the average as shown in Annex 5201. The average annual growth rates of these population forecasted are 1.77% for the low case, 2.77% for the high case and 2.27% for the average case, respectively.

5202 According to the past three population censuses, on the other hand, the average annual growth rates of population of Indonesia are 2.10% for the period from 1961 to 1971, 2.37% for the period from 1971 to 1980 and 2.23% for the period from 1961 to 1980. Among three kinds of growth rate, the average annual growth rate of 2.23% for the period from 1961 to 1980 is close to the average case of the forecast made by LEKNAS-LIPI. Further, taking into consideration the effect of family planning for the future, the average annual growth rate for the period from 1961 to 1980 is adopted to project the population in 2000. The estimation is firstly carried out by Kecamatan based on the 1980 census and the average annual growth rate of each Kecamatan for the said period. Then, the projected population in the Study Area is obtained and tabulated in Annex 5201 compared with the future population figures for the Kabupatens of Serang, Lebak, Pandeglang and Bogor, the Province of West Java, the Java island and the whole Indonesia, being estimated in the same manner.

5203 The total population in the Study Area is estimated to be 2.63 million in 2000. The Kecamatans of Serang, Cilegon, Pulomerak and Kasemen have the average population growth rate of more than 3% per annum for the period from 1961 to 1980 and the share of 18% in the total population of the Study Area in 1980. And this share will grow up to 22% in 2000. If industrial and commercial development activities are more intensified, the future population of these Kecamatans would increase with a higher growth rate than the projected growth rate.

5204 The urban population in the Study Area is estimated on the basis of the forecasted future population of eight Kecamatans and the population distribution ratio between urban and rural as mentioned in Paragraph 3224. The projected urban population in 2000 is 0.29 million as shown in Annex 5204, corresponding to 11% of the total population in the Study Area.

5.3 Irrigation Water Demand

5.3.1 Projected irrigation area

5311 In the Study Area, flat lands of lowlying area have almost been developed as wet paddy fields, but there still exist a lot of lands moderately suitable for paddy cultivation. These lands are distributed on the slopes of 2° to 15° and have partly been terraced for wetland paddy cropping where river flow is available nearby and slope is not so steep. The remaining lands totalling 71,000 ha which belong to this moderately suitable class are presently used to grow dryland paddy and other upland crops and to establish tree crop plantations. It is required for the development of new wet paddy fields on such rather steep lands to provide for supplemental water source, other than rainfall, which may meet the water demand fully throughout the wet season. Due to the topographic condition, however, pump facilities are indispensable from artificial water supply systems for wet paddy fields to be newly developed on these lands. In consequence, the areal increase in wet paddy fields is not taken into account in projecting the future irrigation area until the target year of 2000.

5312 The existing irrigation schemes in the Study Area comprise the double cropping area of 19,200 ha and the single cropping area of 43,500 ha under normal climate. When the dry season is abundant in rainfall and river discharge, the double cropping area increases to 31,000 ha.

Out of the single cropping area, DPU irrigation schemes cover 30,500 ha in total including 14,600 ha in the Ciujung irrigation scheme, 1,800 ha in the Cibanten irrigation scheme, 1,400 ha in the Cisangu irrigation scheme and 1,300 ha each in the Cicinta and Ciwaka irrigation schemes. To increase cropping intensity through development of year-round irrigation water source, the priority is given to such existing single cropping areas in view of effective water resources development, even if some capitals have been invested to improve the existing irrigation and drainage systems.

5313 There exist wet paddy fields totalling 30,300 ha without provision for irrigation facilities in the Study Area. Out of these rainfed paddy fields, a lot of about 8,000 ha is concentrated on the terrace of which topography ranges fairly undulating to flat in the Kecamatans of Pamarayan, Kopo, Cikande and Carenang. Farmers in this area are proficient in paddy cultivation, but, due to rainfed cropping, they are obliged to gain low harvests compared with those of beneficiaries under the existing irrigation schemes. The urgent need for introduction of year-round irrigation system is envisaged at the outset.

5314 Taking into consideration the importance and urgency of an increase in self-sufficiency of rice through irrigation development, the future irrigation area is projected by water source for the target year of 2000 as shown in Annex 5314. The projected irrigation area will increase from 62,700 ha in 1982 to 70,900 ha in 2000 for the wet season cropping and from 19,200 ha in 1982 to 43,200 ha in 2000 for the dry season cropping in the Study Area.

5.3.2 Proposed cropping pattern

5321 Rice is the most profitable crop among various kinds of annual crops when it is grown on a scale of great magnitude by receiving irrigation water throughout the year. As for vegetables to be grown in the dry season, there are many competitive producing areas located nearer to the largest consuming center, Jakarta. From the viewpoint of overall planning on water resource development, two cropping of wetland paddy is taken into account as the proposed cropping pattern for the whole irrigation area, aiming at the estimate of future irrigation water demand. Within the estimated water demand, some minor changes can be made in reviewing comparative patterns for dry season cropping.

5322 In formulating the proposed cropping pattern, a period of one month is considered as a given condition that it is required for maintenance works of the primary canals of the existing Ciujung irrigation scheme and the K-C-C irrigation scheme to be newly planned. To meet this condition, a medium term variety such as Cisadane is selected for the wet season cropping and a short term variety like IR 36 is chosen for the dry season cropping.

5323 Five alternative cropping patterns are made for comparison of irrigation water requirement and proper timing of farming practices. As a result, the most effective one, comprising the wet season cropping starting from November to mid-January with its harvesting period from March to May and the dry season cropping commencing from mid-April to the end of June with its harvesting period from August to the end of September, is adopted as the proposed cropping pattern under the Golongan system having three blocks as illustrated in Annex 5323. The proposed cropping pattern is almost similar to the present patterns prevailing in the irrigation schemes of the Study Area.

5.3.3 Irrigation water demand

5331 The irrigation water demand is calculated on monthly basis for the proposed cropping pattern. Due to insufficiency of field measurement records on evapotranspiration, percolation rate and irrigation loss, many simplified assumptions are set in this calculation. In order to estimate storage capacities required for the study on water source facilities, the irrigation water demand is calculated for the period of 11 years from 1972 to 1982 when the discharge records are available at the Rangkasbitung gauging station on the Ciujung river.

5332 In the calculation, the crop water requirement is equal to the sum of presaturation, evapotranspiration and percolation rate, and the irrigation diversion requirement is obtained by dividing the balance between the crop water requirement and effective rainfall by overall irrigation efficiency.

5333 The estimate of evapotranspiration value is based on the modified Penman method which uses the crop coefficient value recommended by PROSIDA. As to the percolation rate, PROSIDA's standard is adopted. Land preparation requirement under the condition of plot-to-plot irrigation is estimated by employing the formula developed by Zijlstra and Van de Goor. The effective rainfall is assumed to be 40% of monthly rainfall during paddy growing period and 70% of monthly rainfall during land preparation period. The areal rainfall for the period from 1972 to 1982 is estimated by using monthly rainfall at Serang and the Thiessen method with some adjustments. The irrigation efficiency is estimated to be 56% under present conditions of the existing irrigation schemes and 64% as target value which is adopted to the projection of irrigation water demand, taking into consideration the PROSIDA guideline. Details of discussion are described in Appendix H.

5334 The irrigation diversion requirement is estimated on the basis of the proposed cropping pattern with the cropping intensity of 200% and under the rainfall condition during the period from 1972 to 1982. The estimated annual irrigation diversion requirement ranges from 531 to 1,049 mm for the wet season cropping and from 1,167 to 1,435 mm for the dry season cropping in the existing Ciujung irrigation scheme. The diversion requirement estimated is between 823 and 1,311 mm in the wet season and from 1,170 to 1,376 mm in the dry season for the K-C-C area. The average annual irrigation diversion requirement estimated under the said condition is 2,052 mm for the Ciujung irrigation scheme and 2,278 mm for the K-C-C area.

5.4 Domestic and Industrial Water

5401 For the projection of water demand for domestic water supply, the served population ratio and the unit average daily water demand are set based on the study result on the recent trends of these two factors in Jakarta and the Study Area. The assumed ratio of served population is 0.44 in 1980, 0.70 in 1990 and 0.80 in 2000 for the urban area and 0.195 in 1980, 0.44 in 1990 and 0.65 in 2000 for the rural area. The assumed per capita average daily water demand is 110 lit/d in 1980, 125 lit/d in 1990 and 160 lit/d in 2000 for the urban area, 75 lit/d in 1980, 94 lit/d in 1990 and 120 lit/d in 2000 for the IKK area, and constant to 60 lit/d for the rural area.

5402 The unit industrial water demand of the Cilegon Industrial Estate in the future is forecasted to be constant to 1.25 lit/s/ha based on the assumption that the common machinery industries are to be introduced and the unit industrial water demand by each industrial category is to be similar to that in Japan. For the other existing industries, the unit water demand is assumed to follow the present trend. Detailed discussions are given in Appendix I.

5403 The projected water demand in the Study Area will increase to 1.13 ton/s for domestic use and 1.18 ton/s for industrial use in 1990, and 1.78 ton/s for the former and 2.77 ton/s for the latter in 2000 as given in Annex 5403.

5.5 Other Water Demand

5.5.1 River maintenance flow

5511 A certain amount of discharge from the reservoir and that from the point of diversion is necessary to be released to maintain river water quality and environment in downstream reaches of the river. Along the Ciujung river, as there is no intake downstream from the Pamarayan weir, the minimum discharge for river maintenance is estimated, on the basis of the drought flow of 10 years return period, to be 4.70 m^3/s from the Pamarayan weir and 1.40 m^3/s from a potential dam site at Karian. The estimate discharges are based upon the drought flow data at the Rangkasbitung gauging station for 11 years from 1972 to 1982, taking into account the catchment areas, annual rainfalls and losses in the three catchments at Rangkasbitung, Pamarayan and Karian.

5.5.2 Fish pond water

5521 The existing fresh water fish ponds of small sizes and with a total area of 665 ha are scattered in the Ciujung river basin and there is no integrated or improved plan because of low development potentiality. The Kabupaten Office of Pandeglang has a plan to develop new fish ponds totalling 95 ha through REPELITA IV. Taking the above situation into account, therefore, the future hectarage of fresh water fish pond in the Study Area is projected to increase from 665 ha in 1981 to 760 ha in 2000.

5522 In general, it is necessitated to maintain the fish pond water depth of 1 m for intensive fresh water fish culture. From this, the total maximum water demand is estimated to increase from 6.7 million m^3 in 1980 to 7.6 million m^3 in 2000. This demand will be mostly met by surplus runoff in the wet season.

6. DEVELOPMENT PLANS

6.1 Development Needs

6101 Mainstay in the Study Area is rice-based agriculture for which farming population is predominating. Hence, it is necessary to enhance the agriculture so that the farmers' income could be increased and accordingly the living standard in the Study Area could be raised. For the agriculture to be enhanced, the item needed is, among others, the irrigation.

6102 The industrial area concentrated near Cilegon is also important for the economy of the Study Area. For the future prosperity of the industry of this area, the item needed is, among others, also water. The area near Cilegon is, however, not favoured with water resources either from surface water or from groundwater.

6103 Domestic water supply is important to raise the level of the towns and villages in the Study Area. The water supply for these towns and villages will have to depend on the surface water as far as possible because of the cost. Only for those towns and villages which are located far from available surface water source, the supply will depend on groundwater to be available by wells or from springs.

6104 Some of the towns and villages and some of the rural areas are suffering from floods or inundation. For such towns and villages, removal or mitigation of damages by floods or inundation is needed to raise the level of economic activities and to stabilize the livelihood of the inhabitants. For such rural areas, removal or mitigation of the inundation is needed to raise up the productivity.

6105 There is not yet hydroelectric power station in the Study Area. Though the electric power is not an item to be subsidized in an area, yet it is good to support power to a larger system in which the Study Area is encompassed if hydroelectric power could be generated in the Study Area at a cost acceptable.

6.2 Development Potential

6201 It is comprehended that available arable lands in the Study Area have been cultivated for paddy-based agriculture leaving almost no room for new reclamation. These cultivated lands are mostly irrigated and some parts are left unirrigated. Existing irrigation facilities are designed to provide supplemental irrigation in the wet season, and the dry season irrigation is made only by the available water in the dry season. Hence, irrigated area in the irrigation commanding area in the dry season becomes limited.

6202 For the purpose of increasing the agricultural products, it is needed to increase the irrigated area. For this aim, it is necessary (1) to provide irrigation water in the dry season for those areas which have irrigation facilities, and (2) to construct new irrigation facilities and to provide irrigation water throughout the year for those areas which have not yet irrigation facilities. In this context, the demand for irrigation water is already existing.

6203 Demands for town and village water supply are of nature to grow with time. Provision of water for these demands is integrated in the master plan. Demand for the industrial water supply in the Cilegon area is not yet quantifiable because the enterprise of industrial estate is still in the preparation stage. However, provision of water for this demand is also integrated, assuming the water requirement per unit area of estate and the timing of implementation of the estate.

6204 Hydroelectric power generation in the present study is considered to follow the possibility to be created for other purposes. Hence, this category is not of the main subjects of the present study.

6205 Damages by the floods and inundation caused by the Ciujung river are taking place almost every year. Hence, demand for removal or mitigation of such damages is existing, and necessary countermeasures will have to be taken incorporated in the water resources development.

6.3 Development Strategy

6301 The arable lands in the Study Area are located in two patterns. On the low lands which occupy the northern and northeastern parts of the Study Area, the arable lands are concentrated in a large scale. These lands are suited for the irrigation schemes of large size. Whilst in the hilly areas which occupy the central and western parts of the Study Area, the arable lands of small sizes are scattered. They are not suited for the irrigation schemes of middle or larger size. On the other hand, the industrial area is located in the northwestern part of the Study Area. Thus, the area for which water is demanded is mostly concentrated in the northern and northeastern parts of the Study Area.

6302 As the water resources in the Study Area, the surface water and groundwater are considered. As for the surface water, the largest source is the Ciujung river together with the Cibeureum river which yields nearly two thirds of the surface water of the Study Area. Other rivers such as the Cibanten, Cidanau, Kali Anyer and other minor rivers share the rest of the total outflow. Groundwater with suitable yield for use is only available around the Gunung Karang in rather high elevation, between Els. 200 and 300 m, and they have already been used up.

6303 The dry season flow of the lower Ciujung river is fully used by the existing Ciujung irrigation scheme. The dry season flow of the Cibanten river is also fully used by the existing Cibanten irrigation scheme. As for the Cidanau river, the intake structure for P.T. Krakatau Steel Works had been built, and the capacity almost coincides the minimum dry season flow of Cidanau river. The springs around the Gunung Karang are already used fully for the local irrigation schemes of small sizes and for the town water supply. In consequence, the surface flow in the dry season and the spring water have been used almost fully, leaving very little residue for further use.

6304 Use of the dry season flow is as such, only the measure to use more water is to tap the wet season flow which is abundant and left untouched. The means of tapping the wet season flow are the storage reservoirs by dam on the upper reaches of the major rivers in the Study Area.

6305 Thus, the strategy of the present study on the water resources development in the Study Area is to overcome two conditions. One condition is that the water source for further use is biased in the wet season. The other is the condition of location that the possible water sources are located in the southern part of the Study Area whereas the demand areas are located in the northern and northeastern parts of the Study Area.

7. WATER USE AND MANAGEMENT PLANS

7.1 Flood Control

7.1.1 General

7111 The lower reaches of the Ciujung and Cibanten rivers have already been provided with dykes, and their designs have been put under review in the drainage improvement project on the Ciujung irrigation scheme by PROSIDA. At present, the river improvement works are under way by PROSIDA for the river sections of 9 km on the lower reaches of the Ciujung river and 6 km on the lower reaches of the Cibanten river. Their design flood discharges are estimated on the basis of 25 years return period.

7112 The basic consideration in planning river improvement under the framework of the present study are decided, taking account of the results obtained by field survey and examples of other river improvement projects in Indonesia, as follows:

(1) The return period of the design flood discharge for the master plan of the Ciujung river will be 50 years.

(2) The first stage improvement of the Ciujung river will be planned with the design flood discharge of 10 years return period.

(3) The Manning's roughness coefficient of the Ciujung river, for the estimation of flow capacities, will be 0.030 in general except the river courses with coarse bed materials of gravel or boulder.

(4) In view of the fact that the Cibanten river improvement works have already been under implementation by PROSIDA on the design flood with the return period of 25 years, the on-going plan will be considered in the master plan.

7.1.2 Ciujung river system

7121 The Ciujung river has the course length of about 136 km and the catchment area of 1,850 km^2 at the estuary. Three main tributaries, the Ciberang, Cisimeut and upper Ciujung rivers join at Rangkasbitung. The conditions of river channels along the main stem and tributaries of the Ciujung river are as follows:

(1) From the estuary to Kragilan (18.3 km point): The riverbed slope is from 1/6,000 to 1/5,000 and the river width is from 170 to 100 m. This section has already been provided with dykes on both river banks. The river improvement works, mainly by heightening of dykes, are under way for the river section of 9 km with the design flood discharge of 1,100 m^3/s.

(2) From Kragilan to the Pamarayan weir (37.1 km point): The mean riverbed slope is 1/3,200 and the river width is from 100 to 150 m. The embankments of the Ciujung irrigation canals running on both river banks form the boundaries of flooded area of the Ciujung river. A remarkable river bend exists about 3 km upstream from the Kragilan bridge, which has resulted in the collapse of river banks.

(3) From the Pamarayan weir to Rangkasbitung (54.0 km point): The mean riverbed slope is about 1/3,000. Many meanders exist in this section, which have resulted in the collapse of river banks. The sedimentation is remarkable on the riverbed upstream from the weir, which may aggravate the flood water level. The present longitudinal profile of the Ciujung river is illustrated in Annex 7121.

(4) Upstream from Rangkasbitung: The conditions of river channels along the three main tributaries upstream from Rangkasbitung are as follows:

- The upper Ciujung river has the riverbed slope from 1/2,400 to 1/770 and the river width is about 50 m from Rangkasbitung to the possible dam site at Bojongmanik. Some troubles caused by the collapse of river banks are seen giving damages to the road and farmland along the river.
- The Ciberang river has the riverbed slope of 1/2,500 from Rangkasbitung to the confluence of the Cisimeut river and 1/1,300 further upstream to the possible dam site at Karian. The river width is about 50 m. Some short cuts have already been constructed on the large bends near Rangkasbitung. Groynes are built near the confluence of the Cisimeut river to stabilize the river channel.
- The Cisimeut river has the riverbed slope from 1/2,000 to 1/560 from the confluence of the Ciberang river to the possible dam site at Pasir Kopo. The river width is about 50 m.

7122 The Pamarayan weir is the most important structure on the Ciujung river at present. It was completed in 1918 to divert river water to the Ciujung irrigation scheme. The weir has a total crest length of 160 m with 10 gates of 12 m in span and 6 m in height. During the flood in November 1981, the gate hoists were operated by man-power, but they have been motorized by diesel driven generator since then.

7123 The flow capacities of the Ciujung and Ciberang rivers, from the estuary to Karian, are estimated on the basis of P3SA's river cross-sectional and longitudinal survey results and by using the non-uniform flow calculation.

The flow capacities of the upper Ciujung and Cisimeut rivers are estimated based on JICA's survey result and by adopting the uniform flow calculation. The Manning's roughness coefficient is assumed to be 0.030 for the lower reaches of the upper Ciujung river and 0.035 for the Cisimeut river and the upper reaches of the upper Ciujung river. The estimated flow capacities are as below and shown in Annex 7123.

(1) Along the Ciujung river: 1,000 m^3/s from the estuary to Kragilan, 700 m^3/s from Kragilan to the Pamarayan weir and 400 m^3/s from the Pamarayan weir to Rangkasbitung.

(2) Along the Ciberang river: 400 m^3/s from Rangkasbitung to the confluence of the Cisimeut river and 300 m^3/s upstream thereafter to the possible dam site at Karian.

(3) Along the upper Ciujung river: 400 m^3/s from the confluence of the Ciberang river (0 km point) to the 10 km point, 200 m^3/s from the 10 km point to the 25 km point, 430 m^3/s from the 25 km point to the 30 km point and 750 m^3/s upstream thereafter to the 40 km point.

(4) Along the Cisimeut river: 400 m^3/s from the confluence of the Ciberang river (0 km point) to the 5 km point, 200 m^3/s from the 5 km point to the 20 km point and 400 m^3/s upstream thereafter to the 30 km point.

7.1.3 Flood damage

7131 A flood damage survey on the Ciujung river basin was carried out by the Second M/P Study Team, based on the data from the Serang and Pandeglan-Rangkasbitung Regional Offices, DPUP, informations obtained in the flooded area, the topographic map of 1/50,000 in scale and the land use map of 1/25,000 in scale. The survey revealed the inundated area, number of submerged houses and buildings, extent of

farmland by crop and inundation depth during the flood in November 1981 which is reported to have inflicted the largest damage in the past.

7132 In November 1981, the flood inundated 4,800 ha from the estuary to the Pamarayan weir and 850 ha upstream from the Pamarayan weir as shown in Annex 7132 (1/4). The inundation area is illustrated in Annex 7132 (2/4). The number of inundated houses and buildings was about 6,000 downstream from the Pamarayan weir and about 2,400 upstream from the Pamarayan weir as shown in Annex 7132 (3/4). The inundated farmland area was 4,600 ha downstream from the Pamarayan weir and 770 ha upstream from the Pamarayan weir. The estimated flood damage at the 1982 current price amounts to Rp 5.5 billion downstream from the Pamarayan weir and Rp 3.9 billion upstream from the Pamarayan weir as summarized in Annex 7132 (4/4).

7133 The average annual flood damage is estimated as follows:

(1) The results of non-uniform flow calculation for the Ciujung river show that the no-damage flood discharge at the Rangkasbitung gauging station will be approximately 500 m^3/s, which is roughly equivalent to a probability of 1/1.

(2) From the same non-uniform flow calculation, the flow corresponding to the flood mark stage at the Rangkasbitung bridge is estimated to be 1,150 m^3/s, which is equivalent to a probability of about 1/20, taking account of the flood peak data at the Rangkasbitung gauging station over a period of 10 years from 1972 to 1981. As the flood peak data at the Rangkasbitung gauging station are affected by the natural flooding and inundation along the upstream reaches, the derived probability of 1/20 represents the probability of flood damage

under the natural conditions, however, resulting in a smaller peak value than that of the standard project flood of the same probability.

(3) Thus, flood damages are assessed on the assumption that the no-damage flow probability would be equivalent to 1/1, and the damage by the flood in November 1981 would be equivalent to a probability of 1/20, with the damage estimated based on interpolation or extrapolation for other probable years.

(4) Assuming the condition of year-round irrigation system to be completed, the average annual flood damage is estimated to be Rp 1.9 billion in the downstream area of the Pamarayan weir and Rp 1.4 billion in the upstream area for 10 years return period, and Rp 2.3 billion in the former and Rp 1.7 billion in the latter for 50 years return period.

7.1.4 Flood regulation by dam

7141 The flood regulation, by flood control storage at the possible dam site, is studied considering the type of spillway without gate. Based on the standard project flood of 50 years return period, the flood regulation is planned for the possible reservoirs at Karian, Pasir Kopo and Bojongmanik as shown in Annex 7141. The regulated discharge is expected to be 440 m^3/s at Karian, 570 m^3/s at Pasir Kopo and 400 m^3/s at Bojongmanik. The flood control storage expected is 30 million m^3 at Karian, 15 million m^3 at Pasir Kopo and 16 million m^3 at Bojongmanik.

7142 The effect of flood regulation by reservoir upon Rangkasbitung and the downstream reaches is estimated for the two cases of 50 and 10 years return periods, respectively, as shown in Annex 7142. The flood regulation in both cases will reduce discharge in the main stem of the Ciujung

river downstream from Rangkasbitung by 300 m^3/s by one reservoir at Karian, 400 m^3/s by two reservoirs at Karian and Pasir Kopo, and 600 m^3/s by three reservoirs at Bonjongmanik in addition to the above in the case of 50 years return period.

7.1.5 Alternative plans and design flood distribution

7151 Two series of river improvement plans are made for the Ciujung river system, which are the improvement plan of the master plan level with the design flood discharge of 50 years return period and for the first stage improvement plan with the design flood discharge of 10 years return period. The latter aims mainly at the mitigation of flood damage around Rangkasbitung for the first stage purpose. In studying the alternative river improvement plans, the effect of flood regulation by the three possible reservoirs is compared from the economic aspects and then the two possible reservoirs at Karian and Pasir Kopo are incorporated to seven alternative plans as shown in Annex 7151.

7152 The design flood distribution for each alternative case is obtained based on the standard project flood as given in Annex 4138 and the effect of flood regulation by reservoirs. It is presented in Annex 7152 (1/2 & 2/2).

7.1.6 River improvement plan

7161 The river section subject to the study is as follows:

(1) Ciujung river: The section of 54 km from the estuary to Rangkasbitung, including the confluence treatment of the Ciberang river, is subject to the study. However, for the first stage plan, the section of 17 km from the Pamarayan weir to Rangkasbitung is subject to the study if the design flood is less than 1,100 m^3/s.

(2) Upper Ciujung river: The section of 10 km upstream from Rangkasbitung is subject to the study. In the first stage plan, however, the section of 5 km near Rangkasbitung is subject to the study.

(3) Ciberang river: The section of 3.5 km from Rangkasbitung to the confluence of the Cisimeut river is subject to the study.

(4) Cisimeut river: The improvement of the confluence of the Ciberang river is subject to the study in the master plan level.

7162 The main items of the planning standard for river improvement are as follows:

(1) The standard cross section of the river is planned with the Manning's roughness coefficient of 0.030 for the low water channel and 0.060 for the high water channel.

(2) The standard cross section of dyke is planned, in line with the cross section of dyke under construction by PROSIDA on the lower Ciujung, with the crown width of 4.0 m in general, 6 m when used as a road, and 3 m for the first stage plan, with both side slopes of 1:2.

(3) The design water level is determined by non-uniform flow calculation. A freeboard of 1 m will be provided throughout the section subject to the study. The design bed slope is determined in consideration of the planned short cut and the existing riverbed slope.

(4) The low water channel is planned with side slope of 1:2, and with the standard design depth of 4 m in consideration of the existing channel depth. The high water channel is planned with the width of more than 30 m. Detailed discussions are presented in Appendix E.

(5) The short cut is planned in the section between the Pamarayan weir and Rangkasbitung where stabilization of river channels is difficult owing to the existence of meanderings and river bends.

(6) The sedimentation is remarkable on the riverbed upstream from the Pamarayan weir, which may aggravate the flood water level. Dredging of riverbed is planned in this section.

7163 The river improvement plan on the master plan level is made covering the whole section subject to the study as shown in Annex 7163 (1/2 & 2/2). Main points of the plan are as follows:

(1) The reduction of channel length by the planned short cut totals 9.0 km comprising 0.8 km between the estuary and Kragilan, 2.7 km from Kragilan to Pamarayan, 3.7 km between Pamarayan and Rangkasbitung, and 1.8 km for the upper Ciujung river.

(2) By the planned short cut, the riverbed gradient will change from 1/5,000 to 1/4,780 between the estuary and Kragilan, from 1/3,200 to 1/2,600 between Kragilan and Pamarayan, and from 1/3,000 to 1/2,200 between Pamarayan and Rangkasbitung.

(3) Dredging in the river section upstream from the Pamarayan weir is planned to remove the sediment above the planned riverbed gradient, which connects the sill height of the Ramarayan weir with the mean riverbed height at Rangkasbitung.

(4) An excavated flood way is planned at the confluence of the upper Ciujung and Ciberang rivers for the purpose of confluence treatment and short cut of the large river bend located downstream.

(5) A flood way of about 900 m is planned for the purpose of confluence treatment and short cut of the river bend of the Cisimeut river.

7164 The river improvement plan in the first stage is made with an emphasis placed on the mitigation of flood damage around Rangkasbitung as shown in Annex 7164 (1/2 & 2/2). Main points of the plan are as follows:

(1) The dredging in the upstream reaches of the Pamarayan weir and a series of short cuts of meanderings thereafter are planned to mitigate the flood damage around Rangkasbitung, with consideration given to the stabilization of river channel and the aspects of cost as well.

(2) No treatment plan for the confluence of the upper Ciujung and Ciberang rivers and that of the Cisimeut and Ciberang rivers is made in the first stage plan.

7.1.7 Cost

7171 The construction cost of river improvement is estimated for six alternatives as shown in Annex 7171. For the first stage plan, the estimated total construction cost excluding price contingency is Rp 35.0 billion for the case F-1 without any reservoir, Rp 10.0 billion for the case F-2 with a reservoir at Karian, and Rp 9.0 billion for the case F-3 with two reservoirs at Karian and Pasir Kopo. For the master plan level, the cost increases to Rp 48.8 billion for the first case, M-1, Rp 47.1 billion for the second case, M-2, and Rp 46.4 billion for the third case, M-3.

7172 The cost needed for flood control is equivalent to the sum of the estimated river improvement cost and the share of flood control in dam construction cost as estimated in Annex 7172. The cost needed totals Rp 16.1 billion for the case F-2 with a reservoir at Karian and Rp 21.9 billion

for the case F-3 with two reservoirs at Karian and Pasir Kopo in case of the first stage plan. It increases to Rp 53.2 billion for the case M-2 and Rp 59.3 billion for the case M-3 at the master plan level.

7.1.8 Benefit

7181 The benefit is estimated on the basis of the average annual damage decrement attributable to the flood regulation by reservoir and the river improvement. The annual benefit estimated for the first stage plan is Rp 3.27 million for the case F-1, Rp 1.98 million for the case F-2 and Rp 2.23 million for the case F-3. The annual benefit estimated for the master plan level is Rp 4.01 million for the three respective cases of M-1 to M-3.

7.1.9 Proposed plan

7191 execution of the river improvement at the master plan level will require a vast investment, which might be excessively heavy when the present socio-economic condition in the Study Area is considered. While, the execution of the river improvement plan for the first stage will require less investment and shorter construction period. Among the alternatives for the first stage river improvement plan, the plan for the case F-2 shows an advantageous condition from the economic viewpoint as summarized below. For the calculation of net present value (NPV) and benefit-cost ratio (B/C), discount rate of 10% is applied.

Case	Alternatives	NPV (Rp 10^6)	B/C	EIRR (%)
F-0	One reservoir at Karian alone	-323	0.91	9.2
F-1	River improvement alone	-4,326	0.79	8.1
F-2	River improvement plus one reservoir at Karian	741	1.07	10.7
F-3	River improvement plus two reservoirs at Karian and Pasir Kopo	-2,143	0.85	8.6

7192 The farmland which will suffer from inundation by a flood of 10 years return period is estimated to be about 3,500 ha at present. Of them, about 650 ha lie in the area upstream from the Pamarayan weir. By executing the alternative plan for the case F-2, the damage occurred in the inundated farmland upstream the Pamarayan weir will be completely reduced. As for the houses and buildings which are estimated at about 6,500 houses, about 1,900 houses in the area upstream from the Pamarayan weir will be completely relieved from inundation. Further, the execution of this plan will minimize the effects of flood and inundation on farmland, houses and buildings in the area downstream from the Pamarayan weir.

7193 In due consideration of the results of comparative study, the alternative plan for the case F-2 with a design flood of 10 years return period is proposed as the flood control plan in the present study. The proposed river improvement plan by itself will be effective to cope with a design flood of about five years return period before the completion of a reservoir at Karian.

7.2 Irrigation Water Supply

7.2.1 Additional water supply for Ciujung irrigation scheme

7211 The Ciujung irrigation scheme of 24,200 ha is the biggest water user in the Study Area at present. Due to water shortage in the Ciujung river during the dry season, especially from June to October, about 9,600 ha on an average can receive irrigation water annually.

7212 A limiting factor to the full irrigation for the Ciujung irrigation scheme is the insufficient discharge capacity of the existing primary canals. The capacity presently provided is 22 m^3/s for the left bank primary canal commanding 18,700 ha and 6 m^3/s for the right bank primary canal benefiting 5,500 ha. The peak irrigation

water demand, when these beneficiary areas are fully irrigated during the dry season, exceeds the said capacities for seven years out of 11 years. If the water source is enough, the existing primary canals can convey irrigation water for 23,160 ha on an average during the dry season.

7213 To increase the discharge capacity of the primary canals is technically possible but economically not attractive at present, when it is executed alone. If the widening of these canals are incorporated with other rehabilitation schemes of existing irrigation schemes and development schemes of further irrigation water sources other than the on-going planning, it will become realistic in the future.

7.2.2 New irrigation water supply for K-C-C area

7221 In the K-C-C area where wetland paddy is grown under rainfed condition only for the wet season, about 8,000 ha in net can be irrigated by gravity irrigation system, if it is newly developed. Under this system, irrigation water will be fed from the Cibeureum river at Gadeg where an intake weir will be constructed. Available river discharge at Gadeg can partly meet the irrigation water demand when the K-C-C area is fully developed. Therefore, water source development by regulating natural flow of the Cibeureum river is indispensable for the year-round irrigation water use in the K-C-C area.

7222 On the Cibeureum river, there is a possible dam site at Cilawang. The expected reservoir capacity is, however, insufficient to meet the whole irrigation water demand for the K-C-C area and accordingly the diversion of additional irrigation water from the neighbouring river basin is necessitated for the full irrigation development of the K-C-C area.

7223 A possible diversion route joining the Cibeureum river at an upstream point of Gadeg starts from a possible reservoir at Karian on the Ciberang river and crosses the watershed between the Ciberang and Cibeureum rivers by a tunnel of 1.5 km in length.

7224 The proposed intake weir at Gadeg is a rock fill type dam with a height of 18 m and a crest length of 160 m. The design figure follows the result of the Feasibility Study on the K-C-C Irrigation Development Project which is carried out simultaneously with the present study. The intake water level at Gadeg is El. 38.5 m which is needed to irrigate elevated areas extending over the southern part of the K-C-C area. This weir can also be of concrete gravity type in view of geology and available materials.

7225 In order to convey diverted water to the whole K-C-C area, construction of a main canal of 30 km in length and secondary canals of 95 km in total is required as illustrated in Annex 7225. The tertiary development is planned for the entire K-C-C area and the size of tertiary block is 70 ha on its maximum, comprising service areas of 12 to 15 ha each commanded by quaternary canals.

7.2.3 Additional water supply for Cicinta irrigation scheme

7231 The Cicinta irrigation scheme of 1,434 ha depends its water source upon the Cicinta river. As the catchment area at the existing intake weir site is 30 km^2, the available river discharge during the dry season can irrigate about 100 ha or only 7% of the whole scheme.

7232 If a reservoir is constructed at Cilawang on the Cibeureum river which is located in the adjacent catchment of the Cicinta river, the stored water in the reservoir can be diverted to the 10 km upstream point of the existing intake weir by constructing a tunnel of 1.5 km in length. As a result, the whole Cicinta irrigation scheme can receive

irrigation water for the dry season cropping for nine years out of 11 years.

7.2.4 Recommended development plan

7241 The additional water supply for the dry season paddy cultivation in the Ciujung and Cicinta irrigation schemes and the new water supply for irrigation use with double cropping in the K-C-C area can be integrated into one development scheme, when one or more reservoirs are constructed with enough storage capacity to meet irrigation water demand of the whole scheme.

7242 Based on the reference year for planning, the year 1972, the average cropping intensity for the three schemes is estimated to be 1.87 under the condition that both of two reservoirs at Karian and Cilawang are fully developed.

7243 It is recommended to give priority to the overall irrigation development plan of the Ciujung, Cicinta and K-C-C areas as a component of water resources development in the Study Area.

7.2.5 Development of small-scale irrigation schemes

7251 In the Study Area, the existing 70 small-scale irrigation schemes cover 20,760 ha in total. Among them, the tertiary development has been completed for 10 schemes totalling 7,535 ha by the end of 1982.

7252 The tertiary development for the remaining area is not scheduled yet. In addition, rehabilitation of existing irrigation facilities such as intake weir, a canal and related structures is necessary. Hence, it is recommended to develop small-scale irrigation schemes, aiming at better water management and effective utilization of limited water resources.

7.2.6 Cost

7261 The construction cost is estimated to be Rp 24.4 billion excluding price contingency for the K-C-C area. It is equivalent to Rp 3.05 million per ha or US$4,420 per ha.

7262 As to the development of small-scale irrigation schemes, a total amount of construction cost excluding price contingency is estimated to be Rp 3.17 billion for the future tertiary development of about 13,000 ha and Rp 0.73 million for the future rehabilitation of the existing irrigation facilities of each scheme.

7.2.7 Benefit

7271 The economic direct benefit attributable to the year-round irrigation water source development is composed of the expansion of dry season paddy cultivation area for the existing Ciujung and Cicinta irrigation schemes and the production increase in the wet season cropping plus the newly obtained production in the dry season cropping for the K-C-C area. The future paddy yield is anticipated to be 4.2 ton/ha for the wet season cropping and 4.5 ton/ha for the dry season cropping in the existing Ciujung and Cicinta irrigation schemes and 5.0 ton/ha for both the wet and dry season croppings in the new irrigation scheme of the K-C-C area.

7272 The incremental economic benefit for the recommended development plan is estimated to be Rp 13.6 billion which is expected annually at the full development stage. The economic benefit is sufficient for covering the construction cost for the development of not only irrigation facilities but also source facilities regulating river water in reservoirs to be constructed at Karian and Cilawang.

7273 The economic benefit expected by the small-scale irrigation development comprise the production increase in the wet season cropping through the stabilization of irrigation water supply and the improvement of irrigation water management.

7.3 Domestic and Industrial Water Supply

7301 The water sources for most municipalities in the Study Area are springs and/or deep wells. The policy of obtaining water sources from springs and/or deep wells is recommendable so long as stable and sufficient yields are available. Only the town of Rangkasbitung and some IKKs would change their existing water sources to the regulated surface water to be developed on the upper reaches of the Ciujung river.

7.3.1 Domestic water supply for Serang

7311 The town of Serang has recently found the stable and sufficient springs in Sukacai yielding 114 lit/s and in Citaman yielding 189 lit/s. The development of water supply system for the town is now being proceeded according to the master plan. The Sukacai and Citaman springs can serve the water supply system of the town with sufficient water and satisfy the projected amount of water demand in the 2000's.

7.3.2 Domestic water supply for Pandeglang

7321 The Karang Tanjung springs have recently been found and started water supply for the town. However, the development of additional water sources of springs to cope with the future water demand in the town is required in succession. In the surroundings of the town, there are plentiful springs and deep wells and the development plan depending upon these is recommendable.

7.3.3 Domestic water supply for Rangkasbitung

7331 The domestic water supply for the town of Rangkasbitung depends on deep wells with sufficient yields at present. However, deep wells used have become lower in water level year by year and there is a possibility of drying up of those deep wells. As the surrounding area of Rangkasbitung has no potentiality for development of new springs and deep wells, it is required that the water supply system depends on the surface water of the Ciujung river which is planned to be regulated by reservoirs located in the upstream reaches from Rangkasbitung.

7332 As to the intake of regulated flow for domestic use, there are two alternative plans comprising a direct conveyance pipe system plan and an intake pumping system plan. Among the possible dam sites on the upper reaches of the Ciujung river, the site at Karian is the nearest to the town of Rangkasbitung. For the comparison of the said two alternatives, the nearest site is selected.

7333 The direct conveyance of raw water from a reservoir at Karian requires to construct a water intake tower with the lowest water level of El. 44 m in the reservoir, a gravity pipeline of about 12 km in length and 500 mm in diameter, and a receiving well with a high water level of El. 23 m in a treatment plant.

7334 The intake pumping system consists of (1) water intake tower in the nearby Ciujung river, (2) grid chamber, (3) intake pump facilities, (4) intake pumping house, (5) raw water transmission ductile cast iron pipe of unlined and 450 mm in diameter, and (6) stop and control valves to a receiving well.

7335 The intake pumping system from the Ciujung river is not recommendable compared with the direct conveyance pipe system from the viewpoint of quality, and quantity of operation and maintenance works.

7.3.4 Domestic water supply for Cilegon and IKKs

7341 The scheduled water supply system for Cilegon depends on the private Krenceng water treatment plant of P.T. Krakatau Steel Works. Taking into consideration that the domestic water supply system is to be managed as a public utility, it is recommendable that the town of Cilegon succeeds to the Krenceng water treatment plant. Then, the future shortage of potable water for Cilegon and nearby IKKs can be filled up by supplementing raw water from the end point of the primary irrigation canal to the Krenceng water treatment plant.

7342 Among 40 IKKs in the Study Area, 24 IKKs can expect to take raw water from the Ciujung and Cibeureum river systems, directly or through the existing primary canals of the Ciujung irrigation scheme. When the stable and sufficient water becomes available by constructing reservoirs on these two rivers, the water supply system for the 24 IKKs will be able to change its water source to regulated water by reservoirs.

7.3.5 Rural water supply

7351 The hand-operated pump system will be developed for the time being for the following reasons; (1) the existing dug wells in villages are often dried up in the dry season and (2) the water demand per unit area is not so much to construct bulk or regional water supply system.

7.3.6 Industrial water supply

7361 Of the projected demand for industrial water in 2000, a total of 0.957 m^3/s will not be met by own industrial water supply system and is proposed to be covered by additional water supply system which is planned to convey raw water from the end point of the existing left bank primary canal of the Ciujung irrigation scheme. This amount

of raw water is recommended to be secured by the regulated flow by the reservoir to be constructed at Karian. The raw water will be pumped up from the said irrigation canal and conveyed to the Krenceng water treatment plant.

7362 The system will consist of raw water intake facilities from the irrigation canal to grit chambers, pumping house, pumping facilities with three units and each capacity of 28.7 m^3/min, a main transmission PC pipe of 1,000 mm in diameter and power receiving sub-station facilities.

7.3.7 Cost and benefit

7371 In the present study, it is stressed on the development of water resources and it is not intended to touch upon the water supply facilities including water purification plants.

7372 The direct conveyance pipe system to supply raw water from the reservoir at Karian to the town of Rangkasbitung costs Rp 360 million for construction, while the intake pumping system from the Ciujung river costs Rp 390 million for construction and Rp 25 million for annual operation and maintenance. The benefit of direct conveyance pipe system is estimated to be Rp 55 million.

7373 The intake pumping system from the Ciujung primary irrigation canal costs Rp 1.18 billion for construction and Rp 340 million for annual operation and maintenance. However, the alternative to expand the existing intake facilities including construction of the Cidanau reservoir costs Rp 21.3 billion for construction and Rp 540 million for annual operation and maintenance. The cost of intake pumping system from the irrigation canal is cheaper by Rp 20.3 billion than that of the expansion plan.

7.4 Other Development Plans

7.4.1 Watershed management

7411 The watershed management for water storage, prevention of flush floods and control of soil erosion should be applied at least to the catchment areas at potential dam sites. At present, the lands are developed for agricultural use at the rate of 17% for paddy fields, 49% for upland fields and 2% for plantation of the total catchment areas. Remainings are covered with shrub, dense forests and grasses. The estimation of soil erosion hazard shows that the areas are not faced with the necessity of an emergency measure for soil conservation. In this view, afforestation and reforestation to such areas are not practical.

7412 On the other hand, from agricultural point of view, agro-forestry is recommended on the cultivated land with small farms and individual plots scattered over the area, establishing a plantation of fast-growing trees on a patch of cleared land at the same time as the farmer plants food crops.

7.4.2 Hydroelectric power generation

7421 There are several hydro potential sites found out in the Study Area. But they can not be justified economically standing itself, because their benefits are too small compared with their costs. Among them, only the Karian site is promising because of its preference for irrigation.

7422 Through the present study of suitable sites for reservoirs to store water for optimum use of water resources in the upper Ciujung catchment, the possibility of developing multipurpose facilities at the dam sites to include power generation is found out. They are briefed in the paragraphs to follow.

7423 The Karian site is the best for the irrigation purpose. It can not increase the reservoir capacity for electric power generation by reason of topographical upper limit. Inflow to the reservoir decreases down to 2.8 m^3/s in October, and it brings limited output of hydroelectric power.

7424 However, as the result of preliminary study, a 2,800 kW of generation can be installed. No cost allocation is required for dam facilities against power generation. Annual generated energy will be 19,000 MWh. It is estimated that annual benefit is Rp 897 million, though its construction cost is Rp 2.0 billion and its annual operation and maintenance cost is Rp 55 million.

7425 It is concluded that the economic analysis is justified as feasible dependence on 3.0 in B/C and 32% in EIRR for power generating facilities itself, when no allocation of dam cost is made.

7426 The Pasir Kopo site has high hydro potential for power generation. However, the construction cost of dam is so expensive that the feasibility of irrigation come to falldown. Therefore, there is no reason to develop the multipurpose dam itself, even if the benefit to power generation is counted of high priority.

7427 It is concluded that the hydroelectric potentials in the Study Area except the Karian can not be developed.

7.4.3 Environment

7431 The Ranca Danau Reserve located in the Kecamatan of Padarincang in the Kabupaten of Serang is composed of swamp, fresh water swamp forests and matured montane forests which are in jeopardy of destruction as a result of illegal logging and farming.

7432 The practical way for re-establishing the Ranca Danau Reserve is to keep severely present status away from human interference. The areas amount to 2,180 ha on swamp and about 960 ha on mountain area including not only natural area but also disturbed area. The Reserve's boundary enclosing wet paddy fields should be defined as soon as water resources development plan in this basin will be established in future. In any case, changes in the chemical quality of water may be unavoidable with increasing of human activities and excessive use of agro-chemicals in the basin may affect the ecological system in the swamp.

8. WATER RESOURCES DEVELOPMENT PLAN

8.1 Selection of Dams

8101 For the purpose to select the sites for dam and reservoir which are best suited for the development to meet the water demand, thorough map study is made so that every conceivable sites in the Study Area could be found out. As the results, 16 sites are found on seven rivers as shown in Annex 8101. They are one site on the Cidanau river, one site on the Kali Anyer river, two sites on the Cibanten river, seven sites on the upper Ciujung river, two sites on the Cisimeut river, two sites on the Ciberang river and one site on the Cibeureum river.

8102 The dam site on the Cidanau river, the Cidanau site, is located several km upstream from the estuary or the existing intake owned by P.T. Krakatau Steel Works. The available storage capacity is not large as portrayed in Annex 8102, and the geology is not so favourable as described in Appendix D. Also location is not suitable for the water demand areas except for the Cilegon area. As the Cidanau river has natural swamps near the origin, the river flow is less influenced by the season in comparison with other rivers in the Study Area, so that needs for storage are less keen than the other rivers. Hence, this site is considered to have low priority for the development.

8103 The dam site on the Kali Anyer river, the Kali Anyer site, is located several km upstream from the estuary. Topography is not so favourable for dam and reservoir as shown in Annex 8102 though the geology is not defective as explained in Appendix D. Also, location is far from the main water demand area except for the Cilegon area, and the catchment area is small. Hence, this site is considered not suitable to meet the present water demand. In future,

if the Anyer coast is developed for the tourism area, this site may suit for the source for the domestic water supply.

8104 Two dam sites are found on the Cibanten river, one is located several km upstream from the Serang town, and the other a few km further upstream. New map in 1/5,000 scale is available, and the storage capacity (H-V curve) is measured on the new map. The topography and geology are excellent on both sites as pointed out in Appendix D. However, the storage capacity on both sites is far less favourable in comparison with other sites on the Ciujung or Cibeureum rivers. Also, the catchment area is small, and the flow is somewhat more constant than the other rivers as this river has a spring origin, meaning that the needs for storage is less keen. Therefore, the two dam and storage sites on the Cibanten river are considered unsuitable to meet the present demand for water.

8105 Seven dam sites are found on the upper Ciujung river, and they are tentatively referred to as the sites No. 1 to No. 7 from the upper one in order. New map in 1/5,000 scale is available for the site No. 3, hence, the H-V curves are drawn based on 1/5,000 map for the site No. 3, and on 1/50,000 map for other sites. In view of the available storage capacity and the storage efficiency, the site No. 3 is the best among the seven sites. This site is referred to as the Bojongmanik site. Topography and geology is suited for constructing a dam of fill type as given in Annex 8102 and Appendix D. This site is remained for further study.

8106 Two sites for dam and reservoir are found on the Cisimeut river. Each site is suited for providing storage reservoir by dam, so that these two plans can be coexisting. New map in 1/5,000 scale is available on the upper site, hence, the H-V study is made on 1/5,000 map for the upper site and on 1/50,000 map on lower site. In view of the

available storage and the storage efficiency, the upper site is preferable to the lower site. The upper site is referred to as the Pasir Kopo site. Topography and geology are suited for constructing a dam of fill type as shown in Annex 8102 and Appendix D. This site is remained for further study.

8107 Two dam sites are found on the Ciberang river. The lower site corresponds to the famous Karian dam site which has been surveyed partly by P3SA. New maps in 1/5,000 scale by Japanese assistance and also in 1/10,000 scale by P3SA are available, and the H-V study is made based on the former. Due to the existence of saddle-shaped topography, the dam height on the lower site suffers from a limit. The upper site, located a few km upstream, can provide a topography for higher dam. However, the dam volume on the lower site can be far smaller than that on the upper site. Taking this advantage, the lower site is preferable to the upper site. The storage efficiency of the lower site is excellent as illustrated in Annex 8102, and geology is suited for constructing a dam of fill type as described in Appendix D. This site is remained for the further study.

8108 One site for dam and reservoir is found on the Cibeureum river, several km upstream from the site for the Gadeg weir. For H-V study, map of 1/50,000 is used. Though the dam can not be high due to topographic limit, the storage capacity and efficiency are excellent as shown in Annex 8102. This site is referred to as the Cilawang site. Geology is suited for constructing a dam of either fill type or concrete gravity type as explained in Appendix D. This site is remained for the further study.

8109 Thus four dam sites are remained for the further study. They are, from the east to the west in order, the Cilawang site on the Cibeureum river, the Karian site on the Ciberang river, the Pasir Kopo site on the Cisimeut river and the Bojongmanik site on the upper Ciujung river.

8.2 Combination of Dams

8201 The water demand is considered as a sum of the irrigation water, the industrial and domestic water, and the water necessary to maintain the lower reaches of the rivers. Flood control effect of the dams are also taken into account. As for the hydroelectric power generation, this category is considered to be incidental to the release of water to meet the said water demand.

8202 The irrigation water demand is considered as a sum of (1) the dry season irrigation water for the existing Ciujung scheme, (2) the dry season irrigation water for the existing Cicinta scheme, and (3) the year-round irrigation water for the proposed K-C-C irrigation scheme. The industrial and domestic water demand is considered as a sum of (1) the industrial and domestic water supply in the town of Cilegon and the vicinity area, (2) the town water supply to Rangkasbitung and (3) the domestic water supply to some of IKKs so far as their locations are suitable for taking the surface water.

8203 Selection of a dam or dams is made so that the aforementioned water demand is met by the flow regulated in the reservoir/reservoirs to be created behind the dam/dams. In assessing the storage requirement, the capacity for the flood control is also taken into account.

8204 Under the said condition, three cases of the water source to meet the storage requirement are considered. They are (1) Karian site alone, (2a) Karian plus Pasir Kopo sites, (2b) Karian plus Bojongmanik sites, and (3) Karian plus Cilawang sites. Among them, the Cases 2a and 2b are the simple comparison that which of the Bojongmanik and Pasir Kopo sites is more favourable. In consideration of the storage efficiency, dam volume and availability of construction materials, the Pasir Kopo site is preferable

to the Bojongmanik site, hence, the Case 2b can be eliminated. Thus, final selection is made from the following three cases; namely

Case 1 Karian site alone,

Case 2a Karian plus Pasir Kopo sites, and

Case 3 Karian plus Cilawang sites.

8205 The storage capacity requirement is calculated on the available hydrologic data from 1972 through 1982. The calculated storage requirement varies by year. On the data of 1972 which is the second driest year and deemed to have the drought with 5 years return period, the requirement calculated is 286 million m^3. Against this requirement, the available effective capacity is (1) 188 million m^3 in the Case 1, Karian dam alone, (2) 310 million m^3 in the Case 2a, Karian plus Pasir Kopo dams, and (3) 242 million m^3 in the Case 3, Karian plus Cilawang dams.

8206 Combination of water source and benefited irrigation areas are as follows:

Irrigation Area	Season	Case 1	Case 2a	Case 3
		Karian dam alone	Karian + Pasir Kopo dams	Karian + Cilawang dams
Ciujung	Wet	24,200 ha	24,200 ha	24,200 ha
	Dry	18,650 ha	21,000 ha	21,000 ha
K-C-C	Wet	8,000 ha	8,000 ha	8,000 ha
	Dry	6,160 ha	8,000 ha	6,950 ha
Cicinta	Wet	-	-	1,435 ha
	Dry	-	-	1,250 ha
Total	Wet	32,200 ha	32,200 ha	33,635 ha
	Dry	24,810 ha	29,000 ha	29,200 ha

8207 Relations between the total effective capacity and the cropping intensity as well as the former and NPV of irrigation benefit are calculated on the three Cases as graphed in Annex 8207. The highest NPV of irrigation benefit is achieved in the Case 3, Karian plus Cilawang dams.

8208 Cost-benefit analysis is made for the comparison purpose of the three Cases. For the calculation of NPV and B/C, discount rate of 12% is applied. The results are as follows:

	Case 1	Case 2a	Case 3
NPV (Rp 10^6)	6,137	-5,265	7,406
B/C	1.15	0.91	1.16
EIRR (%)	13.4	11.3	13.6

In every item, the Case 3 shows the highest value. Therefore, it is comprehended that the Case 3, Karian plus Cilawang dams, is the combination which is most favourable as tabulated in Annex 8208. In this context, the Case 3 is proposed to be worthy of development.

8.3 Planning of Proposed Dams

8.3.1 Karian dam

8311 The Karian dam site on the Ciberang river, tributary of the Ciujung river, is located about 10 km upstream from Rangkasbitung, where the riverbed elevation is about El. 18 m and the river is about 20 m wide. The catchment area is 288 km^2. Both banks are relatively steep to about El. 60 m and therefrom become very gentle. The dam height is limited to about 50 m by the topography as shown in Annex8311.

8312 The geology of the dam site belongs to the marine sediment of the Pliocene. Fine to coarse tuff predominates the foundation rock interposed by lapilli tuff and sandy

shale layers. This rock is soft and weak of which shearing strength is estimated to be about 5 kg/cm^2. Hence, construction of a high concrete dam is difficult. Weathered layer of foundation rock will be 3 to 5 m thick on the both banks and 1 m thick on the riverbed. The Karian dam will, hence, be of rock fill type dam. The fill materials for the core and filter will be available from the river terraces which extend on both banks of the river, 7 to 10 km upstream from the Karian dam site. Materials for rock and rip-rap will be available from the Gunung Sondi area where is about 11 km upstream from the dam site.

8313 The crest elevation will be at El. 70 m, hence, the dam height from the riverbed will be 52 m. The crest will be 510 m long. The design will be of the zoned rock fill dam with center core. Slope of the fill will be 1:3 on the upstream surface and 1:2.5 on the downstream surface. Fill volume will amount to 1.1 million m^3 in total as illustrated in Annex 8313.

8314 Spillway will have a capacity of 1,510 m^3/s which corresponds to the probable maximum flood. The spillway crest at El. 65.5 m will be located on the saddle of the right bank separately from the dam body. Diversion tunnel will run on the right bank for 400 m as shown in Annex 8313.

8315 By the said design, the available capacity of the Karian dam is as follows:

(1) Gross capacity : 261 x 10^6 m^3,

(2) Dead capacity : 43 x 10^6 m^3, and

(3) Effective capacity: 218 x 10^6 m^3 of which
flood control capacity: 30 x 10^6 m^3, and
net storage capacity : 188 x 10^6 m^3.

The dead capacity will be sufficient to receive sediment for 100 years of 1.5 mm erosion per year from the catchment area. In studying the reservoir capacity, the newly prepared map, 1/5,000 in scale with 5 m contour intervals, is used for the Karian site. The stage-area-storage curves (H-A and H-V curves) are given in Annex 8315.

8.3.2 Cilawang dam

8321 The Cilawang dam plan has not been proposed in the foregoing studies, and is proposed for the first time wherewith. This dam site is located on the Cibeureum river, the tributary of the Cidurian river. The dam site is located about 15 km to the southeast of Rangkasbitung. Riverbed at the dam site is El. 50 m and the river is about 15 m wide. The catchment area is 93 km^2. Both banks are relatively steep up to El. 80 m and therefrom becomes very gentle. Therefore, the topographic limit of the dam crest is El. 75 m. Then, the dam will be 28 m high from the foundation rock which will lie 3 m below the riverbed.

8322 Geology of the Cilawang dam site resembles to that of the Karian dam site, being composed of tuff layers. The shearing strength of the base rock will be low, but the construction of a concrete gravity dam will be possible because the dam will not be so high. Although the construction of a fill type dam is possible, the Cilawang dam will be a concrete gravity dam for the following reasons. The fill materials will not be available nearby, and will have to depend upon the same borrow area as that for the Karian dam which is located inside the Karian reservoir area. Hence, if a fill type is taken up, then the Cilawang dam will have to be completed before impounding the Karian reservoir. Next reason is that, as the Cilawang dam site is narrow, the concrete dam is suited for the design of spillway and for the convenience of river diversion during construction.

8323 Crest will be at El. 75 m and 190 m long. Dam will be 28 m high above the foundation which lies 3 m below the riverbed. Dam will be of concrete gravity type and the dam volume will be 70,000 m^3. Spillway will be located on the dam. River diversion during construction will be made by the half river closing method as shown in Annex 8323.

8324 The gross capacity will be 69 million m^3. This value is measured on the map with 1/50,000 scale, hence this value will be subject to change when more precise map will be used. Dead capacity is 15 million m^3 for receiving 1.55 mm thick sediment from the catchment area for 100 years. Effective capacity will be 54 million m^3. The H-A and H-V curves are presented in Annex 8315.

8.3.3 Other structures

8331 Beside the Karian and Cilawang dams, some auxiliary structures are needed except for the irrigation facilities of the K-C-C area including the Gadeg weir located about 5 km downstream from the Cilawang dam. Needful structures are (1) a line of tunnel connecting the Karian reservoir and the Cibeureum river, (2) a line of tunnel connecting the Cilawang reservoir and the Cicinta river, and (3) a line of pipeline connecting the end of the existing left bank primary canal of the Ciujung irrigation scheme and the water source facilities of the Cilegon area which will either be the existing Krenceng reservoir or the Krenceng purification plant.

8332 The tunnel connecting the Karian reservoir and the Cibeureum river will start from the right bank of the Karian reservoir and end on the regulating reservoir behind the Gadeg weir on the Cibeureum river. This tunnel will function to supplement irrigation water from the Karian reservoir to the K-C-C area. The tunnel will be about 1,500 m long with horse shoe shape cross section, 2.5 m

in diameter. A gate will be installed near the starting point. The tunnel will run in the lapilli tuff layers and there will be no problem in construction.

8333 The tunnel connecting the Cilawang reservoir and the Cicinta river will start from the right bank of the Cilawang reservoir and end on a tributary of the Cicinta river. This tunnel will function to supply irrigation water in the dry season to the existing Cicinta irrigation scheme. The tunnel will be 1,500 m long with horse shoe shape cross section, 2.5 m in diameter. The tunnel will also run through the lapilli tuff layers, and there will be no problem in construction.

8334 The pipeline to the Cilegon area will start from the western end point of the existing left bank primary canal of the Ciujung irrigation scheme and end either in the existing Krenceng reservoir or in the Kerenceng purification plant. This pipeline will function to supplement water for the domestic use in the Cilegon area as well as for the Cilegon Industrial Estate. The pipeline will be of prestressed concrete pipe, 6.5 km in length and 1.0 m in diameter.

8335 Both tunnels are needed in early stage for the irrigation of the proposed K-C-C irrigation scheme and of the existing Cicinta irrigation scheme. Whereas the pipeline will become necessary when the supply of water by the existing pipeline from the Cidanau river to Krenceng owned by P.T. Krakatau Steel Works will run short in future. The will of P.T. Krakatau Steel Works to let use the existing facilities for the domestic and industrial use in the Cilegon area has not been promised as yet.

8.4 Groundwater

8401 The groundwater in the Study Area is generally poor in available quantity. In the northern and north-western parts of the Study Area, availability of groundwater is poor limited under the level only to meet the individual domestic use. More water demands than the availability of groundwater have to be supplemented from the surface water as planned in the foregoing discussions.

8402 In the area around the Gunung Karang, groundwater is charged from this mountain. Some perennial springs occur in this area, especially in the area to the east and to the south of this mountain. But water from these springs are exhausted for the domestic use and irrigation of small paddy fields on the slopes. Hence, more groundwater in such an area will be available only by digging deep wells. Supplemental domestic water supply for the town of Pandeglang in future will depend on such deep wells. Supplemental domestic water supply for Serang will depend upon existing springs located to the south of the town of which outflow has been used for irrigation purpose at present.

8403 More use of groundwater for irrigation will not be practical as a whole in the Study Area in view of the recharging capacity and the size of subject areas to irrigate.

9. RECOMMENDED DEVELOPMENT PLAN

9.1 The Plan

9101 The water use and management plans have been discussed in Chapter 7 and the selection of the water resources development plan has been discussed in Chapter 8. Although some duplication of description may occur, the recommended development plan is summarized in this chapter.

9102 The present condition in the Study Area is that the arable lands have fully been cultivated mainly for wetland paddy, and the surface water in the dry season has already been exhausted mainly for irrigation. There remains little possibility to enlarge the cultivation area and to irrigate more area. Therefore, there is no other way than to raise the land use intensity by means of putting use of the river flow in the wet season. This aim can be achieved by providing the storage reservoirs by dams.

9103 The plan to be formulated and realized by the target year of 2000 needs to meet as much water demands as possible at the conceivable lowest cost by full use of the surface water by means of gravity flow. The plan is also needed to be effective for the mitigation of damages caused by floods or inundation.

9104 Water demands in the Study Area are predominated in quantity by the irrigation. Priority areas are the existing irrigation schemes and the areas which have not been irrigated. The demands which are far smaller than the irrigation water demands consist of the domestic water supply to the towns and IKKs and the industrial water supply.

9105 The irrigation areas to be benefited are the existing Ciujung irrigation scheme, the existing Cicinta irrigation scheme and the proposed K-C-C irrigation scheme. Benefited towns are Rangkasbitung, Cilegon and many IKKs. To meet these water demands, the proposed dams for the storage reservoirs are the Karian site on the Ciberang river and the Cilawang site on the Cibeureum river with necessary auxiliary structures. Beside the dams, the improvement of the Ciujung river is proposed for the section of 26 km in and around Rangkasbitung.

9106 Expected effects are as follows: The existing Ciujung irrigation scheme commanding 24,200 ha is irrigated fully in the wet season and about one-third is irrigated in the dry season. This scheme will turn to be irrigated almost fully also in the dry season. The existing Cicinta irrigation scheme commanding 1,435 ha is irrigated fully in the wet season, but only about 100 ha are irrigated in the dry season. This scheme will turn to be irrigated almost fully also in the dry season. The K-C-C area which has not been irrigated encompasses 8,000 ha of wet paddy fields. This area will, with the installation of irrigation facilities, be irrigated fully in the wet season and almost fully in the dry season.

9107 Further, water supply for Rangkasbitung will be realized to take water from the Karian reservoir through pipeline. Water for the Cilegon area is included in the provided discharge. Water demand for 24 IKKs is also provided.

9108 By the effect of the Karian dam and the river improvement works, the floods with less than 10 years return period will turn to be harmless to Rangkasbitung.

9109 The construction cost estimated for each component of the proposed development plan totals Rp 149 billion comprising Rp 72 billion for the Karian dam, Rp 23 billion for the Cilawang dam, Rp 39 billion for the K-C-C irrigation scheme and Rp 15 billion for the improvement of the Ciujung river. These construction costs are broken down as tabulated in Annex 9109 (1/2) and the annual disbursement schedule is shown in Annex 9109 (2/2). The annual operation and maintenance costs are assumed to be 0.5% of the direct cost for dam construction and river improvement and 2% for irrigation facilities.

9.2 Economic Analysis

9.2.1 Basis of economic analysis

9211 Economic analysis for the comparison purpose to select the best alternative plan has been treated for flood mitigation in Chapter 7 and for source development in Chapter 8. In this chapter the economic analysis is collectively described for the final plan proposed in the present study.

9212 The economic viability is evaluated by economic internal rate of return (EIRR) together with NPV and B/C, and a sensitivity test of the result is made with regard to variations in cost and/or benefit.

9213 The evaluation is made on the basis of the following assumptions:

(1) Economic life is taken as 50 years from 1985 to 2034, starting from the stage of detail design.

(2) Benefits which is counted in the evaluation is direct tangible benefits only, and indirect and/or intangible benefits are excluded from the evaluation.

(3) Construction period is seven years for all construction works including the period of two years for detail design.

9.2.2 Economic price and cost

9221 To estimate economic cost and benefit, the economic price is assumed as follows:

(1) Foreign exchange rates of US$1 = Rp 690 and ¥100 = Rp 280 are assumed based on the middle exchange rate of the Bank Indonesia at the end of 1982.

(2) Economic price of paddy at the farm gate is estimated to be Rp 180 per kg based on the international market price at Bangkok forecasted by the World Bank for the year 1995 at the 1982 constant prices.

(3) Economic price of unskilled labourers employed in the construction works is estimated to be 60% of the actual market wage for them with reference to the studies of similar projects.

(4) Transfer payments such as tax and duty are assumed that goods and services procured locally would include transfer payment of 10% of their prices and those imported from abroad would exclude any transfer payments. Land acquisition cost is also assumed as transfer payment.

9222 Economic cost for the construction works is estimated by making the adjustment of the above-mentioned economic price and further by subtracting the price contingency from the financial cost. As a result, the economic construction cost is estimated to be Rp 82.5 billion in total. The economic annual costs for operating and maintenance are estimated to be Rp 569 million on the assumption of 0.5% of the economic direct costs for the dam construction and river improvement and 2% for the irrigation facilities.

9.2.3 Economic benefit

9231 The direct tangible benefit consists mainly of both benefits of irrigation and flood control. The economic benefit is given on the basis of the said economic price. The annual economic benefit is estimated to be Rp 17.3 billion in total at the full development stage.

9232 The direct tangible benefit of irrigation, which occupies a greater part of benefits, is given as the incremental net production value from wetland paddy cultivation in the future between with- and without-project conditions. The benefit will be realized immediately after the construction works of irrigation facilities are completed, and it is expected to increase year by year and to reach its maximum in and after five years.

9233 The direct tangible benefit of flood control is given as the economic effect of decrease in damage to be caused by flood. The benefit will arise immediately after the flood control works are completed. The effect is mainly estimated by decrease in flood damage to houses, household articles, stock assets of offices and shops, agricultural crops, public facilities and business activities.

9234 Besides the above direct tangible benefits, there would be the following indirect and intangible benefits:

(1) Construction of dams and reservoirs will create some opportunities of investment to facilities of industries such as tourism, electric power and inland fishery.

(2) Schemes are expected to give the great employment opportunities for people in the Study Area by the implementation of construction works for dams and irrigation canals as well as river improvement works, by the increased cropping intensities and by the increase in farm labour requirement.

(3) Increase in paddy production will arise the farmer's income level and will contribute to the correction of regional and sectoral inequalities in the wealth, and further it can reduce the amount of imported rice which will result in the saving of foreign exchange.

(4) Stimulative effect is expected to cause the significant growth in industries and economic activities in the Study Area and its surrounding areas.

(5) Implementation of flood control works will promote the effective use of land and will produce such good results as the decrease in diseases due to improvement of environment and the stabilization of people's livelihood due to protection from menace of flood.

(6) Local transportation will be improved by the construction of inspection roads.

9.2.4 Economic evaluation

9241 The economic construction cost is Rp 82.5 billion, and the economic annual benefit is Rp 17.3 billion. The annual flow of economic cost and benefit is shown in Annex 9241. By using the said assumptions and discount rate of 12% for the calculation of NPV and B/C, the results of economic evaluation are 13.8% in EIRR, Rp 9.6 billion in NPV and 1.18 in B/C as shown in Annex 9241. The results show that the proposed plan is economically feasible.

9242 By the effect of irrigation development, the incremental production of paddy is estimated to be 116,600 tons every year. Also the effect of the flood control works will decrease the damage to the agricultural crops in a total area of 3,500 ha and to 6,000 houses in the inundation area.

9.2.5 Sensitivity test

9251 Sensitivity test is tried in two cases such as 10% increase in cost and 10% decrease in benefit. The results are as follows:

Case	EIRR (%)	NPV (Rp 10^6)	B/C
Increase in cost by 10%	12.8	4,288	1.07
Decrease in benefit by 10%	12.7	3,327	1.06

The results show that the proposed plan is economically viable even under these assumed conditions.

10. CONCLUSION AND RECOMMENDATION

10.1 Conclusion

0101 After the survey and study by the First and Second M/P Study Teams, it is concluded that the water resources development in the Study Area is needed to be carried out in as early stage as possible. It is because the water demand for irrigation is already existing in a large scale, that for the domestic use is increasing and that for the industry will appear soon. It is also because the urban and rural areas along the lower reaches of the Ciujung river need to be released from repeated damages by floods and inundation.

0102 The project to be developed as early as possible will consist of such items centering about the Karian dam as:

- Karian dam;
- Cilawang dam as auxiliary storage;
- a tunnel to divert water from the Karian reservoir to the Cibeureum river;
- a tunnel to divert water from the Cilawang reservoir to a tributary of the Cicinta river;
- river improvement works in and around Rangkasbitung;
- irrigation facilities to cover 8,000 ha of net irrigation area over the K-C-C area including the Gadeg weir and a main irrigation canal therefrom to the K-C-C area; and
- a pipeline from the end of existing left bank primary canal of the Ciujung irrigation scheme to Krenceng.

This project will be referred tentatively to as the Karian Multipurpose Dam Project (the Project).

0103 Water provided by the Karian and Cilawang reservoirs includes, beside the irrigation water, sufficient amount of water for the domestic use in Rangkasbitung and some IKKs. There are 40 IKKs in the Study Area. Of them, 24 IKKs as well as Rangkasbitung and Cilegon are located to be able to take water from the proposed water systems. Actual facilities to take water for these towns and IKKs are not included in the Project, but sufficient water to meet the demand has already been included in the plan.

0104 By the effect of the Project, cultivation of two crops of paddy will become possible over such areas as the Ciujung irrigation scheme of 24,200 ha, the K-C-C area of 8,000 ha, and the Cicinta irrigation scheme of 1,435 ha. Then 116,600 tons of paddy will be produced in addition to the present paddy production.

0105 This incremental paddy production corresponds to 40% increase of the present paddy production. On the other hand, the Study Area occupies 6% the population of the Province of West Java, while it currently produces 4% of the Province's paddy production. With the said incremental paddy production, the future paddy production will reach 6% of the Province's paddy production. These facts show that the implementation of the Project is beneficial to the socio-economy of the Study Area.

0106 There are unevenness of income in the Province of West Java and also within the Study Area. The K-C-C area is the depressed area in income in the Study Area, and the Study Area itself is the depressed area in income in the Province of West Java. When the effect mentioned in Chapter 9 is achieved, then the income of both the Study Area and the K-C-C area will be raised to the average level in the Province of West Java.

0107 The Karian dam will be effective to cut the peak flood discharge of the Ciberang river. The river improvement works will be effective, combined with the function of the dam, to turn all the high floods which have less than 10 years return period to the harmless discharge. Existing damages by floods and inundation will be largely mitigated.

0108 As discussed in Chapter 9, the Project will have high values either of NPV and B/C showing that this project is economically viable.

0109 Therefore, it is comprehended that the Karian Multipurpose Dam Project formulated in the present study is worthy of implementation. Since the present study is on the master plan study level, it is necessary to make a feasibility study on this project.

10.2 Recommendation

10.2.1 Recommended development project

0211 The Karian Multipurpose Dam Project will be composed of such components as the storage reservoirs by dams, new irrigation facilities to cover the whole K-C-C area, river improvement works, and related or auxiliary structures.

0212 It is necessary to carry out the feasibility study of the Project because the present study is still on the master plan study level. Hence, it is necessary to take necessary steps for the feasibility study.

0213 It is necessary to know the exact amount of flow at the proposed dam sites such as Karian and Cilawang. Present condition is, however, that the Sajira gauging station installed for the Karian dam site is not suitable to know the exact amount of flow for some technical reasons, and there is no gauging station on the Cibeureum river

neither at Gadeg which is the proposed intake site for K-C-C irrigation nor at Cilawang. In the present study, discharges at Karian and Cilawang are estimated to take analogy to the hydrologic data at Rangkasbitung. In this context, it is recommended to install gauging stations soonest at suitable locations for the planning of the Karian and Cilawang dams.

0214 In planning the irrigation over the Study Area, the irrigation efficiency is assumed to be 64% as a product of 20% physical losses multiplied by 20% operation losses. In reality, prevailing irrigation efficiency of the existing irrigation schemes, especially of the Ciujung scheme is 52% to 53%, showing that the operation losses are more than 35%. In this context, it is recommended to initialize necessary activities to lessen the operation losses. This is important to make the optimum use of water resources which can not be available infinitely.

0215 Water for Cilegon planned under the present study consists of water for the industrial use in the industrial estate near Cilegon and for domestic supply in the Cilegon town. This water will be taken from the end point of the existing left bank primary canal of the Ciujung irrigation scheme and pumped through a pipeline, 1 m in diameter and 6.5 km in length, to either the purification plant or the existing Krenceng reservoir of which present owner is P.T. Krakatau Steel Works. However, the will of P.T. Krakatau Steel Works to let use the plant and the reservoir for such purposes has not been ascertained by the Second M/P Study Team yet. Hence, it is recommended to obtain the agreement of the owner to allow these structure for the purposes intended herein.

10.2.2 Necessary future studies

0221 Taking into consideration the importance and urgency of securing irrigation water to increase and stabilize paddy production and of mitigating flood damage in the Study Area, expeditious undertaking of feasibility study on the Karian Multipurpose Dam Project is proposed as a further step to be subsequently taken.

0222 To execute effectively the proposed feasibility study, some preparatory works will be required prior to the commencement of the proposed study. These are mainly composed of preparation topographic maps for (1) the Cilawang reservoir area, the fringe of K-C-C area not included in the existing topographic map, and roads to be needed as access to the dam sites and for the transportation of construction materials, having a scale of 1/5,000 for each; and (2) the dam axes of Karian and Cilawang, and the Gadeg intake sites with a scale of 1/500 and a contour of 0.5 m.

0223 During the proposed study period, execution of the following field investigation works are also required:

- hydrological observation around the Gadeg intake site and along the existing primary canals of the Ciujung irrigation scheme;
- additional boring for the dam and intake sites and prospective quarry sites;
- permeability test at the dam sites;
- soil mechanical tests at quarry and structure sites; and
- soil survey for the northern part of K-C-C area.

0224 The study requires preparation and assessment of:

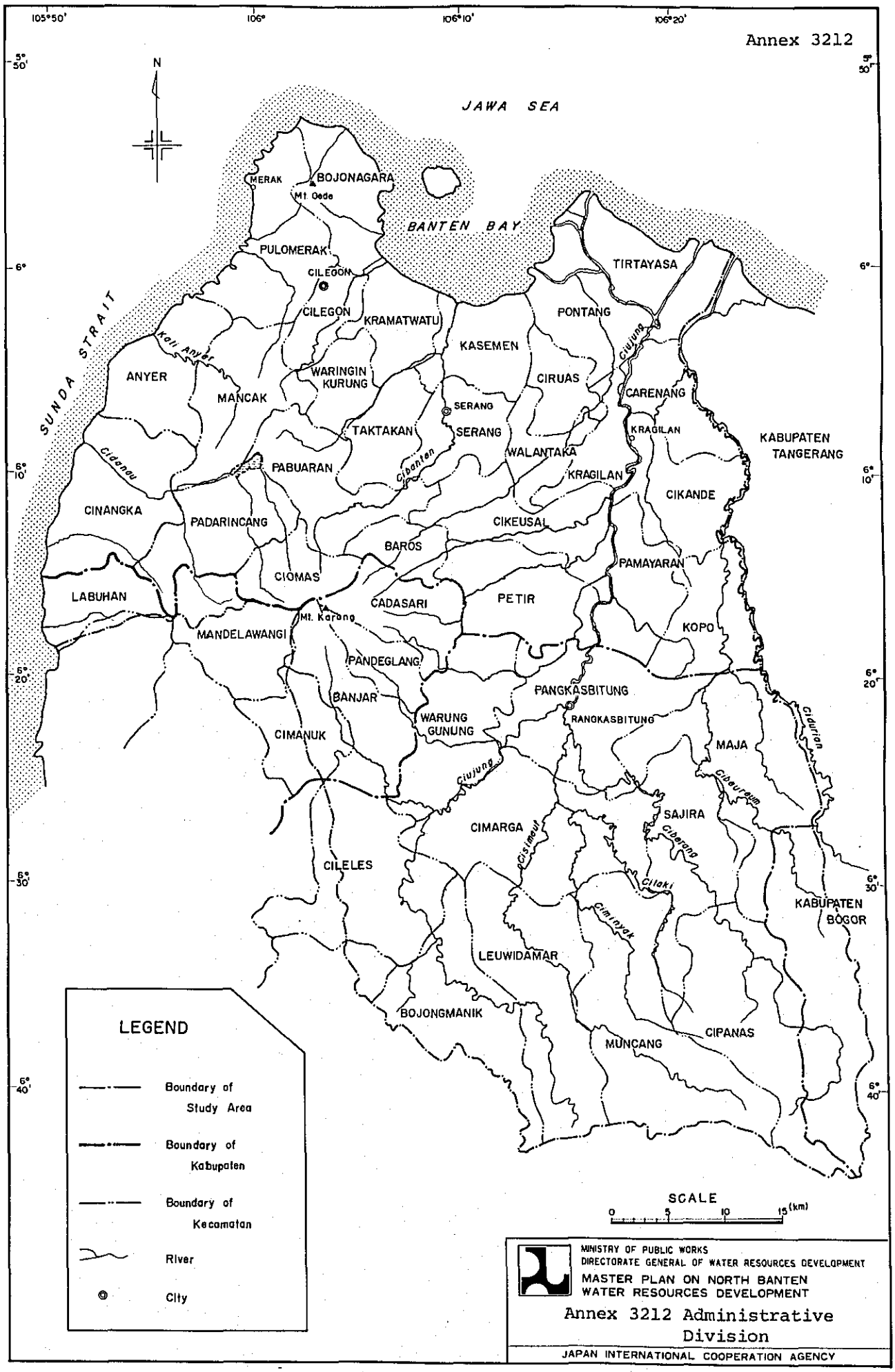
- overall irrigation and drainage plan based on agricultural development plan;

- flood mitigation plan combined with river improvement plan;
- domestic and industrial water supply plan; and
- implementation program of multipurpose dam project.

Annex 1401 LIST OF MEMBERS OF THE SECOND M/P STUDY TEAM AND COUNTERPART

Expertise	Expert	Counterpart
ADVISORY COMMITTEE		
Chairman	Ryuuichi IIDA *1	(up to January 19, 1983)
Chairman	Seishi JOHJIMA *1	(from January 20, 1983)
Water Demand and Supply Planner	Masashi WAKI *2	
River Planner	Hideo OSHIKI *3	
Geologist	Yasuo NAKAMURA *1	
Irrigation and Drainage Engineer	Daijiroh KANAI *4	
Coordinator	Masahito OHYAMA *5	
STUDY TEAM		
Team Leader	Takao ICHIMIYA *6	Ir. Budi Santoso Dipl. HE.
Water Resources Development Planning Engineer	Kazuo HOSODA *7	Ir. Djumpono
Hydrologist	Tomeo OHTA *7	Drs. Agus Praptomo
Dam Planner	Eiji YAGINUMA *6	Ir. Agni Handoyoputro
Geologist	Yasuo SASAKI *6	Harry Witanto BE.
River Planner	Kiyomi WAKAYAMA *7	Ir. Mulyono
Domestic and Industrial Water Supply Planner	Masayoshi KAWAGUCHI *6	Ir. Rachman (part timer) Drs. Sunardi
Agro-economist	Yutaka MATSUMOTO *6	Drs. Hisbullah Rachman
Irrigation and Drainage Planner	Shuuichi SATO *6	Ir. Syahril
Power Market Planner	Yoshinori TOMIYAMA *6	Ir. Mulia Sitohang (part timer) Yusuf Harahap B.E.E.
Agronomist and Environment Planner	Makoto MATSUI *6	Drs. Hisbullah Rachman
Socio-economist	Kinichi OHNO *7	Drs. Sumarno Kadarusman
Hydraulic Engineer	Shigenobu ISOWAKI *7	(Assigned for home works only)

Remarks: *1 = Public Works Research Institute, Ministry of Construction
*2 = River Bureau, Ministry of Construction
*3 = Technology Center for National Land Development
*4 = Water Resources Development Public Corporation
*5 = Social Development Cooperation Department, Japan International Cooperation Agency
*6 = Nippon Koei Co., Ltd.
*7 = Mitsui Consultants Co., Ltd.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BOJONAGARA
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CILEGON
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TIRTAYASA
PONTANG
KASEMEN
CIRUAS
CARENANG
ANYER
MANCAK
WARINGIN KURUNG
SERANG
TAKTAKAN
KRAGILAN
KABUPATEN TANGERANG
WALANTAKA
PABUARAN
CINANGKA
PADARINCANG
CIKANDE
CIKEUSAL
BAROS
PAMAYARAN
CIOMAS
LABUHAN
CADASARI
PETIR
Mt. Karang
MANDELAWANGI
KOPO
PANDEGLANG
PANGKASBITUNG
BANJAR
RANGKASBITUNG
WARUNG GUNUNG
CIMANUK
MAJA
SAJIRA
CIMARGA
CILELES
KABUPATEN BOGOR
LEUWIDAMAR
BOJONGMANIK
CIPANAS
MUNCANG
Kali Anyer
Cidanau
Cibanten
Ciujung
Ciburian
Cibeureum
Cisimeul
Ciberang
Ciloki
Ciminyak
LEGEND
Boundary of Study Area
Boundary of Kabupaten
Boundary of Kecamatan
River
City
SCALE
0 5 10 15 (km)
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN ON NORTH BANTEN WATER RESOURCES DEVELOPMENT
Annex 3212 Administrative Division
JAPAN INTERNATIONAL COOPERATION AGENCY

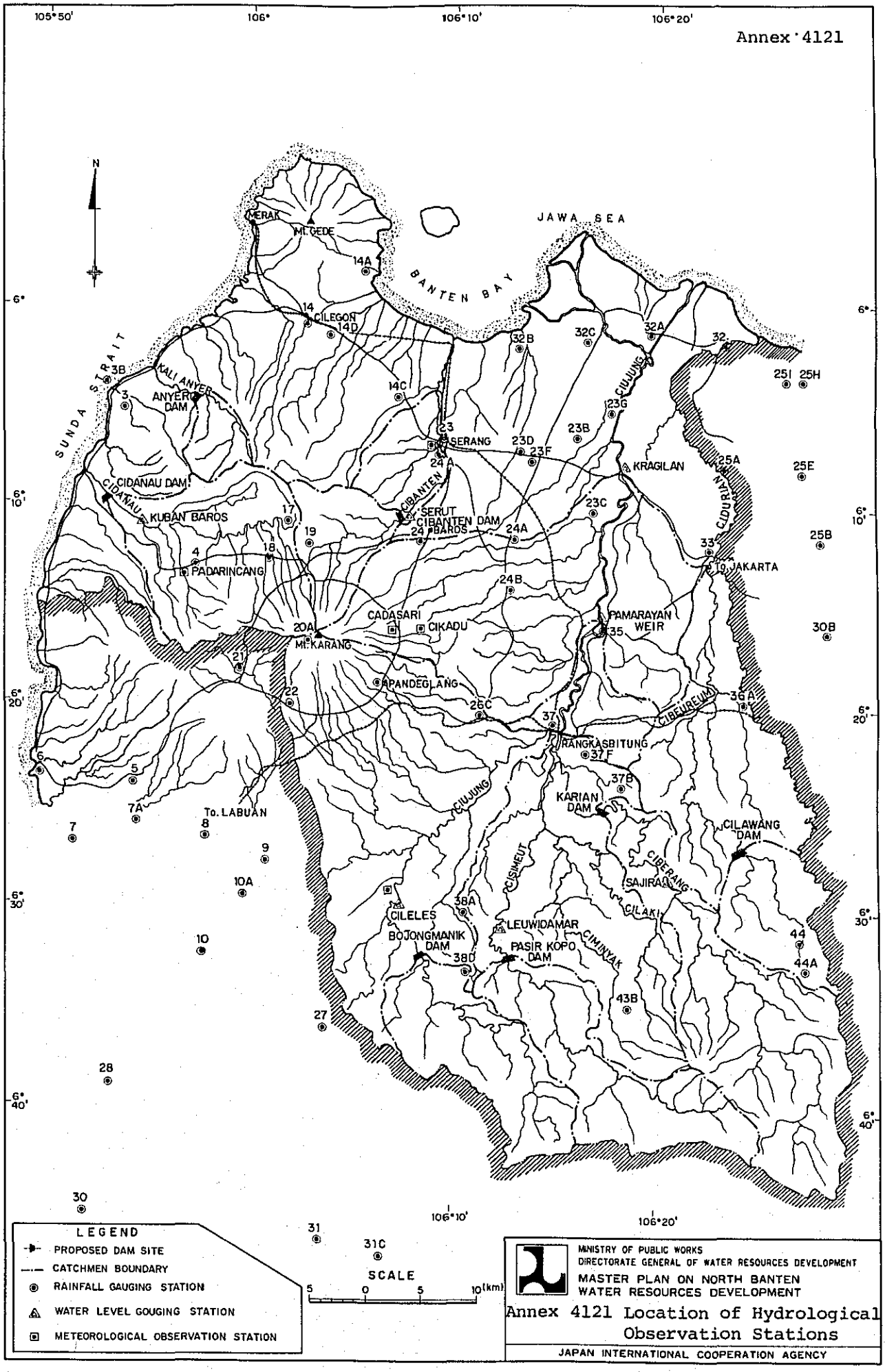
Annex 3221 POPULATION BY CENSUS

	Population Census			Population Density in 1980 (person/km^2)
	1961	1971	1980	
Indonesia	97,085,348	119,208,229	147,490,298	77
Java Island	63,059,575	76,086,327	91,269,528	690
Province of West Java	17,614,555	21,623,529	27,453,525	593
Kabupaten				
Serang	720,169	859,467	1,109,186	591
Lebak	427,802	546,364	682,868	219
Pandeglang	440,213	572,628	694,759	264
Bogor	1,314,156	1,667,687	2,493,909	913
Study Area				
Serang	714,000	852,000	1,100,000	591
Lebak	222,000	273,000	338,000	262
Pandeglang	112,000	134,000	172,000	719
Bogor	29,000	36,000	44,000	303
Total of the Study Area	1,077,000	1,295,000	1,654,000	466

Annex 3222 AVERAGE ANNUAL GROWTH RATE OF POPULATION

Unit: %

	1961/1971	1971/1980	1961/1980
Indonesia	2.10	2.37	2.23
Java Island	1.91	2.02	1.97
Province of West Java	2.09	2.66	2.36
Kabupaten			
Serang	1.80	2.84	2.30
Lebak	2.50	2.48	2.49
Pandeglang	2.69	2.15	2.43
Bogor	2.44	4.52	3.43
Study Area			
Serang	1.80	2.84	2.30
Lebak	2.11	2.36	2.23
Pandeglang	1.77	2.84	2.28
Bogor	2.19	2.25	2.22
Average of the Study Are	1.88	2.72	2.28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MERAK
MT. GEDE
BANTEN BAY
SUNDA STRAIT
CILEGON
KALI ANYER
ANYER DAM
CIDANAU
CIDANAU DAM
KUBAN BAROS
PADARINCANG
SERANG
CIBANTEN
SERUT
CIBANTEN DAM
BAROS
KRAGILAN
CIDURIAN
CIUJUNG
JAKARTA
CADASARI
CIKADU
MT. KARANG
PAMARAYAN WEIR
APANDEGLANG
CIBEUREUM
RANGKASBITUNG
KARIAN DAM
CILAWANG DAM
CISIMEUT
CIBERANG
SAJIRA
CILAKI
CILELES
BOJONGMANIK DAM
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PASIR KOPO DAM
CIMINYAK
To. LABUAN
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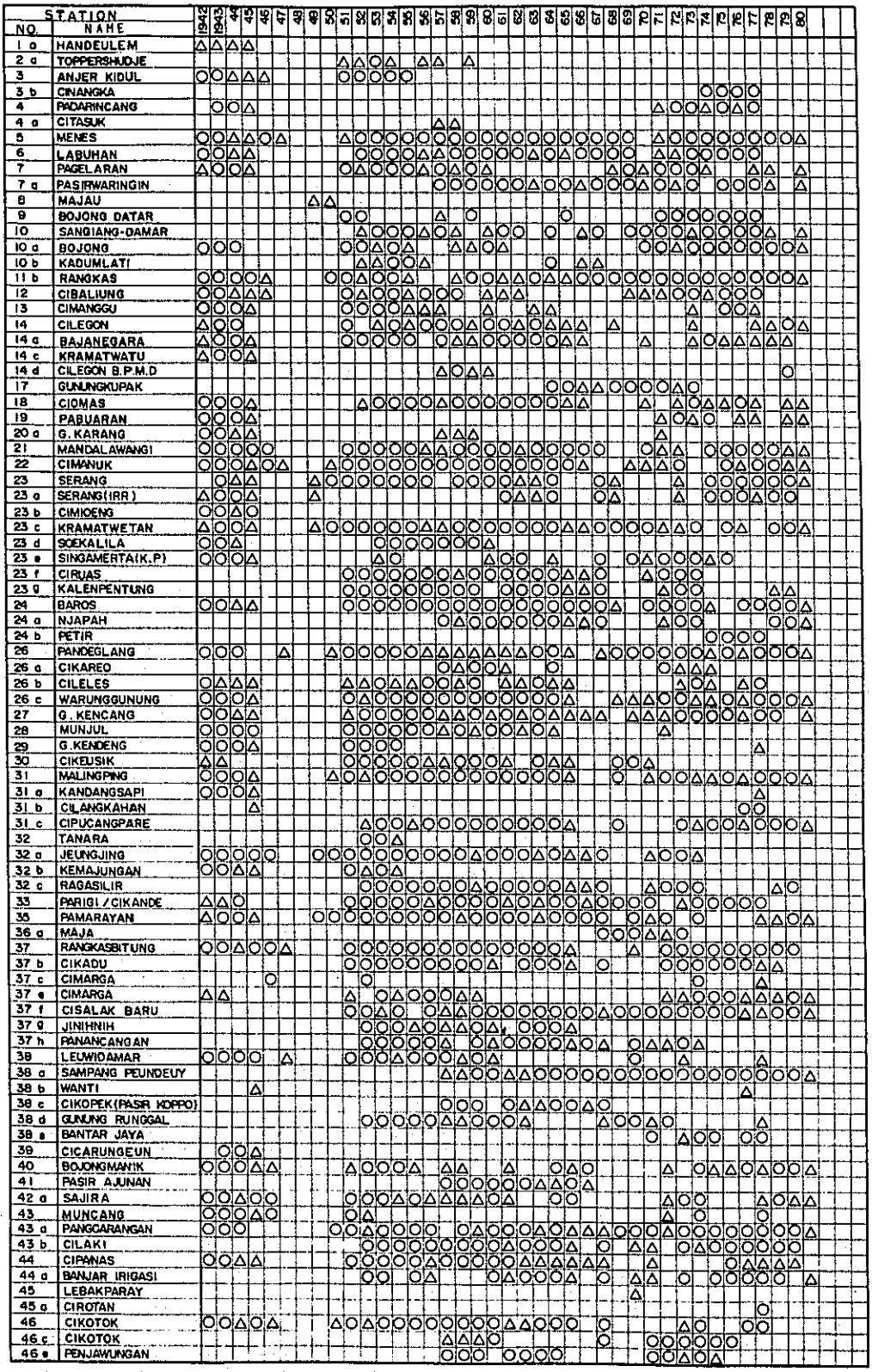
LEGEND
PROPOSED DAM SITE
CATCHMEN BOUNDARY
RAINFALL GAUGING STATION
WATER LEVEL GOUGING STATION
METEOROLOGICAL OBSERVATION STATION
SCALE
5 0 5 10(km)
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN ON NORTH BANTEN WATER RESOURCES DEVELOPMENT
Annex 4121 Location of Hydrological Observation Stations
JAPAN INTERNATIONAL COOPERATION AGENCY

Annex 4122 EXISTING CONDITION OF MONTHLY RAINFALL DATA



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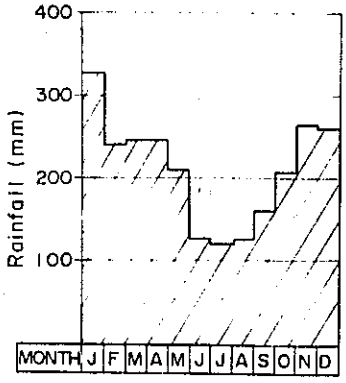
△ Partially Available Data



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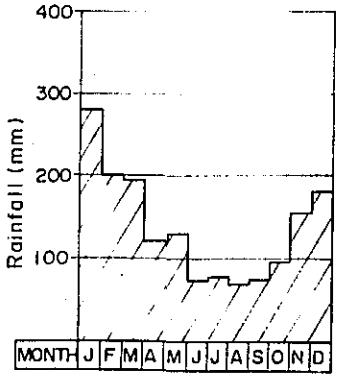

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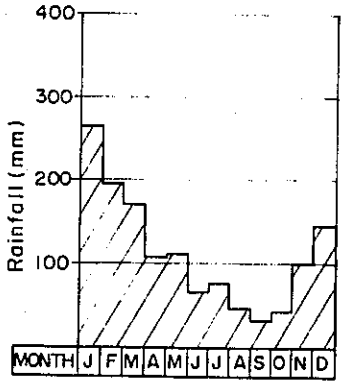

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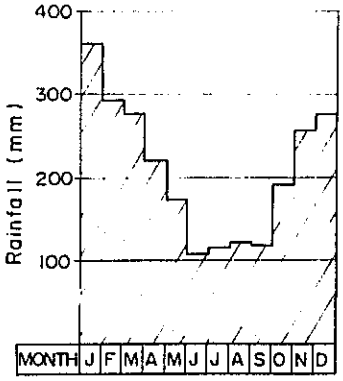

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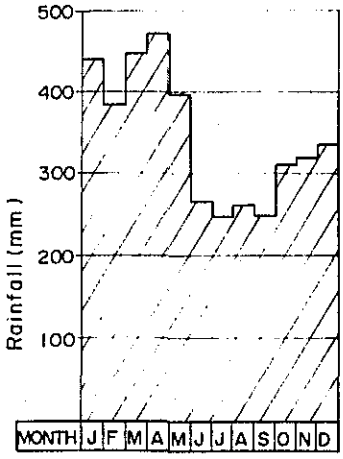

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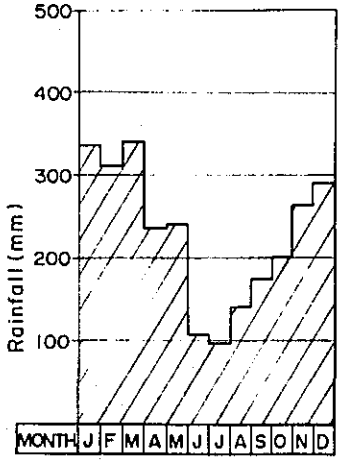
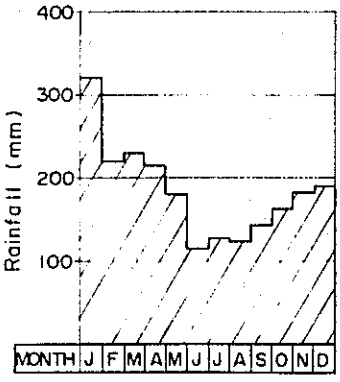


CILELES (No.266)



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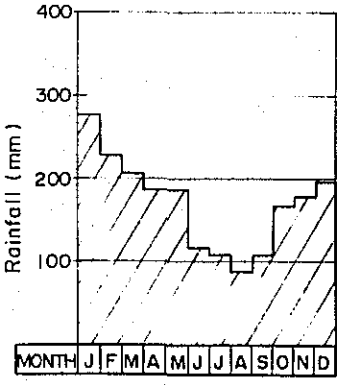

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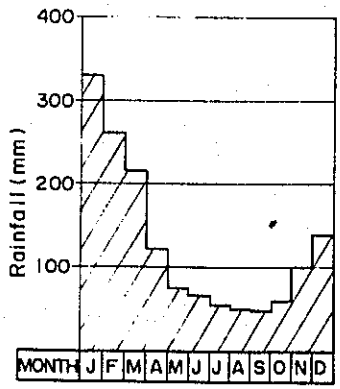
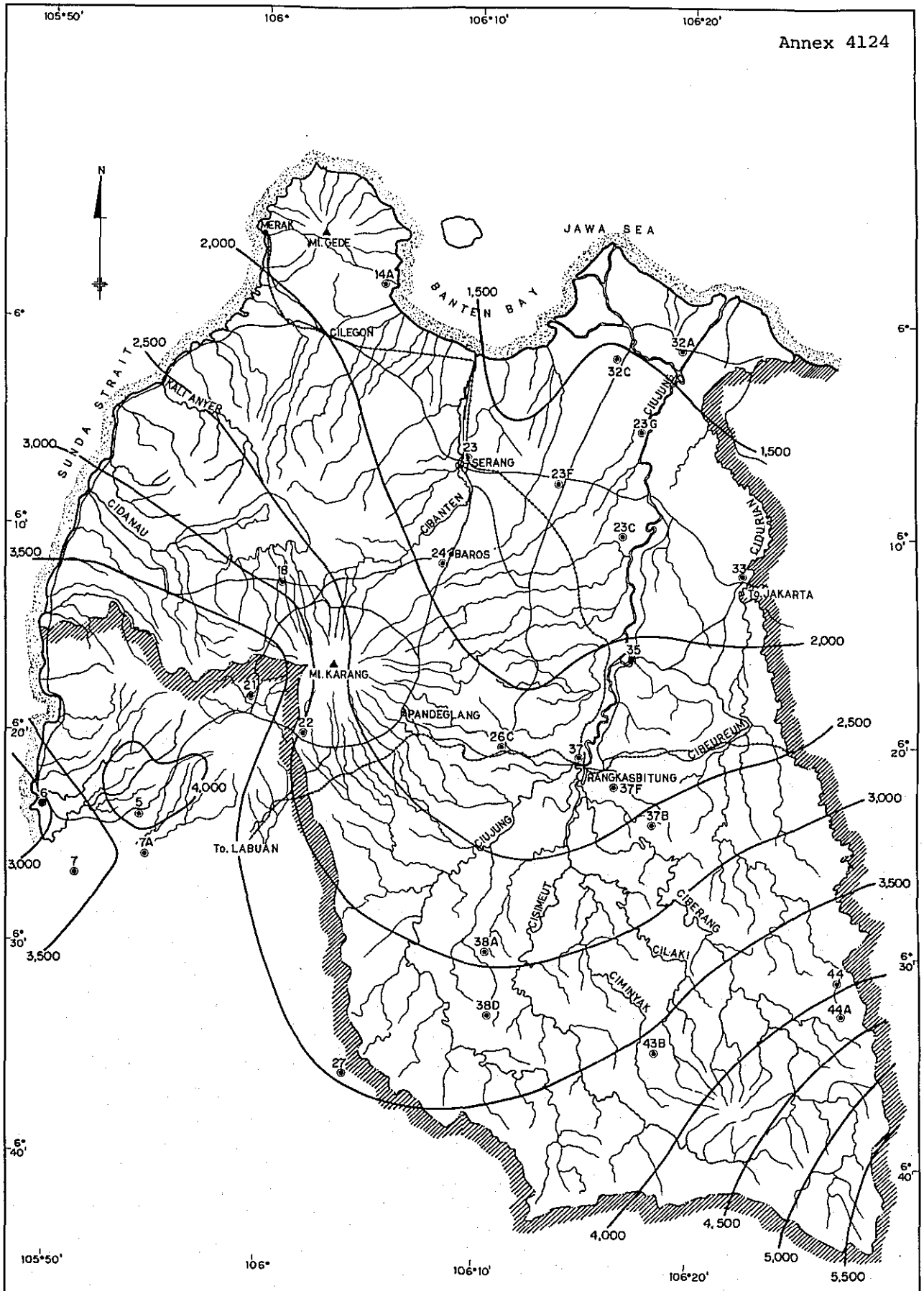


JEUNGJING (No.32A)

MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN ON NORTH BANTEN WATER RESOURCES DEVELOPMENT

Annex 4123 Annual Pattern of Average Monthly Rainfall

JAPAN INTERNATIONAL COOPERATION AGENCY



LEGEND

⊕ AVAILABLE RAINFALL GAUGING STATION

—4,000— MEAN ANNUAL ISOHYETAL LINE

SCALE

5 0 5 10 (km)

MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN ON NORTH BANTEN WATER RESOURCES DEVELOPMENT

Annex 4124 Annual Isohyetal Map

JAPAN INTERNATIONAL COOPERATION AGENCY

Annex 4131 LIST OF WATER LEVEL RECORDERS AND STAFF GAUGES IN THE STUDY AREA

River	Location	Catchment Area (km^2)	Type	Installed by	Year	Available Water Level Data
Cidanau	Curugbetung	200	R	T.A.	1915	1924, 1932, 1936
Cidanau	Kubang Baros	200	R	P3SA	1980	1980 - 1982
Ciberang	Cileuksa	58	R	T.A.	1929	1929, 1934
Ciberang	Sajira	233	R/S	P3SA	1978	1978 - 1981
Cisimeut	Leuwidamar	183	R	P3SA	1979	1980 - 1981
Ciujung	Rangkasbitung	1,383	R/S	DPMA	1969/70	1972 - 1982
Ciujung	Pamarayan Weir	1,451	S	DPU	-	1975 - 1981
Ciujung	Kragilan	1,812	S&R	DPMA	1969	1970, 1972 - 1975, 1978 - 1979
Ciujung	Cileles	216	R/S	P3SA	1978	1978 - 1982
Cibanten	Serut	77	R	P3SA	1977	1977 - 1982

Remarks: R = Automatic rain recorder
S = Daily normal gauge

Annex 4132 AVERAGE MONTHLY MEAN DISCHARGE AT GAUGING STATIONS

Unit: m^3/s

Gauging Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Runoff (10^6 m^3)
Pamarayan	296.4	177.3	133.5	132.5	114.0	85.7	65.0	71.3	110.8	62.8	103.1	140.3	3,872
Kragilan	241.2	156.5	150.5	131.4	121.4	55.3	45.5	48.9	75.8	58.9	87.0	105.6	3,326
Rangkasbitung	192.4	122.9	125.8	111.6	98.5	61.3	86.4	54.9	71.4	60.2	85.4	92.0	2,969
Cileles	31.7	15.8	12.2	-	5.0	4.1	4.0	2.2	5.0	6.7	17.1	12.5	394
Kopomaja	43.2	32.6	29.0	31.5	28.9	16.5	11.6	14.0	21.6	18.1	22.4	19.9	786
Serut	5.7	4.6	3.5	2.2	1.5	1.2	1.3	1.3	1.9	1.5	1.9	2.6	81
Kubang Baros	24.1	16.0	17.0	19.0	13.2	8.3	6.5	6.1	9.5	10.4	21.2	30.6	482

Annex 4133 AVERAGE MONTHLY MEAN DISCHARGE AT DAM SITES

Unit: m^3/s

Dam Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Runoff (10^6 m^3)
Karian	57.4	36.7	37.6	33.3	29.4	18.3	14.9	16.4	18.6	18.0	25.5	27.5	886
Pasir Kopo	30.8	19.7	20.2	17.9	15.4	9.8	8.0	8.8	11.4	9.7	13.7	14.4	474
Bojongmanik	24.3	15.5	15.9	14.1	12.4	7.6	6.3	6.9	9.0	7.6	10.8	11.6	373
Pamarayan Weir	197.1	126.0	128.8	114.4	100.9	62.8	51.1	56.2	73.1	61.7	87.5	94.2	3,032
Cilawang	15.4	9.9	10.1	8.9	7.9	4.9	4.0	4.4	5.7	4.8	6.8	7.4	239
Cibanten	5.7	4.6	3.5	2.2	1.5	1.2	1.3	1.3	1.9	1.5	1.9	2.5	82
Cidanau	26.0	17.3	18.3	20.4	14.2	8.9	7.0	6.6	10.3	11.2	22.9	33.0	512

Annex 4134 PROBABLE MONTHLY MEAN DISCHARGE

Unit: m^3/s

Station	Return Period (year)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Runoff (10^6 m^3)
Pamarayan	1/3	165.7	111.2	99.2	92.2	77.5	40.7	31.3	28.1	22.5	32.9	64.1	64.9	2,668
	1/5	145.1	100.6	82.3	78.6	64.4	31.0	23.1	18.9	12.3	22.5	51.8	50.5	2,406
	1/10	125.8	90.4	67.4	66.3	52.9	23.2	16.7	12.3	6.4	15.0	41.2	38.7	2,157
Rangkasbitung	1/3	161.7	108.6	96.8	89.9	75.6	39.7	30.6	27.5	21.9	32.1	62.6	63.3	2,620
	1/5	141.6	98.2	80.4	76.7	62.9	30.3	22.6	18.4	12.0	22.0	50.6	40.3	2,368
	1/10	122.8	88.2	65.8	64.7	51.6	22.7	16.3	12.0	6.2	14.7	40.3	37.8	2,129
Karian	1/3	48.3	32.4	28.9	26.8	22.6	11.9	9.1	8.2	6.0	9.6	18.7	18.9	782
	1/5	42.2	29.3	24.0	22.9	18.8	9.0	6.7	5.5	3.3	6.6	15.1	14.7	706
	1/10	36.6	26.3	19.7	19.3	15.4	6.8	4.9	3.6	1.8	4.4	12.0	11.3	637
Pasir Kopo	1/3	25.9	17.4	15.5	14.4	12.1	6.4	4.9	4.4	3.5	5.2	10.0	10.2	416
	1/5	22.7	15.7	12.9	12.3	10.1	4.9	3.7	2.9	1.9	3.5	8.1	7.9	375
	1/10	19.7	14.1	10.6	10.4	8.3	3.6	2.7	1.9	1.0	2.4	6.5	6.1	337
Bojongmanik	1/3	20.4	13.7	12.2	11.4	9.5	5.1	3.9	3.5	2.8	4.1	7.9	8.0	328
	1/5	17.9	12.4	10.2	9.7	7.9	3.9	2.9	2.3	1.5	2.8	6.4	6.2	296
	1/10	15.5	11.1	8.3	8.2	6.5	2.9	2.1	1.5	0.8	1.9	5.1	4.8	265
Cilawang	1/3	13.0	8.7	7.6	7.2	6.1	3.2	2.5	2.2	1.8	2.6	5.0	5.1	211
	1/5	11.4	7.9	6.4	6.1	5.1	2.4	1.8	1.5	1.0	1.7	4.0	4.0	189
	1/10	9.9	7.1	5.2	5.2	4.2	1.8	1.3	1.0	0.5	1.2	3.2	3.0	170
Cidanau	1/3	15.8	10.9	14.9	14.4	10.5	7.6	4.8	3.8	5.3	6.6	11.6	19.6	451
	1/5	11.5	7.9	12.8	11.2	8.4	6.7	3.7	2.6	3.6	4.7	7.4	14.0	410
	1/10	8.2	5.7	10.8	8.6	6.5	5.8	2.8	1.8	2.4	3.3	4.6	9.7	369
Cibanten	1/3	4.4	3.4	2.2	1.6	1.2	0.9	0.7	0.9	1.1	0.5	0.7	1.7	47
	1/5	3.6	2.8	1.6	1.3	1.0	0.8	0.5	0.7	0.8	0.3	0.4	1.3	32
	1/10	2.9	2.3	1.2	1.0	0.9	0.6	0.3	0.5	0.6	0.2	0.2	1.0	22

Annex 4137 RATIONAL FORMULA APPLIED TO OBTAIN FLOOD HYDROGRAPHS

Followings show the Rational formula which is applied to obtain flood hydrographs at the potential dam sites. More details are presented in Appendix B.

(1) The triangular hydrograph with the peak discharge Qp obtained by the Rational formula is adopted for the study. The time of recession Tr is assumed as Tr = 2Tc, where Tc is the time of concentration.

(2) The time of concentration Tc is estimated by Rziha's formula.

$$Tc = L/w \text{ (hr)}, \quad w = 72\ (H/L)^{0.6} \text{ (km/hr)}$$

where, Tc: Time of concentration (hr)
w : Velocity of concentration of flood (km/hr)
L : Horizontal length of catchment basin (km)
H : Height difference of catchment basin (km)

(3) The peak discharge Qp is estimated by the Rational formula.

$$Qp = 1/3.6 \cdot f \cdot r \cdot A$$

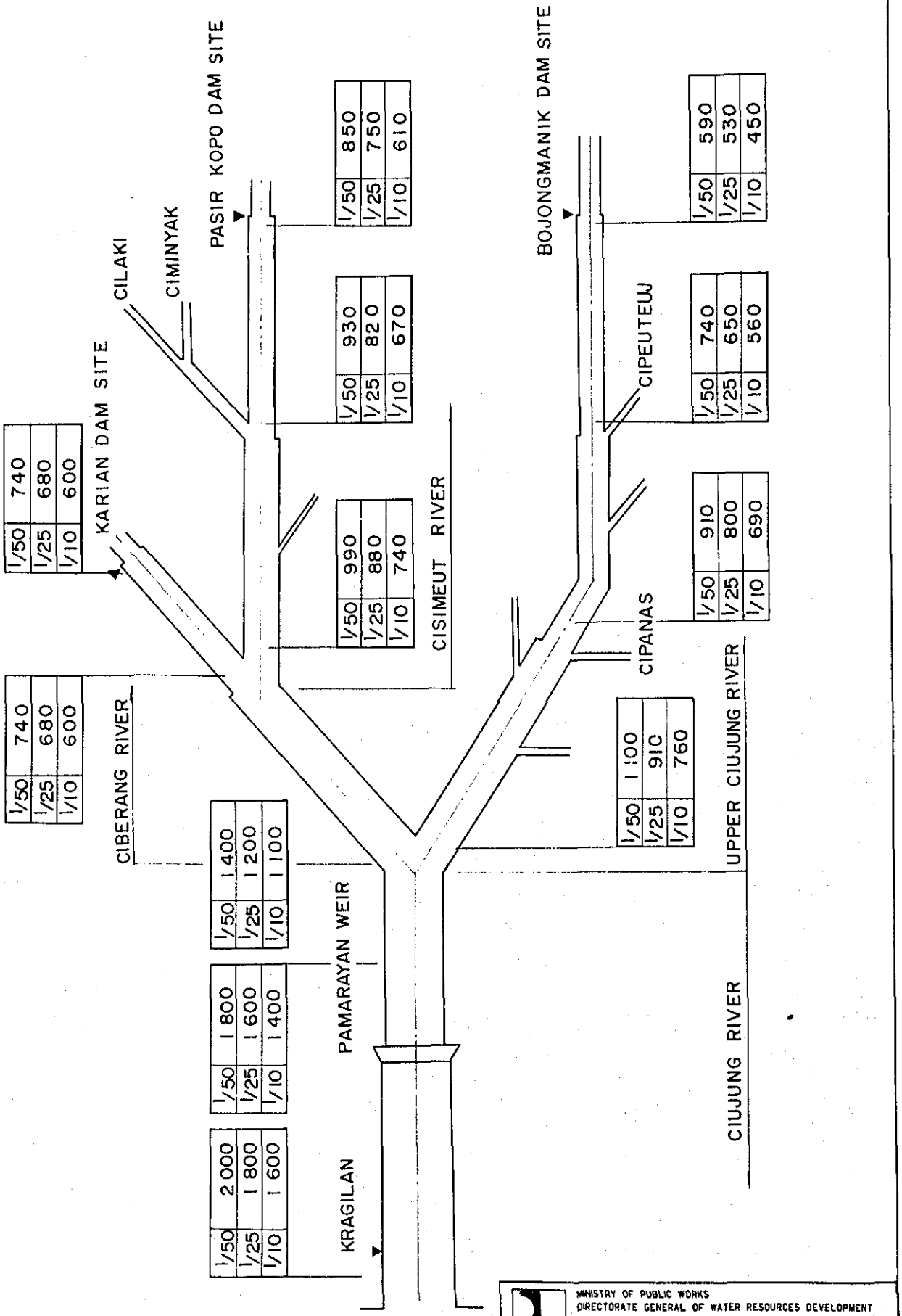
where, Qp: Peak discharge (m^3/s)
f : Runoff coefficient
r : Rainfall intensity (mm/hr)
A : Catchment area (km^2)

(4) The runoff coefficient f is assumed as f = 0.7, considering the conditions of soil-cover, geology and topography of the catchment basin.

(5) The rainfall intensity is estimated by Mononobe's formula which may be derived from daily rainfall data, as the rainfall data in short duration of time are not available at present.

$$r = R_{24}/24 \cdot (24/T)^{2/3}$$

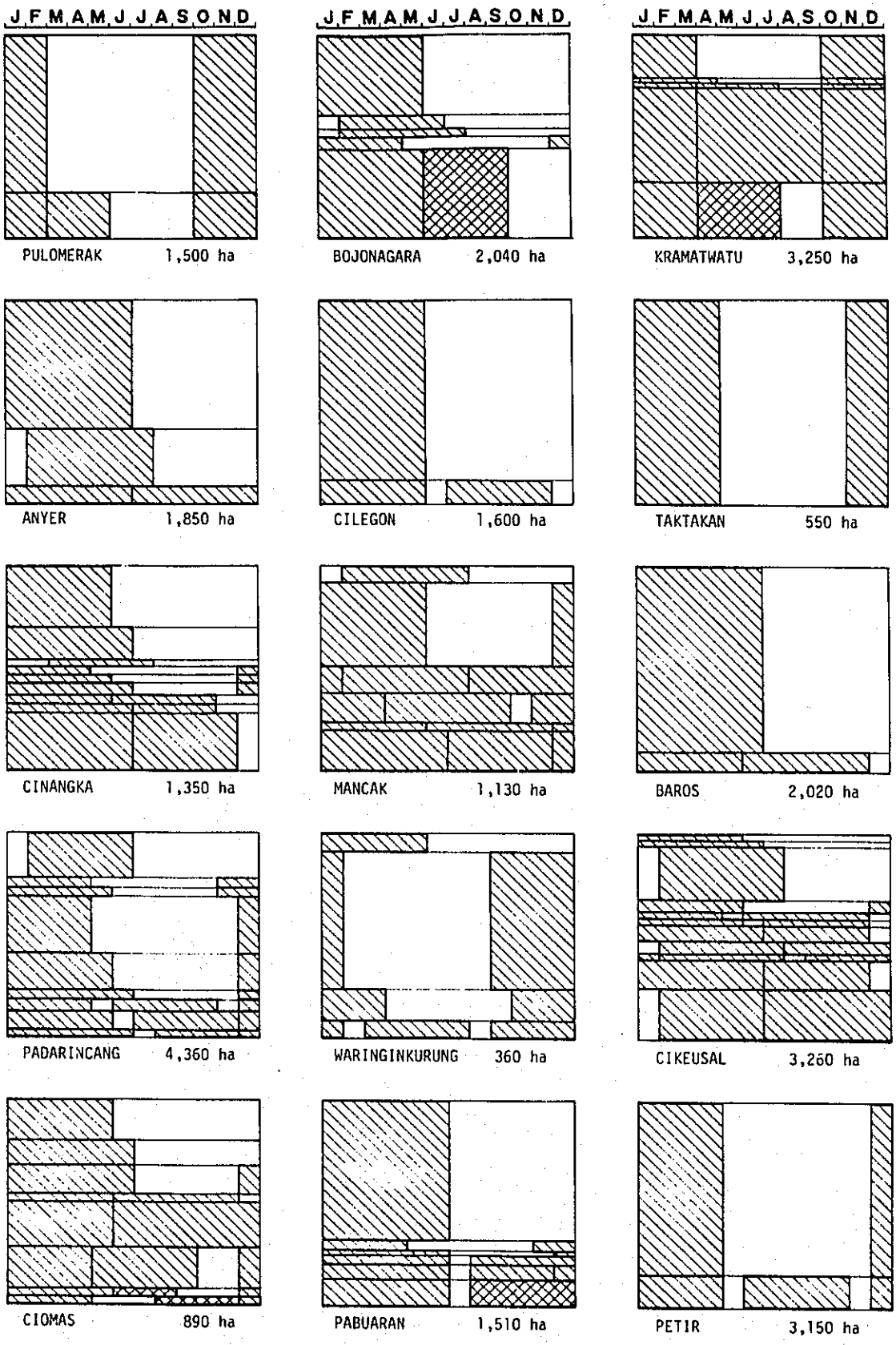
where, R_{24}: Daily rainfall (mm)
r : Rainfall intensity (mm/hr)
T : Rainfall duration (hr)



MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN ON NORTH BANTEN WATER RESOURCES DEVELOPMENT

Annex 4138 Standard Project Flood Distribution of Ciujung River System

JAPAN INTERNATIONAL COOPERATION AGENCY

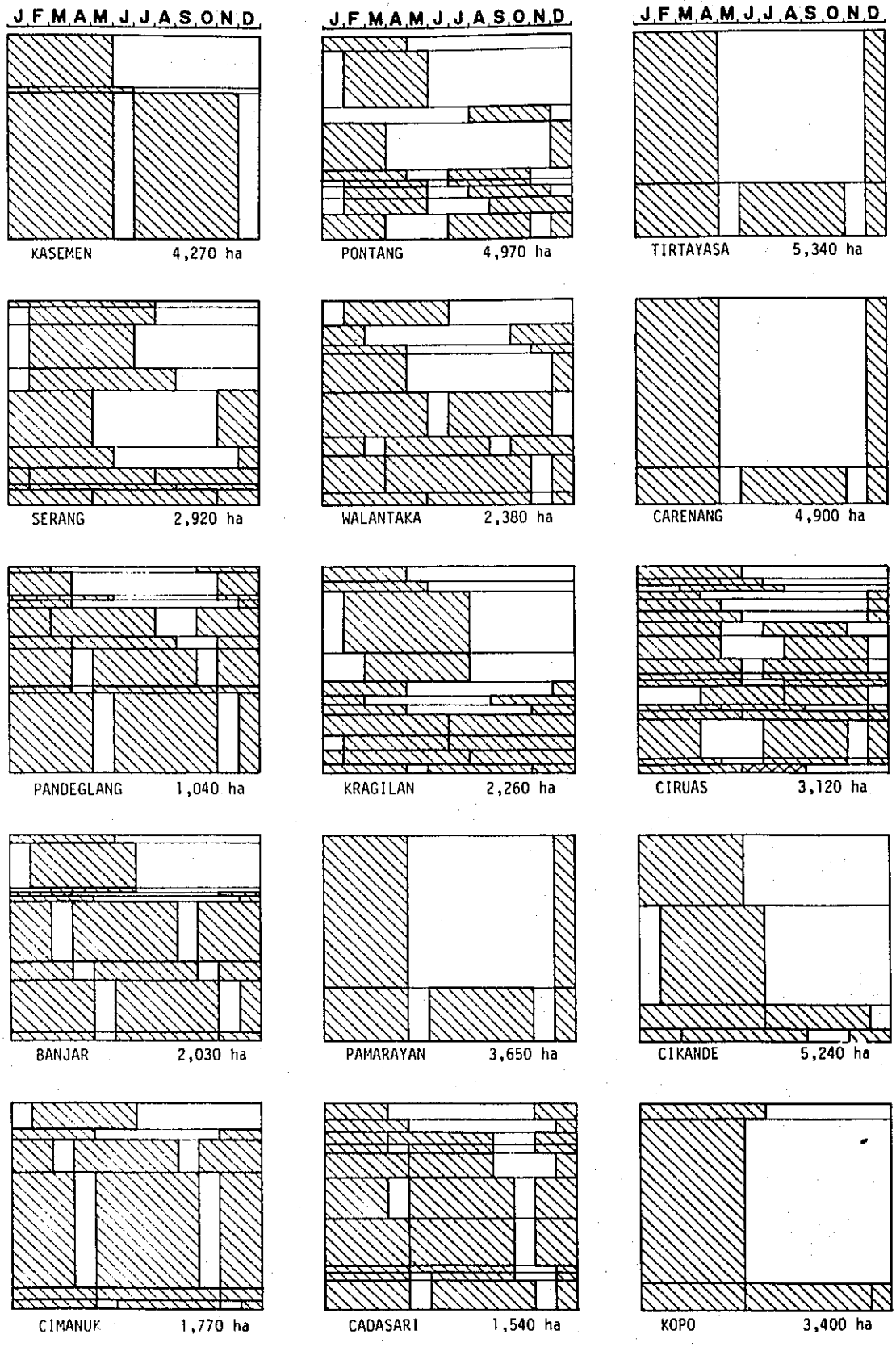


MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN ON NORTH BANTEN WATER RESOURCES DEVELOPMENT

Annex 4311 (1/3) Present Cropping Patterns

JAPAN INTERNATIONAL COOPERATION AGENCY

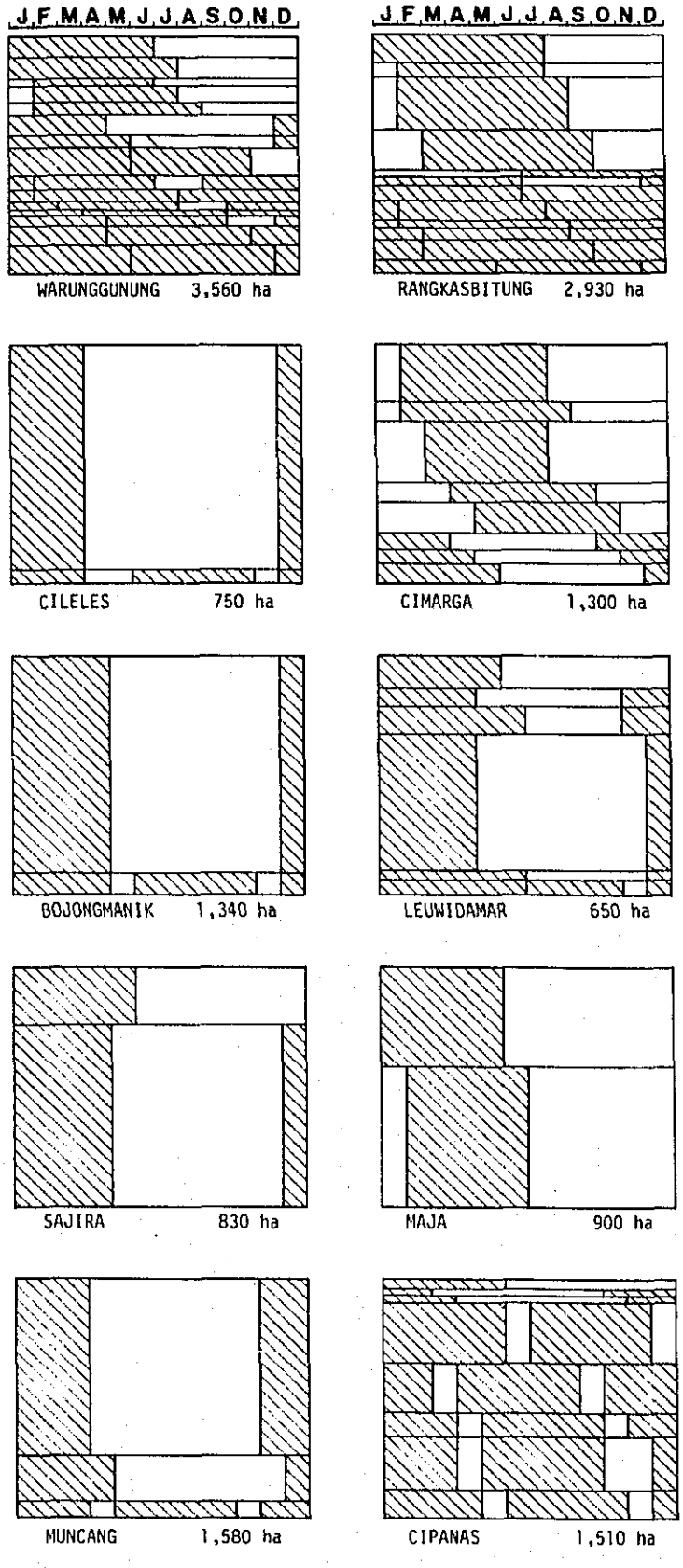
Annex 4311



MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN ON NORTH BANTEN WATER RESOURCES DEVELOPMENT

Annex 4311 (2/3) Present Cropping Patterns

JAPAN INTERNATIONAL COOPERATION AGENCY

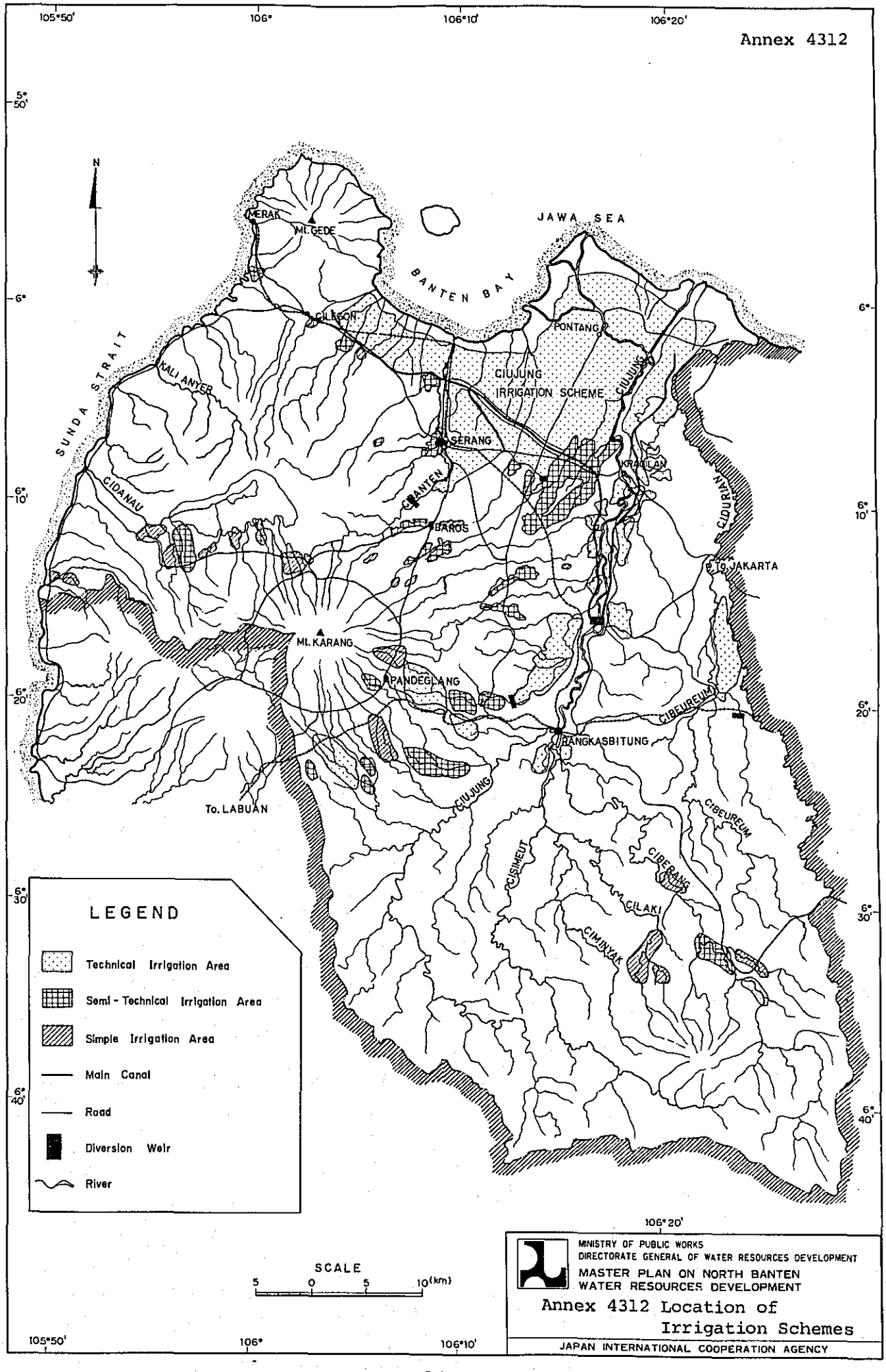


MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN ON NORTH BANTEN WATER RESOURCES DEVELOPMENT

Annex 4311 (3/3) Present Cropping Patterns

JAPAN INTERNATIONAL COOPERATION AGENCY

Annex 4312


105°50'
106°
106°10'
106°20'
5° 50'
6°
6° 10'
6° 20'
6° 30'
6° 40'
N
MERAK
ML. GEDE
JAWA SEA
BANTEN BAY
CILEGON
PONTANG
SUNDA STRAIT
KALI ANYER
CIUJUNG
IRRIGATION SCHEME
CIUJUNG
SERANG
KRAGILAN
CIDANAU
CIANTEN
CIDURIAN
BAROS
To. JAKARTA
ML. KARANG
PANDEGLANG
CIBEUREUM
RANGKASBITUNG
CIUJUNG
To. LABUAN
CIBEUREUM
CISIMEUT
CIBERANG
CILAKI
CIMINYAK
LEGEND
Technical Irrigation Area
Semi - Technical Irrigation Area
Simple Irrigation Area
Main Canal
Road
Diversion Weir
River
SCALE
5 0 5 10(km)
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN ON NORTH BANTEN
WATER RESOURCES DEVELOPMENT
Annex 4312 Location of
Irrigation Schemes
JAPAN INTERNATIONAL COOPERATION AGENCY

Annex 4313 PRESENT IRRIGATION AREA BY WATER SOURCE

Unit: ha

Water Source	DPU Irrigation		Non-DPU Irrigation		Total	
	Wet	Dry	Wet	Dry	Wet	Dry
Ciujung						
U/S Pamarayan	2,533	956	10,722	2,857	13,255	3,813
At Pamarayan	24,200	9,600	-	-	24,200	9,600
D/S Pamarayan	5,652	1,262	3,095	825	8,747	2,087
Sub-total	32,385	11,818	13,817	3,682	46,202	15,500
Cibeureum	1,435	100	-	-	1,435	100
Ciwaka	1,825	351	315	84	2,140	435
Cibanten	2,417	420	45	12	2,462	432
Cidanau	2,219	501	45	12	2,264	513
Others	4,680	1,266	3,558	948	8,238	2,214
Total	44,961	14,456	17,780	4,738	62,741	19,194

Remarks: U/S = Upstream
D/S = Downstream

Annex 4314 PRESENT IRRIGATION WATER USE BY WATER SOURCE

Water Source	Catchment Area (km^2)	Irrigation Area (ha)		Annual Water Demand (10^6 m^3/y)
		Wet	Dry	
Ciujung				
U/S Pamarayan	1,451	13,255	3,813	243
At Pamarayan	1,451	24,200	9,600	371
D/S Pamarayan	1,850/1	8,747	2,087	154
Sub-total	1,850/1	46,202	15,500	768
Cibeureum	255	1,435	100	21
Ciwaka	60	2,140	435	36
Cibanten	185	2,462	432	41
Cidanau	316	2,264	513	40
Others	885	8,238	2,214	149
Total	3,551	62,741	19,194	1,055

Remarks: U/S = Upstream
D/S = Downstream
/1 = Total catchment area of the Ciujung river

Annex 5201 PROJECTED POPULATION

Unit: 10^3 persons

	1980	1990	1995	2000	2005
LEKNAS-LIPI					
Indonesia					
High case	149,347	196,273	225,373	259,494	299,799
Low case	143,734	179,905	195,518	209,372	222,748
M/P STUDY					
Indonesia	147,490	183,885	205,324	229,261	255,990
Java Island	91,270	110,930	122,296	134,826	148,640
Province of West Java	27,454	34,666	38,954	43,773	49,188
Kabupaten					
Serang	1,109	1,402	1,579	1,781	2,011
Lebak	683	873	988	1,117	1,263
Pandeglang	695	883	996	1,123	1,266
Bogor	2,494	3,494	4,136	4,896	5,795
Study Area					
Serang	1,100	1,391	1,566	1,767	1,995
Lebak	338	422	473	529	592
Pandeglang	172	215	241	270	303
Bogor	44	55	62	69	77
Total of the Study Area	1,654	2,083	2,342	2,635	2,967

Annex 5204 PROJECTED URBAN POPULATION

Unit: persons

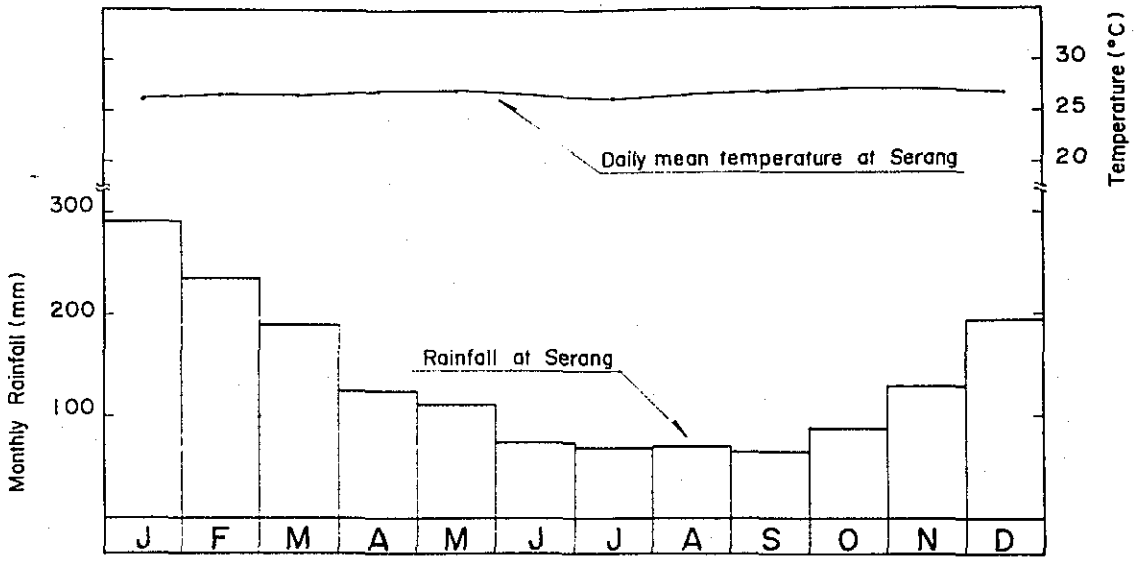
Kecamatan	Urban Population Ratio (%)	1980	1990	1995	2000	2005
Pandeglang	27.2	13,400	17,100	19,500	22,200	25,300
Rangkasbitung	24.6	25,800	32,900	37,300	42,500	48,100
Serang	69.3	76,900	105,300	123,200	143,900	168,300
Cilegon	30.0	16,700	21,200	24,900	29,200	34,400
Pulomerak	16.9	15,500	21,900	26,300	31,600	37,900
Kramatwatu	14.3	4,200	5,300	6,000	6,800	7,800
Ciruas	15.4	5,500	5,900	6,400	6,900	7,400
Ciomas	13.9	2,800	3,800	4,200	4,600	5,100
Total	-	160,800	213,400	247,800	287,700	334,300

Annex 5314 PROJECTED IRRIGATION AREA

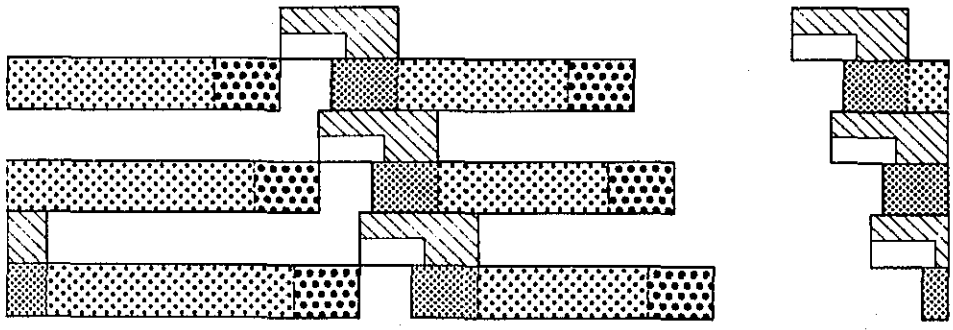
Unit: ha

Water Source	1982		2000		After 2000	
	Wet	Dry	Wet	Dry	Wet	Dry
Ciujung						
U/S Pamarayan	13,255	3,813	13,250	3,800	13,250	8,000
At Pamarayan	24,200	9,600	24,200	24,200	24,200	24,200
D/S Pamarayan	8,747	2,087	8,750	2,100	8,750	5,000
Sub-total	46,202	15,500	46,200	30,100	46,200	37,200
Cibeureum	1,435	100	9,500	9,500	9,500	9,500
Ciwaka	2,140	435	2,150	450	3,400	700
Cibanten	2,462	432	2,500	400	2,700	1,600
Cidanau	2,264	513	2,300	550	4,300	2,600
Other rivers	8,238	2,214	8,250	2,200	12,900	3,400
Rainfed	30,259	-	22,100	-	14,000	-
Total	93,000	19,194	93,000	43,200	93,000	55,000

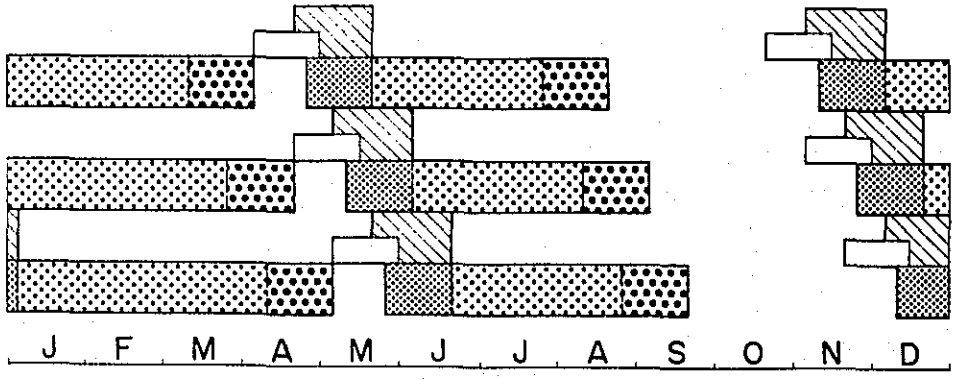
Remarks: U/S = Upstream
D/S = Downstream



Large-scale Irrigation Schemes



Middle- and Small-scale Irrigation Schemes



LEGEND

- Nursery
- Land Preparation
- Transplanting
- Crop Growing
- Harvesting

MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN ON NORTH BANTEN WATER RESOURCES DEVELOPMENT

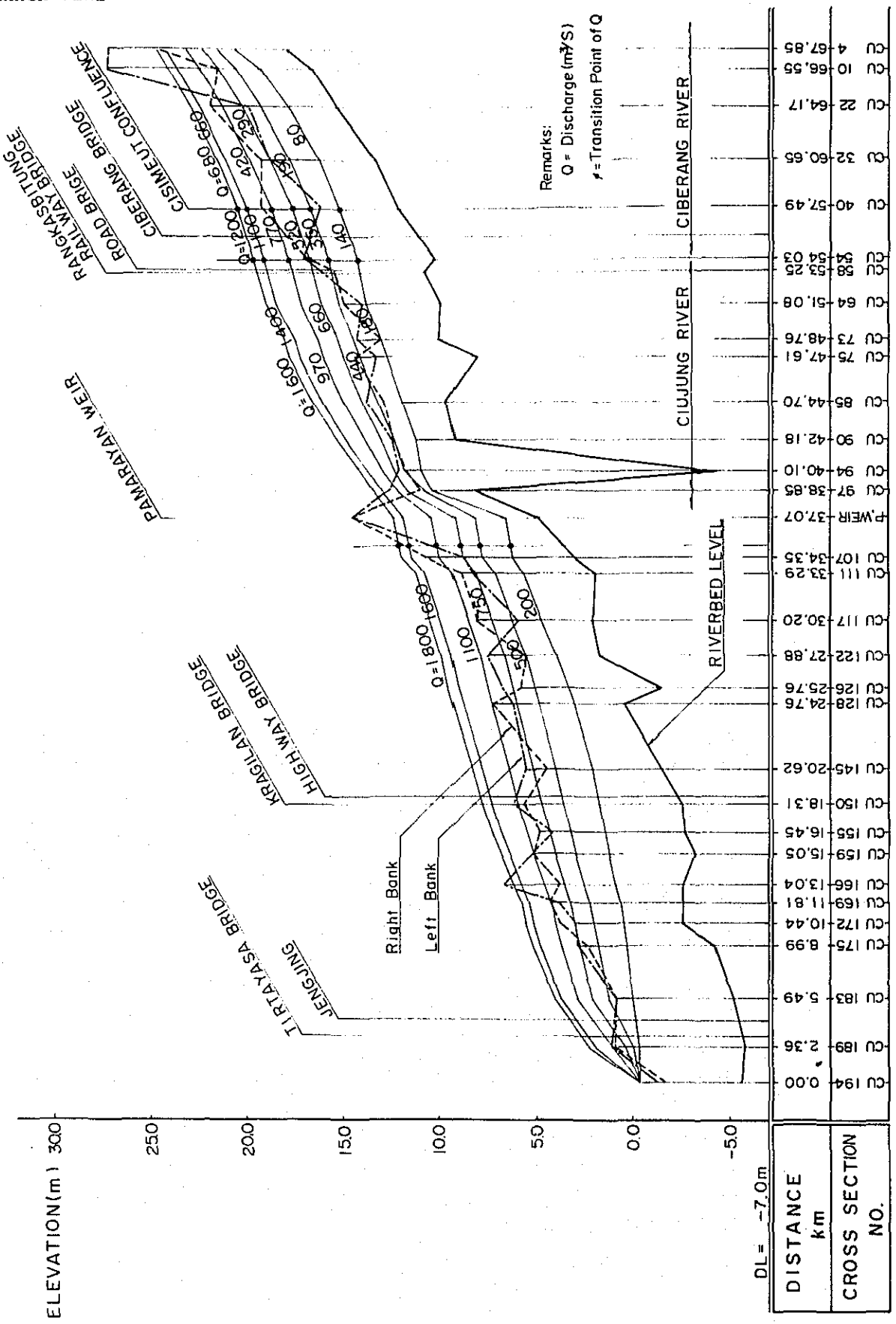
Annex 5323 Proposed Cropping Pattern

JAPAN INTERNATIONAL COOPERATION AGENCY

Annex 5403 PROJECTED DOMESTIC AND INDUSTRIAL WATER DEMAND AT MAXIMUM LEVEL

Unit: lit/s

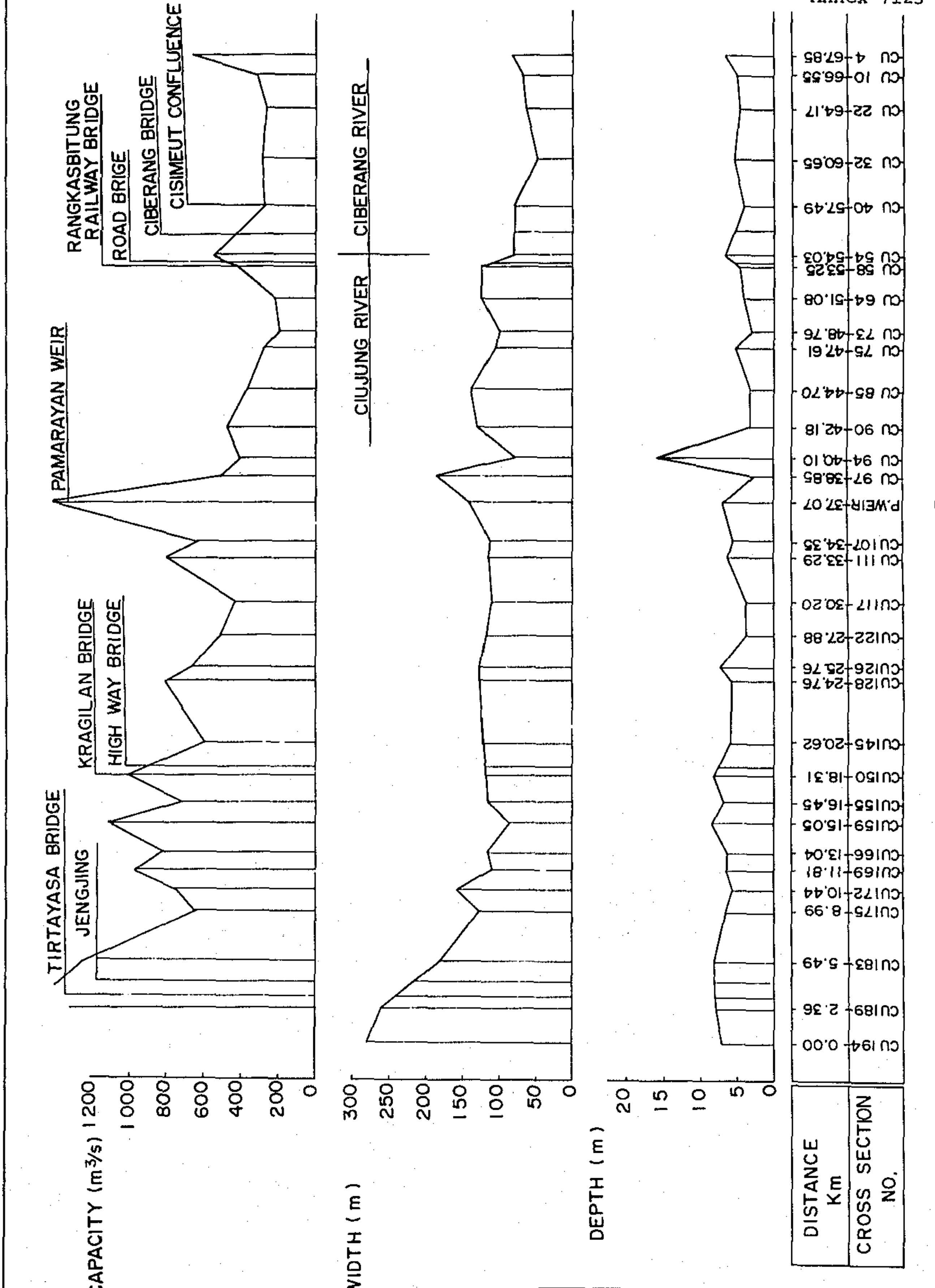
User	1985	1990	1995	2000
1. Urban Water Demand				
- Serang	88	130	188	259
- Pandeglang	26	32	40	51
- Rangkasbitung	61	76	98	124
- Cilegon	26	40	58	81
- IKKs	120	170	233	309
Sub-total	321	448	617	824
2. Rural Water Demand	405	618	829	872
3. Domestic Water Demand in Industrial Estate				
- P.T. Satya Raya Indah Woodbased Industries	4.1	4.1	4.1	4.1
- P.T. Statomer PVC Resin Factory	0.1	0.1	0.2	0.2
- Port & Ferry Installations	0.3	0.4	0.4	0.5
- Suralaya Power Station and Housing Colony	30	40	40	50
- Cilegon Industrial Estate Housing Colony	13	17	24	33
Sub-total	48	62	69	88
Total	774	1,128	1,515	1,784
4. Industrial Water Demand				
- P.T. Satya Raya Indah Woodbased Industries	2.9	2.9	2.9	2.9
- P.T. Statomer PVC Resin Factory	1.6	1.6	1.6	1.6
- Port & Ferry Installations	1.6	1.8	2.0	2.3
- P.T. Krakatau Steel Works (including domestic use)	980	980	980	2,000
- P.T. Suralaya Power Station	18	47	59	70
- Cilegon Industrial Estate	93	148	480	688
Total	1,097	1,181	1,526	2,765
Grand Total	1,871	2,309	3,041	4,549



MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN ON NORTH BANTEN WATER RESOURCES DEVELOPMENT

Annex 7121 Present Longitudinal Profile of Ciujung River

JAPAN INTERNATIONAL COOPERATION AGENCY



MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN ON NORTH BANTEN WATER RESOURCES DEVELOPMENT

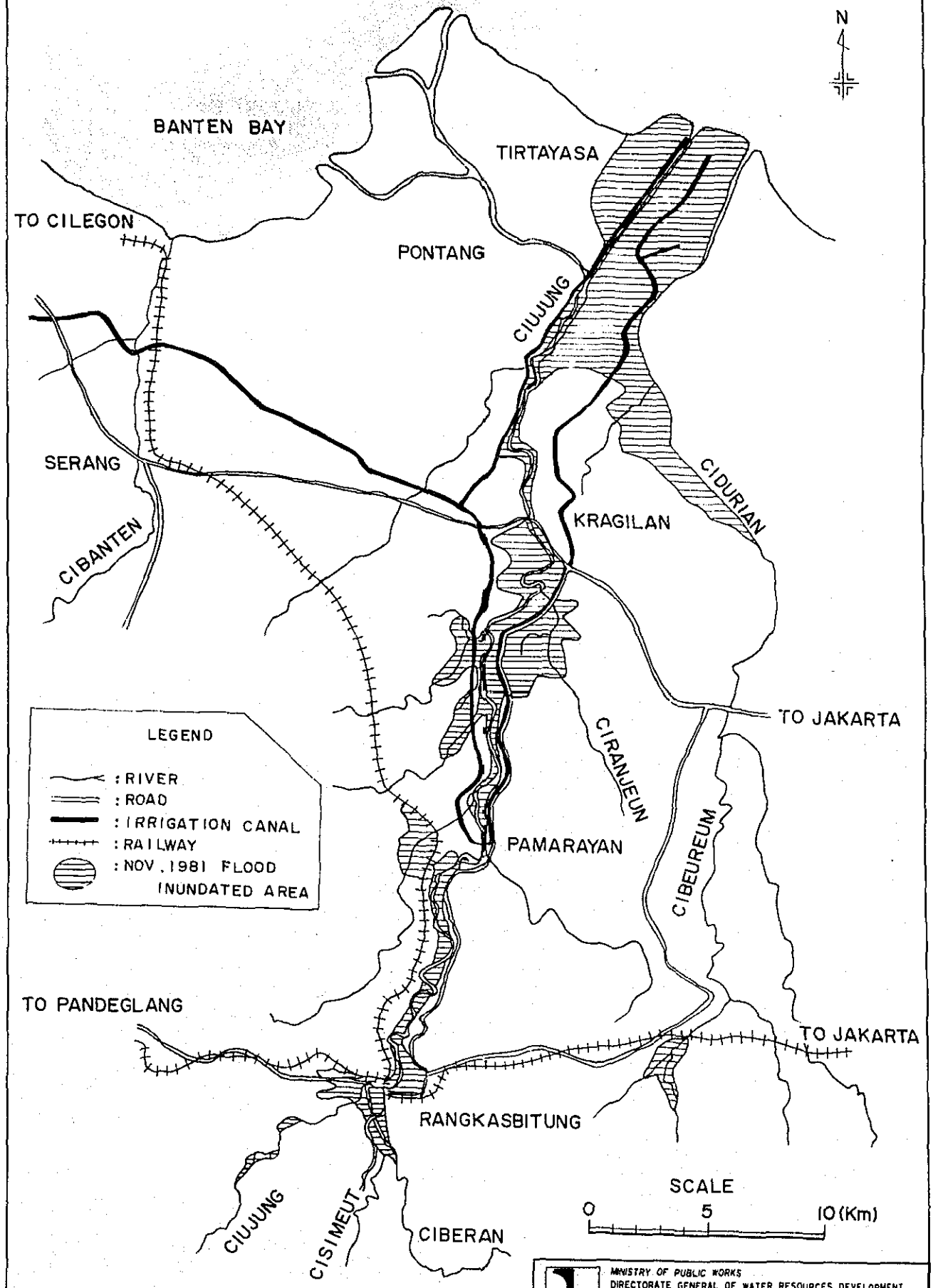
Annex 7123 Flow Capacity and Characteristics of Ciujung River

JAPAN INTERNATIONAL COOPERATION AGENCY

Annex 7132 (1/4) INUNDATED AREA ALONG THE CIUJUNG RIVER BY FLOOD IN NOVEMBER 1981

Unit: ha

Section	Land Use	Inundated Depth (m) 0.00 to 0.49	0.50 to 0.99	1.00 to 1.49	1.50 to 1.99	Total
River Mouth to the Pamarayan Weir	Paddy Field	490	870	1,760	190	3,310
	Upland Field	60	80	160	190	490
	Plantation	30	60	120	40	250
	Fish Pond	550	-	-	-	550
	Village	30	40	90	40	200
	Sub-total	1,160	1,050	2,130	460	4,800
Upstream from the Pamarayan Weir	Paddy Field	10	10	30	50	100
	Upland Field	60	60	130	260	510
	Plantation	20	20	40	80	160
	Village	10	10	20	40	80
	Sub-total	100	100	220	430	850
Total	Paddy Field	500	880	1,790	240	3,410
	Upland Field	120	140	290	450	1,000
	Plantation	50	80	160	120	410
	Fish Pond	550	-	-	-	550
	Village	40	50	110	80	280
	Total	1,260	1,150	2,350	890	5,650



SOURCE: DPUP(SERANG & PANDEGRANG -RANGKASBITUNG)

MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN ON NORTH BANTEN WATER RESOURCES DEVELOPMENT

Annex 7132 (2/4) Inundated Area in and around Ciujung River Basin

JAPAN INTERNATIONAL COOPERATION AGENCY

Annex 7132 (3/4) NUMBER OF INUNDATED HOUSES AND BUILDINGS ALONG THE CIUJUNG RIVER BY FLOOD IN NOVEMBER 1981

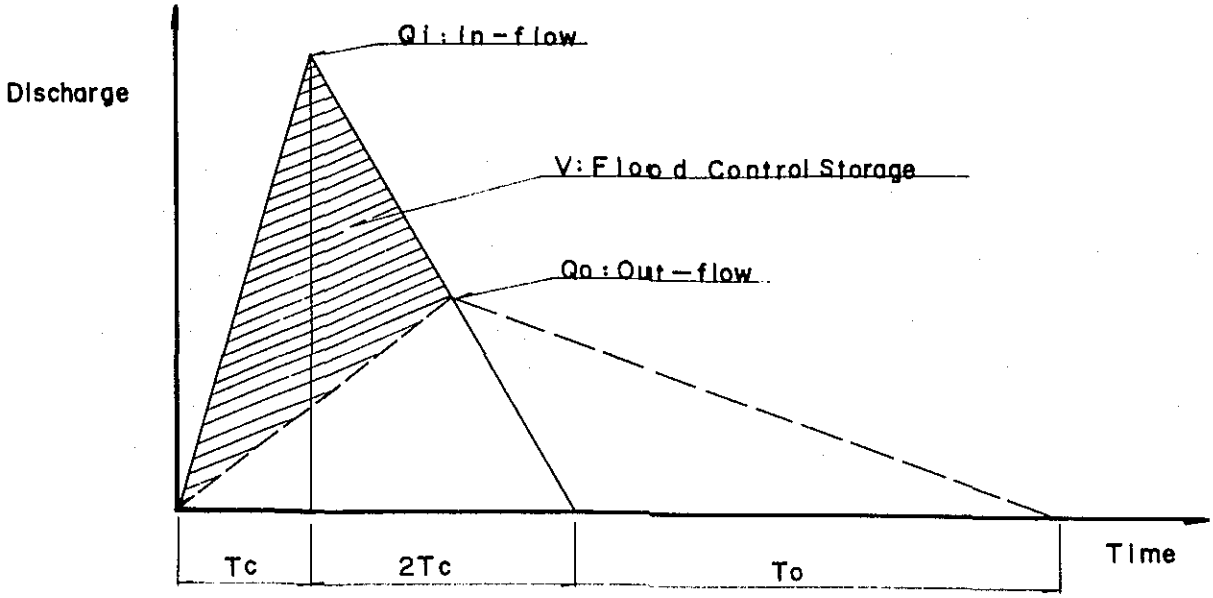
Unit: house

Section	Kind of Houses and Buildings	Inundated Depth (m) 0.00 to 0.49	0.50 to 0.99	1.00 to 1.49	1.50 to 1.99	Total
River Mouth to the Pamarayan Weir	Residence	880	1,170	2,630	1,170	5,850
	Shop	10	20	40	20	90
	School	1	1	2	1	5
	Mosque	9	12	27	12	60
	Sub-total	900	1,203	2,699	1,203	6,005
Upstream from the Pamarayan Weir	Residence	290	290	590	1,170	2,340
	Shop	5	5	10	20	40
	School	0	0	0	2	2
	Mosque	3	3	6	12	24
	Sub-total	298	298	606	1,204	2,406
Total	Residence	1,170	1,460	3,220	2,340	8,190
	Shop	15	25	50	40	130
	School	1	1	2	3	7
	Mosque	12	15	33	24	84
	Total	1,198	1,501	3,305	2,407	8,411

Annex 7132 (4/4) FLOOD DAMAGE ALONG THE CIUJUNG RIVER BY FLOOD IN NOVEMBER 1981

Unit: Rp 10^6 at 1982 price

	Item	River Mouth to the Pamarayan Weir	Upstream from Pamarayan Weir	Total
(1)	Houses and Buildings, Household Effects	2,365.30	1,982.75	4,348.05
(2)	Crops	1,122.55	15.12	1,137.67
(3)	Suspension of Business Activities	141.92	118.97	260.88
(4)	Public Facilities	1,880.41	1,794.39	3,674.80
	Total	5,510.18	3,911.23	9,421.40



	Qi (m^3/s)	Qo (m^3/s)	V ($10^6 m^3$)	Tc (hr)
Karian Dam	740	300	30.0	9
Pasir Kopo Dam	850	280	15.0	4
Bojongmanik Dam	590	190	16.0	6

Remark : Return period 50 years

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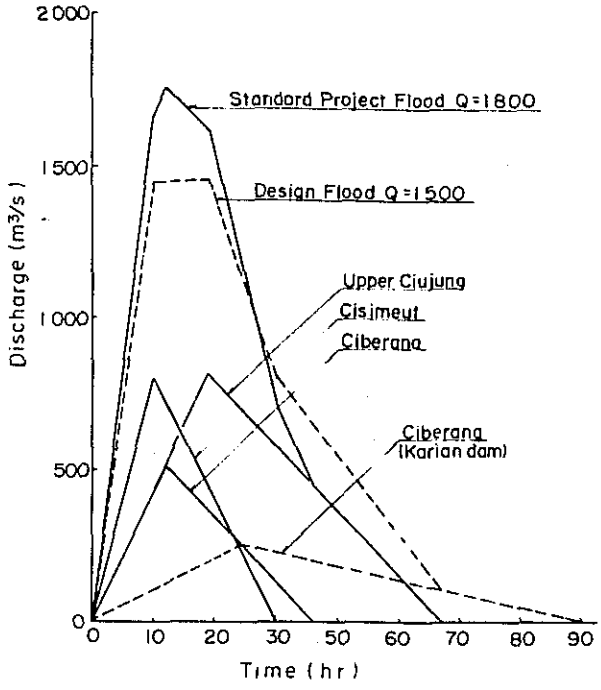
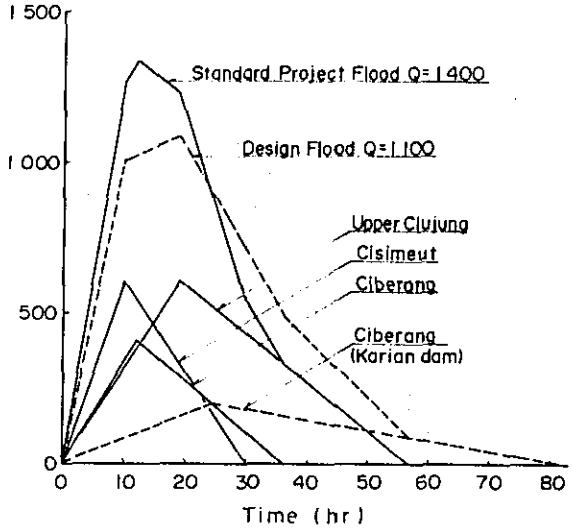
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN ON NORTH BANTEN WATER RESOURCES DEVELOPMENT
Annex 7141 Flood Regulation by Dams
JAPAN INTERNATIONAL COOPERATION AGENCY

Annex 7142

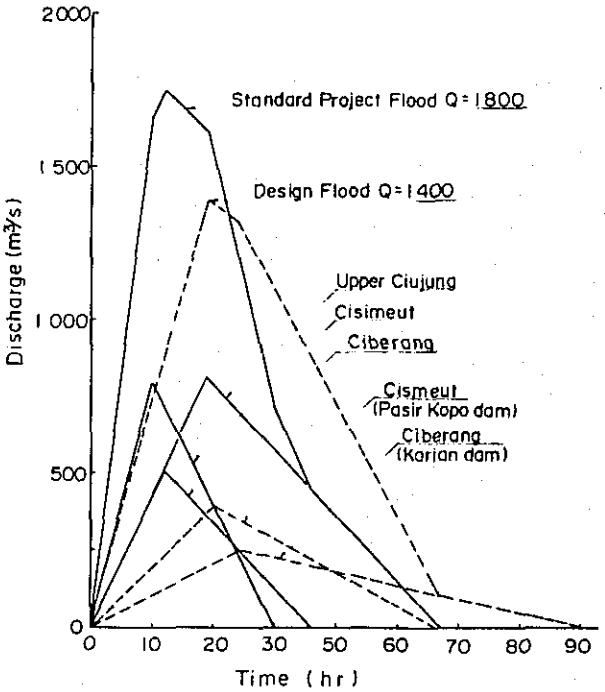


1/50 Flood

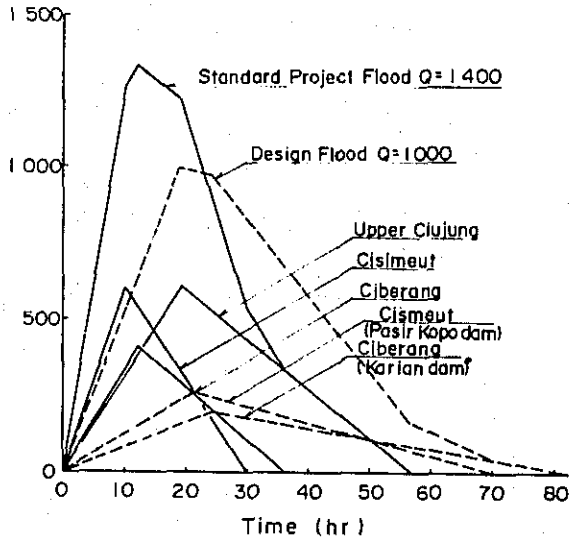


1/10 Flood

KARIAN DAM



1/50 Flood



1/10 Flood

KARIAN + PASIR KOPO DAMS

MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN ON NORTH BANTEN WATER RESOURCES DEVELOPMENT

Annex 7142 Regulated Flow at Rangkasbitung

JAPAN INTERNATIONAL COOPERATION AGENCY

Annex 7151 ALTERNATIVE PLAN FOR RIVER IMPROVEMENT

Alternative Number	First Stage Plan (10 Years)				Master Plan (50 Years)		
	F-0	F-1	F-2	F-3	M-1	M-2	M-3
Design Flood Distribution Case	10-1	10-0	10-1	10-2	50-0	50-1	50-2
River Improvement (Length km)	0	63	26	26	67	67	67
Ciujung River							
River Mouth - pamarayan (37.07 km)	-	+	-	-	+	+	+
Pamarayan - No. 64 (14.01 km)	-	+	+	+	+	+	+
No. 64 Present Channel (2.95 km)	-	+	+	+	-	-	-
No. 54 Short Cut (Rangkasbitung) (1.91 km)	-	-	-	-	+	+	+
Upper Ciujung River (F: 5.5 km, M: 10.0 km)	-	+	+	+	+	+	+
Ciberang River (3.46 km)	-	-	-	-	+	+	+
Cisimeut River (Short Cut 0.9 km)	-	-	-	-	+	+	+
Construction of Dam							
Karian Dam	+	-	+	+	-	+	+
Pasir Kopo Dam	-	-	-	+	-	-	+

Remarks: Design flood distribution case = 10 and 50 indicate return period and 1 to 3 show number of dam
Number of dam = 1 for Karian dam, 2 for Karian plus Pasir Kopo dams and 3 for Karian plus Pasir Kopo and Bojongmanik dams

Annex 7152 (1/2) DESIGN FLOOD DISTRIBUTION OF CIUJUNG RIVER

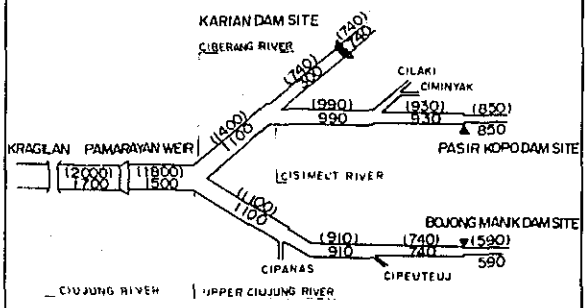
Unit: m^3/s

Case	First Stage Plan (10 Years)			Master Plan (50 Years)			
	10-0	10-1	10-2	50-0	50-1	50-2	50-3
Ciujung River							
Kragilan Bridge	1,600	-	-	2,000	1,700	1,600	1,400
Pamarayan Weir	1,400	1,100	1,000	1,800	1,500	1,400	1,200
Rangkasbitung	1,400	1,100	1,000	1,800	1,500	1,400	1,200
Upper Ciujung River							
Rangkasbitung	760	760	760	1,100	1,100	1,100	950
Cipanase R. Confluence	690	690	690	910	910	910	610
Cipetuj R. Confluence	560	560	560	740	740	740	390
Bojongmanik Dam	450	450	450	590	590	590	190
Ciberang River							
Ciujung R. Confluence	1,100	750	650	1,400	1,100	780	780
Cisimeut R. Confluence	600	230	230	740	300	300	300
Karian Dam	600	230	230	740	300	300	300
Cisimeut River							
Ciberang R. Confluence	740	740	520	990	990	670	670
Ciminyak R. Confluence	670	670	270	930	930	380	380
Pasir Kopo Dam	610	610	210	850	850	280	280

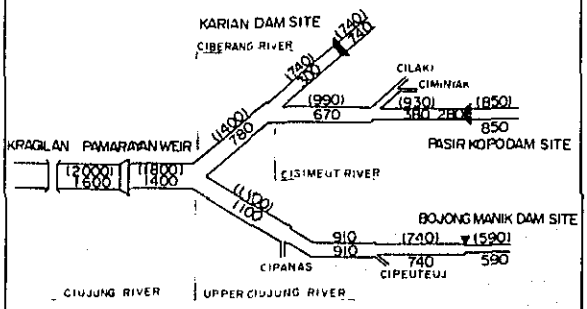
Remarks: Case No. 10-1 = 10 indicates return period, 1 indicates number of dam
1 = Karian Dam, 2 = Karian and Pasir Kopo Dam, 3 = Karian, Pasir Kopo and Bojongmanik Dam

1/50 Flood

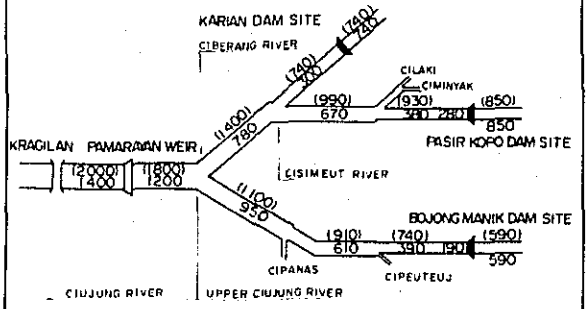
Case No. 50-1



Case No. 50-2

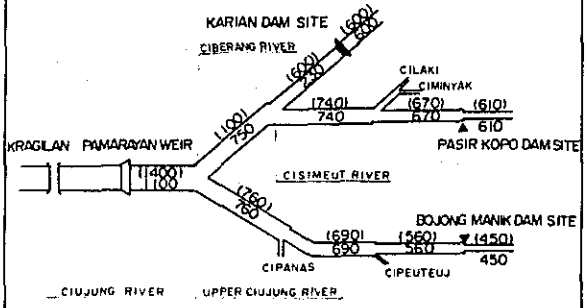


Case No. 50-3

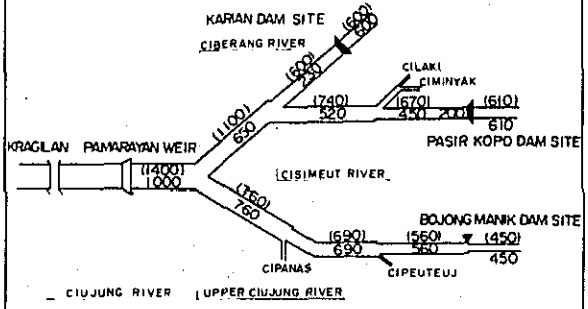


1/10 Flood

Case No. 10-1



Case No. 10-2



Remarks ; Unit : m^3/s

( ) : Standard Project Flood

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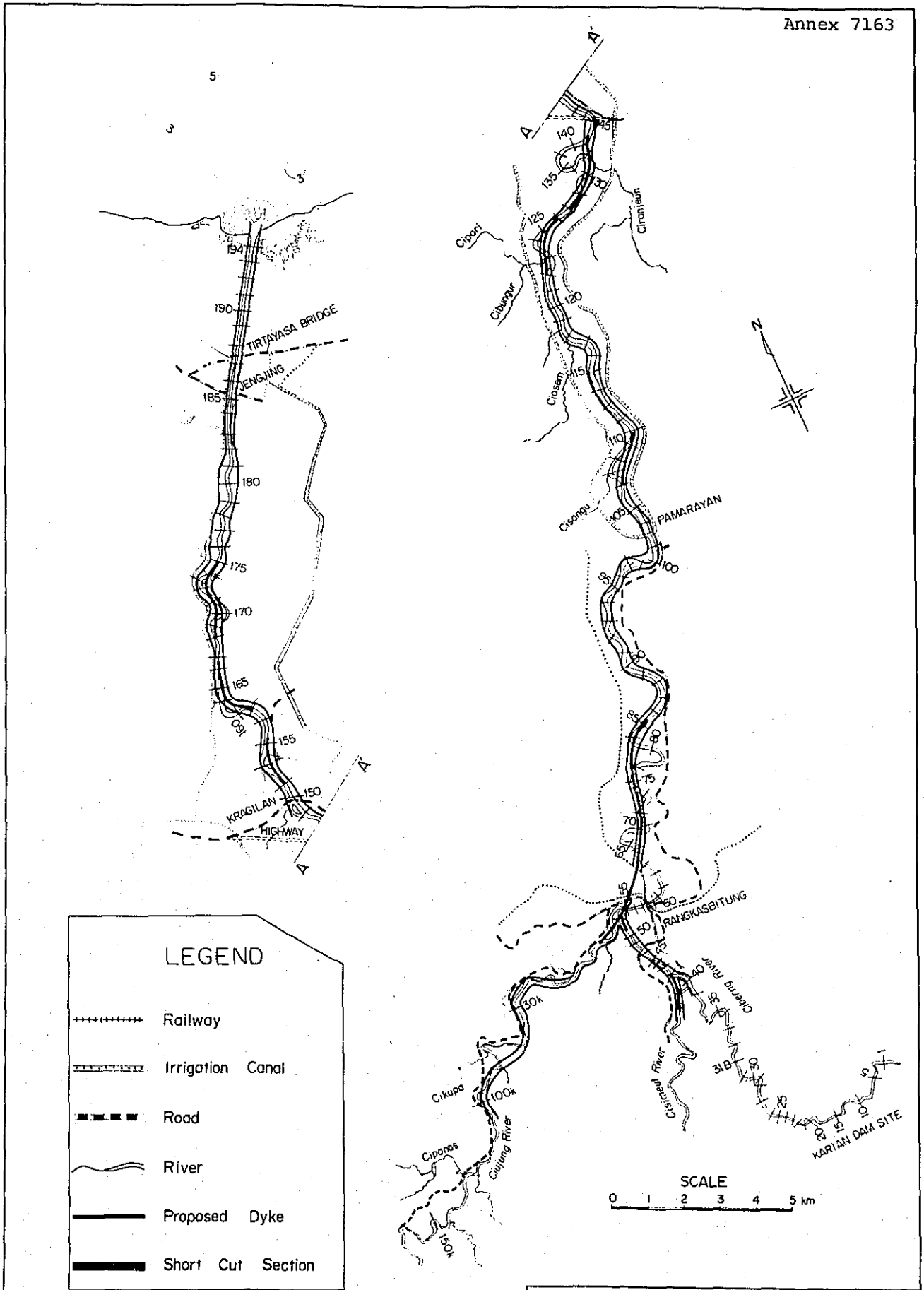
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN ON NORTH BANTEN WATER RESOURCES DEVELOPMENT

Annex 7152 (2/2) Design Flood Distribution of Ciujung River

JAPAN INTERNATIONAL COOPERATION AGENCY

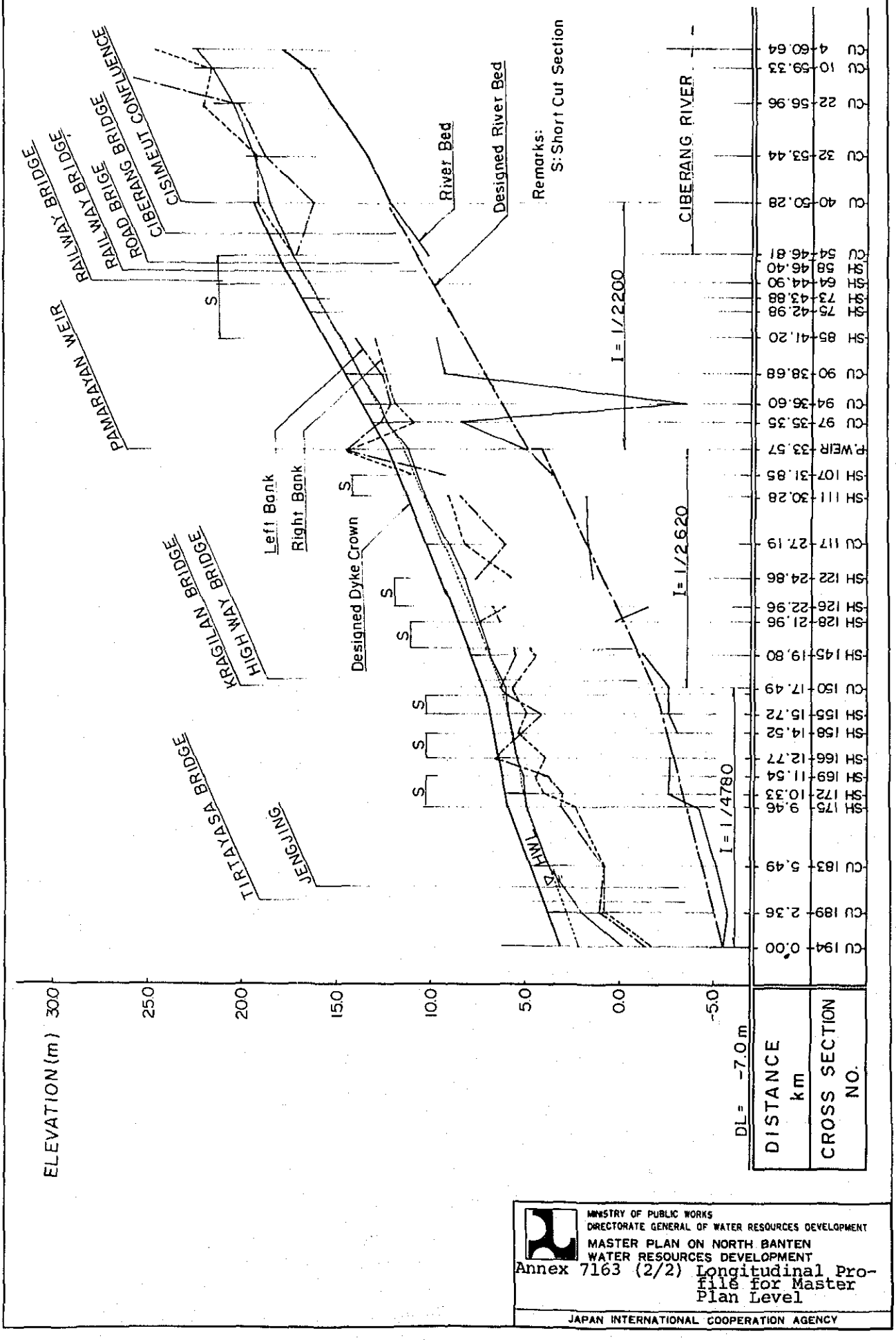


Alternative M-1, M-2, M-3.

MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN ON NORTH BANTEN WATER RESOURCES DEVELOPMENT

Annex 7163 (1/2) Proposed Alignment for Master Plan Level

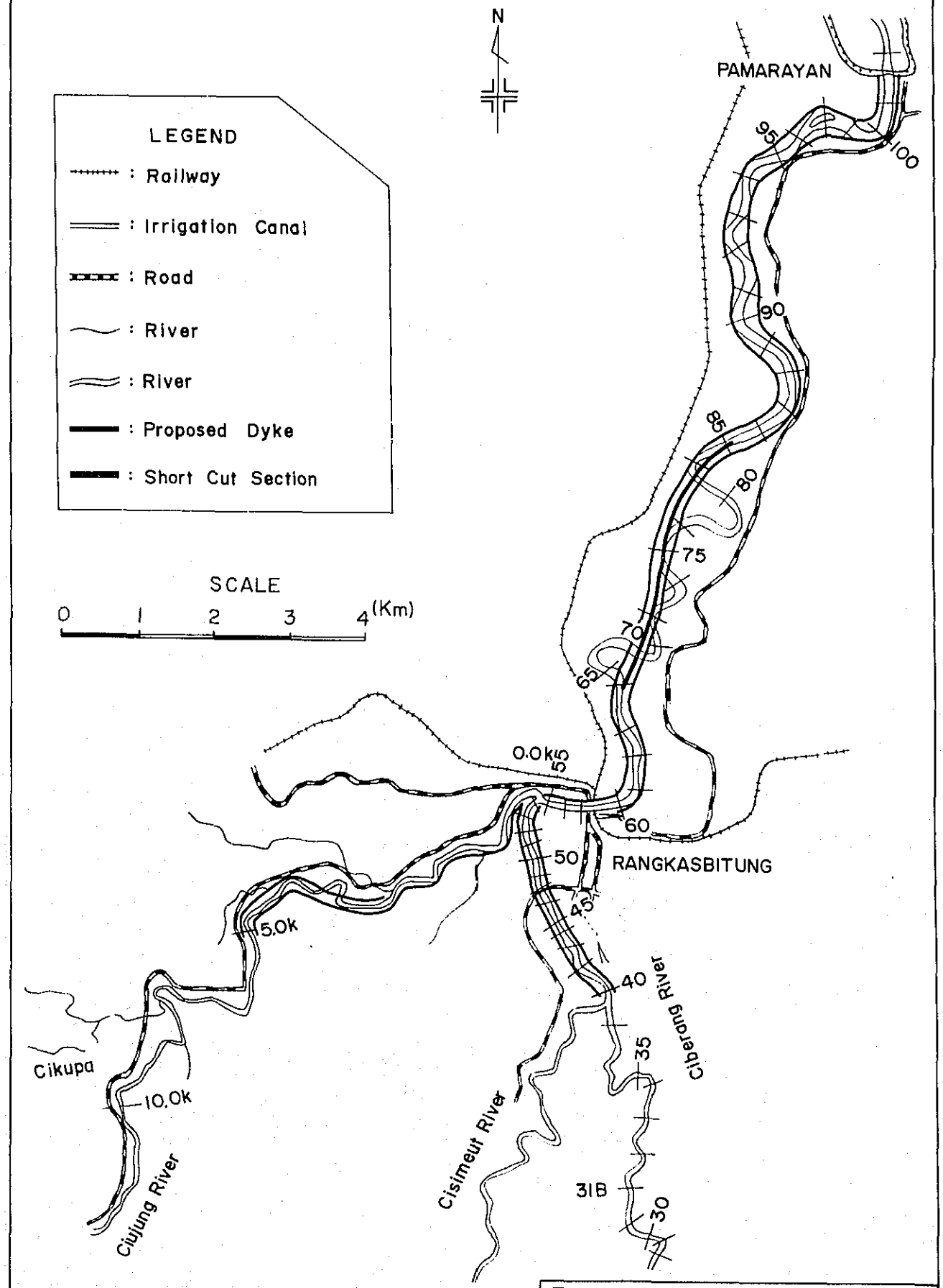
JAPAN INTERNATIONAL COOPERATION AGENCY



MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN ON NORTH BANTEN WATER RESOURCES DEVELOPMENT

Annex 7163 (2/2) Longitudinal Profile for Master Plan Level

JAPAN INTERNATIONAL COOPERATION AGENCY



Alternative F-1, F-2, F-3

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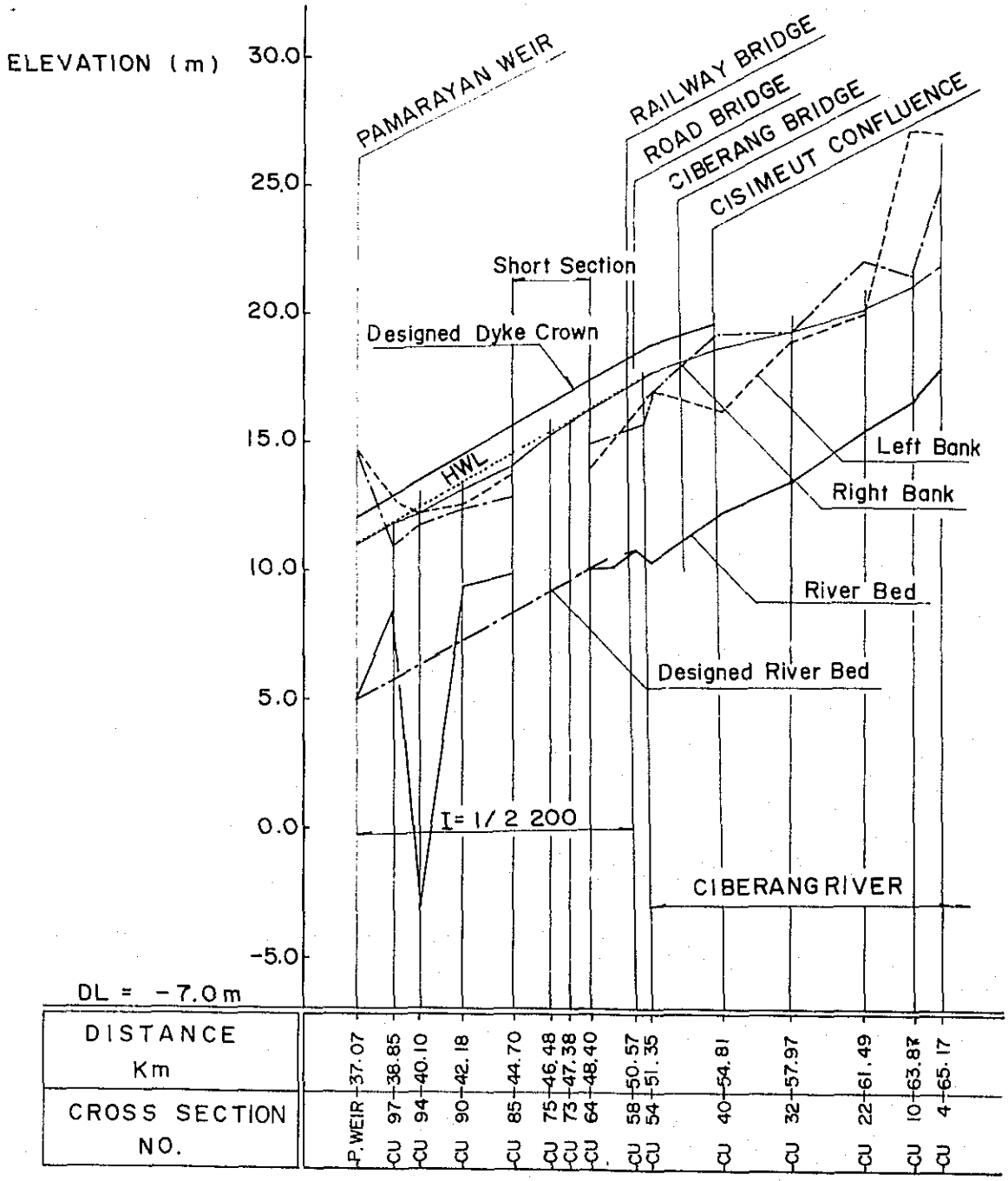
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN ON NORTH BANTEN WATER RESOURCES DEVELOPMENT

Annex 7164 (1/2) Proposed Alignment for First Stage Plan

JAPAN INTERNATIONAL COOPERATION AGENCY



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DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN ON NORTH BANTEN WATER RESOURCES DEVELOPMENT

Annex 7164 (2/2) Longitudinal Profile for First Stage Plan

JAPAN INTERNATIONAL COOPERATION AGENCY

Annex 7171 RIVER IMPROVEMENT COST BY ALTERNATIVE PLAN

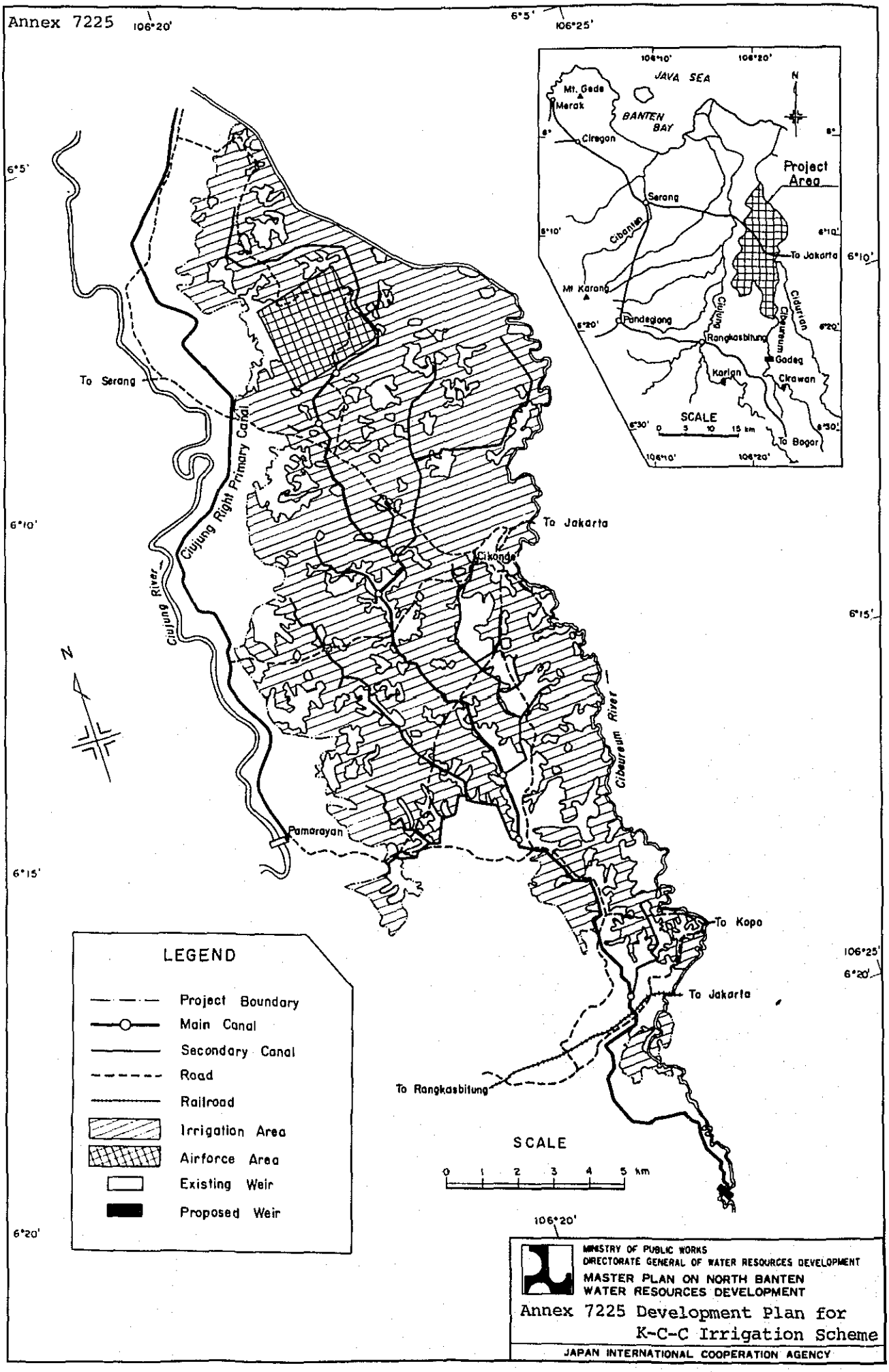
Unit: Rp 10^6

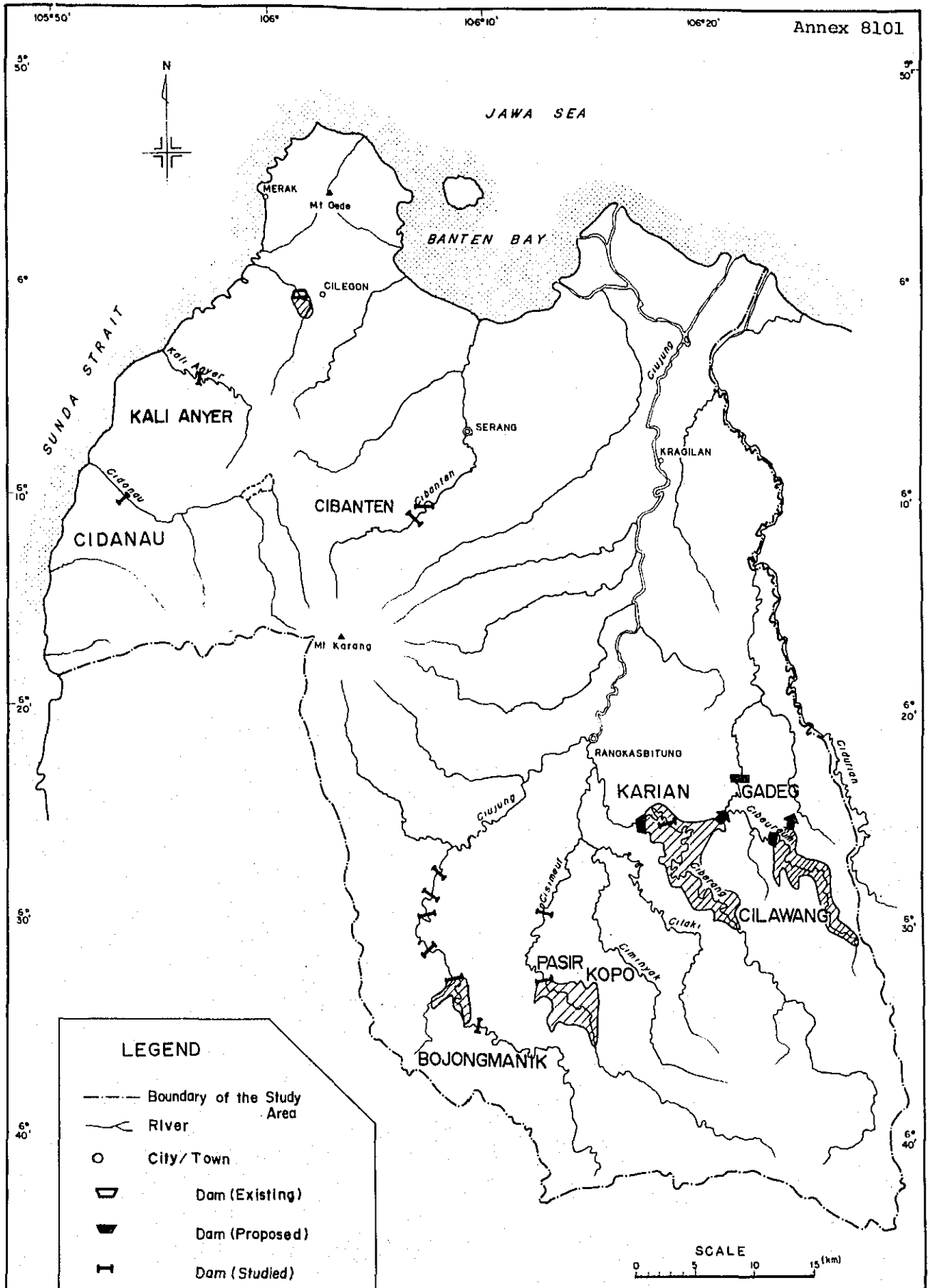
	Alternative Plan					
	F-1	F-2	F-3	M-1	M-2	M-3
River Improvement	33,850	9,703	8,713	47,240	45,671	44,960
Price Contingency	18,978	4,383	3,949	26,778	25,795	25,354
Total	52,828	14,086	12,662	74,018	71,466	70,314
Foreign Portion	32,413	8,605	7,933	44,284	43,354	42,911
Local Portion	20,415	5,481	4,729	29,734	28,112	27,403

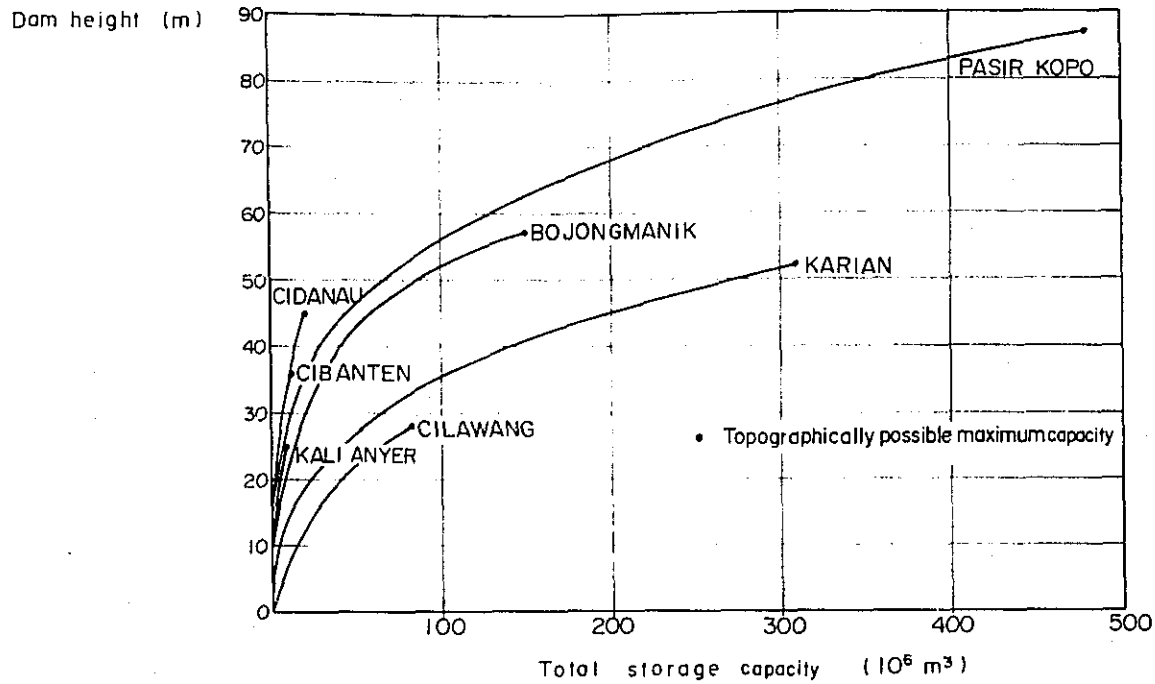
Annex 7172 RIVER IMPROVEMENT COST INCLUDING DAM CONSTRUCTION COST SHARED BY FLOOD CONTROL

Unit: Rp 10^6

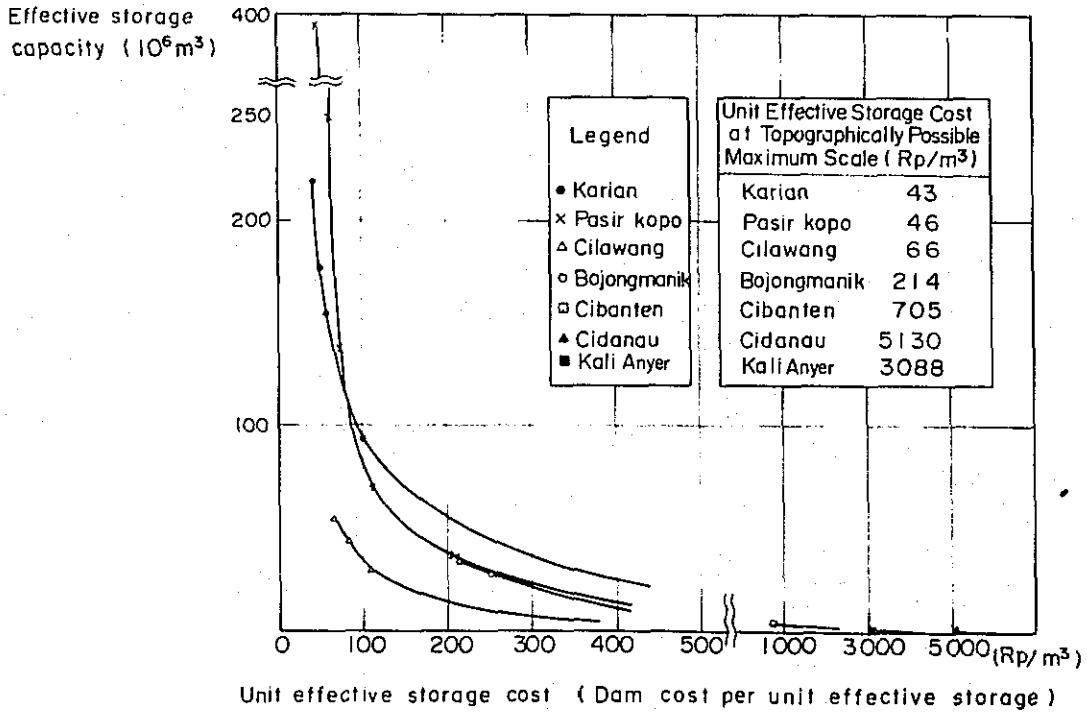
	Alternative Plan					
	F-1	F-2	F-3	M-1	M-2	M-3
River Improvement	33,850	9,703	8,713	47,240	45,671	44,960
Dam Shared by Flood Control	0	4,991	8,763	0	4,991	8,763
Sub-total	33,850	14,694	17,476	47,240	50,662	53,723
Price Contingency	18,978	7,407	9,110	26,778	28,648	30,406
Total	52,828	22,101	26,586	74,018	79,340	84,129
Foreign Portion	32,413	12,180	14,217	44,284	46,787	49,109
Local Portion	20,415	9,921	12,369	29,734	32,523	35,020


Annex 7225
106°20'
6°5'
106°25'
JAVA SEA
Mt. Gede
Merak
BANTEN BAY
Cilegon
Serang
Project Area
Cibanten
To Jakarta
Mt Karang
Pandeglang
Ciujung
Cidurian
Rangkasbitung
Gadeg
Karian
Cirawan
To Bogor
SCALE
0 5 10 15 km
To Serang
Ciujung Right Primary Canal
Ciujung River
Cikande
Cidurian River
Pamarayan
To Kopo
To Rangkasbitung
SCALE
0 1 2 3 4 5 km
N
LEGEND
Project Boundary
Main Canal
Secondary Canal
Road
Railroad
Irrigation Area
Airforce Area
Existing Weir
Proposed Weir
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN ON NORTH BANTEN WATER RESOURCES DEVELOPMENT
Annex 7225 Development Plan for K-C-C Irrigation Scheme
JAPAN INTERNATIONAL COOPERATION AGENCY


105°50'
106°
106°10'
106°20'
5° 50'
6°
6° 10'
6° 20'
6° 30'
6° 40'
N
JAWA SEA
BANTEN BAY
SUNDA STRAIT
MERAK
Mt Gede
CILEGON
Kali Anyer
KALI ANYER
Cidanau
CIDANAU
SERANG
Cibanten
CIBANTEN
Ciujung
KRAGILAN
Mt Karang
RANGKASBITUNG
KARIAN
GADEG
Ciduriun
Cisimeul
Cibaeum
Ciberang
CILAWANG
Cilaki
Ciminyak
PASIR KOPO
BOJONGMANIK
LEGEND
Boundary of the Study Area
River
City/Town
Dam (Existing)
Dam (Proposed)
Dam (Studied)
Diversion Weir (Proposed)
Diversion Tunnel (Proposed)
SCALE
0 5 10 15 (km)
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN ON NORTH BANTEN WATER RESOURCES DEVELOPMENT
Annex 8101 Location Map of Conceivable Dam Sites
JAPAN INTERNATIONAL COOPERATION AGENCY

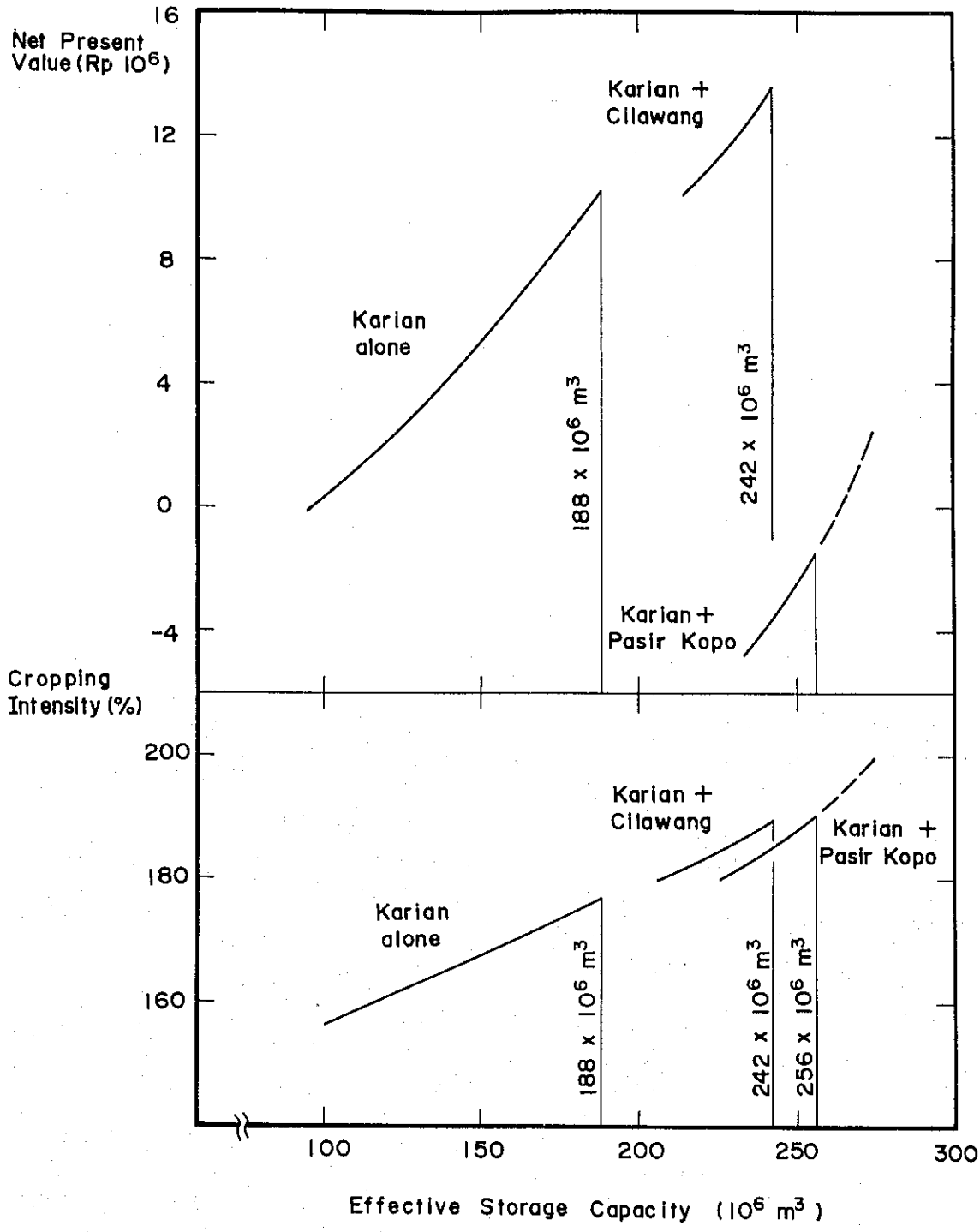


TOTAL STORAGE CAPACITY CURVE



UNIT EFFECTIVE STORAGE COST CURVE

MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN ON NORTH BANTEN WATER RESOURCES DEVELOPMENT
Annex 8102 Storage Capacity and Cost Curve
JAPAN INTERNATIONAL COOPERATION AGENCY



Remark: Benefitted area = Ciujung (24,200 ha) + K-C-C (8,000 ha)

MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN ON NORTH BANTEN WATER RESOURCES DEVELOPMENT

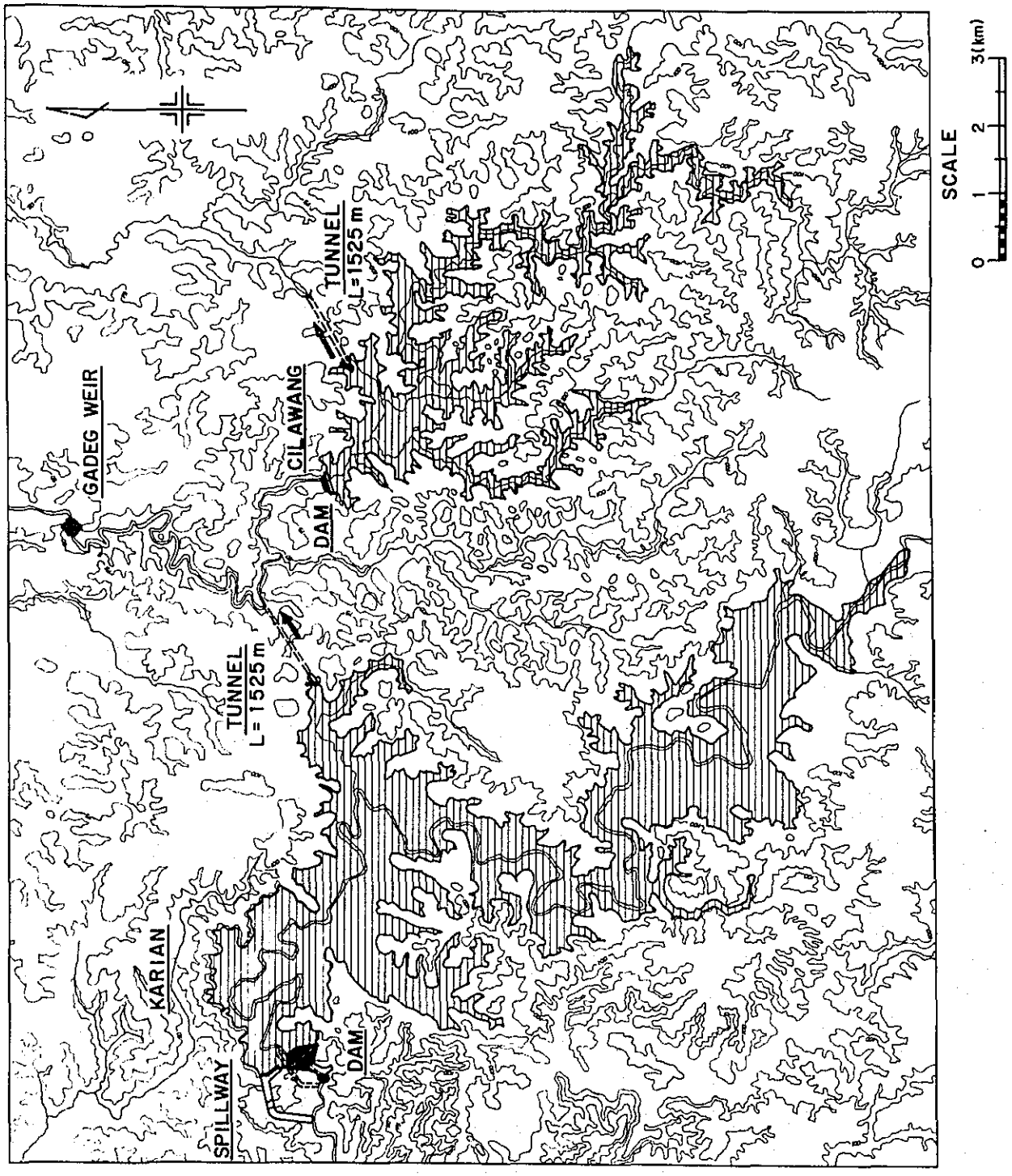
Annex 8207 Evaluation of Combination of Dams

JAPAN INTERNATIONAL COOPERATION AGENCY

Annex 8208 SELECTION OF COMBINATION OF DAMS

		Case 1	Case 2	Case 3
Combination of Dams		Karian alone	Karian + Pasir Kopo	Karian + Cilawang
Effective Storage Capacity (10^6 m^3)				
Karian:	Irrigation	176	176	176
	D & I water supply	12	12	12
	Flood control	30	30	30
	Total	218	218	218
Pasir Kopo:	Irrigation	-	68	-
	Flood control	-	15	-
	Total	-	83	-
Cilawang:	Irrigation	-	-	54
	Total Capacity	218	301	272
Irrigation Area (ha)				
Wet season:	Ciujung	24,200	24,200	24,200
	K-C-C	8,000	8,000	8,000
	Cicinta	-	-	1,435
	Total	32,200	32,200	33,635
Dry season:	Ciujung	18,650	21,000	21,000
	K-C-C	6,160	8,000	6,950
	Cicinta	-	-	1,250
	Total	24,810	29,000	29,200
Flood Control				
River improvement (km)/1		26	26	26
Present Worth (Rp 10^6)/2				
Cost:	Karian dam	24,712	24,712	24,712
	Pasir Kopo dam	-	15,879	-
	Cilawang dam	-	-	7,999
	K-C-C irrigation scheme	14,512	14,512	14,512
	River improvement/1	6,046	9,618	6,046
	Total	45,270	64,721	53,269
Benefit/3:	Irrigation	45,360	54,044	54,628
	Flood control	8,256	8,955	8,256
	Total	53,616	62,999	62,884
Evaluation:	NPV (Rp 10^6)	8,346	-1,722	9,615
	B/C	1.17	0.97	1.18
	EIRR	13.6	11.8	13.7

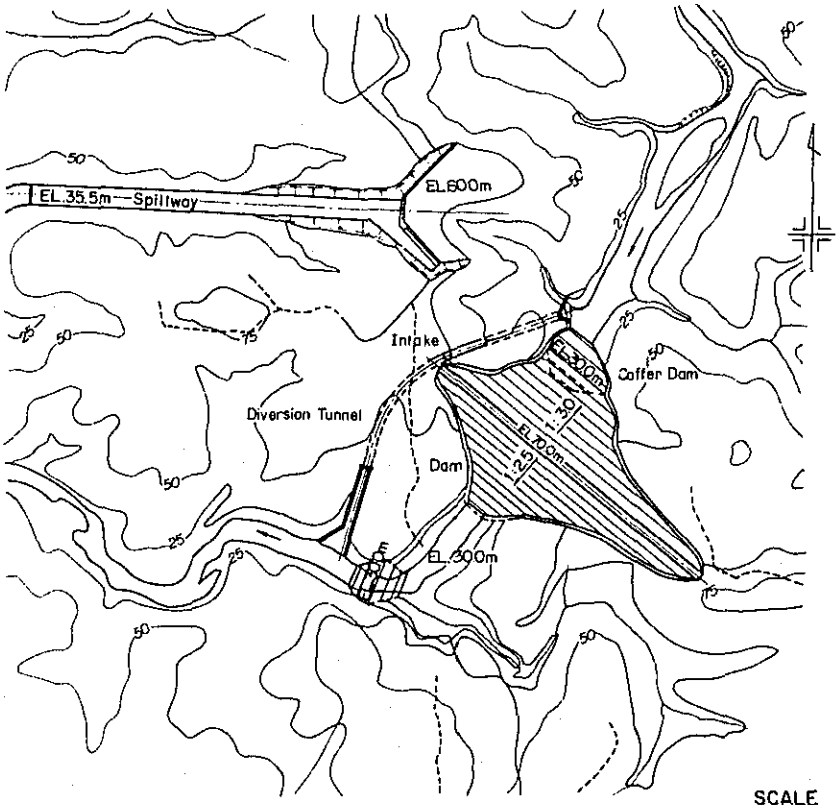
Remarks: /1 = In case of return period of 10 years.
/2 = Discount rate of 12% and 50-year project life are assumed.
/3 = D&I water supply benefit is excluded because this is common to every cases.



MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN ON NORTH BANTEN
WATER RESOURCES DEVELOPMENT

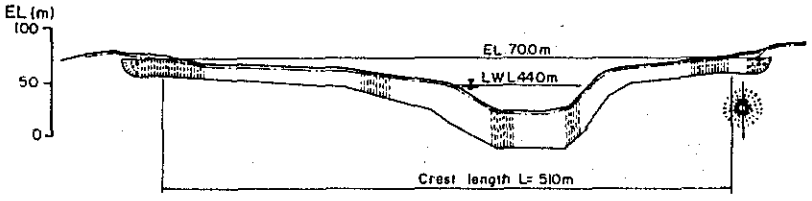
Annex 8311 General Map of Karian and Cilawang Dams

JAPAN INTERNATIONAL COOPERATION AGENCY



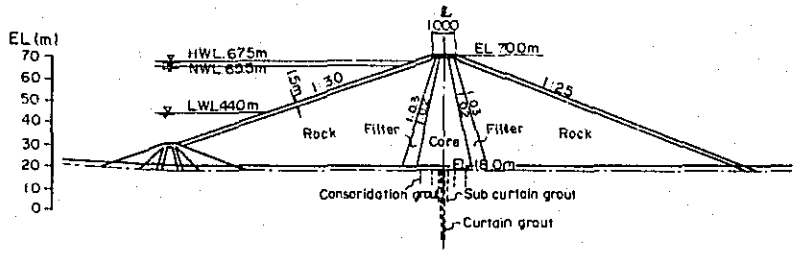
KARIAN DAM PLAN

SCALE 0 100 200 m



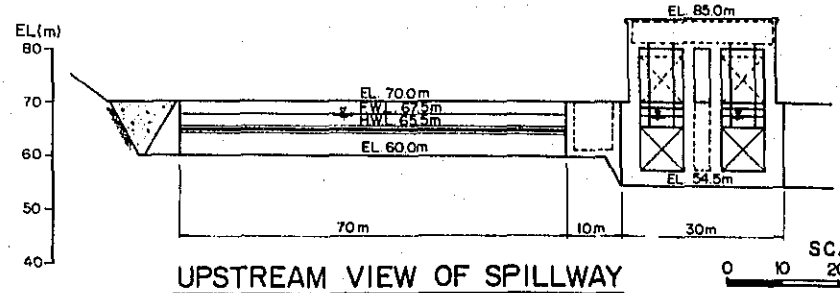
UPSTREAM VIEW OF DAM

SCALE 0 100 200 m



TYPICAL SECTION OF DAM

SCALE 0 50 100 m



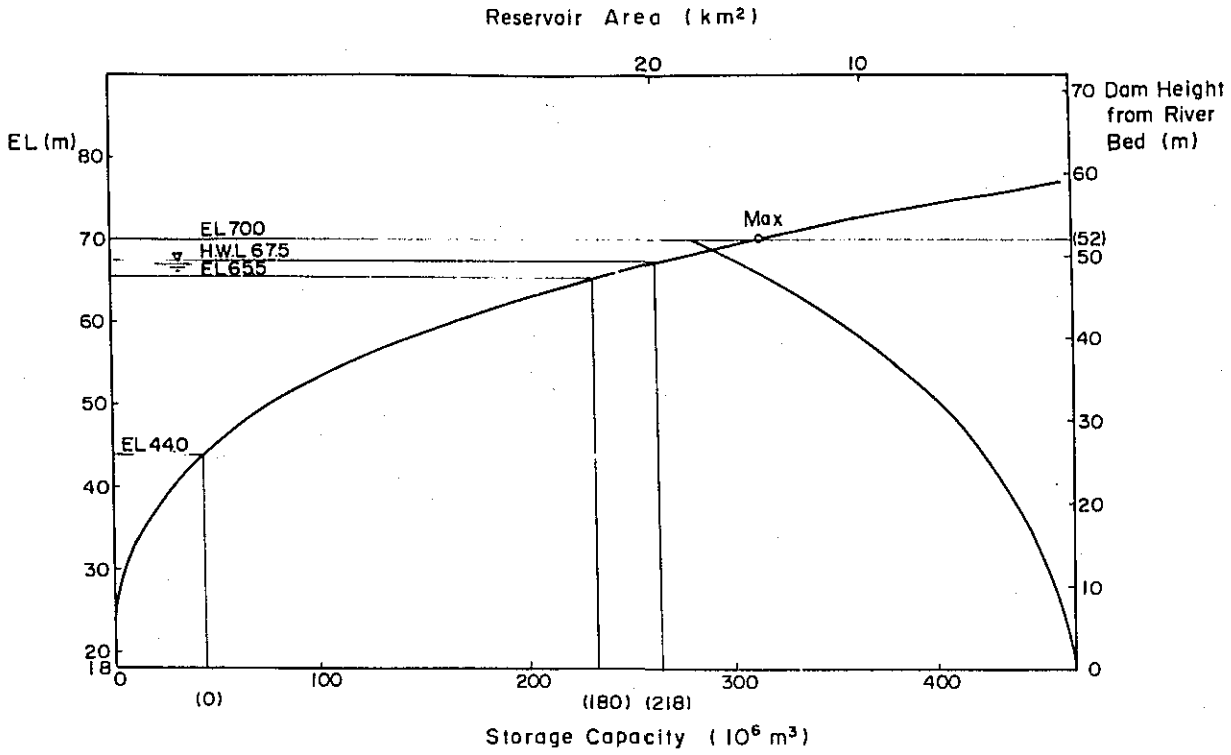
UPSTREAM VIEW OF SPILLWAY

SCALE 0 10 20 30 40 m

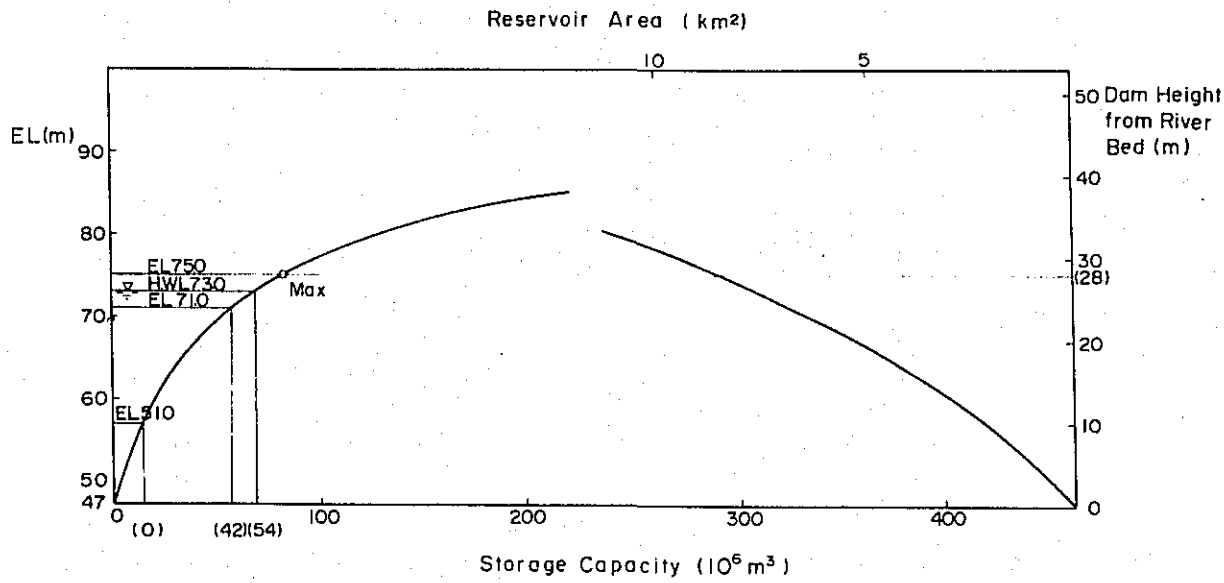
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN ON NORTH BANTEN WATER RESOURCES DEVELOPMENT

Annex 8313 Proposed Karian Dam

JAPAN INTERNATIONAL COOPERATION AGENCY



KARIAN DAM



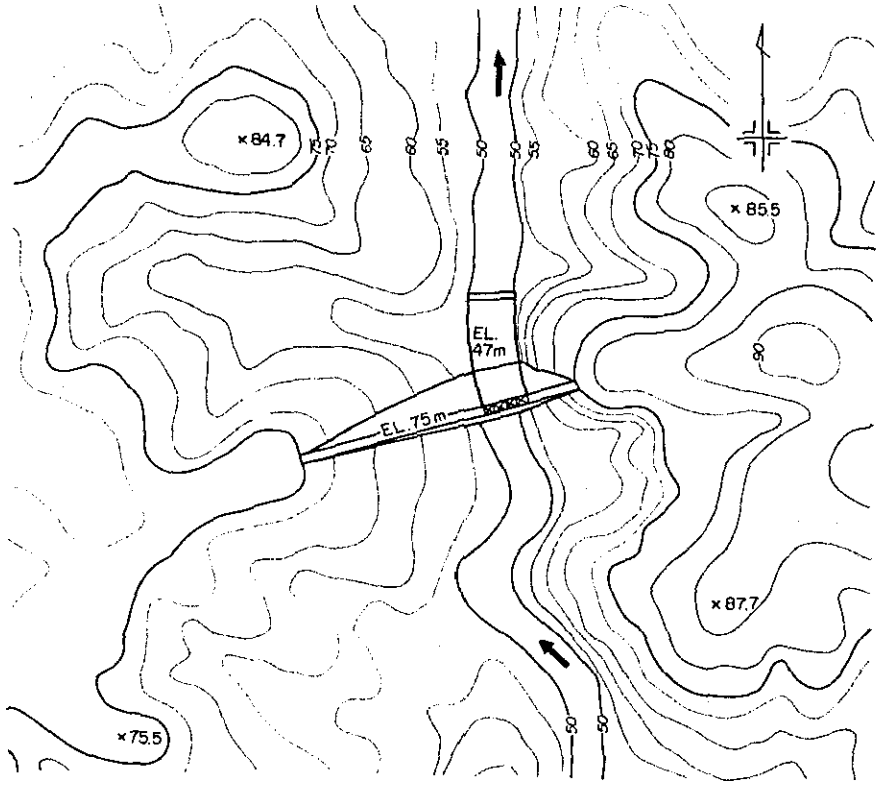
CILAWANG DAM

MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN ON NORTH BANTEN WATER RESOURCES DEVELOPMENT

Annex 8315 Stage-Area-Storage Curve

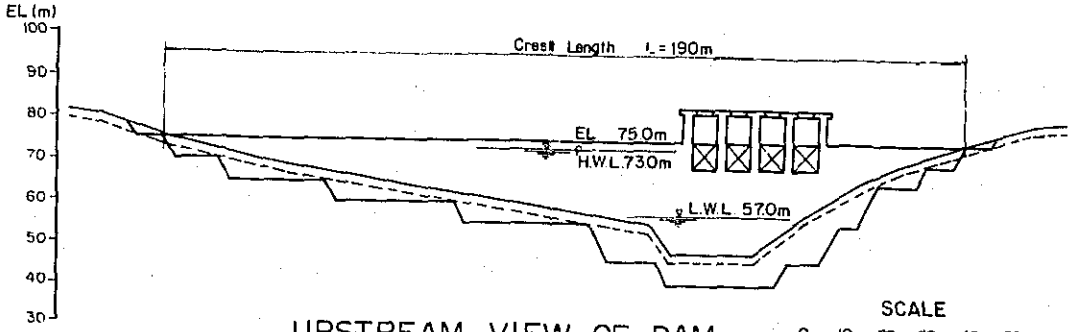
JAPAN INTERNATIONAL COOPERATION AGENCY

Annex 8323



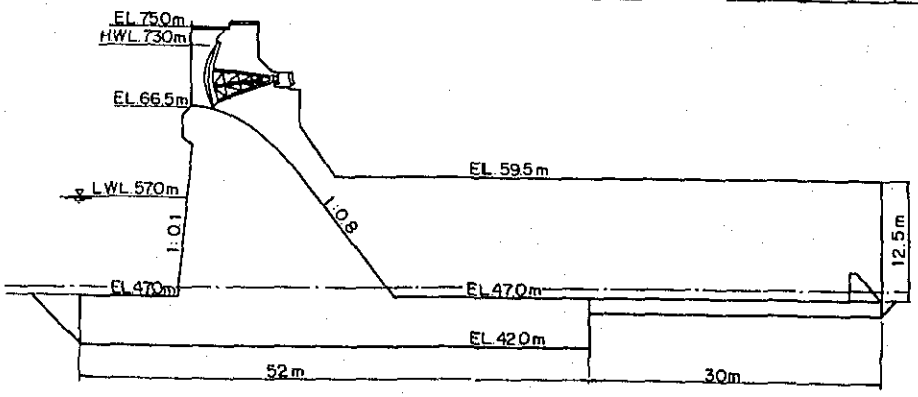
CILAWANG DAM PLAN

SCALE 0 100 200 m



UPSTREAM VIEW OF DAM

SCALE 0 10 20 30 40 50 m



OVERFLOW SECTION

SCALE 0 10 20 m

MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN ON NORTH BANTEN WATER RESOURCES DEVELOPMENT

Annex 8323 Proposed Cilawang Dam

JAPAN INTERNATIONAL COOPERATION AGENCY

Annex 9109 (1/2) BREAKDOWN OF CONSTRUCTION COST

Unit: Rp 10^6

Item	Karian Dam	Cilawang Dam	K-C-C Irrigation	River Improvement	Whole Project
Direct Construction Cost					
Preparatory works	2,320	720	1,090	557	4,687
Diversion works	3,160	-	-	-	3,160
Coffer dam	480	20	-	-	500
Main dam	10,430	4,010	790	-	15,230
Spillway & intake	3,630	420	1,260	-	5,310
Metal work	3,800	1,280	-	-	5,080
Tunnel	1,660	1,660	-	-	3,320
Main canal	-	-	3,500	-	3,500
Secondary canal	-	-	5,700	-	5,700
Tertiary development	-	-	1,600	-	1,600
Drainage canal	-	-	1,200	-	1,200
Farm road	-	-	950	-	950
Dredging	-	-	-	3,544	3,544
Excavation	-	-	-	598	598
Embankment	-	-	-	1,003	1,003
Facing & structure	-	-	-	208	208
Drainage ditch	-	-	-	248	248
Miscellaneous	-	-	10	560	570
Sub-total	25,480	8,110	16,100	6,718	56,408
Land Acquisition	9,200	3,100	1,800	505	14,605
Engineering and Administration	3,820	1,220	2,420	1,136	8,596
Physical Contingency	7,700	2,490	4,080	1,672	15,942
Total	46,200	14,920	24,400	10,031	95,551
Price Contingency	25,620	8,250	14,900	4,571	53,341
Grand Total	71,820	23,170	39,300	14,602	148,892

Annex 9109 (2/2) ANNUAL DISBURSEMENT SCHEDULE OF CONSTRUCTION COST FOR PROPOSED DEVELOPMENT PLAN

Unit: Rp 10^6

Item	Total		1985		1986		1987		1988		1989		1990		1991	
	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC
Karian Dam																
Direct construction	15288	10192	-	-	-	-	2135	1423	3198	2133	3910	2607	3910	2606	2135	1423
Land acquisition	-	9200	-	-	-	4600	-	4600	-	-	-	-	-	-	-	-
Gov. administration	-	550	-	-	-	-	-	110	-	110	-	110	-	110	-	110
Engineering service	2670	600	522	120	522	120	253	54	325	72	398	90	398	90	252	54
Physical contingency	3592	4108	104	24	104	944	478	1243	705	463	862	561	862	561	477	312
Sub-total	21550	24650	626	144	626	5664	2866	7430	4228	2778	5170	3368	5170	3367	2864	1899
Price contingency	10603	15017	91	30	141	1875	891	3451	1702	1696	2589	2599	3132	3194	2057	2172
Total	32153	39667	717	174	767	7539	3575	10881	5930	4474	7759	5967	8302	6561	4921	4071
Cilawang Dam																
Direct construction	4866	3244	-	-	-	-	730	487	973	649	1217	811	1217	811	729	486
Land acquisition	-	3100	-	-	-	1550	-	1550	-	-	-	-	-	-	-	-
Gov. administration	-	160	-	-	-	-	-	32	-	32	-	32	-	32	-	32
Engineering services	870	190	174	38	174	38	78	17	104	22	131	29	131	29	78	17
Physical contingency	1149	1341	35	8	35	318	162	417	215	141	270	175	270	175	162	107
Sub-total	6885	8035	209	46	209	1906	970	2503	1292	844	1618	1047	1618	1047	969	642
Price contingency	3392	4858	30	10	47	631	303	1161	522	517	812	809	982	995	696	735
Total	10277	12893	239	56	256	2537	1273	3664	1814	1361	2430	1856	2600	2042	1665	1377
K-C-C Irrigation Scheme																
Direct construction	5635	10465	-	-	-	-	1127	2093	1409	2616	1409	2616	1127	2093	563	1047
Land acquisition	-	1800	-	-	-	600	-	600	-	600	-	-	-	-	-	-
Gov. administration	-	350	-	-	-	-	-	70	-	70	-	70	-	70	-	70
Engineering services	1570	500	390	125	390	125	158	50	198	50	198	50	158	50	78	50
Physical contingency	1440	2640	78	25	78	145	257	580	321	667	321	547	257	443	128	233
Sub-total	8645	15755	468	150	468	870	1542	3393	1928	4003	1928	3283	1542	2656	769	1400
Price contingency	3899	11001	68	38	105	298	499	1567	776	2444	965	2533	934	2520	552	1601
Total	12544	26756	536	188	573	1168	2041	4960	2704	6447	2893	5816	2476	5176	1321	3001
Flood Control																
Direct construction	4476	2243	-	-	-	-	2019	725	1210	748	1247	770	-	-	-	-
Land acquisition	-	504	-	-	-	116	-	151	-	136	-	101	-	-	-	-
Gov. administration	-	85	-	-	-	17	-	26	-	20	-	18	-	4	-	-
Engineering services	903	147	90	15	135	22	135	22	136	22	136	22	135	22	136	22
Physical contingency	895	449	-	-	-	-	404	145	242	150	249	154	-	-	-	-
Sub-total	6274	3428	90	15	135	155	2558	1069	1588	1076	1632	1065	135	26	136	22
Price contingency	2474	2080	13	3	31	51	795	496	639	657	817	822	82	25	97	26
Total	8748	5508	103	18	166	206	3353	1565	2227	1733	2449	1887	217	51	233	48
Whole Project																
Direct construction	30265	26144	-	-	-	-	6011	4728	6790	6146	7783	6804	6254	5510	3427	2956
Land acquisition	-	14604	-	-	-	6866	-	6901	-	736	-	101	-	-	-	-
Gov. administration	-	1145	-	-	-	17	-	238	-	232	-	230	-	216	-	212
Engineering services	6013	1437	1176	298	1221	305	624	143	763	166	863	191	822	191	544	143
Physical contingency	7076	8538	217	35	217	1385	1301	2357	1483	1389	1702	1403	1389	1145	767	624
Sub-total	43354	51868	1393	355	1438	8595	7936	14395	9036	8701	10348	8763	8465	7096	4738	3963
Price contingency	20368	32956	202	81	324	2855	2488	6675	3639	5314	5183	6763	5130	6734	3402	4534
Total	63722	84824	1595	436	1762	11450	10424	21070	12675	14015	15531	15526	13595	13830	8140	8497

Annex 9241 RESULT OF ECONOMIC EVALUATION FOR PROPOSED PLAN

(1) Economic Cost-benefit Flow

Unit: Rp 10^6

Year		Cost			Benefit	Balance
		Construction	O & M	Total		
1	1985	1,659	0	1,659	0	-1,659
2	1986	7,503	0	7,503	0	-7,503
3	1987	18,551	0	18,551	0	-18,551
4	1988	15,915	0	15,915	0	-15,915
5	1989	17,291	0	17,291	0	-17,291
6	1990	13,859	20	13,879	862	-13,017
7	1991	7,690	20	7,710	862	-6,848
8	1992	0	569	569	14,264	13,695
9	1993	0	569	569	15,032	14,463
10	1994	0	569	569	15,799	15,230
11	1995	0	569	569	16,567	15,998
12	1996	0	569	569	17,334	16,765
13	1997	0	569	569	17,334	16,765
14	1998	0	569	569	17,334	16,765
15	1999	0	569	569	17,334	16,765
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49	2033	0	569	569	17,334	16,765
50	2034	0	569	569	17,334	16,765

(2) Result of Economic Evaluation

Item	Discounted Rate			
	10%	12%	14%	16%
Total Discounted Benefit	85,134	62,884	47,661	36,889
Total Discounted Cost	57,949	53,269	49,201	45,615
Net Present Value (NPV)	27,185	9,615	-1,540	-8,726
Benefit Cost Ratio (B/C)	1.47	1.18	0.97	0.81

Economic Internal Rate of Return (EIRR) 13.8%

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