JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF SETTLEMENT AND REGIONAL DEVELOPMENT
THE REPUBLIC OF INDONESIA

THE DETAILED DESIGN OF FLOOD CONTROL, URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT IN SEMARANG IN THE REPUBLIC OF INDONESIA

FINAL REPORT

IMPLEMENTATION PROGRAM

AUGUST 2000

CTI ENGINEERING INTERNATIONAL CO., LTD.
IN ASSOCIATION WITH
PACIFIC CONSULTANTS INTERNATIONAL
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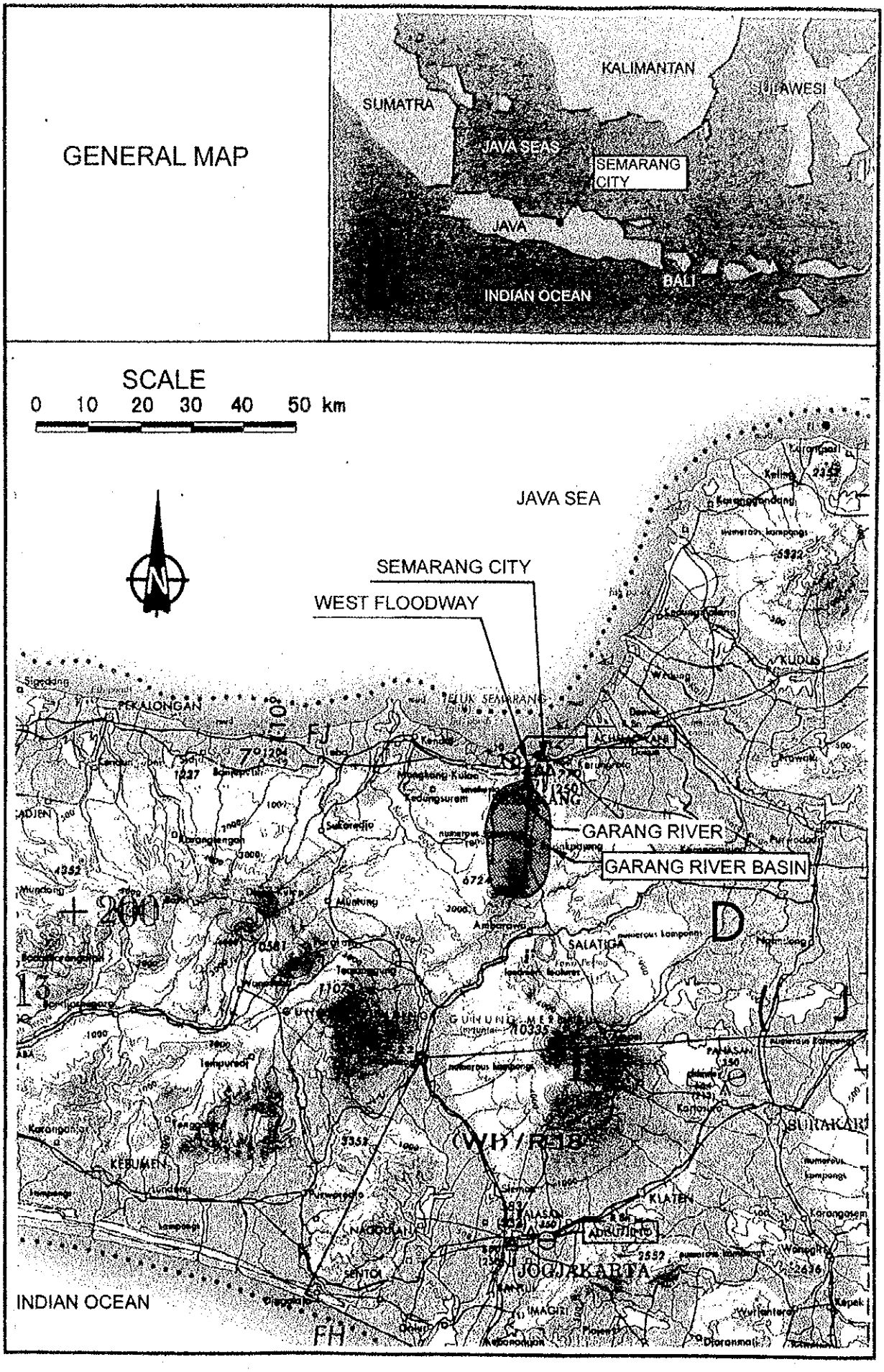
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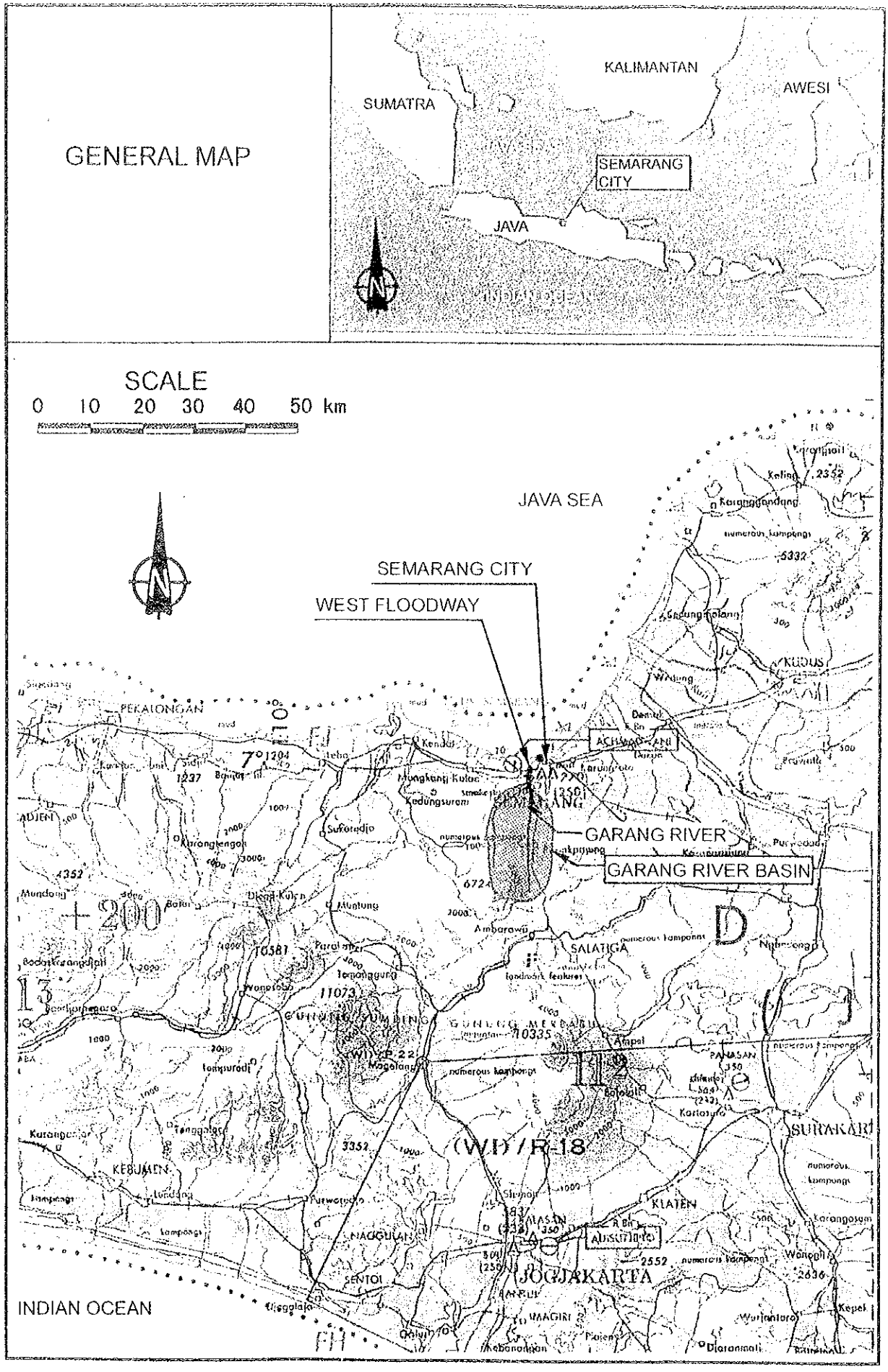
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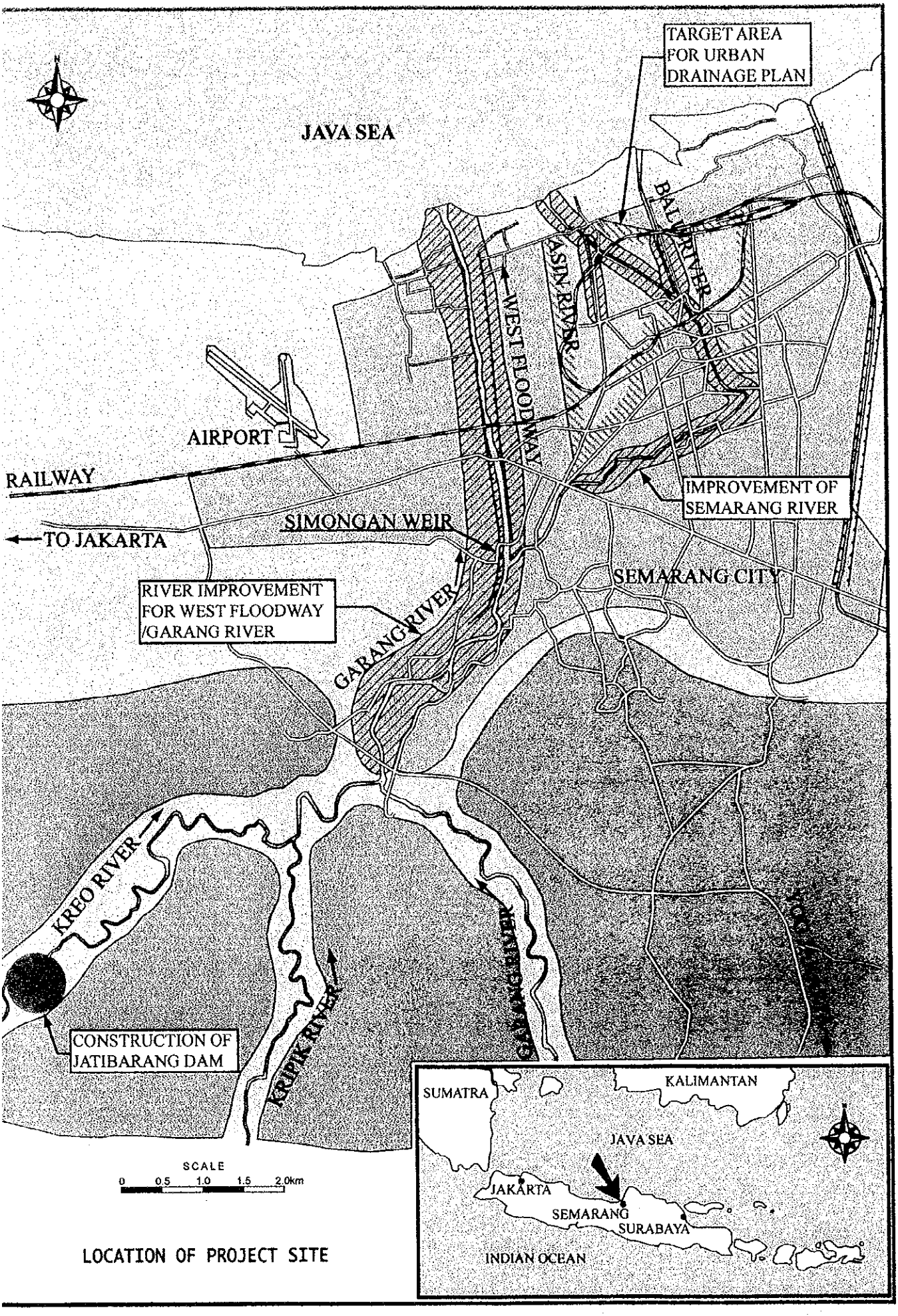

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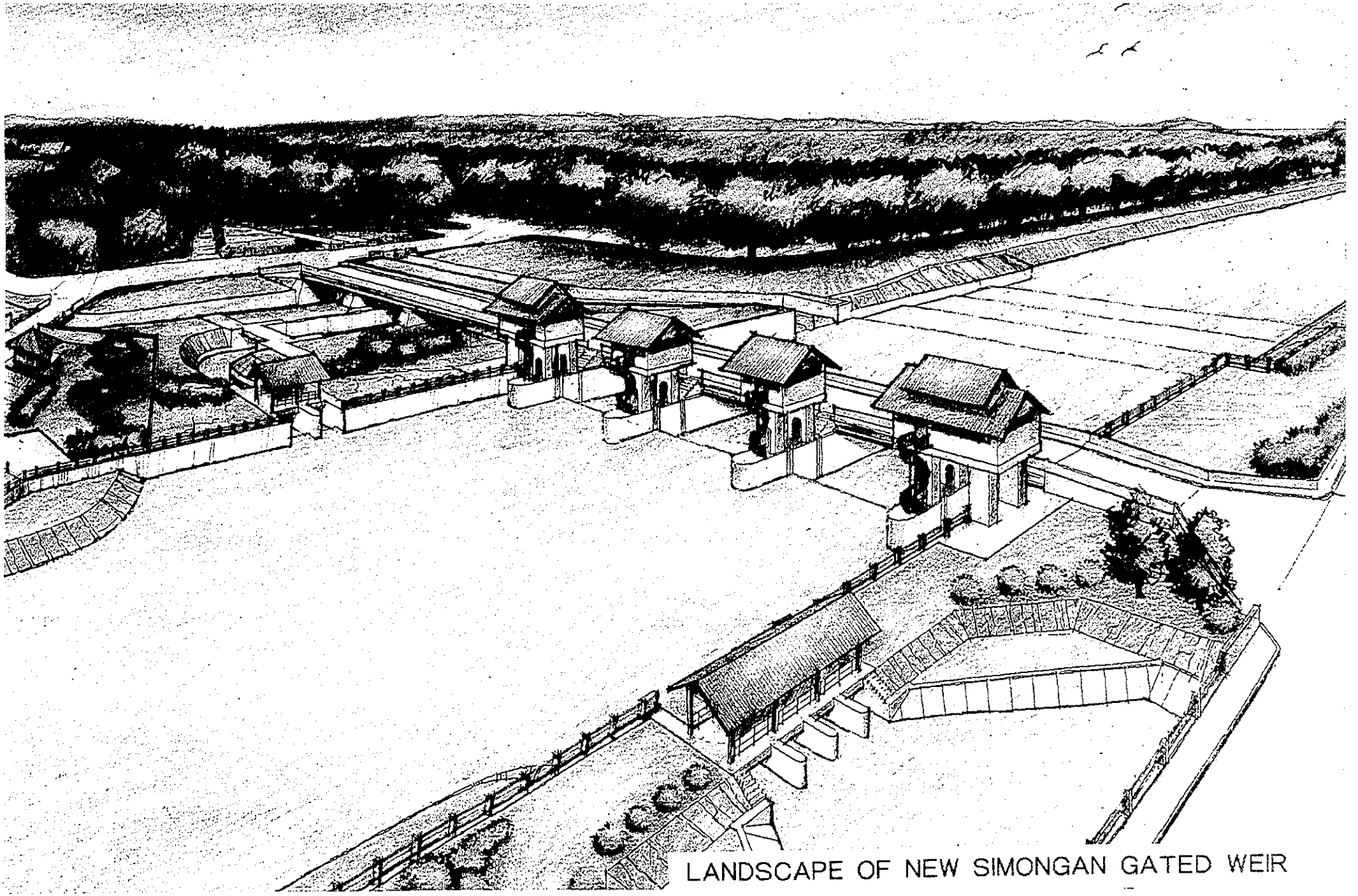
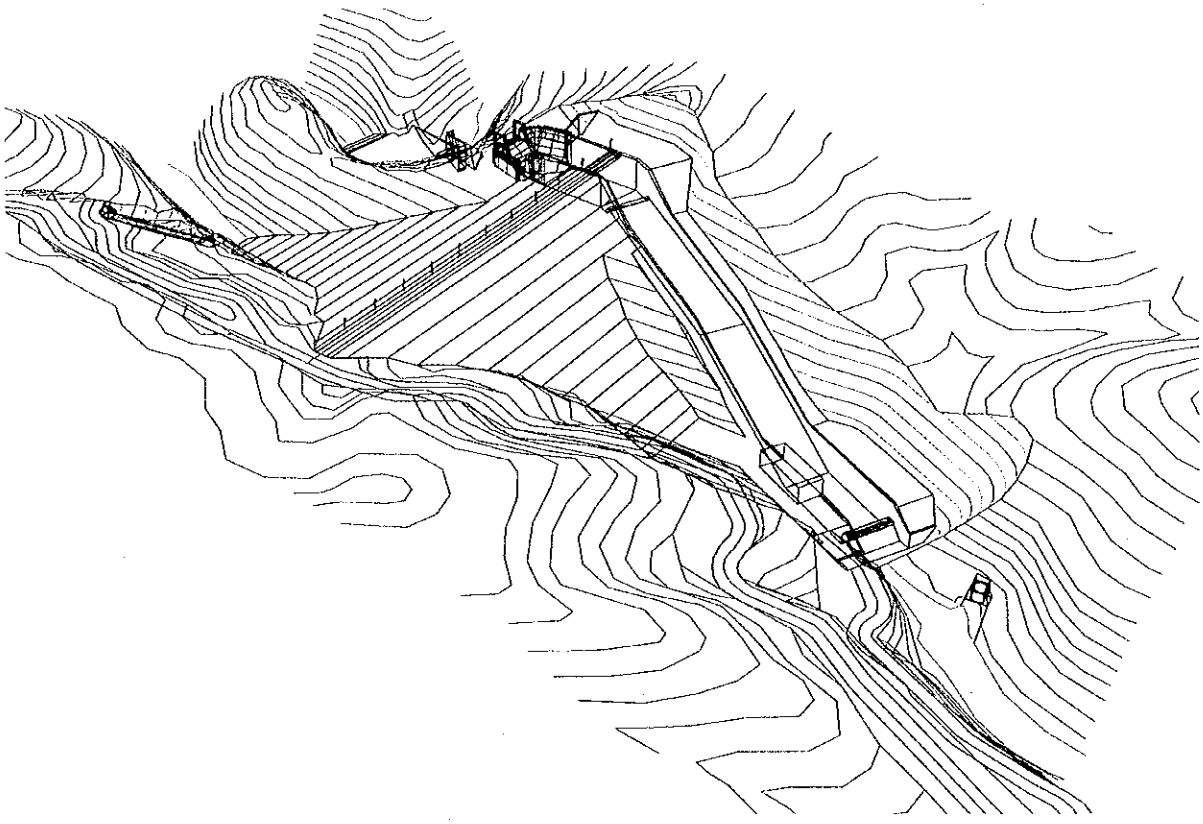
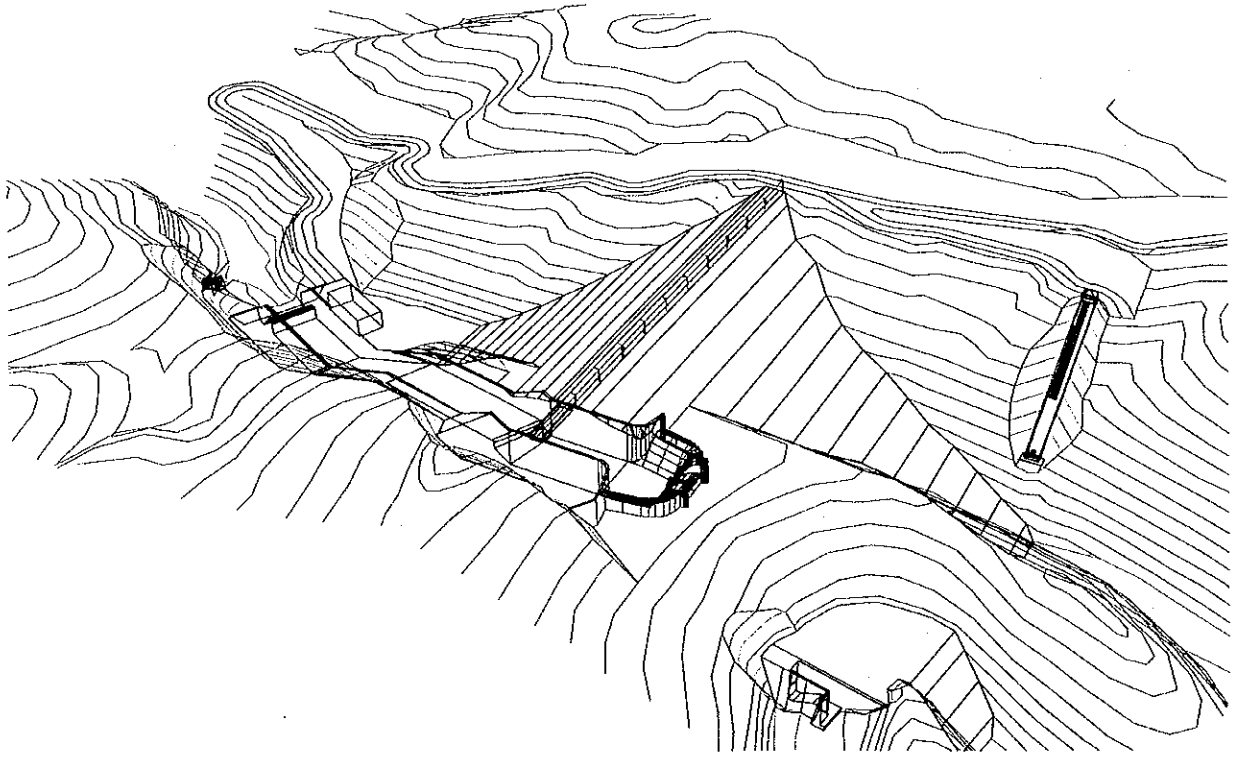


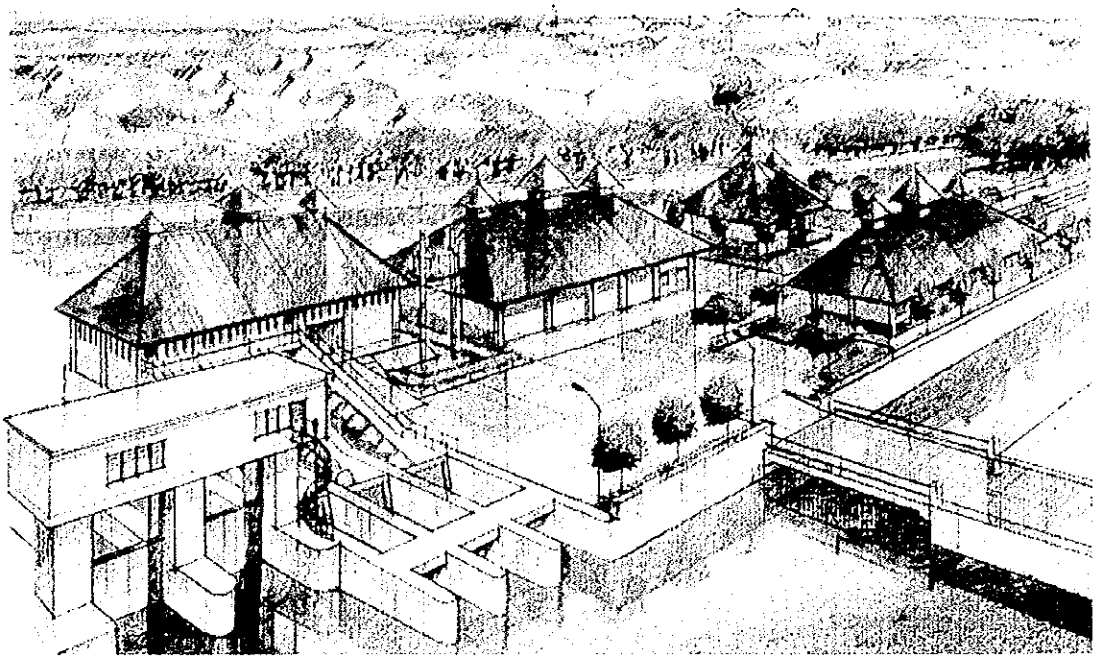
LANDSCAPE OF NEW SIMONGAN GATED WEIR



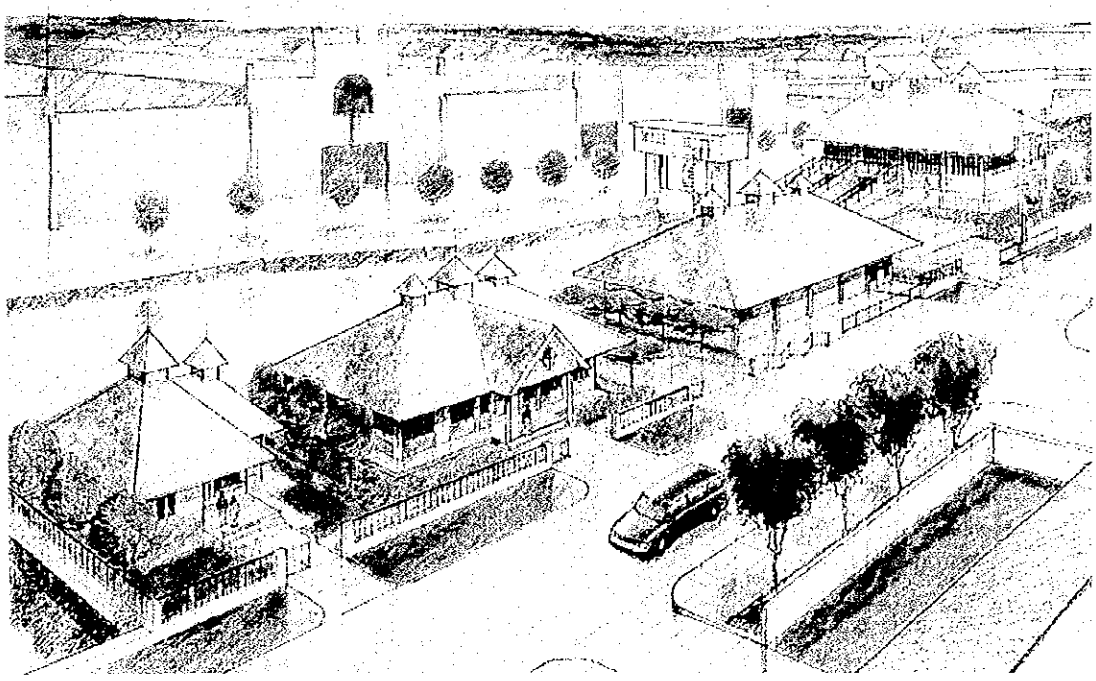
Downstream View of Jatibarang Multipurpose Dam



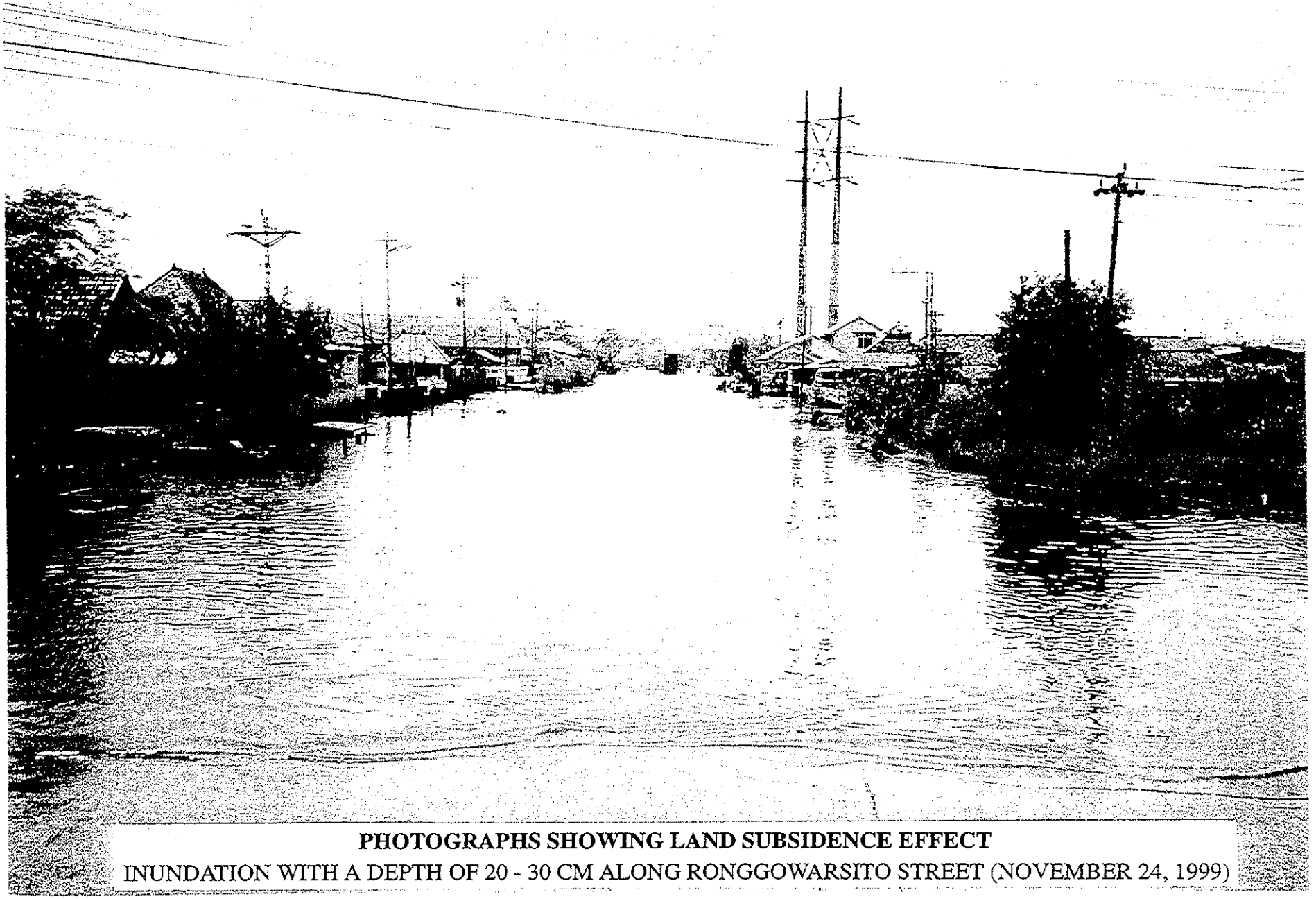
Upstream View of Jatibarang Multipurpose Dam



ASIN PUMPING STATION



BARU PUMPING STATION



PHOTOGRAPHS SHOWING LAND SUBSIDENCE EFFECT

INUNDATION WITH A DEPTH OF 20 - 30 CM ALONG RONGGOWARSITO STREET (NOVEMBER 24, 1999)

IMPLEMENTATION PROGRAM

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

TERMS AND ABBREVIATIONS

1. INDONESIAN GOVERNMENT AGENCIES AND ORGANIZATIONS

GOI	:	Government of Indonesia
BAPPENAS	:	Badan Perencanaan Pembangunan National (National Development Planning Board)
BAPPEDA	:	Badan Perencanaan Pembangunan Daerah (Provincial Development Planning Board)
BINAMARGA	:	Directorate General of Road and Bridge, Ministry of Public Works
BAPEDAL	:	Badan Pengendalian Dampak Lingkungan (Environmental Impact Assessement Board)
BPN	:	Badan Pertanahan Nasional (National Land Agency)
BPP	:	Balai Penyuluhan Pertanian (Agricultural Extension Center)
DPU	:	Departemen Pekerjaan Umum (Ministry of Public Works)
DGWRD	:	Directorate General of Water Resources Development, Ministry of Public Works
DGCK	:	Directorate General of Cipta Karya (Housing, Building and Urban Development, Ministry of Public Works)
DGRD	:	Directorate General of Research and Development, Ministry of Public Works
DOR	:	Directorate of Rivers
DPUP	:	Dinas Pekerjaan Umum Propinsi (Provincial Public Works Services)
IHE	:	Institute of Hydraulic Engineering (Bandung)
PJKA	:	Perusahaan Jawatan Kereta Api (Railway Company, Old Name)
PERUMKA	:	Perusahaan Umum Kereta Api (Indonesian Railway Public Corporation, New Name)
PDAM	:	Perusahaan Daerah Air Minum (Water Works Company)
PMG	:	Pusat Meteorologi dan Geofisika (Center of Meteorology and Geographysics)
PLN	:	Perusahaan Listrik Negara (State Electricity Corporation)
P3SA	:	Proyek Pengembangan dan Penyelidikan Sumber-Sumber Air (Water Resources Development and Investigation Project)

2. JAPANESE GOVERNMENT / INTERNATIONAL ORGANIZATIONS

GOJ	:	Government of Japan
JICA	:	Japan International Cooperation Agency
MOC	:	Ministry of Construction, Japan
JEM	:	Japan Electric Machine Industry

ADB	:	Asian Development Bank
IBRD	:	International Bank for Reconstruction and Development (World Bank)
UNDP	:	United Nations Development Program
WMO	:	World Meteorological Organization
ASTM	:	American Society for Testing and Materials
ASME	:	American Society of Mechanical Engineer
USASI	:	United States of America Standards
IEC	:	International Electrotechnical Committee
NEMA	:	National Electrical Manufacturers Association

3. MEASUREMENT UNITS

(Length)			**(Weight)**		
mm	:	millimeter(s)	g, gr	:	gram(s)
cm	:	centimeter(s)	kg	:	kilogram(s)
m	:	meter(s)	t, ton	:	tonnage (s)
km	:	kilometer(s)			
(Area)			**(Time)**		
mm^2	:	square millimeter(s)	sec., s	:	second(s)
cm^2	:	square centimeter(s)	min	:	minute(s)
m^2	:	square meter(s)	h (hrs)	:	hour(s)
km^2	:	square kilometer(s)	d (dys)	:	day(s)
ha(has)	:	hectare(s)	y, yr(yrs)	:	year(s)

(Volume)

cm^3	:	cubic centimeter(s)
m^3	:	cubic meter(s)

(Combined Units)

Speed/Velocity

cm/sec, cm/s	:	centimeter per second
m/sec, m/s	:	meter per second
km/hr, km/h	:	kilometer per hour

Stress

kgf/cm^2	:	kilogram per square centimeter
tf/m^2	:	ton per square meter
N/mm^2	:	newton per square millimeter
Mpa	:	mega pascal

Discharge

ltr/sec, l/s	:	liter per second
m^3/sec, m^3/s	:	cubic meter per second
m^3/yr, m^3/y	:	cubic meter per year

(Note : Other combined units may be constructed similarly as above)

Electricity

MW	:	megawatt	GW	:	gegawatt
MWh	:	megawatt hour	GWh	:	gegawatt hour
kV	:	kilovolt			

4. MONETARY TERMS

¥	:	Japanese Yen
US$	:	United States Dollar
Rp.	:	Indonesian Rupiah

5. INDONESIAN TERMS

JKT	:	Jakarta
Jawa	:	Java
Propinsi	:	Province
Kabupaten, Kab.	:	District (Regency)
Kotamadya, Kodya	:	Municipality
Kecamatan, Kec.	:	Sub-District
Desa	:	Village (Rural Area)
Kampung, Kp.	:	Village (Rural Area)
Kelurahan	:	Village (Urban Area)
Kali, Sungai	:	River
Gunung	:	Mountain
Rawa	:	Swamp
Danau	:	Lake
Laut	:	Sea
PT.	:	Incorporated or Limited
PPT	:	Panitia Pembebasan Tanah (Land Acquisition Committee)
KOMPUS	:	Komisi Pusat (Central Committee for Environmental Impact Assessment)
KA-ANDAL	:	Terms of Reference of Environmental Impact Statement
ANDAL	:	Environmental Impact Statement
RKL	:	Environmental Management Plan

RPL	:	Environmental Monitoring Plan
AMDAL	:	Environmental Impact Assessment
BPPM2	:	Semarang Port Bench Mark
SPB	:	Semarang Peil Baru (New Semarang Level)
TTG	:	Tanda Tinggi Geodesi (National Bench Mark)

6. OTHERS

JRATUNSELUNA PROJECT : Water Resources Development Projects for Jragung, Tuntang, Serang, Lusi and Juwana Rivers

SSUDP	:	Semarang and Surakarta Urban Development Program
IUIDP	:	Integrated Urban Infrastructures Development Program
SWL	:	Surcharge Water Level
DFWL	:	Design Flood Water Level
PMP	:	Probable Maximum Precipitation
PMF	:	Probable Maximum Flood
EIRR	:	Economic Internal Rate of Return
JIS	:	Japanese Industrial Standard
USASI	:	United States of America Standards
SWR	:	Shadow Wage Rate
CIF	:	Cost, Insurance and Freight
VAT	:	Value Added Tax.

CHAPTER 1 INTRODUCTION

1.1 Background

Semarang City, the capital of Central Java Province, had the population of 1,252,000 in 1996. The city and its surrounding areas suffer almost every year from floods in rainy seasons and from shortage of water supply in dry seasons. The problem on water shortage will aggravate further in the future due to the recent trend of population concentration in the urban area. Further, land subsidence in the coastal area of the City has progressed in the past decade and will continue more due to the excess groundwater exploitation by the industrial sector. To stop the present land subsidence whose annual rate is observed for one (1) year from 1997 to 1998 at 4 cm on an average and 10 cm at the maximum, the industrial water source shall be changed from groundwater to river surface water compulsory.

To mitigate these chronic problems and to enhance the economic development and stabilization of people's livelihood, appropriate measures are indispensable for Semarang City and its surrounding areas. To this end, the Government of Indonesia requested technical assistance from the Government of Japan.

In response to the request of the Government of Indonesia, the Government of Japan dispatched a study team through the Japan International Cooperation Agency (JICA) to formulate a Master Plan for the area of about 800 km^2 including Semarang City and its surrounding areas, and to carry out a Feasibility Study on the selected priority projects in the Master Plan from 1992 to 1993. The study was named as "The Master Plan on Water Resources Development and Feasibility Study for Urgent Flood Control and Urban Drainage in Semarang City and Suburbs".

The study consisted of three components, namely (1) Flood Control, (2) Water Resources Development and (3) Urban Drainage System Improvement and the Master Plan was established for each component. In establishing the Master Plan for the component of the Flood Control, six (6) rivers in the study area were selected as objective rivers and for the component of Urban Drainage System Improvement, the central area of Semarang City was selected as the objective area as well as the construction of four (4) dams for the component of Water Resources Development.

In the final report of the above study, for the component of Flood Control the improvement of West Floodway / Garang River and the construction of Jatibarang Multipurpose Dam on Kreo River which is a tributary of Garang River, and for the component of Urban Drainage System

Improvement, the improvement of the drainage system in the central area of Semarang City with the area of 12.835 km2 were proposed as priority projects from the viewpoint of economic viability and urgent necessity of project realization.

For the urgent realization of the proposed priority projects, the Government of Indonesia requested further technical assistance to the Government of Japan in 1996. JICA then decided to dispatch another study team to carry out the detailed design of the priority projects, and the study was named as "The Detailed Design of Flood Control, Urban Drainage and Water Resources Development in Semarang in the Republic of Indonesia" (hereinafter referred to as "the Study"). The Study has been commenced in August 1997 and will be completed in July 2000.

1.2 Necessity of the Project

Considering the flood and inundation damages repeated almost every year in rainy seasons in Semarang City which bring about significant damages to the citizens and municipal water supply shortage to Semarang City together with the change of the industrial water sources from ground water to surface river water to stop present land subsidence in the coastal and central area of Semarang City, the realization of the projects is indispensable for sustainable economic development of Semarang City as well as Central Java Province.

1.3 Objectives of the Project

The objectives of the Project are :

(1) To mitigate flood and inundation damages along West Floodway / Garang River, to develop water resources for municipal and industrial water in Semarang City and to improve the drainage system in the central area of Semarang City;

(2) To improve the environmental conditions along the river and the urban area; and

(3) To upgrade the living conditions of inhabitant in the project area.

CHAPTER 2 PROJECT DESCRIPTION

2.1 Constitution of the Project

The Project consists of three (3) components, namely:

(A) West Floodway/Garang River Improvement Works;

(B) Construction of Jatibarang Multipurpose Dam; and

(C) Urban Drainage System Improvement Works.

2.2 Location of the Project

Semarang City, the capital of Central Java Province, is located at 6° 57' south latitude and 110° 29' east longitude. As for the component A, Garang River which has the catchment area of 204 km^2 and total length of 35 km originates from Mt. Ungarang (2,050 m) and flows down toward northward at the western area of Semarang City meeting with two (2) major tributaries, Kreo and Kripik rivers. Garang River changes its name to West Floodway downstream from Simongan Weir which is located 5.3 km upstream from the river mouth. The project area covers approx. 10 km of West Floodway/Garang River between the river mouth and the confluence of Garang and Kreo rivers. (refer to Fig. 2.1)

As for the component B, Jatibarang Multipurpose Dam is located on Kreo River, which is the one of the main tributaries of Garang River, and the dam site is located at 13 km upstream from the confluence with Garang River or 23 km upstream from the river mouth of West Floodway (refer to Fig 2.1). The dam site has the catchment area of 53 km^2.

While, for the component C, the project area is located in the central Semarang City and is corresponding to the catchment area of Semarang River which divert from Garang River at Simongan Weir and has the catchment area of 12.835 km^2. The boundaries surrounding the Project area are the North Ring Road to the north, the watershed boundary of Semarang River to the south, Balu River watershed boundary to the west and Ronggowarsito St. and Let. Jend. M.T. Haryono to the east. (refer to Figs. 2.1 to 2.3)

2.3 Present Conditions of the Project Area

2.3.1 Climate

Semarang City belongs to the tropical monsoon area with a little difference of temperature throughout a year. Temperature of Semarang City ranges between 21℃ and 35℃ and annual average temperature is 27.4℃. The climate of the area is divided into two seasons, rainy and dry seasons.

In rainy season which generally continues from November until April in the next year, rainfall is generally brought about by northwest wet wind blowing from Java Sea. On the contrary southeast dry wind bring about dry season from May until October.

Annual average precipitation amounts 2,380 mm and annual average humidity is 76 % in Semarang City. Climatic data at Semarang Station are shown in Table 2.1.

2.3.2 Geography

The Garang river basin is topographically divided into three, (1) mountain region, (2) hilly region and (3) coastal plain region. The mountain region is on the north slope of Mt. Ungaran (EL. 2,050 m), ranging in elevation between EL. 2,050 m and EL. 300 m. The slope gradient of this region is very steep and all rivers in the area originate from this region.

The hilly region lies between the mountain and coastal plain regions at an elevation from EL 300 m to EL 50 m, and has a width of approx. 15 km. This region is featured by undulated highland with deep valleys.

The coastal plain region lies between the hilly region and Java Sea at elevation below EL 50 m, and has a width of approx. 4 km to 10 km. Rivers in this region flow toward north at a gentle gradient of 1 : 2,000 to 1 : 5,000.

Geology of Garang river basin is roughly divided into three categories ; volcanic rock, sedimentary rock which is marine in origin, and alluvial deposits which cover these base rocks. Volcanic rocks consist of lahar, lava flow of Mt. Ungaran, Notopuro Formation and intrusive rock. Sedimentary rocks consist of Damar Formation, Kalibiuk Formation, Banyak Member and Penyatan Formation.

The project area of the Urban Drainage System Improvement mostly consist of alluvium plain except the upper area of Semarang River. As shown in Fig. 2.2, a large part of the project area

is below EL+2.0 m and the northern half of the project area is even lower than EL. + 1.0 m while the Mean High Tide Level of Java Sea is EL. + 0.25 m. These topographical features of the area have been created not only by natural sedimentation process but also by land subsidence of the area caused by excess groundwater exploitation for industrial and commercial purposes.

The geological structure of the surface layer (15 m to 25 m in depth) of the area is alluvium soft soil, composed of sandy clay and grain sand. Underneath lies the sub-surface layer of dilluvium hard clay.

2.3.3 Features of the Project Areas

(1) River Features

Garang River originates from Mt. Ungaran and flows to the north meeting its two (2) major tributaries, Kripik and Kreo, about 12 km and 10 km upstream from the river mouth, respectively (refer to Fig 2.4). The whole catchment area is about 204 km^2, which includes the catchment area of 70 km^2 of Kreo River and 34 km^2 of Kripik River.

Simongan Weir located about 5.3 km upstream from the river mouth is the major river structure of West Floodway/Garang River. The downstream from the weir is called West Floodway (Banjir Kanal Barat), and the discharge from Garang River flows into Java Sea through the Floodway. The annual maximum flood discharges at Simongan Weir is summarized in Table 2.2.

Simongan Weir was constructed at the end of the 19th century and now used as an intake weir for municipal water supply (PDAM) and for maintenance discharge of Semarang River and a small irrigation channel.

A densely populated area spreads out in the lower reaches from the confluence of Kreo River, particularly, the downstream area from Simongan Weir. On the other hand, the upper reaches is used as either cropland or forest area and scarcely populated.

The river bed profile of Garang River between the confluence with Kreo River and Simongan Weir is gentle with the slope gradient of 1/2,000 and the one of West Floodway between Simongan Weir and the river mouth is very gentle with the slope gradient of 1/5,000 or less.

(2) Features of Dam Site

The damsite on Kreo River has an advantage topographically with a wide valley in the upstream area, which changes into a deep V-shaped gorge at the proposed dam axis. The riverbed width is about 15 m at EL. 90 m. The side slope gradient is approximately 75 degrees from the riverbed to 20 m height on the left bank. And the side slope gradient is approximately 60 degrees from the riverbed to 40 m height on the right bank. The slope gradient of the above portion changes to 40 degrees for the left bank, and 30 degrees for the right bank. The gorge width is 175 m at the proposed dam crest elevation of EL. 157.0 m.

The topographic characteristics of the left bank at the dam axis shows a thin and long right shape projecting into the river course. It suggests the geological problems concerned with weathering and permeability of the foundation rock at the left abutment. The right bank hill forms also a ridge shape projecting into the river course, but it is larger than the left thin ridge and it has enough size as a dam abutment.

(3) Features of Drainage Channels

In the project area, there are three main drainage channels, Semarang, Asin and Baru rivers which are the objective drainage channels (refer to Fig. 2.3).

(a) Semarang River

Semarang River, originating from the diversion point at the immediate upstream of Simongan Weir, has a catchment area of 12.835 km^2 and length of 8.3 km. Semarang River Improvement Works had been conducted in the Urban-V Project between 1985 and 1990. The channels had been improved by the project to accommodate the design flood of 5-year return period and furnished with inspection/maintenance roads on both sides of the channel.

However, because of the sedimentation in the channel as well as the land subsidence of the bank, the discharge capacity of the channel is deteriorated. The local government is coping with this problem by regular dredging of the channel and construction of masonry dike along the river. In spite of these efforts, the capacity of present Semarang River is not enough to accommodate the original design flood of 5-year probability. During a heavy rain, flood overflows from many parts of the river banks and inundates urban areas.

(b) Asin River

Asin River which has a catchment area of 4.430 km^2 and length of 1.3 km is a tributary of Semarang River and meet the main channel at 0.95 km upstream from its river mouth. The channel bed elevation of Asin River is as low as EL -1.0 m at the upstream end and its water level is directly affected by tidal level of Java Sea. This relatively high tide water level at down stream stretches and thick sedimentation is hampering the discharge capacity of the channel.

(c) Baru River

Baru River which has a catchment area of 2.185 km^2 and length of 1.5 km diverts from Semarang River at 2.74 km from its river mouth. The channel bed elevation of Baru River at the bifurcation point is lower than EL -1.5 m and tidal level affects the water level of Baru River. Sediment accumulated at the downstream stretches from the North Ring Road which crosses the river at 0.85 km from its uppermost end is being dredged by the Semarang Harbor Authority for navigation purpose, however, thick sediment with the volume of 35,000 m^3 is accumulated upstream from the North Ring Road.

(4) Features of the Drainage Areas

The project area for Urban Drainage is corresponded to the catchment area of Semarang River (12.835 km^2) and is divided into the gravity drainage area (6.220 km^2) and pump drainage area (6.615 km^2). The pump drainage area of 6.615 km^2 is further divided into two sub-drainage areas, Asin Drainage Area and Bandarharjo Drainage Area (refer to Fig. 2.3).

(a) Gravity Drainage Area

The gravity drainage area, where the ground elevation is mostly higher than EL +1.0 m, located at the upstream area from the Station No.126 (about 4 km upstream from the river mouth) of Semarang River. This drainage area is highly urbanized except the southern residential area in a hilly area.

(b) Asin Drainage Area (Pump Drainage Area)

Asin drainage area of 4.430 km^2 is a part of the pump drainage area and is fully urbanized. The Tanah Mas/Pondok Hasanuddin Estates and the areas along

Imam Bonjol /Hasanuddin St. are of middle and high class housing estates. Low income residential areas are situated at the western area along Semarang River and the both sides along the national railway. Institutional and business/commercial areas are located along both sides of the Pemuda St.

Recent progress of land subsidence has made some parts of this area as low as EL -0.2 m. A large part of the whole area is below the Mean High Tide Level of Java Sea (EL +0.25 m) as shown in Fig 2.2. This land subsidence is causing serious problems in the area. During rainy seasons, the area to the north of the national railway is frequently flooded. Even in dry seasons, some low-lying areas are inundated every day because of sea water intrusion during the high tide. The areas along the left bank of Semarang River and on both banks of Asin River are also habitually inundated during rainy seasons.

This area is mostly provided with systematic secondary and tertiary drainage networks. Five (5) main secondary channels are located in the southern part of the area collecting storm water from almost 75 % of the drainage area, and drain them into the uppermost stream of Asin River. Storm water collected by tertiary drains in Tanah Mas Estate is drained by a series of pumps into Asin River directly, without which, the area would been always under water even in dry seasons. This drainage pump system has been installed and is operated by an association of the residents of Tanah Mas Estate and the land developer. The area along the left bank of Semarang River drains directly into the river by gravity force.

(c) Bandarharjo Drainage Area (Pump Drainage Area)

Bandarharjo Drainage Area which is another part of the pump drainage area and has 2.185 km^2 is divided into the West and the East Bandarharjo sub-drainage areas by Baru River. The West Bandarharjo Drainage Area of 0.580 km^2 is triangular shape and surrounded by the North Ring Road, Semarang and Baru rivers. Southern part of the area, which occupies 65 % of it, is developed as low income residential area and Marabunta warehouse. Remaining northern part of the area is under development for housing and a part of it is designated as conservation area for water retarding basin according to the land use plan of Semarang City.

In the West Bandarharjo Drainage Area, where few systematic drainage

networks exist, inundation problems are very serious. During high tide, some low-lying areas are inundated by 0.2 m in depth without any rainstorm due to the backwater effect of Semarang River by sea water intrusion. It is urgently required to provide a systematic pump drainage system.

The East Bandarharjo Area of 1.605 km^2 is surrounded by Baru River, Usman Janatin St., Ronggowarsito St. and small streets. The land use of this area is classified into three categories; residential, industrial/warehouse and business/commercial areas. These are almost similar in area size and situated in north east, in north west, and in north parts of the area respectively .

The East Bandarharjo Area has mostly systematic drainage network consisting of six (6) secondary open channels with outlets to Baru River. However, due to poor capacity of the secondary/tertiary drains and low ground elevation, northern low lying area and old Semarang City area near Tawan railway station are frequently inundated. A northern part of Ronggowarsito St., where the ground elevation is lower than EL -0.1m because of land subsidence, is always underwater through out the year.

2.3.4 Floods and Flood Control Works

(1) Major Floods and Flood Control Works on West Floodway/Grang River

The recent major floods which brought tremendous damages to the areas along West Floodway/Garang River have taken place in 1973, 1990 and 1993. The inundated areas and damages/calamities of the above floods were confirmed by the Ministry of Public Works and the Semarang City Office as presented in the table below, and the inundation areas of the 1990 and 1993 are shown in Fig. 2.5.

Item	1973 February	1990 January	1993 February
Inundation Area			
(1) Seriously Affected Area		Panjangan Area	Sampangan Area
(2) Affected Area (ha)	175	145	200
(3) Number of Affected Houses	420	540	230
(4) Number of Affected Households	-	186	17
(5) Inundation Depth (Max. m)	-	2.0	2.5
(6) Inundation Duration (hours)	2.5	3.0	4.0
Flood Calamities			
(1) Death toll (person)	-	47	2
(2) House Collapsed (unit)	35	25	60
(3) House Damaged (unit)	120	126	145
(4) Public Building (unit)	5	15	5
Estimated Flood Damage (Rp.)	4.0 billion	8.5 billion	6.9 billion

The river improvement/rehabilitation works for West Floodway/Garang River had been executed under the Central Java River Improvement and Maintenance Project by DINAS PU PENGAIRAN. The main works which were undertaken so far were dike/flood wall construction, channel dredging, excavation for short cut channel and some revetment with the construction period of five (5) years from 1989 to 1993. Immediately after the serious flood in January 1990, of which flood discharge was estimated t at around 1,000 m^3/s at Simongan Weir, construction of high earth dike and flood wall were commenced for the river stretch of 3.6 km from Simongan Weir up to the Toll Road Bridge to accommodate the design flood discharge of 1,100 m^3/s which corresponds to 100-year probability.
It is herein noted that the probable discharge of 100-year return period is estimated at 1,010 m^3/s in this Study instead of the 1,100 m^3/s used for the said design discharge.

The improvement works have completed already, however, such necessary works for drainage channels/drains which flow into the main stream requiring prevention of reverse flow from the main stream remained untouched.

(2) Inundation Damage in the Urban Areas

(a) Gravity Drainage Area

In the gravity drainage area (6.220 km^2), no serious inundation damage is observed, as the ground elevation in the area is high enough for rain water to be drained into Semarang River by gravity force. However, because of silting in Semarang River as well as in secondary and tertiary channels, the capacity of the drainage facilities in the area is deteriorating.

(b) Asin Drainage Area (Pump Drainage Area)

Recent progress of land subsidence has made some parts of this area as low as EL -0.2 m. A large part of the whole area is below the Mean High Tide Level of Java Sea (EL +0.25 m). According to an interview survey conducted by JICA Study Team in 1998, the inundation depth in the area is 0.2 m to 0.9 m, the inundation duration of 7 hours to 2 days and inundation frequency is 3 to 40 times a year.

(c) West Bandarharjo Drainage Area (Pump Drainage Area)

In the West Bandarharjo Drainage Area, where few systematic drainage

networks exist, inundation problems are very serious. According to the said interview survey, the inundation depth in the area is 0.2 m to 0.5 m, the inundation duration of 3 hours to 1 day and inundation frequency is 5 to 15 times a year.

(d) East Bandarharjo Drainage Area (Pump Drainage Area)

The East Bandarharjo Area has mostly systematic drainage network consisting of six (6) secondary open channels with outlets to Baru River. However, due to poor capacity of the secondary / tertiary drains and low ground elevation, north west low-lying area, north east low-lying area and old Semarang City area are frequently inundated. According to the interview survey, the inundation depth in the area is 0.4 m to 0.5 m, inundation duration 2 days and inundation frequency is 5 to 15 times a year. The inundation along Ronggowarsito Street and Empu Tantular Street is literally habitual and the situation is worsening year by year.

(3) Drainage Channel Improvement Works

Presently, drainage improvement works are being implemented under the Semarang-Surakarta Urban Development Program (SSUDP) supported by the World Bank. The SSUDP covers the whole Semarang City area and several sectors. The drainage sector is focused mainly on the improvement of secondary and tertiary channels. The detailed design study was carried out from 1990 to 1991 and the implementation of the program has been commenced in 1995 and was completed in 1999.

The demarcation of the objective facilities in Bandarharjo drainage area between this Project and SSUDP was made. This Project include the improvement of the main drainage channels and the construction of pumping stations, while SSUDP covers the improvement of secondary and tertiary drainage channels.

2.3.5 Socio-Economic Conditions

(1) Population

A series of population censuses were conducted in 1961, 1971, 1980 and 1990. According to the 1995 or 1996 census, the population of Indonesia and Central Java Province were 198,343,000 and 29,653,000, respectively, and from 1980 to 1995 or 1996, the average annual growth rates were 1.87% and 1.04%. (refer to Tables 2.3

and 2.4)

The population of Semarang City is 1,252,000 in 1996 with the population density of 3,370 person/km^2 and the number of household is counted at about 278,000. (refer to Table 2.5)

The future population of Semarang City is projected for the year 2005 which is the target year of the priority projects as 1,374,000.

(2) Present Land Use

Central Java Province which has 32,549 km^2 is divided into 10,010 km^2 (31 %) of wet land and 22,538 km^2 (69 %) of dry land. Irrigated farmland occupies about 70% of the wet land. Change in land use can be seen at wet land and farmland with the tendency of gradual decrease, and at house compound and estate with the tendency of gradual increase in the past decade. Such changes will be accelerated in the next decade due to the governmental policy of industrialization.

About 40% of Semarang City is occupied by residential compounds which include residential and commercial areas and 12% by paddy fields and reservoirs which is called wet land.

(3) National Economic Structure

The Gross Domestic Product (GDP) in Indonesia for the period 1994 - 1996 had grown from Rp. 382,222 billion to Rp. 532,630 billion with the average annual growth rate of 18.05 %. Among the sectors, the manufacturing/industry sector was dominant with the average annual growth rate of 23.26 % in the same period. (refer to Table 2.6)

In 1980, export from Indonesia amounted to US $ 23,950 million against the import of US $ 10.834 million, i.e., the balance of trade indicated and export surplus of US $ 13,116 million which was the most favorable balance in the past. After that year the amount of export, on the decrease due to the international recession in the oil market, fell to US $ 14,805 million in 1986, although the trade balance still maintained the export surplus amounting to US $ 4,087 million. However, the external trade of Indonesia, indicating an upward trend after 1986, amounted to the export of US $ 29,620 million and the import of US $ 25,906 million in 1991, i.e., and export surplus of US $ 3,714 million.

(4) Regional Economic Structure

The Gross Regional Domestic Product (GRDP) in Central Java Province in the year 1995 was counted at Rp. 46,623 billion at the current market price with the average growth rate of 18.62 % per annum (refer to Table 2.7). However, GRDP per capita in the same period showed Rp.1,570,000 in 1995 with average growth rate of 17.81 % per annum.

(5) Development Projects

Regional development projects conducted or ongoing in and around Semarang City are summarized below.

Flood Control Project

River	Project	Year	Remarks
Blorong	West Semarang Irrigation Project	1990	Improvement works with design scale of 20-year return period completed.
Silandak	Central Java River Improvement and Maintenance Project	1991	Construction of diversion channel with design scale of 50-year return period. Completed.
Garang	Central Java River Improvement and Maintenance Project	1992	Completed.
East Floodway	Dolok Penggaron Drainage Design Project	2000	Ongoing.
Babon	Central Java River Improvement and Maintenance Project	1991	Improvement works with design scale of 5-year return period. Completed.
	Dolok Penggaron Drainage Design Project	2000	New diversion channel design with the scale of 25-year return period. Delayed.

Urban Drainage Project

(a) Stormwater Drainage Master Plan for Semarang City (1975-76)

This plan was the first master plan of urban storm drainage for Semarang City

with the target year 2000. The Study covered the whole Semarang City and recommended the storm drainage program in the following three phases.

Phase 1 : up to 1980
Phase 2 : up to 1990
Phase 3 : up to 2000

(b) Semarang Drainage Project

Following the master plan mentioned above, the detailed study on Semarang and Banger rivers was conducted in 1982. The project was recommended to be implemented in four phases with the total project cost of Rp. 11.3 billion. The improvement works for Semarang River were undertaken from 1985 to 1990 as Urban V.

(c) Semarang Surakarta Urban Development Project (SSUDP)

This project is an ongoing project of the Directorate General of Cipta Karya and the Directorate of Bina Program, Ministry of Public Works, as a medium term investment program (PJM) for the drainage improvement of Semarang City. The detailed design study was carried out from 1990 to 1991 and the objective of the program is to alleviate the frequent flooding in the coastal flood plain by improving the major drainage systems between Silandak and Babon rivers. The total project cost was estimated at Rp. 57.0 billion at 1991 price level.

Water Resources Development Project

(a) JRATUNSELUNA River Basin Development Project

This project is ongoing and the Kedung Ombo Dam which is one of the main structures planned in the project has been completed some years ago. The project has the following implementation schedule to transmit water to Semarang City. However the actual implementation has been delayed by the financial reason.

Year	Structure to be Constructed	Total Water Supply Capacity at Kudu
1994	Jajar Weir	-
1996	Transmission Main Canal	

	(Klambu - Kudu)	2,500 l/s	
1997	Regulation Tunnel		Delayed
	(Tuntang - Jragung)	-	
1998	Transmission Canal		Delayed
	(Jragung - Main Canal)	4,250 l/s	
1999	Dolok Reservoir	-	Delayed
2000	Transmission Canal		Delayed
	(Barang - Main Canal)	5,000 l/s	

(b) Water Supply System for Western Semarang Areas

To meet the future water demand in the Western Semarang Areas, PDAM prepared a report which contains the construction of three (3) dams, two (2) water intake facilities and water treatment plants.

2.4 Project Formulation

2.4.1 Basic Plan

(1) West Floodway/Garang River Improvement

(a) Flood Control Scheme

The flood control scheme for West Floodway/Garang River is composed of two schemes, the improvement of West Floodway and Garang River for the stretch of about 9.8 km from the river mouth to the confluence with Kreo River including the reconstruction of Simongan Weir and the construction of Jatibarang Multipurpose Dam.

(b) Design Scale

After the improvement of West Floodway/Garang River, the river can accommodate floods of 25-year return period or less. After the completion of Jatibarang Multipurpose Dam the design scale will be increased to 100-year return period with the improvement of West Floodway/Garang River. In this Project the Improvement of West Floodway/Garang River only is included for the reason of urgent realization of the flood control scheme.

(c) Design Flood Discharge

In accordance with the proposed flood control scale as well as the updated probable flood discharges, the design discharges of Garang River System have been estimated as shown in Fig. 2.6.

(d) Project Works

To accommodate the design flood discharge, some improvement works of West Floodway/Garang River and reconstruction of Simongan Weir were proposed. The project works proposed are summarized as below.

Project Works	River Stretch/Location
1. West Floodway Improvement	L=5,456 m
-Dredging downstream channel	L=1,360 m
-Excavation of existing flood plain	L=4,300 m
-Raising/reinforcing existing flood wall	L=2,530 m
-Embankment of dike at the river mouth	L= 740 m
2. Garang River Improvement	L=3,968 m
-Riverbed excavation	L=1,050 m
-Excavation of existing flood plain	L=2,560 m
3. Reconstruction of Simongan Weir	5.3 km upstream
-Gated Weir (roller gate)	from the river mouth
-Intake Structure (slide gate)	

(e) Other Associated Works

There are some other works associated with the above main works.

(i) Raising existing railway bridge (1 bridge)
(ii) Construction of ground sill (2 places)
(iii) Groin
(iv) Revetment
(v) Drainage outlet
(vi) Mooring place
(vii) Unloading place

(2) Construction of Jatibarang Multipurpose Dam

(a) Function of Jatibarang Multipurpose Dam

Jatibarang Multipurpose Dam has such functions as flood control, water resources development and hydropower generation. The flood control function

of the dam reduces the standard flood discharge of 1,010 m^3/s at Simongan Weir which is equivalent to 100-year probability of the design flood discharge 790 m^3/s. The dam will develop 2.69 m^3/s of water anew which consists of 2.04 m3/s of water for municipal and industrial use and 0.65 m^3/s of maintenance flow for Semarang River and an irrigation channel. Further, 1,560 kW of hydropower will be generated by released water from the dam for municipal and industrial use and maintenance flow.

(b) Dam Type

Since the base rock at the dam site consists of soft rock with about 50 kg/cm^2 of unconfined compressive strength, concrete gravity dam cannot be applied for Jatibarang Multipurpose Dam and two types of rockfill dam is compared from technical and economical aspects. As a result of the comparative study, the rockfill dam with center core is adopted for Jatibarang Multipurpose Dam.

(c) Proposed Dam Facilities

Jatibarang Multipurpose Dam consists of the following facilities.

(i) Dam Body

The dam body consists of four (4) zones, impervious zone, semi-pervious zone, pervious zone and rip rap zone.

(ii) Spillway

The spillway is located on the left bank ridge of the dam and has following two (2) functions.

- Function to regulate a 100-year probable flood with peak discharge of 290 m^3/s to 120 m^3/s at the down stream of the Dam and reduce the river discharge from 1,010 m^3/s to 790 m^3/s at Simongan Weir by adding the discharge from Garang and Kripik rivers.
- Sufficient capacity to accommodate the design flood with peak discharge of 1,600 m^3/s (PMF) after regulating the inflow through the reservoir.

(iii) Diversion Tunnel

The objective of a diversion tunnel is to divert stream flow around or through the damsite during the construction period. It can minimize serious potential flood damage to the works in progress. The tunnel is designed to be capable of managing a 25-year probable flood that has been worked out as 280 m^3/s and is located on the left bank. The diversion tunnel has a cross section of a standard horse shoe shape with 5.6 m of inner diameter and the total length of 441 m.

(iv) Outlet Facilities

A water intake structure is installed at the immediate upstream of the dam on the right bank to introduce municipal and industrial water for Semarang City to the downstream of the dam through an outlet pipeline installed in an outlet tunnel on the right bank. The water intake structure and outlet pipeline have a capacity of 6.0 m^3/s considering future water resources development by the construction of Mundingan Dam in the upper reaches of Jatibarang Multipurpose Dam and Interbasin Transfer.

(v) Hydropower Station

Hydropower generation is to be conducted by using the released water for municipal and industrial purpose through the outlet facilities mentioned above. Therefore, the dam reservoir dose not have a capacity for power generation. The power generation station is located at the immediate downstream of the Dam beside the spillway and the installed power generation capacity is estimated at 1,560 kW at the maximum.

(2) Urban Drainage System Improvement

(a) Drainage Measures

After studying the topography of the project area and/or the features of the main channels/rainfall pattern and inundation characteristics, the whole area was divided into two parts, the gravity drainage area in the upper watershed where rain water can be drained into Semarang River by gravity force, and the pump drainage area in the lower watershed where the inland storm water should be drained out by pumps due to lower ground elevation than the High

Tide Level of Java Ses.

In order to release the flood water from the upper watershed safely, the discharge capacity of Semarang River shall be improved by dredging the drainage channels and raising the existing dikes. The lower watershed is further divided into two sub-drainage areas by Semarang River as the boundary, namely Asin Drainage Area and Bandarharjo Drainage Area, and pumping stations shall be installed for each sub-drainage area.

(b) Drainage Component

The Urban Drainage System Improvement is composed of the following three sub-components;

(i) Semarang Drainage System Improvement (6.220 km^2),
(ii) Asin Drainage System Improvement (4.430 km^2), and
(iii) Bandarharjo Drainage System Improvement (2.185 km^2) .

(c) Design Scale

The design scale of 5-year return period is applied. To realize the urgent implementation of the priority project of Semarang River improvement, 5-year return period was selected and implemented in Urban V Project. Therefore, the same return period shall be applied in this Urban Drainage System Improvement Project for urgent implementation.

2.4.2 Project Design and Features

(1) West Floodway/Garang River Improvement

This component consists of the following two major works, (1) Improvement of West Floodway and Garang River and (2) Reconstruction of Simongan Weir.
The designs of the improvement for West Floodway and Garang River which were established in the definitive plan are summarized below.

(a) Alignment

The alignment of the river course is set principally to follow the existing alignment as much as possible. Although meandering portions exist in the upper stretch, channel short cut is not adopted to minimize the land acquisition

and the construction cost. The alignment of West Floodway and Garang River is shown in Fig. 2.7.

(b) Longitudinal Profile

The design longitudinal profile of the river bed follows the existing one to avoid unbalanced scouring and sedimentation as well as to minimize relocation and modification of existing river structures.

The design high water level is set below the hinterland ground level so as to minimize the flood damage potential. The design high water level is, however, unavoidably set higher than the hinterland ground level for the low-lying downstream stretch where the riverbed gradient is extremely flat, and it is technically difficult to set the design high water level lower than the hinterland ground level due to the backwater effect of the tidal level. The design longitudinal profile is shown in Fig. 2.8.

(c) Channel Cross Section

A compound cross section with flood plain and low water channel is adopted to minimize embankment height and to assure channel stability. The flow capacity of the low water channel is designed to accommodate discharge more than 1-year return period to assure channel stability. The typical cross sections of West Floodway/Garang River are shown in Fig. 2.9.

(d) Dike

Earth dike with a side slope of 1 : 2.0 is adopted in principal except portions where presently concrete flood wall is employed due to the difficulty of land acquisition. The freeboard of 1.0 m is adopted for the entire stretch of West Floodway/Garang River.

(2) Reconstruction of Simongan Weir

(a) Necessity of Reconstruction

Since the existing Simongan Weir is a fixed type, it causes over topping of river water in the upstream areas from Simongan Weir at the time of floods. Therefore, the existing Simongan Weir is proposed to be reconstructed to a gated weir to attain smooth flood discharge toward downstream keeping

existing functions of the Weir to intake river water for PDAM and to divert river maintenance flow to Semarang River and an irrigation channel.

(b) Gate Type

A comparative study on the gate type for four types of gate, roller gate, radial gate, tilting gate and rubber gate has been made. Considering the cheapest cost, structural safety and easy operation to control upper stream water level, a roller gate is employed for both main flood discharge gates and sediment flash gates

(c) Location of New Simongan Weir

The new Simongan Weir is to be reconstructed at the same place of the existing weir to keep the existing function to divert maintenance flow to Semarang River and to maintain the upper stream water level.

(d) Features of Simongan Weir

The main dimensions of the Weir are summarized as below and the features are shown in Fig. 2.10.

Flood Discharge Gate

Span Length	18.5 m
Gate Height	3.7 m
Number of Gate	3 gates

Sediment Flush Gate

Span Length	5.5 m
Gate Height	4.35 m
Number of Gate	2 gates

(2) Construction of Jatibarang Multipurpose Dam

Figs. 2.11 and 2.12 show the reservoir area and the layout of the main structures of Jatibarang Multipurpose Dam. The design of the main structures of the dam is summarized as below.

(a) Dam Body

The profile along the dam axis and the standard cross section are shown in

Figs. 2.13 and 2.14. The type of the dam is a center core rockfill dam with the slope of 1 : 2.6 on upstream side and 1 : 1.8 on down stream side. The dam body consists of four zones as shown in the standard cross section and the dam height is 77.0 m and the crest length is 200.0 m.

(b) Spillway

A spillway which is located on the left abutment of the dam consists of a service spillway and an emergency spillway. The service spillway discharge floods less than 120 m^3/s after regulation of the design flood by the reservoir which corresponds to 100-year probability. The emergency spillway is to discharge bigger floods than 100-year probability and is designed to accommodate the probable maximum flood (PMF).

(c) Diversion Tunnel

A diversion tunnel is located under the left ridge of Kreo River to divert river flow during the dam construction period. The tunnel has a standard horse shoe type section with the internal diameter of 5.6 m. The total length of the tunnel is 441 m with longitudinal gradient of 1 : 30. The diversion tunnel can discharge floods up to 280 m^3/s which corresponds to 25-year probability.

(d) Outlet Facilities

Water intake structure is located at the right bank of the upstream side of the dam to introduce municipal and industrial water of 6.0 m^3/s to Semarang City through a steel outlet pipe installed in the outlet tunnel. The steel outlet pipe whose diameter is 1.4 m is installed in the outlet tunnel with the internal diameter of 2.4 m and the cross section of standard horse shoe type. The total length of the outlet tunnel is 393 m with the longitudinal gradient of 1 : 14.65. The outlet pipe is connected to the hydropower station to generate hydropower when reservoir water is released to the down stream of the dam.

(e) Hydropower Station

A hydropower station was planned aimed to generate hydropower when municipal and industrial water is released from the reservoir through the outlet pipe. The hydropower station is equipped with one set of a Francis turbine with horizontal shaft type and a generator with horizontal shaft, 3 phase alternating

current synchronous type. The installed capacity of the power station is 1,560 kW and annual energy output of the generator is calculated at 6,020 MWh.

(3) Urban Drainage System Improvement

Fig. 2.15 shows the location of the proposed drainage improvement works. The outline of the design features of the component is described hereinafter.

(a) Semarang River Improvement Plan

The design discharge distribution of Semarang river system including Asin and Baru rivers is shown in Fig. 2.16. Since the diversion gate from Semarang River to Baru River shall be closed permanently in accordance with the request by the Semarang Harbor Authority, the design discharge of Baru River is zero.

The alignment and the longitudinal profile of Semarang River follows the existing ones, which had been planned in the Urban V Project in 1985, except a part of the channel relocation for the purpose of creation of land for Asin Retarding Pond (refer to Fig. 2.17). The longitudinal plan and cross sectional plan basically follow those of the Urban V plan. Design longitudinal profile and typical design cross section of the channel are sown in Fig. 2.18.

Based on the plan mentioned above, following improvement works shall be implemented.

(i) Dredging

The river bed shall be dredged from the river mouth to Tugu Muda to recover the discharge capacity of the channel. The total length of the dredging stretches is 7.3 km among the total length of the river 8.3km. The total volume of sediment to be dredged is 110,000 m^3, among which 72,900 m^3 sedimented upstream from the Station No.45, is included in the Package 1 (Semarang River Improvement) and 37,100 m^3 downstream from Station No.45 shall be included in the Package 2 (Asin Drainage System Improvement). (refer to Fig. 2.15)

According to the analysis of sediment material of Semarang, Asin and Baru rivers, it has been revealed in the environmental study that various heavy metals are contained with significant amount. In the process of

disposal of the dredged material from the drainage channels, it is necessary to ensure the safety of the disposed soil not to contaminate the groundwater in the neighborhood of spoil banks. The treatment method was studied in the detailed design of JICA Study and to mix the dredged material with cement of 7 % of the dredged material was proposed to secure heavy metals not to be leached out and the treatment cost is included in the Project Cost.

(ii) Raising Existing Dike

The masonry dike along Semarang River shall be raised at places where the height of the existing dike is not enough to accommodate the design flood. The design free board of 0.6 m is applied to the downstream from the railway bridge (3.2 km from the river mouth) and 0.4 m upstream from the railway bridge according to the criteria established in Urban V Plan. The total length of the river stretch of dike raising is 3.6 km as sown in Fig. 2.15.

(iii) Renovation of Inspection and Maintenance Road

Existing inspection and maintenance roads along the both banks of the objective drainage channels shall be renovated as most of them are in poor condition.

(b) Asin Drainage System Improvement

The proposed Asin Drainage System Improvement consists of construction of a pumping station with a retarding pond and improvement of Asin River. The location of Asin Pumping Station is shown in Fig. 2.15.

In order to economize the design capacity of the pump, rain water shall be temporary stored in a retarding pond, Asin River, secondary channels as well as 20% of the protecting area with the depth of 20 cm.

The design rainwater storage distribution is as follows;

Storage in Asin Retarding Pond	:	24,000 m^3
Storage in Asin River	:	35,000 m^3
Storage in secondary channels	:	28,000 m^3

Temporary storage in the protecting area	: 177,000 m^3
Total storage volume	: 264,000 m^3

(i) Asin River Improvement

Asin River shall be improved to have enough capacity as a drainage channel by dredging and excavation of the channel bed. The river alignment and the width of the channel shall be remained as it is and the revetment is reconstructed completely together with dredging of the channel.

The features of Asin River Improvement are as follows;

Channel Excavation	V= 38,000 m^3
Channel Length	L= 1,400 m
Revetment	L= 2,400 m

(ii) Asin Pumping Station

Asin Pumping Station was designed based on the hydrological study results, design criteria, comparative study on pump type and etc.

The Lowest Low Tidal Level of Java Sea is EL-0.9 m and it is 0.7 m lower than the existing lowest land elevation of the drainage area. Therefore, it is possible to drain out the stored water in the retarding pond by gravity force during low tide. A gate is installed adjacent to the pumping station in order to release water when the tide level is lower than the water level in the retarding pond.

Features of Asin Pumping Station are as follows;

<u>Pump</u>

Installed Capacity	: 9.0 m^3/s
Pump Head	: 5.1 m
Pump Type	: Screw Pump
Screw Diameter	: 3,000 mm
No. of Pump Unit	: 3 sets
Engine Output	: 325 HP

Gate

Gate Type	: Roller gate
Width	: 4.0 m
Height	: 3.4 m
No. of Gate	: 2 sets

Fig. 2.19 shows layout of the pump facilities.

(iii) Asin Retarding Pond

Features of Asin River which has function of storage of storm water and Asin Retarding Pond are as follow;

	H.W.L (EL m)	L.W.L (El m)	Area (ha)	Storage Capacity (m^3)
Asin River	- 1.0	- 2.5	2.3	35,000
Asin Retarding Pond	- 1.0	- 2.5	1.6	24,000

A part of Semarang River from Station No.31 to Station No.45 (L = 300 m) shall be relocated in order to create the space for Asin Retarding Pond. Fig. 2.20 shows the layout of Asin Retarding Pond

(iv) Other Related Facilities

Construction of a box culvert channel

A channel of box culvert is planed at the uppermost end of Asin River to enhance the drainage capacity of the inlet channel to Asin River and to avoid house evacuation along the existing inlet channel.

Reconstruction of bridges

Two existing bridges on Asin River shall be reconstructed along with the Asin River improvement works as compensation works. The width of the bridges shall be maintained as they are while the new spans shall be same with the new channel width.

(c) Bandarharjo Drainage System Improvement

The proposed Bandarharjo Drainage System Improvement consists of construction of a pumping station with a retarding pond and improvement of Baru River. In order to economize the design capacity of the pump, rain water

shall be temporary stored in the retarding pond, Baru River, secondary channels as well as 20 % of the protecting area with the depth of 20 cm.

The design rainwater storage distribution is as follows;

Storage in Baru River	: 23,000 m^3
Storage in Baru Retarding Pond	: 8,000 m^3
Storage in secondary channels	: 14,000 m^3
Temporary storage in the protecting area	: 87,000 m^3
Total storage volume	: 132,000 m^3

(i) Baru River Improvement

Baru River shall be improved to have enough capacity as a drainage channel as well as a retarding pond by dredging and excavation of the channel bed. The river alignment and the width of the channel shall be remained as it is and the existing revetment is reconstructed completely .

(ii) Baru Pumping Station

Baru Pumping Station was designed based on the hydrological study results, design criteria, comparative study on pump type and etc. As the Lowest Low Tide Level of Java Sea is EL -0.9 m and it is 0.8m lower than the existing lowest land elevation of the drainage area, it is possible to drain out the stored water in the retarding pond by gravity force during low tide. Therefore, a gate is installed adjacent to the pumping station in order to release water when the tide level is lower than the water level in the retarding pond.

Features of Baru Pumping Station are as follows;

Pump

Installed Capacity	: 4.6 m^3/s
Pump Head	: 2.75 m
Pump Type	: Screw Pump
Screw Diameter	: 2,600 mm
No. of Pump Unit	: 2 sets
Engine Output	: 267 HP

Gate

Gate Type	: Roller gate
Width	: 4.00 m
Height	: 3.65 m
No. of Gate	: 1 set

Fig. 2.21 shows layout of the pump facilities.

(iii) Baru Retarding Pond

Features of Baru River as a retarding pond and Baru Retarding Pond are as follow;

	H.W.L (EL m)	L.W.L (EL m)	Area (ha)	Storage Capacity (m^3)
Baru River	-0.9	-2.4	1.6	24,000
Baru Retarding Pond	-0.9	-2.4	0.8	8,000

Fig. 2.20 shows the layout of Baru Retarding Pond. The surrounding bank of each retarding pond is protected by stone masonry.

Baru Conveyance Channel

Since Baru Retarding Pond is located about 600 m away from the Baru Pumping Station, a conveyance channel which has following features shall be newly constructed to connect them.

Design discharge	: 1.20 m^3/s
Length	: 600 m
Slope of channel	: 1/1,200
Structure	: Box Culvert

Secondary Channel Improvement

Secondary channel improvement works are proposed for Bandarharjo West drainage area to improve the drainage system in the area.

Additional Boundary Dikes

As Ronggowarsito St., the eastern boundary of the Bandarharjo drainage area, is low as EL -0.1 m, it is necessary to construct dike system to enclose the protecting area. As detailed design of this dike construction is

not included in the scope of the detailed design of JICA Study, it is necessary to do it in the implementation stage of the Project as a part of the engineering services.

To protect the drainage areas from sea water intrusion through railways, additional dikes are designed on both sides of railways. The location of the additional dike to be constructed is shown in Fig. 2.22 and the total length of the additional dike amounts approx. 10.0 km.

2.5 Project Cost

2.5.1 Conditions of Cost Estimate

(1) Constitution of Project Cost

The project cost consists of the following cost items.

- Construction Base Cost : Direct cost which is estimated based on the work quantities and the indirect cost,
- Engineering Service Cost : Cost for the construction supervision,
- Value Added Tax : 10 % of the sum of construction base cost and engineering service cost,
- Compensation Cost : Land acquisition and house evacuation cost
- Administration Cost : Project owner's expense for the management of the project,
- Physical Contingency : 6 % or 10 % of the sum of construction base cost, engineering service cost and compensation cost, and
- Price Contingency : 3 % of all costs in foreign currency portion and 8 % of all costs in local currency portion.

(2) Price Level

All unit costs were expressed based on the price level in July 1999. Currency conversion rates were adopted at US $ 1.00 = Indonesian Rp. 6,885 and Japanese Yen 1.00 = Indonesian Rp. 60.39.

2.5.2 Project Cost

The total Project cost of three components, West Floodway / Garang River Improvement, Construction of Jatibarang Dam and Urban Drainage System Improvement is estimated at Rp. 1,139,206 million (US $ 165,461 million or Yen 18,864 million). The composition of foreign and local currencies of the components are tabulated below and the breakdown of the project cost of each component is described hereinafter.

Component	FC (Rp. million)	LC (Rp. million)	Total (Rp. million)
West Floodway / Garang River	160,309	160,961	321,270
Construction of Jatibarang Dam	283,016	295,278	578,294
Urban Drainage System Improvement	110,326	129,316	239,642
Total	553,651	585,555	1,139,206

(1) Project Cost of West Floodway/Garang River Improvement

The financial project cost of the component of West Floodway / Garang River Improvement is estimated at Rp. 321,270 million (US $ 46,662 million or Yen 5,320 million) which consists of Rp. 160,309 million of foreign currency portion and Rp. 160,961 million of local currency portion. The breakdown of the Project Cost is shown in the table below.

Cost Item	FC (Rp.x10^6)	LC (Rp.x10^6)	Total (Rpx10^6)
1. Construction Base Cost	127,396	81,599	208,995
2. Engineering Service Cost	11,950	6,220	18,170
3. Value Added Tax	0	27,554	27,554
4. Compensation Cost	0	710	710
5, Administration Cost	0	14,679	14,679
6. Physical Contingency	8,361	5,312	13,673
7. Price Contingency	12,602	24,886	37,489
Project Cost	160,309	160,961	321,270
Project Cost (US $ x 10^3)	23,284	23,379	46,662
Project Cost (Yen x 10^6)	2,654	2,665	5,320

The breakdown of the construction base cost is shown in Table 2.8 and annual disbursement schedule is presented in Table 2.9.

(2) Project Cost of Jatibarang Multipurpose Dam

The total financial Project Cost amounts Rp. 578,294 million (US $ 83,993 million or Japanese Yen 9,576 million), which consists of Rp. 283,016 million of foreign currency portion and Rp. 295,278 million of local currency portion.

The breakdown of the Project Cost is shown in the table below.

Cost Items	F.C. (Rp.x10^6)	L.C. (Rp.x10^6)	Total (Rp.x10^6)
1. Construction Base Cost	203,161	129,372	332,533
2. Engineering Service Cost	27,709	5,663	33,372
3. Value Added Tax	0	48,218	48,218
4. Compensation Cost	0	13,500	13,500
5. Administration Cost	0	24,222	24,222
6. Physical Contingency	23,087	14,853	37,940
7. Price Contingency	29,059	59,450	88,509
Project Cost	283,016	295,278	578,294
Project Cost (US$ x10^3)	41,106	42,887	83,993
Project Cost (Yen x10^6)	4,687	4,890	9,576

The breakdown of the construction base cost is shown in Table 2.10 and disbursement schedule is presented in Table 2.11.

(3) Project Cost of Urban Drainage System Improvement

The total financial Project Cost amounts Rp. 239,642 million (US$ 34,806 million or Japanese Yen 3,968 million), which consists of Rp. 110,326 million of foreign currency portion and Rp. 129,316 million of local currency portion. The breakdown of the Project Cost is shown in the table below.

Cost Item	FC (Rp.x10^6)	LC (Rp.x10^6)	Total (Rpx10^6)
1. Construction Base Cost	87,072	63,459	150,531
2. Engineering Service Cost	8,230	3,789	12,019
3. Value Added Tax	0	20,083	20,083
4. Compensation Cost	0	4,793	4,793
5, Administration Cost	0	10,873	10,873
6. Physical Contingency	5,718	4,322	10,041
7. Price Contingency	9,305	21,997	31,302
Project Cost	110,326	129,316	239,642
Project Cost (US $ x 10^3)	16,024	18,782	34,806
Project Cost (Yen x 10^6)	1,827	2,141	3,968

The breakdown of the construction base cost is shown in Table 2.12 and annual disbursement schedule is presented in Table 2.13.