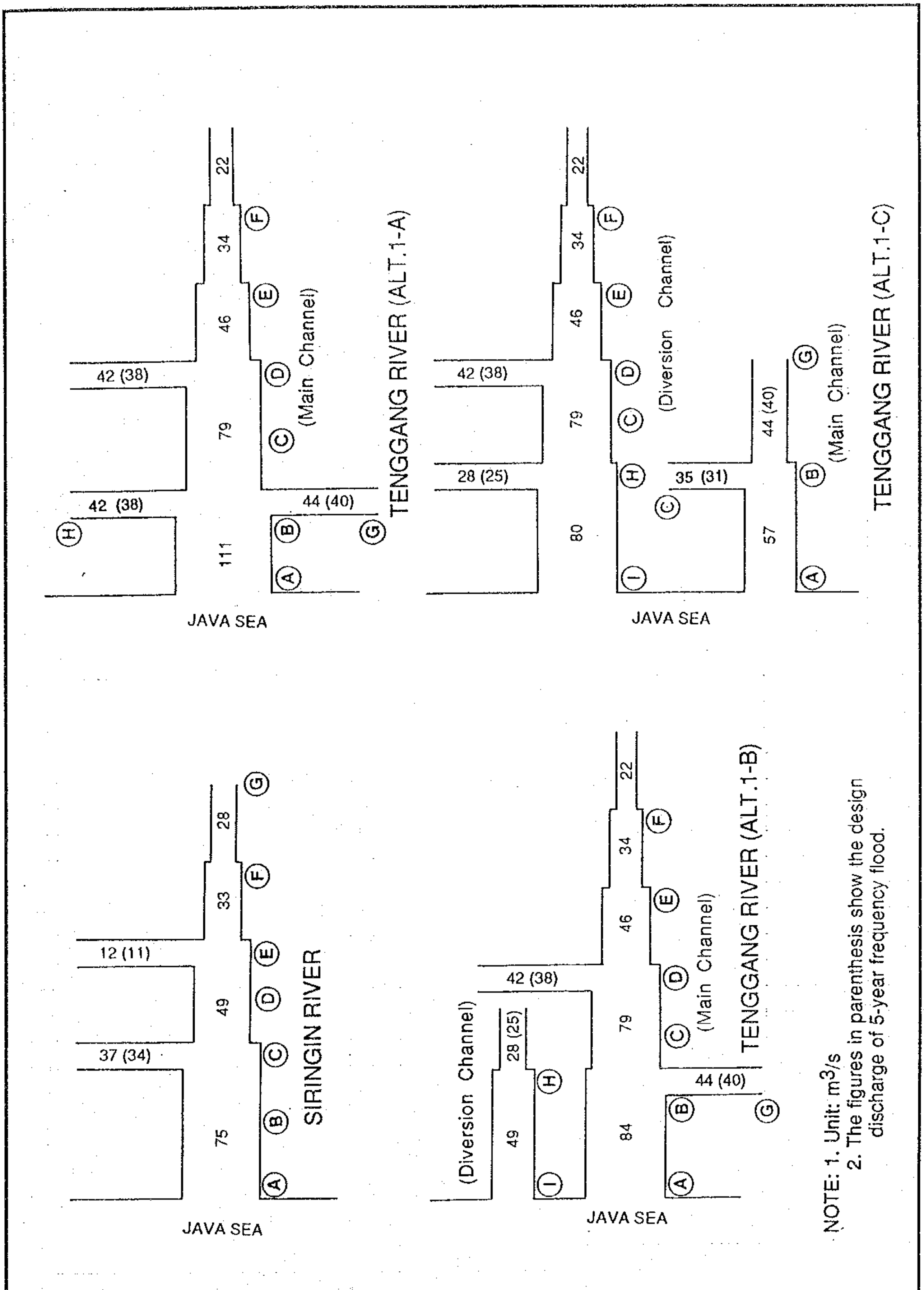
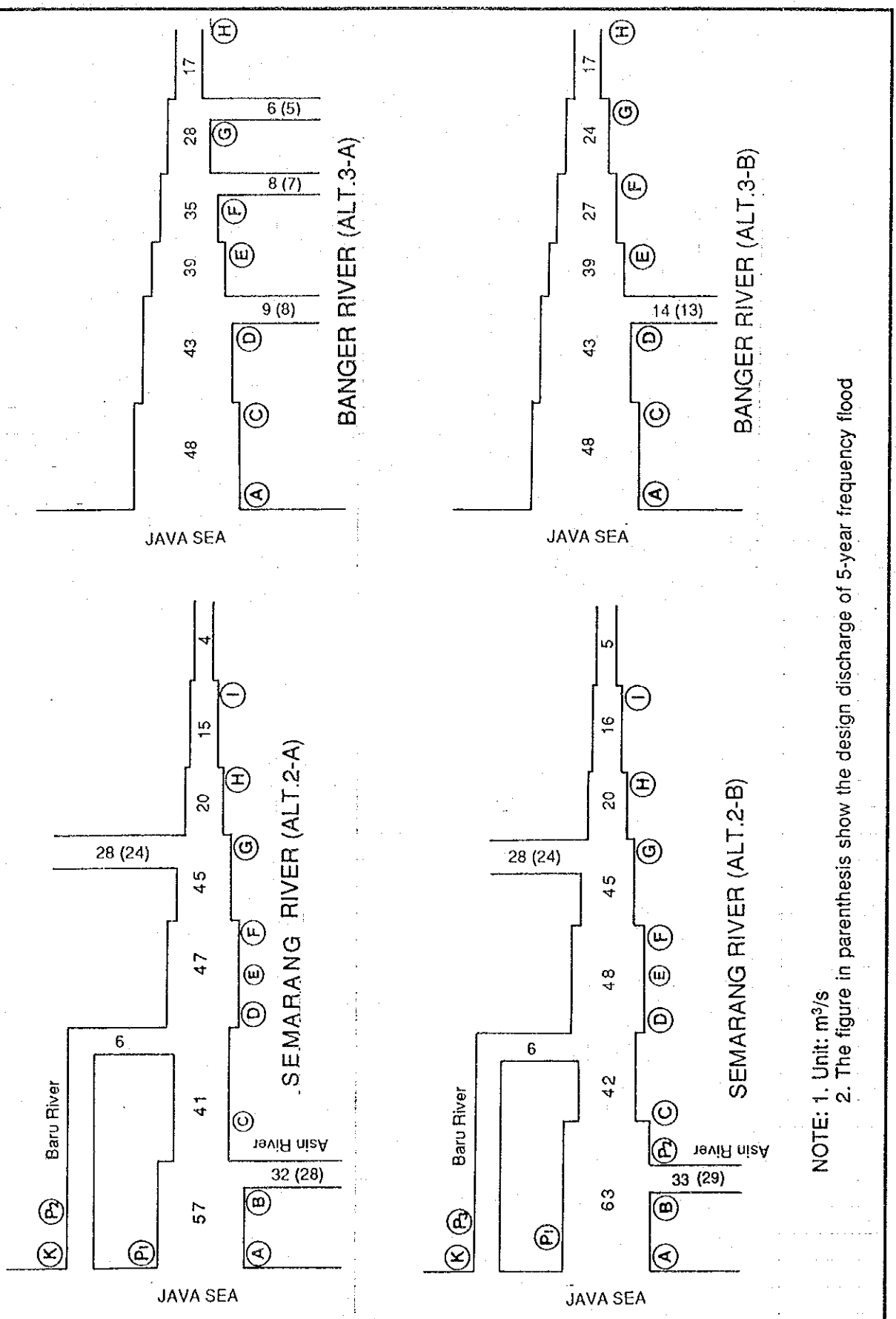


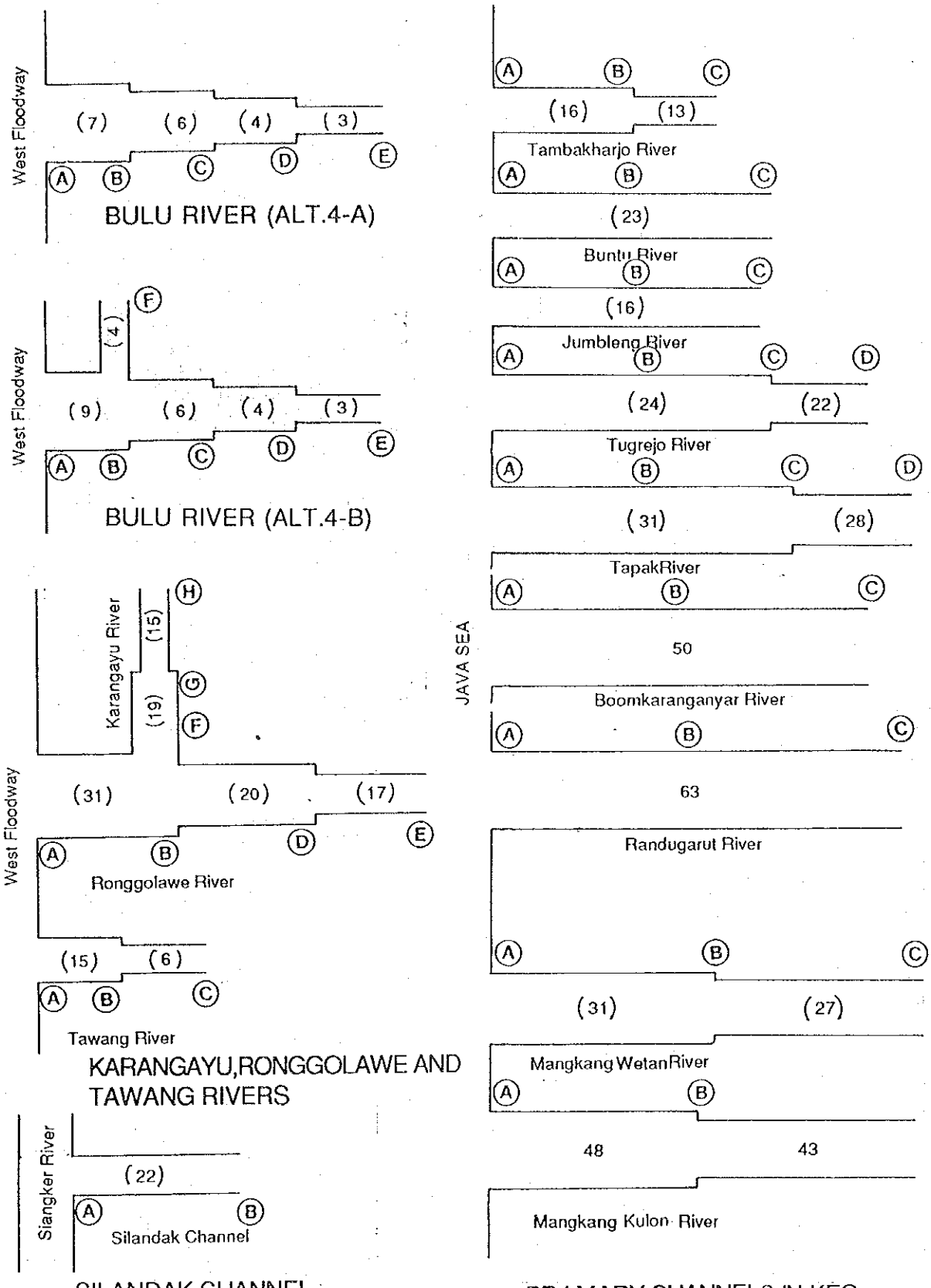
MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. VI.6.8 (1/3) DESIGN DISCHARGE (SIRINGIN AND TENGGANG RIVERS)



MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. VI.6.8(2/3)
DESIGN DISCHARGE (SEMARANG AND BANGER RIVERS)



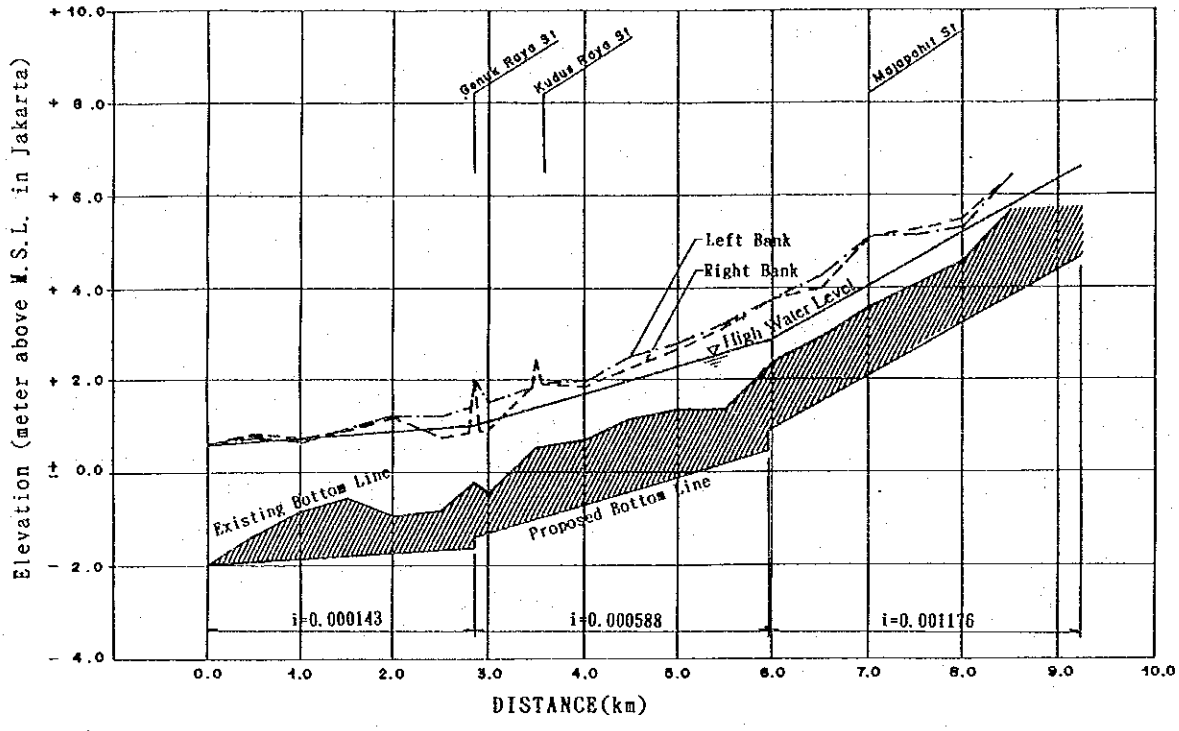
NOTE: 1. Unit: m^3/s
2. The figures in parenthesis show the design discharge of 5-year frequency flood.

MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS

JAPAN INTERNATIONAL COOPERATION AGENCY

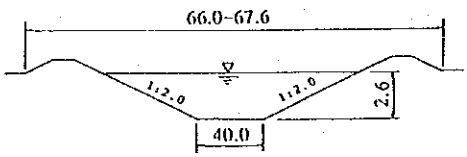
Fig. VI.6.8(3/3)
DESIGN DISCHARGE (PRIMARY CHANNELS IN WEST SEMARANG AND KEC. TUGU AREAS)

SIRINGIN RIVER

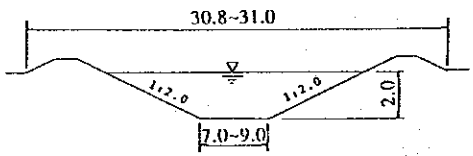


Section No.	Sr－ I	Sr－ II	Sr－ III

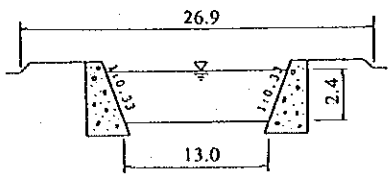
Sr－ I
(0.00～2.87km)



Sr－ III
(5.97～9.22km)

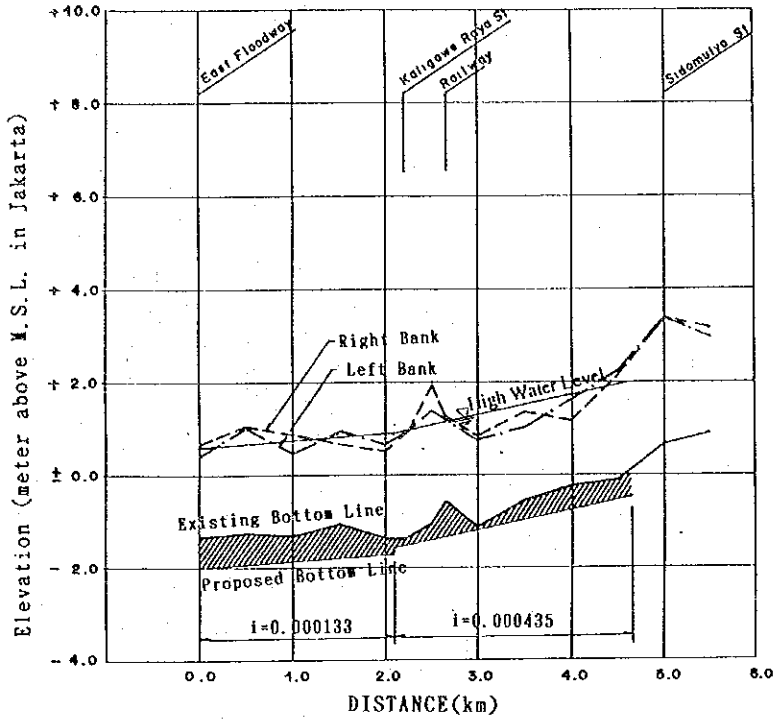


Sr－ II
(2.87～5.97km)



MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. VI.6.9(1/8) PROPOSED LONGITUDINAL AND CROSS SECTIONS OF SIRINGIN RIVER

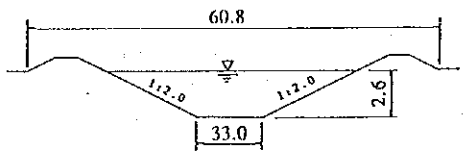
Tenggang River



Section No.	Te－ I	Te－ II

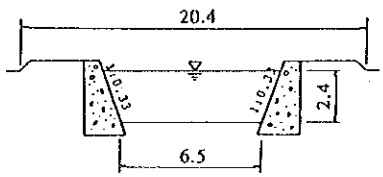
Te－ I

(0.00～2.10km)



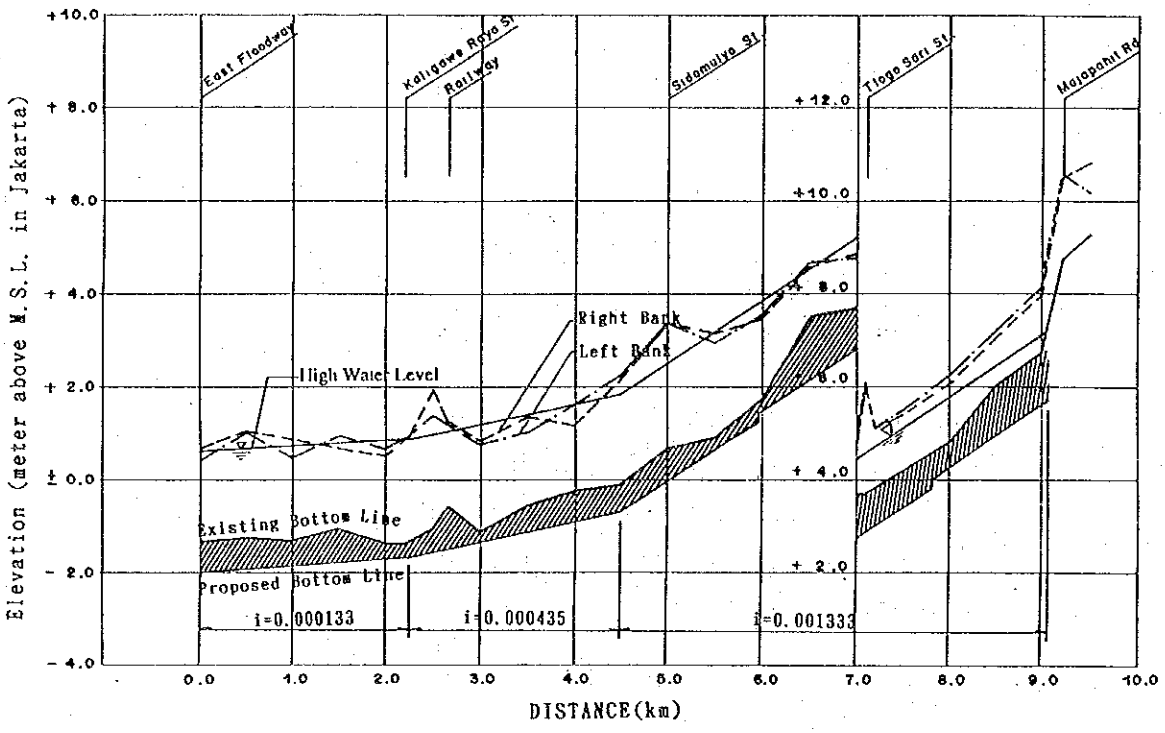
Te－ II

(2.10～4.65km)



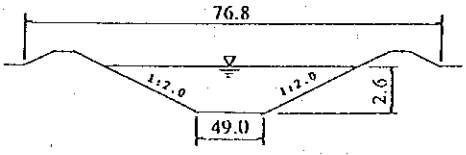
MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. VI.6.9(2/8) PROPOSED LONGITUDINAL AND CROSS SECTIONS OF TENGGANG RIVER

Tenggang River (Diversion)

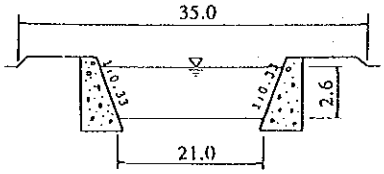


Section No.	Ted－ I	Ted－ II	Ted－ III	Ted－ IV	Ted－ V

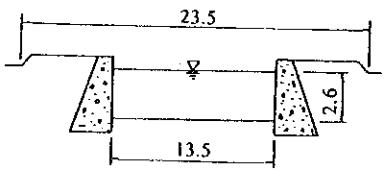
Ted－ I
(0.00～2.25km)



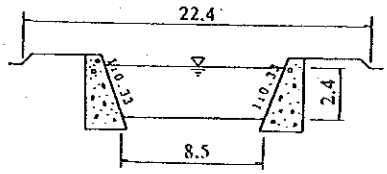
Ted－ II
(2.25～4.50km)



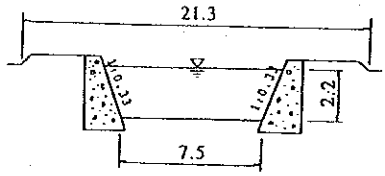
Ted－ III
(4.50～5.95km)



Ted－ IV
(5.95～7.50km)



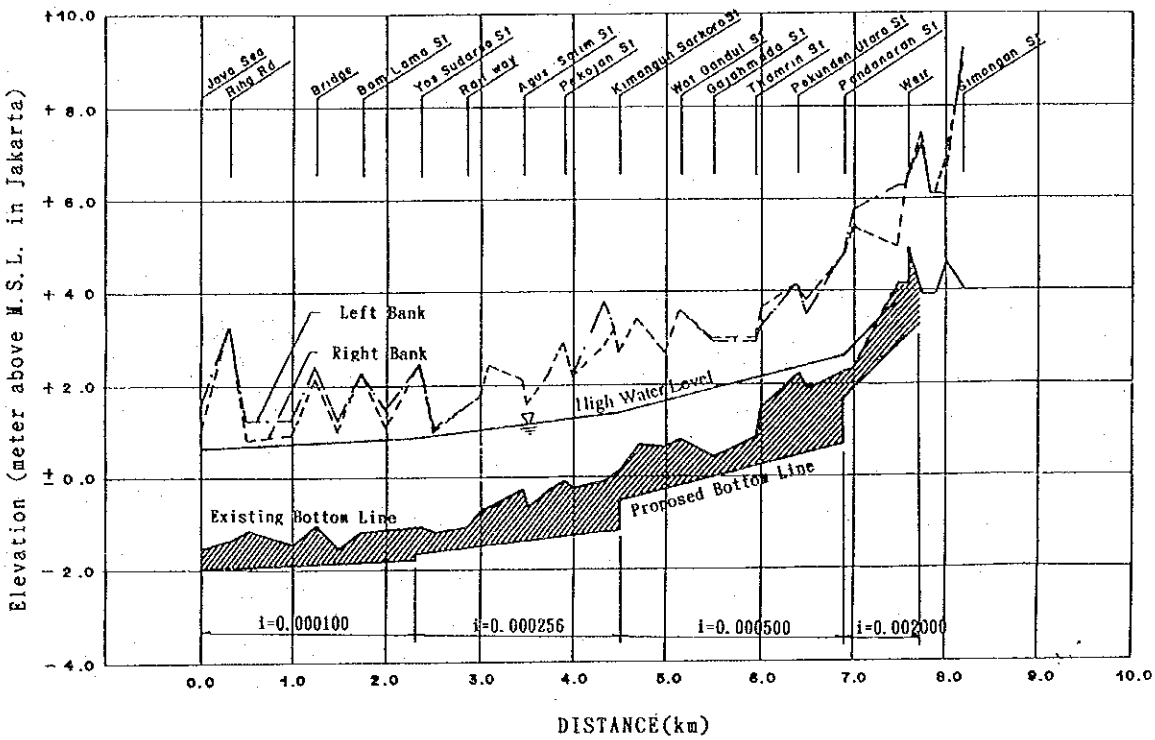
Ted－ V
(7.50～9.05km)



MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS
JAPAN INTERNATIONAL COOPERATION AGENCY

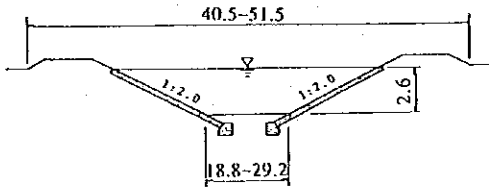
Fig. VI.6.9(3/8)
PROPOSED LONGITUDINAL AND CROSS SECTIONS OF TENGGANG RIVER (DIVERSION)

SEMARANG RIVER

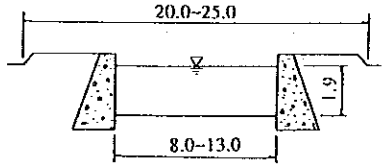


Section No.	Sm－I	Sm－II	Sm－III	Sm－IV

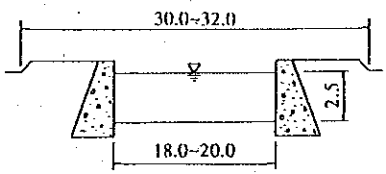
Sm－I
(0.00～2.36km)



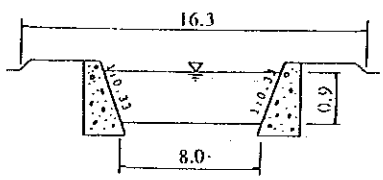
Sm－III
(4.48～6.88km)



Sm－II
(2.36～4.48km)



Sm－IV
(6.88～7.73km)



MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS

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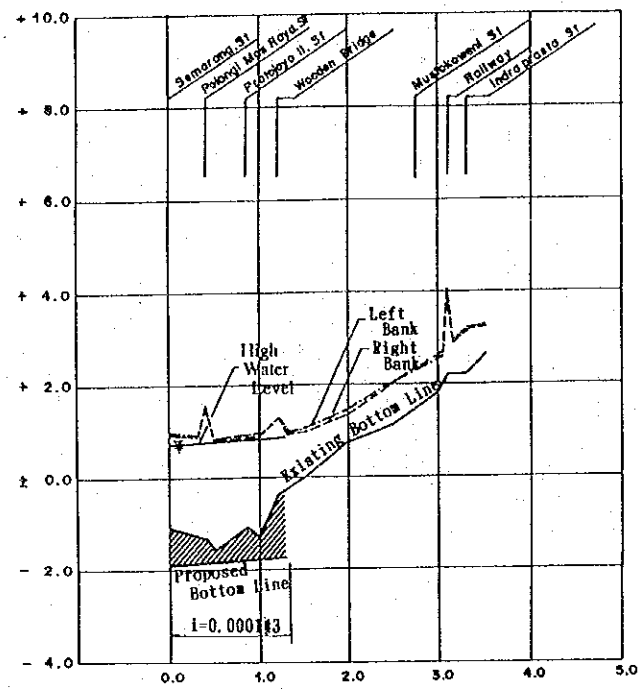
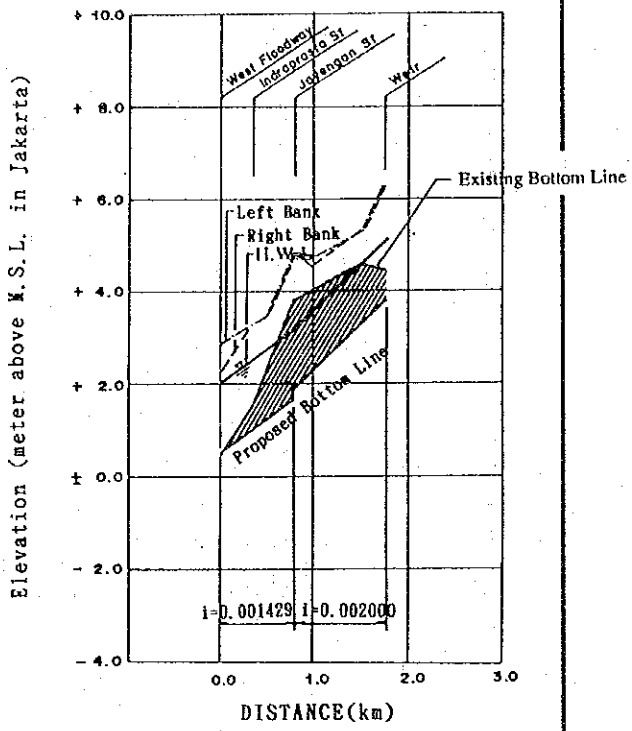
Fig. VI.6.9(4/8)
PROPOSED LONGITUDINAL AND CROSS SECTIONS OF SEMARANG RIVER

ASIN RIVER



Section No.	As－I

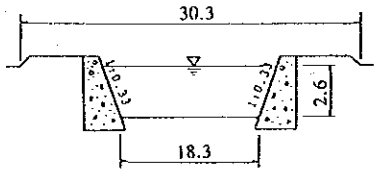
BULU RIVER



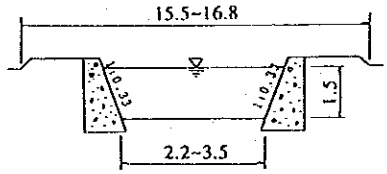
Elevation (meter above M.S.L. in Jakarta)

Section No.	Bu－I	Bu－II

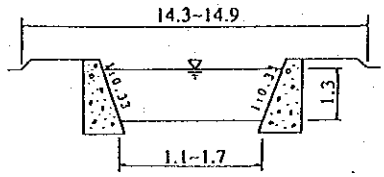
As－I
(0.00～1.30km)



Bu－I
(0.00～0.78km)



Bu－II
(0.78～1.75km)



MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS

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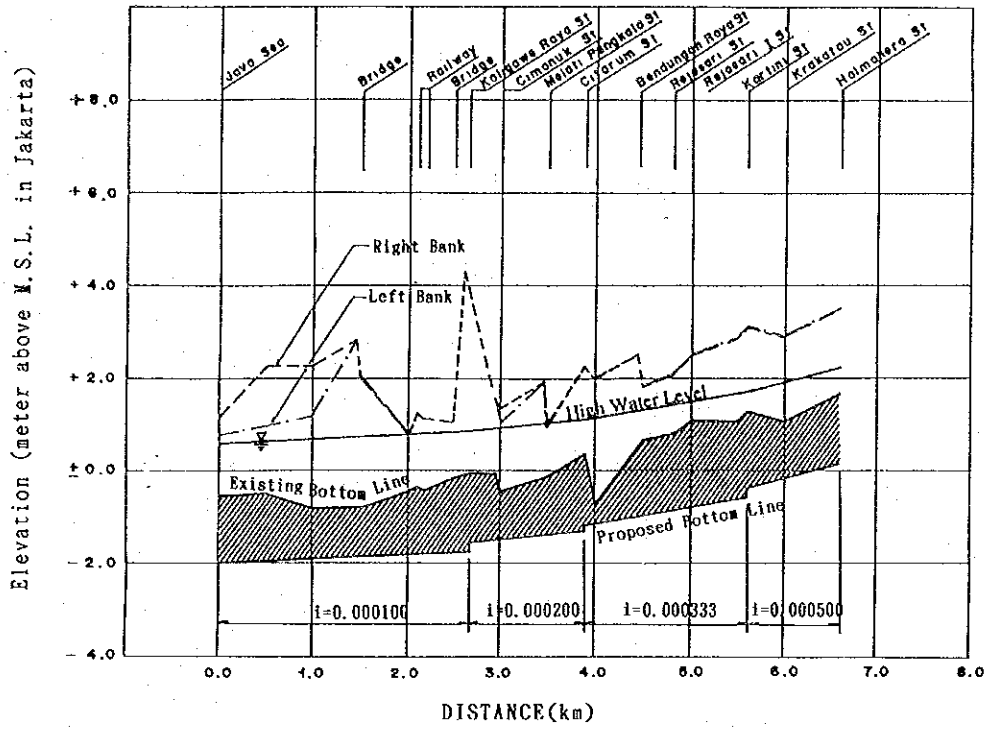
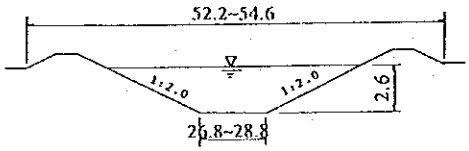
Fig. VI.6.9(5/8)
PROPOSED LONGITUDINAL AND CROSS SECTIONS OF ASIN AND BULU RIVERS

BANGER RIVER

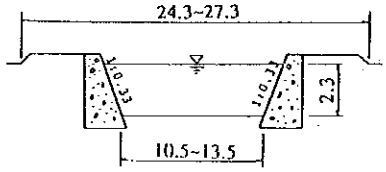


Section No.	Ba－I	Ba－II	Ba－III	Ba－IV	Ba－V

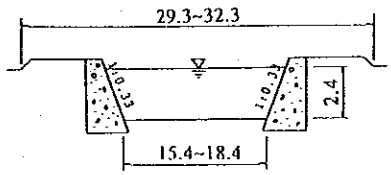
Ba－I
(0.00～2.09km)



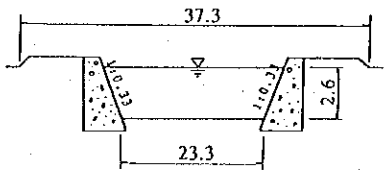
Ba－IV
(3.90～5.60km)



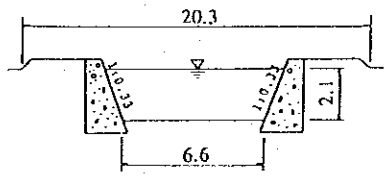
Ba－III
(2.65～3.90km)



Ba－II
(2.09～2.65km)



Ba－V
(5.60～6.68km)



MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS

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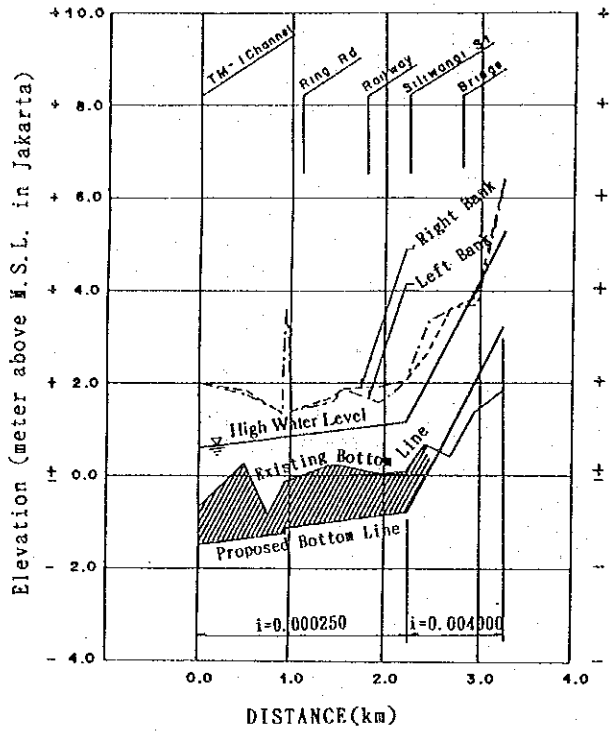
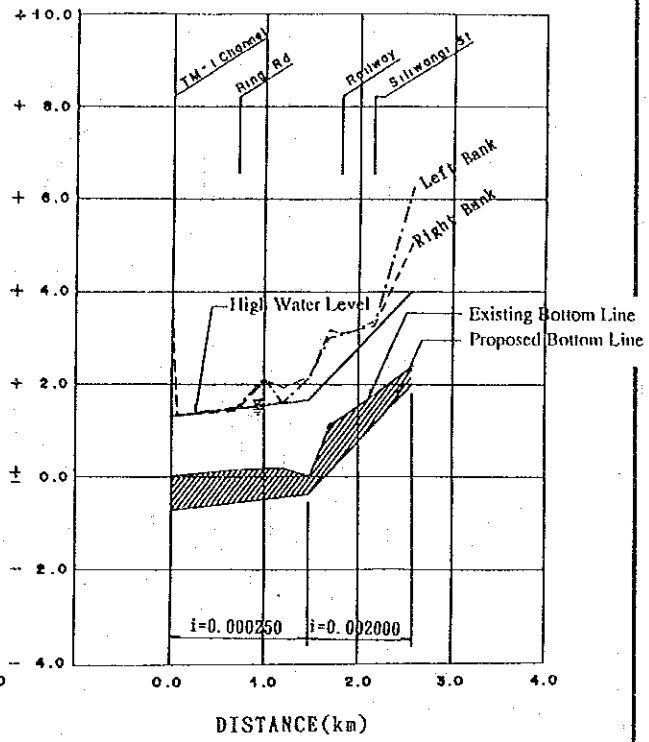
Fig. VI.6.9(6/8)
PROPOSED LONGITUDINAL AND CROSS SECTIONS OF BANGER RIVER

RONGGOLAWE RIVER



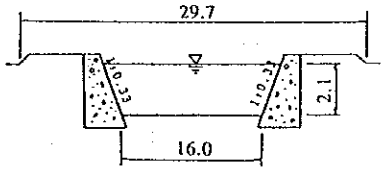
KARANGAYU RIVER



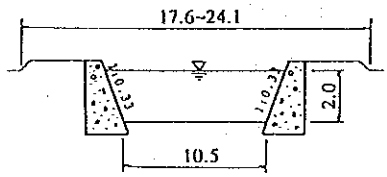
Section No.	Rg－ I	Rg－ II	Rg－ III

Section No.	Kr－ I	Kr－ II

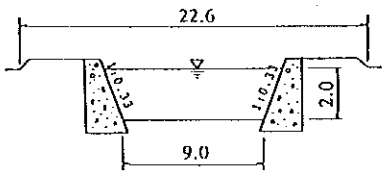
Rg－ I
(0.00～0.95km)



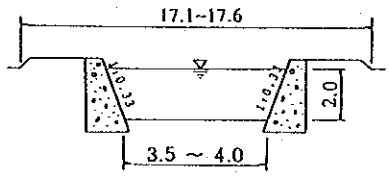
Kr－ I
(0.00～1.50km)



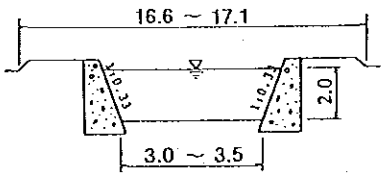
Rg－ II
(0.95～2.25km)



Kr－ II
(1.50～2.68km)



Rg－ III
(2.25～3.25km)



MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS
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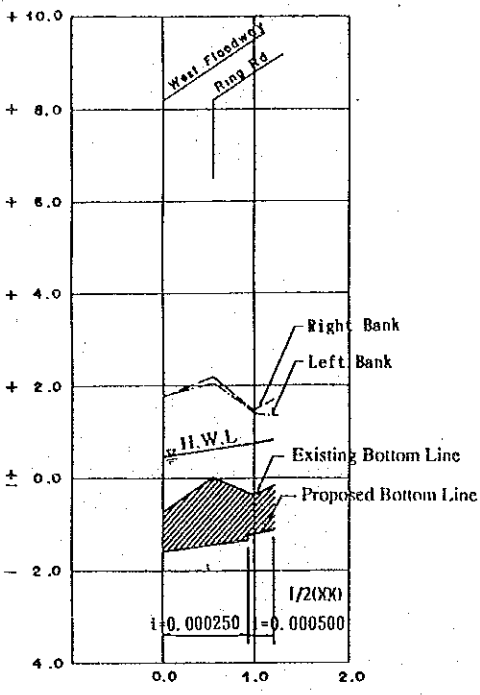
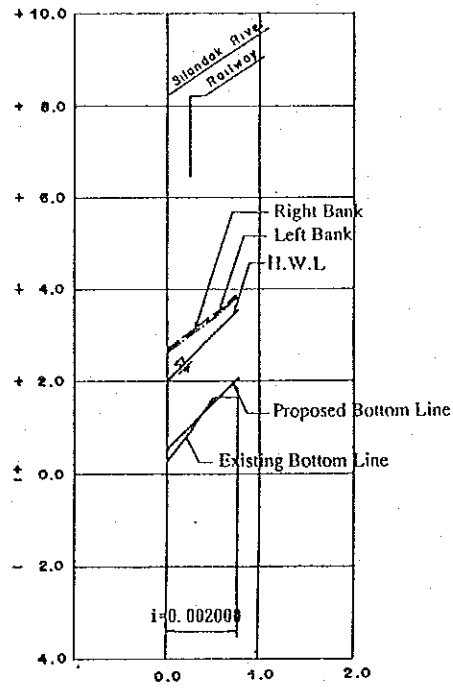
Fig. VI.6.9(7/8)
PROPOSED LONGITUDINAL AND CROSS SECTIONS OF KARANGAYU AND RONGGOLAWE RIVERS

TAWANG RIVER



Section No.	Twe—I	Twe — II

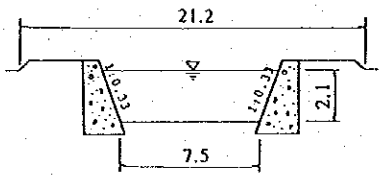
SILANDAK CHANNEL



Section No.	Si — I

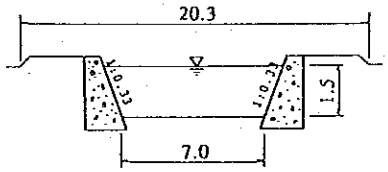
Twe — I

(0.00～0.93km)



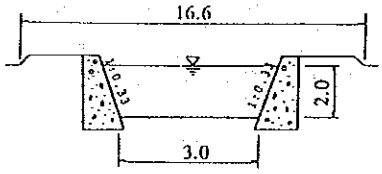
Si — I

(0.00～0.85km)

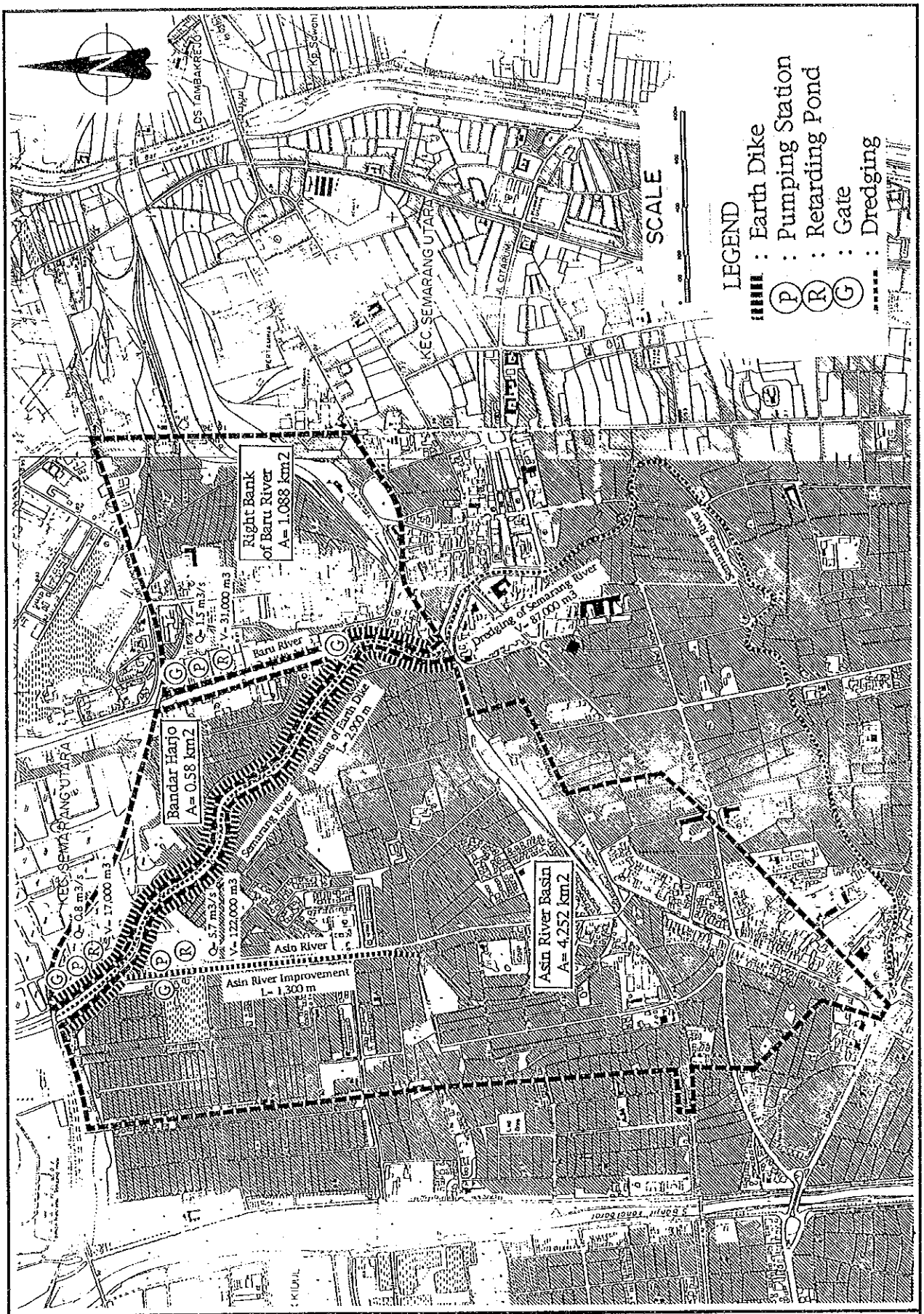


Twe — II

(0.93～1.20km)



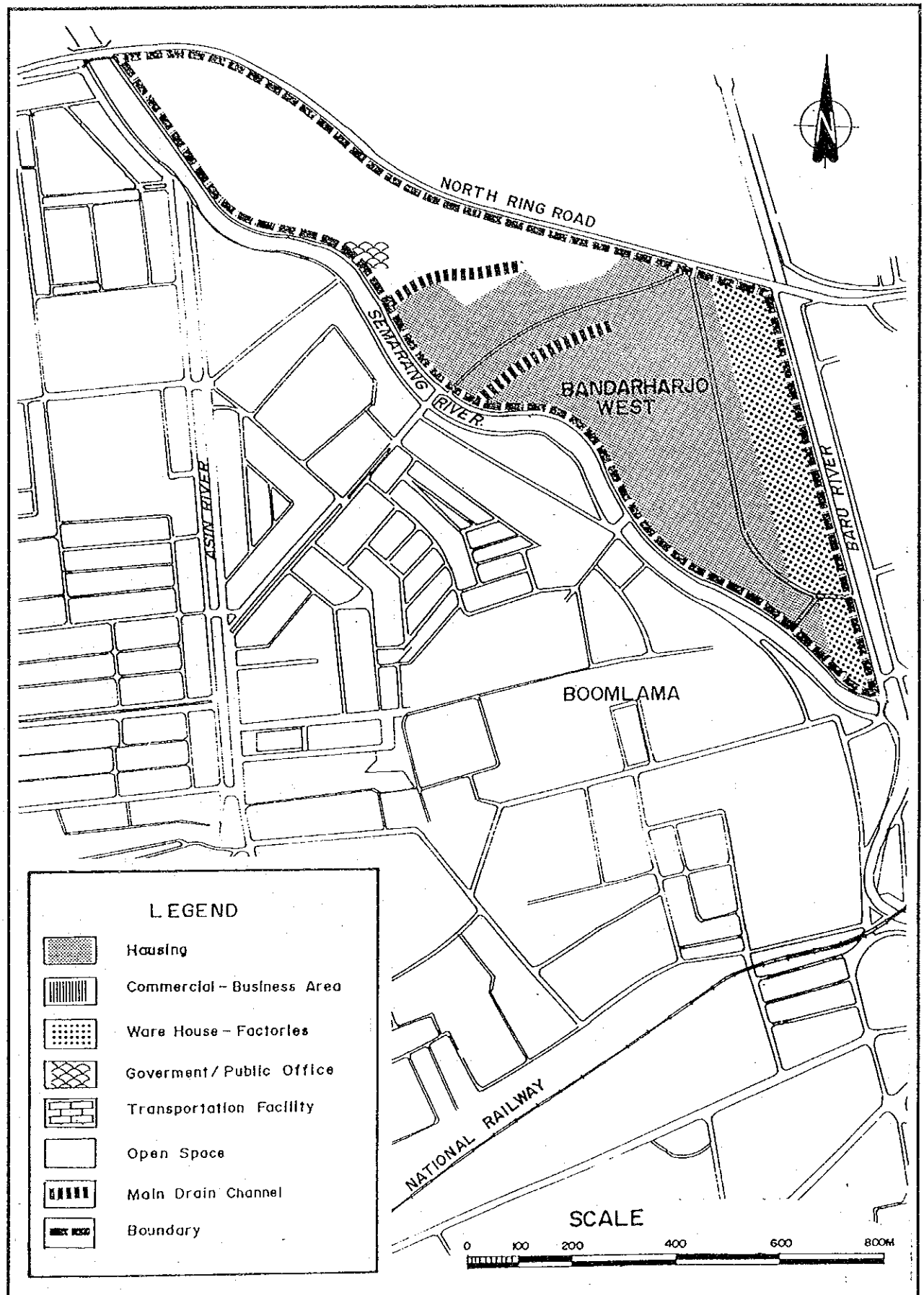
MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. VI.6.9(8/8) PROPOSED LONGITUDINAL AND CROSS SECTIONS OF TAWANG RIVER AND SILANDAK CHANNEL.



MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS

JAPAN INTERNATIONAL COOPERATION AGENCY

FIG. VI.6.10
LOCATION OF PRIORITY PROJECT IDENTIFIED IN MASTER PLAN



MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS

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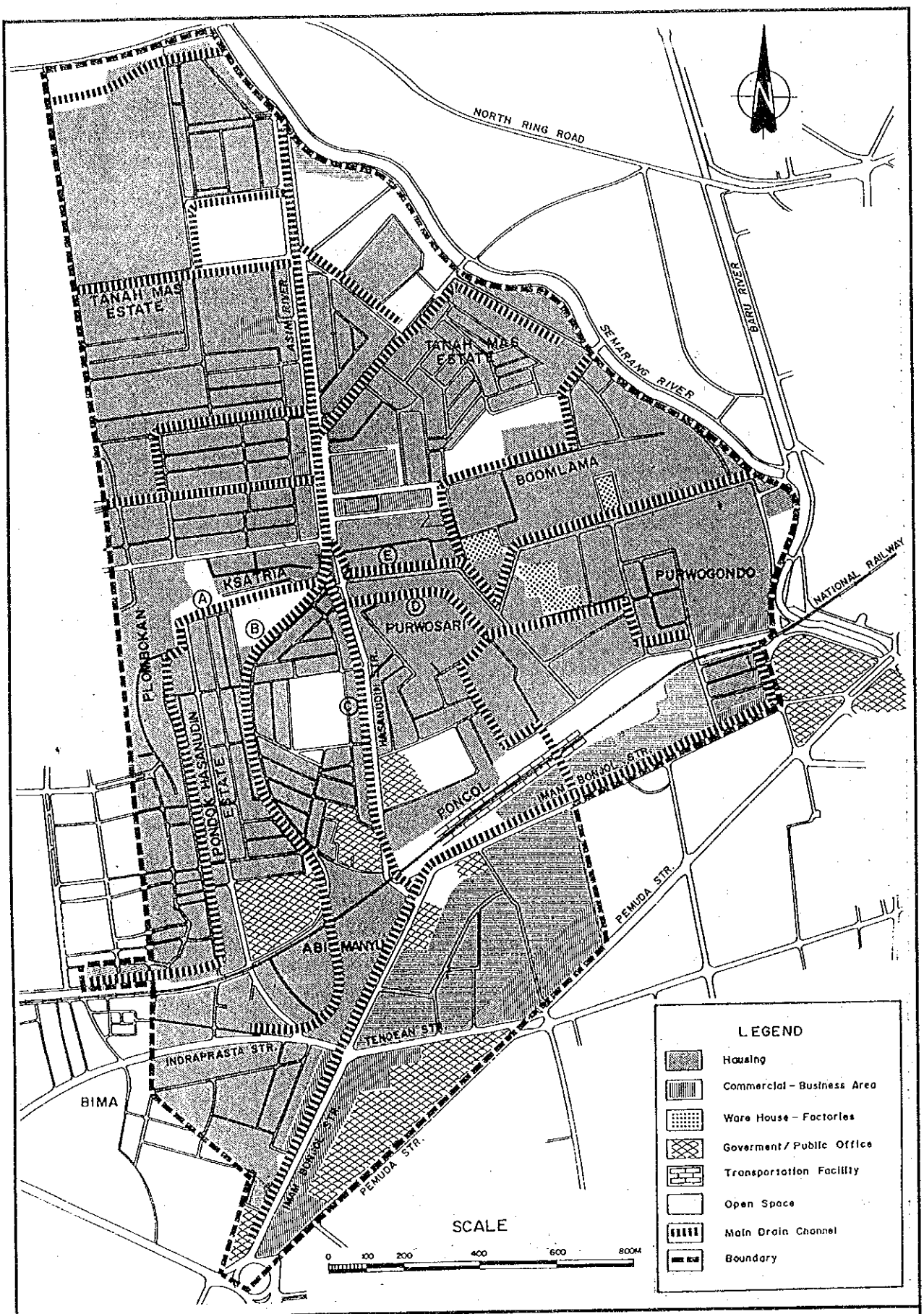
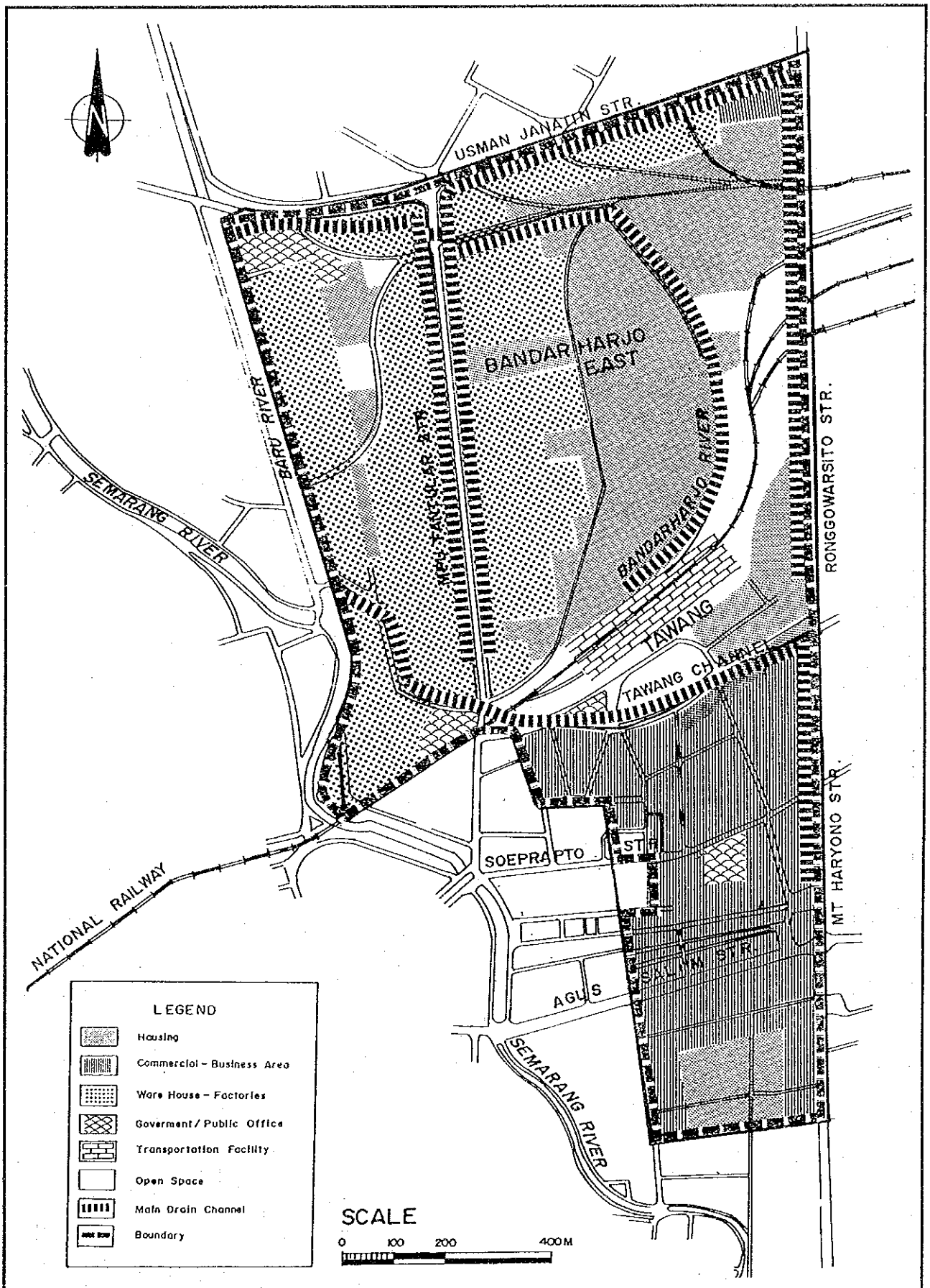
Fig. VI.7.1
PRESENT LAND USE AND DRAINAGE SYSTEM IN BANDARHARJO WEST



MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. VI.7.2
PRESENT LAND USE AND DRAINAGE SYSTEM IN ASIN RIVER BASIN



MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS

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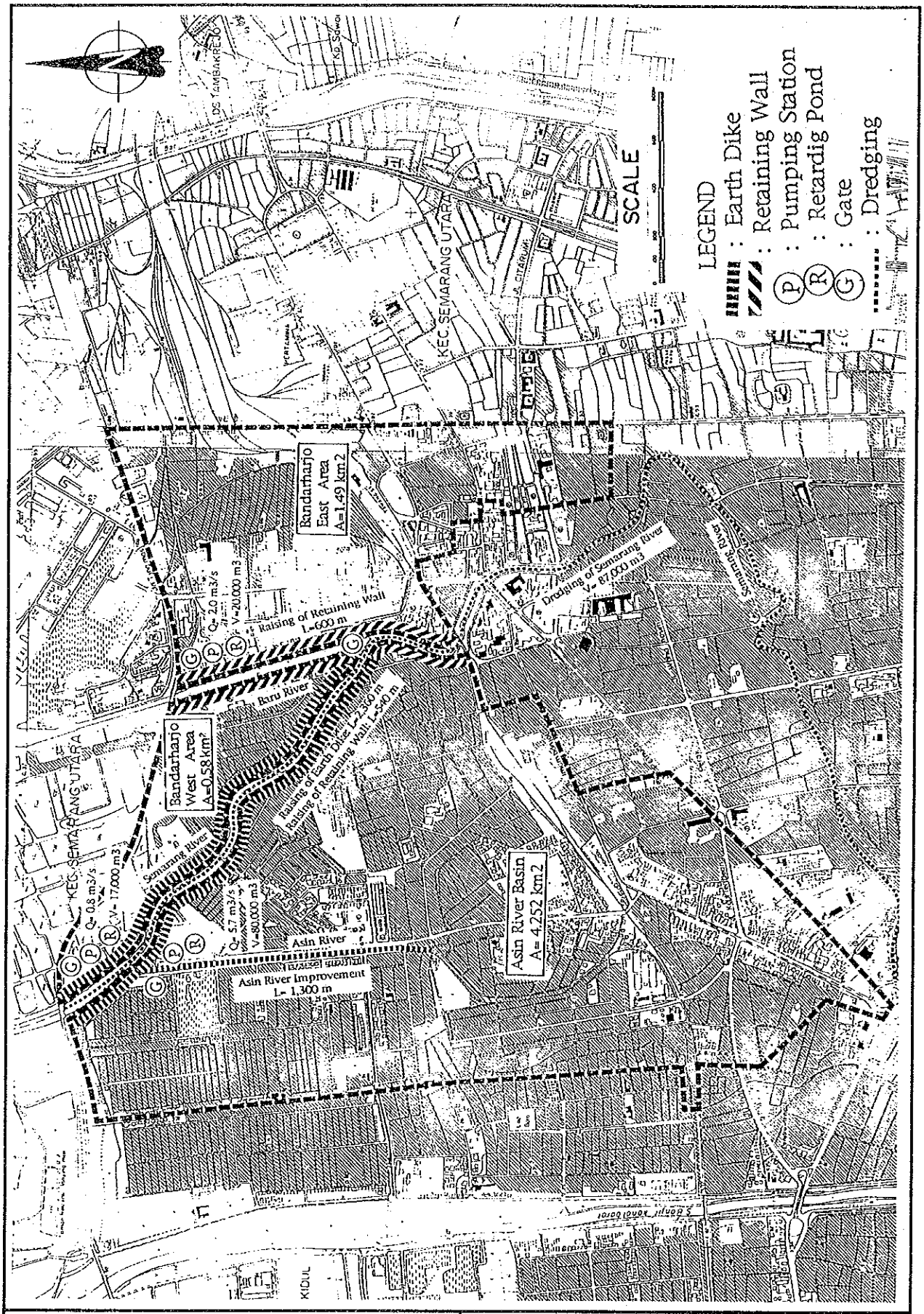
Fig. VI.7.3
PRESENT LAND USE AND DRAINAGE SYSTEM IN BANDARHARJO EAST



MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS

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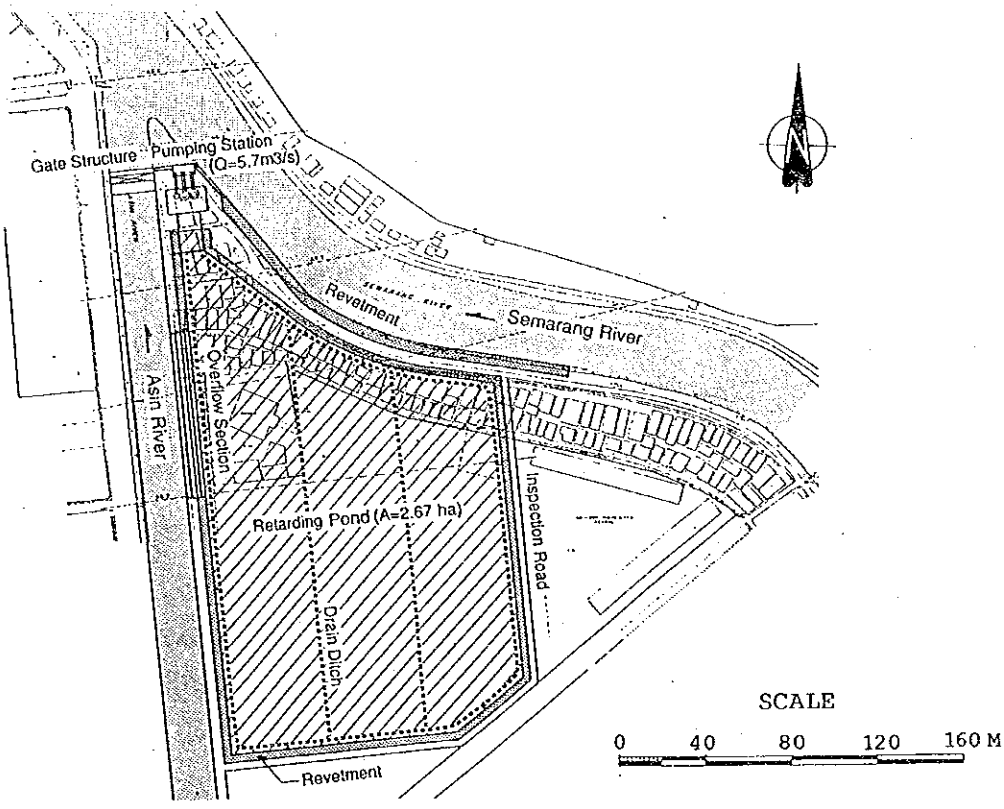
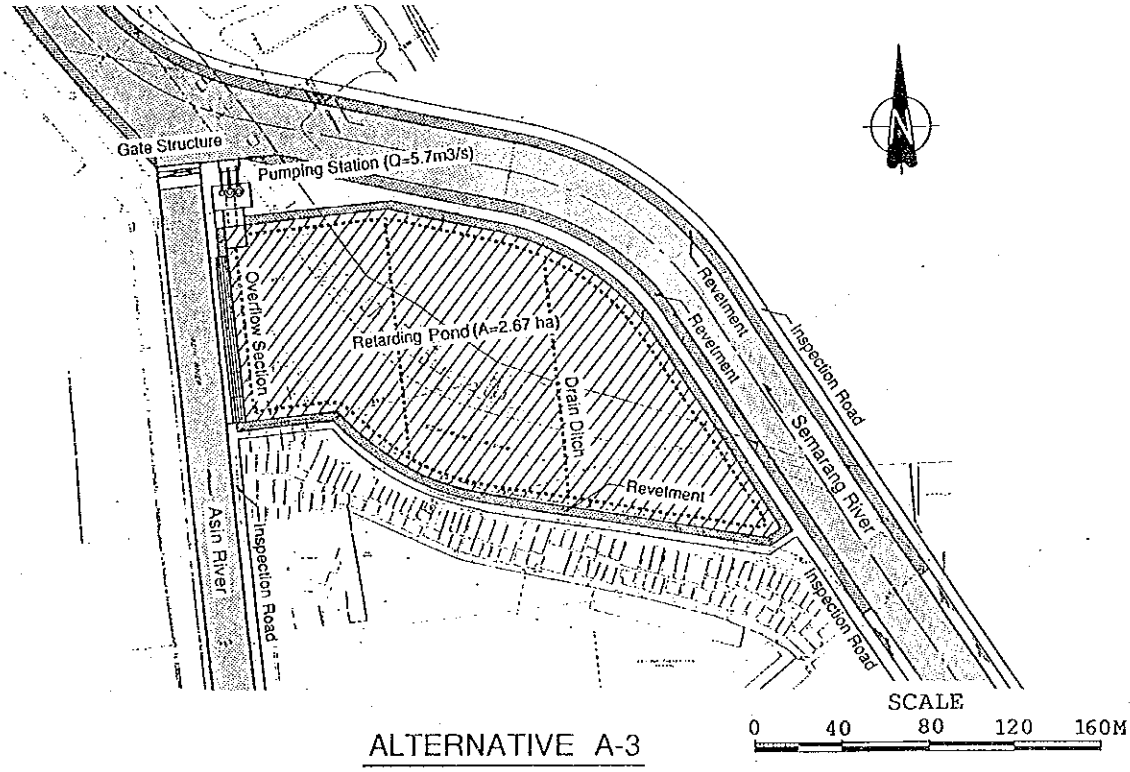
Fig. VI.7.4
LOCATION OF REVISED PRIORITY PROJECT FOR FEASIBILITY STUDY

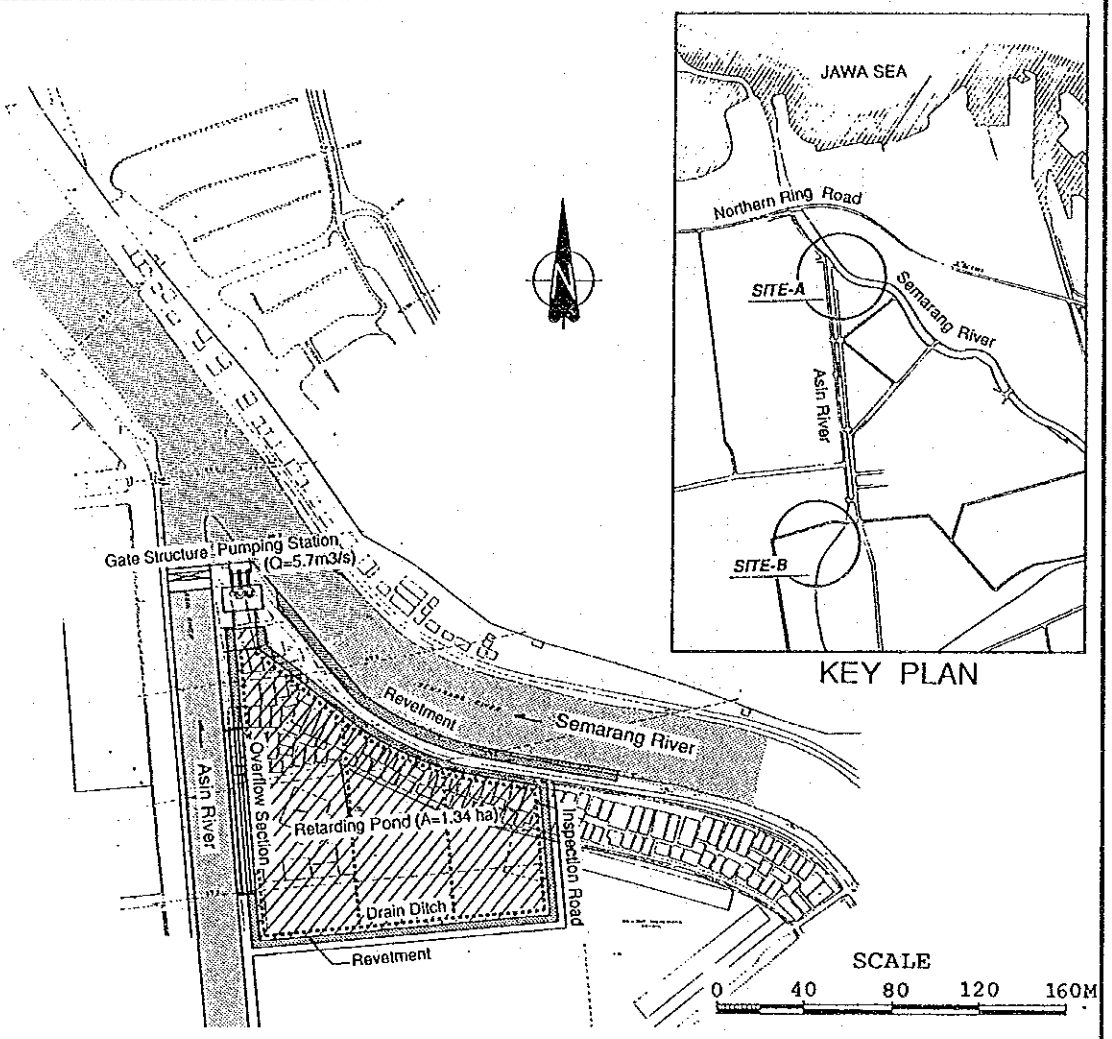


ALTERNATIVE A-1



ALTERNATIVE A-3

MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. VI.7.5(1/2) PUMP DRAINAGE ALTERNATIVES OF ASIN RIVERBASIN



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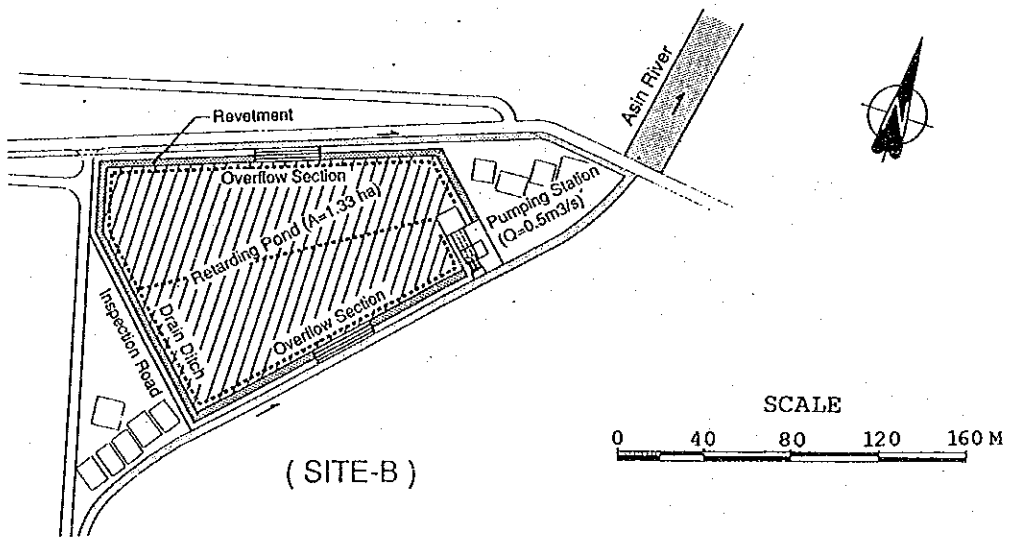
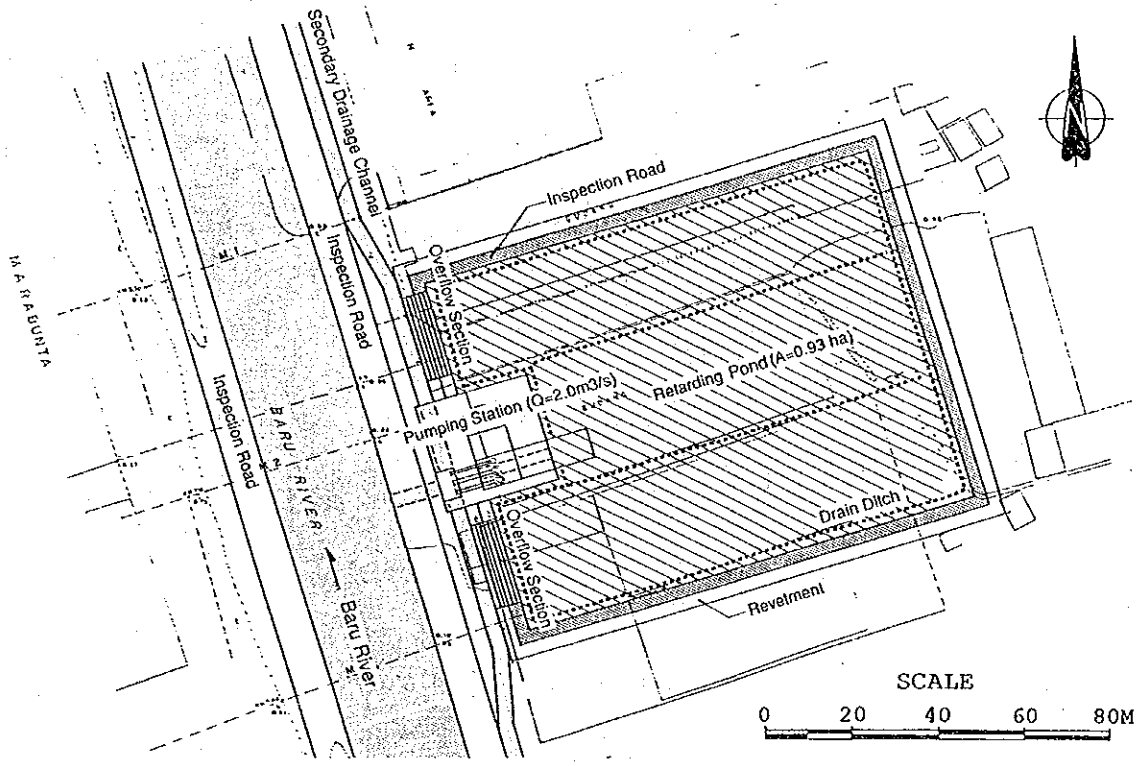


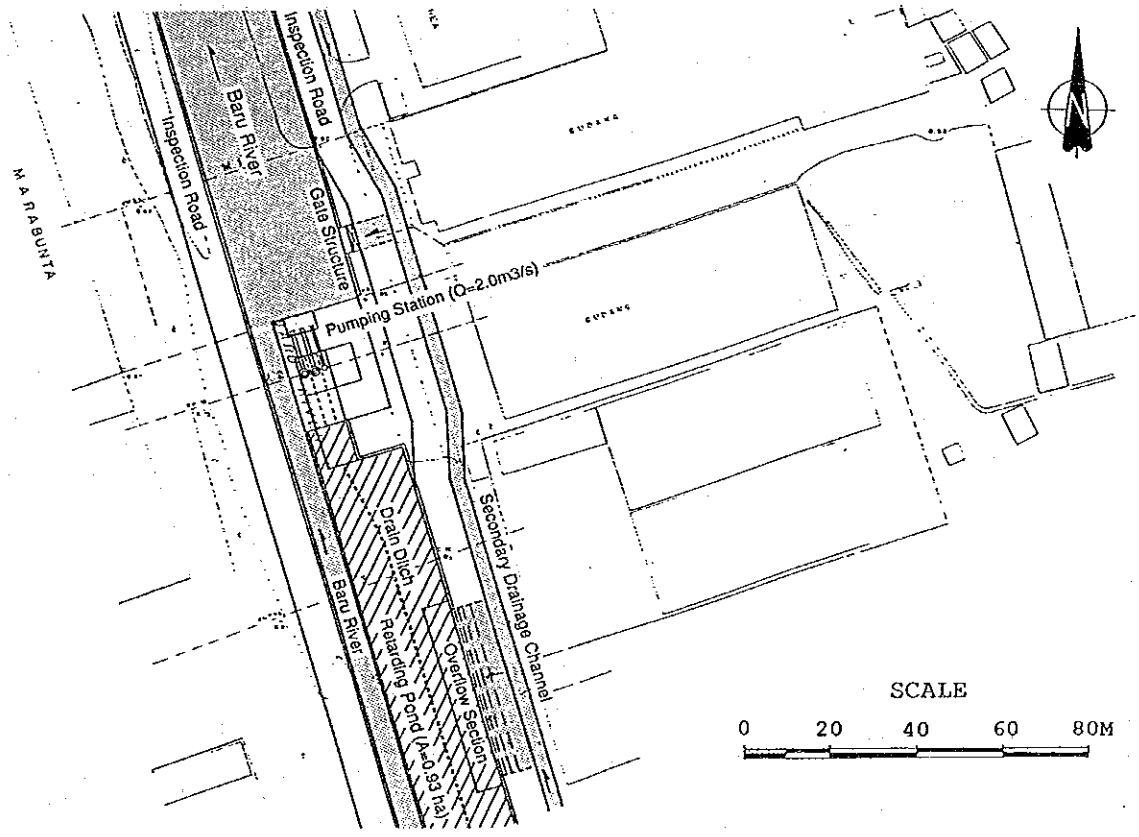
(SITE-B)

ALTERNATIVE A-2

MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. VI.7.5(2/2) PUMP DRAINAGE ALTERNATIVES OF ASIN RIVERBASIN

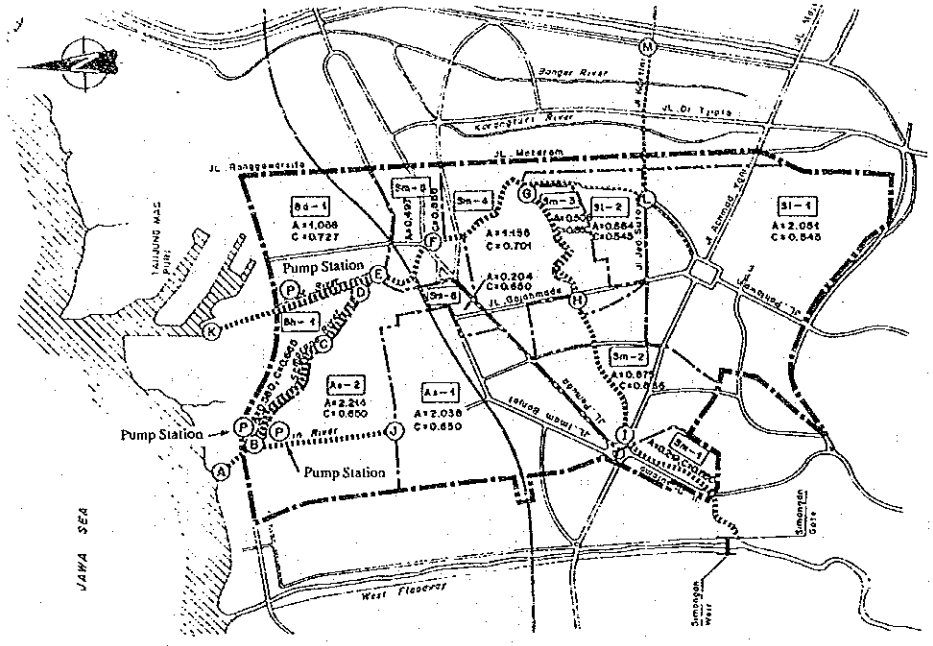


ALTERNATIVE B-1

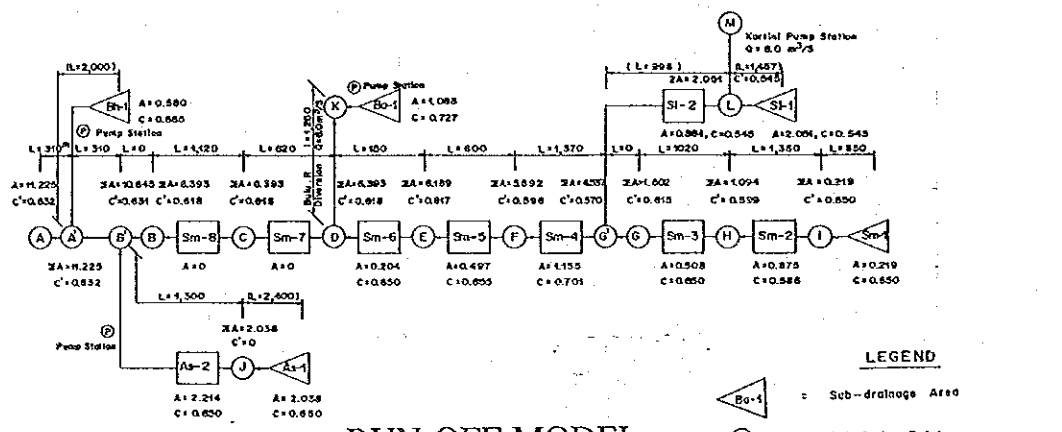


ALTERNATIVE B-2

MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. VI.7.6 PUMP DRAINAGE ALTERNATIVES OF BANDARHARJO EAST AREA



DRAINAGE SYSTEM



RUN-OFF MODEL

LEGEND

Ba-1 = Sub-drainage Area

A = Calculation Point

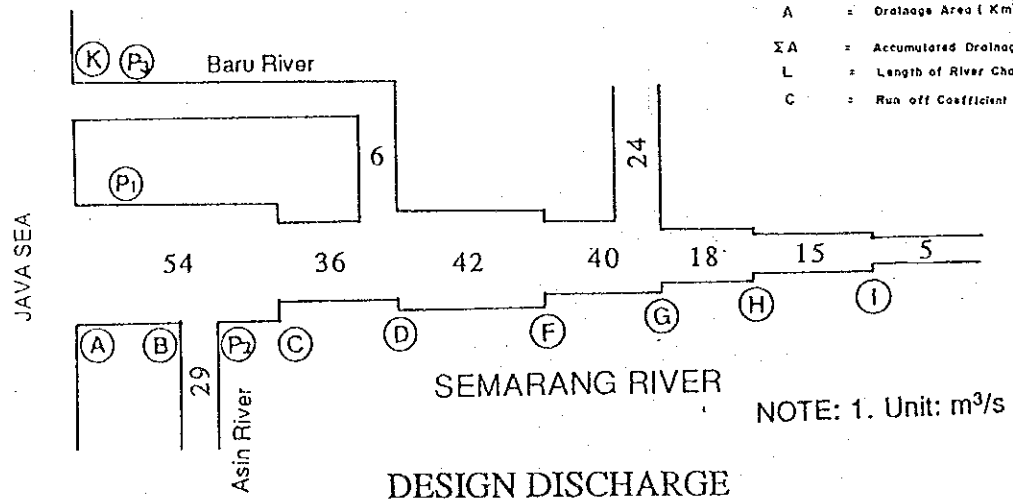
Ba-2 = River Channel

A = Drainage Area (Km^2)

ΣA = Accumulated Drainage Area (Km^2)

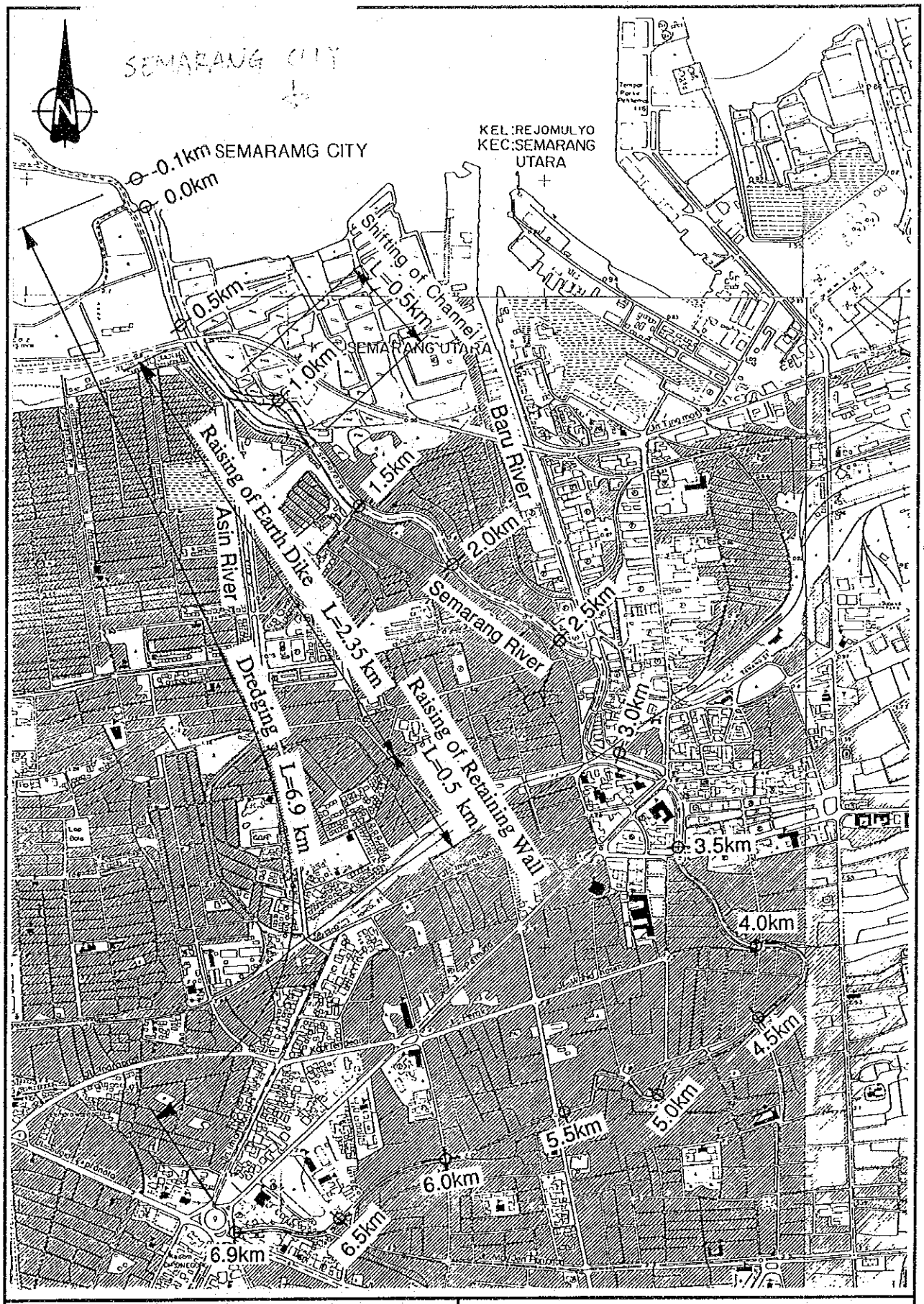
L = Length of River Channel (m)

C = Run off Coefficient

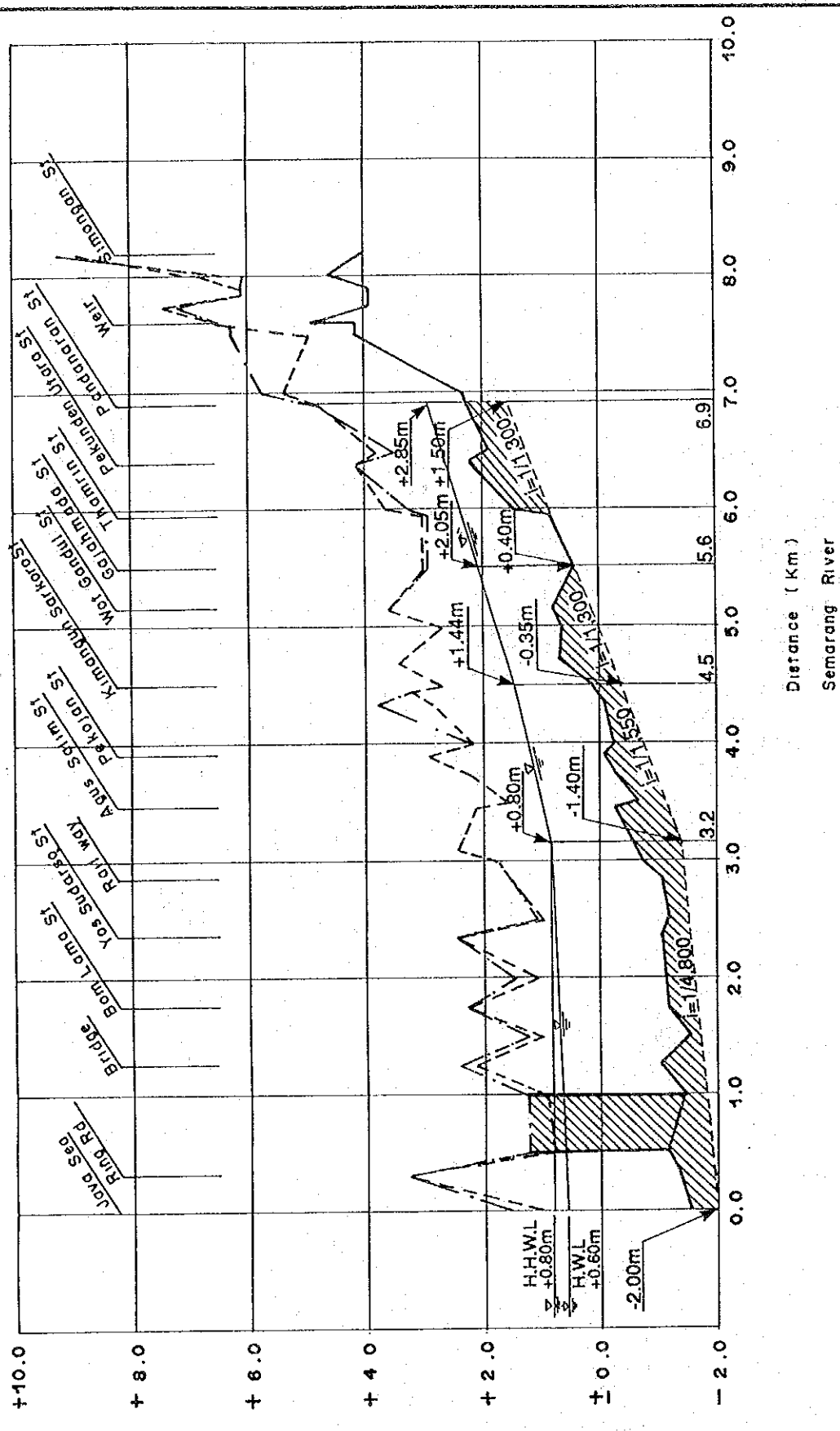


DESIGN DISCHARGE

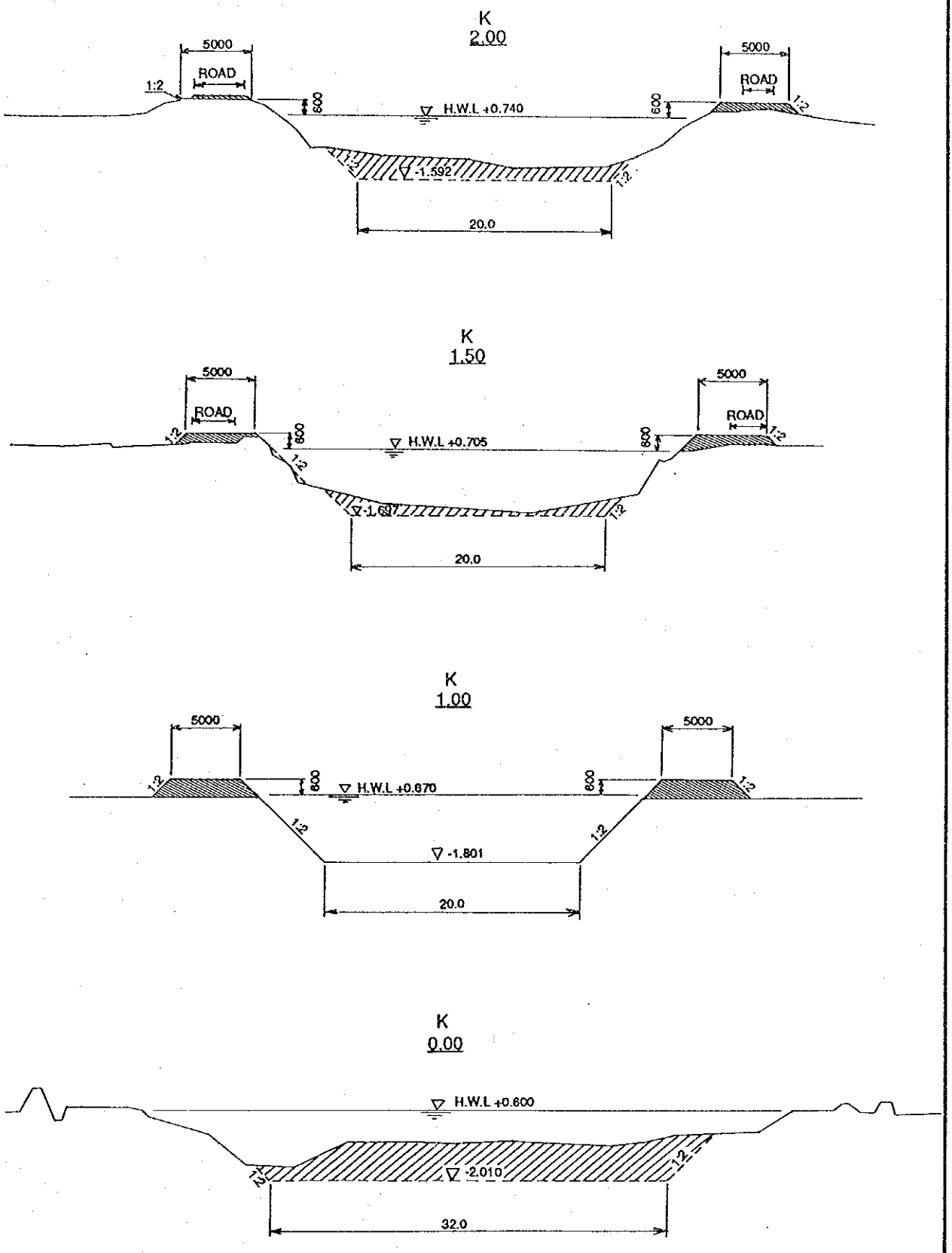
MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. VI.7.7 RUN-OFF MODEL AND DESIGN DISCHARGE OF SEMARANG, ASIN AND BARU RIVERS



MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. VI.7.8(1/4) PLAN OF PROPOSED SEMARANG RIVER IMPROVEMENT



MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. VI.7.8(2/4) PROPOSED LONGITUDINAL SECTION OF SEMARANG RIVER IMPROVEMENT

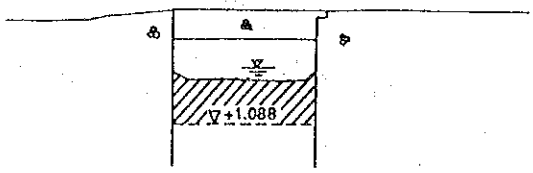


MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS

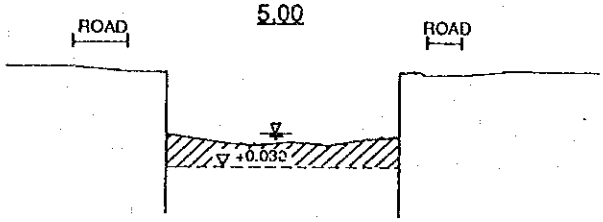
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. VI.7.8(3/4)
PROPOSED TYPICAL CROSS SECTION
OF SEMARANG RIVER IMPROVEMENT(1)

K
6.39



K
5.00



K
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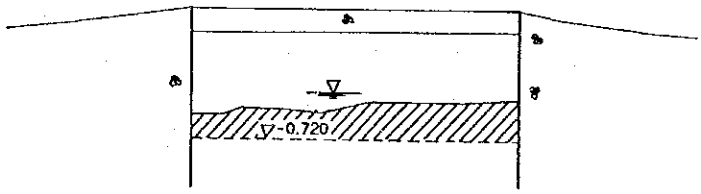
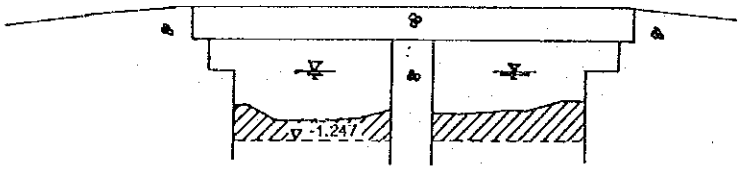
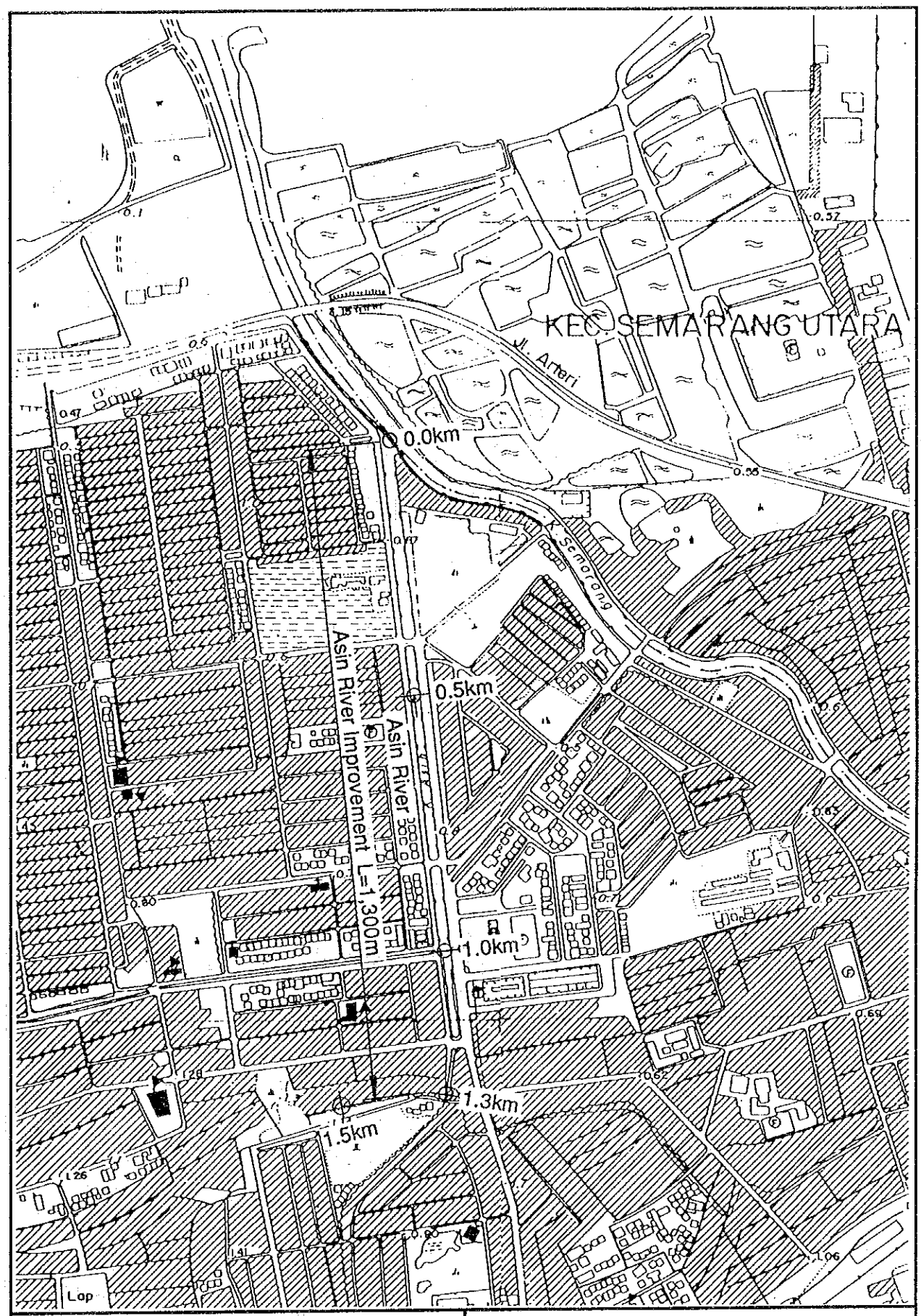


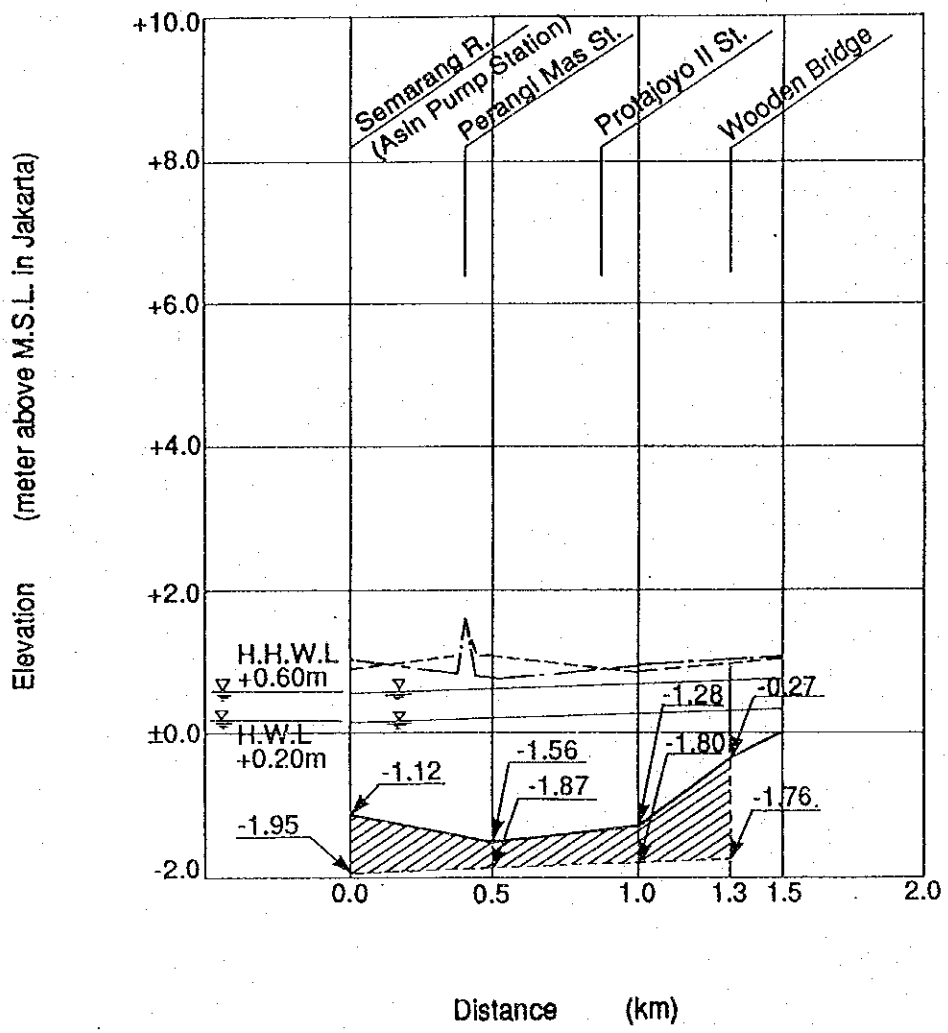
K
3.11



MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. VI.7.8(4/4) PROPOSED TYPICAL CROSS SECTION OF SEMARANG RIVER IMPROVEMENT(2)

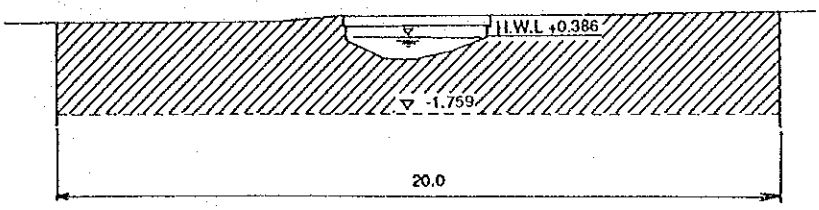


MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. VI.7.9(1/3) PLAN OF PROPOSED ASIN RIVER IMPROVEMENT

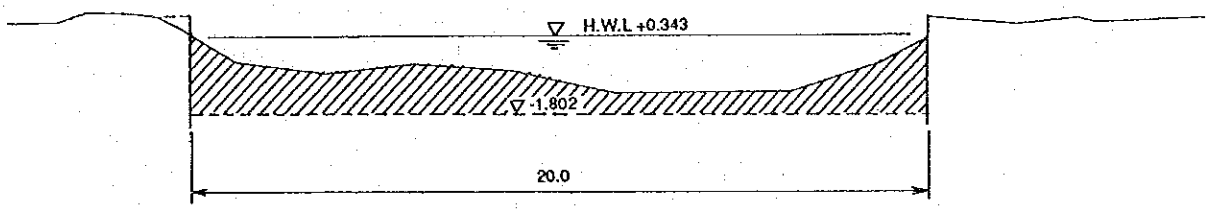


MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. VI.7.9(2/3) PROPOSED LONGITUDINAL SECTION OF ASIN RIVER IMPROVEMENT

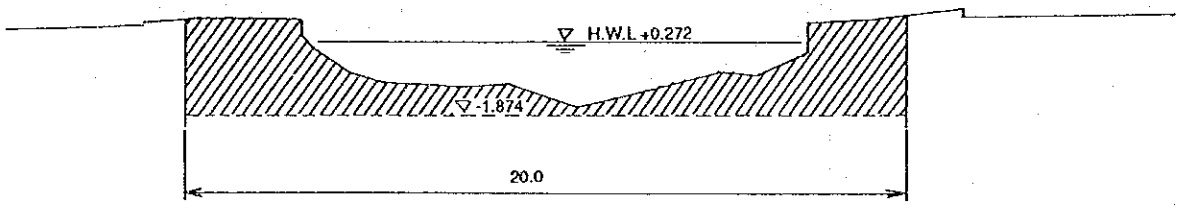
K
1.30



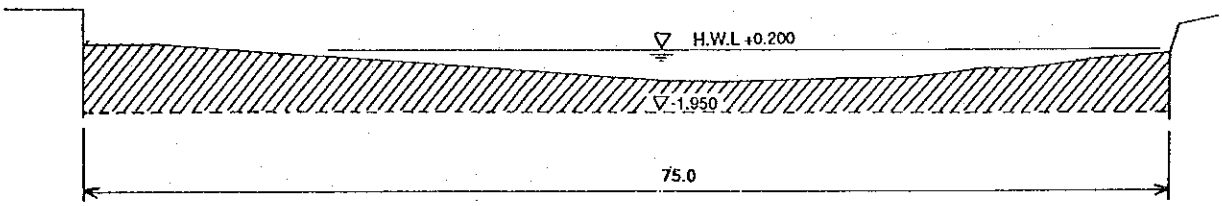
K
1.00



K
0.50



K
0.00



MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS

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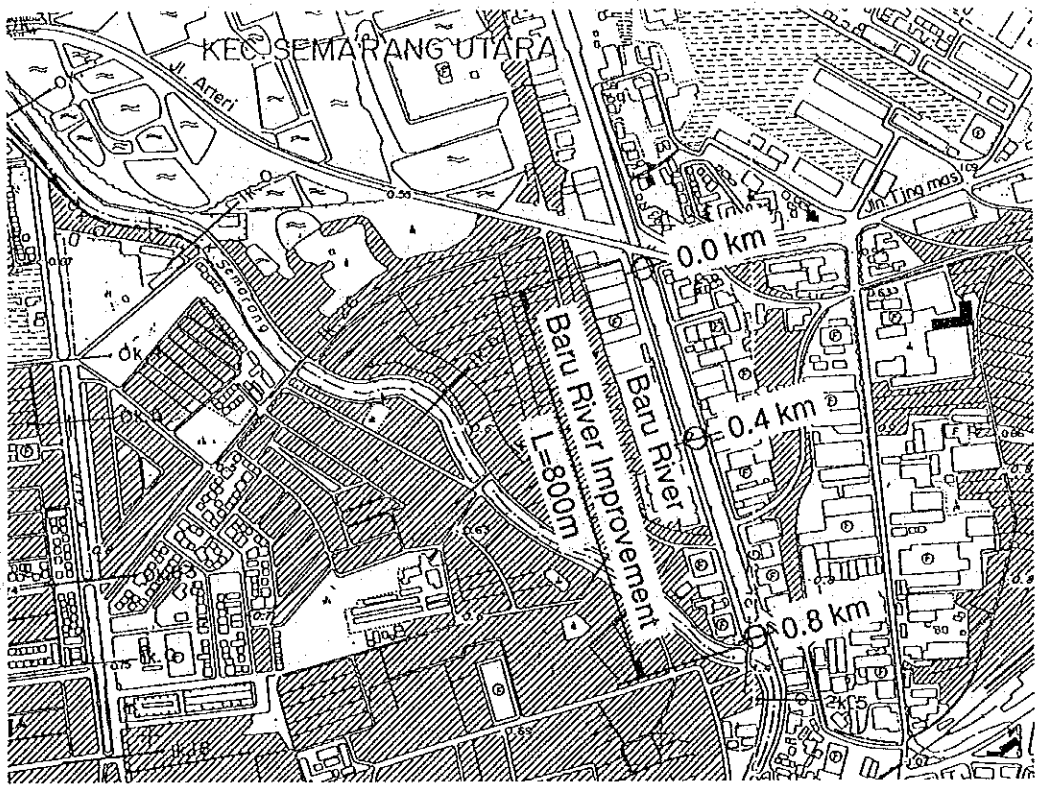
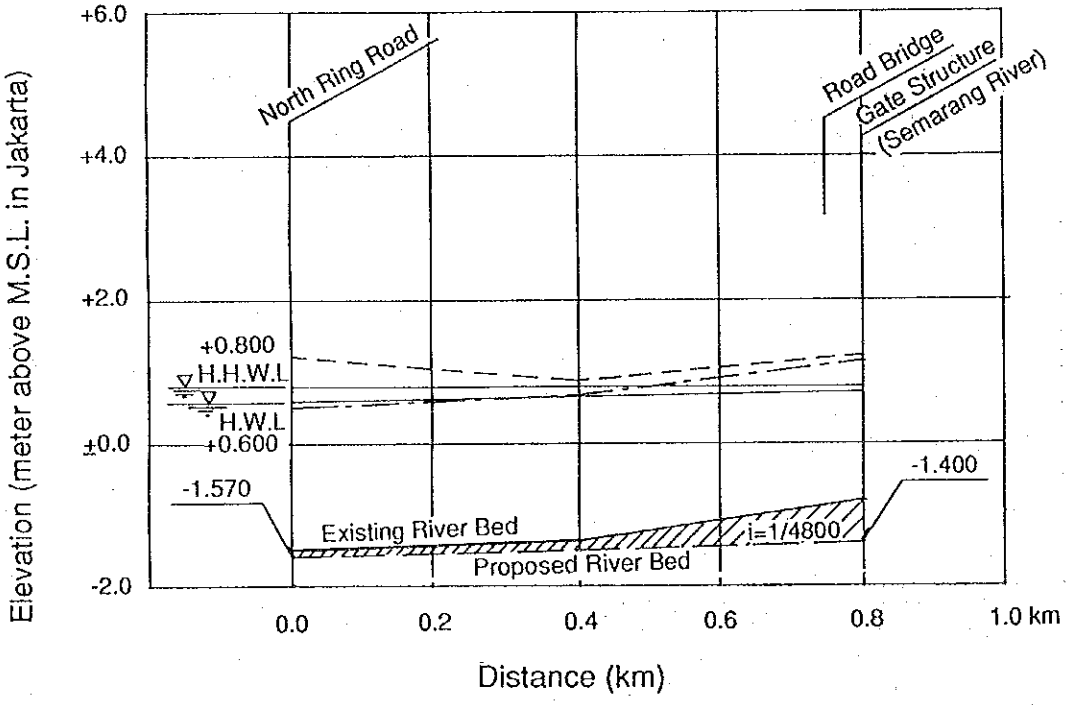
Fig. VI.7.9(3/3)
PROPOSED TYPICAL CROSS SECTION
OF ASIN RIVER IMPROVEMENT

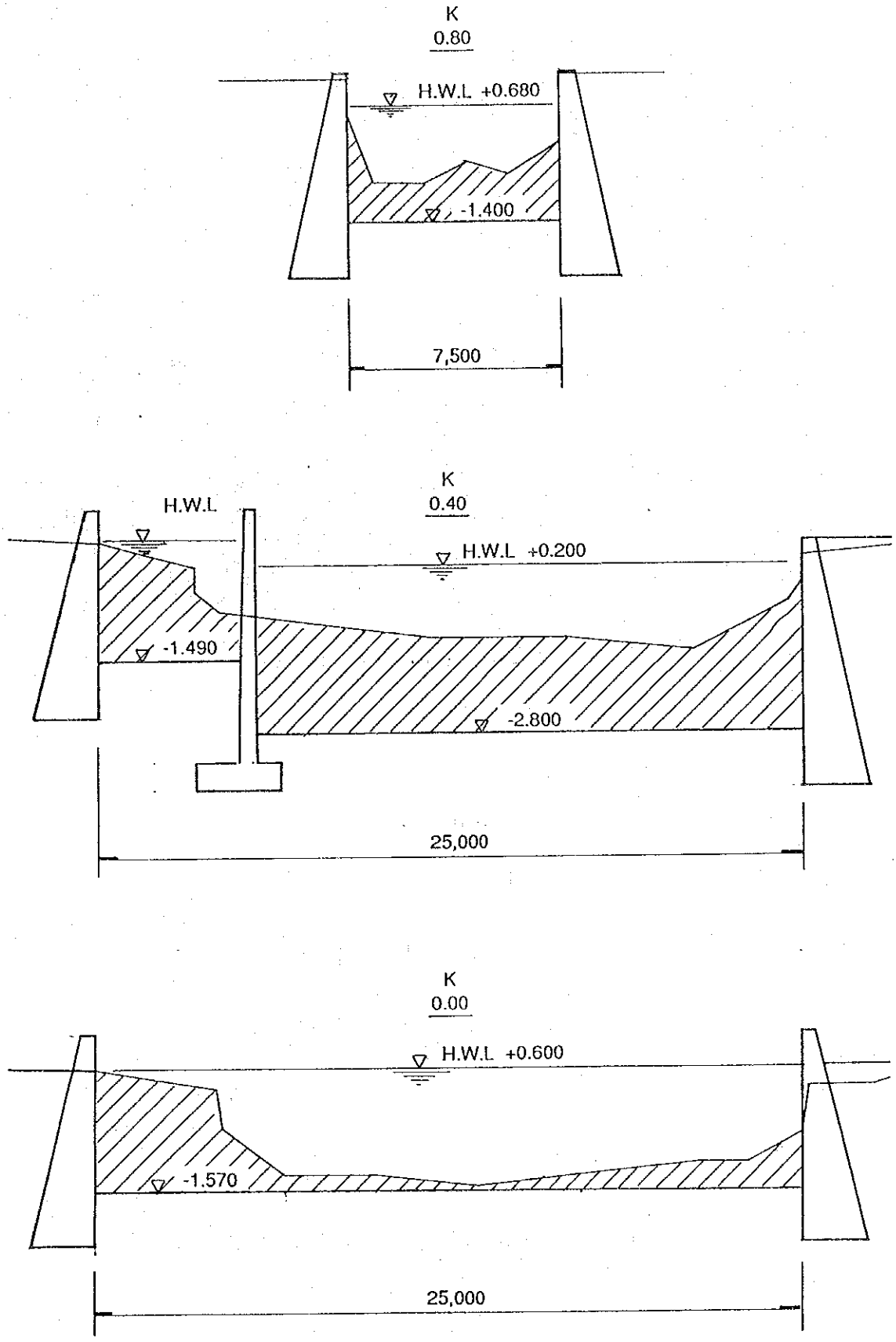


Plan of Baru River



Longitudinal Section of Baru River

MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. VI.7.10(1/2) Proposed Channel Improvement Plan of Baru River



MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS

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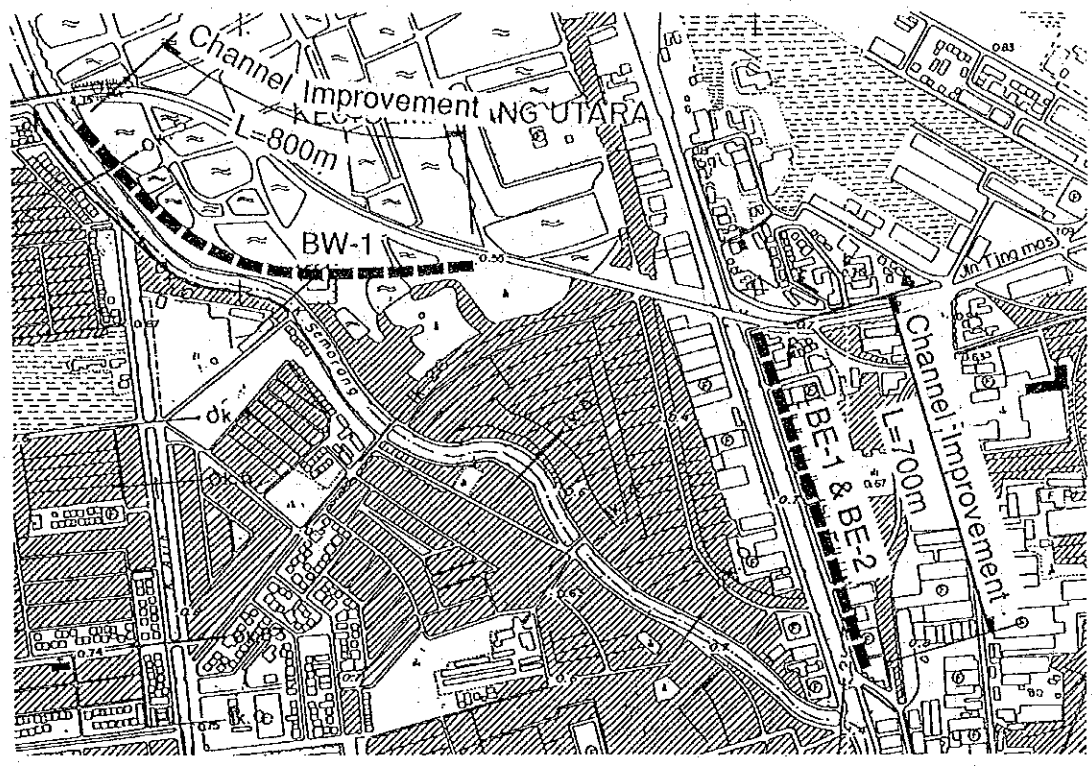
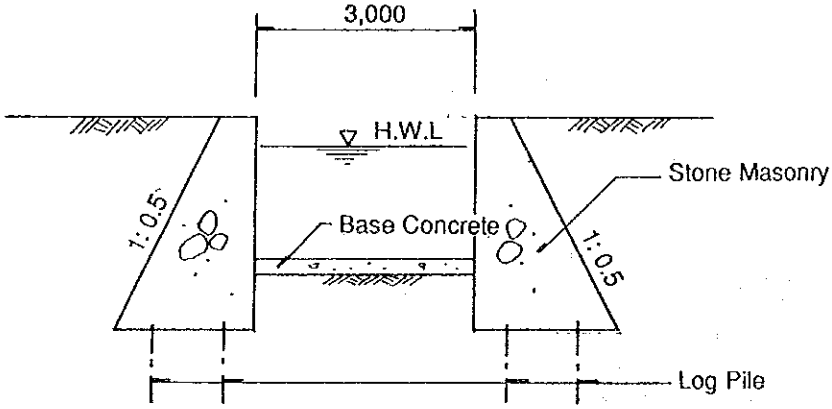
Fig. VI.7.10(2/2)
PROPOSED CHANNEL IMPROVEMENT PLAN OF BARU RIVER



Plan of Secondary Drainage Channel



Typical Section of Secondary Drainage Channnel

MASTER PLAN ON WATER RESOURCES DEVELOPMENT AND FEASIBILITY STUDY FOR URGENT FLOOD CONTROL AND URBAN DRAINAGE IN SEMARANG CITY AND SUBURBS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. VI.7.11 PROPOSED SECONDARY CHANNEL IMPROVEMENT OF BANDARHARJO EAST AND WEST

VII WATER RESOURCES DEVELOPMENT PLAN

VII WATER RESOURCES DEVELOPMENT PLAN

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CHAPTER 1 GENERAL

Semarang City and suburbs have been suffering from the chronic shortage of water supply during the dry season, particularly, municipal water supply. The problem regarding the water supply situation is aggravated by the rapid urbanization.

To cope with the water shortage, the Jratunseluna River Basin Development Project had proposed the water conveyance plan from Kedung Ombo Dam Reservoir which has been recently constructed. In spite of the water conveyance plan, it may be difficult to fulfill the future water demand for Semarang City that is projected at the target year 2015 of the Master Plan.

Considering the above-mentioned condition, Semarang City has been selected as the target area of the water resources development plan in the master plan study, because Semarang City has the most serious problem of water shortage in the whole study area. The water resources development plan proposes the optimum water sources through comparative study on alternatives. Other related water supply facilities such as water treatment and distribution systems are not studied.

CHAPTER 2 describes the present condition of water supply and usage including water quality in the study area that have been studied mainly through the data collection and field investigation. In CHAPTER 3, possible water supply means are proposed to fully meet the future water demand based on the study results of related projects on water supply, the selection of possible water sources and the projection of future water demand including river maintenance flow. The optimum water supply plan which ranks the components of water sources is thus established in terms of cost efficiency and magnitude of social impact, then the priority project for the Feasibility Study is selected

considering optimum effectiveness from the economical and social aspects.

In CHAPTER 4, the Feasibility Study on Jatibarang Dam Development Project, the priority project, is carried out through comparative study based on the newly obtained topographical information. Then, the optimum plan for the Jatibarang reservoir is proposed for water resources development.

CHAPTER 2 PRESENT CONDITION OF WATER SUPPLY AND USE

2.1 Public Water Supply and Use

Public water supply for domestic, commercial, industrial and institutional water use is managed and operated by PDAM. The public water supply system in the study area can be divided broadly into three areas, Semarang City, Kabupaten Kendal and Kabupaten Semarang, in accordance with the organization of PDAM, as follows:

Name of City/Kecamatan	Population in 1990	Water Supply Sources
Semarang City	1,250,971	Spring, Surface Water, Deep Well
Kab. Kendal		
- Kec. Kaliwung	83,736	Deep Well
Kab. Semarang		
- Kec. Ungaran	94,079	Spring, Deep Well
- Kec. Klepu	75,423	Spring

The most recent condition of the public water supply system in the study area is shown in Table VII.2.1.

Semarang City

(1) Water Sources

The present water supply system of Semarang City is shown in Fig. VII.2.1. The water sources are composed of the springs, the deep wells at the foot of Mt. Ungaran, and the surface water of Garang River. The average annual quantities of water obtained from these sources in the recent seven years are shown in Table VII.2.2.

The following capacities of the water supply system are the current figures:

Springs	280 l/s
Garang River Surface Water	580 l/s
Deep Wells	700 l/s

Springs

All active spring sources used by PDAM Semarang are located at the foot of Mt. Ungaran, about 15 to 20 km south of the Semarang business center. In 1911 and 1912, the Mudal and Lawang spring sources were developed for the municipal water supply system of Semarang City, at the first stage. In 1923 and 1932, the Kalidoh Besar and Ancar springs were developed for the same purpose. At present, PDAM is utilizing six springs as water sources for the Semarang City water supply system, and the yield capacity of these springs ranges from 280 l/s to 360 l/s as shown in Table VII.2.3.

The spring water is of good quality that needs only chlorination before transmission to the water distribution system.

Deep Wells

Groundwater is drawn by pumping from 30 deep wells along the fringe road of Mt. Ungaran as shown in Fig. VII.2.1. With reference to Table VII.2.2, deep wells are the main sources to increase the supply capacity in recent years. Total yield capacity of the deep wells ranges 709 l/s to 919 l/s as shown in Table VII.2.4.

The ground water from the 30 deep wells is of good quality and needs no more treatment than chlorine dosing to prevent bacteria from growing in the distribution pipes. The chlorine dosing is made at the surface water treatment plant.

In addition to the deep wells located around hilly areas, 21 deep wells are operated in the city area by PDAM Semarang City. The yield capacity of these wells are relatively small as shown in Table VII.2.5, because the main purpose of these wells is to supplement the existing water supply system and supply water for rural areas.

Garang River

The intake structures on Garang River is located 1.2 km above a river diversion structure known as Simongan Weir. Raw water withdrawn passes through presedimentation basins at the intake before being pumped up to the water treatment plant. The plant on a hill has a capacity of 580 l/s and is operating as a flocculation, sedimentation and filtration plant.

Average annual water amount supplied from Garang River Intake can be estimated at 430 l/s to 520 l/s, on the basis of the recent data as shown in Table VII.2.2.

(2) Water Use

The total number of customers served by the water supply system under PDAM Semarang City is

estimated at about 60,000 units in 1991 (refer to Table VII.2.6). The population supplied water and the service ratio have increased to twice their amount in the last seven years and in proportion to the increment of the service ratio, the water consumption per capita has relatively decreased. This trend can be often seen during the period to increase water supply and distribution capacity, but the service ratio of 40% is still considerably low. The remaining inhabitants are relying on dug or drilled private wells and public water taps supplied by PDAM water trucks.

On the other hand, the difference between the quantity of water supplied to the system and the quantity of water metered in the system, which is called unaccounted for water, ranged from 45 to 55% in the last seven years. This water is lost from the system as a result of leakage from mains and service lines, or because of inaccurate meters, illegal service connections, false meter readings, system flushing and fire fighting, and other similar uses. In particular, serious corrosion problems of the distribution pipes have caused a high percentage of unaccounted for water, because these pipes are generally made of steel, cast iron and galvanized iron.

According to PDAM Semarang City, rehabilitation of the water distribution system is being executed to decrease the ratio of unaccounted for water to 28% in 1995. Based on the water consumption data of PDAM Semarang City, the use of domestic and non-domestic water such as commercial and industrial water use, is estimated. The record of water tariff

collection in March 1992 of PDAM Semarang City shows the actual water consumption as follows:

Actual Water Consumption in Semarang City
(As of March 1992)

Item	Number of Consumers	Consumption (m^3/day)	Ratio (%)
Domestic Water	52,090	39,134	83
Non-Domestic Water:			
- Commercial	3,604	3,599	8
- Industrial	0	0	0
- Public Hydrant	1,358	3,657	8
- Social	401	595	1
Total	57,453	46,985	100

The above table shows that about 17% of the total use is consumed for non-domestic purposes. Industrial water, however, is not supplied by PDAM Semarang City because industrial and some commercial establishments have their own private deep wells numbering 423, which were developed from 1973 to 1990 in Semarang City, as reported by PDAM Semarang City. The total installed production capacity of these wells is approximately estimated at 860 l/s.

Kabupaten Kendal

(1) Water Sources

In the study area of Kabupaten Kendal, there is one water supply area established by PDAM Kab. Kendal, namely, Kec. Kaliwungu. The water source of the water supply system is the groundwater from deep wells as shown in Table VII.2.7. The yield capacity of deep wells is 15 l/s for Kec. Kaliwungu.

(2) Water Use

Under PDAM Kab. Kendal, the total number of customers is 600 units in Kec. Kaliwungu as of March 1992, as shown in Table VII.2.8. Among the water consumptions, domestic use accounts for more than 80%, and the water is not supplied for industrial use.

Kabupaten Semarang

(1) Water Sources

In the study area of Kab. Semarang, there are two water supply systems by PDAM Kab. Semarang, namely, Ungaran and Klepu. Water sources of these systems are summarized in Table VII.2.9. Since Kec. Ungaran and Kec. Klepu are located in the hilly area, the main source of water supply is the spring water. The yield capacity is 64 l/s for the Ungaran system and 5 l/s for Klepu.

(2) Water Use

According to PDAM Kab. Semarang, the number of customers is 3,028 units in Ungaran and 245 units in Klepu. However, detailed data on water consumption are not available.

2.2 Irrigation Water

The existing irrigation areas in the study area are shown in Table VII.2.10 and Fig.VII.2.2. Based on the inventory of irrigation areas, the irrigation area is presently classified into the following three

categories in terms of water utilization and drainage system. The main water source for these irrigation areas is the river surface flow, but spring water is also utilized for supplementary purposes in the hilly area.

Classification of Irrigation Area

Category	Area (ha)	Ratio (%)
1. Technical Irrigation Area	5,763	65
2. Semi-Tech. Irrigation Area	318	4
3. Simple Irrigation Area	2,720	31
Total	8,801	100

In the technical irrigation areas, irrigation facilities are well provided and double cropping is practiced, i.e., a crop intensity of 200%. On the other hand, the semi-technical and simple irrigation areas can only attain the crop intensity of 120% on an average. Most of the irrigation facilities in both areas require rehabilitation or improvement to upgrade the irrigation level.

2.3 Other Water Use

In the study area, there are eight brackish water aquaculture areas in the low-lying area along the seashore which are used mainly for shrimp and tiger prawn cultivation. A total of 1,525 ha is in operation for brackish water aquaculture as shown in Table VII.2.11 and Fig. VII.2.3.

This type of aquaculture is mainly relying on the rainfall and irrigation water tailing. Furthermore,

according to the interview survey, most of these aquaculture also utilize shallow wells.

2.4 Water Quality

Among the rivers in the study area, only Garang River has been classified according to the beneficial usage and regularly monitored as to water quality. The downstream of Simongan Weir is designated Class C as usage for livestock and aquatic life, and the upstream is also designated Class B as usage for raw drinking water requiring treatment (refer to Tables VII.2.12 and VII.2.13, and Fig. VII.2.4).

According to the data monitored by Biro Bina KLH (Provincial Environmental Office), water quality in Garang River is still good in comparison with the water quality criteria. The seasonal changes of water quality in the river system are illustrated in Fig. VII.2.5. This figure shows the dissolved oxygen (DO) above the criteria of Class B and C. The biochemical oxygen demand (BOD) has also quite low value compared with the criteria, except the data at Railway Bridge, the lower part of Garang River, that is West Floodway, since the water is strongly influenced by the tidal cycle from Jawa Sea. The level of contamination by other pollutants such as heavy metals and nutrients is also quite low.

Regarding water quality in the other rivers in the study area, the following problems were observed through the field reconnaisance:

(1) The downstream of Babon River is polluted by industrial wastewater. The surface water becomes turbid and the discharged wastewater is diffused downstream and upstream along with the tidal cycle.

(2) The middle part of East Floodway is polluted by domestic and commercial wastewater and domestic solid waste. The surface water in this portion turns black due to anaerobic fermentation.

Considering the future industrial development and population increase in the study area, the management of water quality shall be established to conserve the water resources and improve the environment. First of all, the following measures shall be carried out urgently to avoid the anticipated environmental degradation.

(1) A leachate treatment facility shall be constructed at the garbage dumping site along Kreo River, because the intake facility for the water supply system in Semarang City is located downstream and the wastewater from this dumping site can become a main source of pollution in the Garang river system.

(2) Industrial development has been implemented in the eastern and western parts of Semarang City. The industrial wastewater can become a main source of pollution in these areas. Therefore, the office in charge of environmental concerns shall have to control each factory to monitor wastewater effluents and install treatment facilities.

CHAPTER 3 WATER RESOURCES DEVELOPMENT MASTER PLAN

3.1 Planning Criteria

The study for the Water Resources Development Master Plan such as the selection of target water sources, the water balance analysis and the formulation of the optimum water supply plan shall conform to the following criteria:

(1) The target water sources will be evaluated considering their possibility to be developed to meet the future water demand;

(2) Future water demand is composed of public water, irrigation water and river maintenance flow which will be set up taking the future conditions into accout;

(3) 5-day discharge which is converted from daily discharge as calculated in CHAPTER 6 of SECTOR I, METEOROLOGY AND HYDROLOGY, is used in the water balance analysis;

(4) Water balance analysis is performed by sequential analysis using the said 5-day discharge of 30 years;

(5) Each of the water supply alternatives is evaluated in a 10-year drought cycle; and

(6) Dead storage of proposed dams is determined by the volume of estimated sediment inflow in CHAPTER 3 of SECTOR VIII, SEDIMENT CONTROL PLAN for the project life of 50 years, and sediment deposit is assumed to be horizontal.

3.2 Related Projects on Water Supply

In connection with the public water supply for Semarang City, the following two projects/studies are ongoing at present.

(1) Water Supply Plan for Demak and Eastern Semarang Areas by Jratunseluna River Basin Development Project

(2) Project Study of Water Supply System for Western Semarang Areas by CIPTA KARYA

In the near future, the former project will start with the implementation of the conveyance canal from Klambu Barrage to Kudu, where the water treatment plant is to be constructed. The latter was the prefeasibility study on the water supply system for Kec. Tugu and Mijen areas performed in June 1991. A brief description and the conclusions drawn from the above-mentioned projects/studies are given below.

Water Supply Plan for Demak and Eastern Semarang Areas

The industrial development programme is being implemented in Eastern Semarang and surrounding areas, especially, in Kec. Genuk and East Semarang in the eastern part of Semarang City, and Kec. Sayung in the western part of Kab. Demak. In accordance with the progress of this development programme, water supply demand is rising due to the increasing population and industrial estates.

Jratunseluna River Basin Development Project has established the water supply plan for these areas. Water supply sources of this plan are composed of two reservoirs and one natural lake, namely, the Kedung

Ombo and Dolok reservoirs and Rawa Pening. Kedung Ombo Reservoir and Klambu Barrage which is located downstream of Serang River, have been constructed, and construction of the water conveyance canal from Klambu Barrage to Kudu will start in the near future with completion planned in 1996. At that moment, Semarang City can receive the water of 2,500 l/s from Kedung Ombo Reservoir.

In accordance with the water supply program of Jratunseluna River Basin Development Project, the following implementation schedule has been proposed (refer to Fig. VII.3.1). In this study, the water supply program is to be regarded as precondition for the Water Resources Development Master Plan in Semarang City.

Year	Structure to be Constructed	Total Water Supply Capacity at Kudu
1994	Jajar Weir	-
1996	Conveyance Main Canal (Klambu-Kudu)	2,500 l/s
1997	Regulation Tunnel (Tuntang-Jragung)	-
1998	Conveyance Canal (Jragung-Main Canal)	4,250 l/s
1999	Dolok Reservoir	
2000	Conveyance Canal (Barang-Main Canal)	5,000 l/s

Project Study on Water Supply System for Western Semarang Areas

The western part of Semarang City consists of Kec. Tugu and Kec. Mijen. These kecamatans have the following contrasting features and plans:

(1) Kec. Tugu is located along the seashore and on the low-lying area, while Kec. Mijen has a hilly area with altitudes of more than 100 m; and

(2) A total area of 250 ha in Kec. Tugu is planned mainly for industrial use, while a total area of 770 ha in Kec. Mijen is planned for residential use.

At present, the service network of the water supply system under PDAM Semarang City does not cover these areas and according to the report of the project study on water supply system for the western Semarang areas, the total future water demand is estimated at 835 l/s. To meet this demand, the following system is proposed on the basis of the topographic conditions and hydrological characteristics of these areas.

(1) Proposed Dam Sites

The following three dam sites are proposed to supply water for Tugu and Mijen areas. Selection of the optimum dam site among the three sites was not made in this study report.

(a) Kaligetas Dam in Kreo River

(b) Desel 2 Dam in Kripik River

(c) Patemon Dam in Garang River

(2) Intake and Water Treatment Plant

In accordance with the difference of topographic condition in the area to be

supplied, the following two intake facilities and water treatment plants are proposed:

(a) For Tugu water supply system, intake and treatment plant with capacity of 700 l/s are placed on the left bank of Garang River just north of the Toll Bridge; and

(b) For Mijen water supply system, intake and treatment plant with capacity of 175 l/s are placed at Kaligetas, which location is the same as Mundingan dam site to be proposed in this Master Plan study.

The results of the study are mentioned in the Master Plan study, and the program on water resources development proposed in the study will be elaborated in the following sections.

3.3 Possible Water Sources

In the study area, there are three available sources for water supply, namely, springs, groundwater and river surface water. The situation of springs and groundwater in this area is rather tight as described below; therefore, it is desirable to limit the water supply source to the river surface water to meet future demand.

Springs

The main springs in the study area and surrounding areas have been utilized for water sources of PDAM Semarang City since the early 20th century. The remaining springs except Air Muncul have a relatively small capacity of production yield, and most of them have been utilized for irrigation use to supplement surface water.

The spring water of Air Muncul have been used for irrigation and hydropower generation in the Tuntang river basin, and will be included in the future water supply program which indicates the supply route from Rawa Pening through the Tuntang-Jragung regulation tunnel proposed by Jratunseluna River Basin Development Project. (Refer to Fig. VII.3.1)

Groundwater

The groundwater aquifer in the study area is composed of three layers, namely, volcanic rock, sedimentary rock and alluvial layers (refer to Fig. VII.3.2). These aquifers correspond to the recharge basins of Zone V, Zone II and Zone I, respectively (refer to Fig. VII.3.2). From the point of view of water resources development, the characteristics of each aquifer are given as follows:

(1) Volcanic Rock Layer (Zone V)

The groundwater around the slope of Mt. Ungaran has been the target for increasing supply capacity to Semarang City in recent years, and the water supply system from 30 deep wells were completed in 1989. The production yield of 700 l/s in the minimum by these wells seems to have reached the rechargeable capacity into the groundwater aquifer, as reported in previous studies.

(2) Sedimentary Rock and Alluvial Layers (Zone II and Zone I)

In the hilly area, an aquifer in the sedimentary rock layer, i.e., Damar Formation, is the only available source for wells. On the

other hand, in the coastal plain the main aquifers are the alluvial layer for shallow wells and the Damar Formation for deep wells.

According to the results of the pumping test for shallow wells conducted by the project funded by Asian Development Bank (ADB) in 1980, the discharge from the unconfined aquifer is inadequate as a source for the public water supply system. Furthermore, saline water intrusion has been extending in the unconfined aquifer, as shown in Fig. VII.3.2, due to overpumping of groundwater. The water from shallow wells also seems to be contaminated by pollutants such as fecal coliforms and detergent due to poor environmental sanitation.

Regarding the artesian groundwater in the coastal plain, overpumping of groundwater causes the land subsidence which is a serious problem to influence the safety of most structures in the low-lying areas. The occurrence of land subsidence is still conjectural because of the lack of available data.

On the basis of the situation mentioned above, further spring and groundwater development is not practically and technically feasible. Therefore, the river surface water is recommendable for the water supply source to be developed anew including the conversion capacity from groundwater withdrawn to river surface water, especially in the coastal plain so as to avoid the adverse phenomena caused by over-extraction of groundwater.

For river surface water development, the following seven (7) potential reservoir sites are identified in

the study area by using the aerophotographs and the topographic maps on the scale of 1:50,000 ,and through geological reconnaissance, taking topographical and geological conditions for dam design into consideration (refer to Fig. VII.3.3).

Potential Dam Sites

Reservoir	River System/ River	Catchment Area(km^2)	Topographic Condition
Babon	Babon/Penggaron	51.9	Hilly Land
Garang	Garang/Garang	70.9	Gorge
Mundingan	Garang/Kreo	45.7	Valley
Jatibarang	Garang/Kreo	53.0	Gorge
Kripik	Garang/Kripik	30.0	Gorge
Blorong	Blorong/Blorong	50.5	Gorge
Kedung Suren	Blorong/Blorong	146.5	Hilly Land

3.4 Future Water Demand Projection

In the study area, the future water demand which the Water Resources Development Master Plan ought to meet in the target year is composed of public water, irrigation water and river maintenance flow.

Public Water

Population and industrial area projection in the target area are the most important factors to estimate the future demand of public water use. In SECTOR III, SOCIOECONOMY AND LAND USE, the population in Semarang City has been projected at 5-year intervals from 1990 to 2015. (Refer to Table III.1.6)

On the other hand, in the industrial water supply plan, Kecamatan Sayung in Kabupaten Demak is needed to be included in the area to be supplied. Based on the review of the Detailed Planning Report for Water Supply and Distribution System in Semarang City prepared in 1992 and the information obtained from the Provincial Coordination Board for Local Investment, industrial areas are projected at 5-year intervals from 1990 to 2015 by five subdivisions as shown in Table VII.3.1.

All of the parameters relevant to water demand such as per capita domestic use, service ratio and so on, are set up through the discussion with CIPTA KARYA. The future public water demand in Semarang City is computed as shown in Table VII.3.2. As the results of projection, the future public water demand is estimated at 8.58 m^3/s in 2005 and 12.12 m^3/s in 2015, respectively.

Irrigation Water

The potential dam sites are located in the Babon, Garang and Blorong river basins. The target areas to be ensured irrigation water supply can be specified in the downstream of these dam sites and hydraulic structures. Considering the location between the potential dam site and the irrigation area, the related irrigation areas are limited to the Babon and Blorong river basins. (Refer to Figs. VII.2.2 and VII.3.3)

Based on the water consumption in line with the cropping calendar obtained from DPUP, the irrigation water demand is estimated in existing irrigation areas. Table VII.3.3 shows a typical water demand for crops in technical and simple irrigation areas, and these periodical specific discharges are

estimated by the required discharge for crops. These values from technical irrigation are applied with 35% allowance of canal loss to whole irrigation areas on the assumption that the present semi-technical and simple irrigation areas will be upgraded to the technical one by the target year of 2015.

Furthermore, according to the report of Jratunseluna River Basin Development Project, the irrigation area in Genuk-East Semarang and Sayung will be reduced to 30% and 10% of the existing irrigation areas in the future, respectively, due to the industrial development. In line with this prediction, the area irrigated from Pucanggading Weir can be set up at 126 ha, to be reduced from 991 ha as a future condition.

The results of the estimation of irrigation water demand by the related weir is summarized in the following table.

Irrigation Water Demand in 2015

Weir	Irrigation Area (ha)	Average Required Discharge (m^3/s)	Water Demand (MCM/yr)
Babon River Basin:			
- Pucanggading	126	0.097	3.1
Blorong River Basin:			
- Sulem	11	0.009	0.3
- Pengilon	3,145	2.608	82.2

River Maintenance Flow

The low flow of the river ought to be maintained to conserve or improve the present natural and social conditions. In this connection, river maintenance flow shall be secured in Babon River, Garang River

and Blorong River where the proposed reservoirs are to be located. In general, river maintenance flow is determined to maintain the non-withdrawal uses such as (1) navigation, (2) fishery, (3) aesthetics, (4) prevention of saline water intrusion, (5) prevention of river mouth clogging, (6) preservation of riparian structures, (7) recharge of groundwater, (8) conservation of natural vegetation and wildlife, and (9) pollution abatement.

Among the functions mentioned above, pollution abatement is an outstanding issue, especially in Semarang River which is the effluent of Garang River. The river flows through the densely inhabited area of Semarang City, where many people still utilize river water for their basic daily activities.

The standard to determine the quantity of river maintenance flow has not been established in Indonesia. Referring to the guideline of Japan, the quantity of river maintenance flow is commonly determined through comparative study among the requirements from related non-withdrawal uses. On the other hand, for rivers where it is difficult to collect detailed information concerning the functions mentioned above, the approximate quantity of river maintenance flow is determined to be the specific discharge of 0.0069 $m^3/s/km^2$ or a low flow discharge between average and minimum one of 99% flow regime in a 10-year drought cycle. The following table shows a comparison among these quantities in Babon River, Garang River and Blorong River.

Comparison among Maintenance Flow Factors

River	Catchment Area (km^2)	Discharge Derived from Specific Value(m^3/s)	99% Discharge	
			Minimum (m^3/s)	Average (m^3/s)
Babon	77	0.5	0.0	0.5
Garang	204	1.4	0.0	1.0
Blorong	157	1.1	0.6	2.0

Based on the comparison above, river maintenance flow is determined as follows:

(1) Babon River

Babon River has a very inferior low flow condition and East Floodway, the effluent of Babon River, is facing the water pollution problem in a similar situation with Semarang River. Furthermore, the low-lying riparian area of Babon River will be highly industrialized in the near future, and river maintenance flow is determined to be 0.5 m^3/s for both East Floodway and Babon River. The distribution rate of discharge into each channel ought to be determined appropriately in accordance with the water quality conditions of both rivers.

(2) Garang River

The value calculated from specific discharge exceeds the average of 99% discharge in Garang River due to inferior low flow condition. Accordingly, the average value of 1.0 m^3/s in the 99% discharge is recommended as river maintenance flow in Garang River.

(3) Blorong River

The necessity for river maintenance flow in Blorong River is quite different from the above two rivers, because the lower part of Blorong River flows down rural areas such as villages, paddy fields and brackish fishponds, and water pollution problems may not occur. This condition along Blorong River on the low-lying area seems to continue in the future considering the land use plan. Taking the condition mentioned above into account, the quantity of river maintenance flow can be set on a relatively small value in comparison with those of Babon River and Garang River.

River maintenance flow, therefore, is determined to be 0.6 m^3/s in Blorong River, derived from the minimum value of 99% discharge in a 10-year drought cycle.

Regarding pollution abatement in Semarang River, upgrading of environmental sanitation in the areas is basically recommendable. Construction of facilities and change of lifestyle, however, will need a certain period. Therefore, river maintenance flow in Semarang River ought to be used for pollution abatement until a sanitary system is completed, then to be used permanently for enhancement of aesthetics in the urban areas.

River maintenance flow of Garang River, 1.0 m^3/s, can all be diverted into Semarang River at Simongan Weir, since the downstream of Garang River from the weir is a tidal compartment. Furthermore, the said condition will create an upgraded environmental situation in the urban area of Semarang City.

Average velocity at the downstream of Simpang Lima which is the center of Semarang City, is estimated at 0.44 m/s when the discharge of 1.0 m^3/s flows down in the Semarang river channel proposed by the Semarang Drainage Project. The velocity of 0.44 m/s can carry the organic materials and suspended load downstream and reduce the biological products from the river-biological point of view.

River maintenance flow will also carry a certain amount of sediment downstream in Semarang River, even though the diversion gate at Simongan Weir can be closed properly during floods. To upgrade the environment and keep the design flow capacity, continuous dredging work to clear siltation and sunken wastes is necessary.

According to the data on water quality monitored at Simongan Weir, the mean concentration of suspended solids can be approximately set at 200 mg/l. The annual siltation volume in the down part of Semarang River can be estimated at about 6,000 m^3/year, on the assumption that maintenance flow of 1.0 m^3/s is introduced into Semarang River throughout the whole day and the whole year, and all suspended solids to be carried will settle down within the tidal compartment of Semarang River.

3.5 Possible Water Supply Means

Preliminary Screening of Possible Reservoirs

The target sources for the water supply system of Semarang City shall concentrate on the river surface flow as described in Section 3.3. Referring to the results of CHAPTER 3 of SECTOR VIII, SEDIMENT CONTROL PLAN and the field survey, preliminary screening of

the potential reservoirs are performed as shown in Table VII.3.4. The estimated factors are as follows:

(1) Gross Storage Capacity; preparing the reservoir storage curves (refer to Fig. VII.3.4) and estimating the gross storage capacity which is determined to subtract the required storage for flood control from the maximum storage (refer to CHAPTER 3 of SECTOR V, FLOOD CONTROL PLAN); and

(2) Required Sediment Capacity; converting the sediment inflow into the sediment capacity considering the project life of 50 years, trap efficiency of 80 to 97% and porosity of 60%.

Table VII.3.4 shows that the Blorong and Garang reservoirs have less liability for water supply system than the other sites, because of the small storage capacity in comparison with the amount of sediment inflow.

Both reservoirs have a relatively small storage capacity because of the topographical characteristics of gorges. Additionally, as a great deal of sediment inflow consists of wash load, structural sediment control measures such as sabo dams are inadequate to reduce completely the sediment inflow into reservoirs from the engineering and economic points of view. Basin-wide land treatment measures such as reforestation, vegetative treatment, contour strip-cropping and gradient terracing shall be employed to control the sediment yield, especially against sheet erosion which is a dominant source of sediment.

In conclusion, newly developed water sources shall focus on the four reservoirs, namely, Babon, Mundingan, Jatibarang and Kedung Suren.

Basic Concept of Water Resources Development

Through the preliminary screening, four reservoirs are selected for the Water Resources Development Master Plan. However, considering the hydrological condition, inferior low flow in particular, an integrated development scheme which means a highly developed water supply plan is needed to meet future water demand. Considering the river systems and the location of the proposed reservoirs, the following three schemes can be proposed as shown in Fig. VII.3.5:

Scheme 1: Babon, Jatibarang, Mundingan and Kedung Suren reservoirs are operated individually.

Scheme 2: Jatibarang and Mundingan reservoirs are operated together.

Scheme 3: In addition to the above-mentioned situation, interbasin transfer is considered to supplement the reservoir storage function by conveyance of surplus water from the upstream of the Blorong river basin to the Mundingan reservoir.

Water Balance Study

Water balance study is executed on the following conditions:

(1) The interval of computed supplying draft is set at 0.5 m^3/s;

(2) Required storage capacity is determined on the third value in the descending order of

calculated yearly maximum storage by sequential analysis for 30 years, as the design scale of a 10-year drought cycle;

(3) Function of interbasin transfer is planned as follows:

Discharge at Rembes in Blorong River -

- Less than 0.6 m^3/s : No function

- More than 0.6 m^3/s : Withdraw the surplus water up to 3.0 m^3/s to Mundingan Reservoir

The firm discharge of 0.6 m^3/s is converted by multiplying the average irrigation water demand at Pengilon Weir by the ratio of drainage areas. The capacity of 3.0 m^3/s through the interbasin transfer is determined by trial-and-error method to obtain the maximum efficiency;

(4) Water balance model is established to obtain the relationship between the supplying draft and the required storage as shown in Fig. VII.3.6;

(5) Existing irrigation water demand is regarded as a precondition for the computation; and

(6) A series of reservoirs with Jatibarang and Mundingan is regarded as one reservoir in the computation, because the area of the subbasin between both reservoirs is relatively small.

In line with the said water development scheme, the results of water balance study are shown in

Table VII.3.5 and Fig. VII.3.7. The possible water supplying draft is summarized in the following table:

Possible Water Supplying Draft
(Unit: m^3/s)

Component	Scheme 1-1	1-2	2	3
Babon Reservoir	1.9	1.9	1.9	1.9
Jatibarang Reservoir	1.5	-	-	-
Mundingan Reservoir	-	2.6	-	-
Series of Reservoirs	-	-	3.2	-
Series of Reservoirs & Interbasin Transfer	-	-	-	4.1
Kedung Suren Reservoir	5.2	5.2	5.2	4.9
Total	8.6	9.7	10.3	10.9

Note: Excluding water supply for existing public water; including irrigation water and river maintenance flow.

Regarding the future water demand for public water and river maitenance flow in 2015, the quantity of water supply capacity to be developed is given below:

(1) Future Water Demand

Public Water Supply	:	12.12 m^3/s
Irrigation Water	:	2.71 m^3/s
River Maintenance Flow	:	2.10 m^3/s
Total (1)	:	16.93 m^3/s

(2) Existing and Ongoing Water Supply Programme

Existing Water Supply	:	1.56 m^3/s
Water Supply Programme by Jratunseluna Project	:	5.00 m^3/s
Total (2)	:	6.56 m^3/s