APPENDIX IV

RIVER IMPROVEMENT

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CHAPTER 1 PRESENT RIVER CONDITIONS

1.1 River Systems

1.1.1 Location

The Pampanga river basin, located in the central part of the Luzon Islands, is the fourth largest one among the major rivers in the Philippines, having catchment area of approximately 10,500 km^2. The general basin map of the Pampanga river is shown in Fig. 4.1.

The basin is bounded by Manila Bay on the south, by the Sierra Madre Mountains on the east, by the Caraballo Mountains on the north, by the Agno river basin on the northwest and by the Zambales Mountains on the west and southwest. It lies between 14°45' to 16°10' north latitude and 120°40' to 121°15' east longitude and covers wholly or partly the provinces of Nueva Ecija, Bulacan, Tarlac and Pampanga.

The project area of the study is located within the upper Pampanga river basin.

1.1.2 River Systems

The Pampanga river originates in the Caraballo Mountain Range and flows down southward, passing through the mountainous and valley areas.

After joining the left tributaries of Digmala and Coronel, it turns southwestward, collecting the runoff waters from the Peñaranda river. Near Mt. Arayat, it joins a principal right tributary of the Rio Chico and finally pours into Manila Bay with several distributaries.

The basin area and river length of the main Pampanga total to 10,500 km^2 and 260 km, respectively. Fig. 4.2 shows the river systems of the basin.

The vast alluvial plain and delta were formed by the Pampanga river and its tributaries, which has been developed agriculturally for a long time and known as the rice granary in the Philippines. The upper Pampanga river basin is relatively flat. Distinct physical features in the central part of the basin are Mt. Arayat with an approximate altitude of 1,000 m and two depressions known as the San Antonio and Candaba swamps. The swamps function as the retarding basins against flood runoff from the upper basins.

The Pampanga river is the principal drainage way of the basin. Major tributaries of the upper Pampanga river basin are Digmala, Coronel and Peñaranda on the left side, and the Rio Chico and Talavera on the right side. The project area is drained mainly by Talavera and Rio Chico rivers to the main Pampanga and by Bulo and Malimba rivers to the Candaba swamp.

Principal features of the upper Pampanga river basin are summarized below.

Principal Features of Upper Pampanga Basin

Item	Drainage Area (ha)	Length (km)	Average Slope
Pampanga	(3,512)		
Main Pampanga	1,837	110	1/125 to 1/2,500
Digmala	383	10	1/40
Coronel	691	20	1/80
Peñaranda	601	40	1/550 to 1/1,450
Rio Chico - Talavera	(3,020)		
Rio Chico	2,359	100	1/200 to 1/1,500
Talavera	661	65	1/200 to 1/1,450
North Candaba Basin	(1,281)		
Bulo	210	20	1/900 to 1/3,800
Malimba	220	25	1/900 to 1/3,800
Others	851	-	-
Total	7,813		

Remarks: Length and average slope denote values in the plain area.

1.2 Flood Control Problems

1.2.1 River Cross Section Survey

The river cross section survey was conducted by the UPRIIS staffs to prepare data for hydrological and partial river improvement studies.

The objective rivers are Pampanga, Talavera (including Talavera Main Canal), Rio Chico, Peñaranda and Bulo. Locations of the surveyed cross section are presented in Fig. 1.12 in Appendix I and the outline of survey is summarized as follows:

Outline of the Survey

River	Interval of Cross Section (km)	No. of Cross Section
Pampanga	5	15
Talavera	4	14
Rio Chico	5	12
Peñaranda	5	4
Bulo	5	4
Talavera M.C.	1	8
Total		57

On the basis of the surveyed cross sections, longitudinal profiles were prepared and are shown in Fig. 4.3. Table 4.1 shows the major physical conditions of the existing channels.

1.2.2 Carrying Capacity of the Present Channels

To estimate the carrying capacities of the existing channels, water levels were calculated using non-uniform flow methods (Ida method). The equation is as follows.

$$He = (H_2 + \frac{D_2}{2g}(\frac{Q_2}{A_2})^2) - (H_1 + \frac{D_1}{2g}(\frac{Q_1}{A_1})^2)$$

$$= 1/2\ (\frac{N_1 \cdot {}^2Q_1{}^2}{A_1 \cdot {}^2R_1{}^{4/3}} + \frac{N_2 \cdot {}^2Q_2{}^2}{A_2 \cdot {}^2R_2{}^{4/3}})\ dX$$

where, D: energy correction factor

He: loss of energy head (m)

N: composite channel roughness (sec, m)

R: composite channel hydraulic radius (m)

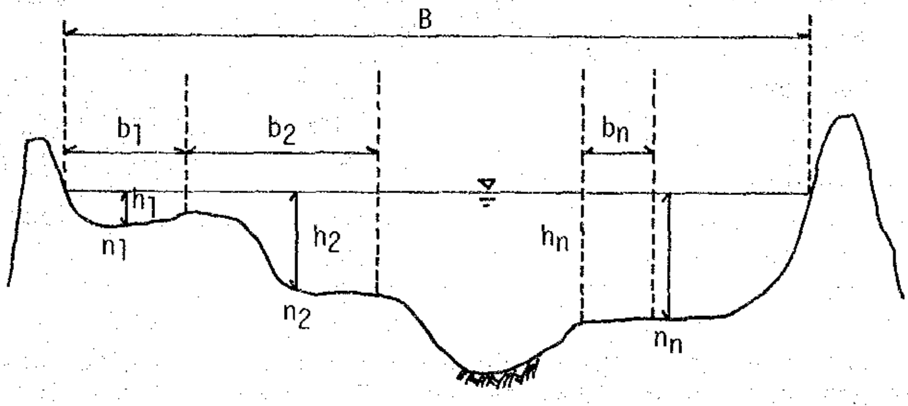
X: distance between the sections (m)

A: composite channel flow area (m^2)

Q: comprise channel discharge (m^3/sec)

Subscripts 1 and 2 denote the values at lower and upper sections under consideration, respectively.

According to Ida, the energy correction factor, composite channel roughness, and composite hydraulic radius of compound section are the functions of the depth, roughness, and width of each river sub-section as shown below.



$$D = a\left(A^2\int_0^B (h^3/n^3)\,db\right) \Big/ \left(\int_0^B (h^{5/3}/n)\,db\right)^3$$

$$N = \left(\int_0^B h^{5/3}\,db\right) \Big/ \left(\int_0^B (h^{5/3}/n)\,db\right)$$

$$R = \left(\frac{1}{A}\int_0^B h^{5/3}\,db\right)^{3/2}$$

where, B: surface width (m)

b, h, n: width (m), depth (m), and roughness of each vertical strip, respectively

a: velocity distribution coefficient

The estimated bankfull carrying capacities of the channels are presented in Fig. 4.4 together with the characteristics of river. The following table shows the carrying capacity and probable flood scale.

River/Reach	Capacity (m^3/sec)	Scale (yr)
Pampanga		
From conf. of Rio Chico to conf. of Peñaranda	2,500	1/5
To conf. of Coronel	2,500	1/10
To PRIS dam	1,000	1/5
Talavera		
From conf. of Rio Chico to Calipahan bridge	200 to 500	less than 1/2
To TRIS dam	1,500 to 3,000	more than 1/20
Rio Chico		
Downstream from conf. of Talavera	more than 1,300	more than 1/15
Upstream from conf. of Talavera	250 to 2,000	1/3 to 1/20
Peñaranda		
Downstream from PENRIS dam	1,000	1/20
Bulo		
Downstream from National Road bridge	less than 250	less than 1/20
Upstream from National Road bridge	200	1/20

Remarks: 1. The following free boards were considered in the rivers confined by both dikes:

Pampanga River ...... 1.5 m
Talavera River ...... 1.0 m
Rio Chico River ..... 1.0 m

2. Scales of the capacity were estimated under the present basin conditions.

As presented in the figures and table, the lower Talavera river portion from the confluence of the Rio Chico to the Calipahan bridge has extremely low capacity of less than 2-yr return period. The other rivers have relatively higher capacities corresponding return period of 5 to 20-yr scale flood under the present conditions.

1.2.3 Probable Flood Water Levels

Probable flood water levels were estimated in the lower reaches of Talavera river based on the results of runoff discharge study in Appendix I.

The probable flood runoff discharge hydrographs applied to the estimation, are shown in Fig. 4.5. The estimation was conducted for 2 channel conditions of existing and improved. (As for improved channel, it is discussed in Chapter 2.)

Discharge rating curves were prepared at 2 confluences of tributaries of the lower Talavera river, using the results of water level calculation by non uniform flow. The curves thus obtained are shown in Fig. 4.6.

Applying the hydrographs and curves mentioned above, probable flood water levels were calculated. Table 4.2 shows the estimated duration of the indicated water levels. According to the table, duration of flood water level above the ground elevation along the lower Talavera river is quite long as much as 390 hr for 20 year probability flood under the present channel condition.

1.2.4 Major Floods by Typhoon

The upper Pampanga river basin has been hit by several big floods. The following are the major floods in the past.

Name of Typhoon	Duration	7-day Rainfall at Cabanatuan (mm)
Didang	1976 May 18 - 19	877.0
Unding	1977 Nov. 10 - 17	185.6
Meding	1978 Aug. 20 - 26	286.0
Kading	1978 Oct. 25 - 27	335.1
Mameng	1979 Aug. 9 - 15	164.4
Aring	1980 Nov. 1 - 7	449.6

Table 4.3 presents the profile of the typhoons that attacked recently and damaged to the Project Area. Table 4.4 presents total rainfall for indicated durations at the selected stations of the Project Area. The typhoon Didang in May 1976 brought to the upper Pampanga river basin a record-breaking volume of rainfall of 424.9 mm/day and 918.8 mm/3 days recorded at TRIS diversion dam.

1.2.5 Overflow from the Talavera River

Principal and urgent flood control problems in the Project Area exist at the lower Talavera river downstream from the Calipahan bridge. The problems are overbanking due to shortage of the channel capacity and back water against the right tributaries joining to the lower Talavera river.

The flood water coming from the upper reaches often overflows at such reaches around Aliaga diversion dam and upstream of the confluence of the Rio Chico river. The critical overflow discharges are estimated at only 200 to 300 m^3/sec which corresponds to the flood scale of 2-year probability. This means that the overflow from the river bank probably occur almost every year in the lower reaches of the Talavera river.

Assuming present bankful carrying capacity at 270 m^3/sec, the estimated volume of overflow from both banks at the downstream reaches of the Talavera river is as follows.

Flood Scale Probability	Volume	Overflow Flood Duration	Average Discharge
	(MCM)	(day)	(m^3/s)
1/5	21.9	6	42.3
1/10	59.9	9	77.1
1/20	110.5	10.5	121.8

Overflow flood from the left bank of the river spreads toward downstream resulting severe damages to the towns of Aliaga and Zaragosa and reaches into the San Antonio swamp.

Flood from the right bank of the river is inundated along the Talavela river because of topographic features and of back water from the confluence of the Talavera and the Rio Chico rivers. In addition, the flood water levels in the Talavera river retains the local drainage flows through several tributaries joining from right side.

1.3 Inundation Area

1.3.1 Assumptions for Analysis

The area at left side of the Talavera river has topographic slope toward the San Antonio swamp and the flood is flowing over the ground and not inundated after ceasing of overflow except depression areas. The area along right side of the river, however, has topographic slope toward the confluence of the Rio Chico and Talavera rivers and the ground elevation of the area is always lower than the flood water level in the river. During flood season, this area is besieged by overflow from the Talavera river, backflow from the confluence and drainage inflow from the upper portion.

The inundation area and its duration are estimated by adopting the following formula assuming inundation volume as a retarding storage.

$$I - O = \frac{dS}{dt}$$

where, I: inflow to the storage (m^3/s)

O: outflow from the storage (m^3/s)

S: storage capacity (m^3)

(1) Overflow Section of the River

Comparing the calculated flood water level with the elevation of river bank, the overflow section is estimated to be between the river sections of T-5 and downstream of T-8. Location of river section is shown in Fig. 4.7.

(2) Average Carrying Capacity

The average carrying capacity of the corresponding overflow section is estimated at 270 m^3/s from the average of bankfull capacities of three sections, T-5, T-6 and T-7.

Carrying Capacity (m^3/s)

T - 5	T - 6	T - 7	T - 8
270	250	280	510

(3) Overflow Discharge

The elevations of the left and right bank of the Talavera river are not uniform but the average elevation for the overflow section is about same at approximately 26.2 m to 26.5 m. It is assumed that the overflow discharge is the excess of the bankfull carrying capacity and it evenly overflows to the left and right side of the river.

Elevation of Present River Bank

(Unit: MSL)

Section No.	T - 5	T - 6	T - 7	T - 8	Average
Right bank	23.1	25.3	27.8	29.8	26.5
Left bank	23.5	26.0	26.8	28.5	26.2

The overflow discharges are calculated and summarized in Table 4.5 for probable flood runoff of 1/5, 1/10 and 1/20.

In the calculation of present inundation area and duration, the drainage inflow discharge from the catchment of right side area was disregarded because the drainage amount is small comparing with the overflowing flood discharge.

(4) Storage Balance Calculation Point

For the convenience of flood inflow and outflow calculation to and from the inundated storage, a calculation line was selected at about 1.25 km downstream of T-5 where the higher counter lines approach near to the Talavera river and from an outlet of the upstream depression area. After outflowing from this line, the flood water will be retained around the triangle area of the confluence of the Talavera and the Rio Chico rivers until the river water level subside sufficiently low.

(5) Inundation Storage Volume and Area Curve

Based on the 1/50,000 scaled topographic map, the storage volume and area upstream of the calculation line was prepared at each water elevation for the right side of the Talavera river. It is presented in Fig. 4.8.

(6) Outflow from the Storage

Taking a cross section at the calculation line, outflow discharge from the inundation area was calculated by applying Manning's formula.

$$Q = \frac{I}{n} A \cdot R^{2/3} \cdot I^{1/2}$$

where, n: representative roughness coefficient 0.5

A: flow area (m^2)

R: hydraulic radius (m)

I: hydraulic gradient to be assumed same as ground surface gradient 1/3,000

Q: outflow from the storage (m^3/sec)

1.3.2 Inundation Area and Duration

The inundation area and duration are calculated by adopting the above methods for the probable flood scale of 1/5, 1/10 and 1/20 with present conditions of the Talavera river. The calculations are shown in Fig. 4.9 and Table 4.6 and summarized below.

Inundation Area and Duration (Right side area)

Flood Scale Probability	Maximum	Inundation Area (ha)		
		More than 2 days	4 days	6 days
1/5	670	640	580	450
1/10	860	830	770	690
1/20	990	960	910	830

As shown in Fig. 4.10, the maximum inundation area at 1/20 flood reaches almost to the town of Quezon.

The left side area of the Talavera river is hit by the overbanked flood from the Talavera river. The flooded area is estimated from the length of overbank and topographic conditions. The area is estimated from Fig. 4.11.

Flooded Area and Duration of Overbank
(Left side area)

Probability of Flood	Flooded Area (ha)	Duration of Flood (day)
1/5	1,500	6.0
1/10	5,500	8.5
1/20	6,100	10.0

CHAPTER 2 PARTIAL RIVER IMPROVEMENT PLAN

2.1 Existing Flood Control Scheme

The Pampanga river basin is frequently hit by tropical typhoons and has repeatedly experienced big floods which inflicted heavy damages on agriculture, property and social activities. In order to protect the basin from such flood damage, flood control projects have been carried out by the MPWH under the existing flood control scheme of the basin.

After historical big floods, construction of the flood control structures started after 1939. The existing flood control projects in the basin are the results of continual efforts since 1939. The present scheme reflects almost entirely the design of BPW (MPWH at present) scheme and is shown in Fig. 4.12 and 4.13 in the form of a schematic diagram.

As seen from these figures, the existing flood control scheme consists of a comprehensive system of earth dikes, cutoff channels and relief floodways, supplemented by utilization of the San Antonio and Candaba swamps as retarding basins. A magnitude of 50-yr flood discharge is applied to the basic plan in the Upper Pampanga basin and 10 to 20-yr period was selected as the first phase of the plan.

The partial river improvement plan of the lower Talavera was studied in line with the existing scheme mentioned above. Furthermore, alternative project scales were studied in the plan to select the most appropriate project scale for the stepwised plan.

2.2 Partial River Improvement Plans

2.2.1 Improvement Plans and Alternative Scales

As stated previously, dikes along the lower Talavera river exist in the lower reaches except some portions.

Taking into consideration of such existing conditions and scheme, the following improvement plans are conceived.

1) Widening of river width (construction of new dikes) and excavation of low water channel.

2) Raising and strengthening of the existing dikes and minor excavation of low water channel.

As for the former plan, it expects difficult problems such as right of way and extremely large amount of excavation volume of the low water channel to lower the flood water levels during the wet season. Whereas, the latter has an advantage of effective utilization of existing dikes, although it is difficult to obtain lower flood water levels than the present condition.

Considering such existing conditions and possibility of realization of the works, the latter one was accepted in the lower Talavera river. Furthermore, alternative scales of 20-yr, 10-yr and 5-yr design discharges were considered to select the most appropriate project scale as the first phase plan.

2.2.2 Design Discharge Allocation

Design discharges for each scale were allocated based on the probable flood runoff discharges in the Talavera river. Allocation of design discharges are shown below.

Design Discharge

(Unit: m^3/sec)

River	Alternative Scale		
	1/20	1/10	1/5
Talavera River	1,250	900	600
Tributary A (Santo Domingo Creek)	315	225	160
Tributary B	195	150	100

2.2.3 River Improvement Plans

The followings were considered in the partial river improvement plan.

(a) Design high water levels were determined on the basis of the condition that both rivers of Talavera and Rio Chico are confined by diking systems. High water level were calculated by non uniform flow method. Peak discharge of probable flood is shown in Table 4.7 and Fig. 4.14 for improved channel condition. Coefficients of roughness were adopted at 0.03 for low water channel and 0.05 for highwater channel.

(b) Low water channel is excavated with average channel width and depth of the lower reaches.

(c) Fig. 4.15 was applied to the standard section of dike to be improved.

(d) For 2 major right tributaries (creeks) will be raised and strengthened as back water levee.

(e) Alternative scales of 20-yr, 10-yr and 5-yr design discharges were considered in the plan.

Design river profiles thus prepared are shown in Fig. 4.16. Typical cross sections are illustrated in Fig. 4.17.

2.3 Improvement Plans of Tributaries

2.3.1 Present Condition of Tributaries

There are two tributaries (drainage creeks) joining from the right side to the Talavera river between the overflow reaches as shown in Fig. 4.18.

(1) Tributary A (Santo Domingo Creek)

This creek joins at T-8, having 5 to 15 m river bed width and 1/1,000 slope.

(2) Tributary B

This creeks was supposed to join at near T-5 section but previous construction of the Talavera river dike has no outlet for this creeks.

The creek course at present diverges into several small streams and disappears near the Talavera river dike. This is one of the major cause of habitual inundation of these area.

2.3.2 Improvement Plans

After the implementation of flood control scheme of the Talavera river by raising the bank height, it will be evident that the flood water level in the Talavera river will affect backwater to the creeks. The present bank height of the creeks is not enough to confine the backwater. To solve this problem, several alternative improvement plans are considered.

Plan I: To raise the river bank of creeks.

Plan II: To construct the gate at confluence point to stop backwater effect to the creek.

Plan III: To construct new drainage creek in parallel with the Talavera river until the confluence point of the Rio Chico and the Talavera rivers.

In case of Plan III, the water level in the creek will be raised higher than the adjacent ground because of backwater from the confluence. The drainage from the adjacent area of the creek will not be possible during high water level after construction of new creek channel of about 16 km.

In case of Plan II, the creeks should have sufficient storage volume during the high water level in the Talavera river. This is most unlikely possible unless otherwise provides the drainage pumps.

In case of Plan I, drainage discharges from upstream area can be drained through creeks but adjacent downstream area will not be drained by gravity. Among these plans, the Plan I is to be of possible alternative.

The undrained water during flood is only such runoff from the adjacent downstream area itself after confining flood water into the Talavera and upstream drainage runoff into the creeks. The inundation area is expected smallest among these plans.

(1) Creek Design Discharge

The design discharges for the Talavera river and creeks are obtained from the calculation results of probable flood runoff as presented in Table 4.7, for improved channel condition.

Design Discharge

(Unit: m^3/sec)

Rivers	Alternative Scale		
	1/20	1/10	1/5
Talavera River	1,250	900	610
Tributary A (Santo Domingo Creek)	315	225	160
Tributary B	195	150	100

(2) Improvement Design

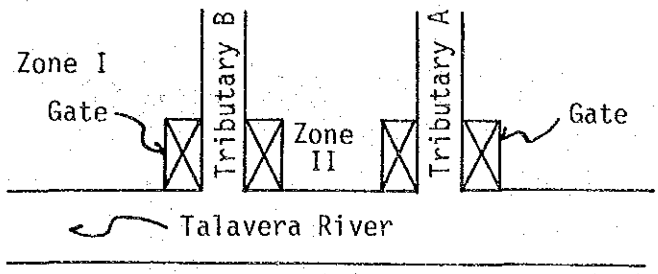
The standard design section of the dike for the improvement of creeks is shown in Fig. 4.15. Design high water level in the creek was calculated by non uniform flow applying the design high water level of the improved Talavera river profile.

Proposed creek profile and high water level are presented in Fig. 4.19 and in Table 4.8.

2.3.3 Inundation Area

As a result of confining the flood water into the river channel by raising the dike, the low lying area along the right side of the Talavera river has difficulties to drain by gravity during flood period. Downstream of such area will be still inundated although the area will no more receive the overbanked flood water from the rivers. Drainage by gravity can be possible through the gate after the flood water level was lowered.

Area and duration of inundation were estimated from the balance of drainage inflow and outflow from the gate. Details of calculation are shown in Tables 4.9 and 4.10 and Figs. 4.20 and 4.21, and it is summarized as follows.



Area and Duration of Inundation

(Unit: ha)

Probability Scale		Inundation Area			
		Zone I	Zone II	Zone II	Total
1/20	Maximum Area	370	240	95	705
	Inundation				
	more than 2 days	285	215	85	585
	more than 4 days	150	165	70	385
	more than 6 days	70	55	-	125
1/10	Maximum Area	245	185	100	530
	More than 2 days	180	170	90	440
	More than 4 days	95	100	75	270
	More than 6 days	65	45	30	140
1/5	Maximum Area	145	170	90	405
	More than 2 days	100	125	80	305
	More than 4 days	75	55	75	205
	More than 6 days	65	45	50	160

2.4 Works on River Improvement

Based on the improvement plans formulated in previous section, the work quantities of improvement for the Talavera river and two tributaries are estimated.

The improved length for each alternative scale are summarized as below:

(Unit: km)

River	Alternative Scale		
	1/20	1/10	1/5
Talavera River	27.0	26.5	26.0
Tributary A	10.9	10.0	4.4
Tributary B	9.0	8.0	7.0

Major items and work volumes of construction works are summarized in Table 4.11.

2.5 Benefit Area

The benefit area for each alternative scale of project formulation is summarized below.

(Unit: ha)

Item	Alternative Scale		
	1/20	1/10	1/5
1. Inundation Area			
1.1 Present Condition			
- Right bank area*	960	830	640
- Left bank area**	6,100	5,500	1,500
1.2 Improved Condition			
- Right bank area	585	440	305
- Left bank area**	0	0	0
2. Benefit Area			
- Right bank area*	375	390	335
- Left bank area**	6,100	5,500	1,500

*: Area affected by inundation of more than 2 days
**: Area under overbanked flood flow

CHAPTER 3 COST ESTIMATE

The direct construction cost for each alternative plan is estimated based on the work volumes and unit cost explained in Appendix X.

The total direct construction costs are summarized as below.

Alternative Plan	Construction Cost (₱10^6)		
	Foreign Currency	Local Currency	Total
5-year	25.83	11.21	37.04
10-year	36.47	16.02	52.49
20-year	62.33	27.17	89.50

The breakdowns of above cost are shown in Table 4.12 to Table 4.14 by the alternative plan.

CHAPTER 4 PROPOSED PLAN

In this chapter, the most optimum scale of the river improvement project has been determined through the economic evaluation for each alternative plan.

4.1 River Improvement Benefit

The river improvement benefit of the project is decrease in flood damages by the river improvement project. Based on the inundation area and affected houses under without project conditions, decreases in the flood damages by the river improvement project are estimated on the basis of the results of hydraulic analysis and damage value per ha or unit.

The flood damages to be reduced by the project will be expected to comprising damage for farm crops, private property, public properties and indirect losses. The damage value per ha is estimated as follows:

1) Damages per ha for farm crops are estimated on the basis of the following: Details on gross income and production cost is shown in Appendix V, Agriculture and Agro-Economy.

Irrigated Land

a) Transplanting Area

Gross Income	3.8 t/ha x 2,045 ₱/t =	7,771 (₱/ha)
Production Cost		3,429
Net Return		4,342

b) Direct Seeding Area

Gross Income	3.8 t/ha x 2,045 ₱/t =	7,771 (₱/ha)
Production Cost		3,187
Net Return		4,584

Rainfed Area

Gross Income	2.4 t/ha x 2,045 ₱/t =	4,908 (₱/ha)
Production Cost		2,629
Net Return		2,279

In the irrigated land, transplanting type area account for 70% of the land and direct seeding area 30%. Accordingly damages for crops per ha in the irrigated land is estimated at ₱4,412/1.

/1: 4,342 x 0.7 + 4,584 x 0.3

2) There is no reliable data and information on the unit price of flood damages for private property. It is assumed that the unit price of damage to private property is estimated at ₱3,000 per house in the project area, referring to the data used in the feasibility report on the Pampanga Delta Development Project.

3) 300% of damage to private property was assumed as damages to public property in the project area.

4) 5% of direct damage was assumed as indirect losses.

After the implementation of the river improvement project, the area benefited by the alternatives: 5-year, 10-year and 20-year flood discharge are as shown below:

(Unit: ha)

Design Discharge	*Irr. Land*	*Rainfed*	*Other Area*	*Total*
5-year	700	768	367	1,835
10-year	1,945	2,767	1,178	5,890
20-year	2,043	3,137	1,295	6,475

Based on the area benefited and unit price of damage, decreases in flood damages with the river improvement project of 5-year, 10-year and 20-year design discharge are estimated as shown in Table 4.15.

Based on the above results, annual equivalent damages are estimated at ₱2.96 x 10^6 for 5-year design flood, ₱7.08 x 10^6 for 10-year and ₱10.36 x 10^6 for 20-year as shown in Table 4.16.

4.2 Economic Cost

Economic construction cost and O & M cost for the improvement projects are estimated based on the construction cost as follows:

(Unit: ₱10^6)

Alternative Plans	O & M Cost	Const. Cost
5-year design flood	0.32	42.9
10-year design flood	0.46	60.6
20-year design flood	0.78	103.2

The construction cost comprises direct construction cost, engineering cost, cost for miscellaneous works and physical contingency.

4.3 Evaluation

Based on the economic cost and river improvement benefit, alternative plans are assessed economically by the internal rate of return (IRR). The internal rate of return for each alternative plan is calculated as follows:

Alternative Plan	IRR (%)
5-year	5.2
10-year	9.7
20-year	8.3

As a result, the alternative plan with the 10-year design flood discharge is determined as the most optimum scale for the project.

Table 4.1(1) CONDITIONS OF THE EXISTING CHANNELS

Station	Distance (km)		Deepest Riverbed	Width of Low Water Channel	Elevation of N.G./1 (MSL, m)		Elevation of Dike (MSL, m)	
	Single	Accum.	(MSL, m)	(m)	Left	Right	Left	Right
(1) Pampanga River								
P - 48	0	0	-1.0	260	9.4	8.5	13.0	-
50	2	2	1.8	140	10.0	10.3	13.7	-
52	2	4	1.1	140	7.4	9.6	13.3	-
54	2	6	2.8	220	10.4	11.1	13.5	-
56	2	8	2.2	370	12.2	11.9	13.9	-
58	2	10	4.9	420	12.6	11.9	14.5	-
60	2	12	5.0	450	13.1	13.6	14.8	15.4
62	2	14	5.7	300	15.5	12.8	16.7	14.9
64	2	16	8.0	420	15.6	14.6	16.8	15.6
66	2	18	8.1	300	16.5	14.0	17.3	15.8
P - 0	1.5	19.5	7.3	240	17.4	-	-	-
1	1	1	9.7	220	17.0	16.7	18.5	-
2	5	6	10.2	140	17.2	19.6	-	-
3	5	11	9.4	140	20.6	19.8	-	-
4	5	16	12.6	150	21.6	22.3	-	-
5	5	21	16.1	285	25.0	24.2	-	-
6	5	26	17.6	370	27.2	26.2	-	-
7	5	31	21.4	2,000	29.4	27.4	-	-
8	5	36	23.0	950	28.8	27.8	-	-
9	4	40	25.1	580	35.0	31.7	37.3	-
10	1	41	24.5	1,280	28.8	32.0	33.5	-
11	5	46	28.9	1,180	36.2	33.4	-	-
12	5	51	35.4	1,060	40.4	41.8	-	-
13	5	56	38.1	860	54.4	43.4	-	-
14	2	58	41.8	600	55.0	49.0	-	-
15	1	59	43.5	300	49.8	52.0	-	-
16	2	61	46.3	220	57.5	52.0	-	-
17	5	66	46.6	310	53.0	53.5	-	-
18	5	71	61.3	160	66.0	63.8	-	-
19	5	76	62.6	160	66.5	67.0	-	-
20	5	81	69.1	160	73.2	72.2	-	-
21	4	85	69.1	600	75.0	79.0	76.3	-
22	1	86	72.9	320	77.5	hill	-	-
23	1	87	76.7	380	82.1	hill	-	-
24	4	91	110.3	235	hill	126.4		

(to be continued)

Table 4.1(2) CONDITIONS OF THE EXISTING CHANNELS

Station	Distance (km)		Deepest Riverbed	Width of Low Water Channel	Elevation of N.G./1 (MSL, m)		Elevation of Dike (MSL, m)	
	Single	Accum.	(MSL, m)	(m)	Left	Right	Left	Right
(2) Talavera River								
T - 0	-	-	10.0	-	14.5	-	19.7	-
1	2	2	10.4	35	14.2	15.5	18.8	-
2	2	4	13.9	20	17.0	17.1	18.0	-
3	2	6	15.6	42	17.5	18.0	20.1	20.8
4	2	8	16.1	30	18.5	18.5	22.6	22.2
5	2	10	18.7	70	20.0	19.5	23.5	23.1
6	2	12	21.1	31	21.3	20.8	26.0	25.3
7	2	14	22.4	112	25.5	25.3	26.8	27.8
8	2	16	22.9	40	26.7	26.8	28.5	29.8
9	2	18	24.5	62	29.0	28.2	31.0	31.7
10	2	20	27.5	110	32.0	32.0	33.4	35.2
11	2	22	29.9	80	35.0	34.0	35.7	37.6
12	2	24	32.1	120	36.3	36.3	37.5	39.6
13	4	28	38.6	300	44.3	44.6	-	-
14	4	32	46.1	320	51.3	49.7	-	-
15	4	36	63.5	400	70.5	70.0	-	-
16	4	40	-	-	-	-	-	-
17	4	44	71.9	300	79.5	78.0	-	-
18	4	48	83.2	515	92.0	87.0	-	-
19	4	52	81.2	680	90.6	92.6	-	-
20	4	56	95.6	465	101.9	101.9	-	-
21	4	60	112.7	565	119.5	113.9	-	115.1
							wall	wall
22	4	64	132.9	145	137.9	138.4	138.4	139.3
23	1	65	137.5	370	hill	hill	-	-
24	1	66	145.6	550	hill	hill	-	-
(3) Rio Chico River								
R - 1	0	0	0.5	60	12.7	14.3	17.6	-
2	5	5	6.3	50	14.0	18.2	19.3	22.0
3	5	10	9.5	80	14.5	16.0	19.7	18.0
4	5	15	13.7	40	17.5	18.0	18.9	18.5
5	5	20	15.6	40	19.7	19.5	20.4	20.5
6	5	25	16.0	40	21.5	22.0	-	-
7	5	30	22.9	45	28.6	28.0	-	-
8	5	35	27.5	81	36.3	34.9	-	-
9	5	40	33.8	305	40.3	39.3	-	-
10	2	42	35.9	138	44.6	44.5	-	-
11	3	45	40.4	218	46.0	44.6	-	-
12	5	50	49.5	160	54.0	54.0	-	-

(to be continued)

Table 4.1(3) CONDITIONS OF THE EXISTING CHANNELS

Station	Distance (km)		Deepest Riverbed	Width of Low Water Channel	Elevation of N.G./1 (MSL, m)		Elevation of Dike (MSL, m)	
	Single	Accum.	(MSL, m)	(m)	Left	Right	Left	Right
(4) Peñaranda River								
PN - 0	0	0	9.7	190	18.5	16.7	-	-
1	5	5	12.6	190	18.5	18.3	-	-
2	5	10	16.6	230	24.5	21.2	-	-
3	5	15	20.2	250	26.5	26.6	-	-
4	5	20	29.0	240	37.5	32.1	-	-
(5) Bulo River								
B - 0	0	0	5.5	20	9.3	9.3	-	-
1	1	1	5.5	20	9.8	9.5	-	-
2	1	2	6.1	20	10.3	9.5	-	-
3	1	3	6.1	16	10.3	10.4	-	-
4	1	4	6.4	20	11.4	11.5	-	-
5	1	5	6.8	32	12.7	12.8	-	-
5.5	0.5	5.5	7.2	32	12.7	12.8	-	-
6	0.5	6	7.2	46	13.7	13.5	-	-
7	1	7	7.4	24.5	13.8	13.4	-	-
7.5	0.5	7.5	7.0	22	12.9	12.8	-	-
8	0.5	8	7.3	25	13.2	13.2	-	-
9	1	9	7.5	19	13.8	14.1	-	-
10	1	10	9.8	21	14.5	14.4	-	-
11	1	11	11.5	20	16.5	16.5	-	-
12	1	12	11.2	19	17.5	17.4	-	-
13	1	13	12.7	19	17.7	17.7	-	-
14	1	14	13.6	18	19.3	19.3	-	-
15	1	15	15.0	23.5	20.0	20.4	-	-
16	1	16	13.1	23	21.5	21.3	-	-

/1: N.G.: Normal ground surface.

Table 4.2 DURATION OF THE INDICATED WATER LEVELS

Section	Indicated Water Level (m, MSL)	Duration (hr)			
		1/2 Present	1/5 Present	1/10 Present	1/20 Present
T-5	20.5 (0.5 m)	200	320	380	390
Natural ground	21.0 (1.0 m)	170	280	320	340
EL = 20.0	22.0 (2.0 m)	-	130	200	230
	Max. Water Level	21.6	22.3	22.6	22.8
T-8	27.0 (0.2 m)	-	-	54	144
Natural ground	27.5 (0.7 m)	-	-	-	-
EL = 26.8	28.0 (1.7 m)	-	-	-	-
	Max. Water Level	26.1	26.8	27.1	27.4

Remarks: 1. Duration has estimated based on the flood hydrographs of May 1976 type.

2. ( ) denotes water depth above the natural ground level.

Table 4.3 TYPHOONS ATTACKED TO REGION III (1976 - 1981)

Name	Duration	Duration of Disaster Operation	Affected Area (Region)	Total Rainfall (7 days) (mm)
Year, 1976				
Didang	May 19 - 28	May 19 - 28	I, II, III, IV	877.0
Huaning	June 22 - July 2	June 22 - July 2	I, II, III, IV, V, VIII, IX, X	327.5
Year, 1977				
Elang	July 16 - 19	July 16 - 19	I, III, IV	-
Ibiang	Aug. 17 - 23	Aug. 17 - 23	I, III, IV	No Data
Openg	Sept. 14 - 20	Sept. 14 - 20	I, III	-
Unding	Nov. 10 - 17	Nov. 10 - 17	I, II, III, IV, V, VI, VIII	185.6
Year, 1978				
Heling	Aug. 9 - 14	Aug. 9 - 14	III, IV	94.4
Meding	Aug. 20 - 26	Aug. 20 - 26	III	286.0
Weling	Sept. 24 - 28	Sept. 24 - 28	II, III, IV, VIII	115.7
Yaning	Oct. 7 - 14	Oct. 7 - 14	II, III, IV, V, VI, VII	118.1
Kading	Oct. 25 - 27	Oct. 25 - 27	I, II, III, IV, V, VIII	335.1
Year, 1979				
Etang	June 30 - July 1	June 30 - July 8	I, II, III, IV, V	No Data
Hering	July 25 - 29	July 23 - Aug. 10	II, III, IV	110.9
Ising	July 29 - Aug. 2	July 29 - Aug. 15	I, II, III	48.1
Mameng	Aug. 9 - 15	Aug. 7 - 28	I, II, III, IV, VI	164.4
Year, 1980				
Gloring	May 23 - 26	May 23 - June 7	III	148.8
Nitang	July 19 - 22	July 19 - Aug. 15	I, II, III	116.0
Osang	July 22 - 27	July 21 - Aug. 15	IV, V	199.2
Yoning	Oct. 28 - 30	Oct. 28 - Nov. 7	II, III, IV, V, VI	115.9
Aring	Nov. 1 - 7	Nov. 1 - 23	I, II, III, IV, V, VI, VIII	449.6
Year, 1981				
Elang	July 3 - 5	July 3 - 20	II, III, IV	No Data
Anding	Nov. 22 - 27	Nov. 22 - Dec. 12	I, II, III, IV	No Data

Remarks: 1. Data source : Typhoon Committee at Manila
2. Total rainfall: Cabanatuan Station

Table 4.4(1) TOTAL RAINFALL DEPTHS OF MAJOR TYPHOONS

(Unit: mm)

FLOOD	1. TRIS DAM				2. PANTABANGAN DAM				8. BALOC			
	DURATION				DURATION				DURATION			
	1-day	2-day	3-day	7-day	1-day	2-day	3-day	7-day	1-day	2-day	3-day	7-day
May 1976 (Didang)	424.9	680.5	918.8	1,303.2	208.3	335.8	520.0	788.8	179.3	296.2	399.6	627.0
Nov. 1977 (Unding)	74.4	98.8	118.9	127.1	90.4	130.3	154.7	175.8	116.6	134.6	152.1	158.2
Oct. 1978 (Kading)	96.0	171.7	171.7	190.8	122.5	166.5	168.0	172.5	199.7	228.7	235.5	235.8
Aug. 1979 (Mameng)	62.5	106.8	129.9	227.0	95.5	113.5	130.0	182.0	50.5	73.7	92.2	114.1
Nov. 1980 (Aring)	280.2	413.9	418.5	424.9	163.6	306.2	308.2	315.5	260.2	308.4	308.7	326.5
Nov. 1981 (Auding)					168.0	178.0	178.0	187.5				

FLOOD	11. PBRIS DAM				15. QUEZON				20. CABANATUAN CITY			
	DURATION				DURATION				DURATION			
	1-day	2-day	3-day	7-day	1-day	2-day	3-day	7-day	1-day	2-day	3-day	7-day
May 1976 (Didang)	198.6	338.5	492.5	785.9	101.7	167.6	-	-	226.1	442.0	582.9	877.0
Nov. 1977 (Unding)	122.4	137.1	145.9	145.9	77.2	112.8	139.0	143.1	92.7	138.2	182.6	185.6
Oct. 1978 (Kading)	-	-	-	-	141.0	181.6	183.6	199.6	230.6	300.9	306.4	335.1
Aug. 1979 (Mameng)	20.2	32.3	37.1	85.5	49.5	75.9	84.3	115.2	69.0	97.0	109.4	164.4
Nov. 1980 (Aring)	172.1	252.0	262.4	275.5	198.4	256.9	258.4	273.5	297.2	415.7	416.8	449.6
Nov. 1981 (Auding)	-	-	-	-	-							

(to be continued)

Table 4.4(2) TOTAL RAINFALL DEPTHS OF MAJOR TYPHOONS

(Unit: mm)

Flood	28. LAMBAKIN				31. MANGINO GAPAN				34. CONCEPCION CABIAO			
	DURATION				DURATION				DURATION			
	1-day	2-day	3-day	7-day	1-day	2-day	3-day	7-day	1-day	2-day	3-day	7-day
May 1976 (Didang)	166.4	274.4	378.5	647.4	206.3	312.3	398.5	713.5	236.0	337.6	428.5	739.1
Nov. 1977 (Unding)	61.2	87.1	97.5	107.4	73.6	125.2	135.4	143.5	109.2	173.7	237.7	240.6
Oct. 1978 (Kading)	-	-	-	-	147.3	192.0	199.1	223.0	172.3	224.9	225.4	248.3
Aug. 1979 (Mameng)	35.8	56.3	72.0	114.6	80.8	114.6	121.2	168.8	123.2	162.9	200.7	221.3
Nov. 1980 (Aring)	-	-	-	-	-	-	-	-	89.6	157.7	158.5	176.8
Nov. 1981 (Anding)	-	-	-	-	-	-	-	-	72.4	97.0	97.0	116.3

Table 4.5(1) OVERFLOW DISCHARGE IN THE TALAVERA RIVER

River Condition : Present
Scale : 5 yr
Safety Discharge: 270 m^3/s

Date/Time		(1) Discharge (m^3/s)	(2) Overflow Discharge (m^3/s)	(3) (3) = (2)/2 (m^3/s)	(4) Overflow Volume (x 10^3 m^3)	(5) $\sum(4)$ (x 10^3 m^3)
May 23	0	149.9	-	-	-	-
	6	193.7	-	-	-	-
	12	242.9	-	-	-	-
	18	257.6	-	-	-	-
24	0	276.6	6.6	3.3	35.6	35.6
	6	285.7	15.7	7.9	120.4	156.0
	12	292.2	22.2	11.1	204.7	360.7
	18	294.5	24.5	12.3	252.2	612.9
25	0	300.4	30.4	15.2	296.5	909.4
	6	207.6	37.6	18.8	367.2	1,276.6
	12	313.0	43.0	21.5	435.2	1,711.8
	18	321.7	42.7	21.4	462.8	2,174.6
26	0	334.0	64.0	32.0	576.2	2,750.8
	6	339.3	69.3	34.7	719.8	3,470.6
	12	342.7	72.7	36.4	766.8	4,237.4
	18	344.8	74.8	37.4	796.5	5,033.9
27	0	341.8	71.8	35.9	791.6	5,825.5
	6	339.1	69.1	34.6	760.9	6,586.4
	12	335.0	65.0	32.5	724.1	7,310.5
	18	330.1	60.1	30.1	675.5	7,986.0
28	0	325.2	55.2	27.6	622.6	8,608.6
	6	318.6	48.6	24.3	560.5	9,169.1
	12	311.6	41.6	20.8	487.1	9,656.2
	18	304.5	34.5	17.3	410.9	10,067.1
29	0	297.3	27.3	13.7	333.7	10,400.8
	6	290.1	20.1	10.1	256.0	10,656.8
	12	282.8	12.8	6.4	177.7	10,834.5
	18	275.6	5.6	2.8	99.4	10,933.9

(to be continued)

Table 4.5(2) OVERFLOW DISCHARGE IN THE TALAVERA RIVER

River Condition : Present
Scale : 5 yr
Safety Discharge: 270 m^3/s

Date/Time		(1) Discharge (m^3/s)	(2) Overflow Discharge (m^3/s)	(3) (3) = (2)/2 (m^3/s)	(4) Overflow Volume (x 10^3 m^3)	(5) $\sum$(4) (x 10^3 m^3)
May 30	0	268.5	-	-	30.2	10,964.1
	6	261.4	-	-	-	-
	12	254.4	-	-	-	-
	18	247.6	-	-	-	-
31	0	240.9	-	-	-	-
	6	234.3	-	-	-	-
	12	227.8	-	-	-	-
	18	221.5	-	-	-	-
June 1	0	216.4	-	-	-	-
	6	209.3	-	-	-	-
	12	203.0	-	-	-	-
	18	191.5	-	-	-	-
2	0	184.0	-	-	-	-
	6	177.0	-	-	-	-
	12	170.0	-	-	-	-
	18	163.0	-	-	-	-
3	0	156.0	-	-	-	-
	6	149.0	-	-	-	-
	12	142.0	-	-	-	-
	18	135.0	-	-	-	-
4	0	128.0	-	-	-	-
	6	121.0	-	-	-	-
	12	114.0	-	-	-	-
	18	107.0	-	-	-	-
5	0	100.0	-	-	-	-

Table 4.5(3) OVERFLOW DISCHARGE IN THE TALAVERA RIVER

River Condition : Present
Scale : 10 yr
Safety Discharge: 270 m^3/s

Date/Time		(1) Discharge (m^3/s)	(2) Overflow Discharge (m^3/s)	(3) (3) = (2)/2 (m^3/s)	(4) Overflow Volume (x 10^3 m^3)	(5) $\sum$(4) (x 10^3 m^3)
May 23	0	208.2	-	-	-	-
	6	261.3	-	-	-	-
	12	315.8	45.8	22.9	247.3	247.3
	18	328.3	58.3	29.2	562.1	809.4
24	0	344.6	74.6	37.3	717.7	1,527.1
	6	350.9	80.9	40.5	839.7	2,366.8
	12	359.9	89.9	45.0	922.3	3,289.1
	18	363.1	93.1	46.6	988.2	4,277.3
25	0	371.5	101.5	50.8	1,050.8	5,328.1
	6	381.6	111.6	55.8	1,150.7	6,478.8
	12	386.3	116.3	58.2	1,230.7	7,709.5
	18	391.0	121.0	60.5	1,282.0	8,991.5
26	0	401.3	131.3	65.7	1,362.4	10,353.9
	6	402.6	132.6	66.3	1,425.1	11,779.0
	12	401.6	131.6	65.8	1,426.7	13,205.7
	18	400.3	130.3	65.2	1,414.3	14,620.0
27	0	395.7	125.7	62.9	1,382.4	16,002.4
	6	392.5	122.5	61.3	1,340.3	17,342.7
	12	387.5	117.5	58.8	1,296.0	18,638.7
	18	381.3	111.3	55.7	1,235.5	19,874.2
28	0	375.3	105.3	52.7	1,169.6	21,043.8
	6	369.2	99.2	49.6	1,104.3	22,148.1
	12	363.1	93.1	46.6	1,038.4	23,186.5
	18	357.2	87.2	43.6	973.6	24,160.1
29	0	351.3	81.3	40.7	909.9	25,070.0
	6	345.5	75.5	37.8	847.3	25,917.3
	12	339.8	69.8	34.9	784.6	26,701.9
	18	334.9	64.9	32.5	724.4	27,429.3

(to be continued)

Table 4.5(4) OVERFLOW DISCHARGE IN THE TALAVERA RIVER

River Condition : Present
Scale : 10 yr
Safety Discharge: 270 m^3/s

Date/Time		(1) Discharge (m^3/s)	(2) Overflow Discharge (m^3/s)	(3) (3) = (2)/2 (m^3/s)	(4) Overflow Volume (x 10^3 m^3)	(5) $\sum(4)$ (x 10^3 m^3)
May 30	0	328.7	58.7	29.4	667.4	28,096.7
	6	323.3	53.3	26.7	604.8	28,701.5
	12	317.9	47.9	24.0	546.5	29,248.0
	18	312.7	42.7	21.4	489.2	29,737.2
31	0	307.3	37.3	18.7	432.5	30,169.7
	6	298.6	28.6	14.3	355.9	30,525.6
	12	290.1	20.1	10.1	263.0	30,788.6
	18	281.8	11.8	5.9	172.3	30,960.9
June 1	0	273.8	3.8	1.9	84.2	31,045.1
	6	265.9	-	-	20.5	31,065.6
	12	258.2	-	-	-	-
	18	250.7	-	-	-	-
2	0	241.0	-	-	-	-
	6	232.0	-	-	-	-
	12	223.0	-	-	-	-
	18	214.0	-	-	-	-
3	0	205.0	-	-	-	-
	6	196.0	-	-	-	-
	12	187.0	-	-	-	-
	18	178.0	-	-	-	-
4	0	169.0	-	-	-	-
	6	160.0	-	-	-	-
	12	151.0	-	-	-	-
	18	142.0	-	-	-	-
5	0	133.0	-	-	-	-
	6	124.0	-	-	-	-
	12	115.0	-	-	-	-
	18	106.0	-	-	-	-

Table 4.5(5) OVERFLOW DISCHARGE IN THE TALAVERA RIVER

River Condition : Present
Scale : 20 yr
Safety Discharge: 270 m^3/s

Date/Time			(1) Discharge (m^3/s)	(2) Overflow Discharge (m^3/s)	(3) (3) = (2)/2 (m^3/s)	(4) Overflow Volume (x 10^3 m^3)	(5) $\sum(4)$ (x 10^3 m^3)
May	23	0	264.5	-	-	-	-
		6	329.4	59.4	29.7	320.8	320.8
		12	385.0	115.0	57.5	941.8	1,262.6
		18	388.5	118.5	59.3	1,260.9	2,523.5
	24	0	409.3	139.3	69.6	1,392.1	3,915.6
		6	416.9	146.9	73.5	1,545.5	5,461.1
		12	427.9	157.9	78.9	1,645.9	7,107.0
		18	430.7	160.7	80.4	1,720.4	8,827.4
	25	0	431.9	161.9	81.0	1,742.0	10,569.4
		6	435.7	165.7	82.9	1,769.0	12,338.4
		12	436.4	166.4	83.2	1,793.3	14,131.7
		18	442.5	172.5	86.3	1,830.1	15,961.8
	26	0	455.8	185.8	92.9	1,934.8	17,896.6
		6	457.4	187.4	93.7	2,015.3	19,911.9
		12	456.4	186.4	93.2	2,018.5	21,930.4
		18	454.9	184.9	92.5	2,005.0	23,935.4
	27	0	449.3	179.3	89.7	1,966.7	25,902.1
		6	445.5	175.5	87.8	1,915.9	27,818.8
		12	439.4	169.4	84.7	1,862.5	29,680.5
		18	432.0	162.0	81.0	1,789.6	31,470.1
	28	0	424.8	154.8	77.4	1,710.7	33,180.8
		6	417.5	147.5	73.8	1,632.4	34,813.2
		12	410.4	140.4	70.2	1,554.7	36,367.9
		18	403.4	133.4	66.7	1,478.5	37,846.4
	29	0	396.5	126.5	63.3	1,403.5	39,249.9
		6	389.8	119.8	59.9	1,330.0	40,579.9
		12	383.2	113.2	56.6	1,258.2	41,838.1
		18	376.7	106.7	53.4	1,187.5	43,025.6

(to be continued)

Table 4.5(6) OVERFLOW DISCHARGE IN THE TALAVERA RIVER

River Condition : Present
Scale : 20 yr
Safety Discharge: 270 m^3/s

Date/Time		(1) Discharge (m^3/s)	(2) Overflow Discharge (m^3/s)	(3) (3) = (2)/2 (m^3/s)	(4) Overflow Volume (x 10^3 m^3)	(5) $\sum(4)$ (x 10^3 m^3)
May 30	0	370.3	100.3	50.2	1,117.8	44,143.4
	6	364.1	94.1	47.1	1,049.8	45,193.2
	12	358.0	88.0	44.0	983.3	46,176.5
	18	352.0	82.0	41.0	918.0	47,094.5
31	0	346.1	76.1	38.1	853.7	47,948.2
	6	340.4	70.4	35.2	791.1	48,739.3
	12	334.7	64.7	32.4	729.5	49,468.8
	18	329.1	59.1	29.6	668.5	50,137.3
June 1	0	323.6	53.6	26.8	608.6	50,745.9
	6	318.2	48.2	24.1	549.7	51,295.6
	12	312.9	42.9	21.5	491.9	51,787.5
	18	307.7	37.7	18.9	435.2	52,222.7
2	0	297.7	27.7	13.9	353.2	52,575.9
	6	287.0	17.0	8.5	241.4	52,817.3
	12	277.0	7.0	3.5	129.6	52,946.9
	18	267.0	-	-	37.8	52,984.7
3	0	257.0	-	-	-	-
	6	247.0	-	-	-	-
	12	237.0	-	-	-	-
	18	227.0	-	-	-	-
4	0	217.0	-	-	-	-
	6	207.0	-	-	-	-
	12	197.0	-	-	-	-
	18	187.0	-	-	-	-
5	0	167.0	-	-	-	-
	6	157.0	-	-	-	-
	12	147.0	-	-	-	-
	18	137.0	-	-	-	-

Table 4.6(1) FLOOD WATER BALANCE

Right Side of Talavera R.
Condition: Present
Scale : 1/5

Date/Time		Inflow Discharge (x 10^3 m^3)	Water Depth (m)	Outflow Discharge (x 10^3 m^3)	Storage Capacity (x 10^3 m^3)	Water Level (m, MSL)	Inundation Area (ha)
May 23	12	-	-	-	-	-	-
24	0	35.6	0	0	35.6	19.1	7.1
	12	325.1	0	0	360.7	20.1	62.4
25	0	548.7	0	0	909.4	20.8	84.4
	12	802.4	0	0	1,711.8	21.5	134.1
26	0	1,039.0	0	0	2,750.8	22.1	216.4
	12	1,486.6	0	0	4,237.4	22.5	370.9
27	0	1,588.1	0.4	84.1	5,741.4	22.9	527.2
	12	1,485.0	0.6	282.1	6,944.4	23.1	610.8
28	0	1,298.1	0.8	480.8	7,761.7	23.2	647.0
	12	1,047.6	0.8	619.6	8,189.7	23.3	665.9
29	0	744.6	0.9	686.1	8,248.2	23.3	668.5
	12	433.7	0.8	673.5	8,008.4	23.2	657.9
30	0	129.6	0.8	597.6	7,540.4	23.1	637.2
	12	-	0.7	496.0	7,044.4	23.1	615.2
31	0	-	0.6	407.0	6,637.4	23.1	597.2
	12	-	0.6	340.0	6,297.4	23.0	582.1
June 1	0	-	0.5	289.1	6,008.4	22.9	555.0
	12	-	0.4	236.3	5,772.0	22.9	530.3
2	0	-	0.4	181.8	5,590.2	22.8	511.5
	12	-	0.3	141.4	5,448.9	22.8	496.8
3	0	-	0.3	113.3	5,335.5	22.8	485.0
	12	-	0.3	93.2	5,242.3	22.7	475.3
4	0	-	0.2	78.2	5,164.1	22.7	467.2
	12	-	0.2	66.7	5,097.4	22.7	460.3
5	0	-	0.2	57.5	5,039.9	22.7	454.3
	12	-	-	-	-	-	-

Table 4.6(2) FLOOD WATER BALANCE

Right Side of Talavera R.
Condition: Present
Scale : 1/10

Date/Time		Inflow Discharge (x 10^3 m^3)	Water Depth (m)	Outflow Discharge (x 10^3 m^3)	Storage Capacity (x 10^3 m^3)	Water Level (m, MSL)	Inundation Area (ha)
May 23	12	247.3	0	0	247.3	19.8	49.5
24	0	1,279.8	0	0	1,527.1	21.4	121.8
	12	1,762.0	0	0	3,289.1	22.2	272.4
25	0	2,039.0	0.3	41.8	5,286.3	22.7	479.9
	12	1,281.4	0.5	192.8	6,374.9	23.0	585.5
26	0	2,644.4	0.9	508.9	8,510.4	23.3	680.1
	12	2,851.8	1.2	999.1	10,363.1	23.6	762.2
27	0	2,796.7	1.4	1,560.4	11,599.4	23.7	817.0
	12	2,636.3	1.5	1,998.4	12,237.3	23.8	845.2
28	0	2,405.1	1.6	2,209.5	12,433.0	23.8	853.9
	12	2,142.7	1.6	2,252.2	12,323.5	23.8	849.0
29	0	1,883.5	1.5	2,197.4	12,009.5	23.8	835.1
	12	1,631.9	1.5	2,078.8	11,562.7	23.7	815.3
30	0	1,394.8	1.4	1,888.4	11,069.1	23.6	793.5
	12	1,151.3	1.3	1,652.3	10,568.1	23.6	771.3
31	0	921.7	1.2	1,426.2	10,063.6	23.5	748.9
	12	618.9	1.1	1,209.1	9,473.4	23.4	722.8
June 1	0	256.5	1.0	984.8	8,745.2	23.3	690.5
	12	20.5	0.8	767.2	7,998.5	23.2	657.5
2	0	-	0.7	593.5	7,405.0	23.1	631.2
	12	-	0.7	472.9	6,932.1	23.1	610.2
3	0	-	0.6	388.0	6,544.1	23.0	593.0
	12	-	0.5	325.6	6,218.5	23.0	576.7
4	0	-	0.5	276.1	5,942.5	22.9	548.0
	12	-	0.4	222.6	5,719.8	22.9	524.9

Table 4.6(3) FLOOD WATER BALANCE

Right Side of Talavera R.
Condition: Present
Scale : 1/20

Date/Time		Inflow Discharge (x 10^3 m^3)	Water Depth (m)	Outflow Discharge (x 10^3 m^3)	Storage Capacity (x 10^3 m^3)	Water Level (m, MSL)	Inundation Area (ha)
May 23	12	1,262.6	-	-	1,262.6	21.2	104.2
24	0	2,653.0	-	-	3,915.6	22.4	337.5
	12	3,191.4	0.6	189.0	6,918.0	23.1	609.6
25	0	3,462.4	1.1	700.9	9,679.5	23.5	731.9
	12	3,562.3	1.4	1,445.2	11,796.7	23.7	825.7
26	0	3,764.9	1.7	2,184.3	13,377.3	23.9	895.7
	12	4,033.8	1.8	2,766.2	14,644.9	24.1	944.7
27	0	3,971.7	1.9	3,218.1	15,398.5	24.2	972.5
	12	3,778.4	2.0	3,497.6	15,679.3	24.2	982.8
28	0	3,500.3	2.0	3,589.6	15,590.0	24.2	979.5
	12	3,187.1	2.0	3,524.0	15,253.1	24.1	967.1
29	0	2,882.0	1.9	3,355.4	14,779.8	24.1	949.7
	12	2,588.2	1.8	3,135.1	14,232.9	24.0	929.6
30	0	2,445.7	1.8	2,915.7	13,762.8	24.0	912.3
	12	2,167.6	1.7	2,708.5	13,221.9	23.9	888.8
31	0	1,901.3	1.6	2,494.0	12,629.1	23.9	862.5
	12	1,644.8	1.6	2,276.5	11,997.5	23.8	834.6
June 1	0	1,398.0	1.5	2,043.7	11,351.8	23.7	806.0
	12	1,158.3	1.3	1,772.2	10,737.8	23.6	778.8
2	0	927.1	1.2	1,496.5	10,168.4	23.5	753.6
	12	594.6	1.1	1,244.6	9,518.4	23.4	724.8
3	0	167.4	1.0	990.2	8,695.7	23.3	688.3
	12	0	0.8	755.3	7,940.0	23.2	654.9
4	0	0	0.7	581.6	7,358.7	23.1	629.1
	12	0	0.6	464.2	6,894.6	23.1	608.6

Table 4.7 PEAK DISCHARGE OF PROBABLE FLOOD
(Improved Conditions)

(Unit: m^3/s)

Point	Location	Return Period (yr) 1/2	1/5	1/10	1/20	1/50
Upper Pampanga						
2		611	987	1,219	1,450	1,450
3		588	875	975	1,089	1,292
16	Coronel R.	294	660	911	1,152	1,965
17	Coronel R.	290	647	812	978	1,169
20		1,118	1,961	2,432	2,890	3,463
23	Cabanatuan	1,208	1,977	2,366	2,726	3,205
25		1,354	2,240	2,704	3,134	3,693
33	Peñaranda R.	237	542	753	948	1,197
34	Peñaranda	230	530	733	865	1,046
35	San Isidro	1,543	2,409	2,722	3,099	3,303
Talavera						
36		225	448	677	927	1,276
39		303	606	900	1,238	1,708
40		203	425	640	825	1,060
42		224	470	704	905	1,160
43		185	307	526	736	983
Rio Chico						
48	Ilog-Baliwag R.	146	291	393	491	637
49		127	261	372	466	593
52		230	505	717	921	1,199
53		203	458	667	860	1,149
57		474	974	1,394	1,889	2,516

Table 4.8(1) WATER LEVEL OF TRIBUTARIES

Design Discharge: 160 m^3/s (1/5 Flood)
Free Board : 0.6 m

Tributary - A

Station No.	X (m)	S	B (m)	A (m2)	P (m2)	R (m)	H (m)	V (m/sec)	WL (m, MSL)	DL (m, MSL)
TA.0			40.8	161.4	44.2	3.6	5.6	1.0	28.5	29.5 (29.1)
TA.1	1,000	1/750	28.7	99.3	31.4	3.2	4.55	1.6	28.8	29.5 (29.4)
TA.2 + 0.6	1,600	1/750	25.8	73.4	28.0	2.6	3.6	2.2	30.0	30.6
TA.3 + 0.7	1,100	1/750	25.5	70.9	27.6	2.6	3.5	2.3	31.3	31.9
TA.4 + 0.4	700	1/1,060	26.1	76.0	28.3	2.7	3.7	2.1	32.2	32.8
TA.7 + 0.1	2,900	1/1,060	26.7	81.3	29.1	2.8	3.9	1.9	34.9	35.5
TA.9	1,900	1/1,660	25.4	69.6	27.4	2.5	3.45	2.3	37.0	37.6

Remarks: Calculated by non-uniform flow

X : Distance
A : Flow area
H : Water depth
DL: Dike elevation
S : Slope
P : Wetted perimeter

V : Velocity
B : Width of water surface
R : Hydraulic radius
WL: Water level
Roughness coefficient: n = 0.03

Table 4.8(2) WATER LEVEL OF TRIBUTARIES

Design Discharge: 225 m^3/s (1/10 Flood)
Free Board : 0.8 m

Tributary - A

Station No.	X (m)	S	B (m)	A (m^2)	P (m^2)	R (m)	H (m)	V (m/sec)	WL (m, MSL)	DL (m, MSL)
TA.0			43.8	203.7	47.8	4.3	6.6	1.1	29.5	30.5 (30.3)
TA.1	1,000	1/750	35.7	131.7	39.0	3.4	5.55	1.7	29.8	30.6
TA.2 + 0.6	1,600	1/750	28.5	97.9	31.2	3.1	4.5	2.3	30.9	31.7
TA.3 + 0.7	1,100	1/750	27.9	92.2	30.5	3.0	4.3	2.5	32.1	32.9
TA.4 + 0.4	700	1/9,060	28.2	95.0	30.9	3.1	4.4	2.4	32.9	33.7
TA.7 + 0.1	2,700	1/1,060	29.1	103.3	31.9	3.2	4.69	2.2	35.7	36.2
TA.9	1,900	1/950	28.5	97.9	31.2	3.1	4.5	2.3	37.5	38.3
TA.11	1,000	1/950	28.5	97.9	31.2	3.1	4.5	2.3	38.5	39.3

Remarks: Calculated by non-uniform flow

X : Distance
A : Flow area
H : Water depth
DL: Dike elevation
S : Slope
P : Wetted perimeter

V : Velocity
B : Width of water surface
R : Hydraulic radius
WL: Water level
Roughness coefficient: n = 0.03

Table 4.8(3) WATER LEVEL OF TRIBUTARIES

Tributary - A

Design Discharge: 315 m^3/s (1/20 Flood)
Free Board : 0.8 m

Station No.	X (m)	S	B (m)	A (m^2)	P (m^2)	R (m)	H (m)	V (m/sec)	WL (m, MSL)	DL (m, MSL)
TA.0			45.6	230.6	50.0	4.6	7.2	1.4	30.1	31.1 (30.9)
TA.1	1,000	1/750	37.6	155.5	41.4	3.8	6.2	2.0	30.4	31.2
TA.1 + 0.6	1,600	1/750	35.1	214.6	38.3	3.3	5.35	2.5	31.8	32.6
TA.3 + 0.7	1,100	1/750	34.9	122.8	38.1	3.2	5.3	2.6	33.1	33.9
TA.4 + 0.4	700		35.4	128.1	38.7	3.3	5.45	2.5	34.0	34.8
TA.7 + 0.1	2,700		36.1	137.0	39.6	3.5	5.7	2.3	36.7	37.5
TA.9	1,900		34.8	121.1	37.9	3.2	5.25	2.6	38.8	39.6
TA.10	1,000		34.8	121.1	37.9	3.2	5.25	2.6	39.6	40.4

Remarks: Calculated by non-uniform flow

X : Distance
A : Flow area
H : Water depth
DL: Dike elevation
S : Slope
P : Wetted perimeter

V : Velocity
B : Width of water surface
R : Hydraulic radius
WL: Water level
Roughness coefficient: n = 0.03

Table 4.8(4) WATER LEVEL OF TRIBUTARIES

Design Discharge: 100 m^3/s (1/5 Flood)
Free Board : 0.6 m

<u>Tributary - B</u>

Station No.	X (m)	S	B (m)	A (m^2)	P (m^2)	R (m)	H (m)	V (m/sec)	WL (m, MSL)	DL (m, MSL)
TB.0			27.0	84.0	29.4	2.9	4.0	1.2	23.3	23.9 (24.3)
TB.2	2,000	1/1,630	25.8	73.4	28.0	2.6	3.6	1.4	24.1	24.7
TB.2 + 0.8	800	1/1,630	25.5	70.9	27.6	2.6	3.5	1.4	24.5	25.1
TB.5	2,200	1/1,630	25.1	67.1	27.1	2.4	3.35	1.5	25.7	26.3
TB.7	2,000	1/1,630	25.1	67.1	27.1	2.4	3.35	1.5	27.0	27.6
TB.9	2,000	1/1,250	17.0	47.3	19.9	2.4	3.5	2.1	28.7	29.3

Remarks: *: TB-9 Existing cross section

Calculated by non-uniform flow

X : Distance
A : Flow area
H : Water depth
DL: Dike elevation
S : Slope
P : Wetted perimeter

V : Velocity
B : Width of water surface
R : Hydraulic radius
WL: Water level
Roughness coefficient: n = 0.03

Table 4.8(5) WATER LEVEL OF TRIBUTARIES

Tributary - B

Design Discharge: 150 m^3/s (1/10 Flood)
Free Board : 0.6 m

Station No.	X (m)	S	B (m)	A (m^2)	P (m^2)	R (m)	H (m)	V (m/sec)	WL (m, MSL)	DL (m, MSL)
TB.0			29.1	103.6	31.9	3.2	4.7	1.4	24.0	24.6 (25.0)
TB.2	2,000	1/1,630	28.2	95.0	30.9	3.1	4.4	1.6	24.9	25.5
TB.2 + 0.8	800	1/1,630	27.9	92.2	30.5	3.0	4.3	1.6	25.3	25.9
TB.5	2,200	1/1,630	27.6	89.5	30.1	3.0	4.2	1.7	26.6	27.2
TB.7	2,000	1/1,630	27.6	89.5	30.1	3.0	4.2	1.7	27.8	28.6
TB.9	2,000	1/1,250	26.7	81.3	29.1	2.8	3.9	1.8	29.1	29.7

Remarks: Calculated by non-uniform flow

X : Distance
A : Flow area
H : Water depth
DL: Dike elevation
S : Slope
P : Wetted perimeter

V : Velocity
B : Width of water surface
R : Hydraulic radius
WL: Water level
Roughness coefficient: N = 0.03

Table 4.8(6) WATER LEVEL OF TRIBUTARIES

Tributary - B

Design Discharge: 195 m^3/s (1/20 Flood)
Free Board : 0.6 m

Station No.	X (m)	S	B (m)	A (m^2)	P (m^2)	R (m)	H (m)	V (m/sec)	WL (m, MSL)	DL (m, MSL)
TB.0			34.6	119.4	37.7	3.2	5.2	2.1	24.5	(25.1) (25.5)
TB.2	2,000	1/1,630	34.3	115.9	37.4	3.1	5.1	1.7	25.6	26.2
TB.2 + 0.8	800	1/1,630	34.3	115.9	37.4	3.1	5.1	1.7	26.1	26.7
TB.5	2,200	1/1,630	34.0	112.8	37.1	3.4	5.0	1.7	27.4	28.0
TB.7	2,000	1/1,630	29.9	111.0	32.9	3.4	4.95	1.8	28.6	29.2
TB.9	2,000	1/1,250	28.8	100.7	31.6	3.2	4.6	1.9	29.8	30.4

Remarks: Calculated by non-uniform flow

X : Distance
A : Flow area
H : Water depth
DL: Dike elevation
S : Slope
P : Wetted perimeter

V : Velocity
B : Width of water surface
R : Hydraulic radius
WL: Water level
Roughness coefficient: n = 0.03

Table 4.9 WATER LEVELS IN THE TALAVERA RIVER

Condition: Improved

(Unit: m, MSL)

Date/Time		20 Year Zone I, II T-5	20 Year Zone III T-8	10 Year Zone I, II T-5	10 Year Zone III T-8	5 Year Zone I, II T-5	5 Year Zone III T-8
May 22	0	21.3	25.8	21.0	25.6	20.7	25.3
	12	21.8	26.3	21.4	25.9	21.0	25.2
23	0	23.1	27.4	22.5	27.0	21.9	26.3
	12	24.0	28.6	23.6	28.1	23.0	27.4
24	0	23.4	27.9	23.1	27.5	22.6	27.0
	12	23.9	28.4	23.5	28.0	23.1	27.4
25	0	24.9	28.5	23.6	28.1	23.2	27.6
	12	24.0	28.6	23.6	28.1	23.2	27.6
26	0	23.9	28.4	23.6	28.0	23.2	27.6
	12	23.5	28.0	23.2	27.7	22.9	27.2
27	0	23.9	27.3	22.6	27.0	22.3	26.8
	12	22.3	26.3	22.1	26.6	21.9	26.4
28	0	21.9	26.3	21.7	26.2	21.6	26.1
	12	21.5	26.0	21.4	26.0	21.3	25.8
29	0	21.3	25.8	21.2	25.7	21.1	25.6
	12	21.1	25.6	21.0	25.5	20.9	25.5
30	0	20.9	25.5	20.8	25.4	20.8	25.3
	12	20.7	25.3	20.7	25.3	20.6	25.2
31	0	20.6	25.2	20.6	25.2	20.6	25.2
	12	20.5	25.1	20.5	25.1	20.5	25.1

Table 4.10(1) FLOOD WATER BALANCE
ZONE I

Condition: Improved
Scale : 5 yr

Date/Time		Inflow Discharge (x 10^3 m^3)	Water Depth (m)	Outflow Discharge (x 10^3 m^3)	Storage Capacity (x 10^3 m^3)	Water Level (m, MSL)	Reservoir Area (ha)
May 22	0	11.8	0.1	0	11.8	19.1	2.4
	12	66.7	0.5	0	78.5	19.5	15.7
23	0	100.0	1.1	0	178.5	20.1	31.4
	12	215.9	1.6	0	394.4	20.6	42.2
24	0	225.5	2.1	0	619.9	21.1	54.0
	12	217.3	2.4	0	837.2	21.4	66.4
25	0	201.9	2.7	0	1,039.1	21.7	77.9
	12	178.8	3.0	0	1,217.9	22.0	88.2
26	0	162.5	3.1	0	1,380.4	22.1	106.9
	12	152.4	3.1	0	1,532.8	22.1	126.6
27	0	123.5	3.2	0	1,656.3	22.2	142.6
	12	98.5	3.2	237.4	1,517.4	22.1	124.6
28	0	77.3	3.1	433.6	1,161.1	21.9	84.9
	12	59.8	3.0	238.2	982.7	21.6	74.7
29	0	46.8	2.7	76.5	953.1	21.6	73.0
	12	37.1	2.6	84.2	906.0	21.5	70.3
30	0	29.8	2.6	102.0	833.8	21.4	66.2
	12	24.0	2.4	115.2	742.5	21.3	61.0
31	0	19.6	2.3	109.8	652.4	21.1	55.8
	12	16.1	2.2	90.0	578.5	21.0	51.6
June 1	0	13.4					
	12	11.1					
2	0	4.9					

Table 4.10(2) FLOOD WATER BALANCE
ZONE I

Condition: Improved
Scale : 10 yr

Date/Time		Inflow Discharge (x 10^3 m^3)	Water Depth (m)	Outflow Discharge (x 10^3 m^3)	Storage Capacity (x 10^3 m^3)	Water Level (m, MSL)	Reservoir Area (ha)
May 22	0	16.9	0.1	0	16.9	19.1	3.4
	12	95.2	0.7	0	112.1	19.7	22.4
23	0	153.4	1.3	0	265.5	20.3	35.8
	12	345.9	2.1	0	611.4	21.1	53.5
24	0	346.2	2.6	0	957.6	21.6	73.3
	12	323.4	3.0	0	1,281.0	22.0	94.0
25	0	293.3	3.1	0	1,574.3	22.1	132.0
	12	255.0	3.2	0	1,829.3	22.2	165.0
26	0	225.8	3.3	0	2,055.1	22.3	194.2
	12	207.5	3.4	0	2,262.6	22.4	221.0
27	0	169.9	3.5	0	2,432.5	22.5	243.0
	12	133.5	3.5	344.2	2,221.8	22.4	215.8
28	0	103.7	3.4	690.7	1,634.8	22.2	139.8
	12	79.2	3.2	574.1	1,139.8	21.8	83.7
29	0	61.4	2.9	277.5	923.7	21.5	71.4
	12	48.1	2.6	86.1	885.7	21.5	69.2
30	0	38.2	2.5	86.5	837.4	21.4	66.4
	12	30.6	2.5	103.0	765.0	21.3	62.3
31	0	24.7	2.3	103.9	685.8	21.2	57.8
	12	20.2	2.2	100.3	605.6	21.1	53.2
June 1	0	16.6					
	12	13.8					
2	0	6.0					

Table 4.10(3) FLOOD WATER BALANCE
ZONE I

Condition: Improved
Scale : 20 yr

Date/Time		Inflow Discharge (x 10^3 m^3)	Water Depth (m)	Outflow Discharge (x 10^3 m^3)	Storage Capacity (x 10^3 m^3)	Water Level (m, MSL)	Reservoir Area (ha)
May 22	0	23.3	0.2	0	23.3	19.2	4.7
	12	133.1	1.0	0	156.4	20.0	30.3
23	0	233.1	1.6	0	389.5	20.6	42.0
	12	502.2	2.5	0	891.7	21.5	69.5
24	0	488.9	3.1	0	1,380.6	22.1	106.9
	12	447.9	3.2	0	1,828.5	22.2	164.9
25	0	400.2	3.4	0	2,228.7	22.4	216.7
	12	343.9	3.5	0	2,572.6	22.5	261.2
26	0	305.5	3.6	0	2,878.1	22.6	300.7
	12	281.6	3.7	0	3,159.9	22.7	337.2
27	0	223.2	3.8	0	3,382.9	22.8	366.0
	12	174.3	3.9	415.0	3,142.4	22.7	334.9
28	0	134.1	3.8	890.7	2,385.8	22.4	237.0
	12	101.5	3.5	847.4	1,639.9	22.2	140.5
29	0	78.0	3.2	600.3	1,117.7	21.8	82.4
	12	60.7	2.9	286.4	892.0	21.5	69.5
30	0	47.8	2.6	99.6	840.2	21.4	66.6
	12	38.1	2.5	96.2	782.1	21.3	63.3
31	0	30.5	2.4	109.5	703.1	21.2	58.8
	12	24.9	2.3	107.8	620.3	21.1	54.0
June 1	0	20.4					
	12	16.8					
2	0	7.3					

Table 4.10(4) FLOOD WATER BALANCE
ZONE II

Condition: Improved
Scale : 5 yr

Date/Time		Inflow Discharge (x 10^3 m^3)	Water Depth (m)	Outflow Discharge (x 10^3 m^3)	Storage Capacity (x 10^3 m^3)	Water Level (m, MSL)	Reservoir Area (ha)
May 22	0	43.0	0.3	0	43.0	19.3	8.6
	12	235.5	1.4	0	278.5	20.4	33.7
23	0	360.0	2.2	0	638.5	21.2	51.5
	12	881.0	3.3	0	1,519.5	22.3	113.5
24	0	905.5	4.0	709.2	1,715.8	22.5	124.5
	12	880.9	4.1	914.6	1,682.0	22.5	122.6
25	0	903.7	4.1	205.4	238.4	23.0	160.7
	12	859.2	4.5	578.9	2,660.7	23.2	166.9
26	0	817.9	4.6	1,276.2	2,202.4	22.9	151.7
	12	765.3	4.3	1,407.8	1,559.9	22.4	115.8
27	0	596.4	3.8	1,498.3	658.0	21.3	53.2
	12	457.4	3.0	906.2	209.2	20.2	31.7
28	0	351.8	2.1	118.4	442.6	20.8	38.4
	12	269.4	2.4	1.3	710.7	21.4	57.6
29	0	210.5	2.7	73.6	847.6	21.6	69.0
	12	167.1	2.8	229.1	785.6	21.5	63.8
30	0	134.8	2.7	298.3	622.1	21.2	50.2
	12	110.0	2.4	254.5	477.6	20.9	39.4
31	0	91.0	2.1	168.6	400.0	20.7	37.1
	12	75.9	1.9	97.1	378.8	20.7	36.5
June 1	0	64.1					
	12	55.0					
2	0	24.3					

Table 4.10(5) FLOOD WATER BALANCE
ZONE II

Condition: Improved
Scale : 10 yr

Date/Time		Inflow Discharge (x 10^3 m^3)	Water Depth (m)	Outflow Discharge (x 10^3 m^3)	Storage Capacity (x 10^3 m^3)	Water Level (m, MSL)	Reservoir Area (ha)
May 22	0	74.0	0.5	0	74.0	19.5	14.8
	12	398.8	1.9	0	472.8	20.9	39.2
23	0	665.1	3.0	0	1,137.9	22.0	92.1
	12	1,757.2	4.3	0	2,895.1	23.3	172.1
24	0	1,700.6	5.2	1,114.0	3,481.7	23.6	185.1
	12	1,603.4	5.4	2,125.3	2,959.8	23.3	173.6
25	0	1,678.6	5.2	1,843.3	2,795.1	23.2	169.9
	12	1,605.8	5.1	1,591.7	2,809.2	23.3	170.2
26	0	1,509.2	5.1	1,492.6	2,825.7	23.3	170.6
	12	1,394.3	5.0	1,705.1	2,515.0	23.1	163.7
27	0	1,058.0	4.7	2,080.9	1,492.0	22.3	112.0
	12	783.7	3.9	2,087.2	188.5	20.1	31.1
28	0	587.8	2.5	978.5	0	19.0	0
	12	440.9	1.8	0	440.9	20.8	38.3
29	0	339.2	2.5	18.6	761.5	21.4	61.8
	12	266.6	2.9	154.8	873.3	21.6	71.1
30	0	213.2	3.0	357.4	729.1	21.4	59.1
	12	173.1	2.7	381.4	520.8	21.0	41.7
31	0	142.5	2.3	247.1	416.2	20.8	37.6
	12	118.8	2.1	150.7	384.3	20.7	36.7
June 1	0	100.1					
	12	85.2					
2	0	37.9					

Table 4.10(6) FLOOD WATER BALANCE
ZONE II

Condition: Improved
Scale : 20 yr

Date/Time		Inflow Discharge (x 10^3 m^3)	Water Depth (m)	Outflow Discharge (x 10^3 m^3)	Storage Capacity (x 10^3 m^3)	Water Level (m, MSL)	Reservoir Area (ha)
May 22	0	97.0	0.7	0	97.0	19.6	19.4
	12	540.0	2.2	0	637.0	21.2	51.4
23	0	951.9	3.4	0	1,588.9	22.4	117.4
	12	2,394.7	4.9	0	3,983.6	23.9	196.3
24	0	2,231.7	5.9	1,297.8	4,917.5	24.3	222.9
	12	2,055.7	6.1	2,487.8	4,485.3	24.1	210.0
25	0	2,123.7	6.0	1,579.3	5,029.8	24.4	226.2
	12	2,004.9	6.2	1,539.7	5,495.0	24.6	240.1
26	0	1,889.8	6.3	2,398.7	4,986.1	24.4	224.9
	12	1,727.4	6.1	2,583.2	4,130.3	24.0	199.6
27	0	1,274.1	5.5	2,184.5	3,219.9	23.5	179.3
	12	930.0	5.0	2,241.0	1,908.8	22.6	135.3
28	0	688.9	4.1	2,529.7	68.0	19.5	13.6
	12	510.5	2.1	1,138.3	0	19.0	0
29	0	388.7	1.7	0	388.7	20.7	36.8
	12	302.7	2.3	13.4	678.0	21.3	54.8
30	0	240.2	2.7	128.8	789.4	21.5	64.1
	12	193.6	2.8	314.4	668.6	21.3	54.0
31	0	158.3	2.5	352.2	474.6	20.9	39.3
	12	131.1	2.2	241.0	364.7	20.6	36.1
June 1	0	109.9					
	12	93.0					
2	0	41.3					

Table 4.10(7) FLOOD WATER BALANCE
ZONE III

Condition: Improved
Scale : 5 yr

Date/Time		Inflow Discharge (x 10^3 m^3)	Water Depth (m)	Outflow Discharge (x 10^3 m^3)	Storage Capacity (x 10^3 m^3)	Water Level (m, MSL)	Reservoir Area (ha)
May 22	0	14.0	0	0	14.0	28.3	2.8
	12	68.3	0.7	35.7	46.6	28.9	9.3
23	0	112.1	1.0	101.3	57.4	29.0	10.7
	12	382.9	1.9	170.0	270.2	30.0	31.6
24	0	379.7	2.3	223.8	426.1	30.4	44.1
	12	377.5	2.6	247.2	556.4	30.6	54.5
25	0	467.4	2.8	264.0	759.9	31.0	70.2
	12	494.3	3.1	280.3	973.8	31.3	75.6
26	0	499.5	3.4	295.8	1,177.5	31.5	80.7
	12	466.4	3.6	308.0	1,336.0	31.7	84.6
27	0	345.3	3.6	313.8	1,367.5	31.8	85.4
	12	250.6	3.6	313.1	1,304.9	31.7	83.9
28	0	186.6	3.4	307.9	1,183.6	31.5	80.8
	12	140.6	3.2	298.8	1,025.4	31.3	76.9
29	0	109.3	3.0	286.7	848.0	31.1	72.5
	12	87.2	2.7	272.9	662.3	30.8	63.0
30	0	71.1	2.5	257.6	475.8	30.5	48.1
	12	59.0	2.1	236.1	298.7	30.1	33.9
31	0	49.8	1.7	208.7	139.8	29.4	19.0
	12	42.6	1.2	169.6	12.7	28.3	2.5
June 1	0	36.9					
	12	32.2					
2	0	14.6					

Table 4.10(8) FLOOD WATER BALANCE
ZONE III

Condition: Improved
Scale : 10 yr

Date/Time		Inflow Discharge (x 10^3 m^3)	Water Depth (m)	Outflow Discharge (x 10^3 m^3)	Storage Capacity (x 10^3 m^3)	Water Level (m, MSL)	Reservoir Area (ha)
May 22	0	27.0	0.0	508.3	0	28.0	0
	12	135.3	0.9	1,196.5	0	28.0	0
23	0	239.9	1.4	807.5	0	28.0	0
	12	786.5	2.5	340.4	446.1	30.4	45.7
24	0	731.2	3.0	474.8	702.5	30.9	66.2
	12	698.0	3.3	524.2	876.3	31.2	73.2
25	0	847.1	3.7	561.3	1,162.1	31.5	80.3
	12	876.3	4.0	598.3	1,440.1	31.9	87.3
26	0	859.2	4.2	628.1	1,671.2	32.1	92.4
	12	796.8	4.4	649.5	1,818.5	32.3	95.4
27	0	573.4	4.3	654.0	1,737.9	32.2	93.8
	12	404.4	4.1	637.9	1,504.4	31.9	88.9
28	0	294.2	3.7	607.7	1,190.9	31.6	81.0
	12	217.0	3.3	565.9	842.0	31.1	72.2
29	0	165.9	2.8	511.2	496.7	30.5	49.7
	12	130.6	2.3	439.3	188.0	29.7	23.8
30	0	105.2	1.6	335.4	0	28.0	0
	12	86.5	0.7	944.1	0	28.0	0
31	0	72.3	0.6	1,625.9	0	28.0	0
	12	61.4	0.6	1,651.9	0	28.0	0
June 1	0	52.7					
	12	45.8					
2	0	20.8					

Table 4.10(9) FLOOD WATER BALANCE
ZONE III

Condition: Improved
Scale : 20 yr

Date/Time		Inflow Discharge ($\times 10^3$ m^3)	Water Depth (m)	Outflow Discharge ($\times 10^3$ m^3)	Storage Capacity ($\times 10^3$ m^3)	Water Level (m, MSL)	Reservoir Area (ha)
May 22	0	36.4	0.2	504.8	0	28.0	0
	12	195.0	1.2	1,160.4	0	28.0	0
23	0	347.0	1.7	773.1	0	28.0	0
	12	1,076.3	2.9	434.1	642.2	30.8	61.4
24	0	952.8	3.5	698.1	896.9	31.2	73.7
	12	883.6	3.7	780.0	1,000.5	31.3	76.3
25	0	1,063.3	4.0	821.5	1,242.3	31.6	82.3
	12	1,085.7	4.3	867.7	1,460.3	31.9	87.8
26	0	1,068.0	4.5	905.1	1,623.2	32.1	91.5
	12	970.9	4.5	924.6	1,669.5	32.1	92.4
27	0	678.6	4.3	910.5	1,437.6	31.9	87.2
	12	468.0	3.9	855.8	1,049.9	31.4	77.5
28	0	334.6	3.3	766.8	617.7	30.7	59.4
	12	242.7	2.6	641.9	218.5	29.8	26.9
29	0	183.2	1.8	431.6	0	28.0	0
	12	142.6	1.0	948.1	0	28.0	0
30	0	114.0	0.8	1,587.5	0	28.0	0
	12	93.1	0.7	1,605.8	0	28.0	0
31	0	77.3	0.6	1,646.1	0	28.0	0
	12	65.1	0.6	1,667.2	0	28.0	0
June 1	0	55.9					
	12	48.3					
2	0	21.8					

Table 4.11 WORK QUANTITIES BY ALTERNATIVE PLANS

Work Item	Unit	Alternative Plan		
		1/20	1/10	1/5
1. Talavera River				
Improved Length	km	27.0	26.5	26.0
Direct Works				
Excavation	10^3m^3	720	720	720
Embankment	10^3m^3	1,560	1,020	470
Compensation				
Land (farm land)	ha	150	137	116
2. Tributary A				
Improved Length	km	10.0	9.0	4.4
Direct Works				
Excavation	10^3m^3	370	250	170
Embankment	10^3m^3	210	90	50
Bridge		2	1	-
Gate (3.0mx3.0m)	no.	2	2	2
Compensation				
Land (farm land)	ha	28	21	4
3. Tributary B				
Improved Length	km	9.0	8.0	7.0
Direct Works				
Excavation	10^3m^3	220	170	100
Embankment	10^3m^3	430	290	170
Bridge		1	-	-
Gate	no.	3.0x3.0x1 no. 3.0x1.5x1 no.	3.0x3.0x1 no. 3.0x1.0x1 no.	3.0x3.0x1 no. 3.0x0.5x1 no.
Compensation				
Land (farm land)	ha	21	19	10

Table 4.12(1) BREAKDOWN OF DIRECT CONSTRUCTION COST FOR RIVER IMPROVEMENT (5 YEAR FLOOD)

Work Item	Unit	Quantity	Amount (P10^3) Foreign Currency	Amount (P10^3) Local Currency
I. TALAVERA RIVER				
1. Preparation Work			807	371
2. Civil Work				
- Excavation by BHS	m^3	720,000	5,832	1,944
- Spreading	m^3	470,000	1,692	611
- Compacting	m^3	470,000	2,209	940
- Excavation in borrow area	m^3	250,000	2,025	675
- Hauling to site	m^3	250,000	4,575	2,150
Sub-total			16,333	6,320
3. Land Acquisition	ha	116	-	1,299
Total			17,140	7,990
II. TRIBUTARY A				
1. Preparation Work			172	53
2. Civil Work				
- Excavation by BHS	m^3	170,000	1,377	459
- Hauling to spoil area	m^3	120,000	936	444
- Spreading	m^3	50,000	180	65
- Compacting	m^3	50,000	235	100
Sub-total			2,728	1,068
3. Structure				
- Gate (3.0 x 3.0m)	no.	2	900	144
4. Land Acquisition	ha	4	-	45
Total			3,800	1,310

(to be continued)

Table 4.12(2) BREAKDOWN OF DIRECT CONSTRUCTION COST FOR RIVER IMPROVEMENT (5 YEAR FLOOD)

Work Item	Unit	Quantity	Amount (₱10³) Foreign Currency	Local Currency
III. TRIBUTARY B				
1. Preparation Work			221	80
2. Civil Work				
- Excavation by BHS	m^3	100,000	810	270
- Spreading	m^3	170,000	612	221
- Compacting	m^3	170,000	799	340
- Excavation in borrow area	m^3	70,000	567	189
- Hauling to site	m^3	70,000	1,281	602
Sub-total			4,069	1,622
3. Structure (Gate)				
- 3.0 x 3.0 m	no.	1	450	72
- 3.0 x 1.0 m	no.	1	150	24
Sub-total			600	96
4. Land Acquisition	ha	10	-	112
Total			4,890	1,910
Grand Total			25,830	11,210

Table 4.13(1) BREAKDOWN OF DIRECT CONSTRUCTION COST FOR RIVER IMPROVEMENT (10 YEAR FLOOD)

Work Item	Unit	Quantity	Amount (₱10³) Foreign Currency	Local Currency
I. TALAVERA RIVER				
1. Preparation Work			1,112	436
2. Civil Work				
- Excavation by BHS	m^3	720,000	5,832	1,944
- Spreading	m^3	1,020,000	3,672	1,326
- Compacting	m^3	1,020,000	4,794	2,040
- Excavation in borrow area	m^3	300,000	2,430	810
- Hauling to site	m^3	300,000	5,490	2,580
Sub-total			22,218	8,700
3. Land Acquisition	ha	137	-	1,534
Total			23,330	10,670
II. TRIBUTARY A				
1. Preparation Work			252	87
2. Civil Work				
- Excavation by BHS	m^3	250,000	2,025	675
- Hauling to spoil area	m^3	160,000	1,248	592
- Spreading	m^3	90,000	324	117
- Compacting	m^3	90,000	423	180
Sub-total			4,020	1,564
3. Structure				
- Bridge	no.	1	38	100
- Gate (3.0 x 3.0 m)	no.	2	900	144
Sub-total			938	244
4. Land Acquisition	ha	21	-	235
Total			5,210	2,130

(to be continued)

Table 4.13(2) BREAKDOWN OF DIRECT CONSTRUCTION COST FOR RIVER IMPROVEMENT (10 YEAR FLOOD)

Work Item	Unit	Quantity	Amount (₱10³) Foreign Currency	Local Currency
III. TRIBUTARY B				
1. Preparation Work			378	139
2. Civil Work				
- Excavation by BHS	m^3	170,000	1,377	459
- Spreading	m^3	290,000	1,044	377
- Compacting	m^3	290,000	1,363	580
- Excavation in borrow area	m^3	120,000	972	324
- Hauling to site	m^3	120,000	2,196	1,032
Sub-total			6,952	2,772
3. Structure (Gate)				
- 3.0 x 3.0 m	no.	1	450	72
- 3.0 x 1.0 m	no.	1	150	24
Sub-total			600	96
4. Land Acquisition	ha	19	-	213
Total			7,930	3,220
Grand Total			36,470	16,020

Table 4.14(1) BREAKDOWN OF DIRECT CONSTRUCTION COST FOR RIVER IMPROVEMENT (20 YEAR FLOOD)

Work Item	Unit	Quantity	Amount (₱10³) Foreign Currency	Local Currency
I. TALAVERA RIVER				
1. Preparation Work			2,024	896
2. Civil Work				
- Excavation by BHS	m^3	620,000	5,832	1,944
- Spreading	m^3	1,560,000	5,616	2,028
- Compacting	m^3	1,560,000	7,332	3,120
- Excavation in borrow area	m^3	840,000	6,804	2,268
- Hauling to site	m^3	840,000	15,372	7,224
Sub-total			40,956	16,584
3. Land Acquisition	ha	150	-	1,680
Total			42,980	19,160
II. TRIBUTARY A				
1. Preparation Work			336	137
2. Civil Work				
- Excavation by BHS	m^3	370,000	2,997	999
- Hauling to spoil area	m^3	160,000	1,248	592
- Spreading	m^3	210,000	756	273
- Compacting	m^3	210,000	987	420
Sub-total			5,988	2,284
3. Structure				
- Bridge	no.	1	76	201
- Gate (3.0 x 3.0 m)	no.	2	900	144
Sub-total			976	345
4. Land Acquisition	ha	28	-	314
Total			7,300	3,080

(to be continued)

Table 4.14(2) BREAKDOWN OF DIRECT CONSTRUCTION COST FOR RIVER IMPROVEMENT (20 YEAR FLOOD)

Work Item	Unit	Quantity	Amount (₱10³) Foreign Currency	Local Currency
III. TRIBUTARY B				
1. Preparation Work			555	213
2. Civil Work				
- Excavation by BHS	m^3	220,000	1,782	594
- Spreading	m^3	430,000	1,548	559
- Compacting	m^3	430,000	2,021	860
- Excavation in borrow area	m^3	210,000	1,701	567
- Hauling to site	m^3	210,000	3,843	1,806
Sub-total			10,895	4,386
3. Structure (Gate)				
- 3.0 x 3.0 m	no.	1	450	72
- 3.0 x 1.0 m	no.	1	150	24
Sub-total			600	96
4. Land Acquisition	ha	21	-	235
Total			12,050	4,930
Grand Total			62,330	27,170

Table 4.15 DECREASE IN FLOOD DAMAGES WITH RIVER IMPROVEMENT PROJECT

Item	Unit	Q'ty	Unit Price (₱)	Amount (₱10⁶)
(A) 5-Year Design Flood				19.74
- Damage to crops				4.84
Irrigated land	ha	700	4,412	3.09
Rainfed area	ha	768	2,280	1.75
- Damage to private properties	house	1,163	3,000	3.49
- Damage to public properties/1				10.47
- Indirect losse/2				0.94
(B) 10-Year Design Flood				62.67
- Damage to crops				14.89
Irrigated land	ha	1,945	4,412	8.58
Rainfed area	ha	2,767	2,280	6.31
- Damage to private properties	house	3,734	3,000	11.20
- Damage to public properties/1				33.60
- Indirect losse/2				2.98
(C) 20-Year Design Flood				68.67
- Damage to crops				16.16
Irrigated land	ha	2,043	4,412	9.01
Rainfed area	ha	3,137	2,280	7.15
- Damage to private properties	house	4,105	3,000	12.31
- Damage to public properties/1				36.93
- Indirect losse/2				3.27

Remarks: /1: 300% of damage to private properties

/2: 5% of total damages to crops, private properties and public properties

Table 4.16 ANNUAL EQUIVALENT FLOOD DAMAGES

(Unit: ₱10^6)

Scale of Flood (m^3/s)	Exceeding Probability	Annual Average Probability between Scaled Flood	Damages by Flood	Average Damage between Scaled Flood	Annual Equivalent Damages between Scaled Flood	Annual Equivalent Damages
220	1/2 (0.5)	-	0	0	0	0
600	1/5 (0.2)	0.3	19.74	9.87	2.96	2.96
900	1/10 (0.1)	0.1	62.67	41.21	4.12	7.08
1,250	1/20 (0.05)	0.05	68.67	65.67	3.28	10.36

Fig. 4.1 GENERAL BASIN MAP OF THE PAMPANGA RIVER

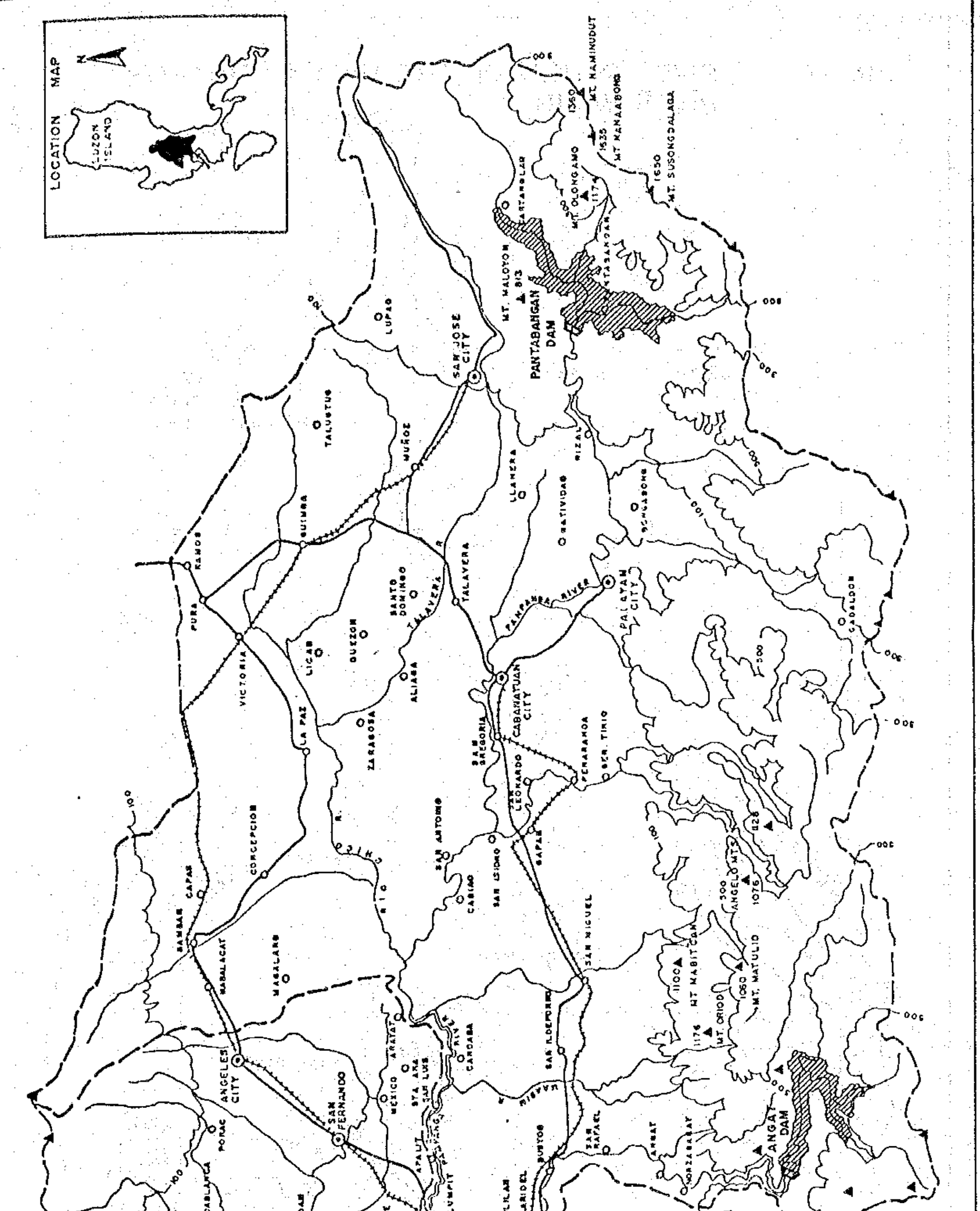


Fig. 4.2 RIVER SYSTEM OF THE UPPER PAMPANGA RIVER BASIN

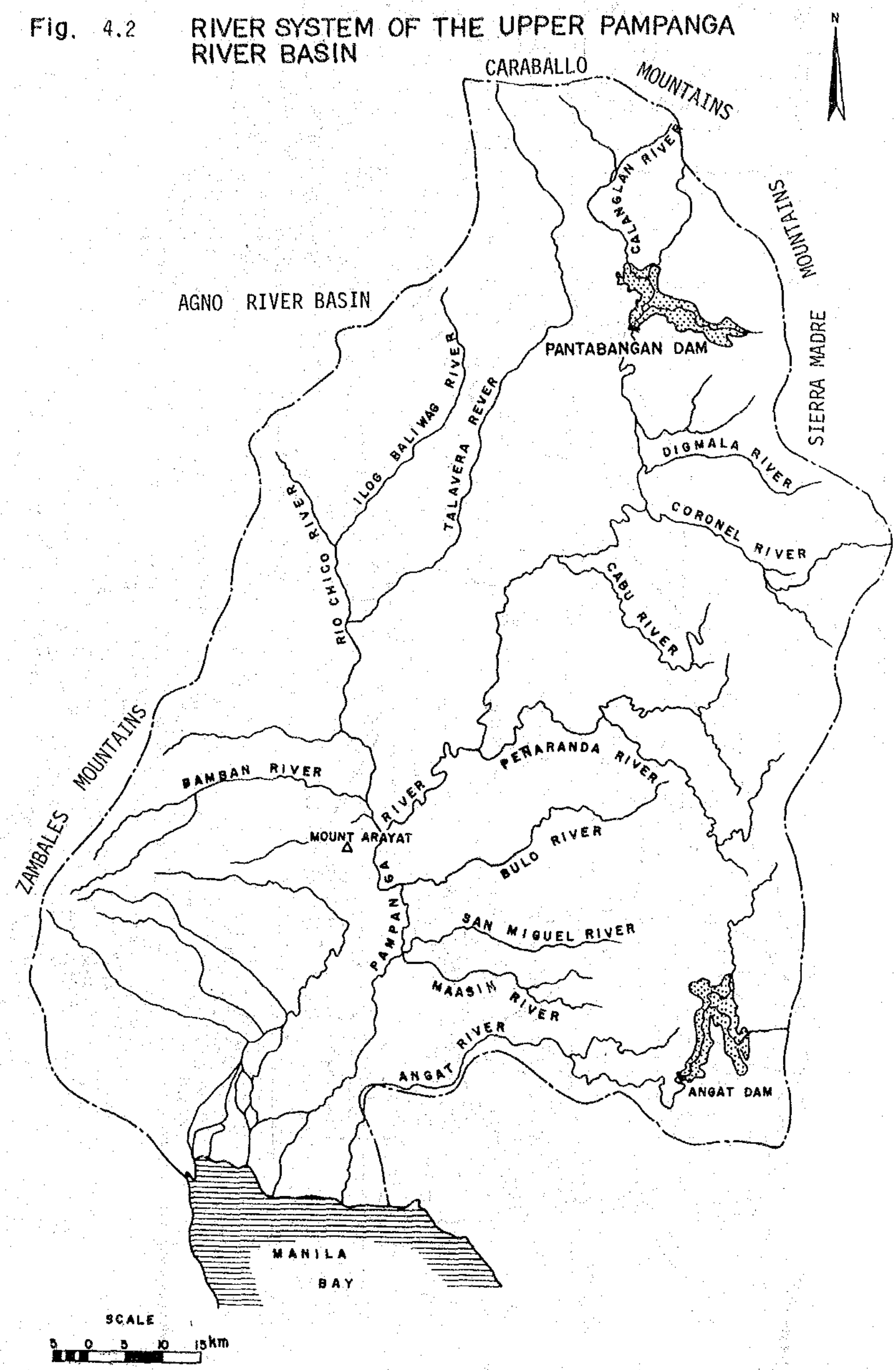


Fig. 4.3(1) LONGITUDINAL PROFILE OF RIVERS

- the Pampanga River

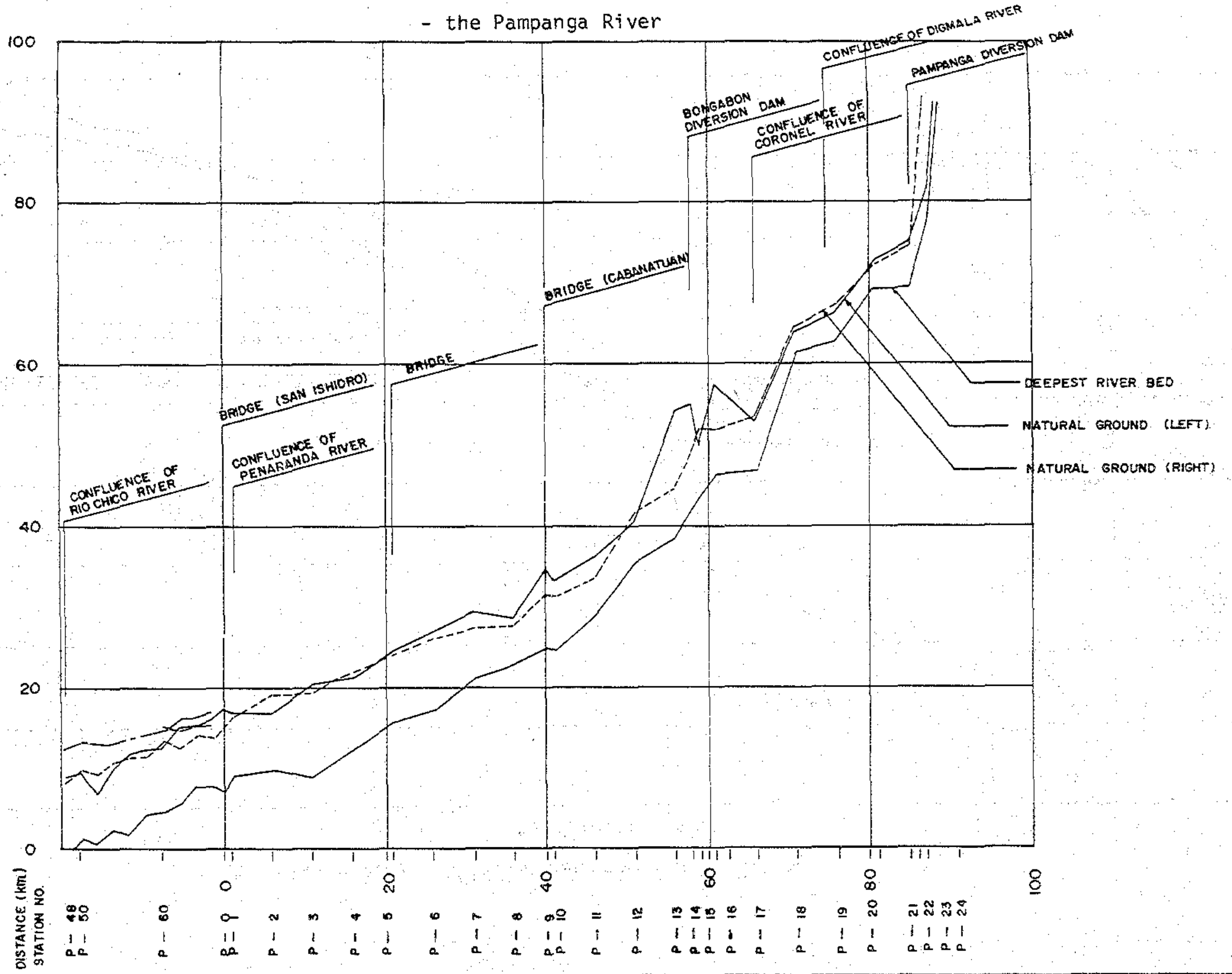


Fig. 4.3(2) LONGITUDINAL PROFILE OF RIVERS

- the Talavera River

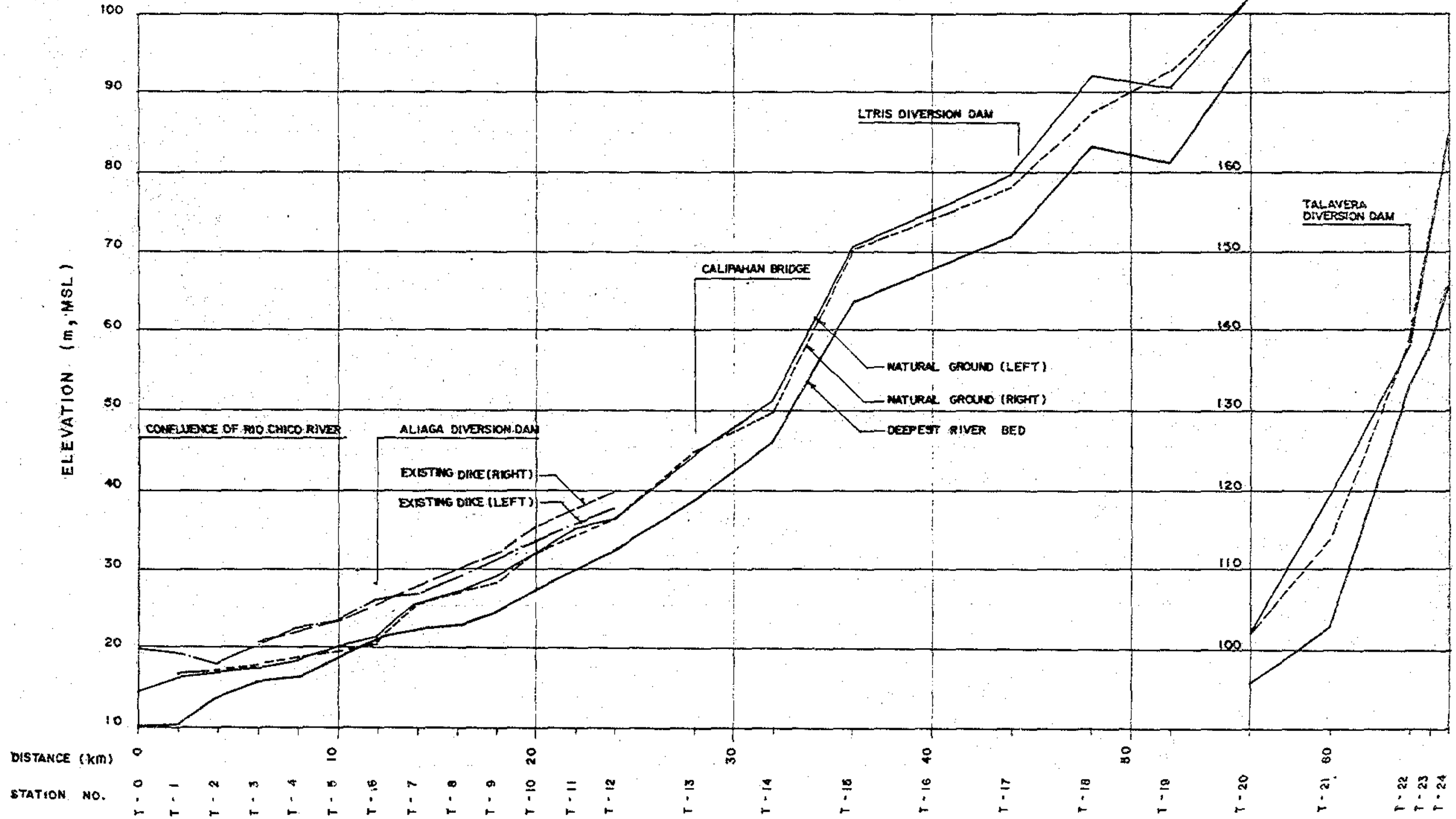
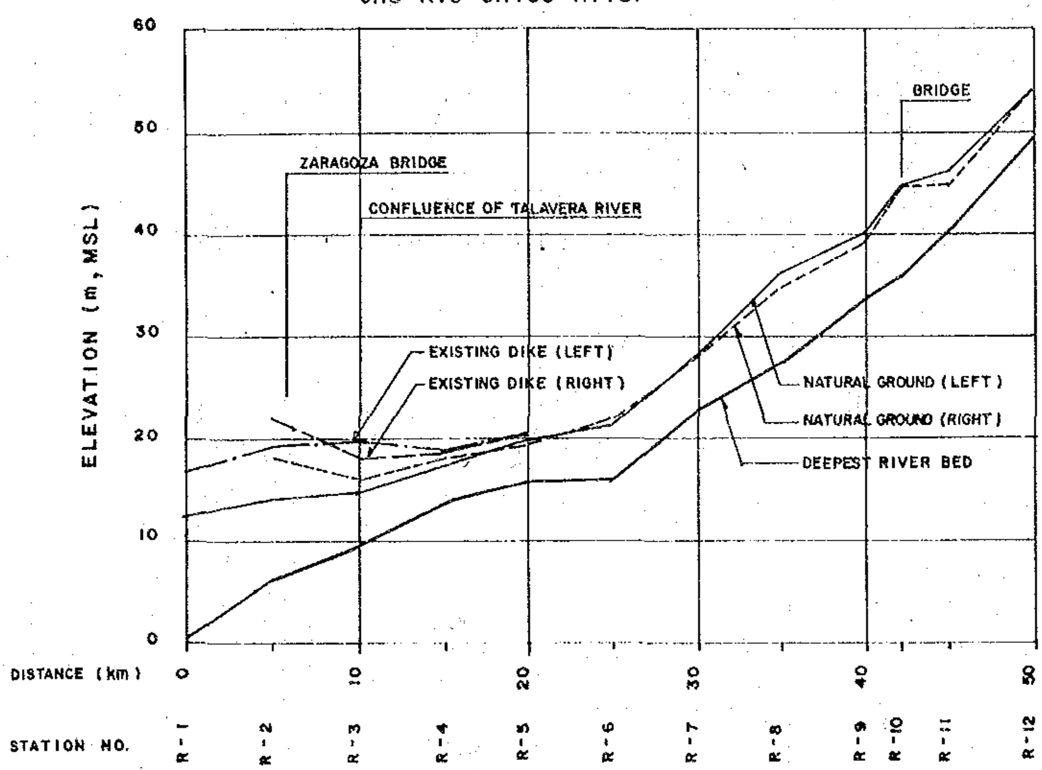


Fig. 4.3(3) LONGITUDINAL PROFILE OF RIVERS

- the Rio Chico River



- the Peñaranda River

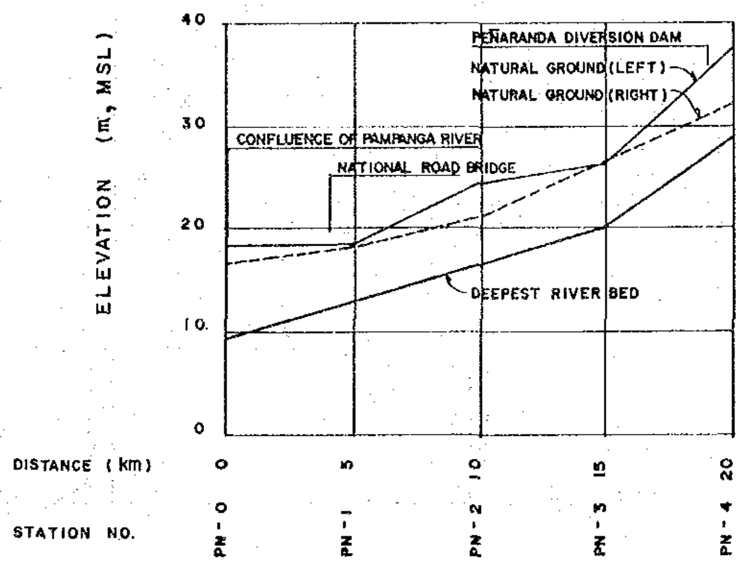


Fig. 4.3(4) LONGITUDINAL PROFILE OF RIVERS

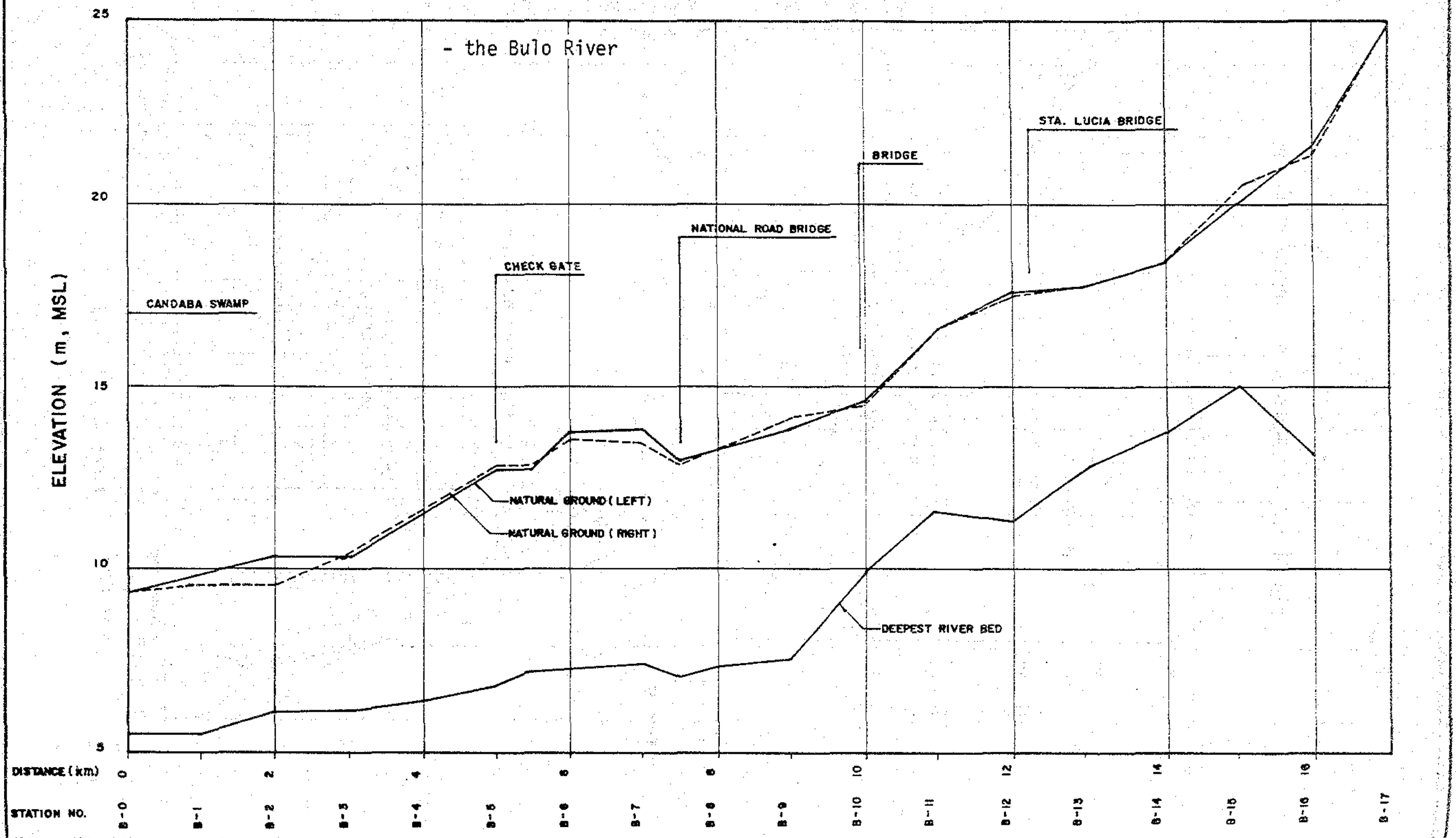


Fig. 4.4(1) MAJOR CHARACTERISTICS OF RIVERS
- the Pampanga River

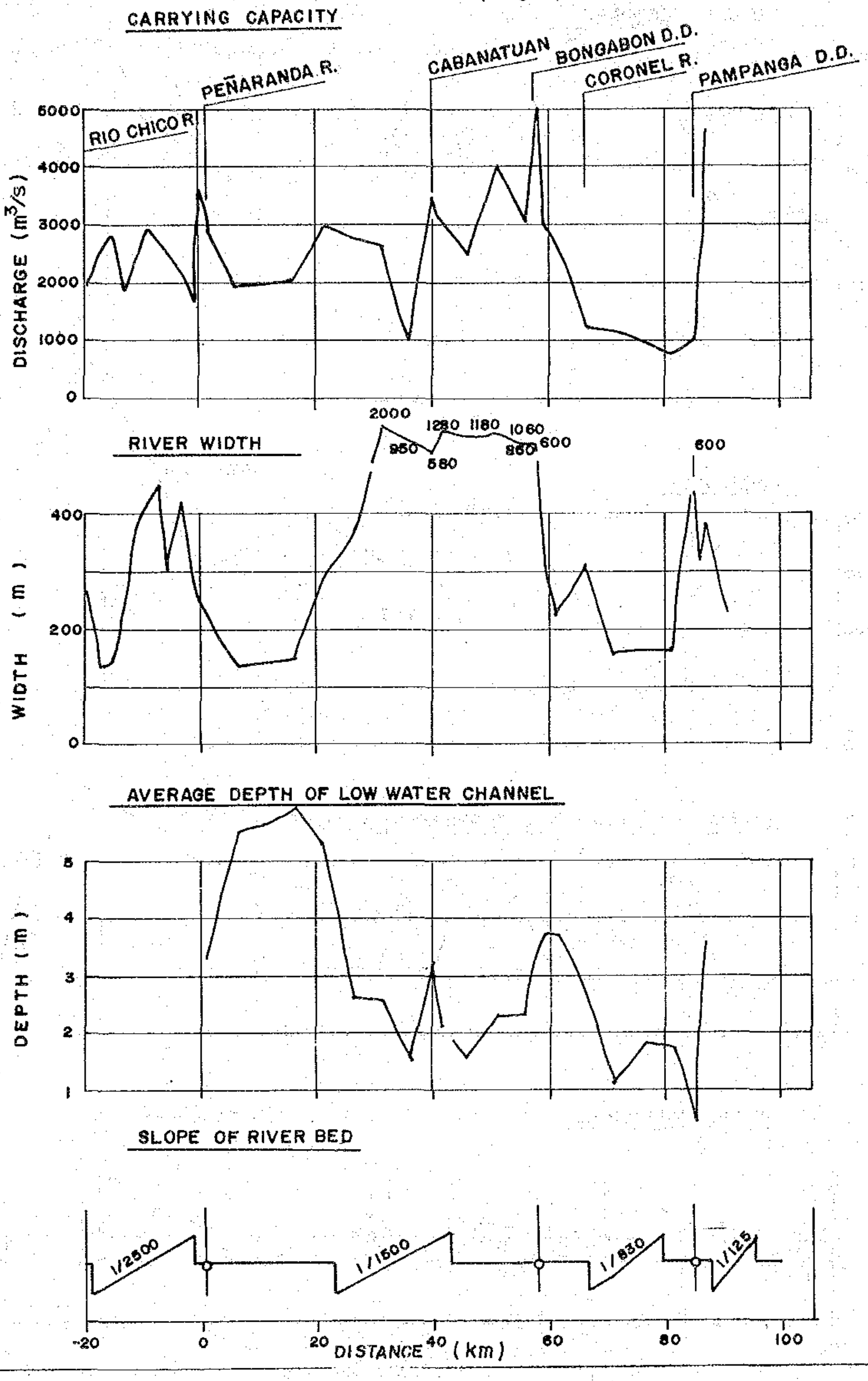


Fig. 4.4(2) MAJOR CHARACTERISTICS OF RIVERS
- the Talavera River

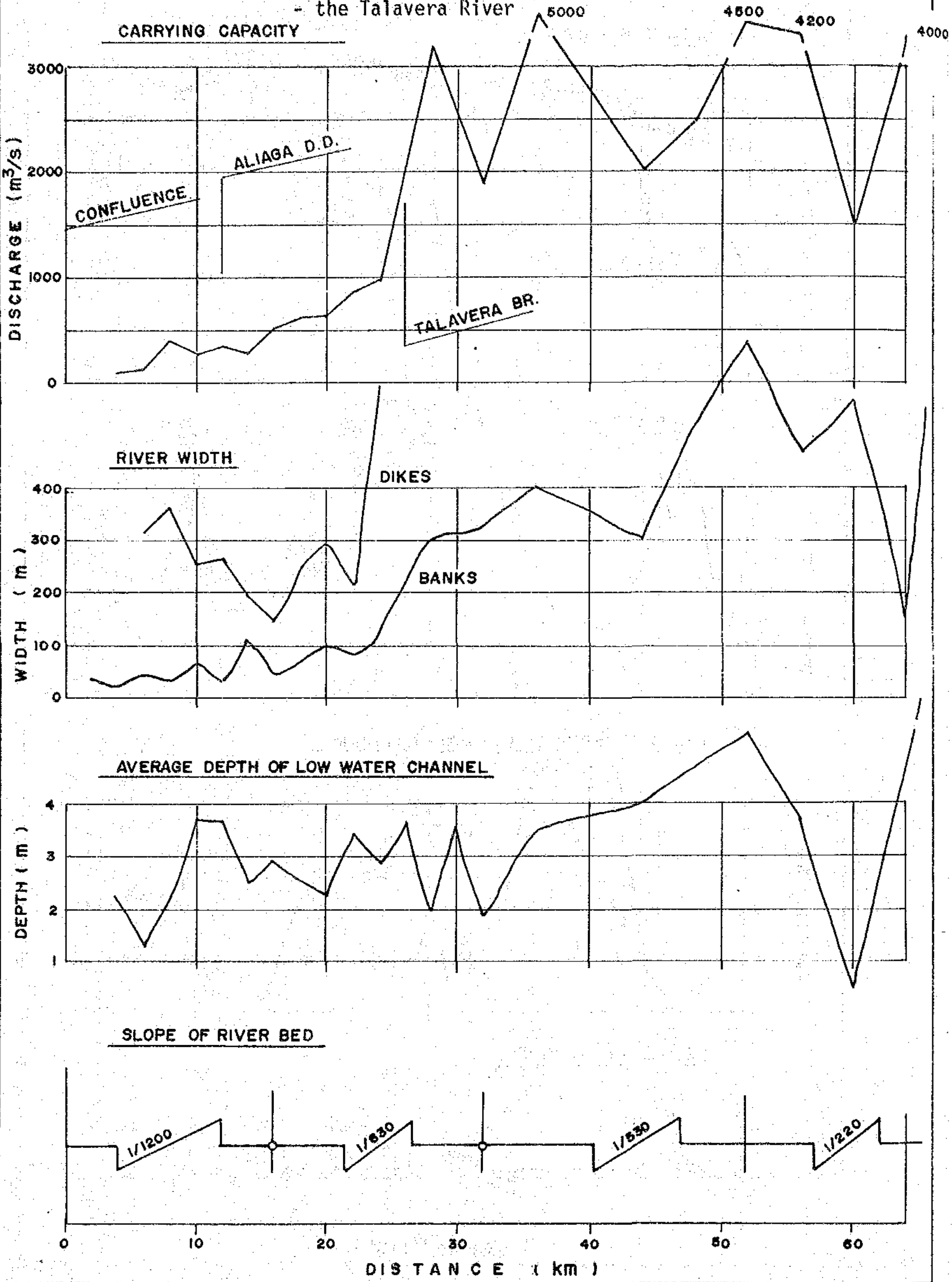


Fig. 4.4(3) MAJOR CHARACTERISTICS OF RIVERS
- the Rio Chico River

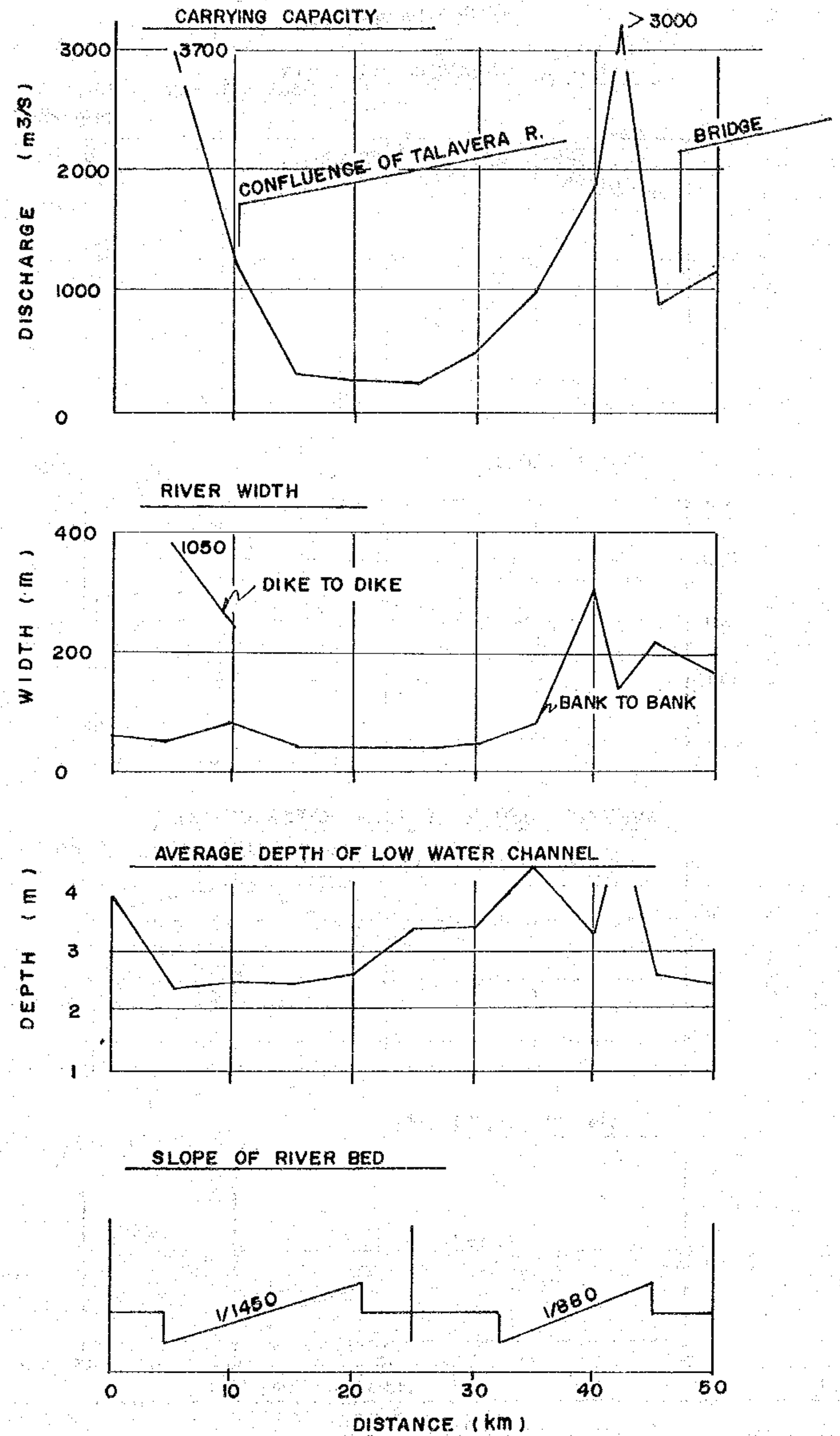


Fig. 4.4(4) MAJOR CHARACTERISTICS OF RIVERS - the Peñaranda River

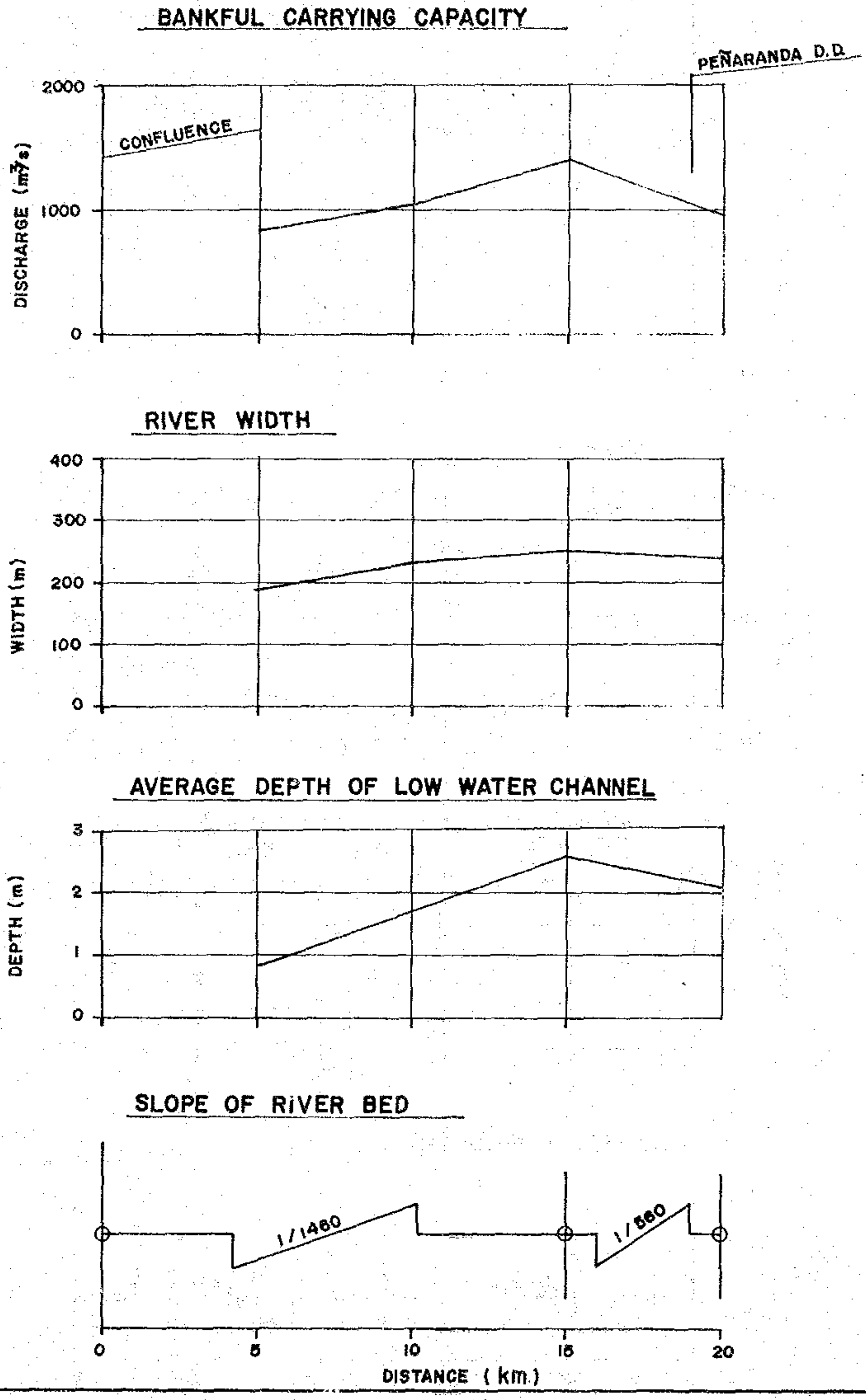


Fig. 4.4(5) MAJOR CHARACTERISTICS OF RIVERS

- the Bulo River

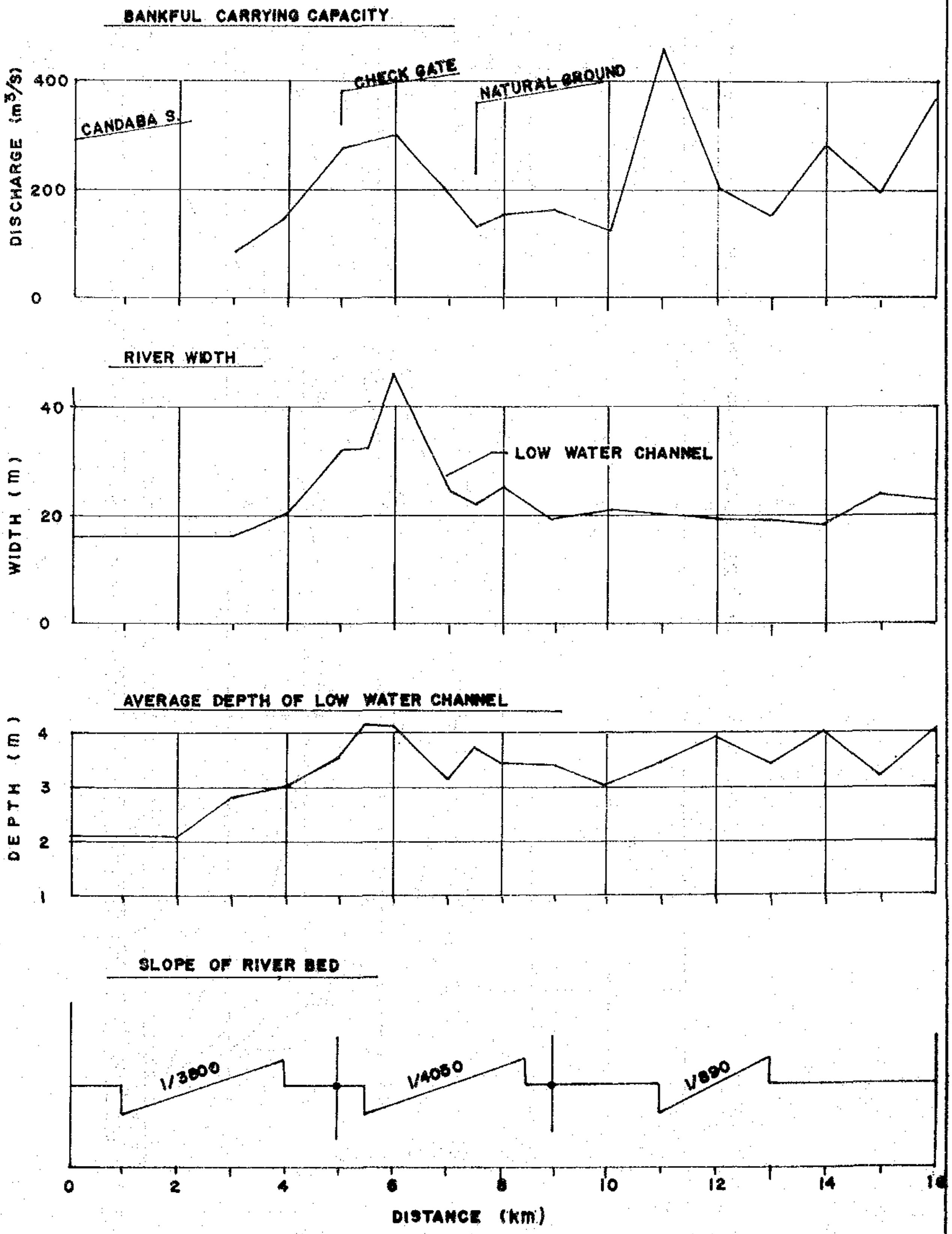


FIG. 4.5 PROBABLE FLOOD RUNOFF HYDROGRAPH (Talavera R : Present)

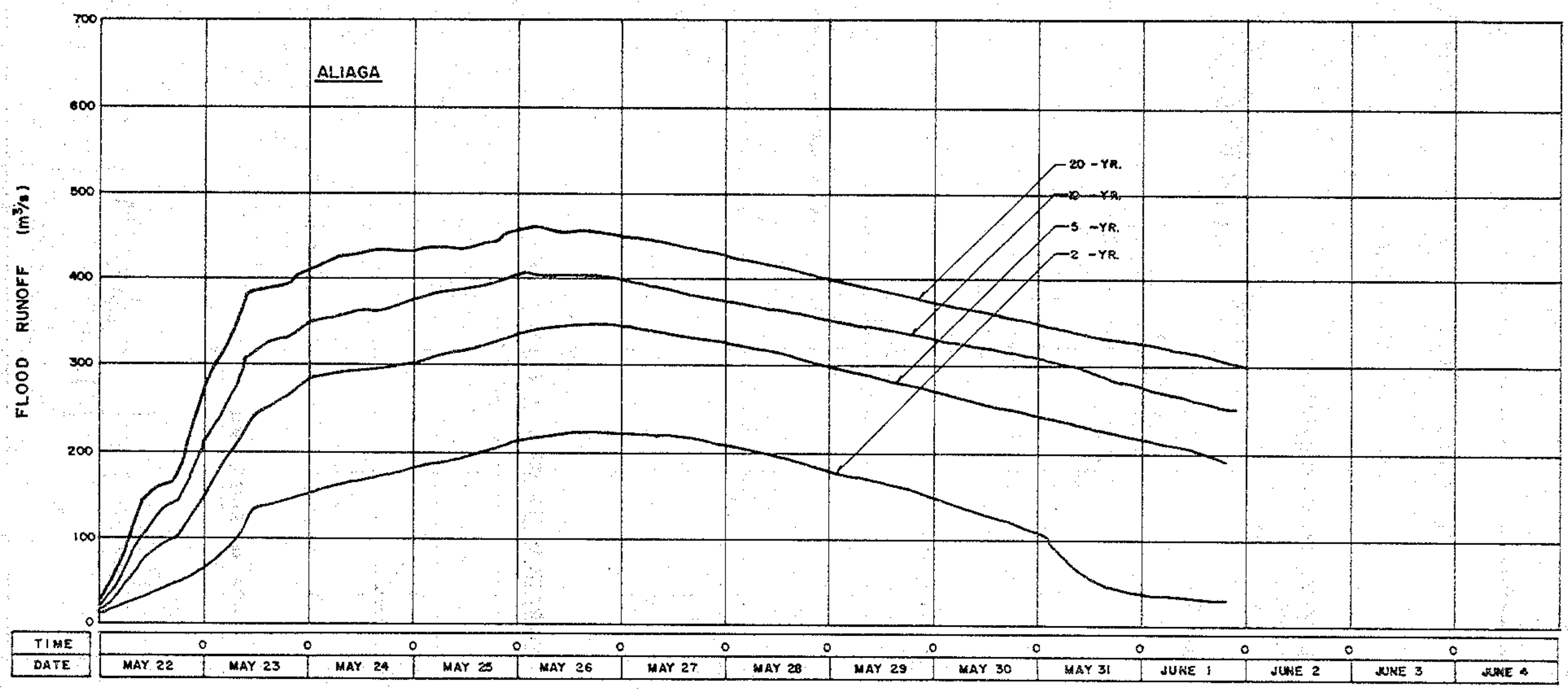
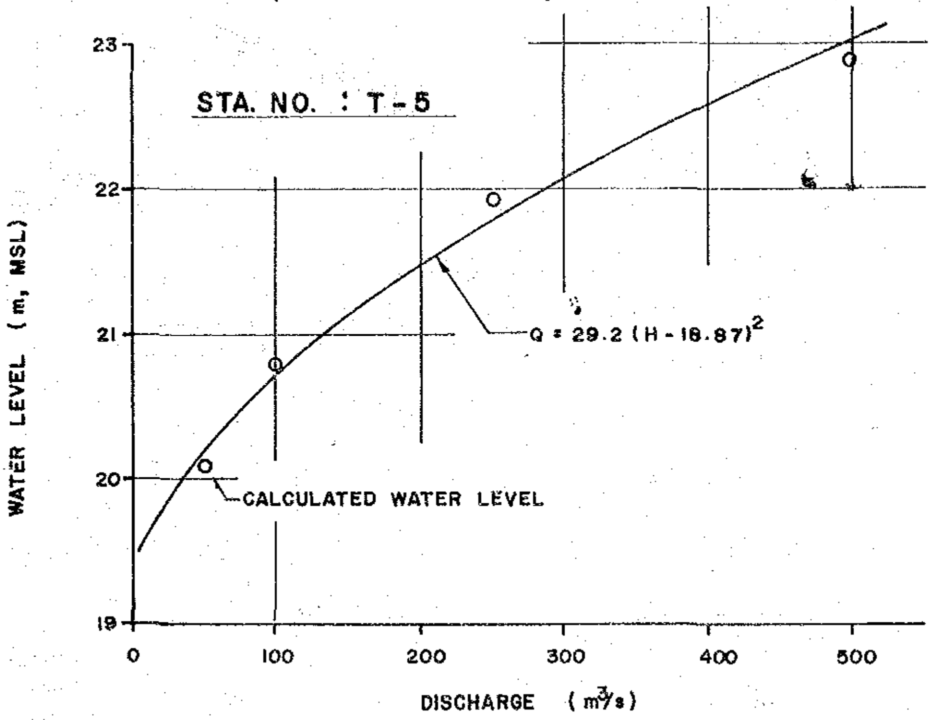


Fig. 4.6(1) DISCHARGE RATING CURVE AT SELECTED STATIONS IN THE TALAVERA RIVER

(Present Condition)



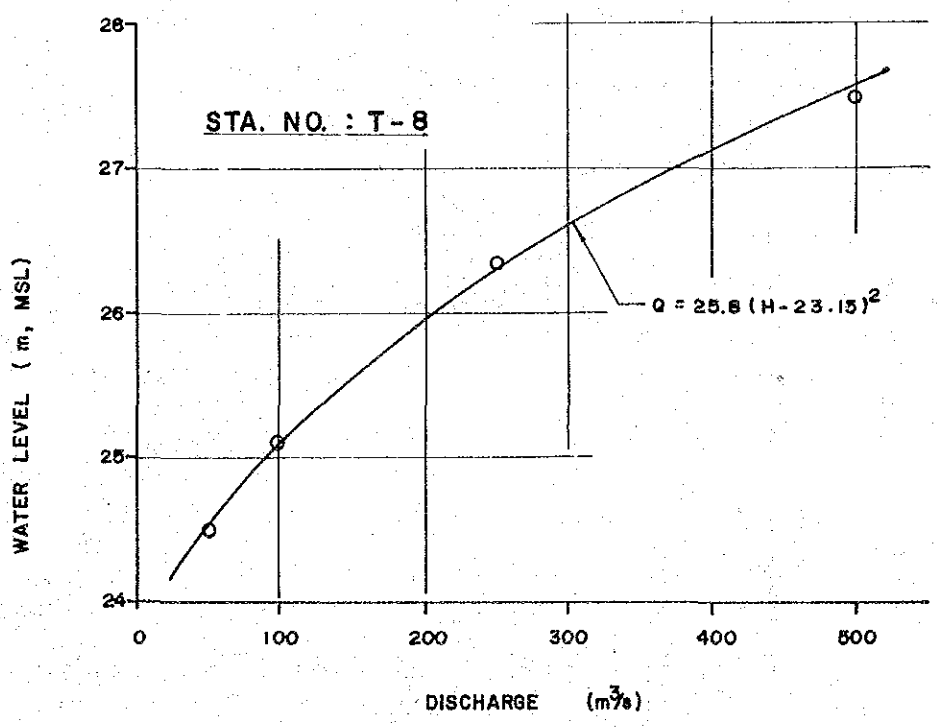


Fig. 4.6(2) DISCHARGE RATING CURVE AT SELECTED STATIONS IN THE TALAVERA RIVER

(Improved Condition)

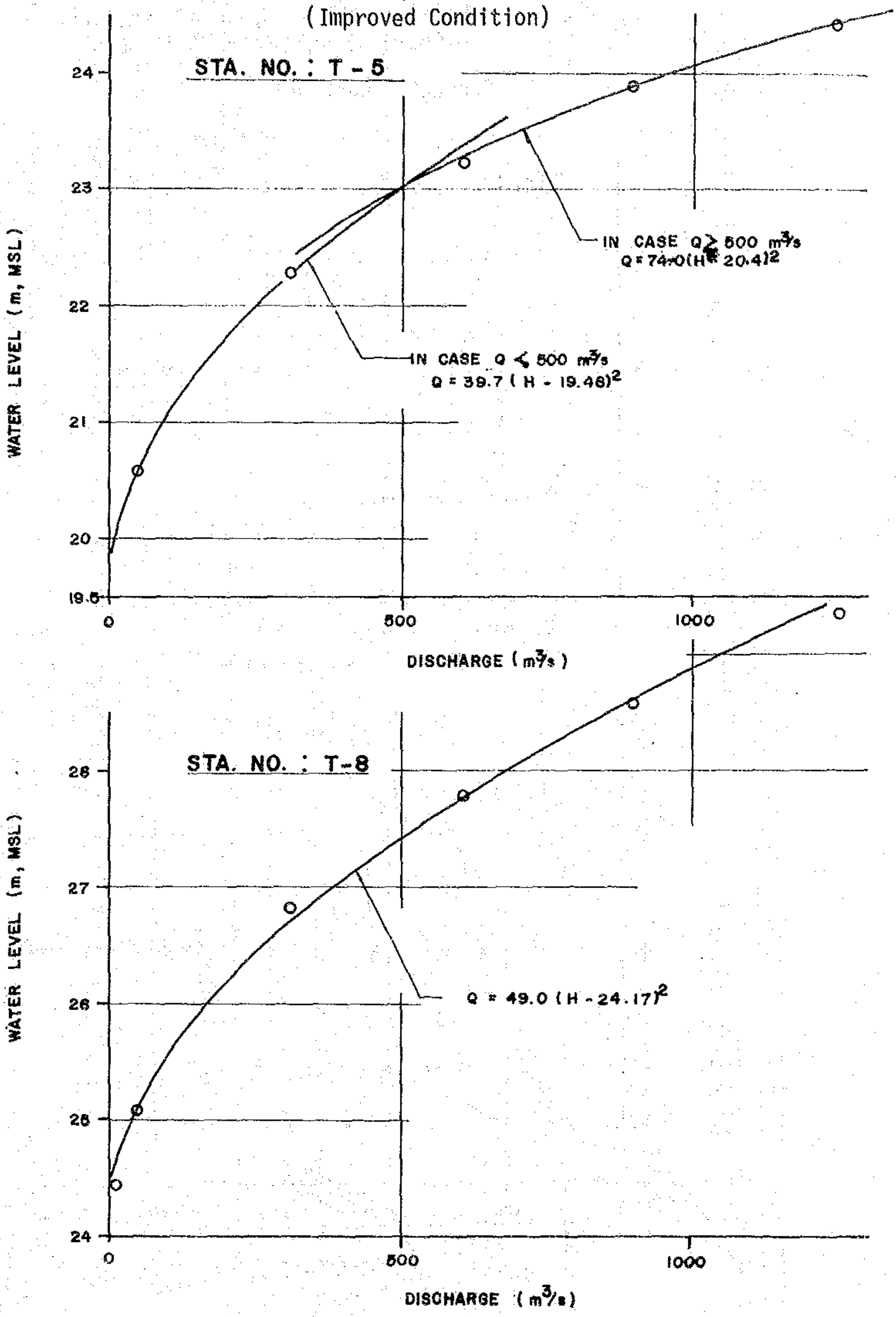


Fig. 4.7 PLAN OF THE TALAVERA RIVER

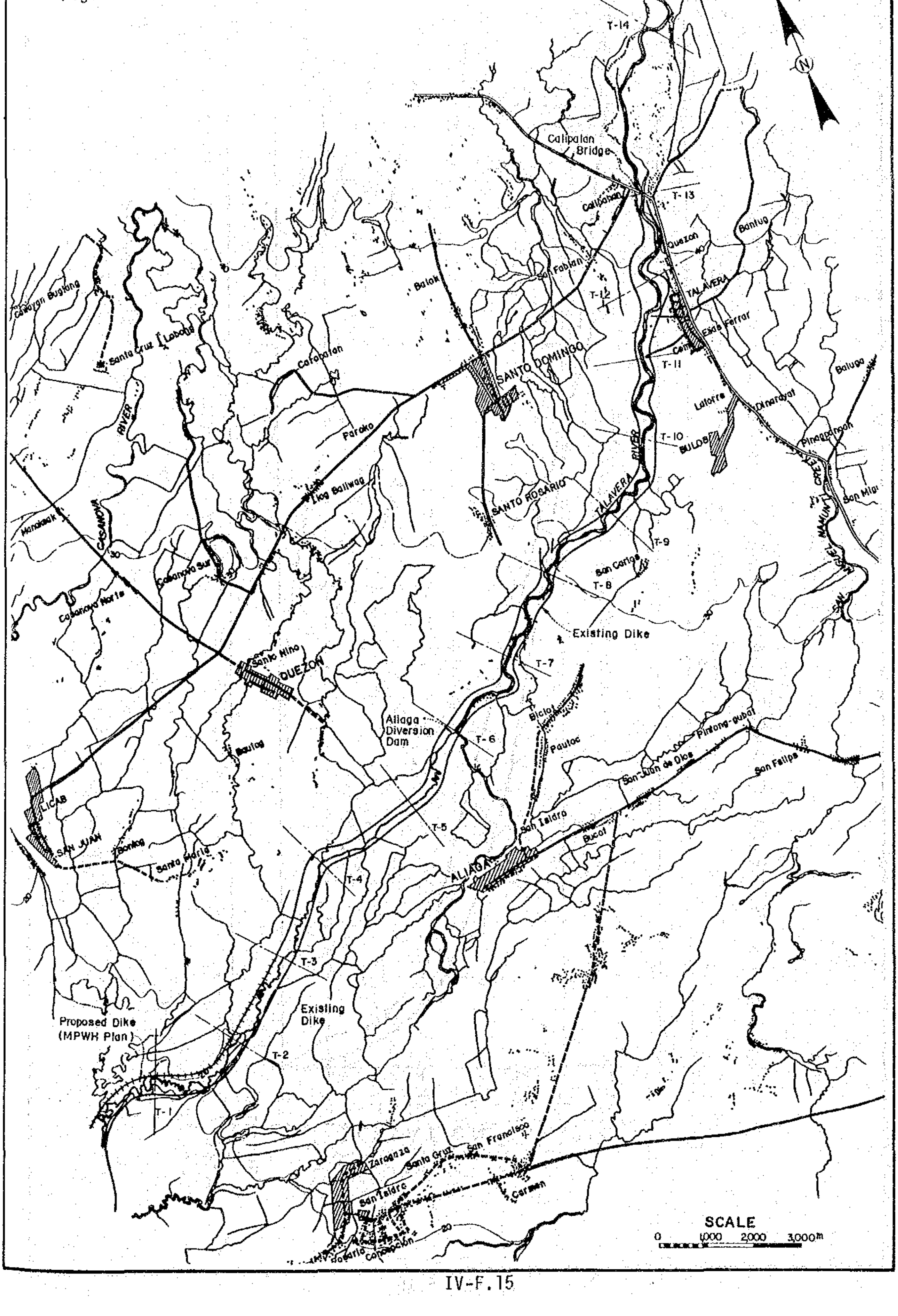


Fig. 4.8 STORAGE CAPACITY AND AREA CURVE

(Lower Talavera Right Side Area)

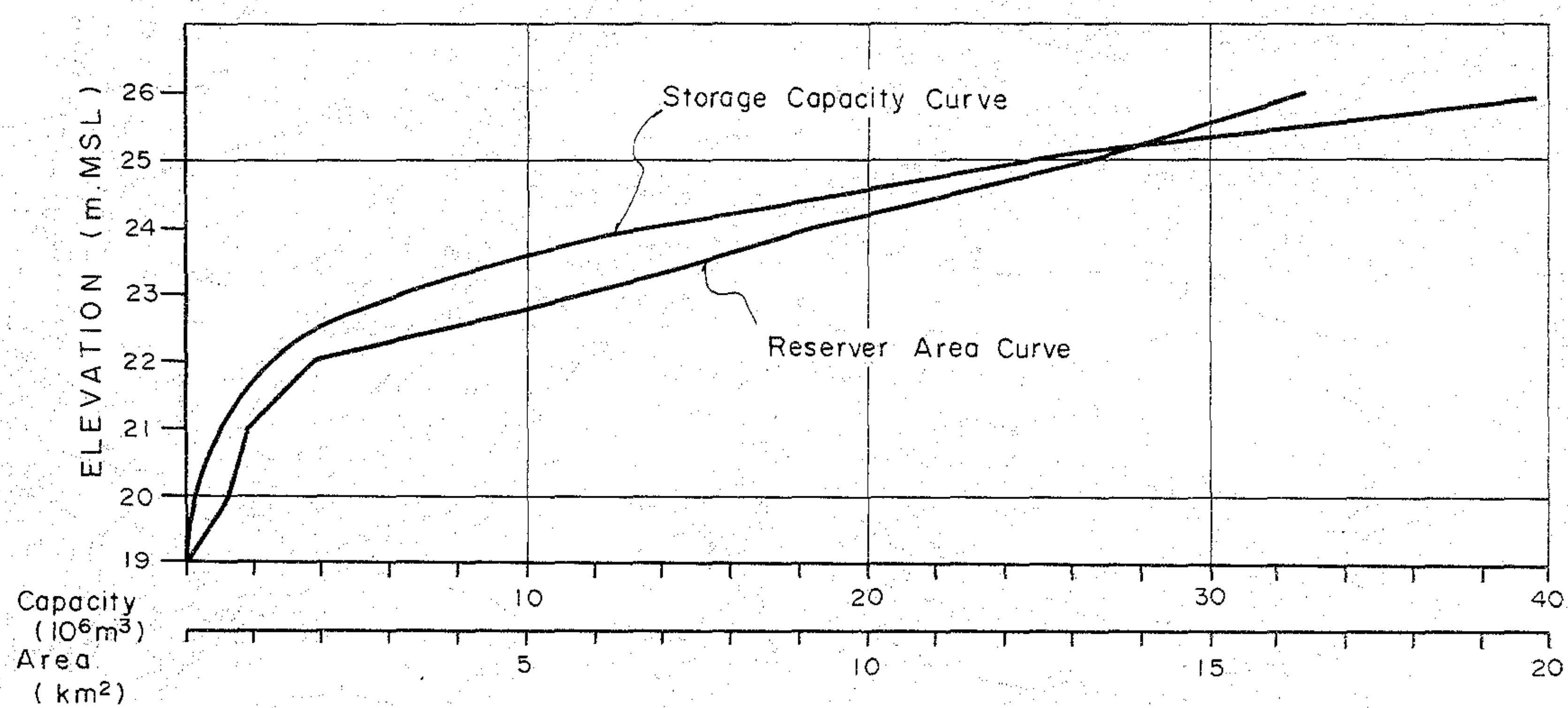


Fig. 4.9 AREA AND DURATION OF INUNDATION

(Right Side of Talavera ; Present Condition)

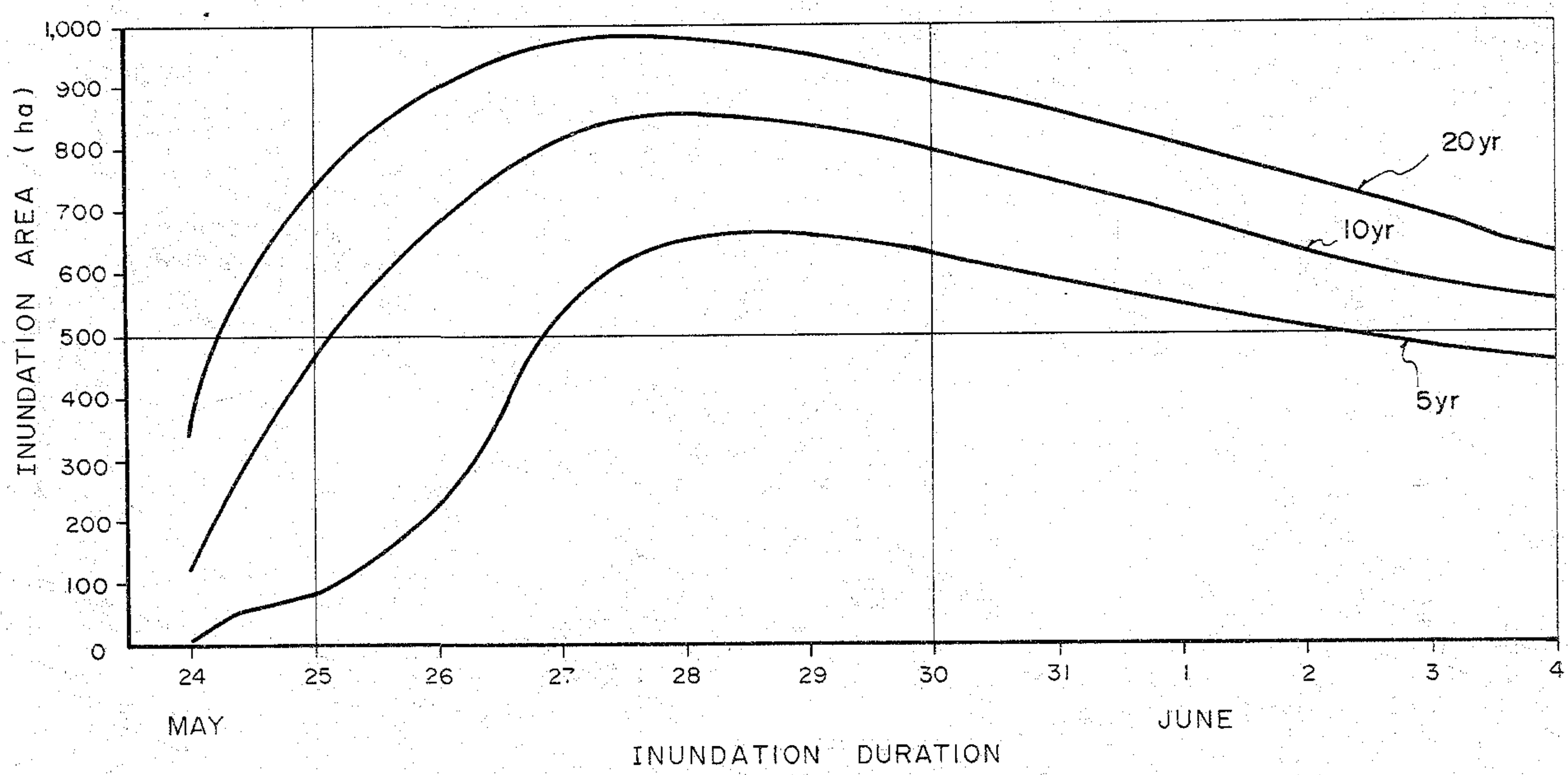


Fig. 4.10 INUNDATION AREA OF RIGHT SIDE
(Present Condition)

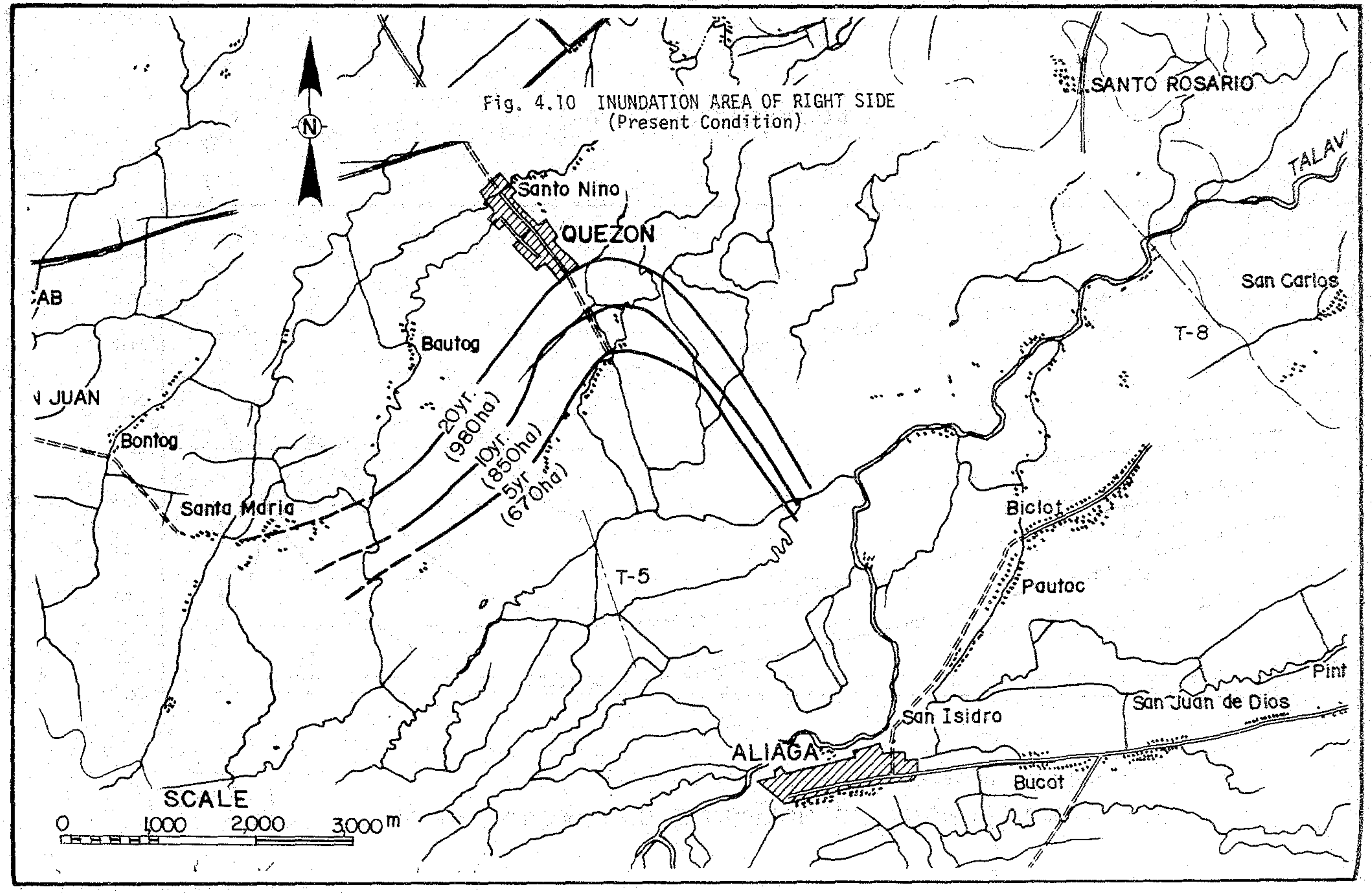


Fig. 4.11 INUNDATION AREA OF LEFT SIDE
(Present Condition)

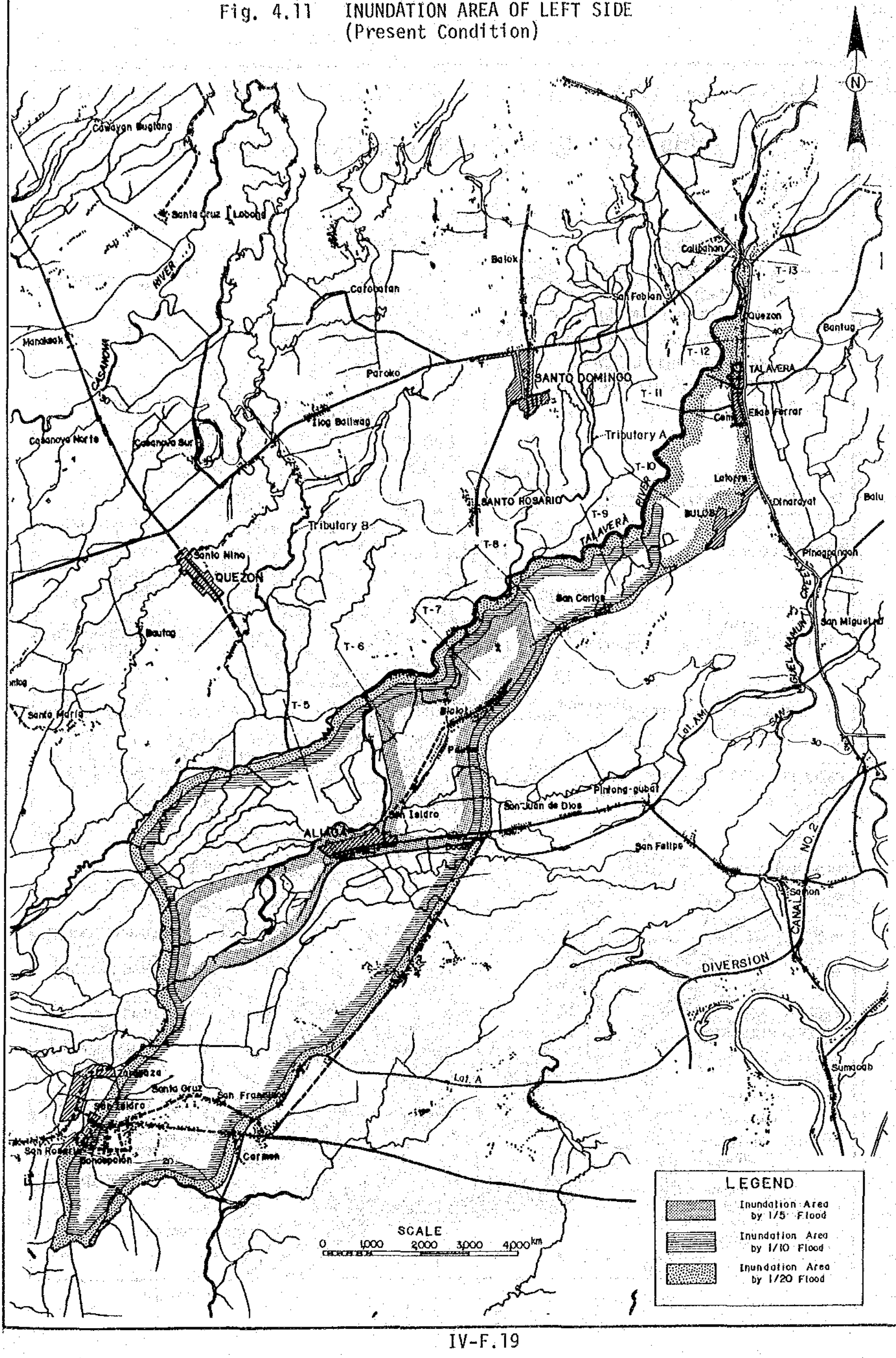


Fig. 4.12 BPW FLOOD CONTROL SCHEME-III

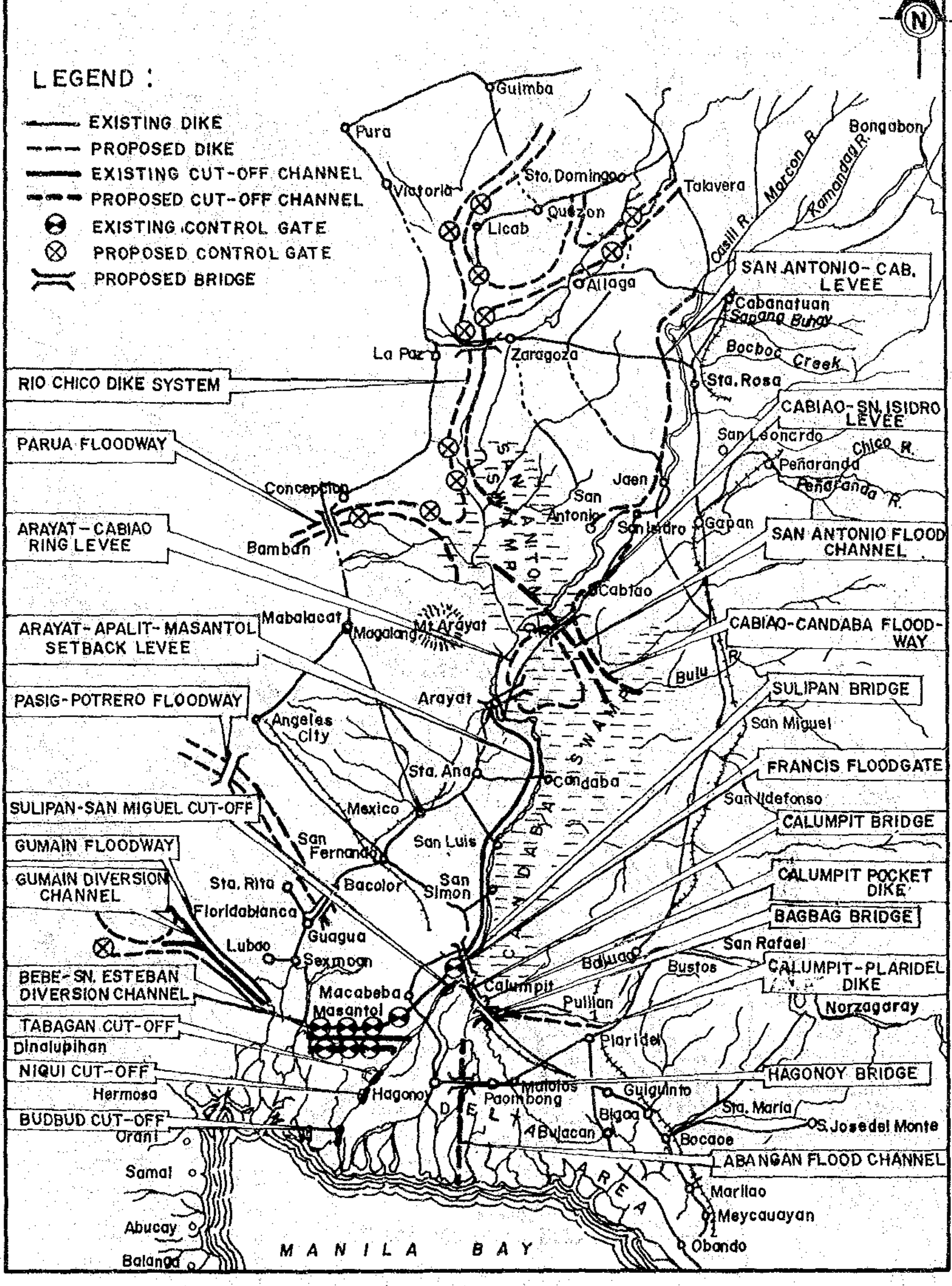


Fig. 4.13 MPW SCHEMATIC FLOOD FLOW DIAGRAM

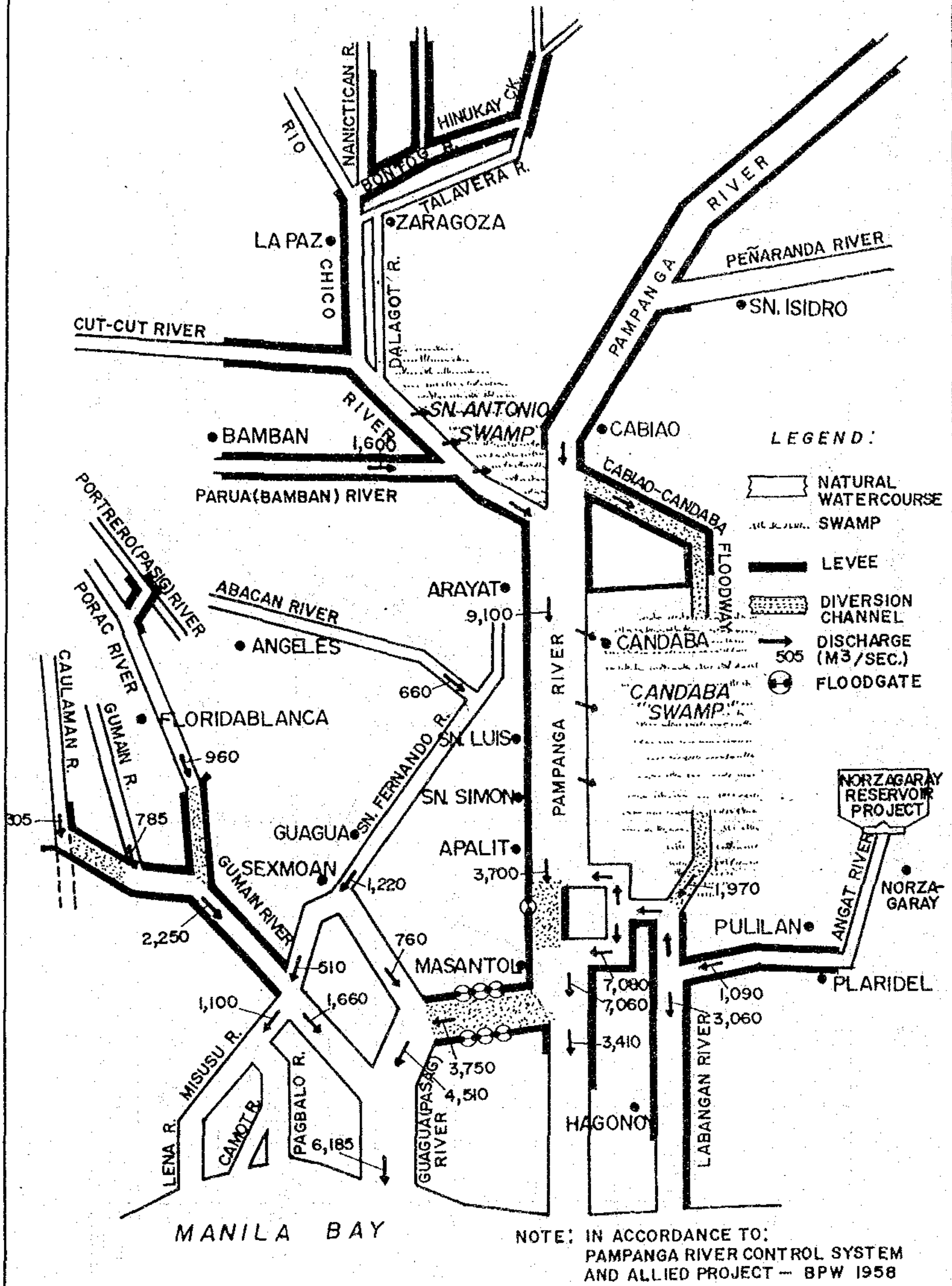


FIG. 4.14 PROBABLE FLOOD RUNOFF HYDROGRAPH (Talavera R.: Improvement)

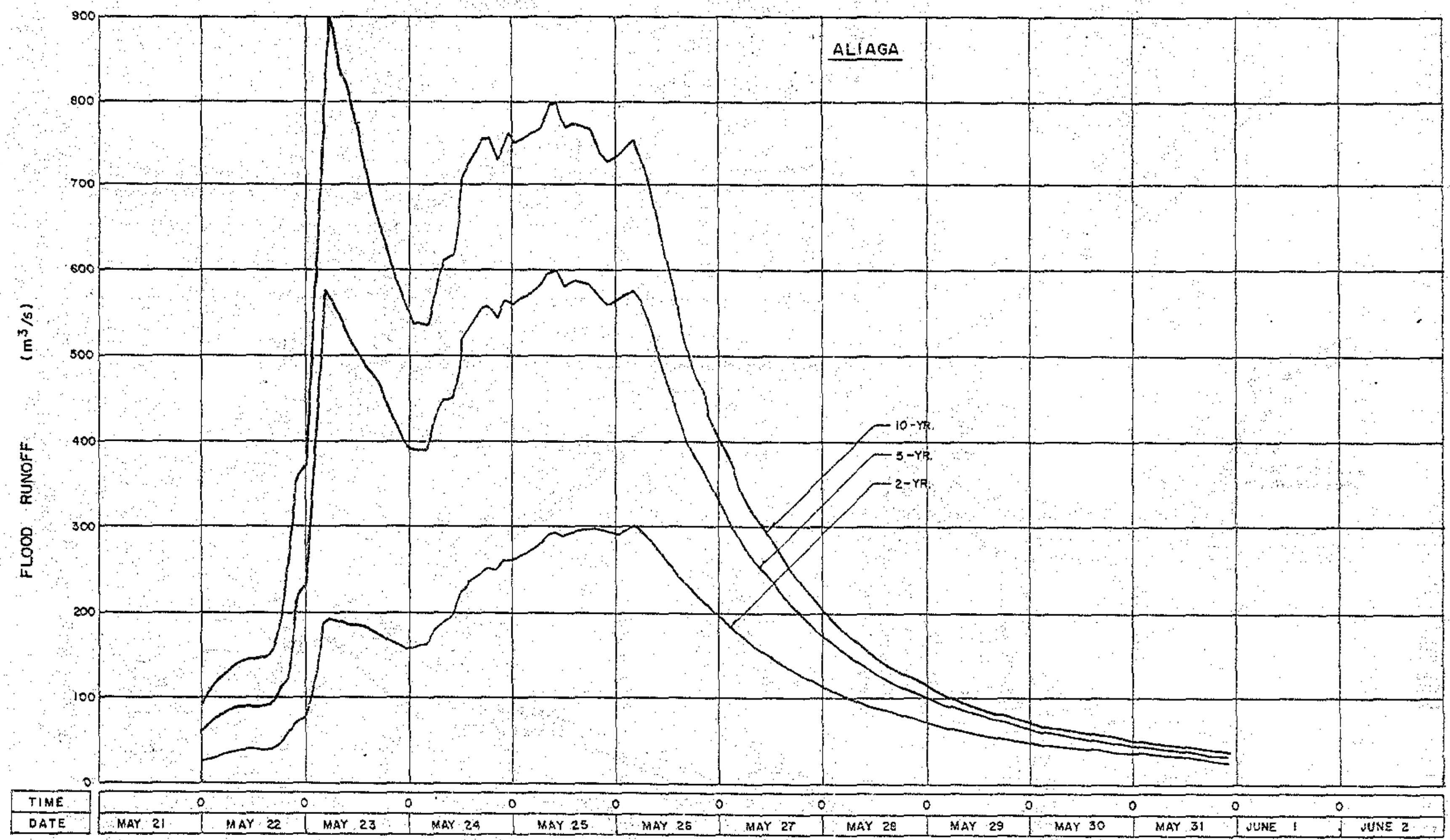
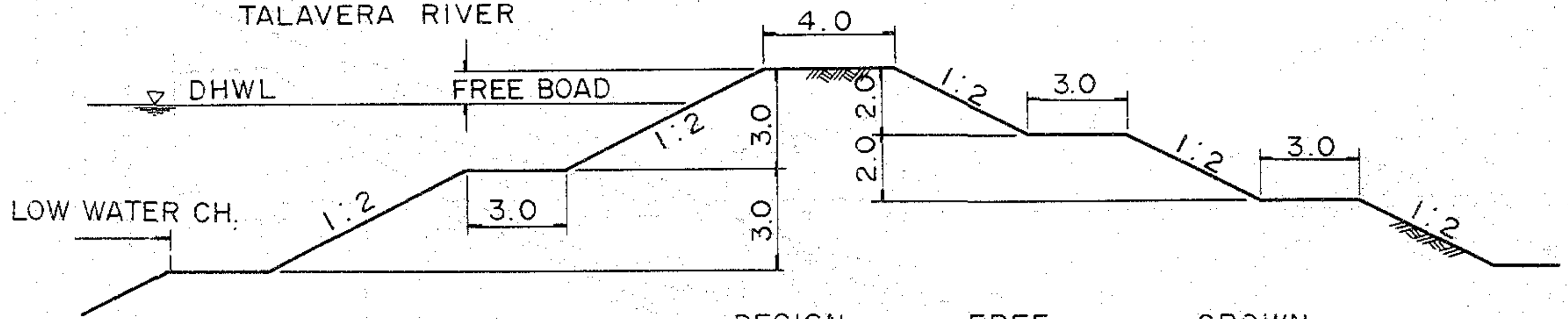


Fig. 4.15 STANDARD DIKE SECTION

TALAVERA RIVER



DESIGN DISCHARGE (m^3/s)	FREE BOARD (m)	CROWN WIDTH (m)
< 200	0.6	3
200 to 500	0.8	3
500 to 2,000	1.0	3

TRIBUTARIES

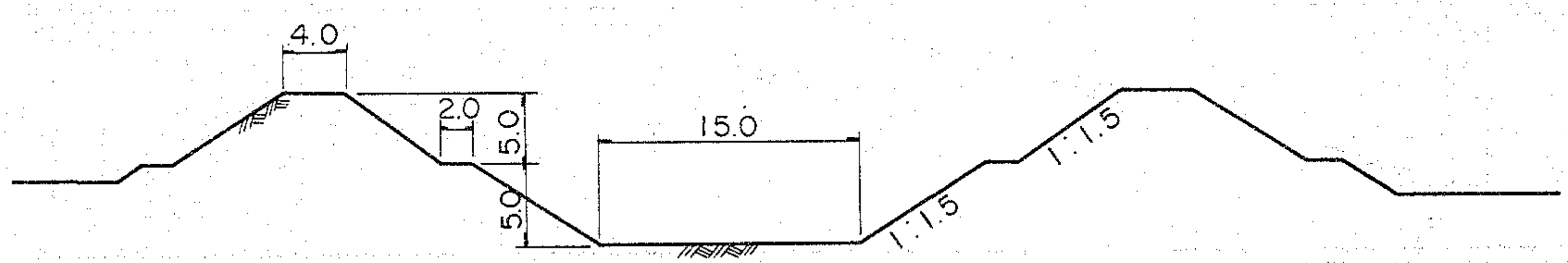


FIG. 4.16(1) DESIGN PROFILE OF THE TALAVERA RIVER (5 - YR)

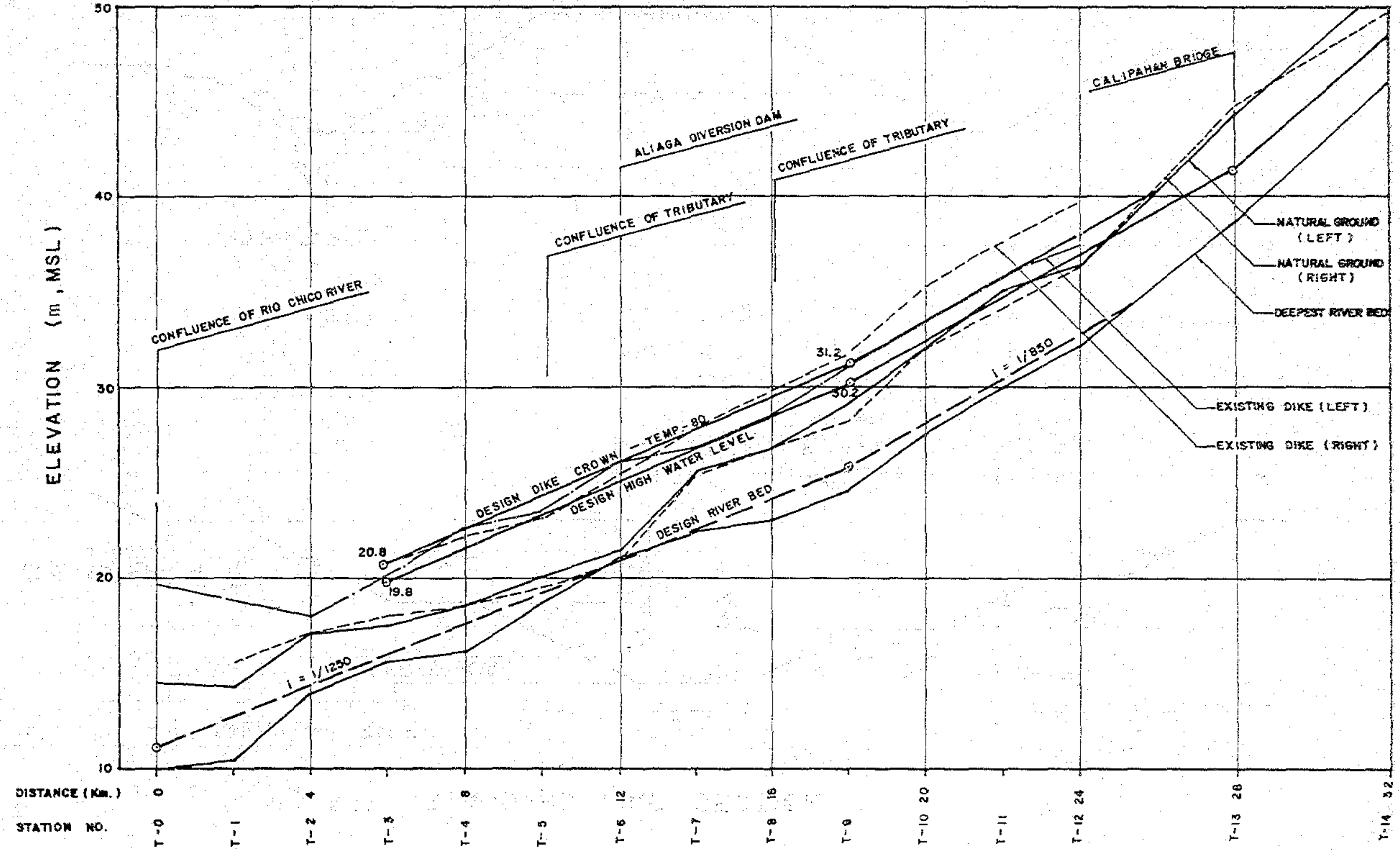


FIG. 4.16(2) DESIGN PROFILE OF THE TALAVERA RIVER (10 – YR)

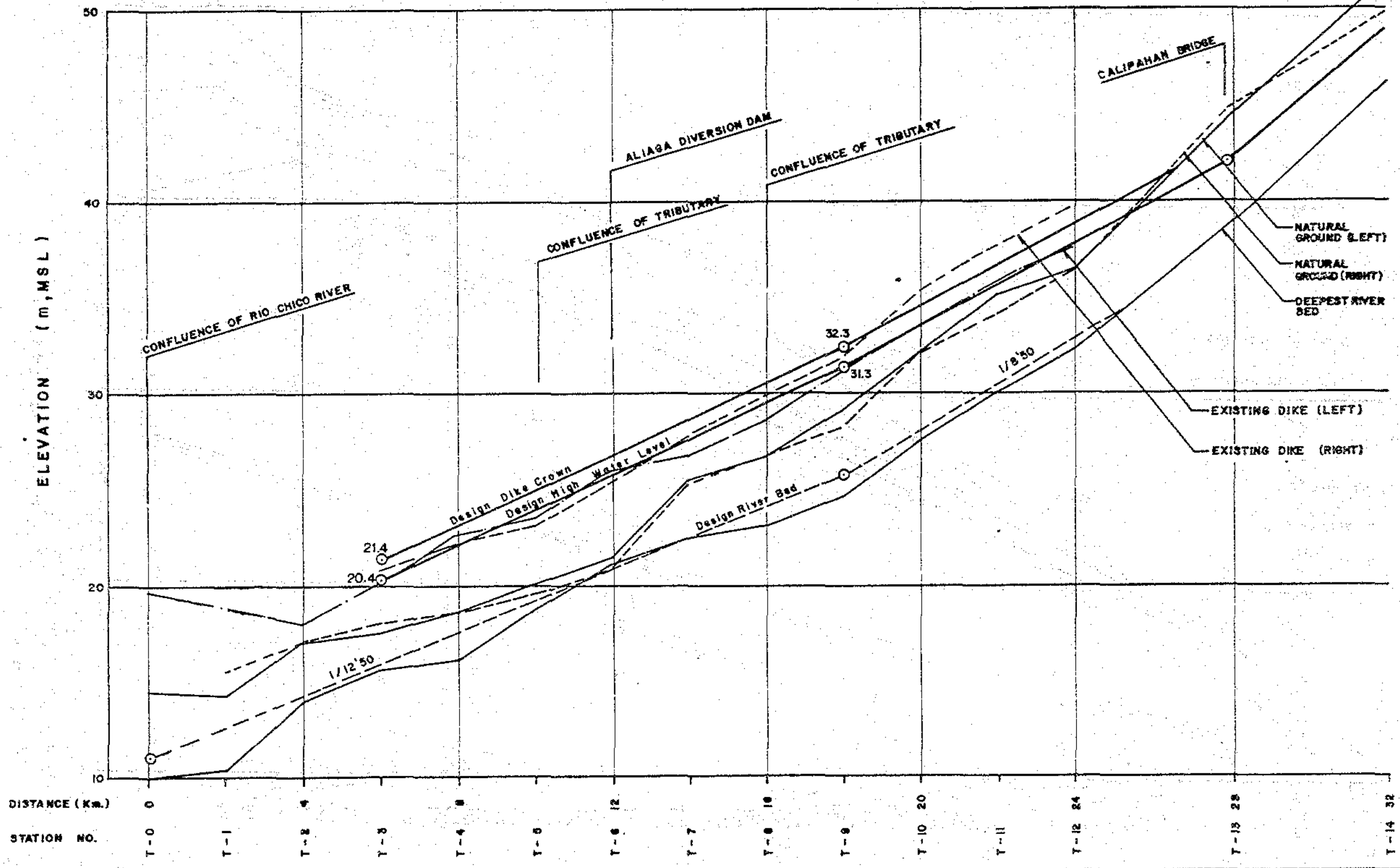


FIG. 4.16(3) DESIGN PROFILE OF THE TALAVERA RIVER (20-YR.)

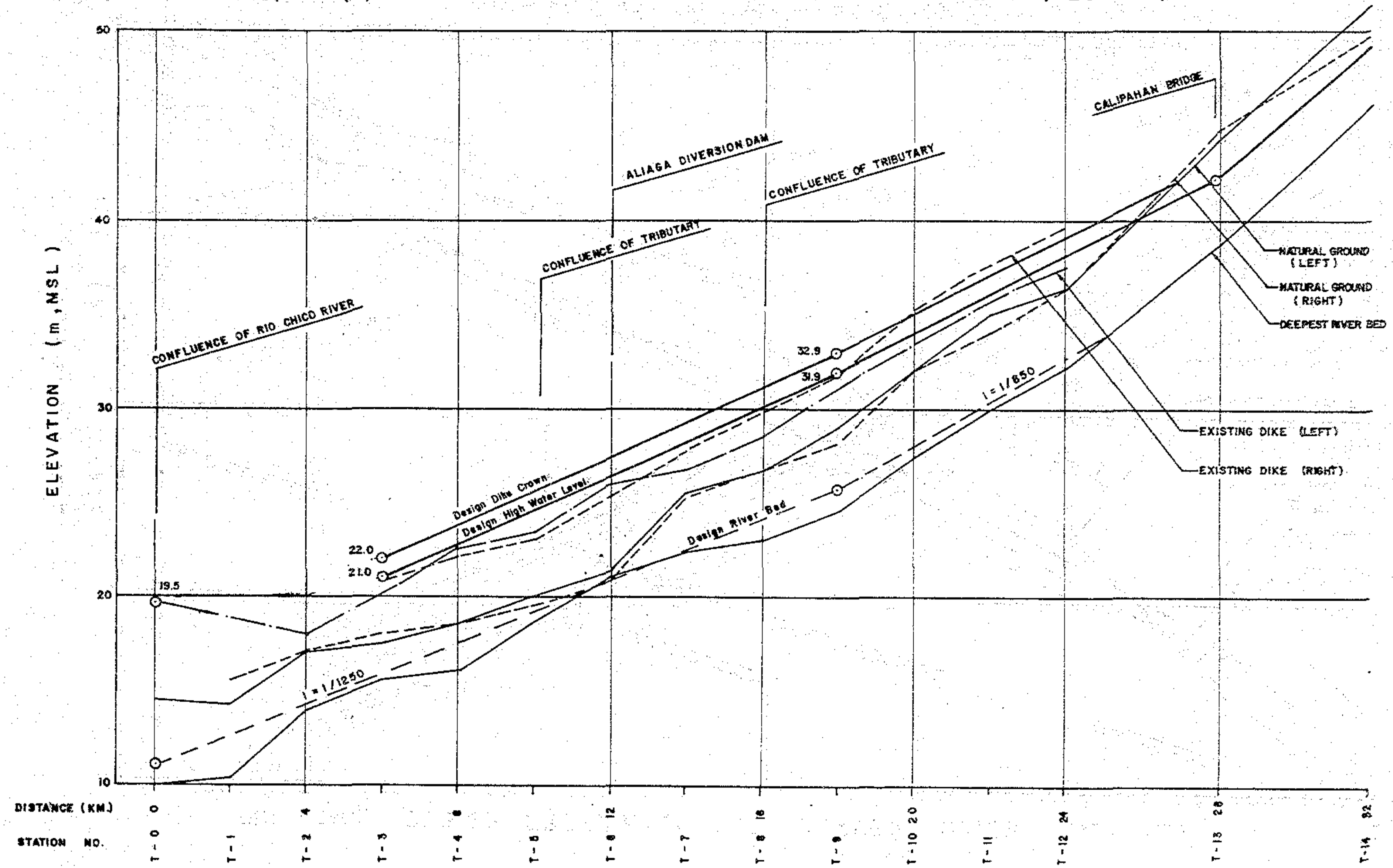


Fig. 4.17 DESIGN CROSS SECTION OF THE TALAVERA RIVER

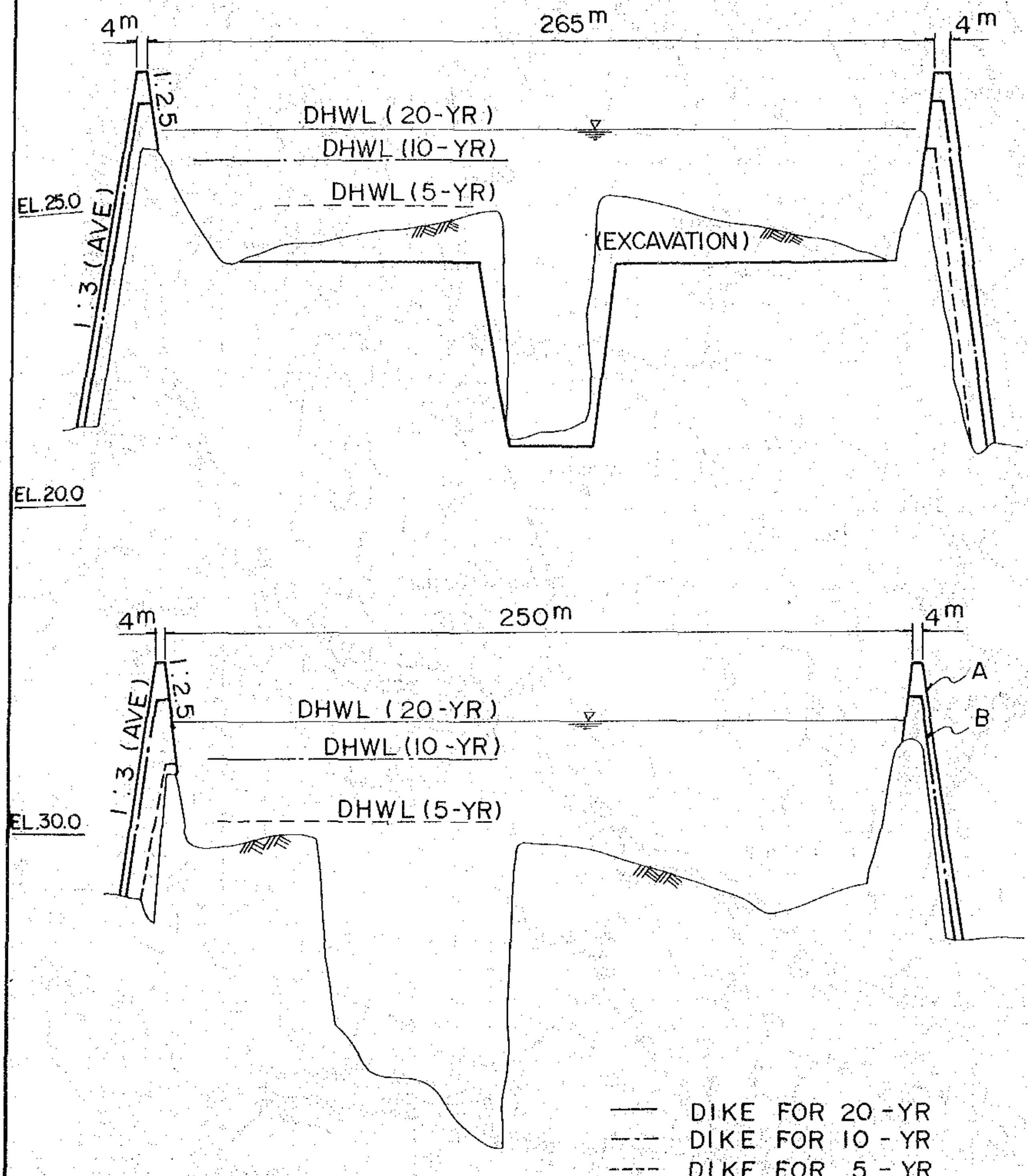


Fig. 4.18 LOCATION MAP OF TRIBUTARIES

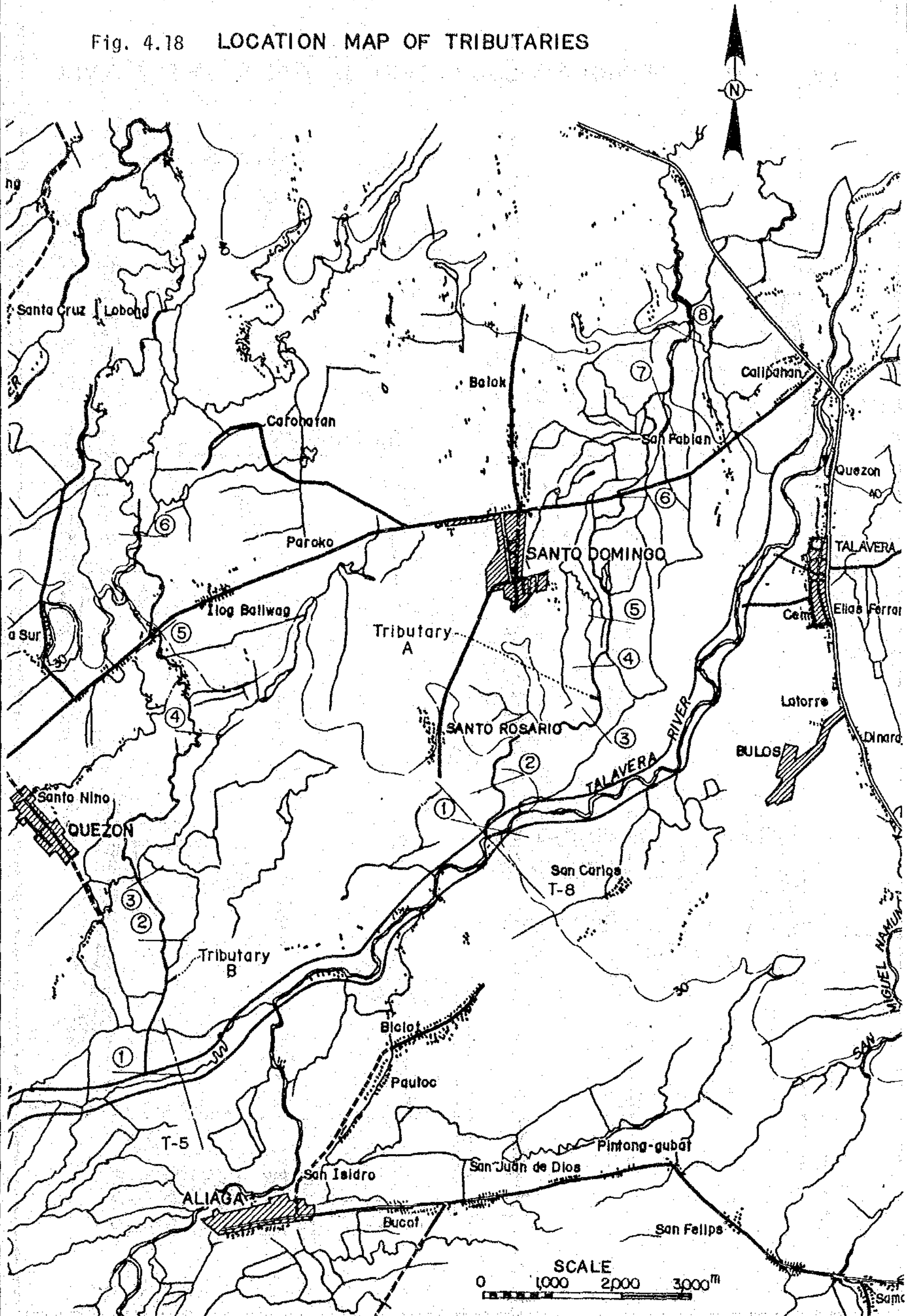
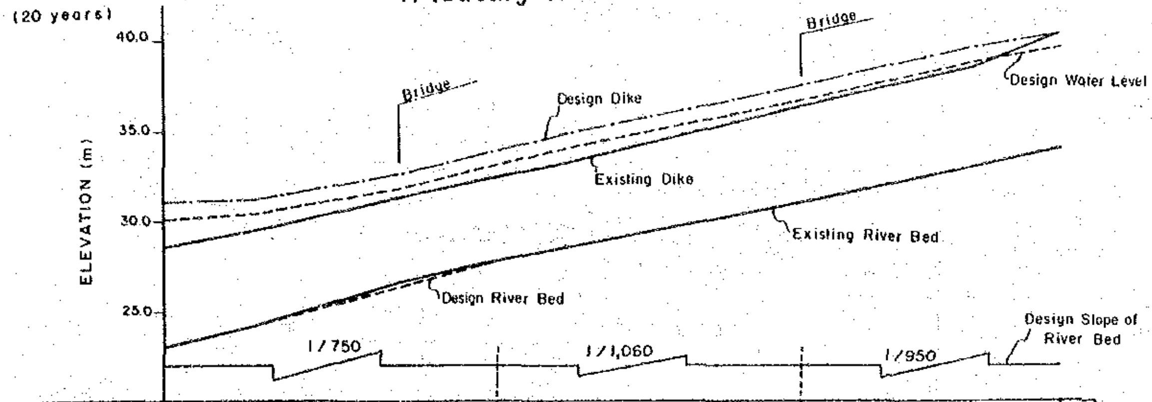
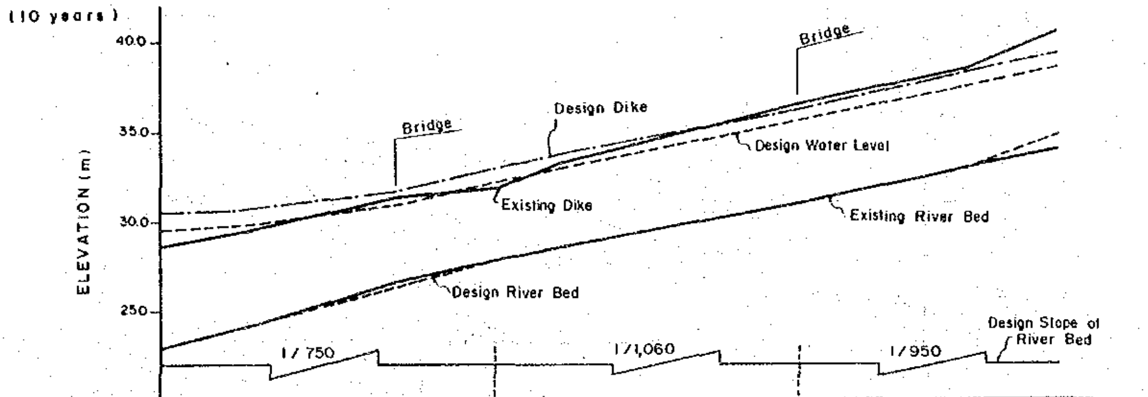
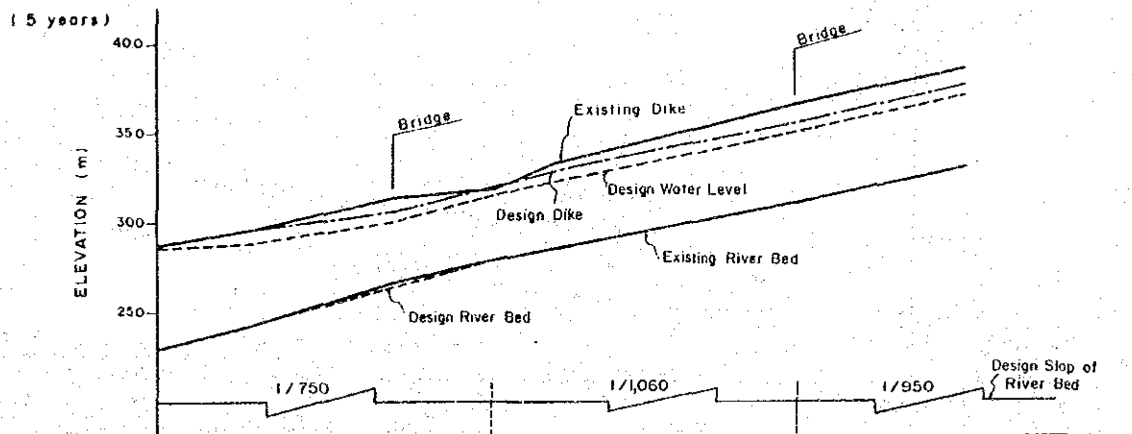


Fig. 4.19(1) DESIGN PROFILE OF TRIBUTARIES

- Tributary A





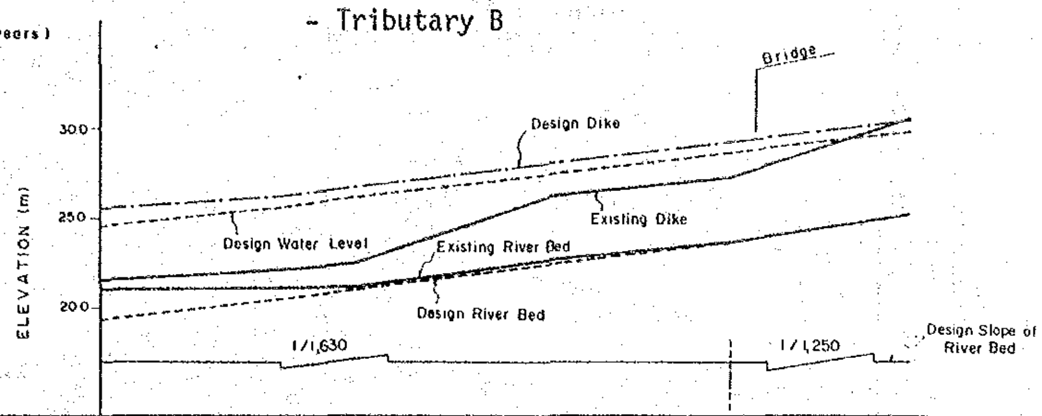


STATION NO.	TA0	TA1	TA2	+0.6	TA3	+0.7	TA4	+0.4	TA5	TA6	TA7	+0.1	TA8	TA9	TA10
DISTANCE (km)	0	1.0	2.0	2.6	3.0	3.7	4.0	4.4	5.0	6.0	7.0	7.1	8.0	9.0	10.0
(20 years) DESIGN WATER LEVEL (m)	30.1	30.4		31.8		33.1		34.0				36.7		38.8	39.6
(20 years) DESIGN DIKE (m)	31.1	31.2		32.6		33.9		34.8				37.5		39.6	40.4
(20 years) DESIGN RIVER BED (m)	22.9	24.2		26.4		27.8		28.5				31.0		33.0	34.0
(10 years) DESIGN WATER LEVEL (m)	28.5	29.8		30.9		32.1		32.9				35.4		37.5	38.5
(10 years) DESIGN DIKE (m)	30.5	30.6		31.7		32.9		33.7				36.2		38.3	39.3
(10 years) DESIGN RIVER BED (m)	22.9	24.2		26.4		27.8		28.5				31.0		33.0	34.6
(5 years) DESIGN WATER LEVEL (m)	28.5	28.8		30.0		31.3		32.2				34.9		37.0	
(5 years) DESIGN DIKE (m)	28.5	28.5		30.6		31.9		32.8				35.5		37.6	
(5 years) DESIGN RIVER BED (m)	22.9	24.2		26.4		27.8		28.5				31.0		33.0	
EXISTING DIKE (m)	28.6	28.5		31.3		31.6		33.2				36.5		38.5	40.5
EXISTING RIVER BED (m)	22.9	24.2		26.6		27.8		28.5				31.0		33.0	34.0

Fig. 4.19(2) DESIGN PROFILE OF TRIBUTARIES

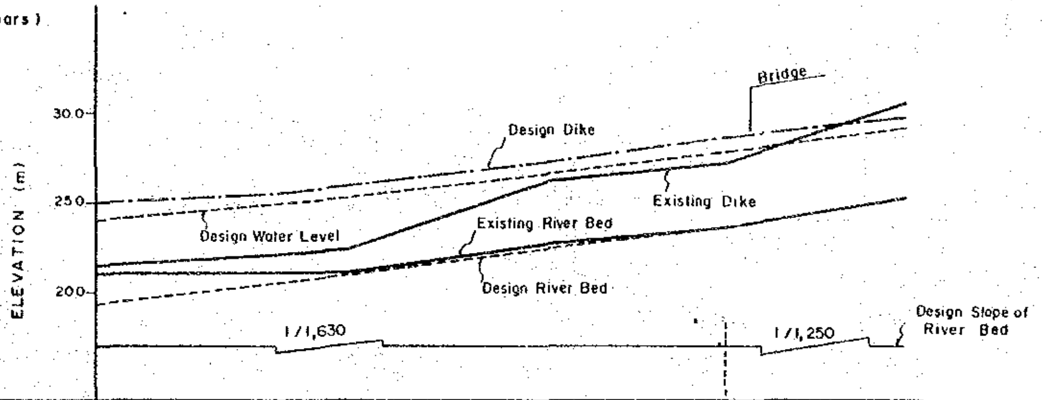
- Tributary B

(20 years)



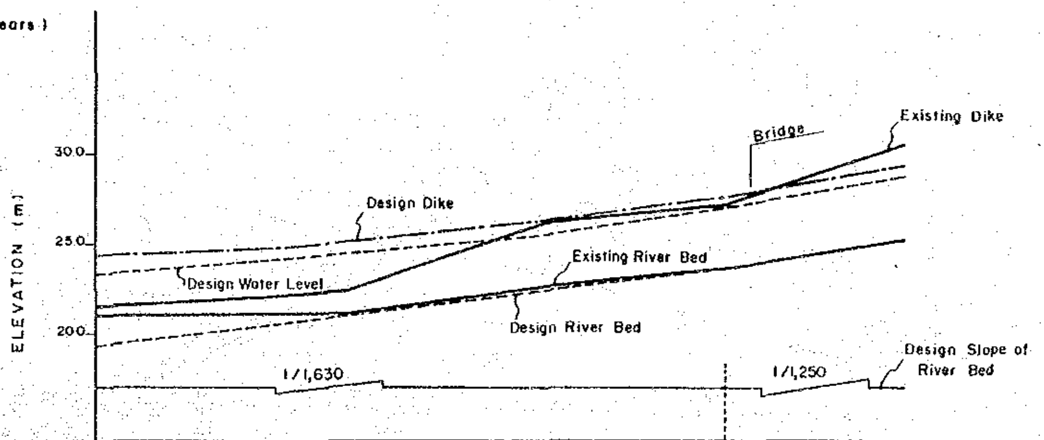
DESIGN WATER LEVEL (m)	24.5	25.6	26.1	27.4	28.6	29.8
DESIGN DIKE (m)	25.5	26.2	26.7	28.0	29.2	30.4
DESIGN RIVER BED (m)	19.3	20.5	21.0	22.4	23.6	25.2

(10years)



DESIGN WATER LEVEL (m)	24.0	24.9	25.3	26.6	27.0	29.1
DESIGN DIKE (m)	25.0	25.5	25.9	27.2	28.6	29.7
DESIGN RIVER BED (m)	19.3	20.5	21.0	22.4	23.6	25.2

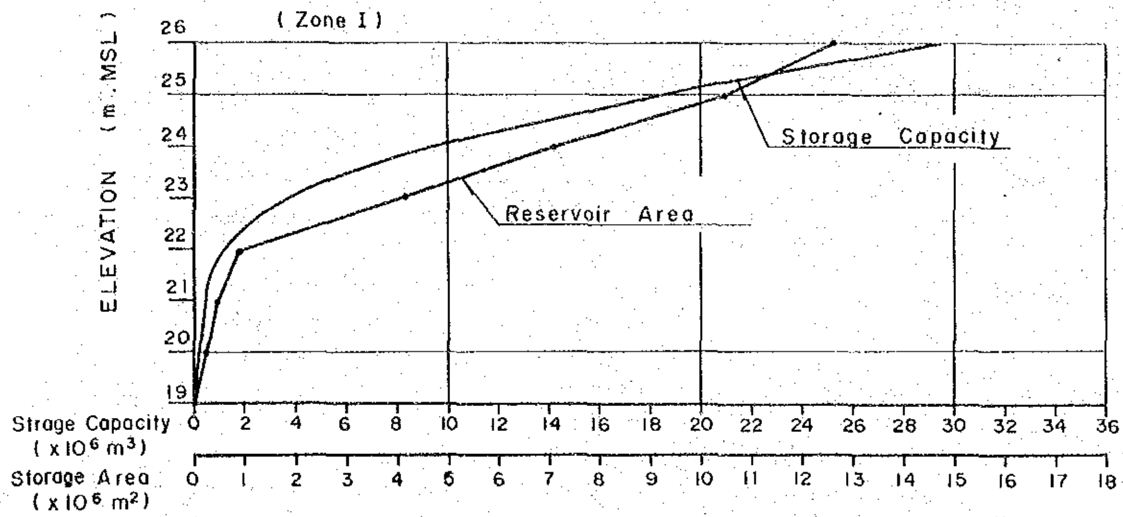
(5 years)

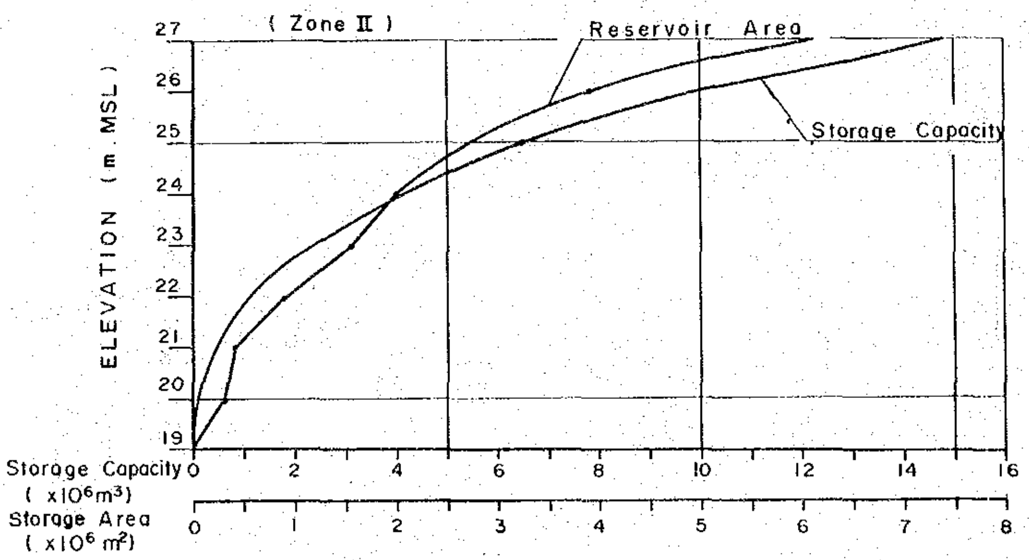


DESIGN WATER LEVEL (m)	23.3	24.1	24.5	25.7	27.0	28.7
DESIGN DIKE (m)	24.3	24.7	25.1	26.3	27.6	29.3
DESIGN RIVER BED (m)	19.3	20.5	21.0	22.4	23.6	25.2

EXISTING DIKE (m)	21.5		22.1	22.4			26.2		27.2		30.5
EXISTING RIVER BED (m)	21.0		21.1	21.1			22.6		23.6		25.2
DISTANCE (km)	0	1.0	2.0	2.8	3.0	4.0	5.0	6.0	7.0	8.0	9.0
STATION NO.	TB0	TB1	TB2	0.8	TB3	TB4	TB5	TB6	TB7	TB8	TB9

Fig. 4.20 STORAGE CAPACITY AND AREA CURVE
(Improved Condition)





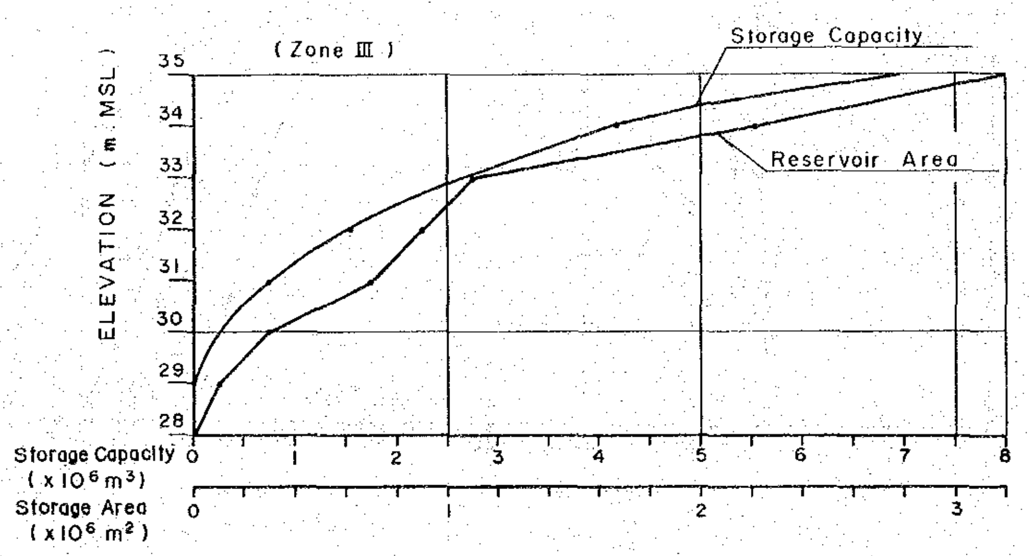


Fig. 4.21 INUNDATION AREA AND DURATION