2.3 Flood Damage Analysis

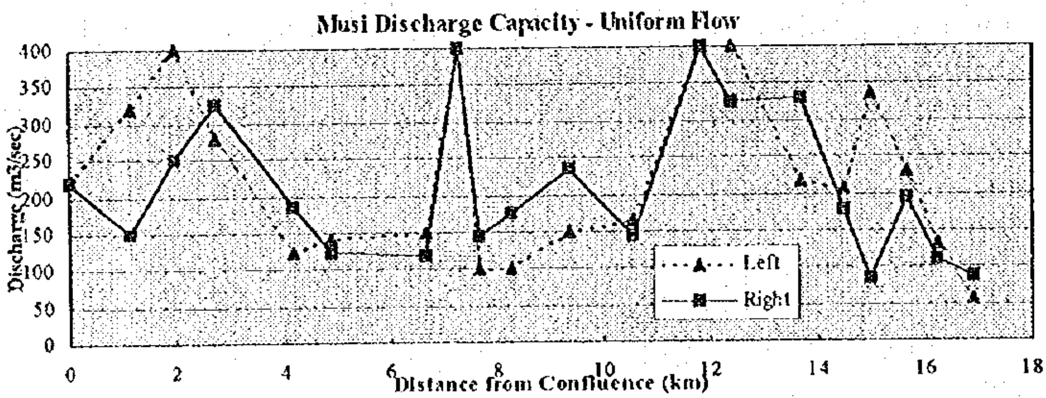
2.3.1 Discharge Capacity of River Channels

Longitudinal and cross sectional river surveys for Samal and Kobi rivers, and their tributaries Musi and Tinupa, were carried out during this Study. The results of these surveys were used to assess the current discharge capacity of the rivers. This cross section data was compiled and the uniform flow calculation method was used to obtain stage discharge (H / Q) curves for every cross section over a range of flows up to a maximum of 800 m^3/sec (400 m^3/sec for Musi & Tinupa). The discharge capacity at each section was then estimated by comparing the left and right bank heights to the calculated stage discharge curves.

Based on this analysis, the discharge capacity of each river is summarized in Table-II.2.8. The summary table gives the average and extreme values of minimum discharge capacity. Figure-II.2.3 shows the variation of calculated discharge capacity at each cross section of the target rivers in the Pasahari area.

Table-II.2.8 Summary Result of Discharge Capacity

	Discharge Capacity (m^3/sec) - Uniform Flow	
River Name	Average Minimum	Extreme Minimum
Samal River	100 - 150	81
Musi River	100 - 150	66
Kobi River	100 - 150	84
Tinupa River	100 - 150	72



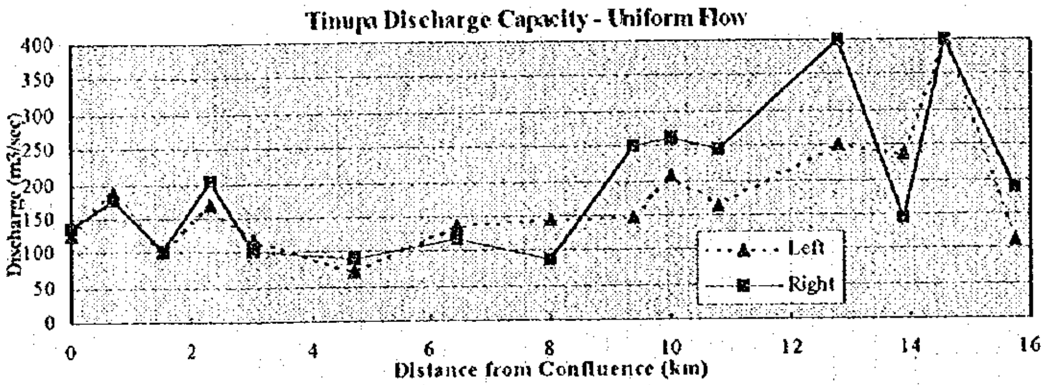
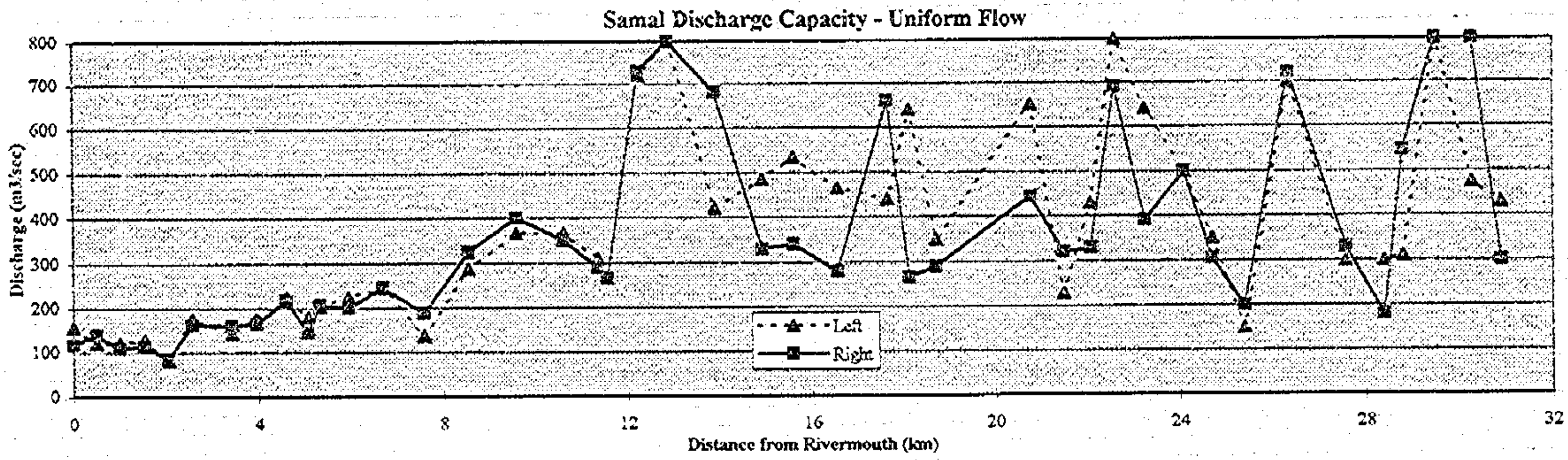


Figure-II.2.3(1) Discharge Capacity



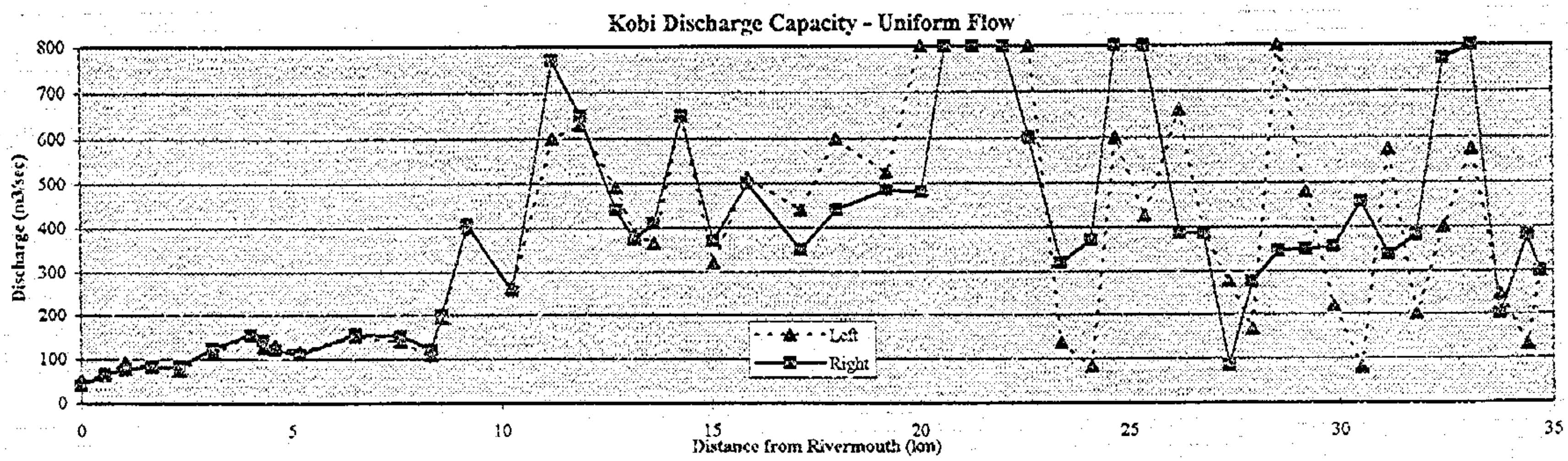


Figure-II.2.3(2) Discharge Capacity

2.3.2 Estimation of Flood Damage

(1) Methodology

It is necessary to estimate the damage to be caused by future floods in the "without Project" case, in order to quantify the benefits in the "with Project" case. There are two approaches, combination of which is also possible, for this analysis:

1) To examine the damage caused by the past major floods, such as those occurred in 1988, 1992, 1996 and annual flood, approximate its monetary value and estimate future damage.
2) To specify the area to be able to be flooded in the future and its water level by examining river discharge capacity and contours, and apply a standard damage rate.

Both approaches have their drawbacks: for 1), most of the damage data for the past floods were lost and thus it is difficult to approximate the monetary value of the floods; and for 2), the flood pattern does not always coincide with the contours while there is no standard damage rate available in Indonesia. Since these two approaches can supplement each other, the combination of the two approaches was used for this Study.

In this Study, the flood damage analysis was carried out in the following way:

1) Specify the height of water and the area flooded of the past three major floods and annual flood through interviews and contour analysis
2) Estimate the damage of the above floods
3) Draw a "flood discharge - damage value" curve based on the results of above 2)
4) Calculate yearly benefits of the project, in other words, yearly average of damage alleviation derived from probabilities of several water amount cases.

(2) Damage to General Assets (houses/buildings, household articles and farmland)

The damage to the houses and buildings and farm had to be estimated through interviews with residents and owners of business activities.

The exact damage to houses and buildings was, however, difficult to estimate, since people's memory on the floods was already lost, while damage to the structure of the houses does not show immediately. After comparing the damage situation acquired from interviews with the standard damage rate used in Japan, the Study Team judged that it would be reasonable to apply the Japanese damage rate which was acquired by the past experience in Japan. Table-II.2.9 shows the standard asset damage rate applicable in Japan.

Table-II.2.9 Standard Asset Damage Rate in Japan

Height of water above the floor *	under 50 cm	50 cm to 99 cm	100 cm to 199 cm	200 cm to 299 cm	more than 300 cm	Remarks
Houses	12.4%	21.0%	30.8%	43.9%	57.2%	Group C
Household Articles	8.6%	19.1%	33.1%	49.9%	69.0%	
Farm Depreciable Assets	15.6%	23.7%	29.7%	36.6%	45.0%	
Farm Stock Assets	19.9%	37.0%	49.1%	57.6%	69.2%	

Source : Manual for River Works in Japan, Survey

Note

- Floor height in Indonesia is usually very low and is set as 0 cm in this Study.
- Houses are grouped into A, B and C on the basis of ground gradient. Group C is categorized into the gradient of 1/500 and over.

The Study Team estimated the value of each type of general assets in all the flooded area through the field investigation (refer to Table-II.2.10), and made a zoning map based on this information. On the other hand, the data on the height of water were obtained, by the flood damage survey, through the interviews with around 50 residents in the Study Area.

Table-II.2.10 Value of General Assets

Item	Houses	Household Articles	Farm Depreciable Assets	Farm Stock Assets	Rice Crop
Unit	per Building	per Building	per Building	per Building	per ton
Unit Value (Rp million)	8	1.5	2	0.4	0.4

(3) Damage to Infrastructure

Damage data to the infrastructure in Pasahari were not obtained. Then the Study Team used the Japanese standard damage rate on the infrastructure: when damage to general assets is 100, the damage to the roads and bridges can be estimated at 28, to the fields 6 and to the irrigation facility 43, to the electricity 2.4, totaling 79.4.

(4) Crop Damage

The main farm crop in Pasahari is paddy rice. Since the flood damage cost and rates to crops are not known, the damage rates shown in the following table for the cost of crop damage caused by past floods in Japan shall be applied to calculate crop damage in the Project area.

Table-II.2.11 Paddy Rice Damage Rates

Inundation Depth	Less than 0.5m				0.5-0.99m				1.0m or more			
Inundation Days	1-2	3-4	5-6	6<	1-2	3-4	5-6	6<	1-2	3-4	5-6	6<
Damage Rate (%)	21	30	36	50	24	44	50	71	37	54	64	74

Source : Manual for River Works in Japan, Survey, Ministry of Construction

Note: The farm crop damage rate is the ratio of damage assuming the crop production value to be 100.

(5) Estimation of Past Flood Damage

The three past flood damages and annual flood damage are estimated and are shown in Table-II.2.12.

Table-II.2.12 Estimation of Past Flood Damage

Flood	Item	Samal	Kobi	Total
1988/01/27	No. of Houses	577	201	778
	General Assets Damage	1103	328	1431
	Crop Damage	568	372	940
	Infrastructure Damage	1327	556	1883
	Total Damage	2997	1255	4252
1992/04/03	No. of Houses	505	115	620
	General Assets Damage	882	192	1074
	Crop Damage	476	294	770
	Infrastructure Damage	1078	386	1464
	Total Damage	2436	872	3308
1996/02/19	No. of Houses	60	13	73
	General Assets Damage	91	29	120
	Crop Damage	62	116	178
	Infrastructure Damage	121	114	235
	Total Damage	274	259	533
Annual	No. of Houses	28	8	36
	General Assets Damage	43	17	60
	Crop Damage	42	3	45
	Infrastructure Damage	67	16	83
	Total Damage	152	36	188

Source : JICA Study Team Unit : Rp. million

(6) Estimation of Assumed Flood Damage

Flood damage at probable discharge with 100-year return period was estimated. In this case, assuming that all of flood discharge flows inside of the river course, river water level, namely flood water level is calculated by using uniform flow calculation. Referring to the estimated flood water level, micro-topography of flooded area, the past flooded area and water depth, flooded area and water depth with 100-year return period was studied. The flooded area with 100-return period is presented in Figure-II.2.4.

Applying the same method of the past flood damage estimation, the flood damage with 100-year return period was estimated and is shown in Table-II.2.13.

Table-II.2.13 Estimation of Flood Damage with 100-year return period

Flood	Item	Samal	Kobi	Total
Flood with 100-year Return Period	No. of Houses	1147	906	2053
	General Assets Damage (Rp. Million)	2937	2243	5180
	Crop Damage (Rp. Million)	1581	1883	3464
	Infrastructure Damage (Rp. Million)	3587	3276	6863
	Total Damage (Rp. Million)	8105	7402	15507

Source : JICA Study Team

Table-II.2.14 Peak Discharge (m^3/sec)

Probability	Location	Samal	Kobi
1/20	River Mouth	2,428	2,616
1/100	River Mouth	2,908	3,121

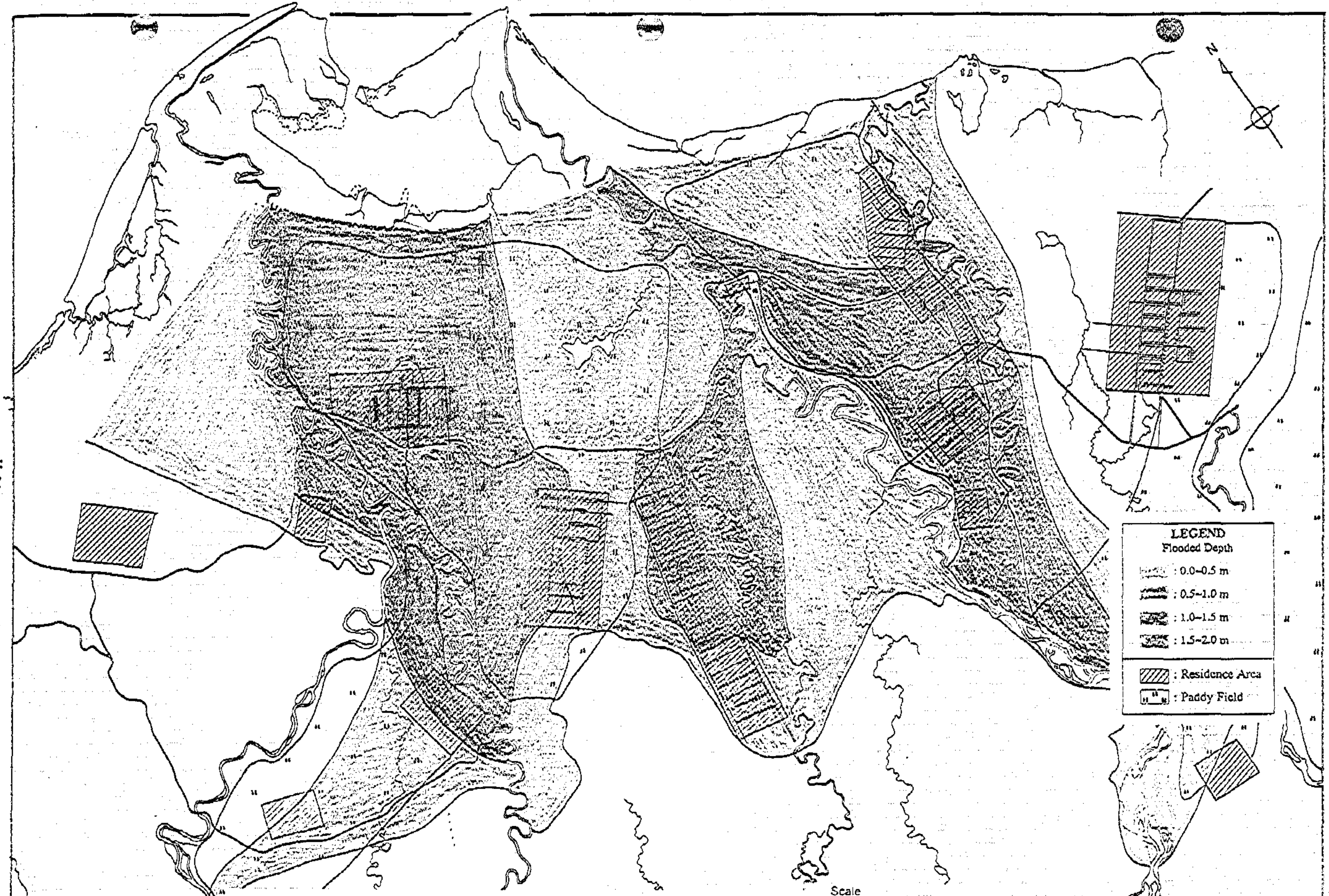


Figure-II.2.4 Estimated Flooded Area with 100-year Return Period

2.3.3 Flood Discharge - Damage Curve

(1) Estimation of the Past Flood Discharge

The past flood discharges and probability were estimated from daily rainfall, because hourly rainfall data were not obtained. These are presented in Table-II 2.15

Table-II.2.15 Estimation of Past Flood Discharges

Item		1988/01/27 Flood	1992/04/03 Flood	1996/02/19 Flood
Daily Rainfall (mm/day)		145.8	108.9	63.1
Return Period		10-year	5-year	1-year
Discharge (m^3/sec)	Samal at River Mouth	2218	2006	1520
	Kobi at River Mouth	2395	2172	1670

Source : JICA Study Team

(2) Flood Discharge - Damage Value Curve

Based on the above flood damage study, relationship between flood discharge and flood damage is estimated, taking into account of follows: Refer to Table-II.2.16.

- The flood discharge with no damages is assumed as the discharge capacity of each river.
- Damaged flood occurs 1 times a year in both rivers.
- The flood on 1996/02/19 was estimated to be 1-year return period.
- The flood on 1992/04/03 was estimated to be 5-year return period.
- The flood on 1988/01/27 was estimated to be 10-year return period.
- Flood damage with 20-year and 100-year return period were estimated by the Study Team.

Table-II.2.16 Estimation Method

Return Period	Discharge	Damage
0.5-year	Discharge capacity	No damage
1-year *	Annual flood discharge	Actual annual flood damage(1996/02/19)
5-year	Discharge with 5-year return period	Actual flood damage on 1992/04/03
10-year	Discharge with 10-year return period	Actual flood damage on 1988/01/27
20-year	Discharge with 20-year return period	Flood damage with 20-year return period read from graph
100-year	Discharge with 100-year return period	Estimated flood damage with 100-year return period

The relationship between flood discharge / flood probability and damage value was shown in Table-II.2.17, Figure-II.2.5 and Figure-II.2.6.

Table-II.2.17 Relationship between Flood Discharge and Damage Value

Samal River			Kobi River		
Return Period	Discharge (m3/sec)	Damage (Rp Mil.)	Return Period	Discharge (m3/sec)	Damage (Rp Mil.)
0.5-year	1310	0	0.5-year	1450	0
1-year	1520	274	1-year	1670	259
5-year	2006	2436	5-year	2172	872
10-year	2218	2998	10-year	2395	1256
20-year	2428	3565	20-year	2616	1939
100-year	2908	8105	30-year	3121	7402

Source : JICA Study Team

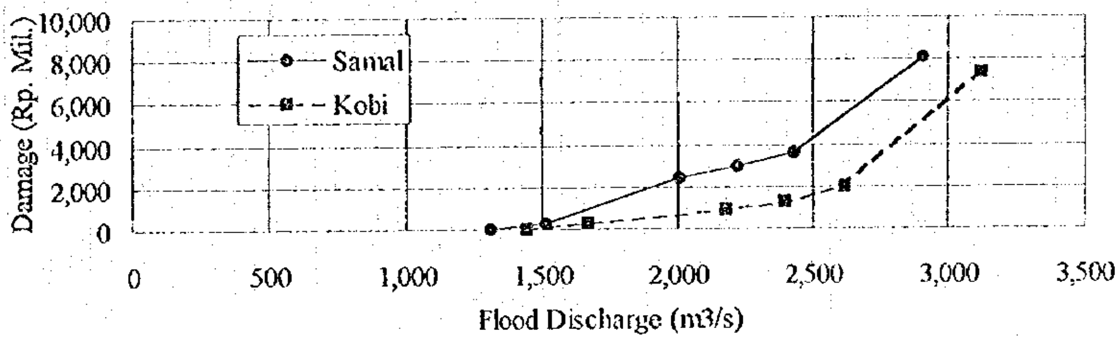


Figure-II.2.5 Flood Discharge - Damage Value Curve

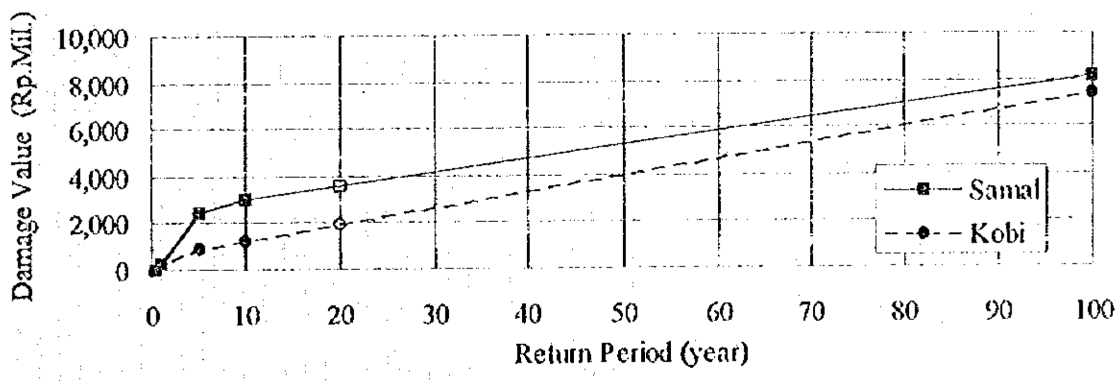


Figure-II.2.6 Flood Return Period - Damage Value Curve

CHAPTER 3 FLOOD CONTROL CONCEPTUAL PLAN

3.1 Basic Policy of Flood Control Plan

3.1.1 Principal Planning Conditions

(1) Project Target Year

The target year of the Conceptual Plan for flood control in Pasahari area was set at the year 2015, after discussion with PU Maluku Province.

(2) Protected Area

There are three irrigation development areas along the target rivers, Samal River and Kobi River, namely Samal I, Samal II and Kobi. The maximum probable flood area was studied in Section 2.2. Based on both the irrigation development and maximum flood areas, the protected area against the flood by Samal and Kobi River was determined. In addition, the area with no irrigation development plan is not included in the protected area even if the area is prone to flood.

(3) Design Scale

A flood control project should safely convey all flow up to the design flood, which is generally defined in terms of return period (recurrence interval), without threat to life or property. The design return period of flood control plan is evaluated by the return period of daily rainfall depth. In determining the design flood return period, the following items are taken into account.

1) Nation-wide balance of design flood return period used in Indonesia
2) The degree of importance of the river in question
3) Return period of past severely damaged floods

"Flood Control Manual Volume II", provides a summary of return period criteria which have been used in the design of various flood control projects in Indonesia. In the area of agricultural or rural development like Pasahari area, however design flood return period varies from 5 to 25 years in short term, and 15 to 50 years in long term.

Also in the same manual, recommended minimum design flood standard are presented in Table-II.3.1. For the new project like this project in Pasahari, minimum design flood return periods of more than 10 years in the initial phase and more than 25 years in the final phase are recommended.

On the other hand, the recently experienced severe flood in 1988 is estimated to have a return period of approximately 10 years.

As a result of these findings, the design flood return period of 20 years is adopted for the Flood Control Conceptual Plan in the Pasahari Area.

Table-II.3.1 Recommended Minimum Return Period of Design Flood

Flood Conveyance System	Project Type(for River Flood Control Project) and Total Population (for Drainage System)	Initial Phase	Final Phase
River System	Emergency Project	5	10
	New Project	10	25
	Updating Project for rural and/or urban with P < 2,000,000	25	50
	Updating Project for urban with P > 2,000,000	25	100
Primary Drainage System (Catchment area > 500 ha)	Rural	2	5
	Urban P < 500,000	5	10
	Urban 500,000 < P < 2,000,000	5	15
	Urban P > 2,000,000	10	25

Notes :

1) Higher design flood standard should be applied if an economic analysis indicates that it is desirable or if flooding is a significant risk to human life.
2) P = Total Urban Population
3) Emergency Projects are developed without preliminary engineering and economic feasibility studies at sites where flooding is excessive and flooding problems present a significant risk to human life.
4) New Project include flood control projects where no previous flood projects have been developed or where Emergency Projects have been developed.
5) Updating Projects include rehabilitation projects and improvements to existing project. Most River Basin Development Projects are considered to be updating projects.
6) Initial Phase is recommended for immediate use.
7) Final Phase is recommended for use in upgrading existing facility when the necessary funds become available.

3.1.2 Policy of Flood Control Measures

Based on the basin characteristics and river conditions, the policy of flood control measures is set up as follows :

1) **Low Cost River Improvement Works** : As the Pasahari area is still undeveloped, low cost river improvement works for flood control should be recommended rather than high cost flood control measures such as dams and reservoirs.
2) **River Dikes Planned Widely Surrounding the Current River Course** : As both the rivers are meandering on the alluvial plain, river dikes should be planned to widely surround the current river course. That is to say, the current river course will act as the low water channel and flood plains with a wide compound cross section should be formed by the river dikes.
3) **Economical Flood Control Measures** : The height of the river dikes should be kept low, using areas with slightly higher elevation as dikes and increasing the river width as much as possible. Thus, dike construction cost could be reduced, and rain water drainage facilitated because flood water level will be lower.
4) **Multi-purpose Dikes** : River dikes should be planned as multi-purpose, and should be used for roads, canals, etc., in order to maximize the benefit of the initial investment.
5) **Staged Construction to be Prioritized** : Currently flooded areas to be protected should be prioritized according to importance. Further, staged construction should be proposed based on the development plans of the irrigation area, residential area and upstream area.

3.2 Plan and Design of Flood Control Measures

3.2.1 Design Criteria

Design criteria of river improvement works are set as follows:

1) River improvement plans are studied with a 20 year design return period.

2) Results of the survey conducted by the JICA Study Team are used to fully understand the river characteristics.

3) Current river alignment is not in principal changed. However, river dikes should be planned to widely surround the current river course.

4) The planned river cross section is assumed as the schematic drawing shown in Figure-II.3.1. Using the assumed cross section shown below, discharge capacity is calculated using uniform flow calculation (Manning's Formula).

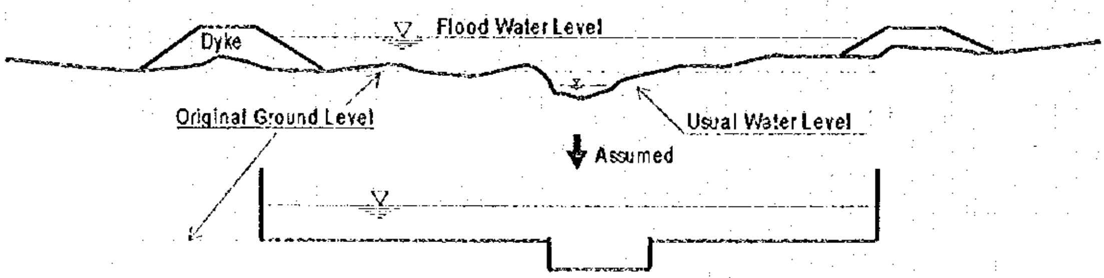


Figure-II.3.1 Schematic Cross Section of River

5) Taking into account the condition of the planning area and the assumed shallow water depth on the flood plains, Manning's coefficient (n) is set as followings:
   - Current River Course : n=0.035
   - Planned River Course : n=0.050

6) When determining the dike height, freeboard shall be taken into account. According to "Flood Control Manual Volume III", the freeboard of dike shall not be less than the value given in Table-II.3.2, based on the design flood discharge. Samal River and Kobi River have the discharge range of between 750 m^3/sec and 2,650 m^3/sec with 20-year return period. According to the Table-II.3.2, freeboard of 1.0 - 1.2m could be applied for both rivers. For the study area, however, freeboard of 0.6 m is adopted for all the river sections because temporary rises of water level caused by wind, waves, swell and hydraulic jump are not likely to occur, since the planned river dikes and flood plains will be wide so that velocity is slow and water height is low.

Table-II.3.2 Freeboard Relative to Design Flood Discharge

Design Flood Discharge (m3/sec)	Freeboard (m)
Less than 200	0.5 (0.6)
200 and up to 500	0.8
500 and up to 2,000	1.0
2,000 and up to 5,000	1.2
5,000 and up to 10,000	1.5
10,000 and over	2.0

Memo. Figures are based on "Flood Control Manual Volume III"
() is based on "Manual for River Works in Japan, Planning"

3.2.2 Alternative Flood Control Plans

(1) Current and Planned River Conditions

The longitudinal section along the planned river course and current river width of Samal River and Kobi River are shown in Figure-II.3.3 to Figure-III.3.6.

Based on location of confluences and the characteristics of river slope and width, Samal River and Kobi River can be divided into 6 representative sections as shown in Figure-II.3.2. The current and planned river conditions, such as the original river width and depth, gradient and design discharges of each section, are shown in Table-II.3.3. for each river. It is noted that the gradients mentioned in the table are both the gradients along the current river course and planned river course (the survey line).

Table-II.3.3 Current and Planned River Conditions

River		Samal River				Musi River	
Section		~ 7k000	~ 10k000	~ 16k000	~ 16'600	~ 4k500	~ 5k500
Original River Width (m)		40	40	85	85	30	50
Original River Height (m)		6.0	5.0	2.5	2.5	2.5	2.0
Gradient along River Course		1/9600	1/920	1/530	1/300	1/560	1/450
Planned Gradient		1/5600	1/550	1/330	1/200	1/270	1/220
Planned River Length (m)		7,000	3,000	6,000	600	4,500	1,000
Design Discharge (m^3/sec)	5-year	2,050	2,050	1,300	1,300	750	750
	10-year	2,250	2,250	1,400	1,400	850	850
	20-year	2,450	2,450	1,550	1,550	900	900
River		Kobi River				Timpa River	
Section		~ 6k000	~ 9k500	~ 15k000	~ 16'600	~ 4k000	~ 6k500
Original River Width (m)		35	35	100	100	20	30
Original River Height (m)		5.0	5.0	2.5	1.5	3.5	3.0
Gradient along River Course		1/8400	1/950	1/360	1/220	1/1100	1/530
Planned Gradient		1/4900	1/430	1/250	1/180	1/520	1/230
Planned River Length (m)		6,000	3,500	6,000	1,600	4,000	2,500
Design Discharge (m^3/sec)	5-year	2,250	1,600	1,600	1,600	650	650
	10-year	2,450	1,750	1,750	1,750	700	700
	20-year	2,650	1,900	1,900	1,900	750	750

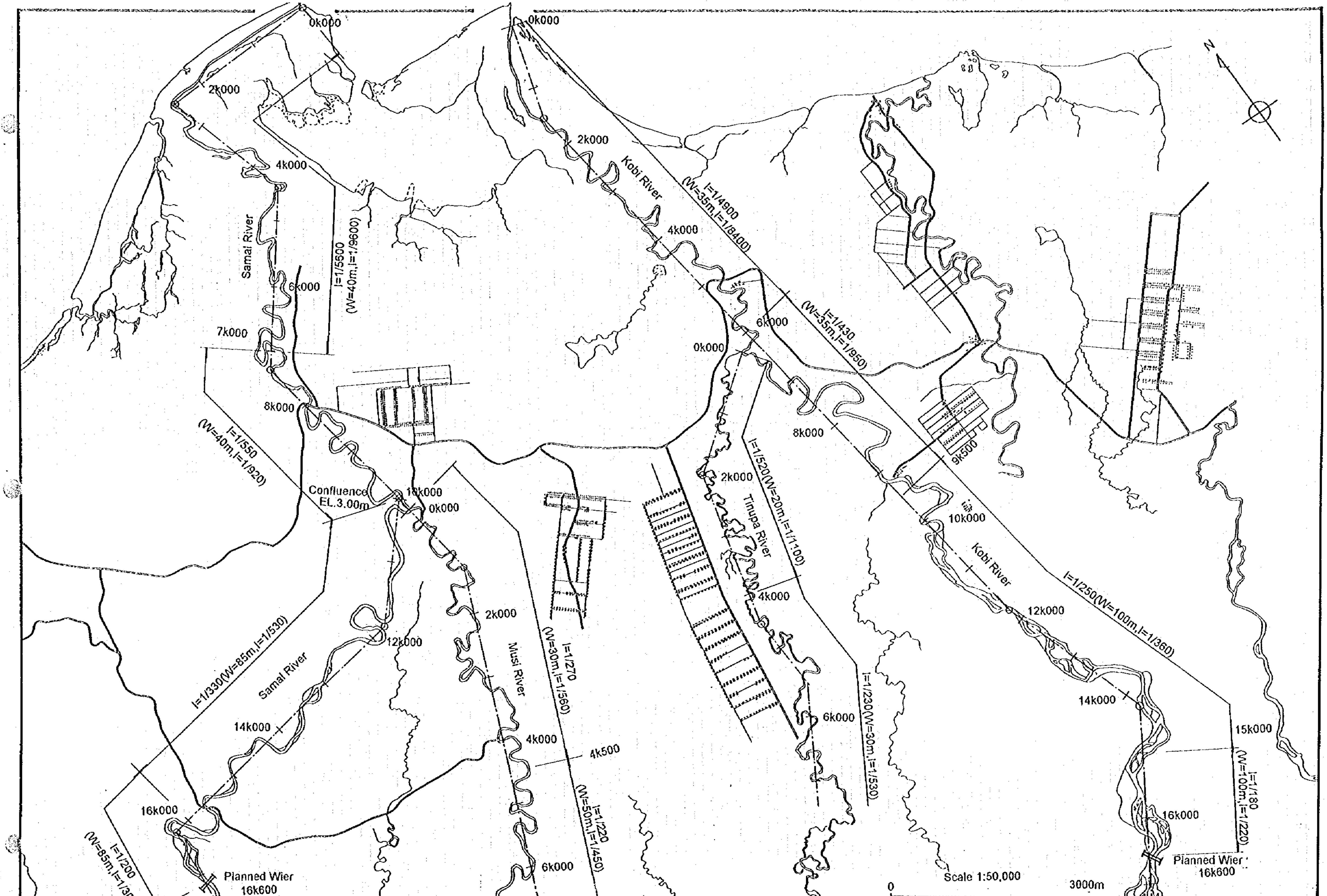


Figure-II.3.2 Division of River Sections for River Improvement Plan

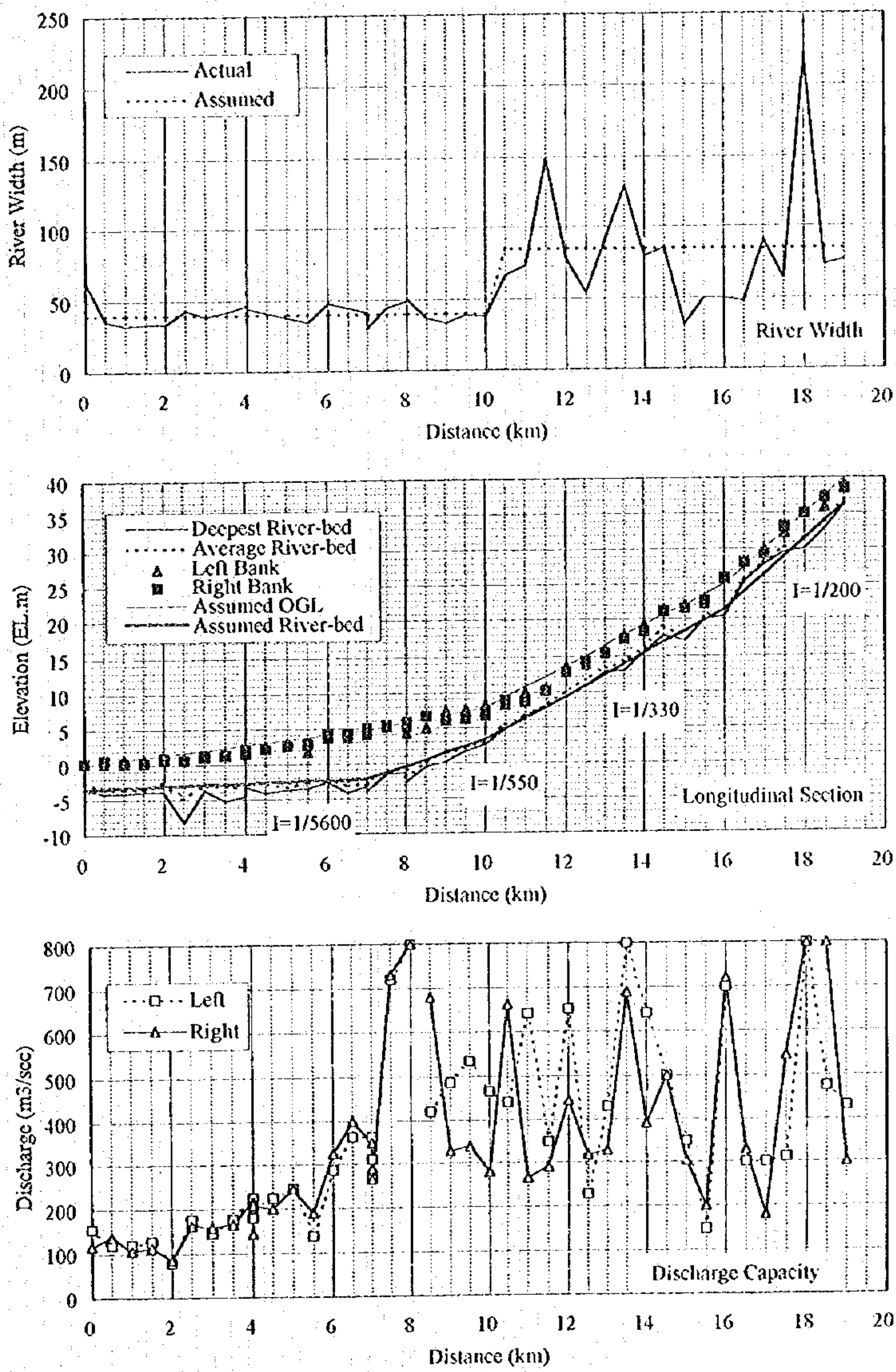


Figure-II.3.3 Current Condition of Samal River along the Planned River Course

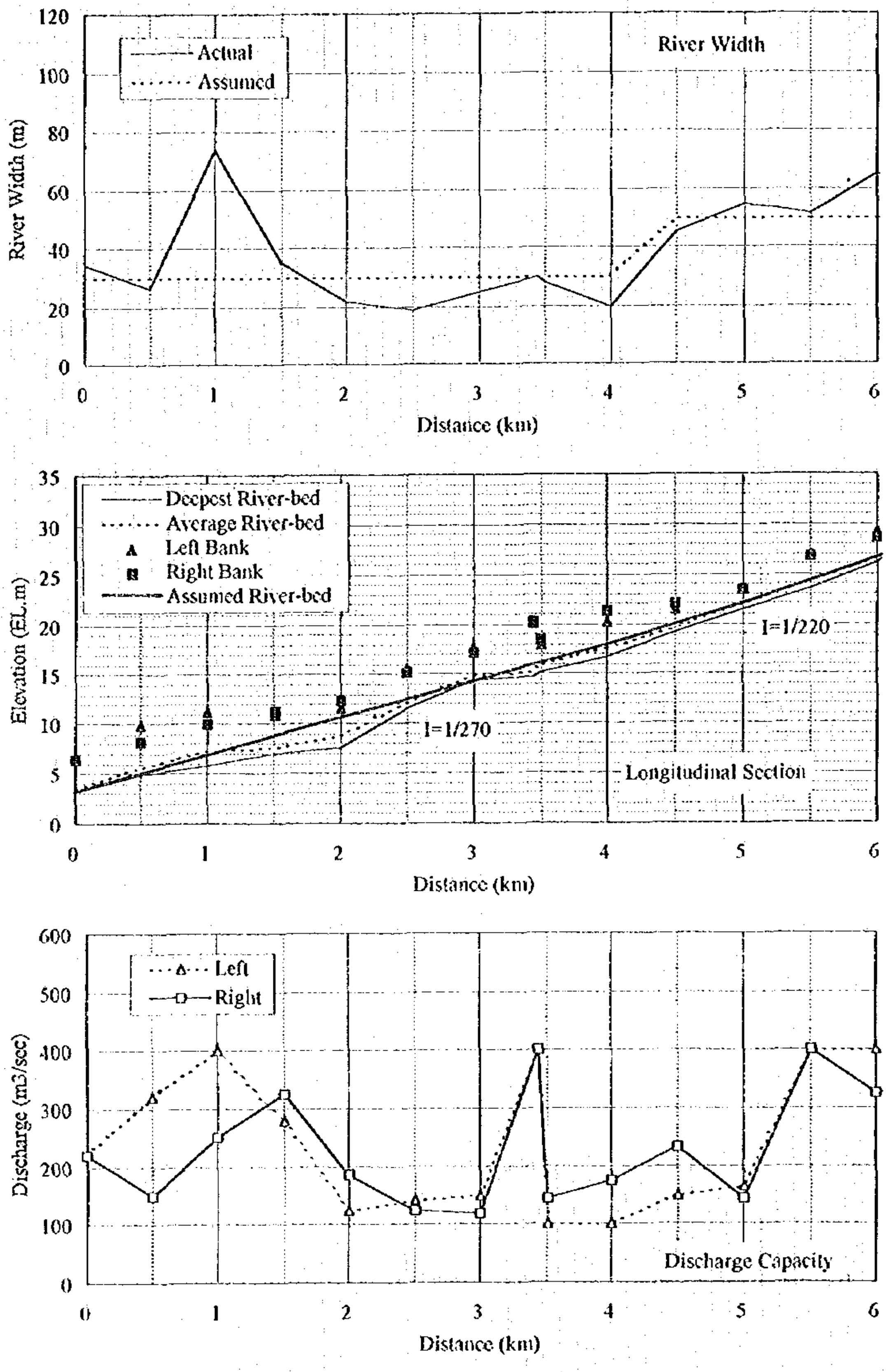


Figure-II.3.4 Current Condition of Musi River along the Planned River Course

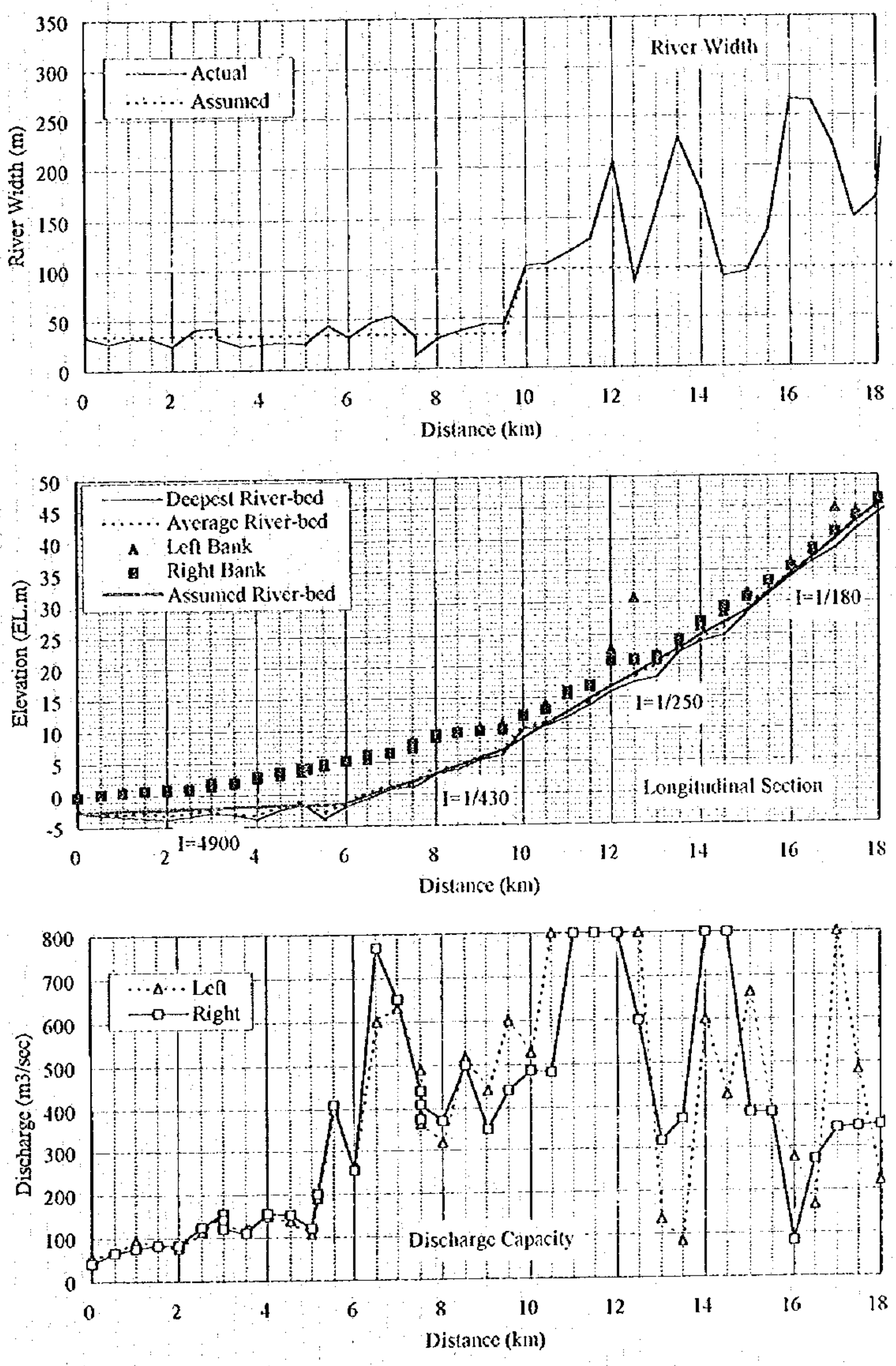


Figure-II.3.5 Current Condition of Kobi River along the Planned River Course

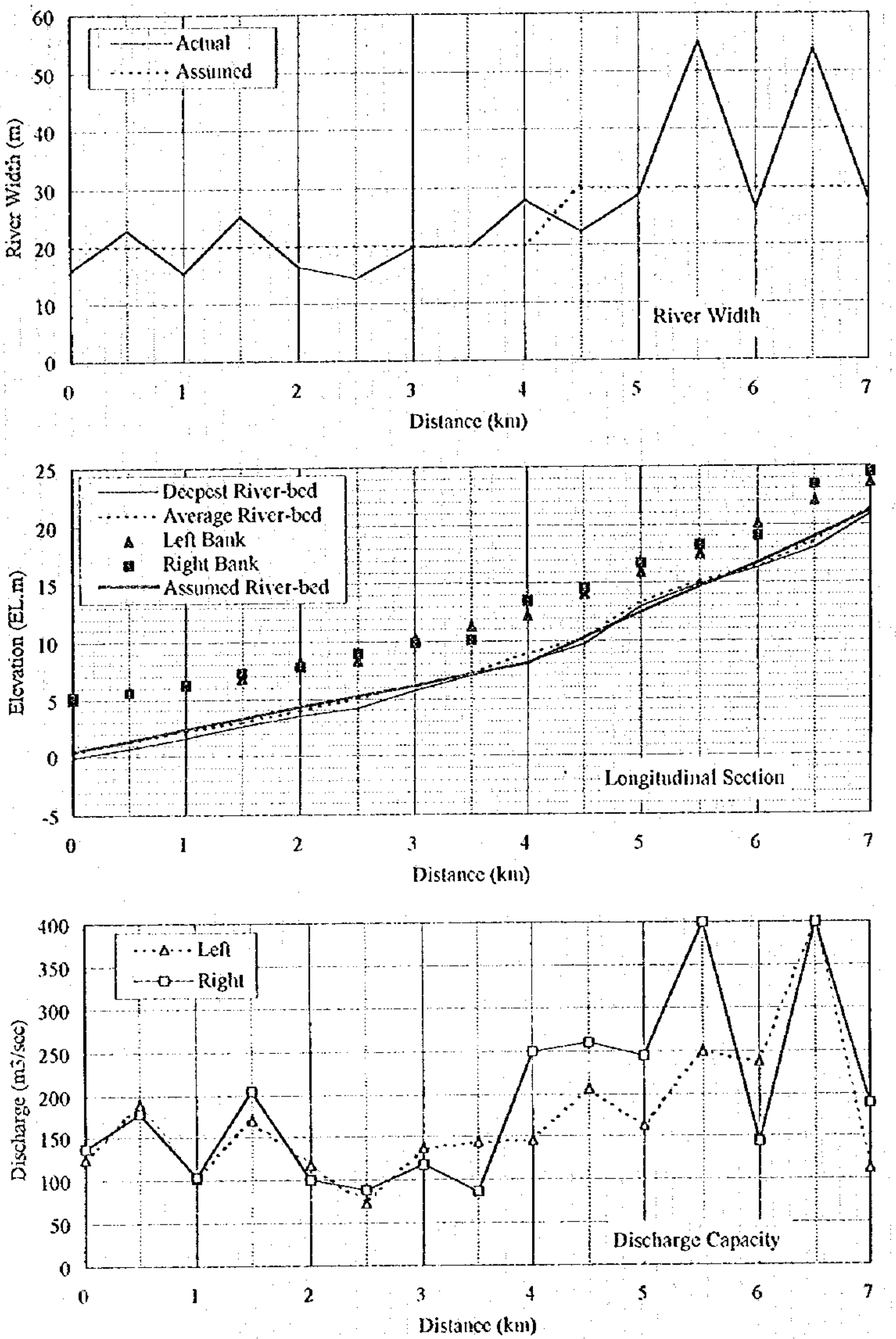


Figure-II.3.6 Current Condition of Tinupa River along the Planned River Course

(2) Plan and Design of Flood Control Measures

Assuming several dike heights, the necessary river width for the 20-year design scale was calculated applying uniform flow calculation method. The results are shown in Table-II.3.6 and Table-II.3.7 for both Samal and Kobi River. Moreover, necessary dike heights with 5 and 10-year return period according to the river width planned with 20-year return period, are shown in the same tables. Based on the results, flood control measures are planned as follows:

<Samal River>

For Samal river and its tributary, Musi river, dikes are planned on both left and right banks, since irrigation areas have been planned and developed on both sides of the river. However, the left side of Samal River from 10k000 to 16k000 is located closely to hilly side so that dikes are not necessary to be constructed. In addition, the downstream left side of Samal River from 0k000 to 7k000 is mostly marsh and dikes are not necessary.

Studying the river width of the upstream section from 7k000, the necessary section width from 7k000 to 10k000 is 3,100 m if dike height is adopted as 1.5 m. It is too wide to be adopted for the plan. In this study, two dike heights, 2.0 m and 2.5 m, are adopted as alternative plans, the specifications of which are shown in Table-II.3.4. Dike alignment of both plans are shown in Figure-II.3.8 and Figure-II.3.9. The standard cross section is designed as shown in Figure-II.3.7.

Table-II.3.4 Alternative Flood Control Plans : Samal River System

River	Samal River				Musi River	
Section	~ 7k000	~ 10k000	~ 16k000	~ 16'600	~ 4k500	~ 5k500
Planned Gradient	1/5600	1/550	1/330	1/200	1/270	1/220
Planned River Length (m)	7,000	3,000	6,000	600	4,500	1,000
Design Discharge (m^3/sec)	2,450	2,450	1,550	1,550	900	900
Case-S1 : Dike Height (m)	2.00	2.00	2.00	2.00	2.00	2.00
Planned River Width (m)	2850	1400	540	350	340	260
Water Height (m)	7.40	6.40	3.90	3.90	3.90	3.40
Velocity (m/sec)	0.58	1.13	1.62	2.23	1.66	1.96
Case-S2 : Dike Height (m)	2.50	2.50	2.50	2.50	2.50	2.50
Planned River Width (m)	1550	820	280	160	190	140
Water Height (m)	7.90	6.90	4.40	4.40	4.40	3.90
Velocity (m/sec)	0.77	1.41	2.09	3.03	2.08	2.51

<Kobi River>

A dike is planned on the right bank of Kobi river and on the left bank of Tinupa river, because there is no planned irrigation in the area between Kobi river and Tinupa river. However, for Kobi River from 4k000 to 6k000 (confluence), it is necessary to construct dikes on both sides. However, the downstream of Kobi River from 3k000 is mostly marsh area so that dikes are not necessary.

Studying the river width of the most downstream section, the necessary section width is 5,950 m and 2,650 m if the dike height is adopted as 1.5 m and 2.0 m respectively. It is too wide to be adopted for the plan. In this study, two dike heights, 2.0 m and 2.5 m, are adopted as alternative plans, the specifications of which are shown in Table-II.3.5. For both plans, dike height of 2.5 m is adopted for the most downstream section. Dike alignment of both plans are shown in Figure-II.3.8 and Figure-II.3.9. The standard cross section is designed as shown in Figure-II.3.7.

Table-II.3.5 Alternative Flood Control Plans : Kobi River System

River	Kobi River				Tinupa River	
Section	~ 6k000	~ 9k500	~ 15k000	~ 16'600	~ 4k000	~ 6k500
Planned Gradient	1/4900	1/430	1/250	1/180	1/520	1/230
Planned River Length (m)	6,000	3,500	6,000	1,600	4,000	2,500
Design Discharge (m^3/sec)	2,650	1,900	1,900	1,900	750	750
Case-K1 : Dike Height (m)	2.50	2.00	2.00	2.00	2.00	2.00
Planned River Width (m)	1500	920	540	540	410	220
Water Height (m)	6.90	6.40	3.90	2.90	4.90	4.40
Velocity (m/sec)	0.90	1.30	1.90	2.10	1.17	1.92
Case-K2 : Dike Height (m)	2.50	2.50	2.50	2.50	2.50	2.50
Planned River Width (m)	1500	530	300 (270)	300	240	120
Water Height (m)	6.90	6.90	4.40	3.40	5.40	4.90
Velocity (m/sec)	0.90	1.63	2.50	2.65	1.45	2.44

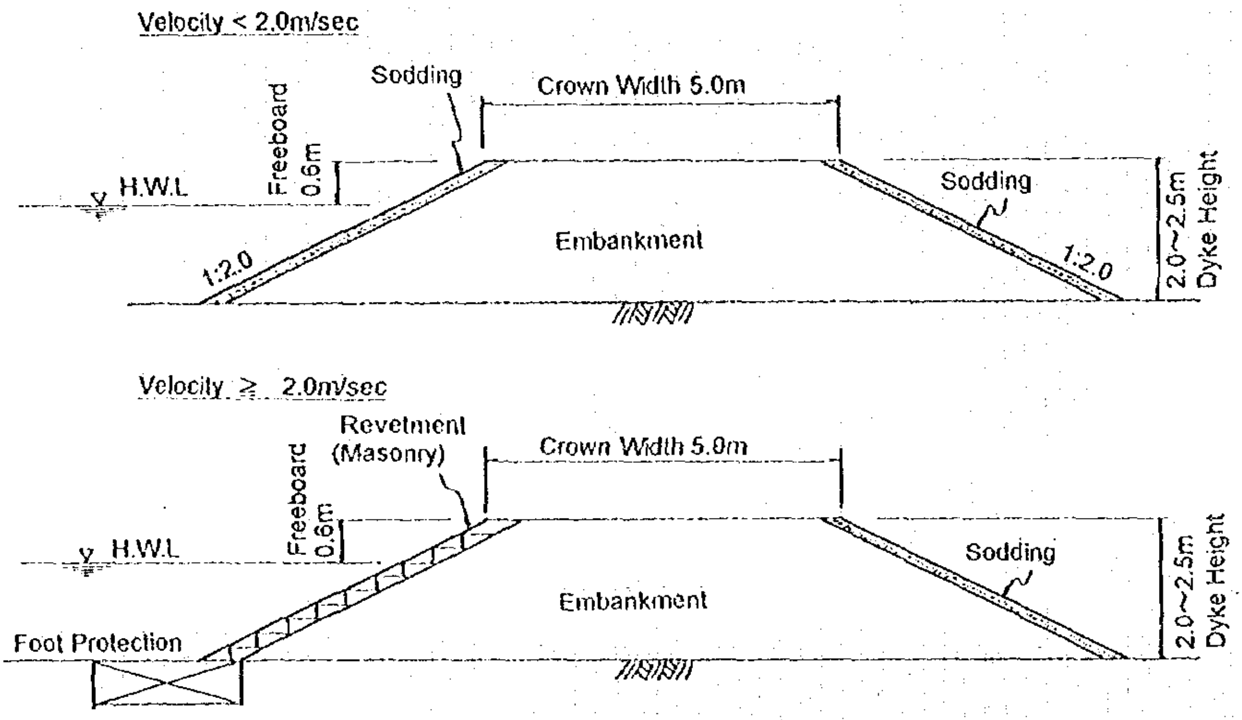


Figure-II.3.7 Standard Cross Section of Dike

Table-II.3.6 Results of Uniform Flow Calculation : Samal River System

River		Samal River				Musi River	
Section		~ 7k000	~ 10k000	~ 16k000	~ 16'600	~ 4k500	~ 5k500
Original River Width (m)		40	40	85	85	30	50
Original River Height (m)		6.0	5.0	2.5	2.5	2.5	2.0
Gradient along River Course		1/9600	1/920	1/530	1/300	1/560	1/450
Planned Gradient		1/5600	1/550	1/330	1/200	1/270	1/220
Planned River Length (m)		7,000	3,000	6,000	600	4,500	1,000
Design Discharge (m^3/sec)	5-year	2,050	2,050	1,300	1,300	750	750
	10-year	2,250	2,250	1,400	1,400	850	850
	20-year	2,450	2,450	1,550	1,550	900	900
20-year Return period							
Dike Height (m)		1.50	1.50	1.50	1.50	1.50	1.50
Planned River Width (m)		6600	3100	1300	890	750	610
Water Height (m)		6.90	5.90	3.40	3.40	3.40	2.90
Velocity (m/sec)		0.40	0.83	1.14	1.54	1.21	1.40
Dike Height (m)		2.00	2.00	2.00	2.00	2.00	2.00
Planned River Width (m)		2850	1400	540	350	340	260
Water Height (m)		7.40	6.40	3.90	3.90	3.90	3.40
Velocity (m/sec)		0.58	1.13	1.62	2.23	1.66	1.96
Dike Height (m)		2.50	2.50	2.50	2.50	2.50	2.50
Planned River Width (m)		1550	820	280	160	190	140
Water Height (m)		7.90	6.90	4.40	4.40	4.40	3.90
Velocity (m/sec)		0.77	1.41	2.09	3.03	2.08	2.51
Dike Height (m)		3.00	3.00	3.00	3.00	3.00	3.00
Planned River Width (m)		960	530	170	85	120	80
Water Height (m)		8.40	7.40	4.90	4.75	4.90	4.40
Velocity (m/sec)		0.97	1.66	2.56	3.85	2.48	3.09
5-year and 10-year Return period							
Planned River Width (m) (with the above plan)		6600	3100	1300	890	750	610
Dike Height (m)	5-year	1.41	1.40	1.39	1.39	1.40	1.39
	10-year	1.46	1.45	1.43	1.43	1.47	1.46
Planned River Width (m) (with the above plan)		2850	1400	540	350	340	260
Dike Height (m)	5-year	1.86	1.85	1.82	1.79	1.82	1.81
	10-year	1.93	1.93	1.89	1.88	1.93	1.93
Planned River Width (m) (with the above plan)		1550	820	280	160	190	140
Dike Height (m)	5-year	2.32	2.28	2.23	2.17	2.26	2.20
	10-year	2.41	2.39	2.34	2.30	2.42	2.38
Planned River Width (m) (with the above plan)		960	530	170	85	120	80
Dike Height (m)	5-year	2.77	2.72	2.59	2.37	2.69	2.62
	10-year	2.88	2.87	2.74	2.57	2.90	2.87

Table-II.3.7 Results of Uniform Flow Calculation : Kobi River System

River		Kobi River				Tinupa River	
Section		~ 6k000	~ 9k500	~ 15k000	~ 16'600	~ 4k000	~ 6k500
Original River Width (m)		35	35	100	100	20	30
Original River Height (m)		5.0	5.0	2.5	1.5	3.5	3.0
Gradient along River Course		1/8400	1/950	1/360	1/220	1/1100	1/530
Planned Gradient		1/4900	1/430	1/250	1/180	1/520	1/230
Planned River Length (m)		6,000	3,500	6,000	1,600	4,000	2,500
Design Discharge (m^3/sec)	5-year	2,250	1,600	1,600	1,600	650	650
	10-year	2,450	1,750	1,750	1,750	700	700
	20-year	2,650	1,900	1,900	1,900	750	750
20-year Return period							
Dike Height (m)		1.50	1.50	1.50	1.50	1.50	1.50
Planned River Width (m)		5950	2050	1300	1250	900	510
Water Height (m)		5.90	5.90	3.40	2.40	4.40	3.90
Velocity (m/sec)		0.48	0.95	1.34	1.51	0.86	1.37
Dike Height (m)		2.00	2.00	2.00	2.00	2.00	2.00
Planned River Width (m)		2650	920	540	540	410	220
Water Height (m)		6.40	6.40	3.90	2.90	4.90	4.40
Velocity (m/sec)		0.69	1.30	1.90	2.10	1.17	1.92
Dike Height (m)		2.50	2.50	2.50	2.50	2.50	2.50
Planned River Width (m)		1500	530	270	300	240	120
Water Height (m)		6.90	6.90	4.40	3.40	5.40	4.90
Velocity (m/sec)		0.90	1.63	2.50	2.65	1.45	2.44
Dike Height (m)		3.00	3.00	3.00	3.00	3.00	3.00
Planned River Width (m)		920	340	150	190	160	70
Water Height (m)		7.40	7.40	4.90	3.90	5.90	5.40
Velocity (m/sec)		1.11	1.93	3.15	3.20	1.71	2.98
5-year and 10-year Return period							
Planned River Width (m) (with the above plan)		5950	2050	1300	1250	900	510
Dike Height (m)	5-year	1.46	1.40	1.40	1.40	1.42	1.41
	10-year	1.46	1.45	1.45	1.45	1.46	1.46
Planned River Width (m) (with the above plan)		2650	920	540	540	410	220
Dike Height (m)	5-year	1.87	1.85	1.81	1.84	1.87	1.84
	10-year	1.94	1.92	1.91	1.92	1.94	1.91
Planned River Width (m) (with the above plan)		1500	530	270	300	240	120
Dike Height (m)	5-year	2.31	2.27	2.22	2.26	2.30	2.23
	10-year	2.40	2.38	2.36	2.38	2.39	2.34
Planned River Width (m) (with the above plan)		920	340	150	190	160	70
Dike Height (m)	5-year	2.80	2.71	2.58	2.66	2.72	2.65
	10-year	2.90	2.85	2.78	2.82	2.83	2.80

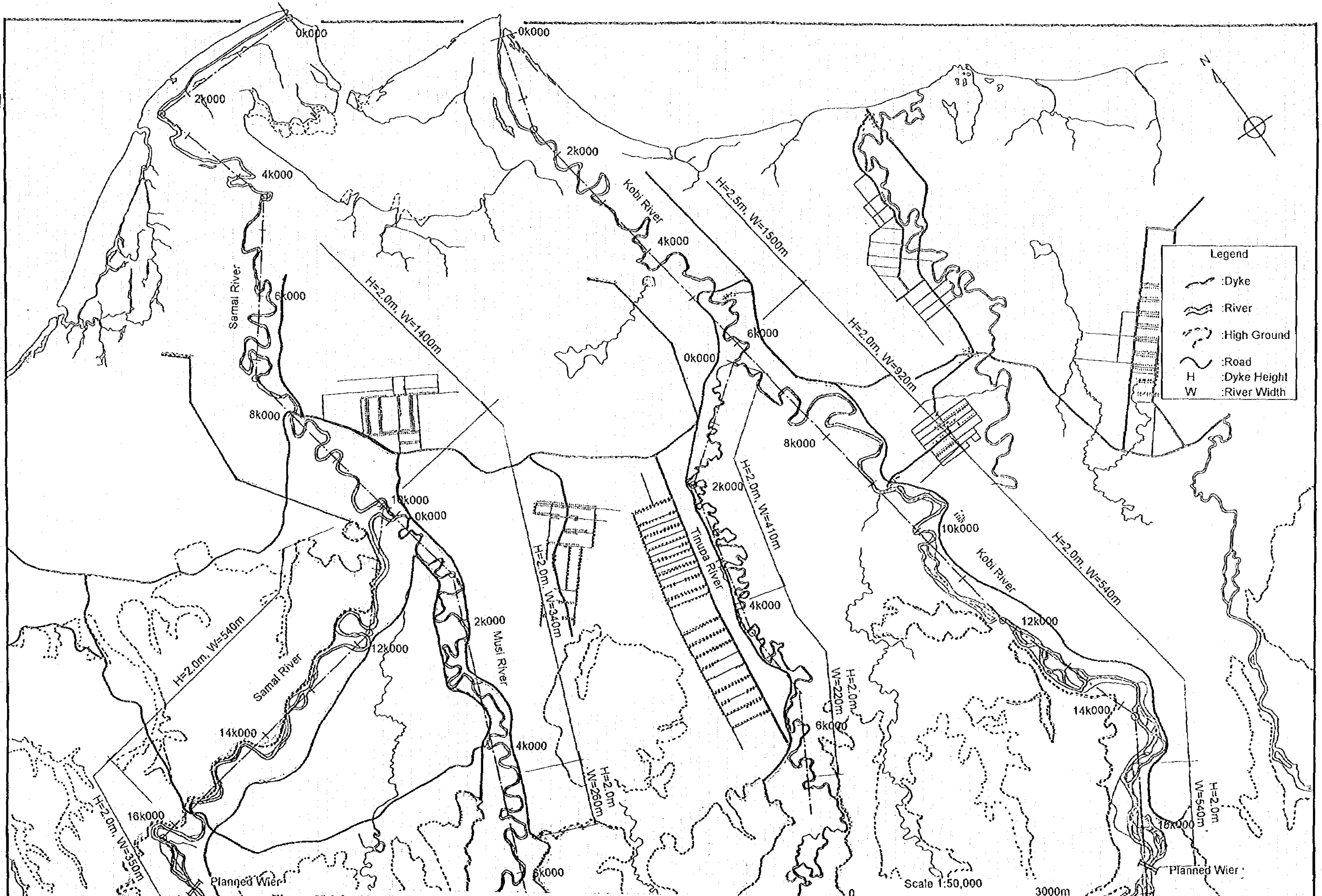


Figure-II.3.8 Alternatives of Flood Control Plan for Case-S1 and Case-K1
(Dike height = 2.0 m with exception of Kobi River downstream = 2.5 m)

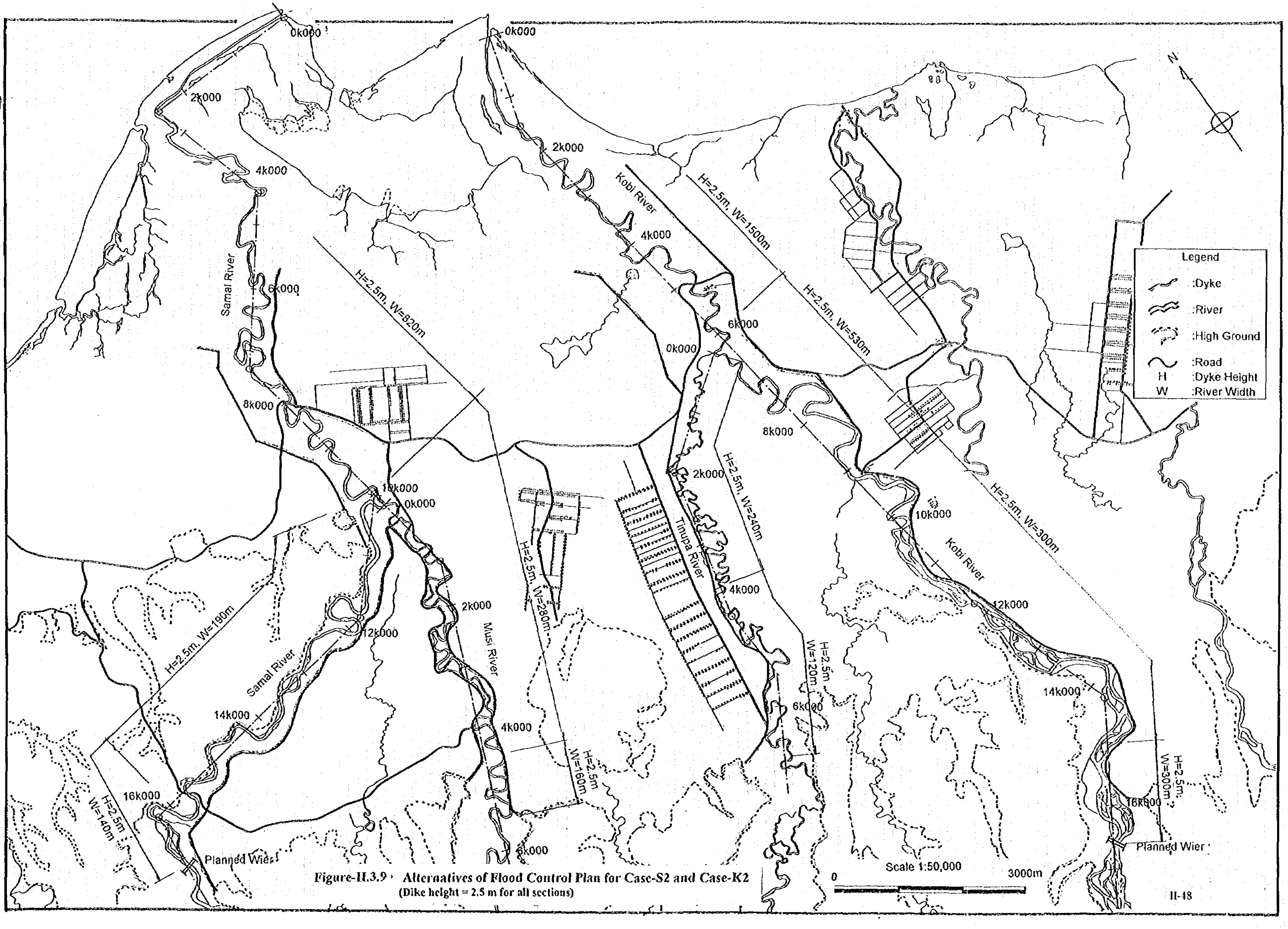


Figure-II.3.9 Alternatives of Flood Control Plan for Case-S2 and Case-K2
(Dike height = 2.5 m for all sections)

3.3 Selection of Optimum Plan

3.3.1 Work Quantities

Based on the plan and design described above, dike work quantities were calculated and are shown in Table-II.3.8.

Table-II.3.8 Work Quantities of Dikes

Case	Item	Samal River				Musi River		Total
		~ 7k000	~ 10k000	~ 16k000	~ 16k600	~ 4k500	~ 5k500	
Case-S1	Dike Height (m)	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	Dike Length (m)	1,300	7,700	6,100	500	8,300	1,100	25,000
	Embankment (m^3)	23,400	138,600	109,800	9,000	149,400	19,800	450,000
	Revetment Work (m^2)	-	-	-	2,250	-	-	2,250
	Foot Protection (m)	-	-	-	500	-	-	500
	Land Acquisition (m^2)	22,100	130,900	103,700	8,500	141,100	18,700	425,000
Case-S2	Dike Height (m)	2.5	2.5	2.5	2.5	2.5	2.5	2.5
	Dike Length (m)	1,300	3,800	6,700	600	10,100	1,500	24,000
	Embankment (m^3)	32,500	95,000	167,500	15,000	252,500	37,500	600,000
	Revetment Work (m^2)	-	-	37,520	3,360	56,560	8,400	105,840
	Foot Protection (m)	-	-	6,700	600	10,100	1,500	18,900
	Land Acquisition (m^2)	24,700	72,200	127,300	11,400	191,900	28,500	456,000
Case	**Item**	**Kobi River**				**Tinupa River**		**Total**
		~ 6k000	~ 9k500	~ 15k000	~ 16k600	~ 4k000	~ 6k500	
Case-K1	Dike Height (m)	2.5	2.0	2.0	2.0	2.0	2.0	2.0
	Dike Length (m)	5,400	4,000	6,400	1,200	3,500	3,200	23,700
	Embankment (m^3)	135,000	72,000	115,200	21,600	63,000	57,600	464,400
	Revetment Work (m^2)	-	-	-	5,400	-	-	5,400
	Foot Protection (m)	-	-	-	1,200	-	-	1,200
	Land Acquisition (m^2)	102,600	68,000	108,800	20,400	59,500	54,400	413,700
Case-K2	Dike Height (m)	2.5	2.5	2.5	2.5	2.5	2.5	2.5
	Dike Length (m)	5,400	4,000	6,400	1,400	3,500	3,200	23,900
	Embankment (m^3)	135,000	100,000	160,000	35,000	87,500	80,000	597,500
	Revetment Work (m^2)	-	-	35,840	7,840	-	17,920	61,600
	Foot Protection (m)	-	-	6,400	1,400	-	3,200	11,000
	Land Acquisition (m^2)	102,600	76,000	121,600	26,600	66,500	60,800	454,100

Note. Embankment is to include sodding.

3.3.2 Cost Estimates

Project costs of the alternative plans were estimated as shown in Table-II.3.9.

Table-II.3.9 Project Costs

Case	Work Item	Unit Cost	Quantity	Cost ($\times 10^6$Rp)	Remarks
	Samal River				
Case-S1	(1) Construction Cost	-	-	14,377	
	(1-1) Embankment	23,000 Rp./m^3	450,000 m^3	10,350	
	(1-2) Revetment Work and Foot Protection	210,000 Rp/m^3	3,375 m^3	709	
	(1-3) Other Cost	-	-	3,318	[(1-1)+(1-2)]×30%
	(3) Indirect Cost	-	-	3,595	(1)×25%
	(4) Land Acquisition Cost	5,000 Rp/m^2	425,000 m^2	2,125	
	(5) Project Cost	-	-	20,077	
Case-S2	(1) Construction Cost	-	-	47,140	
	(1-1) Embankment	23,000 Rp./m^3	600,000 m^3	13,800	
	(1-2) Revetment Work and Foot Protection	210,000 Rp/m^3	158,760 m^3	33,340	
	(1-3) Other Cost	-	-	47,140	[(1-1)+(1-2)]×30%
	(3) Indirect Cost	-	-	11,785	(1)×25%
	(4) Land Acquisition Cost	5,000 Rp/m^2	456,000 m^2	2,280	
	(5) Project Cost	-	-	61,205	
	Kobi River				
Case-K1	(1) Construction Cost	-	-	16,097	
	(1-1) Embankment	23,000 Rp./m^3	464,400 m^3	10,681	
	(1-2) Revetment Work and Foot Protection	210,000 Rp/m^3	8,100 m^3	1,701	
	(1-3) Other Cost	-	-	3,715	[(1-1)+(1-2)]×30%
	(3) Indirect Cost	-	-	4,024	(1)×25%
	(4) Land Acquisition Cost	5,000 Rp/m^2	413,700 m^2	2,067	
	(5) Project Cost	-	-	22,190	
Case-K2	(1) Construction Cost	-	-	43,091	
	(1-1) Embankment	23,000 Rp./m^3	597,500 m^3	13,743	
	(1-2) Revetment Work and Foot Protection	210,000 Rp/m^3	92,400 m^3	19,704	
	(1-3) Other Cost	-	-	9,944	[(1-1)+(1-2)]×30%
	(3) Indirect Cost	-	-	10,773	(1)×25%
	(4) Land Acquisition Cost	5,000 Rp/m^2	454,100 m^2	2,271	
	(5) Project Cost	-	-	56,135	

3.3.3 Optimum Flood Control Plan

Based on the cost estimation results, the most economical alternative plan for each river was selected as the conceptual flood control plan. These plans are as follows:

- Samal River : Case-S1 (Dike Height 2.0 m)
- Kobi River : Case-K1 (Dike Height 2.0 m)

3.4 Implementation Schedule

Implementation schedule of the conceptual flood control plan for Samal River and Kobi River was prepared as shown in Table-II.3.10, assuming embankment quantity of 30,000-35,000m^3/year. Dikes of all the river section are divided into stages and each section is implemented as the staged construction. In principal, dikes are constructed from the downstream of each river.

Table-II.3.10 Implementation Schedule of Conceptual Flood Control Plan

Year / Project and Section	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Samal River																		
(1) Detail Design	■	■	■															
(2) Construction																		
(a) Samal : 6k000~ 7k000 : 7k000~10k000				■	■	■	■	■										
(b) Samal : 10k000~16k600														■	■	■	■	■
(c) Musi : 0k000~5k500									■	■	■	■	■					
Kobi River																		
(1) Detail Design	■	■	■															
(2) Construction																		
(a) Kobi : 3k000~6k000 : 6k000~9k500				■	■	■	■	■										
(b) Kobi : 9k500~16k600									■	■	■	■	■					
(c) Timpa : 0k000~6k500														■	■	■	■	■

3.5 Project Evaluation

3.5.1 Initial Environmental Examination

An initial environmental examination (IEE) was conducted for the Flood Control Conceptual Plan for Pasahari Area based on a brief environmental survey in the project area.

The projects proposed in the Flood Control Conceptual Plan include river dike construction for Samal and Kobi Rivers. The impacts of project implementation on the environment were examined by an environmental examination matrix (Table-II.3.11) with its horizontal axis consisting of columns for project activities that might cause environmental impacts, and vertical axis consisting of tows of environmental elements grouped in 3 categories: social environment, natural environment and environment pollution.

As a result, certain negative impacts are identified on some environmental elements during project construction, but no negative impact is anticipated when the project is put into operation. Explanation on the initial environmental examination is given in the following section.

Table-II.3.11 Environmental Examination Matrix

Environmental Element		Project Activity			
		Construction Phase		Operation Phase	
		Samal R.	Kobi R.	Samal R.	Kobi R.
Social Environment	Resettlement		△		
	Economic Activity	△	△		
	Traffic & Living Facilities		△		
	Archaeological & Cultural Properties				
	Water Right / Right of Common				
	Public Health & Sanitation				
	Solid Waste	△	△		
	Risk of Disaster				
Natural Environment	Topography & Geography				
	Soil Erosion				
	Groundwater				
	Lake and River				
	Coastal Area	△	△		
	Flora & Fauna				
	Meteorology				
	Landscape				
Environment Pollution	Air Pollution				
	Water Pollution	△	△		
	Soil Pollution				
	Noise & Vibration				
	Ground Subsidence				
	Offensive Odor				

△: Possible Negative Impact ×: Significant Negative Impact Shade: No Negative Impact

(1) Social Environment

Near Samal River and its tributary Musi River, although there are 3 villages: Samal, Wai Musi and UPT L (a new transmigration village on the left bank of Samal River), since the residential area is more than 200-300 m from the river bank, dike construction will not result in relocation of any houses. However, there is one village (Seti Bakti) located no more than 20 m from the right bank of Kobi River. It is a local village of 33 household with 145 villagers. Some of the houses may have to be relocated when river dikes are constructed. A resettlement plan may be required.

Along both Samal and Kobi Rivers, there exist large areas of coconut trees. Many villagers depend on coconuts selling for a part of income besides agriculture. Since some of the coconut trees near the river bank may have to be destroyed before the dike construction, impacts on economic activity is anticipated.

For Kobi River, certain impacts on living facilities are related to the resettlement problem.

Large quantity of solid waste will be generated during dike construction. However, since Pasahari is not a densely populated area, finding suitable place for waste disposal may not be very difficult.

For the other items within social environment category, no negative impact is anticipated.

(2) Natural Environment

Since river dike construction is limited to the river side area, and the work is not in a great scale, its impacts on natural environment may not be significant. The only impact anticipated is on coastal area from the runoff of river sediment. Its quantity may increase during dike construction. Therefore, counter measures have to be taken to mitigate the impacts.

(3) Environmental Pollution

Impacts of project construction on water quality are also from the increase in sediment quantity. No other pollutant sources are anticipated.

Noise and vibration will be generated during construction work. However, since Pasahari is a rural area and along the 2 rivers there are a few villages but almost no public facilities, the impact will be negligibly small. Impacts on the other items related to environment pollution are negligible or may not happen at all.

3.5.2 Economic Evaluation

(1) Yearly Average of Damage Alleviation

The following table shows the yearly averages of damage alleviation of Samal River and Kobi River at a 20 year return period, estimated by the Study Team:

Table-II.3.12 Yearly Averages of Damage Alleviation at a 20 Year-Return Period

Name of River	Yearly Average of Damage Alleviation
Samal River	Rp 1,657 million
Kobi River	Rp 768 million

Source: Study Team

(2) Economic Analysis

(a) Assumptions for Economic Analysis

Economic analysis was conducted under the following assumptions:

- Price level : End of December 1996
- Design scale : 20-year Return Period
- Project life : 50 years
- Maintenance costs : 0.5% of the total construction costs per year
- Standard conversion rate : 85%
- Growth rate of property value : Until 2010 : 6.0% per annum
  From 2011 : 1.6% per annum

<Price Level>
The price level for the estimation of costs and benefits was set at the end of December 1996. The exchange rate for the Master Plan was fixed at Rp 2,500 to US$ 1.00 for calculation purposes.

<Design Scale>
The design scale was set at 20-year return period, taking into account that damage alleviation is not expected to increase significantly when the design scale is raised to more than 20-year return period.

<Project Life>
The economic life of the project was set at 50 years; the residual value of the facilities is considered to be zero after 50 years when they will need to be replaced.

<Maintenance Costs>
The maintenance work is assumed to require 0.5% of total construction costs every year. The maintenance activities will be necessary from the year following completion of construction until the last year of the project life.

<Standard Conversion Rate>
Taxes and duties must be deducted from financial costs in order to obtain economic costs. 0.85 was used for the standard conversion rate.

<Growth Rate of Property Value>

The value of the houses in the Pasahari Area is expected to increase significantly in accordance with the increase in rice production resulting from the completion of construction of irrigation facilities. The residents' income in the area is expected to be doubled by 2010 and most of their houses, which are currently in poor condition, will be upgraded. The Study assumed a 6.0% increase per year in property value until 2010, while from 2011, a 1.5% increase per year is assumed to be achievable due to an increase in agriculture productivity and residents' opportunities to work in cities during agricultural off-seasons.

(b) Economic Analysis and Sensitivity Analysis on Samal River

Table-II.3.13 shows the results of economic analysis on the construction of the flood control facilities in Samal River, on the assumption that the facilities are constructed in three stages. Since a 16.0% IRR will be achieved in this Project component, the construction of the flood control facilities in Samal river is judged to be economically feasible.

Table-II.3.13 Economic Cost, NPV, B/C and IRR of Samal River

Stage	Economic Cost	NPV at 10%	B/C at 10%	IRR
1st Stage	Rp 5,688 million	Rp 7,885 million	1.88	16.0%
2nd Stage	Rp 5,688 million			
3rd Stage	Rp 5,688 million			
Total	Rp 17,065 million			

Table-II.3.14 shows the results of sensitivity analysis under the assumption of follow:

1) Case-1 : the growth rate in property value in the Study Area is 3 % per year until 2010.
2) Case-2 : the construction cost increases by 10%.

The Project component is economically feasible in either case since their IRR are above 12%.

Table-II.3.14 Sensitivity Analysis - Samal River

NPV at 10%		Internal Rate of Return (IRR)	
Case-1 3 % Increase in Property Value	Case-2 10% Increase in Cost	Case-1 3 % Increase in Property Value	Case-2 10% Increase in Cost
Rp 2,449 million	Rp 6,985 million	12.1%	15.0%

(c) *Economic Analysis and Sensitivity Analysis on Kobi River*

Table-II.3.15 shows the results of economic analysis on the construction of the flood control facilities in Kobi River, under the same assumption as that of Samal River. Economic feasibility on the construction of Kobi River flood control facilities is marginal: its IRR is 8.2%.

Table-II.3.15 Economic Cost, NPV, B/C and IRR of Kobi River

Stage	Economic Cost	NPV at 10%	B/C at 10%	IRR
1st Stage	Rp 6,287 million	- Rp 2,122 million	0.79	8.2%
2nd Stage	Rp 6,287 million			
3rd Stage	Rp 6,287 million			
Total	Rp 18,862 million			

Table-II.3.16 shows the results of sensitivity analysis on Kobi River under the same assumption as those for Samal River.

Table-II.3.16 Sensitivity Analysis - Kobi River

NPV at 10%		Internal Rate of Return (IRR)	
Case-1 3 % Increase in Property Value	Case-2 10% Increase in Cost	Case-1 3 % Increase in Property Value	Case-2 10% Increase in Cost
- Rp 4,641 million	- Rp 3,116 million	5.5%	7.5%

Under the assumption that property value increase by 3% per year, construction of flood control facilities in Kobi River is not economically justifiable. However, it should be noted that flood control facilities in Kobi River can be used as roads which have additional impact on the local economy, although its benefits are difficult to quantify due to lack of traffic data.

The future development plan of the Pasahari Area is currently not yet defined by the Government. The feasibility of the construction of Kobi River's flood control facilities cannot be judged at this moment since it is contingent on future development prospects of the area.

CHAPTER 4 RECOMMENDATIONS

(1) Further Stages of the Conceptual Plan

The flood control measures on Samal and Kobi Rivers in Pasahari were proposed as a conceptual plan, based on the following concept: 1) low cost river improvement works, 2) river dikes planned widely surrounding the current river course, 3) economical flood control measures and 4) multi-purpose dikes. As Pasahari area has high potential for agricultural production, further stages of flood control plan and implementation, such as Master Plan, Feasibility Study, Detail Design and Construction should proceed in line with irrigation projects.

(2) Continuous Effort of Collecting Hydrometric Data

There are daily rainfall data in Pasahari but no hourly rainfall data. As for water level and discharge data in Samal and Kobi Rivers, there are practically no available data. For the further study of not only flood control plan but also irrigation projects, hydrometric data, such as rainfall data and river discharge data is needed. As hydrometric stations were installed in this Study, these data should be continuously measured, stored and processed.

(3) Land Use Regulation

The river dikes were planned widely surrounding the current river course. The planned river width is set at 1,400-1500 m in the downstream of Samal and Kobi Rivers, with the dike height of 2.0-2.5 m. The area between dikes (inside area of the rivers) has very wide space and people may want to utilize the area as a residential area or agricultural land. However it should be reminded that this area is the area inside of the rivers and is prone to flooding. Thus land use regulation for the area between dikes is needed. These areas should be utilized as farm land for inundation-proof crops, not as a residential area.

APPENDICES

APPENDIX - A

List of JICA Advisory Committee Members

No.	Name	Position in Committee
1	Shigeru YAMAMOTO	Leader / Flood Control Measures
2	Hidetomi OI	Flood Control Planning
3	Yukihiro OKAMURA	Watershed Management

APPENDIX - B

List of Steering Committee Members

No.	Name	Position / Organization	Pos. in Committee
1	Ir. Krenius MARPAUNG	Director of Bina Program (Program Development)	Chairman
2	Dr.Ir. Hafied A. GANY	Director of PPSDA (Water Resources and Conservation)	Member
3	Ir. Marhuarar NAPITUPULU	Director of Bina Teknik (Technical Development)	Member
4	Ir. Susilo SOEKARDI	Secretary of Directorate General DGWRD	Member

APPENDIX - C

List of Technical Committee Members

No.	Name	Position / Organization	Pos. in Committee
1	Dr.Ir. M.S. LATUCONSINA	Head of BAPPEDA Maluku	Chairman / Member
2	Ir. Pieter MUSTAMU	Head of Sub-Dinas Pengairan Dinas PU Maluku	Secretary / Member
3	Ir. HANDRADJADI	Head of Regional Office PU Maluku	Member
4	Ir. Tedjo PURNOMO	Head of Dinas PU Maluku	Member
5	Drs. W. TUHUMURY	Head of Regional Office BPN Maluku	Member
6	Colonel GUNAWAN	Head of Dit. Social Political Maluku	Member
7	Ir. J. SURIPTO	Head of Regional Office Ministry of Forestry Maluku	Member
8	Drs. J. SOPLANIT	Head of BAPPEDA Ambon	Member
9	A.M. LATUCONSINA	Head of BAPPEDA Central Maluku	Member
10	Drs. H.M. SEMARANG	Chief of Physical & Infrastructure Division BAPPEDA Maluku	Member
11	Ir. Willy SOEWITO	Chief of Sub-Dinas Cipta Karya Dinas PU Maluku	Member
12	Ir. A. SIHALOHO	Chief of Sub-Dinas Bina Marga Dinas PU Maluku	Member
13	Ir. Adi SARWOKO	Head of Sub-Dit Binlak Wil Tim III DGWRD	Member
14	Ir. Mohammad HASAN	Head of Sub-Dit of General Planning Bina Program DGWRD	Member
15	Ir. Ketut KALER	Head of Sub-Dit River Bintek DGWRD	Member
16	Ir. Budi ATMADI	Head of Sub-Dit Water Resources & Conservation PPSDA DGWRD	Member
17	Drs. Effendi MANSYUR	Head of Legal Division DGWRD	Member
18	Satoto BASUKI	Project Manager PSAPB (Water Resources & Flood Control) Maluku	Member

APPENDIX - D

List of JICA Study Team Members and Counterparts

No.	Name	Position in Study Team
	JICA Study Team	
1	M. WATANABE	Team Leader
2	K. NAGATA	Flood Control
3	J. KOJIMA	Facility Plan
4	T. FUKUDA	Construction Plan / Cost Estimate
5	D.J. MERRETT	Hydrology / Hydraulics
6	N. FUJISAKI	Flood Analysis
7	N. UCHISETO	Topography / Geology
8	S. MORI	Socio-economy / Land Use
9	X. WANG	Environment
10	H. GOTO	Surveying
11	T. KUWABARA	Coordinator
	Team Counterparts	
1	A.R. MADJID	Flood Control
2	J.A. SILOOY	Facility Plan
3	E. POLOLESSY	Facility Plan
4	E. IRLAND	Construction Plan / Cost Estimate
5	A. RUSMANA	Hydrology / Hydraulics
6	PRIYONO	Flood Analysis
7	WIYONO	Flood Analysis
8	A.R. MULYANA	Topography / Geology
9	S. BAMBANG	Topography / Geology
10	I. SAIFANNUR	Socio-economy / Land Use
11	W. GIRSANG	Socio-economy / Land Use
12	R. OSZAER	Environment
13	E. HUWAE	Surveying