CHAPTER 2 FLOOD RUNOFF ANALYSIS

2.1 Division of Catchment Areas

The division of the Wai Samal and Wai Kobi catchment areas is shown in Figure-N.2.1. The main discharge reference points were chosen as the existing road bridges near the downstream of both rivers. In addition, the confluence of the tributaries of Wai Musi and Wai Tinupa were taken as discharge reference points. The catchment area, river length and average slope associated with each of the reference points are given in Table-N.2.1.

Table-N.2.1 Division of Samal and Kobi Catchment Areas

River	Catchment Area (km^2)	River Length (km)	Max. Elev (m)	Min. Elev (m)	Slope
Samal - Total to Bridge	260.4	45.1	1300	16	1/35
Samal Free Intake	152.7	30.4	1300	40	1/24
Intake - Bridge	20.4	14.7	40	16	1/612
Wai Musi	87.3	35.5	500	20	1/74
Kobi - Total to Bridge	264.0	42.5	800	3	1/53
Kobi Free Intake	177.8	32.1	800	20	1/41
Intake - Bridge	28.1	10.4	20	3	1/612
Wai Tinupa	58.1	24.2	350	5	1/70

2.2 Estimation of Peak Discharge by Rational Formula

Rainfall Intensity

The rainfall intensity curve for the Seram area was calculated using the probable daily and probable hourly rainfall data for Kairatu meteorological station. In order to calculate the flood runoff in the Pasahari area, it is necessary to take into account the differences between Kairatu and Kobisonta stations, and the effect of altitude on the mean rainfall in the Samal and Kobi river basins. As the annual mean rainfall is similar for both Kairatu and Kobisonta, it is reasonable to use the Kairatu rainfall intensity curve multiplied by a factor of 1.5 (to allow for increased altitude in the upper Samal and Kobi basins) to calculate the peak discharge for various return periods, as described in the following sections.

Runoff Coefficient

The runoff coefficient used in the Rational Formula is determined based on the topography, ground cover, vegetation and land use in the catchment area. As explained previously, the value of runoff coefficient adopted can vary between 0.5 and 0.9, depending on the condition of the catchment area. Typical values for different types of land use for rivers in Japan are presented in Table-N.2.2. Referring to the values of runoff coefficient proposed for "Irrigated paddy field : 0.7 - 0.8", "Mountainous land : 0.7" and "Rugged land and forests : 0.50 - 0.75", a value of runoff coefficient f = 0.7 is adopted for the rivers in the Pasahari study area.

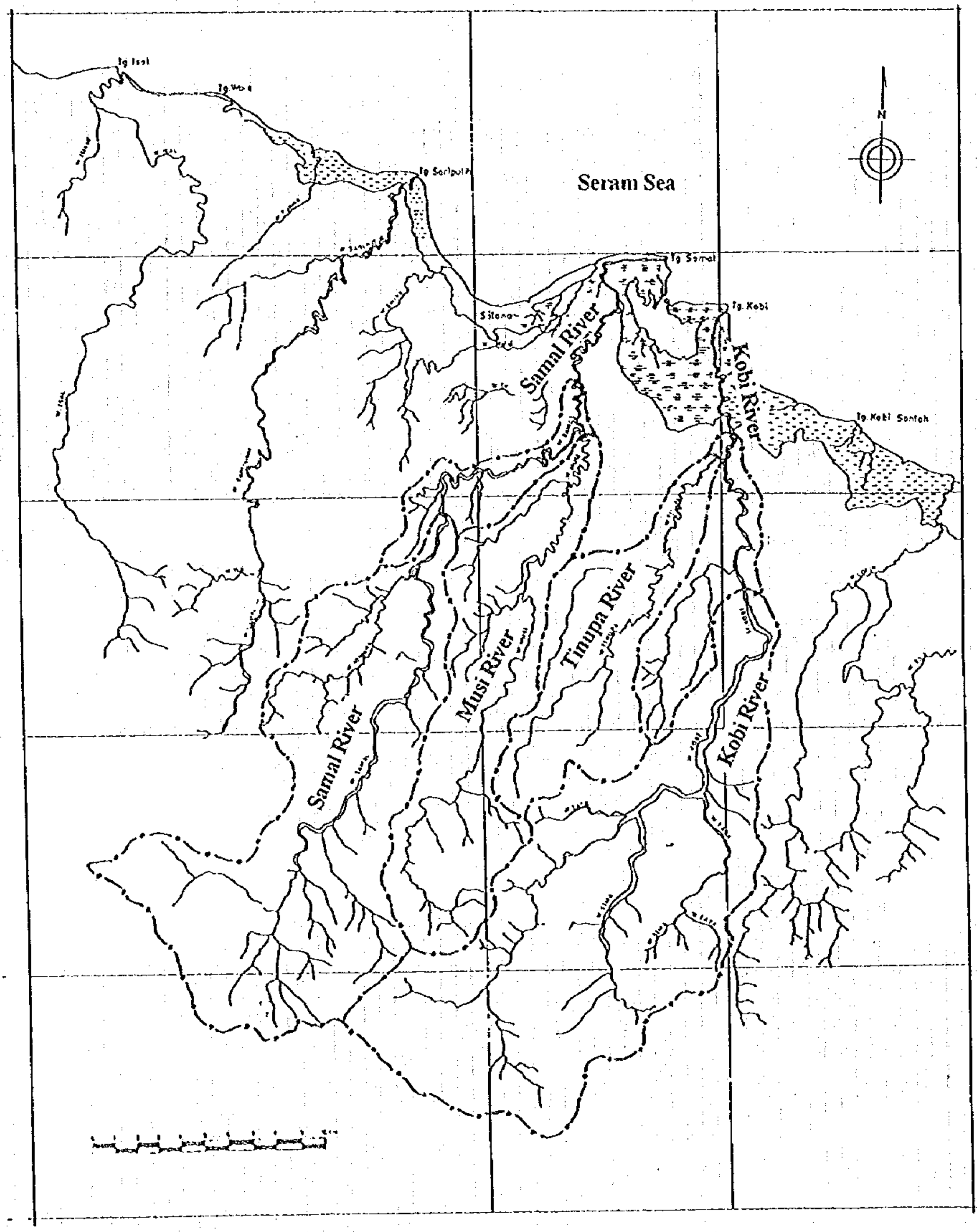

Figure-N.2.1 Division of Samal and Kobi Catchment Areas

Table-N.2.2 Proposed Values of Runoff Coefficient

Planning Value Proposed by "Manual for River Works in Japan, Planning"		Rivers in Japan proposed by Monobe	
Land Use	Runoff Coefficient	Land Use	Runoff Coefficient
Dense urban area	0.9	Steep mountainous region	0.75 - 0.90
General urban area	0.8	Mountains of Tertiary strata	0.70 - 0.80
Farm land and field	0.6	Rugged land and forests	0.50 - 0.75
Paddy field	0.7	Flat cultivated land	0.45 - 0.60
Mountainous land	0.7	Irrigated paddy field	0.70 - 0.80
		Rivers in mountainous region	0.75 - 0.85
		Small rivers in level land	0.45 - 0.75
		Large rivers with over half of the catchment in flat land	0.50 - 0.75

Time of Flood Concentration

The time of flood concentration is estimated by Kraven's formula, given below, and the results are shown in Table-N.2.3.

Kraven's Formula $Tp = L1 / W$

where:

Tp : Time of Flood Concentration (sec)
L 1 : Length of main water course (m)
I 1 : Slope of main water course
W : Flood runoff velocity (m/sec)

I	over 1/100	1/100 - 1/200	below 1/200
W	3.5 m/sec	3.0 m/sec	2.1 m/sec

Table-N.2.3 Time of Flood Concentration (Kraven's Formula)

River Basin	C.A. (km^2)	Elevation (m)		Length L 1 (m)	Slope I 1	W (m/sec)	Tp (min)
		Highest	Lowest				
Wai Samal	173.1	1300	16	45100	1/35	3.5	215
Wai Musi	87.3	500	20	35500	1/74	3.5	169
Wai Kobi	205.9	800	3	42500	1/53	3.5	202
Wai Tinopa	58.1	350	5	24200	1/70	3.5	115

Peak Discharge by Rational Formula

The peak flood discharge was calculated for various return periods using the Rational Formula, as shown below :

Rational Formula $Qp = (1 / 3.6) . f . R . A$

where:

Qp : Peak flood discharge (m^3/sec)
f : Dimensionless runoff coefficient (f = 0.7 for Pasahari)
R : Rainfall intensity during time of flood concentration (mm/hr)
Tp : Time of flood concentration (hrs)
A : Catchment area (km^2)

The rainfall intensity R is estimated using the Talbot Formula with coefficients calculated from the daily and hourly rainfall data.

Talbot Formula : $R = a / (Tp + b)$

where:

- R : Rainfall intensity during time of flood concentration (mm/hr)
- Tp : Time of flood concentration (hrs)
- a, b : Coefficients determined from hourly and daily rainfall data

The results of the peak discharge calculation, and the corresponding specific discharge for each return period, are given in Table-N.2.4. These results are used in the Flood Control Plan for the Pasahari area presented in Chapter 4.

Table-N.2.4 Peak Flood and Specific Discharge by Rational Formula

Discharge Ref. Point	C.A. (km2)	Tp (min)	Peak Discharge (m3/sec) 2	5	10	15	20	25	30	50	70	100	200
Talbot Formula Coeff (a)			170.7	210.4	240.4	258	270.7	280.5	288.6	311	325.6	341.5	372.3
Talbot Formula Coeff (b)			1.723	2.009	2.187	2.276	2.341	2.388	2.429	2.526	2.582	2.643	2.749
WAI SAMAL													
Free Intake	152.7	215	955	1117	1237	1307	1356	1395	1425	1511	1568	1629	1746
Before Confl.	171.0		1070	1251	1385	1464	1519	1562	1596	1693	1756	1824	1955
Wai Musi	87.3	169	638	740	816	860	891	915	934	988	1024	1062	1135
After Conf.	258.3		1708	1990	2201	2324	2410	2477	2530	2681	2780	2886	3090
Road Bridge	260.4		1721	2006	2218	2342	2428	2496	2549	2702	2801	2908	3114
Specific Discharge (m3/sec/km2)			6.61	7.70	8.52	8.99	9.33	9.59	9,79	10.37	10.76	11.17	11.96
WAI KOBI													
Free Intake	177.8	202	1160	1353	1497	1581	1639	1685	1721	1825	1892	1965	2105
Before Confl.	204.5		1334	1556	1722	1818	1885	1938	1980	2099	2177	2260	2421
Wai Tinopa	58.1	115	530	605	662	695	718	736	750	791	818	846	901
After Conf.	262.6		1864	2161	2384	2513	2604	2675	2730	2890	2994	3106	3322
Road Bridge	264.0		1873	2172	2395	2526	2616	2688	2741	2904	3009	3121	3339
Specific Discharge (m3/sec/km2)			7.09	8.23	9.07	9.57	9.91	10.18	10.39	11.00	11.40	11.82	12.65

CHAPTER 3 FLOOD DAMAGE ANALYSIS

3.1 Flood Damage

3.1.1 Field Survey

The flood damage survey has been carried out in the flooded area of Samal River and Kobi River in Pasahari Area. In the flood damage survey, three major floods and the annual flood were investigated as shown in Table-N.3.1.

Table-N.3.1 Investigation Flood of Damage Survey

Flood Name	Daily Rainfall (mm) [Kobisonta Station]	Hourly Rainfall	Return Period*1
1988/01/27 Flood	145.8	-	1/10
1992/04/03 Flood	108.9	-	1/5
1996/02/19 Flood	63.1	-	1/1
Annual Flood	-	-	under 1 year

*1 : These were estimated with daily rainfall data comparing with probable daily rainfall..

The interview survey of flood damage was conducted at 37 points in Samal River and at 15 points in Kobi River and the interview at each location included the following :

1) Residential house or business
2) House / building value
3) House / building was flooded or not.
4) Flood water depth above floor
5) Inundated hours of houses
6) Cause of flooding ?
7) House / building was damaged or not.
8) Approximate cost of the damage to house / building
9) Number of days necessary to clean / repair house / building
10) Contents / possessions of house / building lost or damaged ?
11) Damage cost of contents / possessions of house / building
12) Number of casualties ?

3.1.2 Survey Results

Transmigration to Seram Island started in the fiscal year 1982/83. However, since residential houses are still widely scattered and government organizations do not exist in the Pasahari Area, the flood damage information from inhabitants and government organizations was difficult to obtain. Accurate flood damage data could be collected only for the 1996 flood, so that the other flood damages were estimated / assumed based on the 1996 flood damage data and a little memory of inhabitants. The duration of inundation was collected only for transmigration settlement area with no data for the irrigated paddy fields. According to the interview, the duration of inundation ranges from 0.5 hours to 24 hours in Samal River, and 1 hours to 28 hours in Kobi River.

Based on the survey mentioned above, inundation area of each flood and each river were drawn in Figure-N.3.2. Inundation area, inundation flood water depth, and inundation hours of damaged houses are summarized in Table-N.3.2 and Figure-N.3.1.

Table-N.3.2 Features of Past Flood Damage

Item	Flood	Samal River		Kobi River	
		Ave.	Max.	Ave.	Max.
Flooded Area (ha)	1988	1048	-	607	-
	1989	912	-	482	-
	1996	117	-	160	-
	Annual	75	-	9	-
Flood Water Depth (cm)	1988	73	100	73	100
	1989	69	100	63	100
	1996	45	100	50	100
	Annual	25	80	43	50
Inundation Hours (hour)	1988	19	24	19	28
	1989	13	24	15	24
	1996	3	12	5	8
	Annual	2	6	9	12

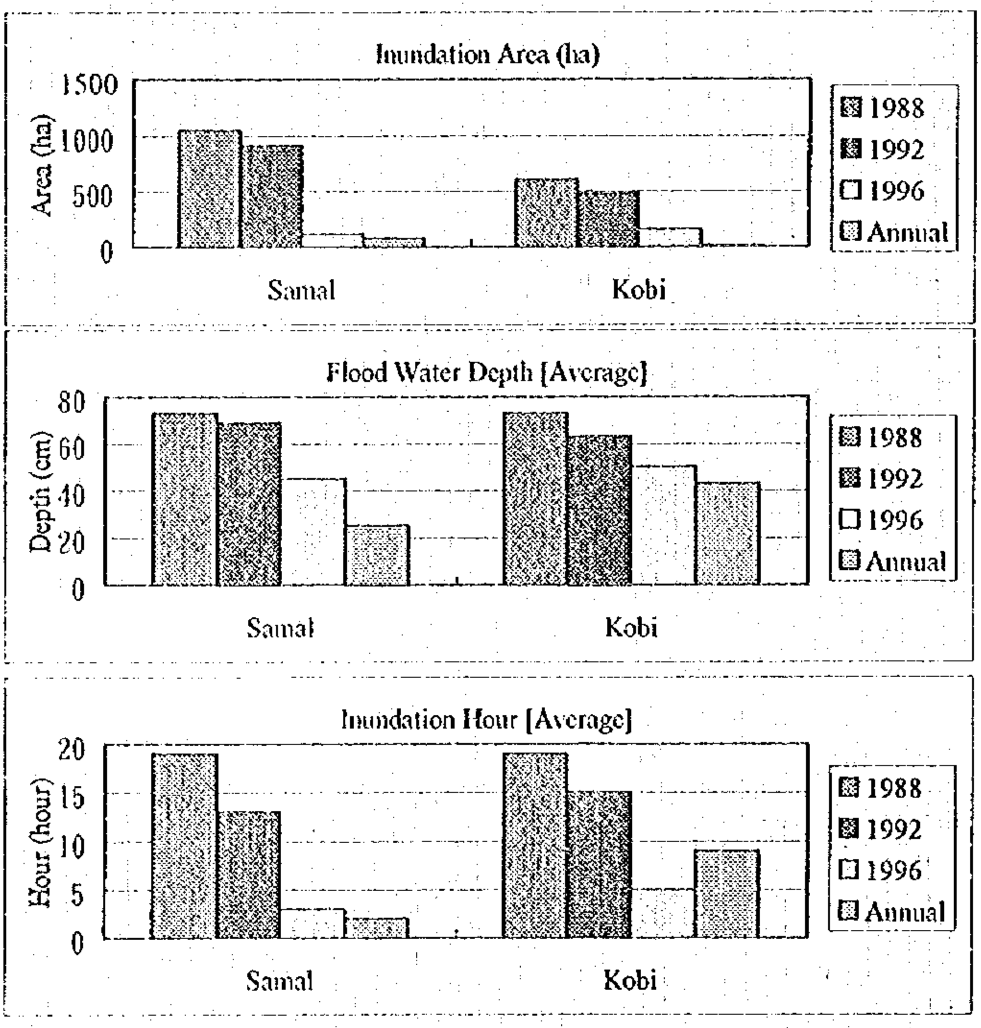

Figure-N.3.1 Features of Past Flood Damage

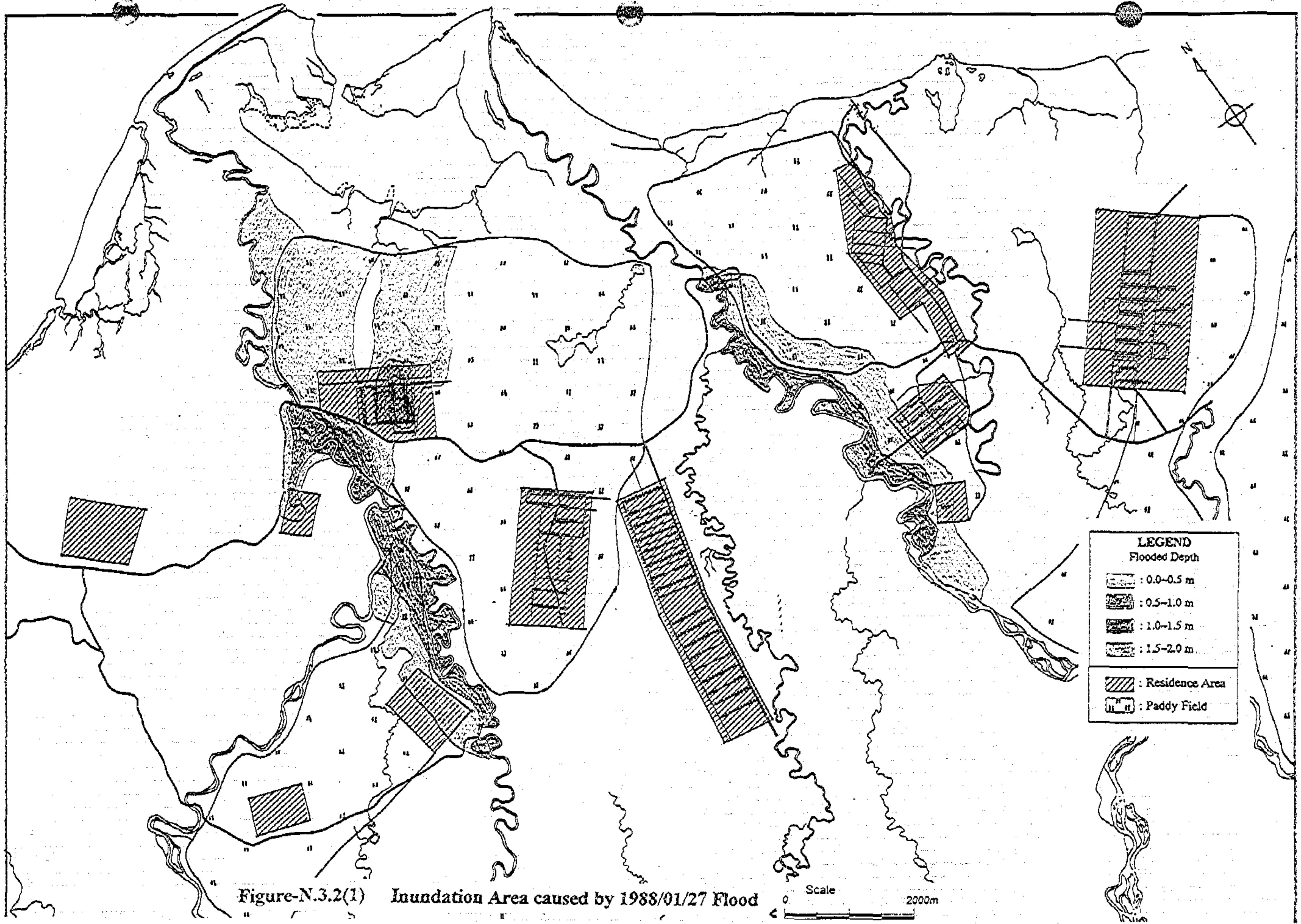

Figure-N.3.2(1) Inundation Area caused by 1988/01/27 Flood

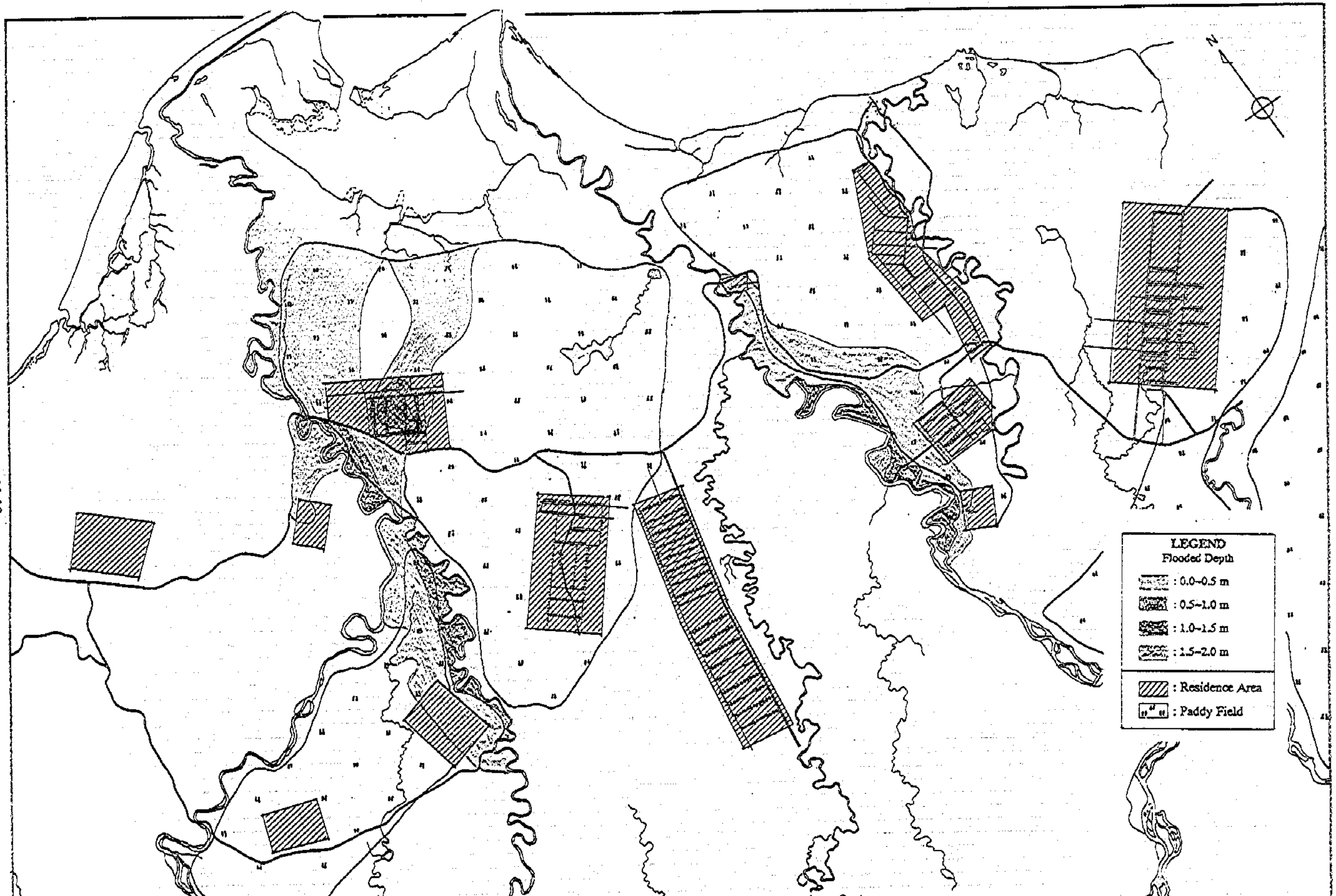

Figure-N.3.2(2) Inundation Area caused by 1992/04/03 Flood

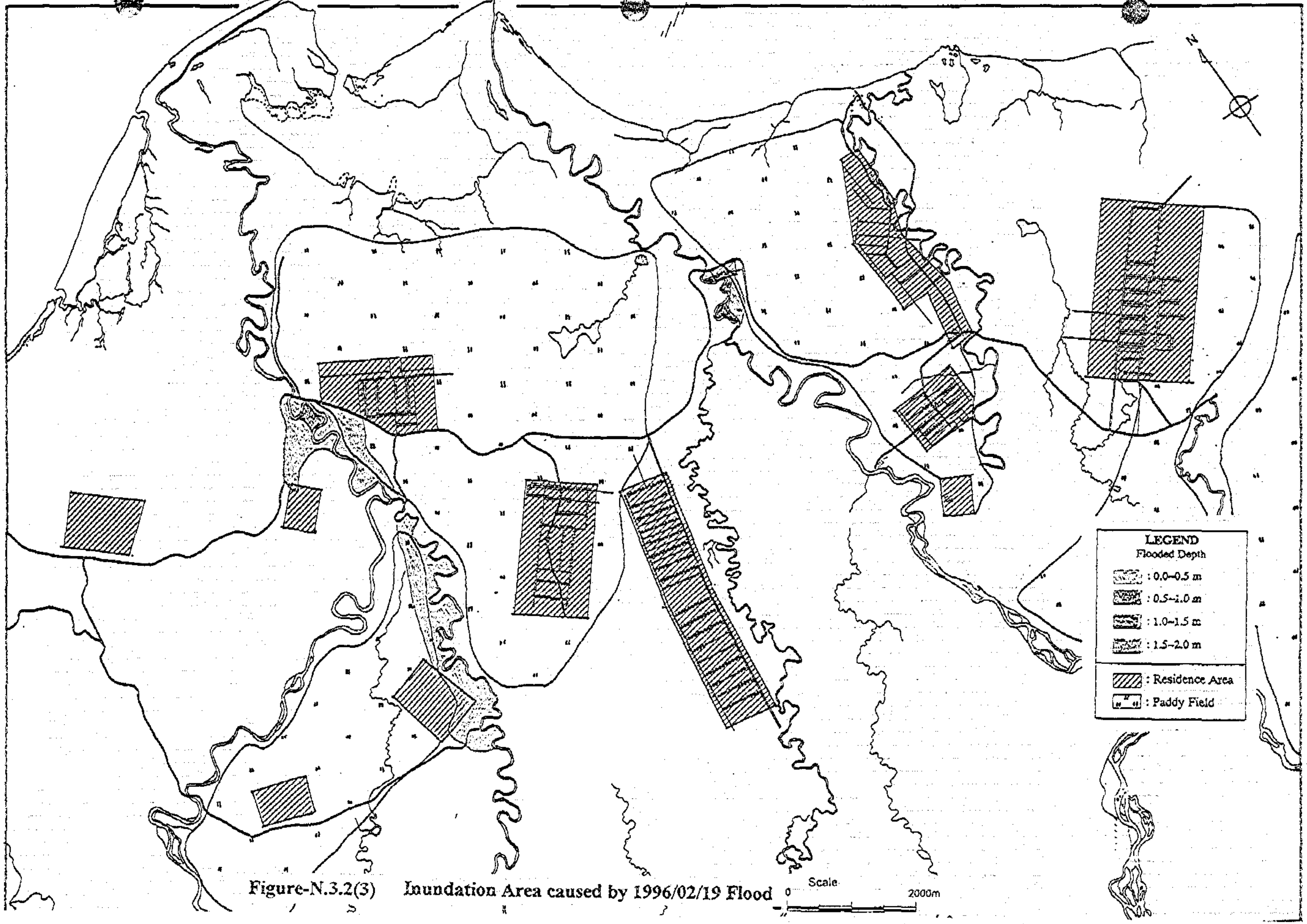

Figure-N.3.2(3) Inundation Area caused by 1996/02/19 Flood

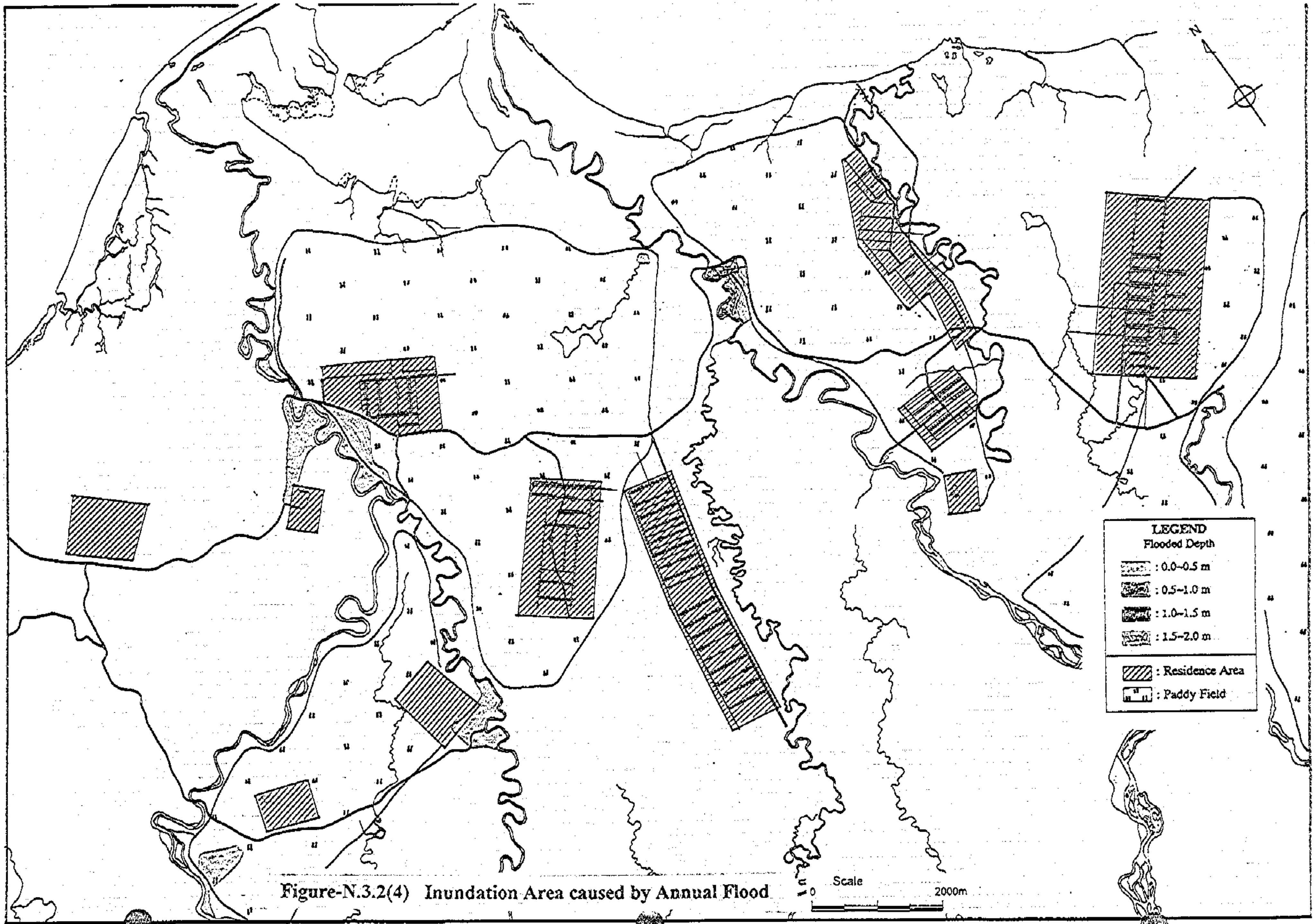

Figure-N.3.2(4) Inundation Area caused by Annual Flood

3.2 Flood Forecasting and Warning System

3.2.1 Field Survey

The survey of flood forecasting and warning system was carried out mainly based on the following interview with inhabitants in the Pasahari Study Area and government authorities in Ambon and Seram.

To Inhabitants

- Personal Identity (Name / Age / Address/ Date of Birth / Social Position)
- Is there any forecasting about flood disaster ?
- From where the information about the coming-up flood forecasting is received ?
- In what form is the information found ?
- The expected information about the coming-up flood disaster forecasting ?
- Is there any warning system against the flood disaster from the people ?
- Is there any warning system against the flood disaster from the government ?
- The steps that have been taken when the flood was occurring.
- Which preparations have been taken to anticipate the flood disaster ?
- What kind of aid ever received from the work team for overcoming calamity when the flood was occurring.
- Is there any proposal about the warning system if the flood disaster occur.

To Government Authority

- Name of Authority
- Position in Work team
- Are there any currently forecasting data on the coming-up flood disaster ?
- From where were the forecasting data on the flood disaster received ?
- Is there any plan to make the coming-up flood disaster forecasting ?
- Is there any warning system against the flood disaster that coordinated by the
- District Government ?
- Is there any plan to make the warning system against the flood disaster ?
- The steps that have been taken when the flood calamity was occurring.
- Is there any training/exercising to anticipate the flood ?
- The primary job of this authority in overcoming the flood ?

The survey sample for concerned organizations included government agencies involved in the development of the Pasahari area and consisted of only 4 organizations, none of which is actually situated in Pasahari. The sample for inhabitants was randomly selected from the residents who live in the flooded areas. Five persons for each river were selected.

3.2.2 Survey Results

(1) Flood Forecasting System

Floods, as one of the disasters facing human life in traditional society, can be forecast by interpreting natural indicators such as rainfall. For inhabitants in Pasahari, flood forecasting is only based upon experienced rainy season in December, January and February. Simple methods of flood forecasting by the indigenous people include the observation of very dark rain clouds in the mountainous upstream regions and the fact that large floods tend to occur every four years, usually after the long period of the dry season. Although there are government offices in Masohi and Wahai, there is no government office in Pasahari and actually no formal methods of flood forecasting.

(2) Flood Warning System

As mentioned above, there are no government offices in the Pasahari area and those at Wahai or Masohi are too far from the flood prone area to provide any flood forecasting or flood warning facilities. For the people living in the study area, generally they do not have any flood warning system and the only warning method is by shouting on the river banks.

(3) Flood Fighting Activity

There are no flood fighting activities in the Pasahari area organized by the Government offices or related organizations in Wahai or Masohi. Reasons for this include the distance from Pasahari and the fact that the flooded area is largely uninhabited land, such as paddy fields and other agricultural land. In the Pasahari area, the Chief of the village or the transmigration settlement unit in the flooded area usually coordinates the food aid or evacuation procedures. Informal army (Hansip) action coordinates security during the occurrence of floods and the evacuation period.

There are no flood fighting procedures during times of flood and activities are limited to evacuation only. After flooding, the condition of roads, irrigation canals and other public facilities is assessed and reported to the Government. From the result of the survey, it is obvious that people expect flood protection countermeasures for any vital public facilities such as the irrigation network, the Samal and Kobi road bridges and the transportation facilities.

3.3 Flood Damage Analysis

3.3.1 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.

3.3.2 Estimation of Past Flood Damage

The damage caused by the past three major floods and annual flood was estimated in the following way.

(a) 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-N.3.3 shows the standard asset damage rate applicable in Japan.

Table-N.3.3 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-N.3.4), 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-N.3.4 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

(b) 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.

(c) 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-N.3.5 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.

(d) Estimation of Past Flood Damage

The three past flood damages and annual flood damage are estimated and are shown in Table-N.3.6.

Table-N.3.6 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

3.3.3 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-N.3.3.

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-N.3.7.

Table-N.3.7 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-N.3.8 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

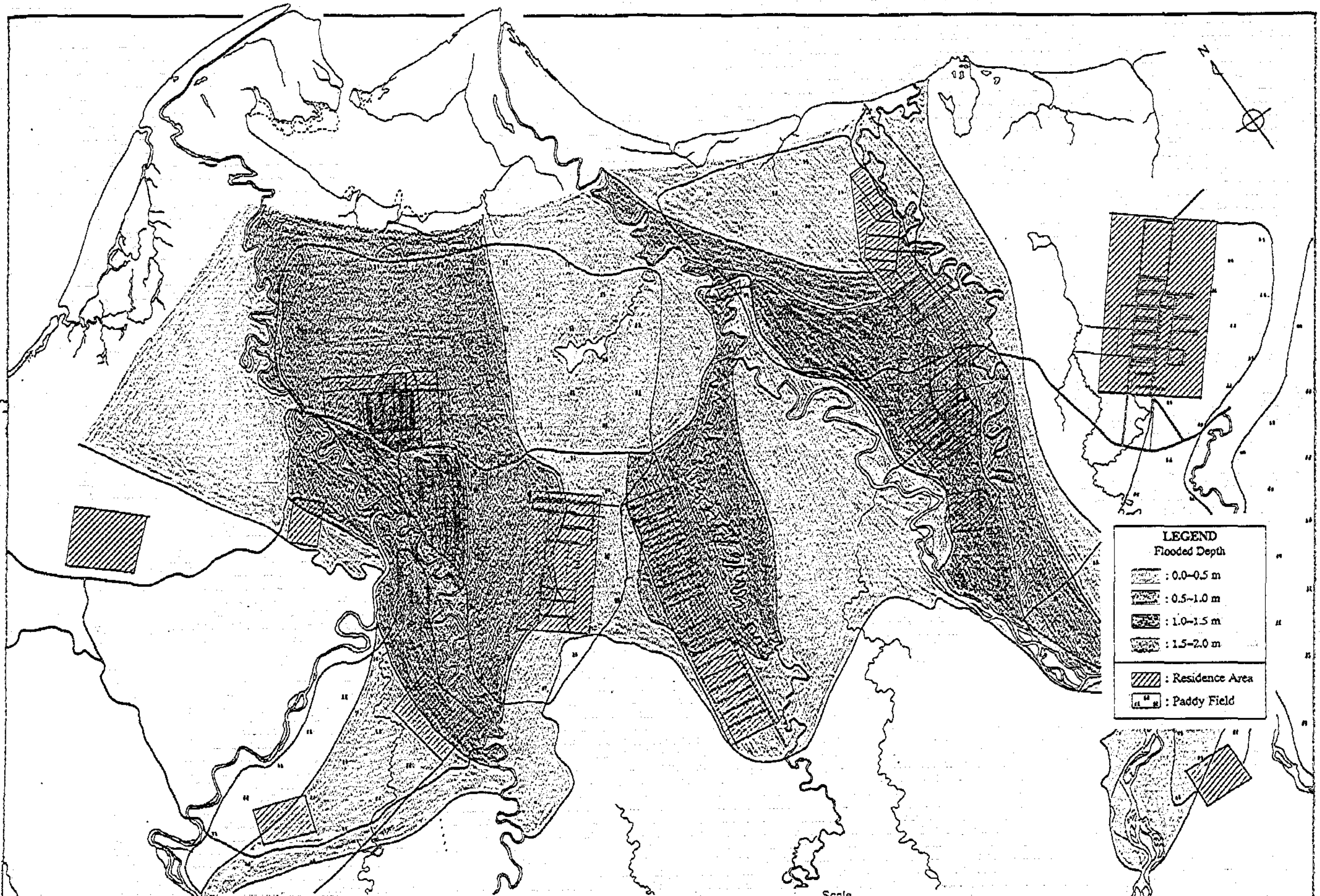

Figure-N.3.3 Estimated Flooded Area with 100-year Return Period

3.3.4 Flood Discharge - Damage Curve

(a) 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-N.3.9.

Table-N.3.9 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	Samal at River Mouth	2218	2006	1520
(m^3/sec)	Kobi at River Mouth	2395	2172	1670

Source : JICA Study Team

(b) 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-N.3.10.

- 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-N.3.10 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-N.3.11, Figure-N.3.4 and Figure-N.3.5.

Table-N.3.11 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

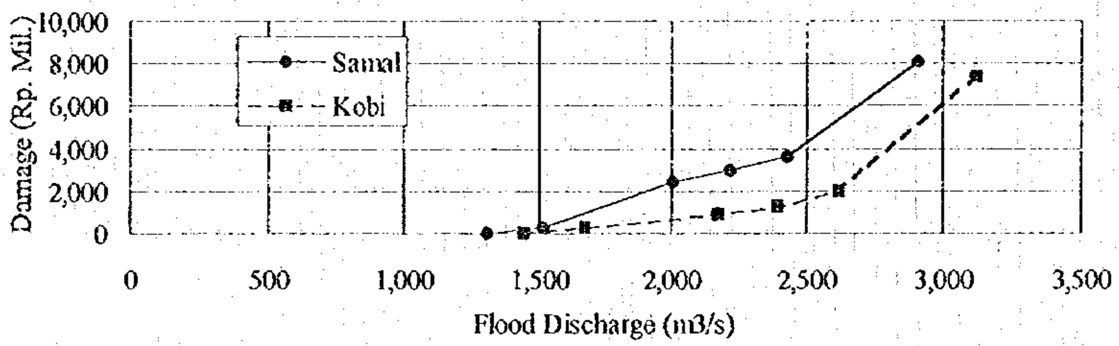

Figure-N.3.4 Flood Discharge - Damage Value Curve

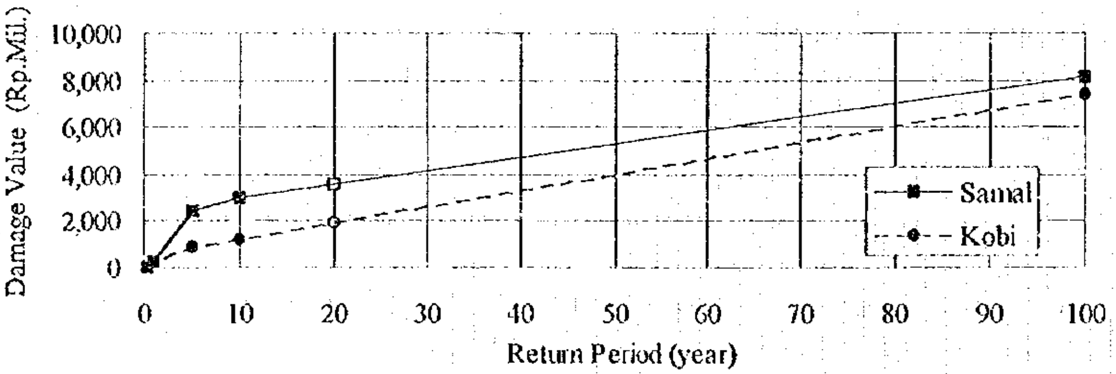

Figure-N.3.5 Flood Return Period - Damage Value Curve

CHAPTER 4 FLOOD CONTROL PLAN AND DESIGN

4.1 Basic Policy of Flood Control Plan

4.1.1 Principal Conditions of Plan

(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 Chapter 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

Table-N.4.1, referring to "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. The table shows the variation of the previous design flood return period. 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-N.4.2. 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 recommended for the Flood Control Conceptual Plan in the Pasahari Area.

Table-N.4.1 Design Flood Return Period Used in Indonesia

Project Name	Location	Design Recurrence Interval (Years)					
		Agricultural Development		Rural Development		Urban/Industrial Development	
		Short Term	Long Term	Short Term	Long Term	Short Term	Long Term
Cimanuk and Cisanggarung River Basin Development Project	West Java	10 - 15	25 - 50	10 - 15	25 - 15	25 - 50	25 - 50
Citaduy River Basin Development	West Java	25	50	25	50	25	50
South Kedu Multipurpose Project	Central Java	5 - 15	15 - 20	15	20	15	20
Solo River Basin Development	Central Java	5 - 10	50	10	50	10 - 50	50
Brantas River Basin Development	East Java	10 - 25	50	25	50	25	50
Pemali Flood Control	Central Java	5	25	5	25	5	25
Jakarta Metropolitan Flood Control	West Java	25	100	-	100	-	100
Krueng Aceh Flood Control	Aceh	5	-	5	-	5	-
Lower Asahan River Flood Control	North Sumatra	25	-	25	-	25	-
Padang Urban Flood Control	West Sumatra	25	50	25	50	Varies	50
Jeneberang River Basin Development	South Sulawesi	Varies	50	25	50	25	50

Notes :
1) Flood control projects in Indonesia are often implemented in stages depending on the availability of funds. Accordingly, a lower level of flood protection is provided initially, but a higher level of protection is provided in the long term, after other works are implemented.
2) Area Division
   Agricultural Development : There is very little risk to life and potential economic loss is low.
   Rural Development : There is little risk to life and potential economic loss is significant.
   Urban/Industrial Development : There is considerable risk to life and potential economic loss is high.
3) Source : Flood Control Manual, Volume II, June 1993

Table-N.4.2 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.

4.1.2 Basic Policy of Flood Control Measures

The Study Team has made field investigations into the condition of the rivers and irrigated and inhabited areas on Samal River, its tributary Musi River and Kobi River. The current condition of the target area is summarized as follows :

- Samal and Kobi weirs (to be constructed) will be located at the opening to the alluvial plain from the mountain area. To the upstream of these planned weirs, it appears that the rivers flow in V shape valleys.
- The areas irrigated by both rivers, namely Samal I, Samal II and Kobi, are very flat with little undulation, and are utilized mainly for paddy field with pasture in some places.
- Natural forest remains along both rivers to a width of several meters. It is considered that these areas are relatively low and that the forest interferes with flood flow velocity.
- Marshy areas are found in the irrigated area.
- Main roads suitable for vehicle access are limited.
- The width of both rivers is 35 - 40 m in the downstream near Samal bridge and Kobi bridge, and 85 - 100 m in upper location near Samal weir and Kobi weir.
- Both rivers flood several times a year and the irrigated area is widely inundated.

Based on these conditions, the basic policy of flood control measures is set up as follows :

1) 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 dam and reservoir construction.
2) River improvement works for flood control should be planned for both Samal and Kobi rivers downstream of the proposed weirs.
3) As both the rivers are meandering on the alluvial plain, river dikes should be planned to widely surround the current river course. That is, 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.
4) The height of the river dikes should be kept low, using the micro-topography with slightly higher elevation areas as dikes and increasing the river width as much as possible. Thus, dike construction cost could be reduced, as well as facilitating rain water drainage because flood water level will be lower.
5) River dikes should be planned as multi-purpose, and should be used for roads, canals, etc., in order to maximize the benefit of initial investment.
6) River dikes should be constructed mainly with sand and gravel excavated from the river in the vicinity of the dike, in order to reduce the construction cost.
7) 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.

4.2 Plan and Design of Flood Control Measures

4.2.1 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-N.4.1. Using the assumed cross section shown below, discharge capacity is calculated using uniform flow calculation (Manning's Formula).

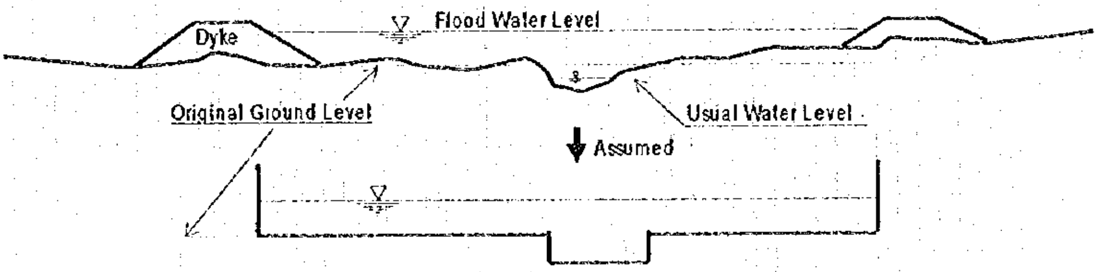

Figure-N.4.1 Schematic Cross Section of River

5) Taking into account the condition of the planning area and the assumed shallow water depth on the floodplains, 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-N.4.3, 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-3.2.1, 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 floodplains will be wide so that velocity is slow and water height is low.

Table-N.4.3 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"

4.2.2 Alternative Flood Control Plans for Samal and Kobi Rivers

(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-N.4.3 to Figure-N.4.6.

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-N.4.2. 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-N.4.4. 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-N.4.4 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				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

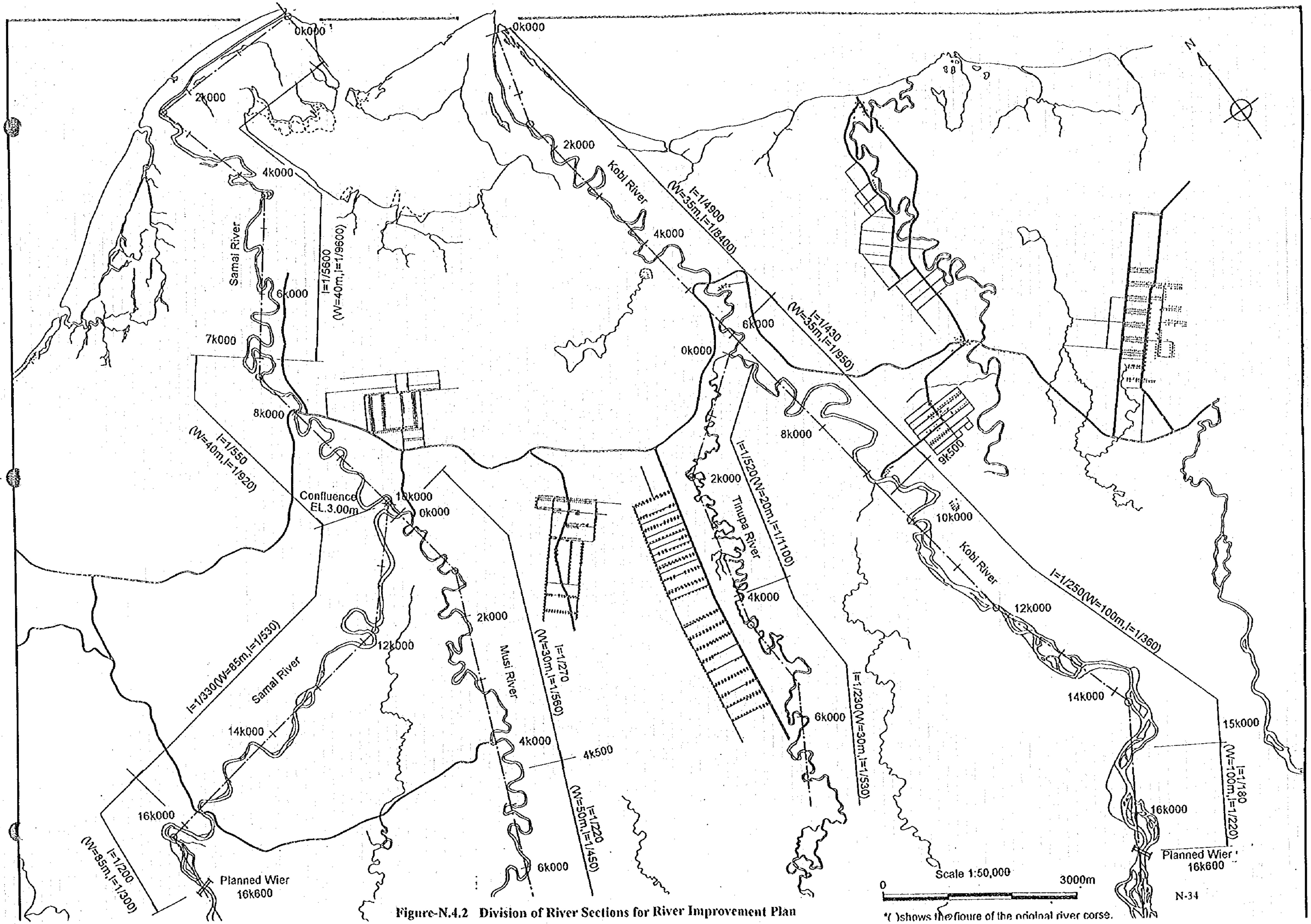

Figure-N.4.2 Division of River Sections for River Improvement Plan

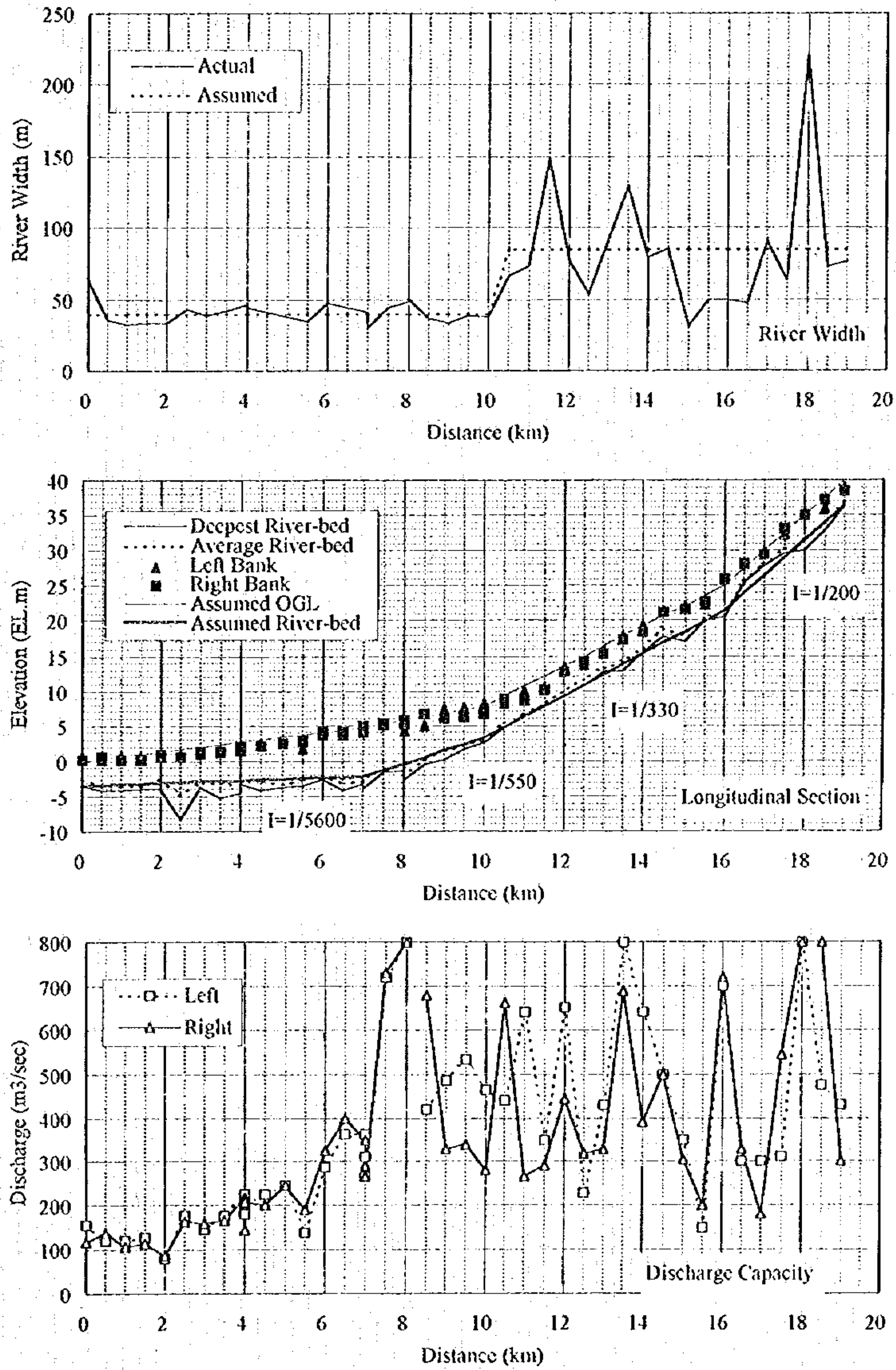

Figure-N.4.3 Current Condition of Samal River along the Planned River Course

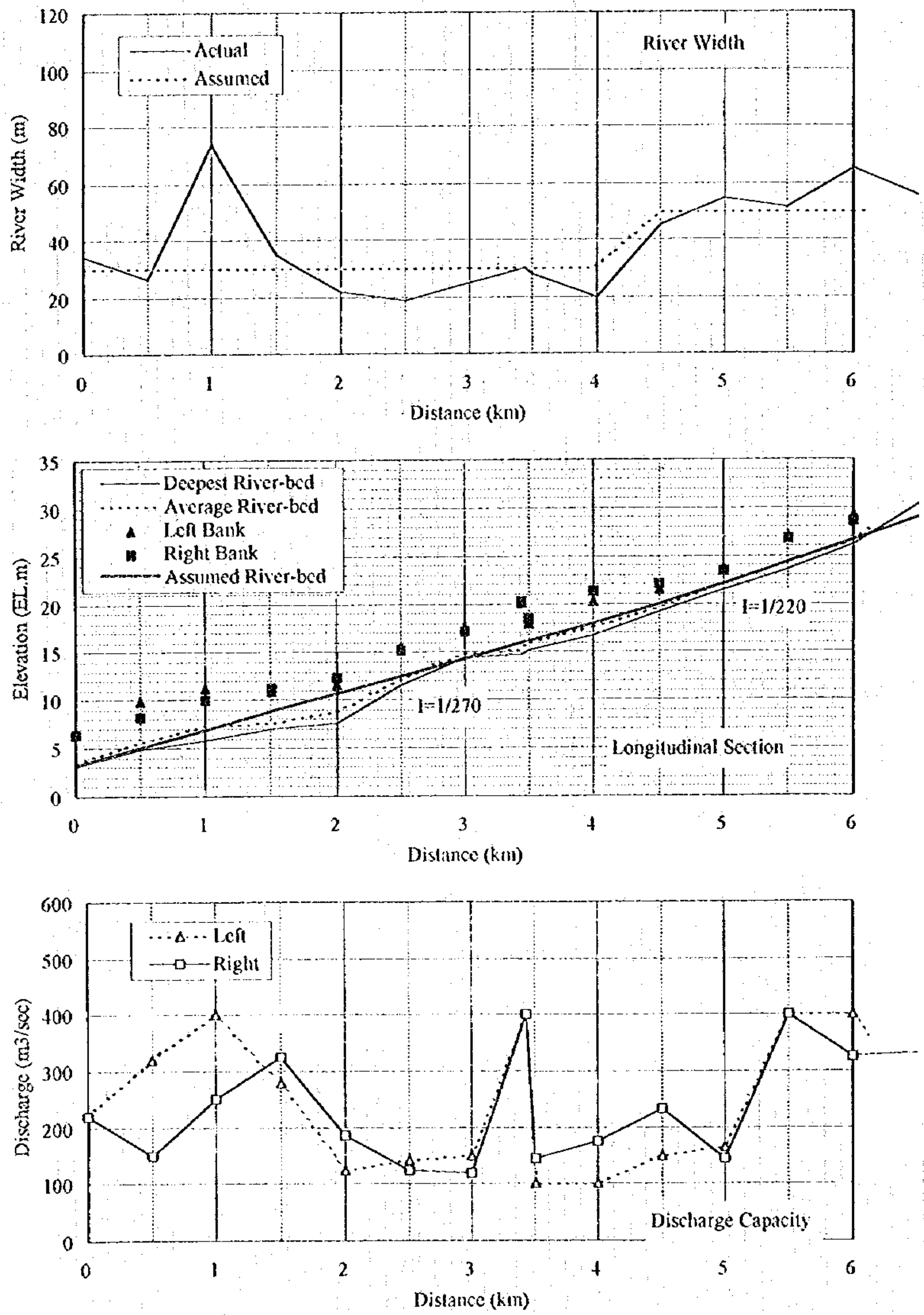

Figure-N.4.4 Current Condition of Musi River along the Planned River Course

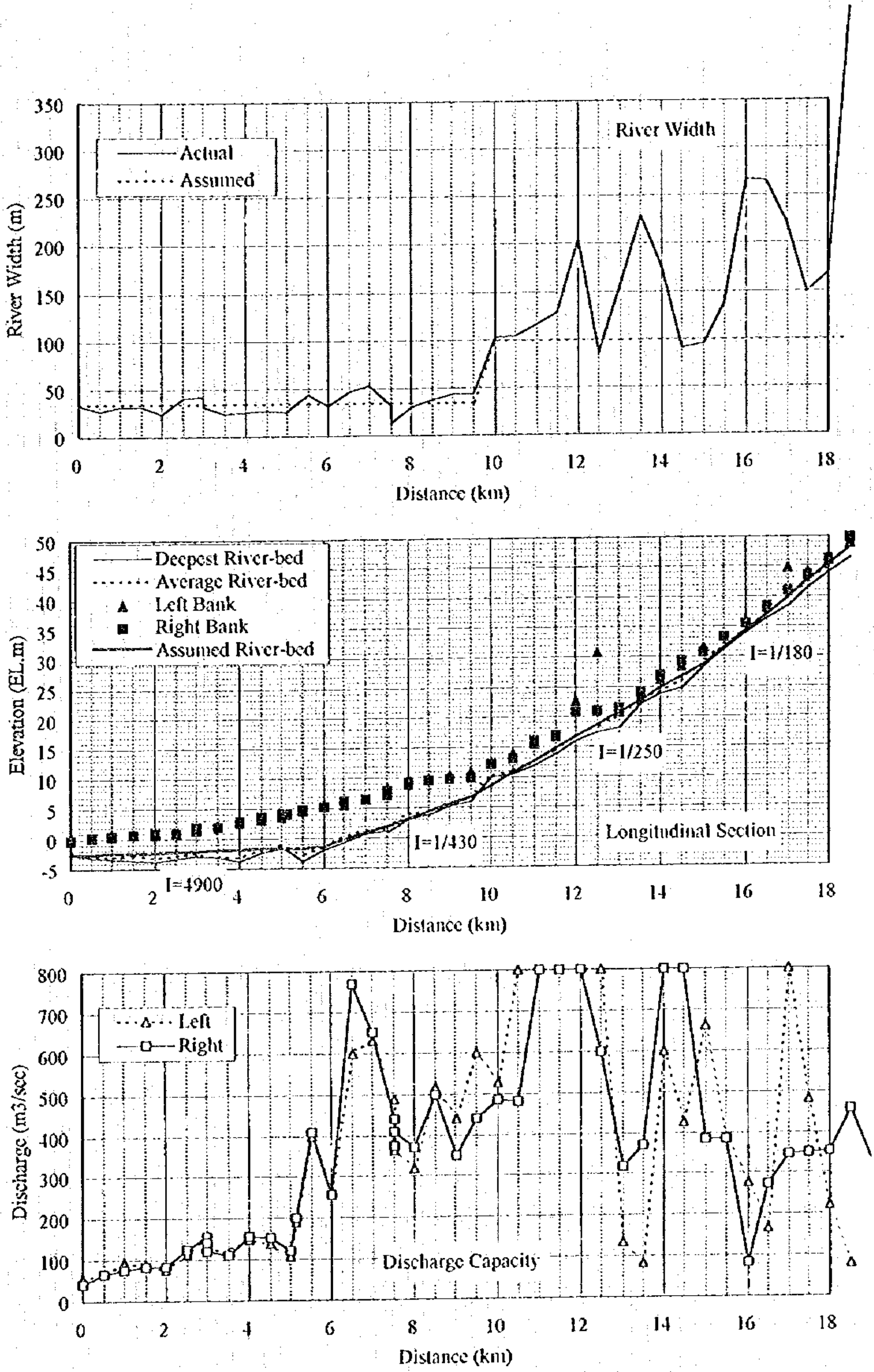

Figure-N.4.5 Current Condition of Kobi River along the Planned River Course

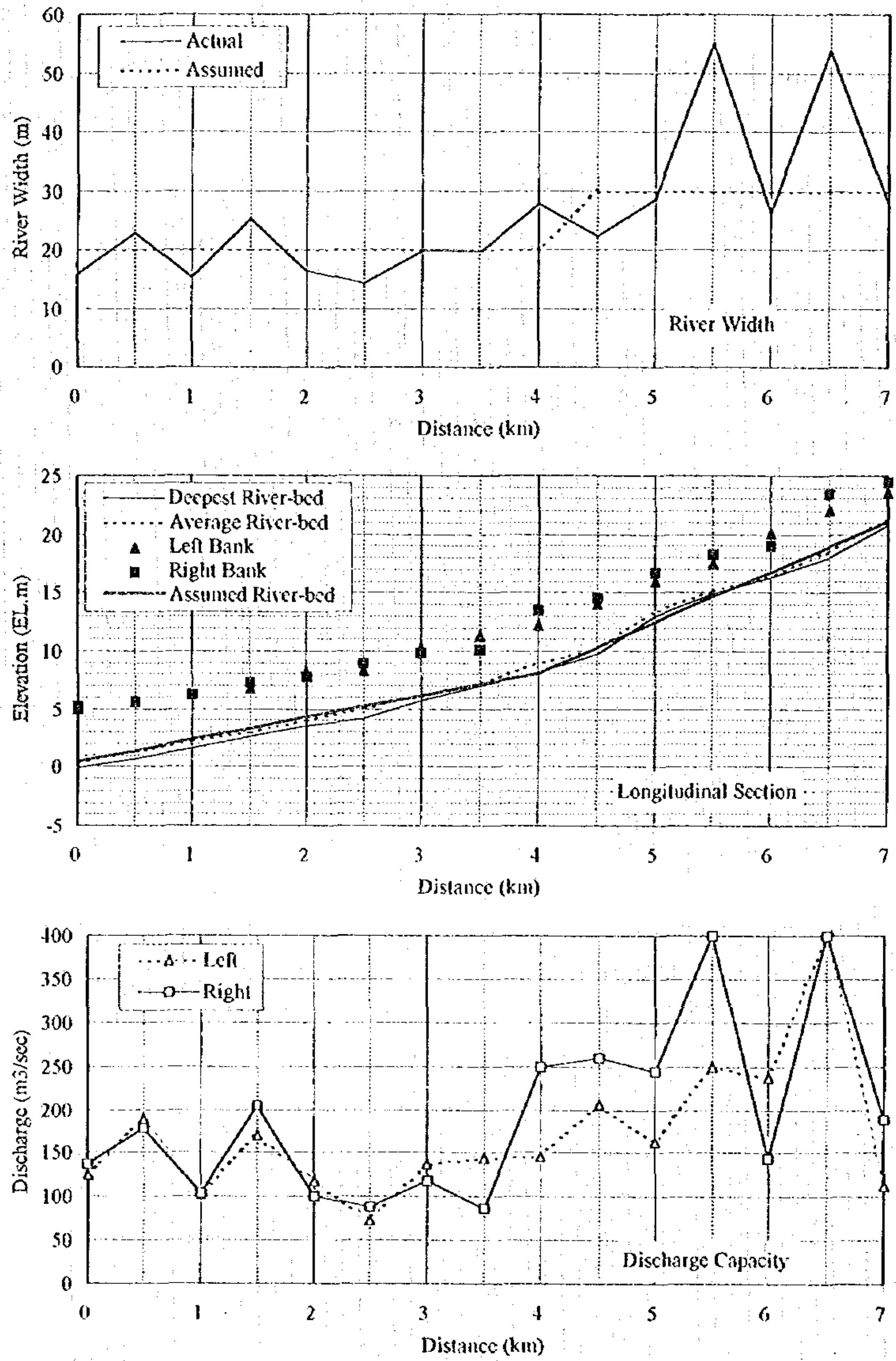

Figure-N.4.6 Current Condition of Tinupa River along the Planned River Course

(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-N.4.7 and Table-N.4.8 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-N.4.5. Dike alignment of both plans are shown in Figure-N.4.8 and Figure-N.4.9. The standard cross section is designed as shown in Figure-N.4.7.

Table-N.4.5 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-N.4.6. 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-N.4.8 and Figure-N.4.9. The standard cross section is designed as shown in Figure-N.4.7.

Table-N.4.6 Alternative Flood Control Plans : Kobi River System

River	Kobi River				Timpa 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

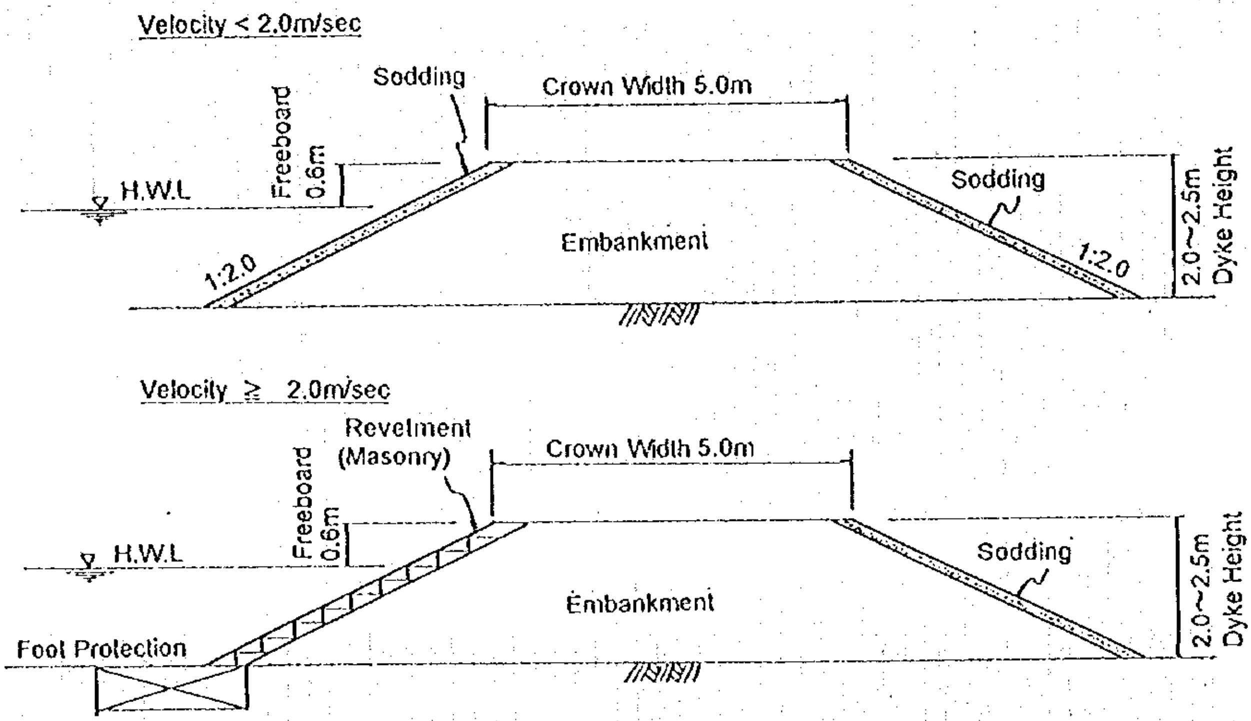

Figure-N.4.7 Standard Cross Section of Dike

Table-N.4.7 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-N.4.8 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

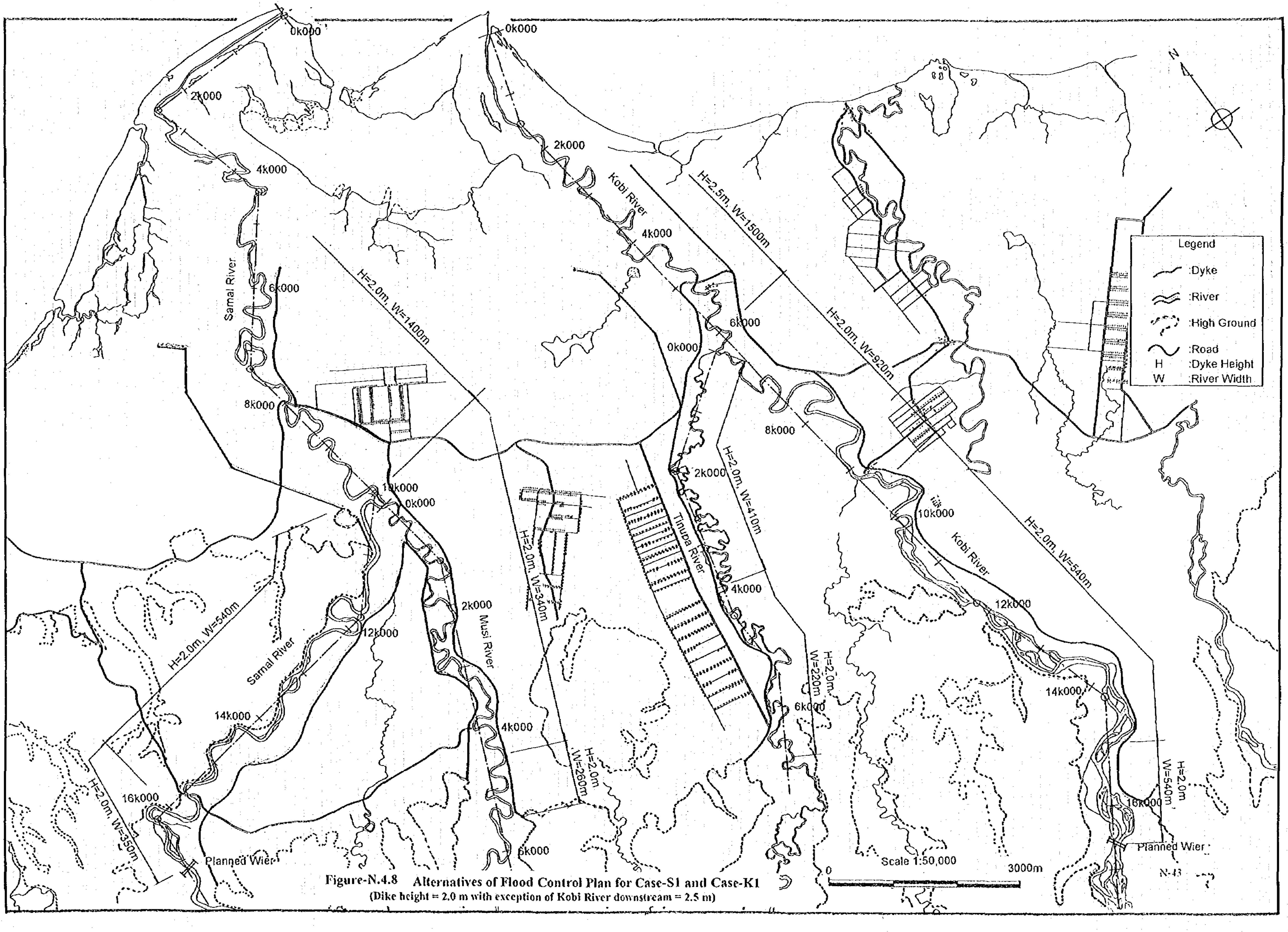

Figure-N.4.8 Alternatives of Flood Control Plan for Case-S1 and Case-K1
(Dike height = 2.0 m with exception of Kobi River downstream = 2.5 m)

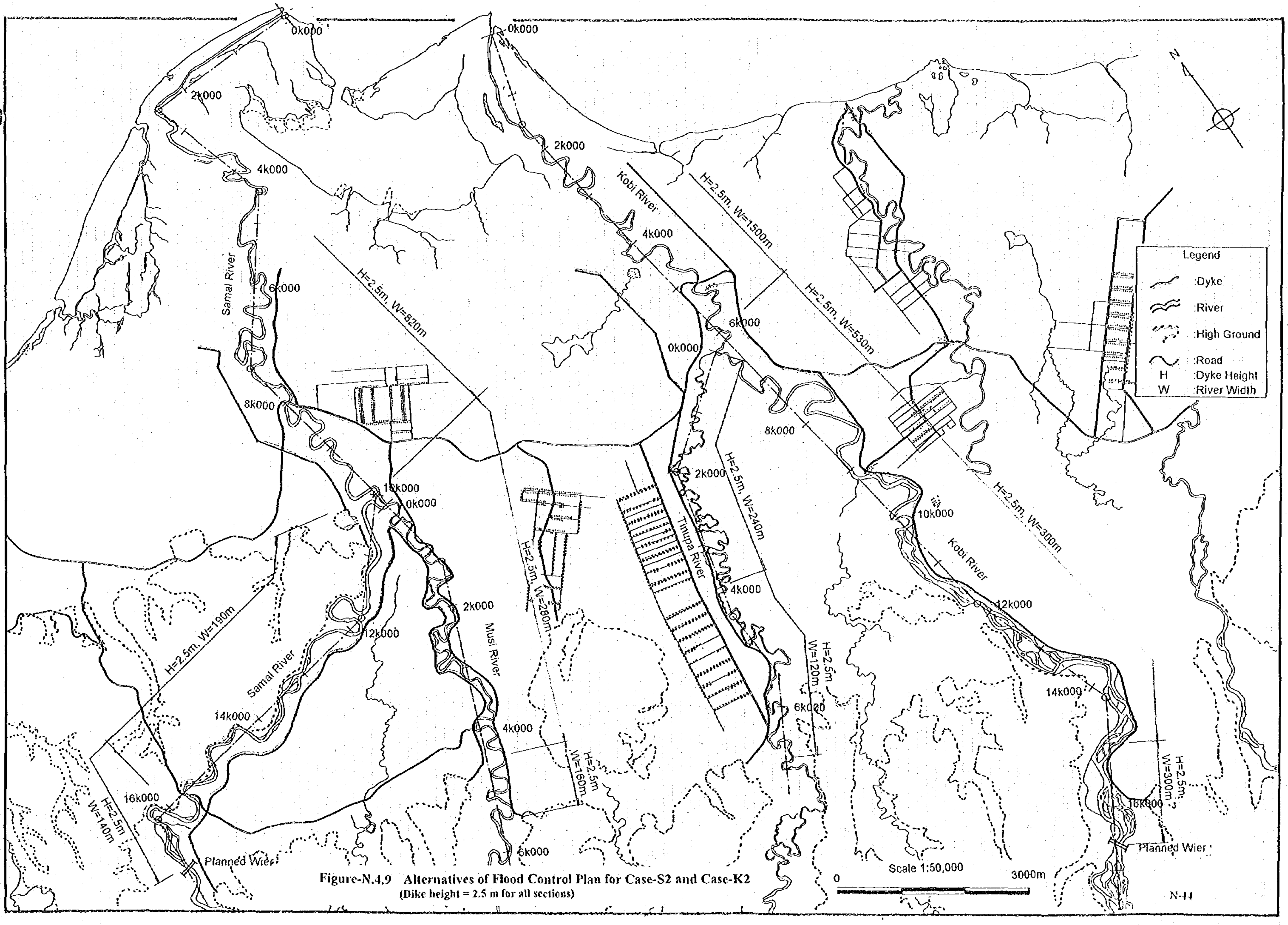

Figure-N.4.9 Alternatives of Flood Control Plan for Case-S2 and Case-K2

(Dike height = 2.5 m for all sections)

4.3 Cost Estimate and Selection of Optimum Plan

4.3.1 Work Quantity

Based on the plan and design described above, dike work quantities were calculated and are shown in Table-N.4.9.

Table-N.4.9 Work Quantity 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.

4.3.2 Project Cost

Project costs of the alternative plans were estimated as shown in Table-N.4.10.

Table-N.4.10 Project Cost

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	

4.3.3 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)

4.4 Implementation Schedule

Implementation schedule of the conceptual flood control plan for Samal River and Kobi River was prepared as shown in Table-N.4.11. 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-N.4.11 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 : 0k000~7k000				■	■	■	■	■										
(b) Samal : 7k000~10k000				■	■	■	■	■										
(c) Samal : 10k000~16k600														■	■	■	■	■
(d) Musi : 0k000~5k500									■	■	■	■	■					
Kobi River																		
(1) Detail Design	■	■	■															
(2) Construction																		
(a) Kobi : 0k000~6k000				■	■	■	■	■										
(b) Kobi : 6k000~9k500				■	■	■	■	■										
(c) Kobi : 9k500~16k600									■	■	■	■	■					
(d) Tinupa : 0k000~6k500														■	■	■	■	■

SUPPORTING REPORT

PART-O

ENVIRONMENT

THE STUDY ON FLOOD CONTROL FOR AMBON AND PASAHARI AREA IN THE REPUBLIC OF INDONESIA
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CHAPTER 1 ENVIRONMENTAL SETTING IN THE STUDY AREA

1.1 Social Environment

See Part-K for fundamental factors on social environment - economic activities, social conditions and land use.

1.1.1 Resettlement and Land Acquisition

Pasahari is a newly developed agricultural area where most of the population are transmigrated from Java under the Government's Transmigration Program. Therefore, resettlement is a common practice in this area. Besides transmigration from Java, 23 households in Tihauna Village came from Ambon after a fire incident in 1995. Resettlement happened even within the Pasahari area - 36 household left a village near Kobi River and built their new homes in Mobomet about 5 km upstream because of the flood damage in 1990. However, there has been no experience of resettlement due to industrial or any infrastructure development activity.

Since Pasahari is still an underdeveloped area and lands are allocated by the Government to the resettled people for housing and farming, and to other developments such as the construction of the irrigation systems etc., land acquisition has not become a problem so far.

1.1.2 Transportation and Public Facilities

Infrastructure has not yet been well constructed in Pasahari area - most of the roads are unpaved, electricity is not available in most of the villages and there is almost no public telecommunication service. No public transport is yet available.

The public facilities in Pasahari area are limited to schools (one junior high school and one senior high school at Kobisonta and primary schools at most of the villages), health centers (refer to 1.1.4 below), one post office (at Kobisonta) and mosques (at each village).

1.1.3 Historical Site and Protected Area

With a short history of human settlement in Pasahari area, there is not any historical nor archaeological sites.

In the Seram Island, there are protected forest areas designated by Maluku Province Government, but most of them are in the western part far away from the Study Area.

1.1.4 Public Health

As for public health service, there is one community health center in Samal area with 2 doctors and one in Kobi area with 1 doctor. There are sub-health centers in most of the villages each with one person for simple medical care. The medical services are provided by the Government under the transmigration scheme. Malaria, skin infection, diarrhea and influenza are the main diseases in this area, and death from diarrhea happens occasionally.

1.2 Environmental Sanitation

1.2.1 Water Supply

In Pasahari area, domestic water supply mainly depends on groundwater from dug-wells. In the rainy season well water is sufficient, but in the dry season people in some villages have to get water from the Samal and Kobi Rivers at their upstream side. There are not any water quality data available but villagers have complained salinity, high iron concentration and turbidity problems.

To improve water supply, the Transmigration Agency planned to construct water pipes to transfer clean river water to the transmigration villages and piping work has already started at some villages in Samal area.

1.2.2 Sanitary Facilities

Only traditional toilets are available in the villages and no septic tanks have been built. The domestic sewage, night soil and garbage are discharged to the river or irrigation canals where people often do washing, bathing and swimming. Doctors in the health centers have pointed out that direct use of irrigation water may cause eye disease and skin infection and advise people to accumulate rain water for washing and bathing. This is based on a consideration of the high salinity and mud content of the irrigation water, and also the pollution by human wastes.

1.3 Natural Environment

1.3.1 Flora and Fauna

Although there are no data available on the vegetation in Pasahari area, it is said that the main flora species, especially those in the forests, are about the same as those in Ambon area (refer to Part-G, Master Plan and Feasibility Study for Ambon Area).

As for wildlife, wild boar, deer and some species of birds are dominant in the forest area.

1.3.2 River and Coastal Environment

In the estuaries of the Samal and Kobi Rivers, there are large areas of mangrove forests which extend 2 or 3 km to the upstream direction and protect the river bank well. Bank erosion is found to be serious from the end of mangrove forest to the middle stream part of the river. The upstream part of the river flows through the forest and grassland area where river course is broad and shallow and bank erosion is less serious. Situations are similar for the 2 rivers.

In rainy season, sediment runoff is the main problem for the rivers and estuaries. Sea water turns yellowish in a broad coastal area. Through a survey from the estuary to the upstream part of Kobi River, it was found that most of the sediment was from the middle stream part of the river. The influence of sediment runoff on the coastal environment is significant.

No coral reefs exist in the estuary area. This may be because of, but not limited to, the sediment runoff that shut down the sunlight penetration - a necessary condition for the corals to grow.

1.4 Environmental Pollution

No environmental monitoring has ever been conducted in Pasahari area. However, considering its low population density and limited development activity, it can be said environmental pollution is not significant presently from man-made pollution sources. Some environmental problems mentioned above are mainly caused by natural reasons. For example, sea water intrusion may be the main reason for the salinity problem with the groundwater and river water quality.

CHAPTER 2 INITIAL ENVIRONMENTAL EXAMINATION OF CONCEPTUAL PLAN

2.1 Environmental Examination Matrix

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-O.2.1) 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-O.2.1 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

2.2 Explanations

2.2.1 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.

2.2.2 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.

2.2.3 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.