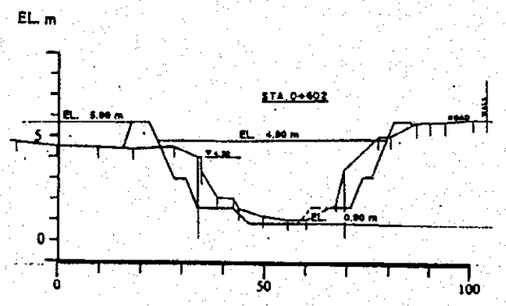
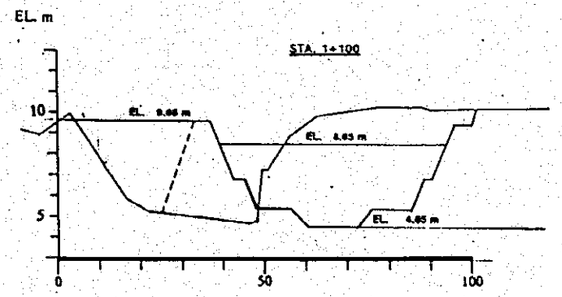
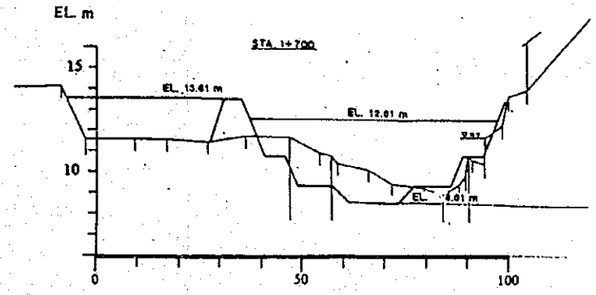
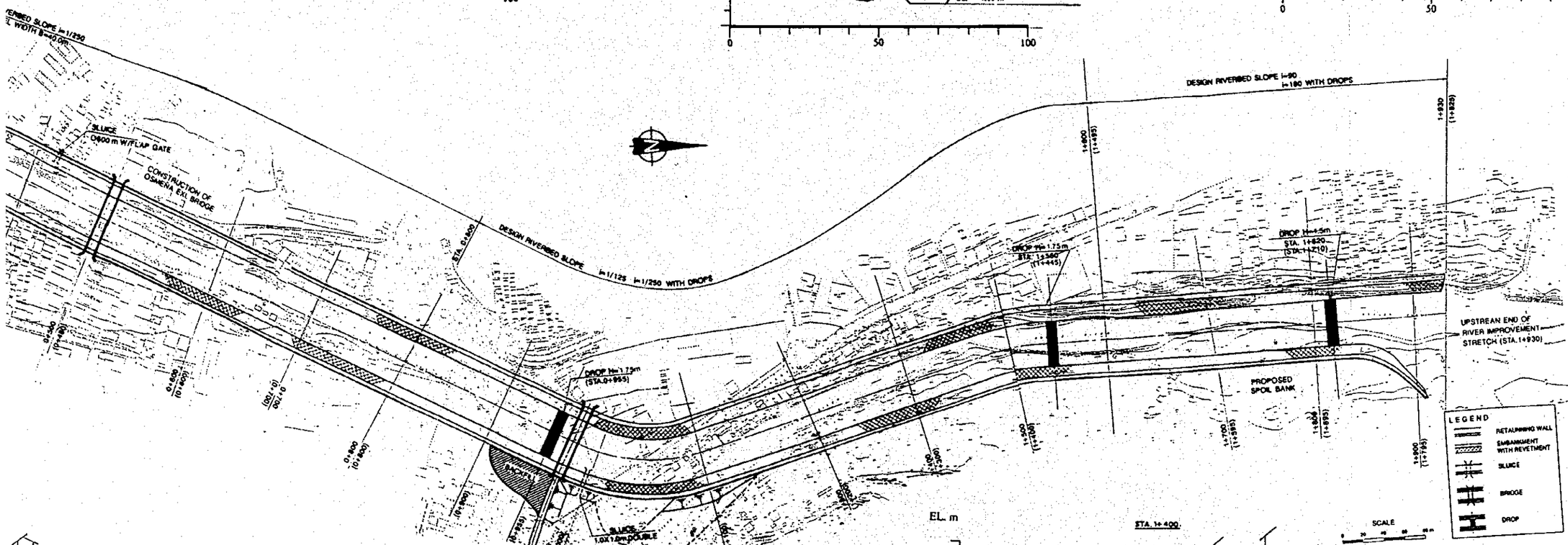
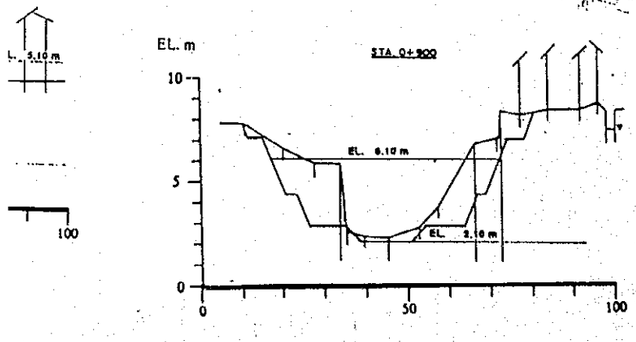
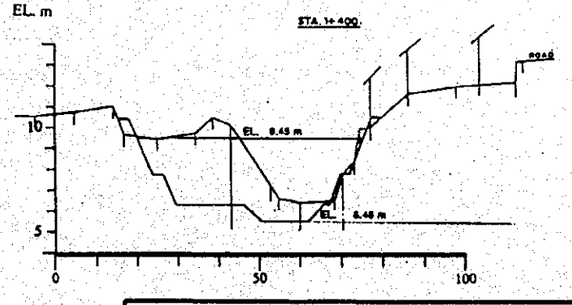








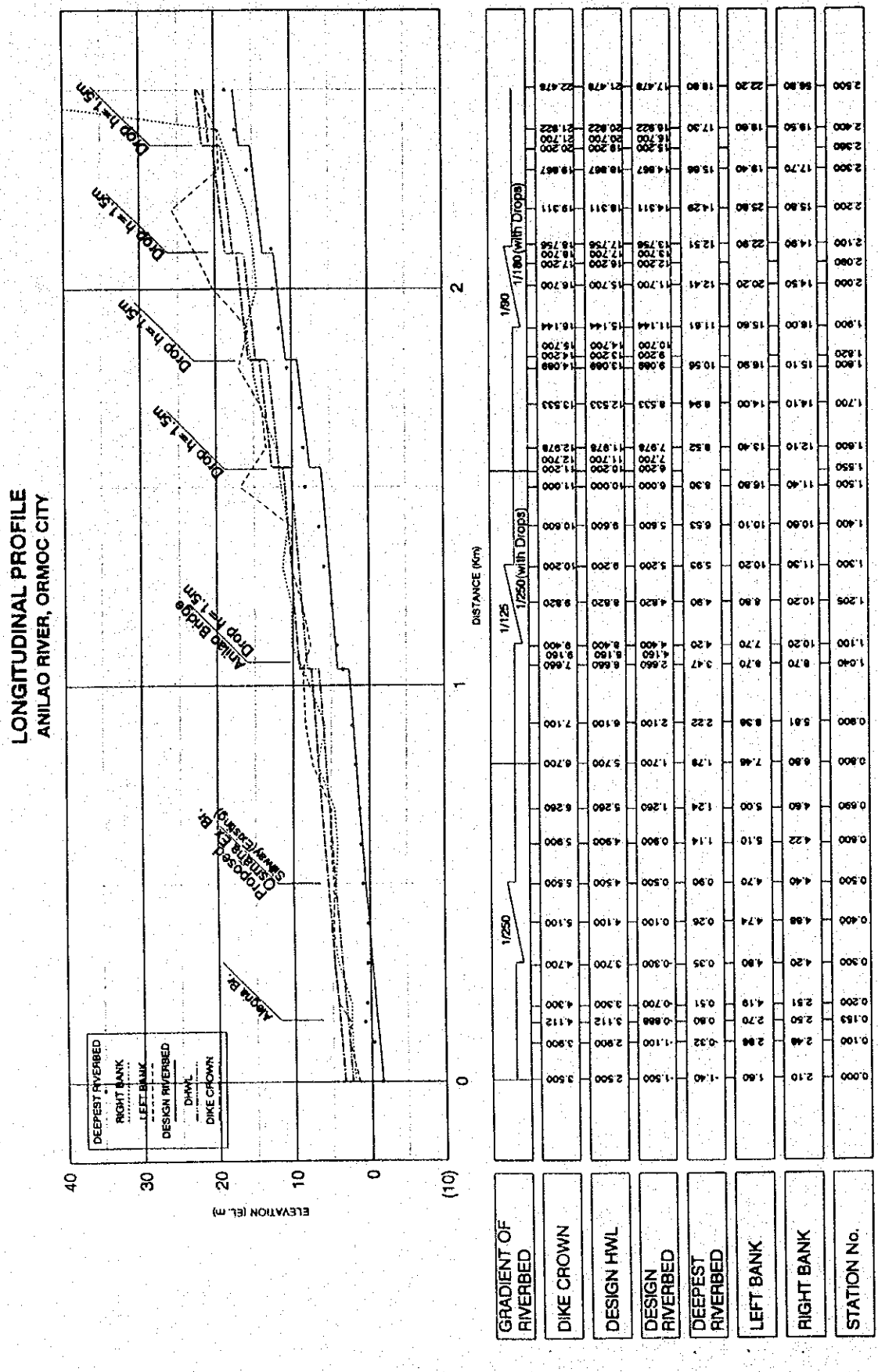




THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.20
Proposed Channel Alignment and Cross Section of Anilao River

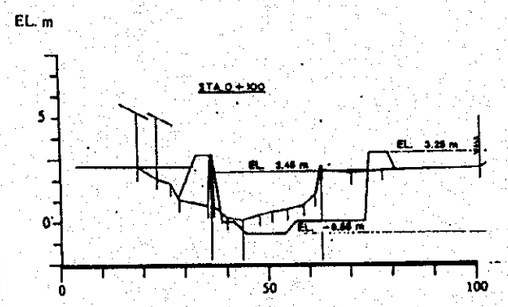


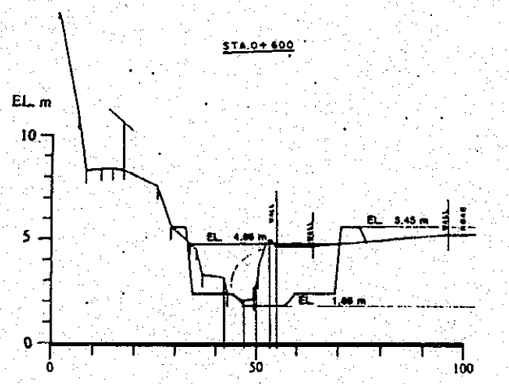
THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS

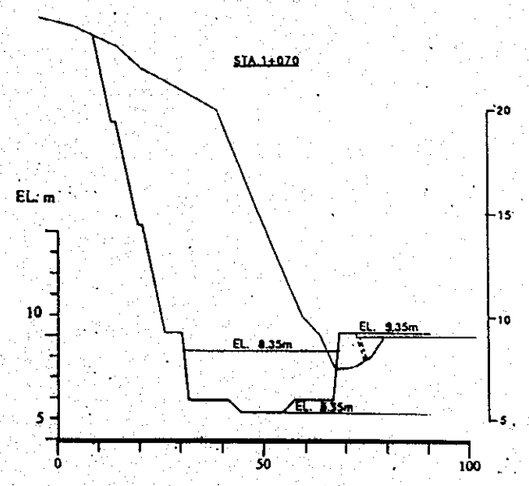
JAPAN INTERNATIONAL COOPERATION AGENCY

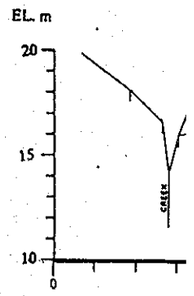
Fig. 3.21

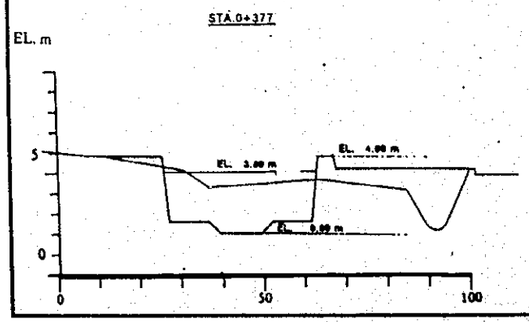
Longitudinal Profile of Anilao River

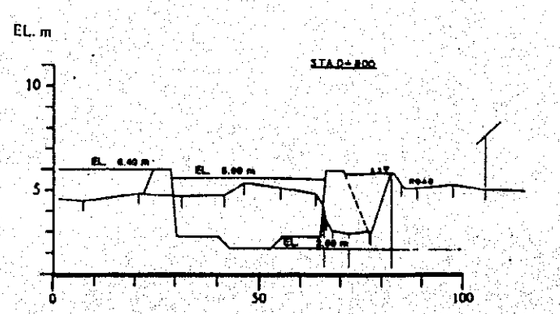


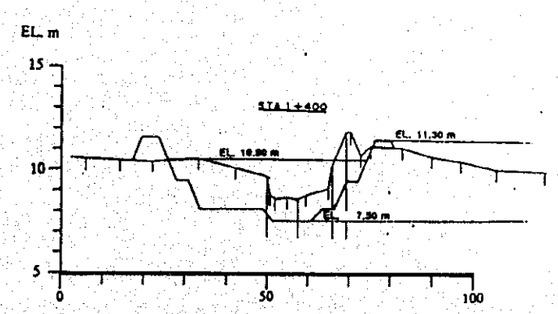






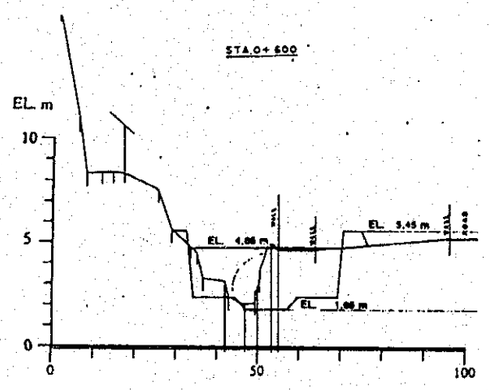


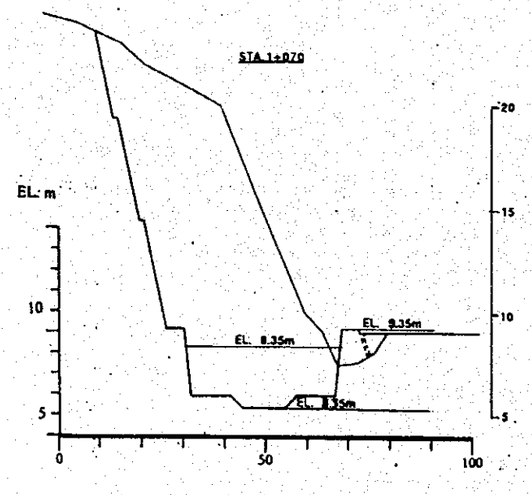


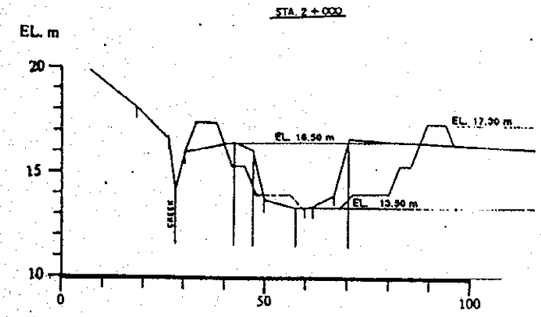


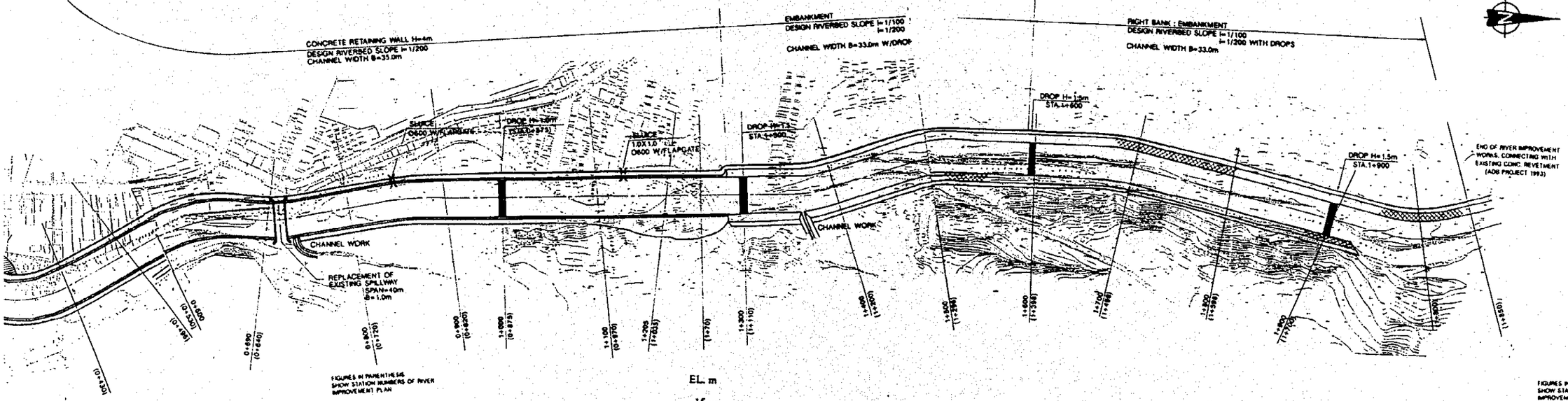
THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS

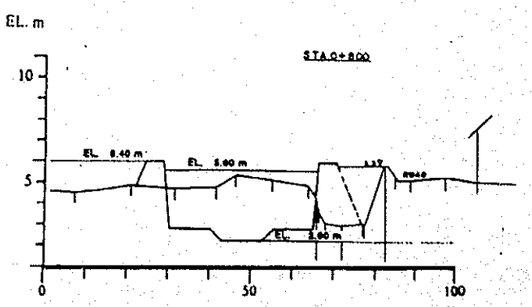
JAPAN INTERNATIONAL COOPERATION AGENCY

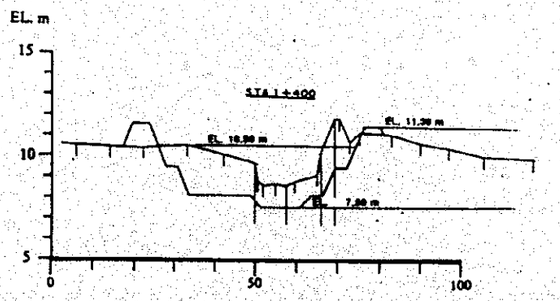






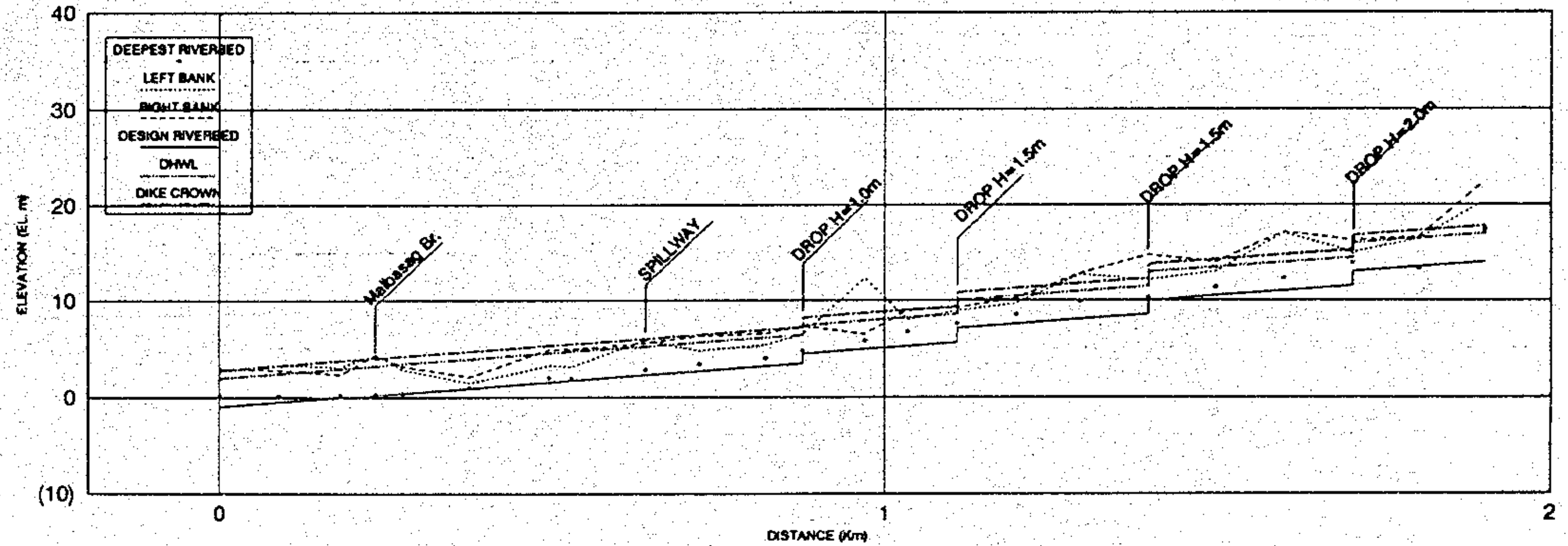






THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 3.22 Proposed Channel Alignment and Cross Section of Malbasag River

LONGITUDINAL PROFILE
MALBASAG RIVER, ORMOC CITY



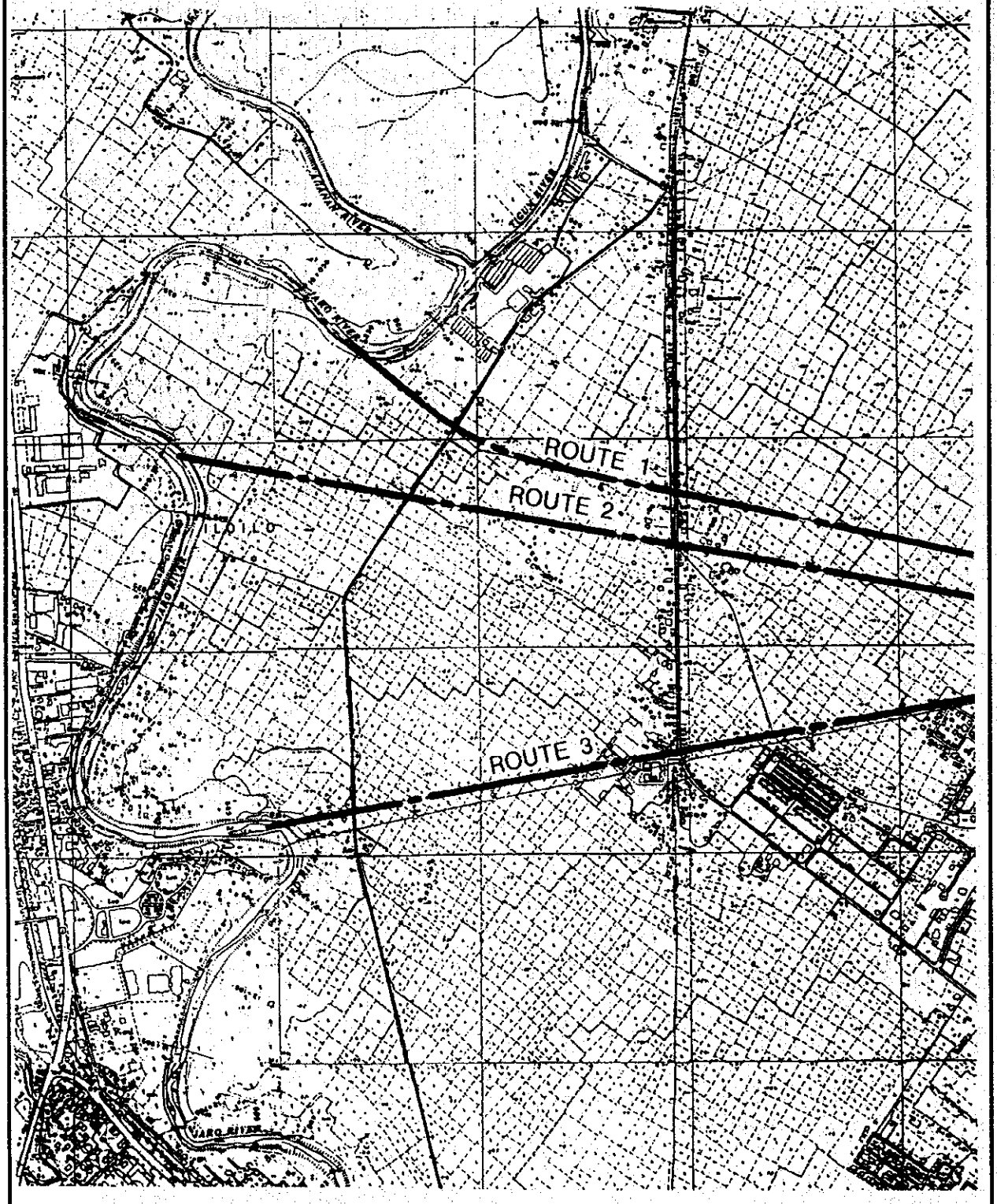
GRADIENT OF RIVERBED: 1/200 (STATION 0.000 – 0.875); 1/100, 1/200 with Drops (STATION 0.875 – 1.900)

DIKE CROWN	2.800	3.250	3.715	3.965	4.185	4.685	4.950	5.280	5.450	6.000	6.400	6.800	7.175 / 8.175	8.650	8.975	9.350 / 10.850	11.300	11.790	12.290 / 13.790	14.290	14.790	15.300 / 16.800	17.300	17.800
DESIGN HWL	2.000	2.450	2.815	3.165	3.385	3.885	4.150	4.480	4.650	5.200	5.600	6.100	6.375 / 7.375	7.850	8.175	8.550 / 10.050	10.500	10.980	11.480 / 12.980	13.480	13.980	14.500 / 16.000	16.500	17.000
DESIGN RIVERBED	-1.000	-0.550	-0.085	0.165	0.385	0.885	1.150	1.480	1.650	2.200	2.600	3.100	3.375 / 4.375	4.850	5.175	5.550 / 7.050	7.500	7.980	8.480 / 9.980	10.480	10.980	11.500 / 13.000	13.500	14.000
DEEPEST RIVERBED	0.20	0.17	0.23	0.40	0.38	0.97		2.00	1.95	2.80	3.36	3.94	4.70	5.77	6.76	7.54	8.52	9.90	10.32	11.42	12.33	13.95	13.30	17.41
LEFT BANK	2.80	2.70	2.30	4.30	3.09	2.04		4.80	4.87	5.50	6.26	6.51	7.30	6.41	8.86	9.15	10.26	12.80	14.76	14.00	17.11	18.26	18.80	22.54
RIGHT BANK	2.60	3.25	3.07	4.30	2.78	1.39		3.15	3.05	5.80	4.66	5.30	6.40	12.34	7.93	8.64	9.68	12.70	12.14	12.98	17.01	15.01	16.40	20.46
STATION No.	0.000	0.090	0.183	0.237	0.277	0.377	0.430	0.496	0.530	0.640	0.720	0.820	0.875	0.970	1.035	1.110	1.200	1.296	1.396	1.496	1.596	1.700	1.800	1.900

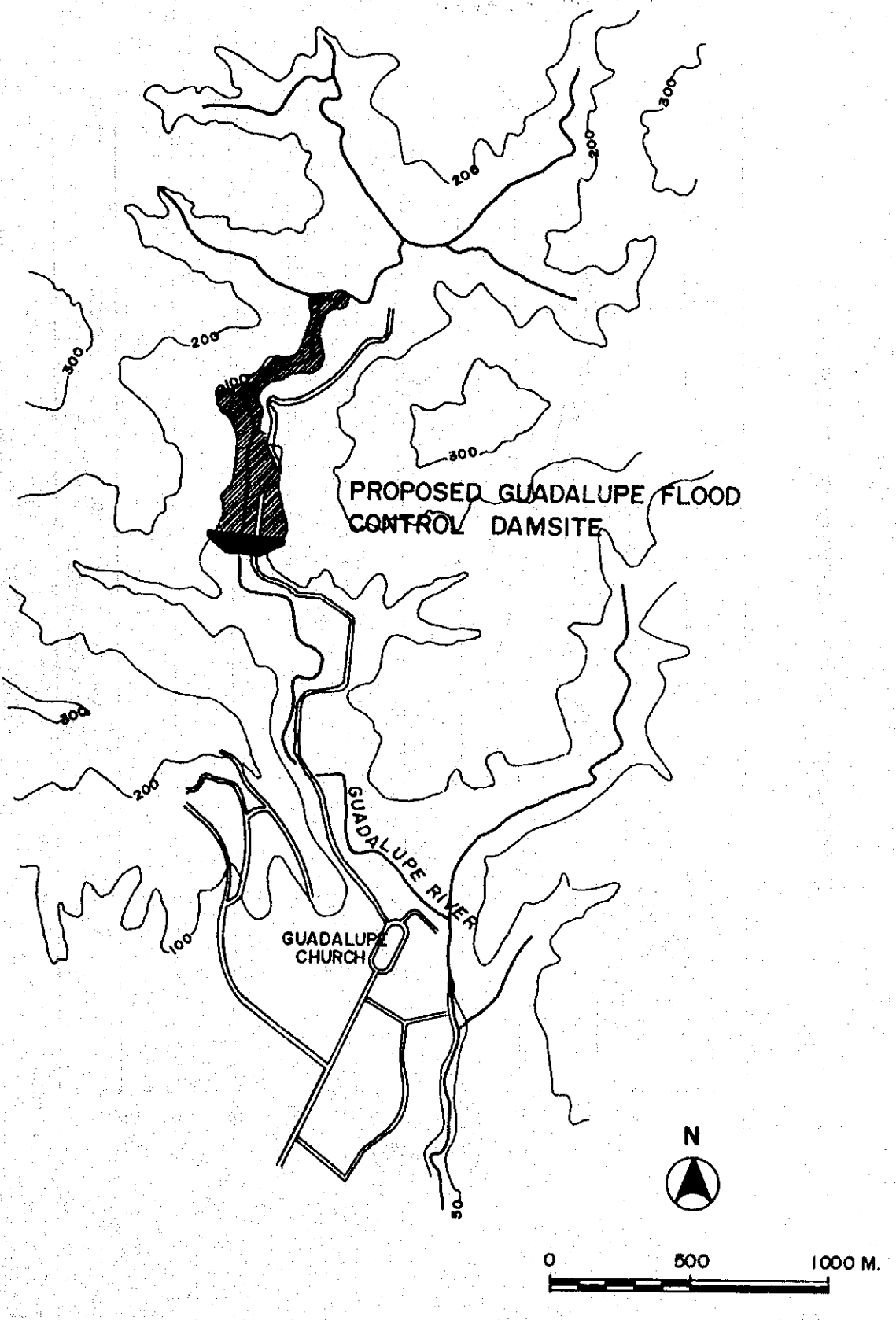
THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS

JAPAN INTERNATIONAL COOPERATION AGENCY

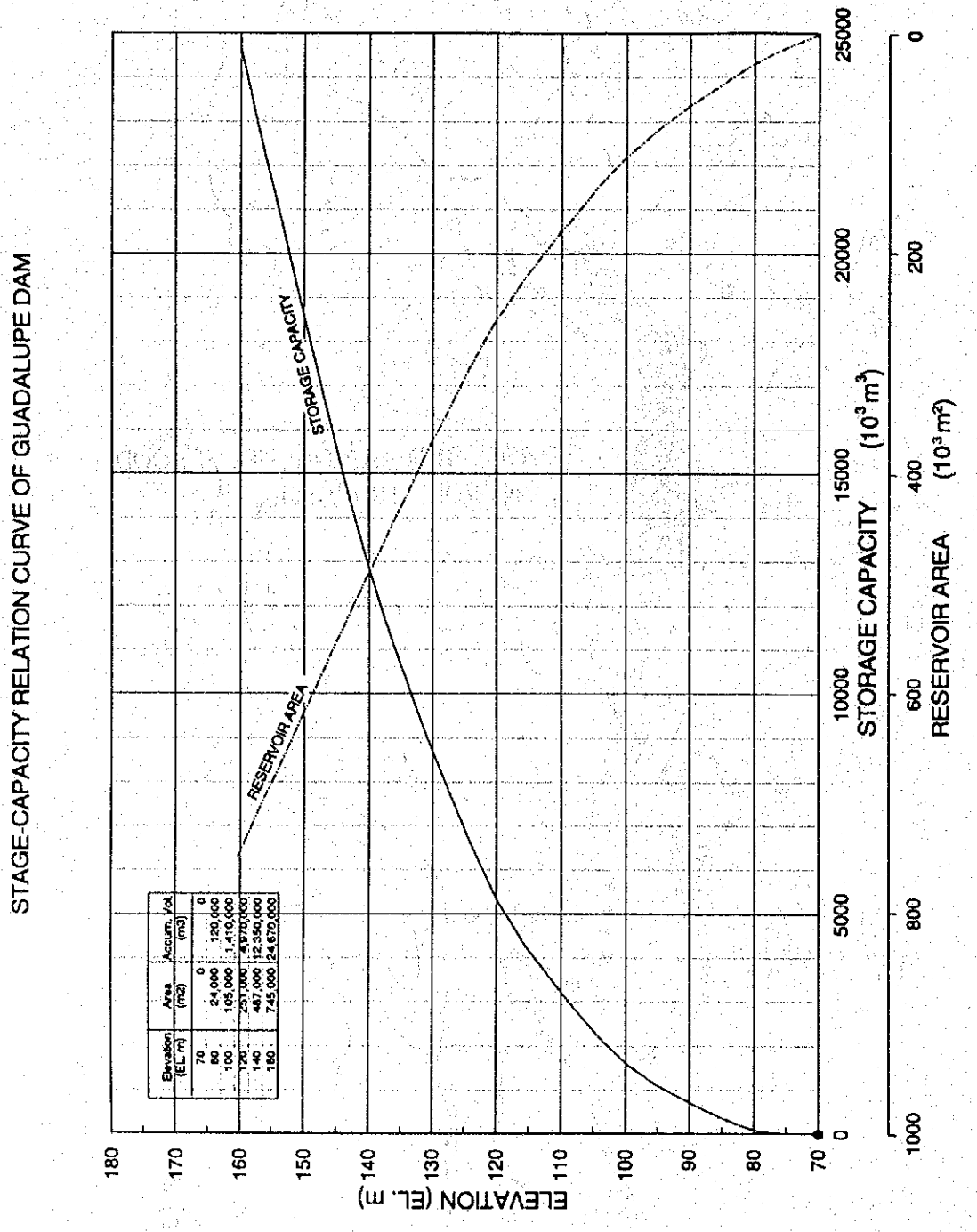
Fig. 3.23
Longitudinal Profile of Malbasag River



THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS	Fig. 3.24 Alternatives of Diversion Point and Alignment of Jaro Floodway
JAPAN INTERNATIONAL COOPERATION AGENCY	

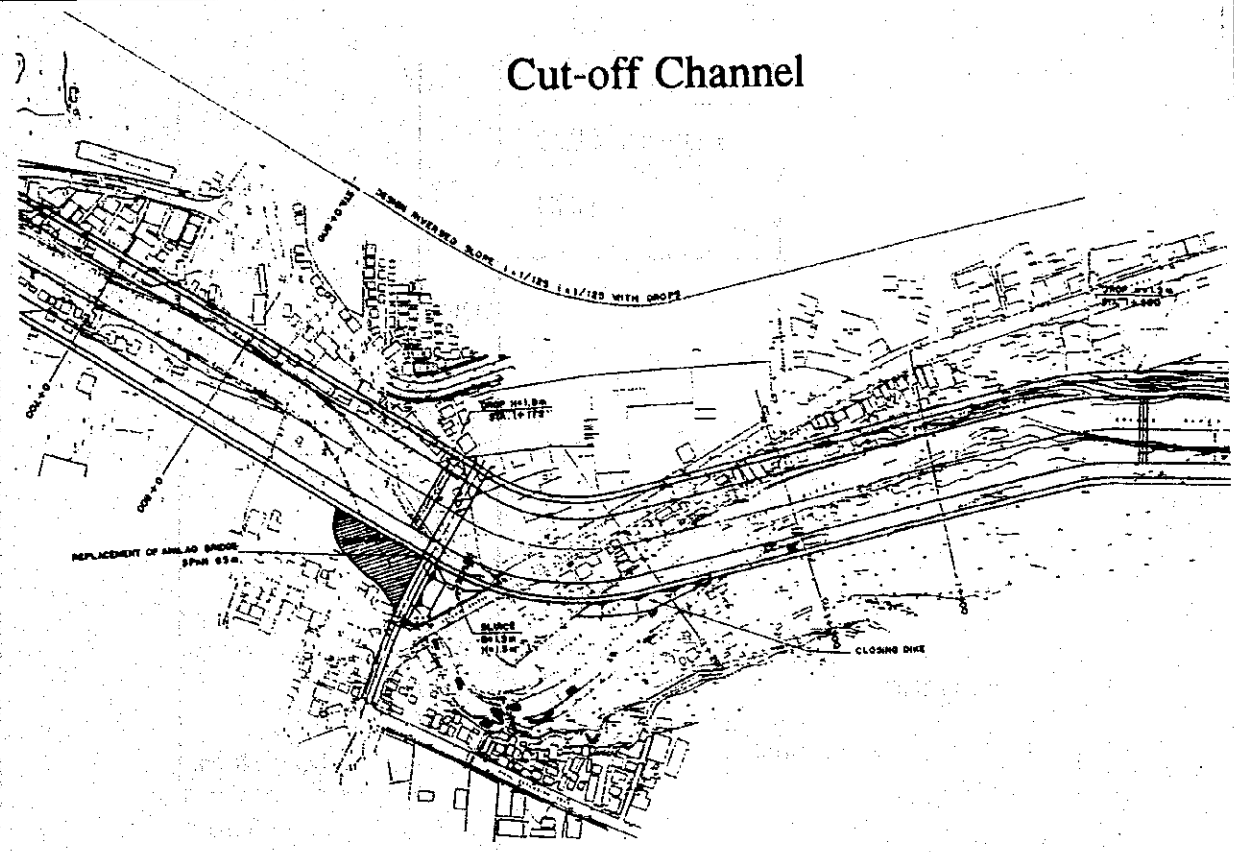


THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS	Fig. 3.25
JAPAN INTERNATIONAL COOPERATION AGENCY	Possible Dam Site of Guadalupe Flood Control Dam

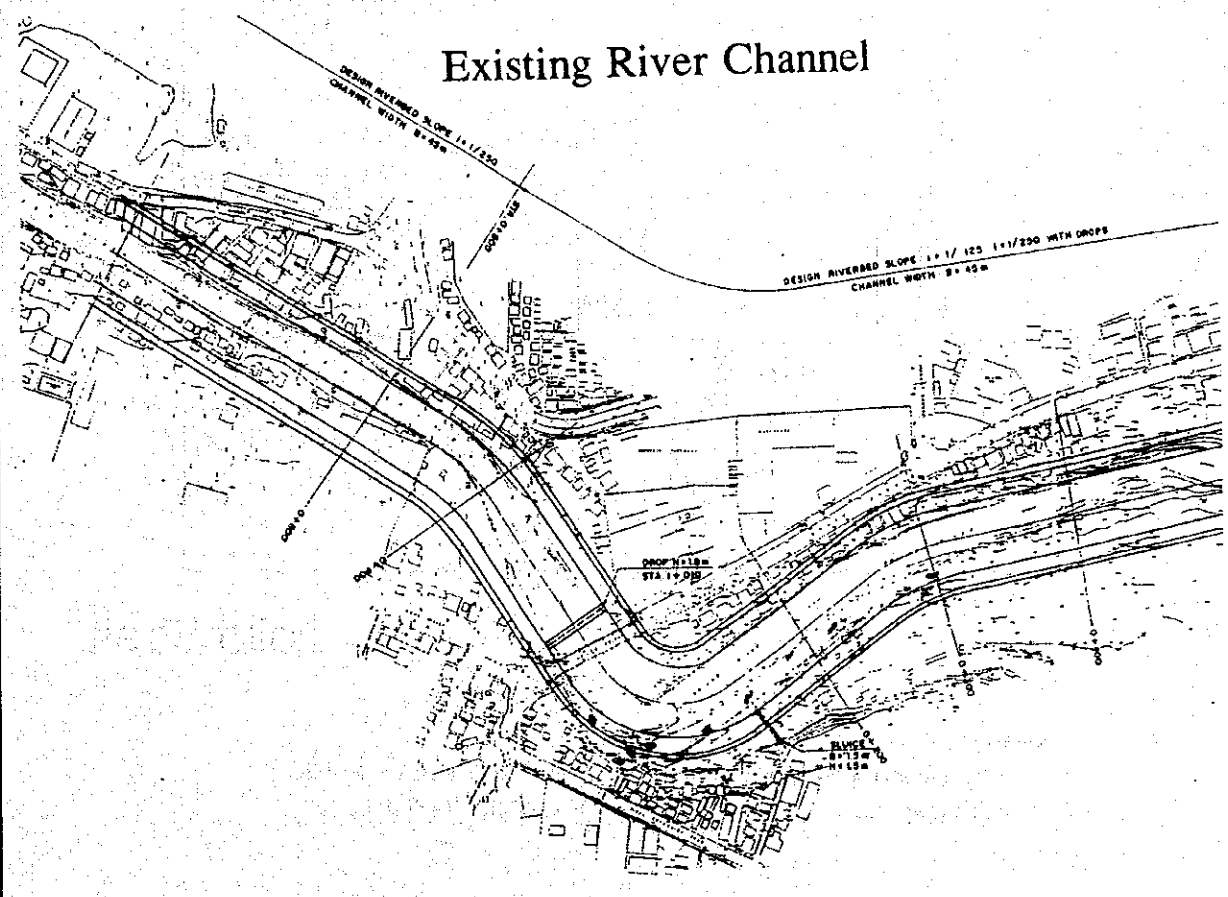


THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 3.26 Stage-Capacity Relation Curve of Guadalupe Flood Control Dam

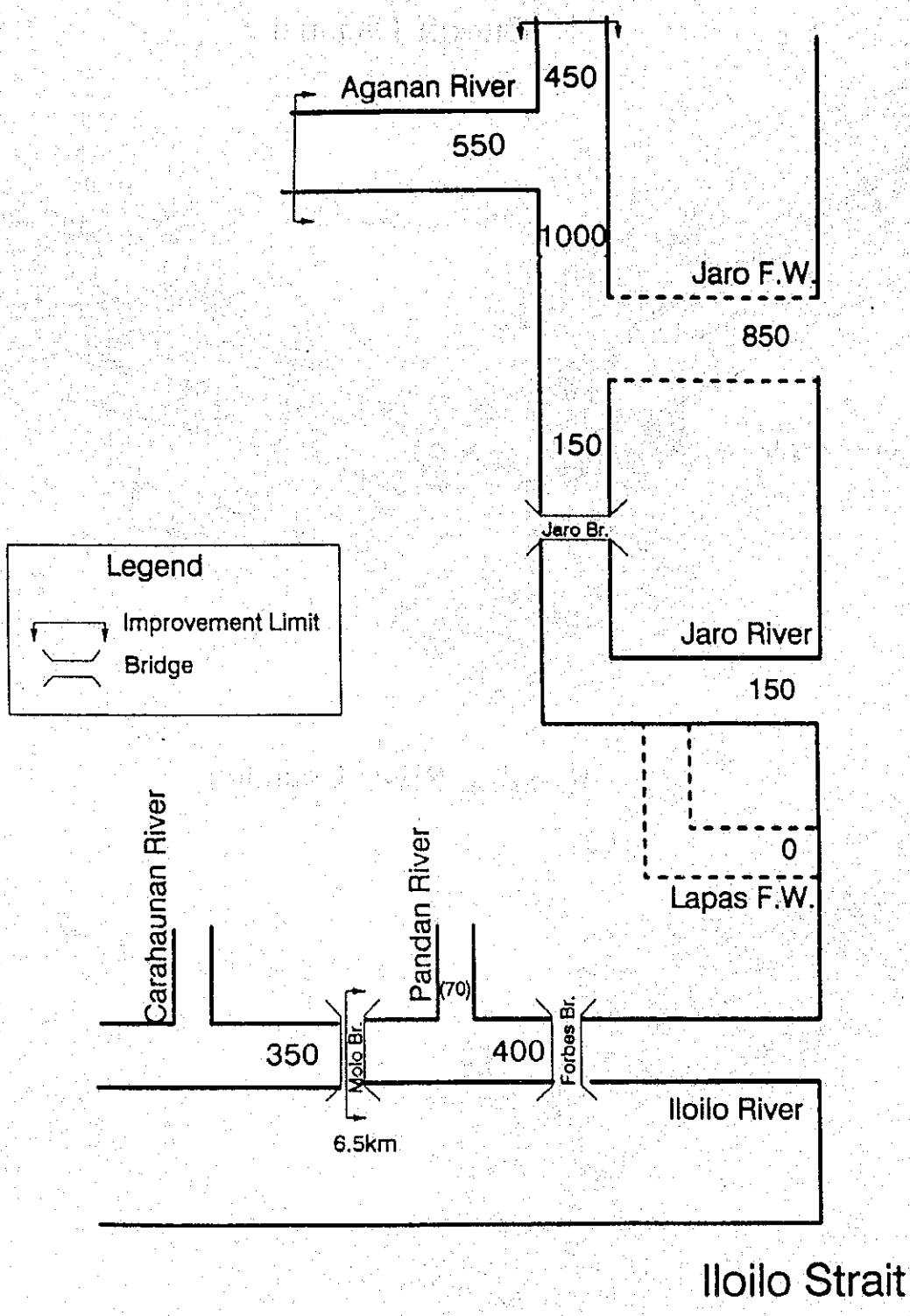
Cut-off Channel



Existing River Channel



THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS	Fig. 3.27
JAPAN INTERNATIONAL COOPERATION AGENCY	Channel Alignment of Alternatives for Anilao River

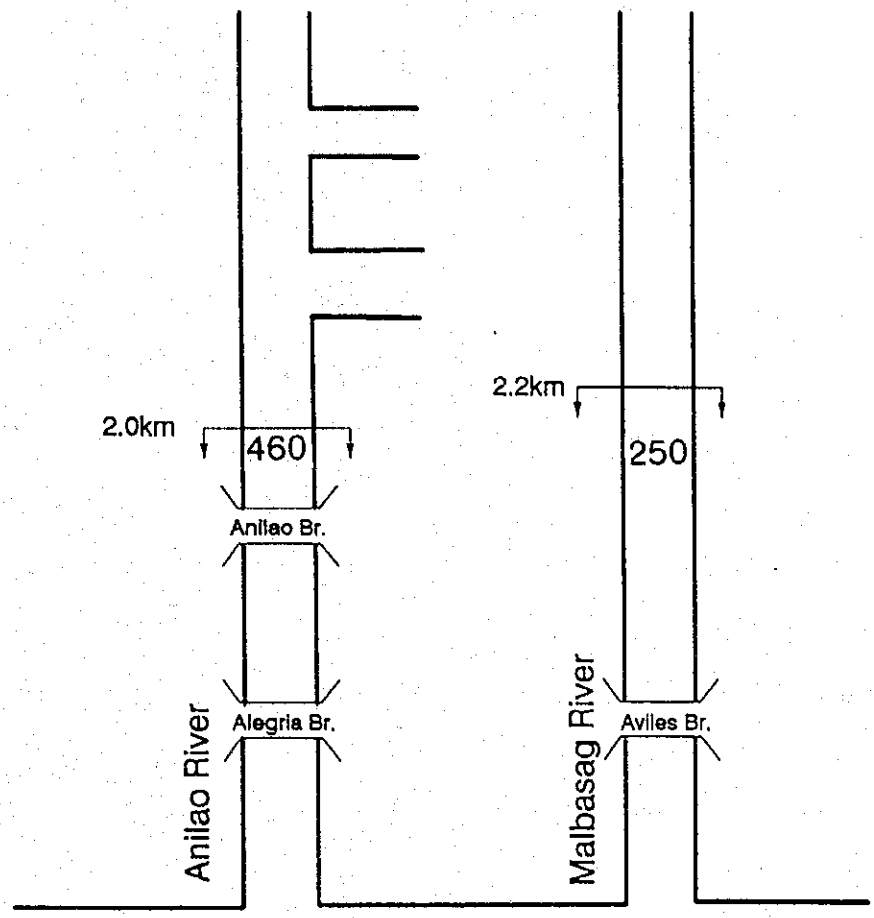


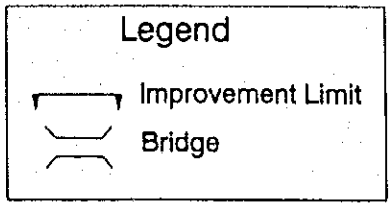
Note:1.Unit:m3/s

2.The Figures show probable Flood Discharge of 50-Year Return Period

3.( ) shows probable Flood Discharge of 20-Year Return Period

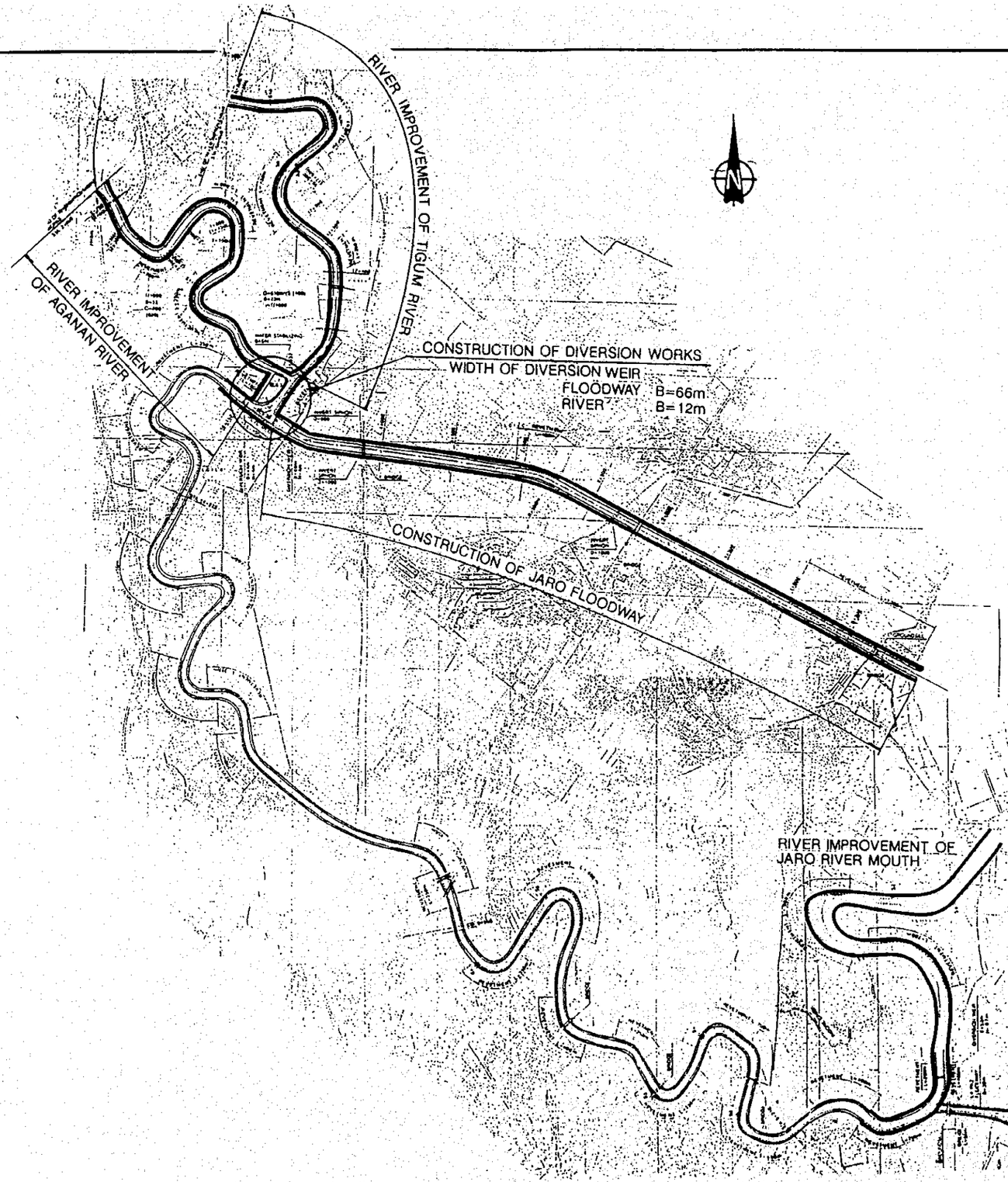
THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 4.1(1/2) Distribution of Design Discharge for Urgent Plan (Iloilo)

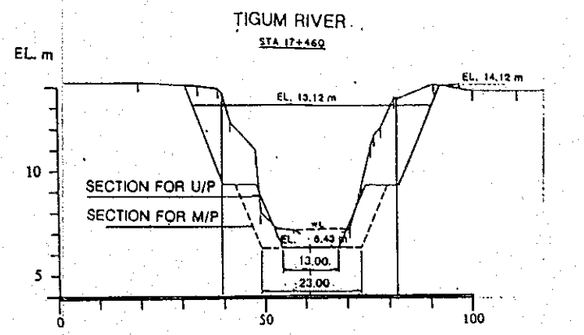


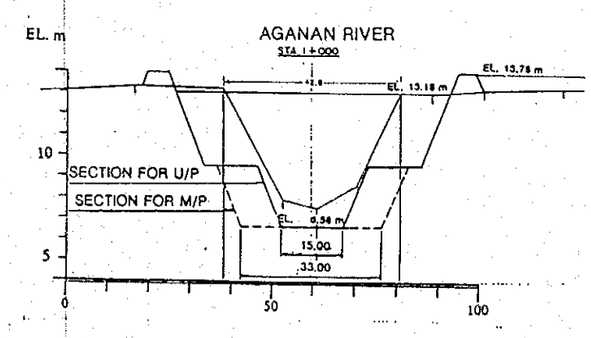


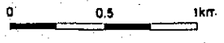
Note: 1. Unit: m3/s
2. The Figures show probable Flood Discharge of 50-Year Return Period

THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 4.1(2/2) Distribution of Design Discharge for Urgent Plan (Ormoc)

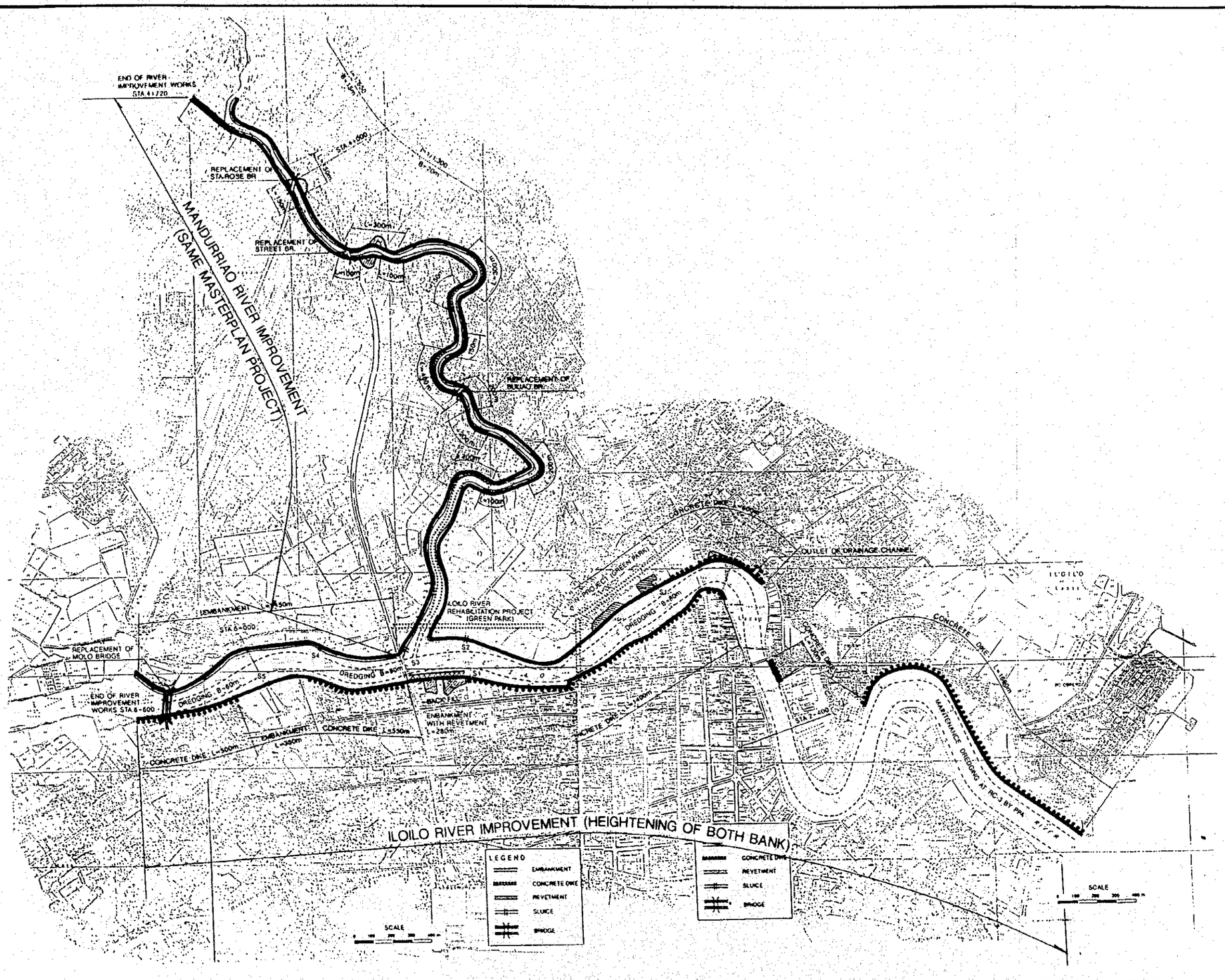




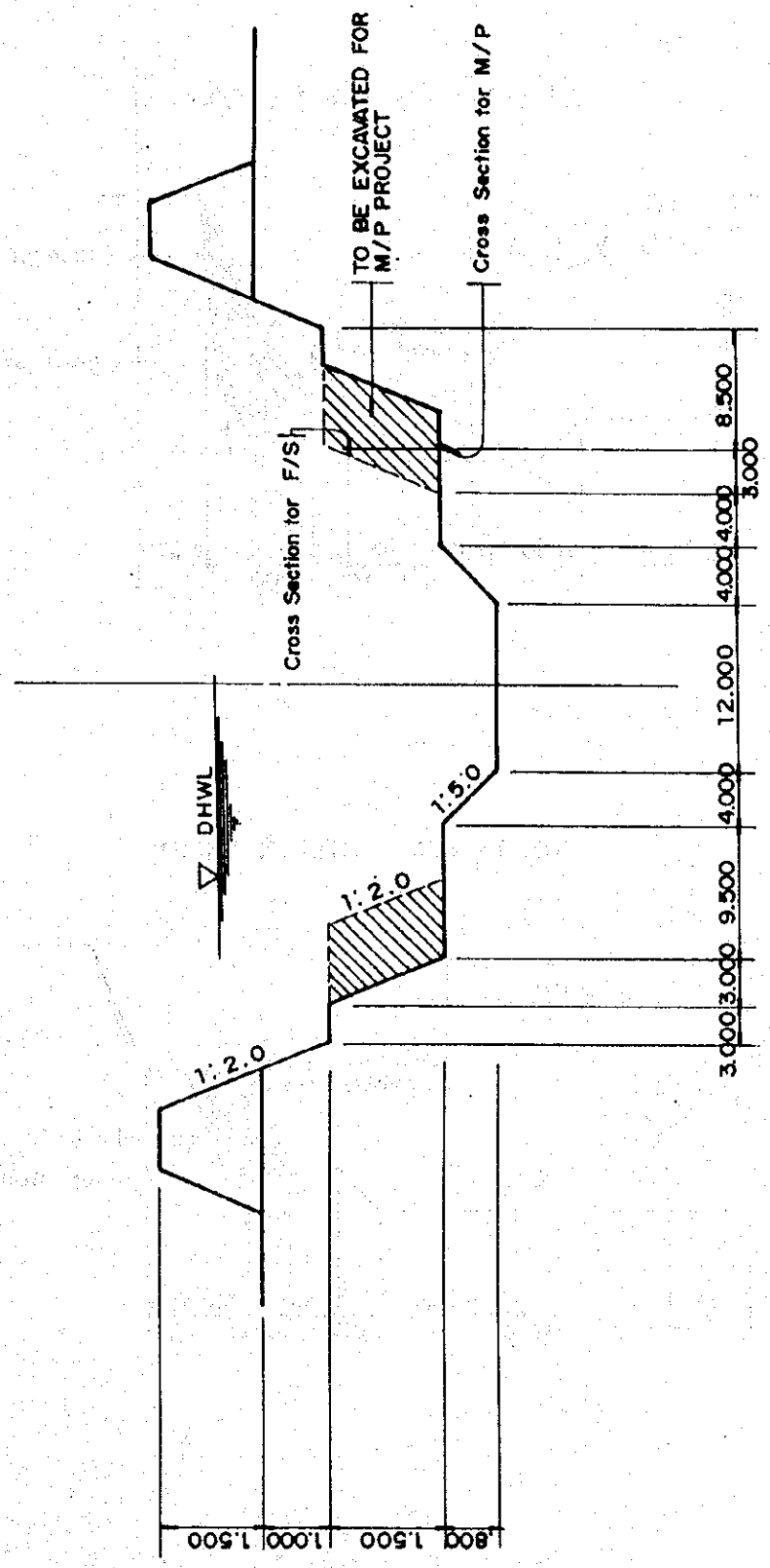




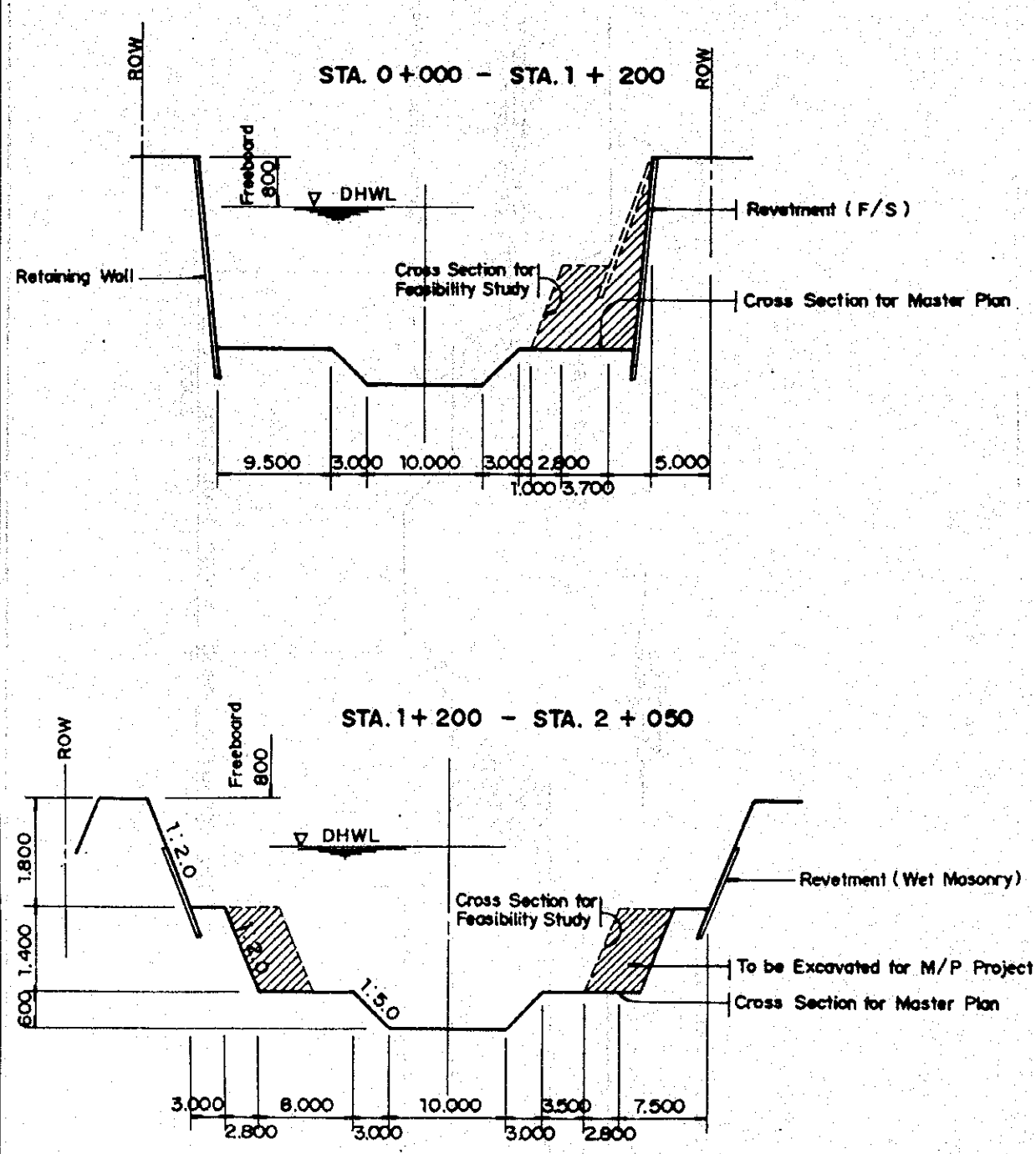
THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS	Fig. 4.2 Urgent Plan of Jaro River Improvement
JAPAN INTERNATIONAL COOPERATION AGENCY	



THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS	Fig. 4.3
JAPAN INTERNATIONAL COOPERATION AGENCY	Urgent Plan of Iloilo River Improvement

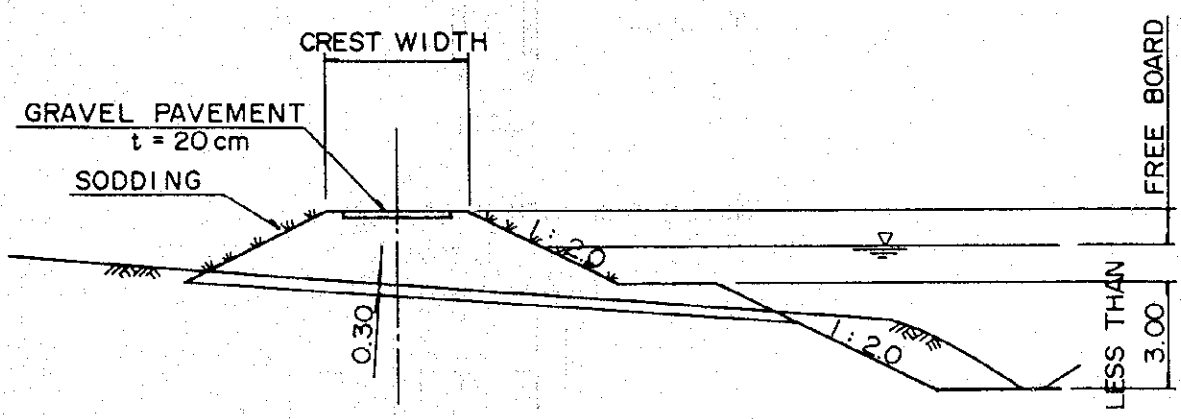


THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS	Fig. 4.4 Cross Section for Master Plan and Urgent Plan (Anilao River)
JAPAN INTERNATIONAL COOPERATION AGENCY	



THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 4.5 Cross Section for Master Plan and Urgent Plan (Malbasag River)

EARTH DIKE



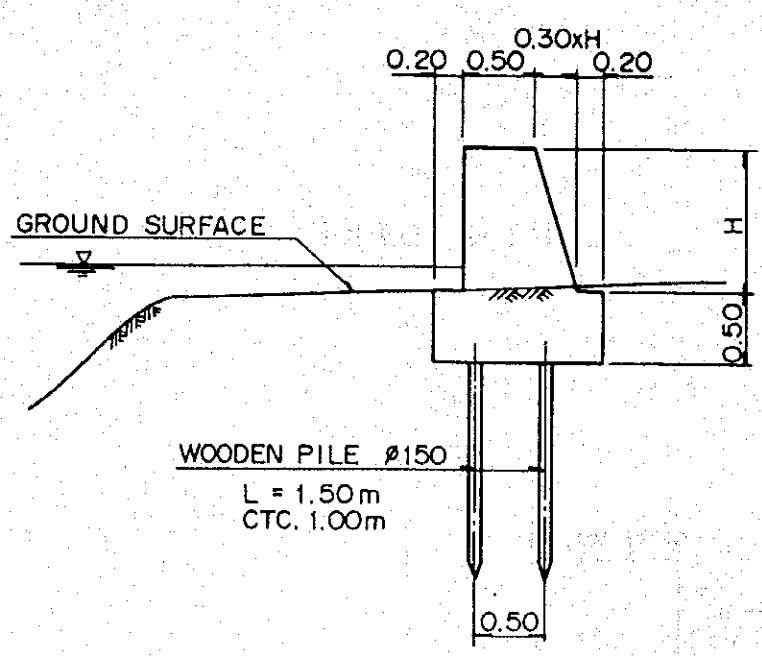
DISTANCE (m3/s)	CREST WIDTH (m)	FREEBOARD (m)
less than 200	3.00	0.60
200 to 500	3.00	0.80
more than 500	4.00	1.00

THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS

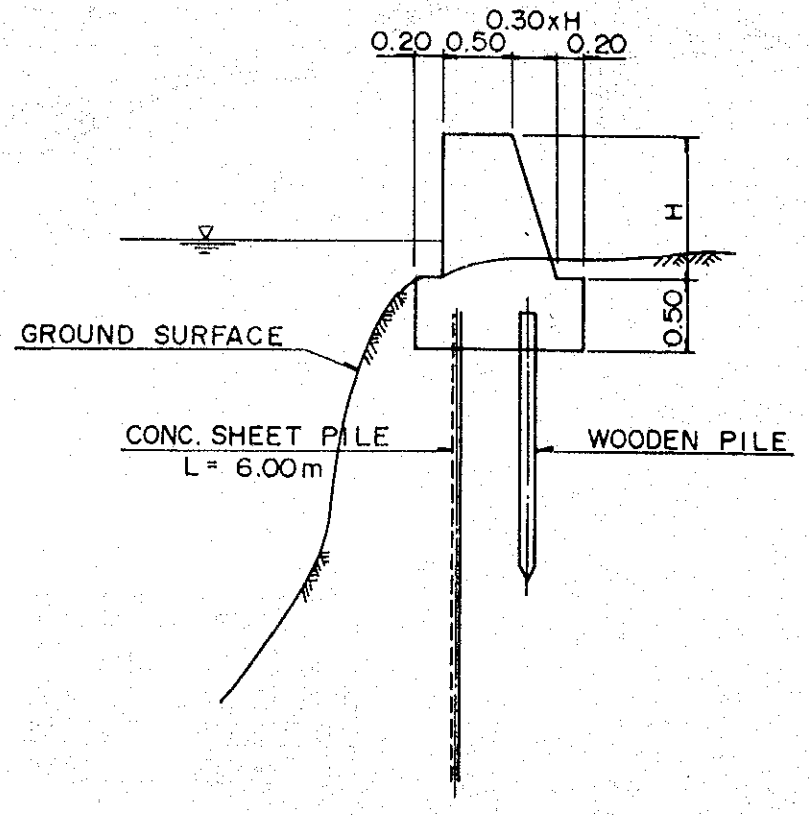
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 5.1
Typical Section of Earth Dike

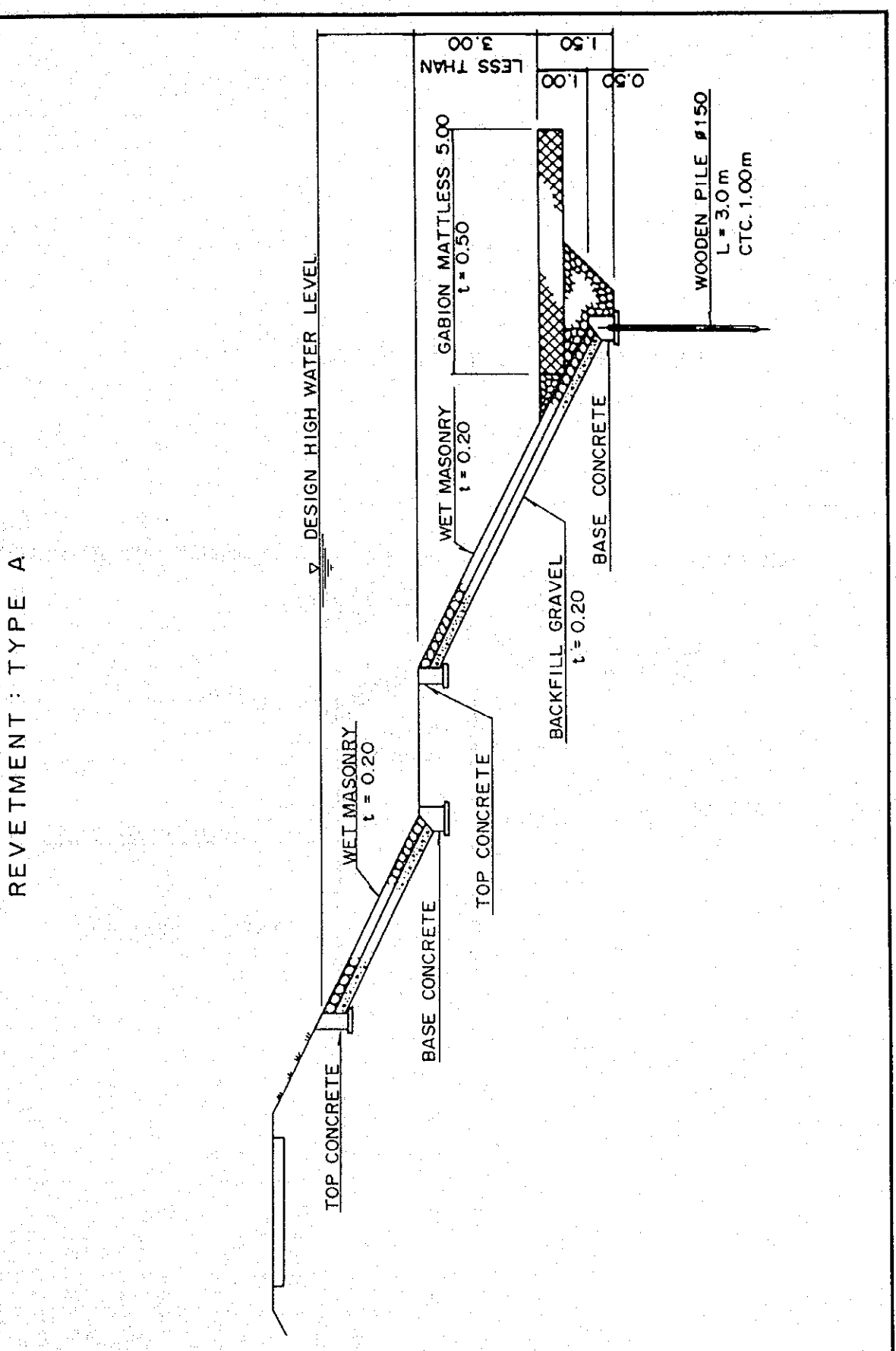
CONCRETE DIKE



CONCRETE DIKE WITH SHEET PILE

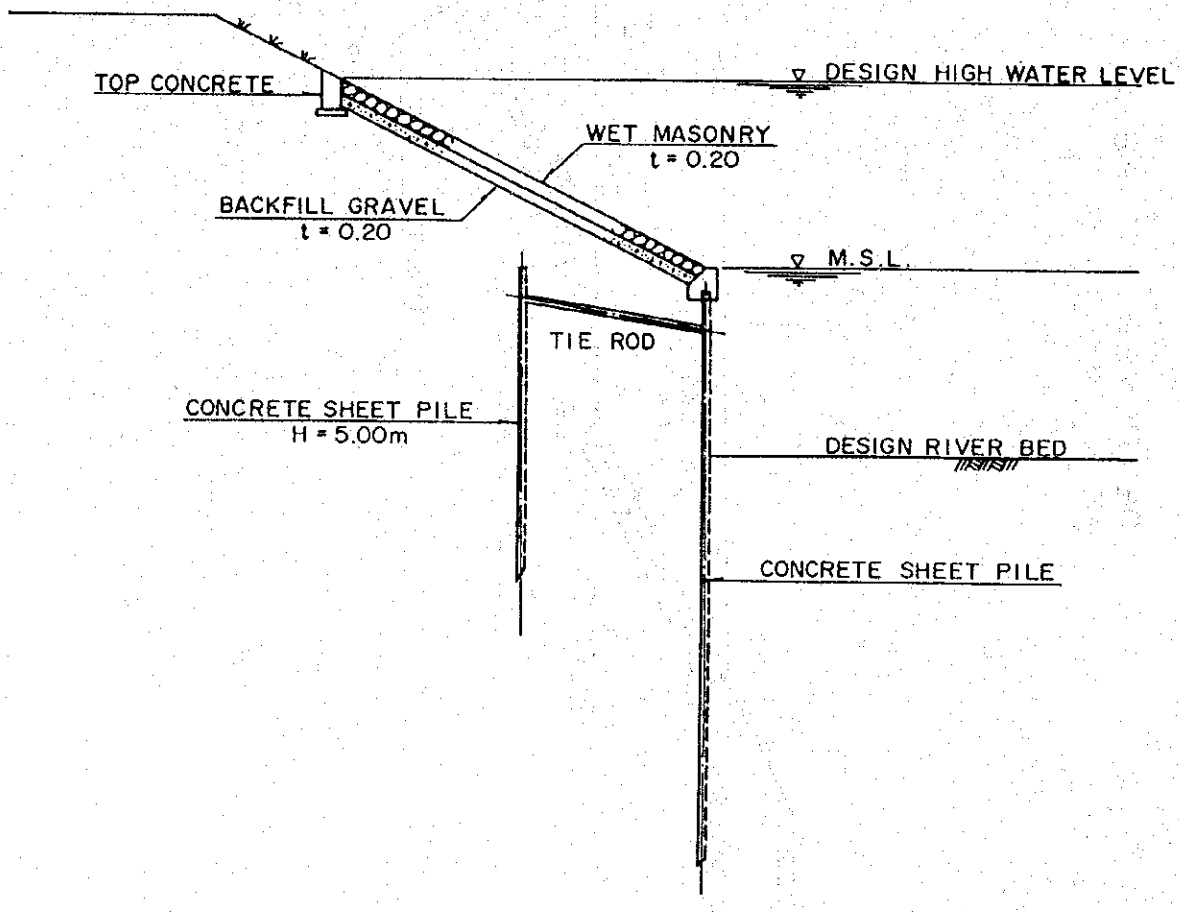


THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 5.2 Typical Section of Concrete Dike

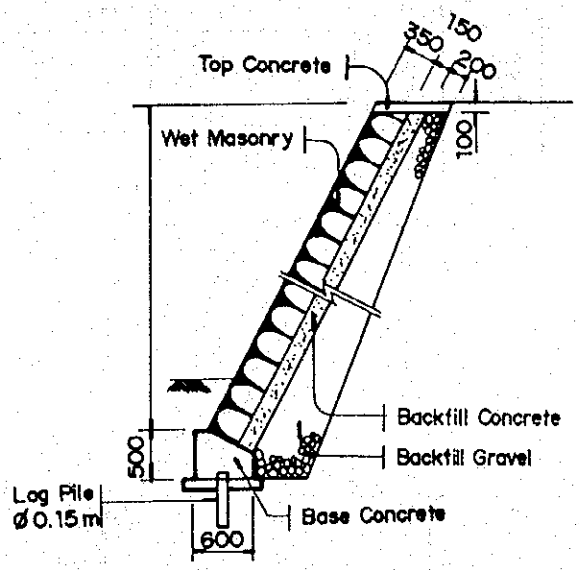


THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 5.3 Typical Section of Revetment Type A

REVETMENT : TYPE B

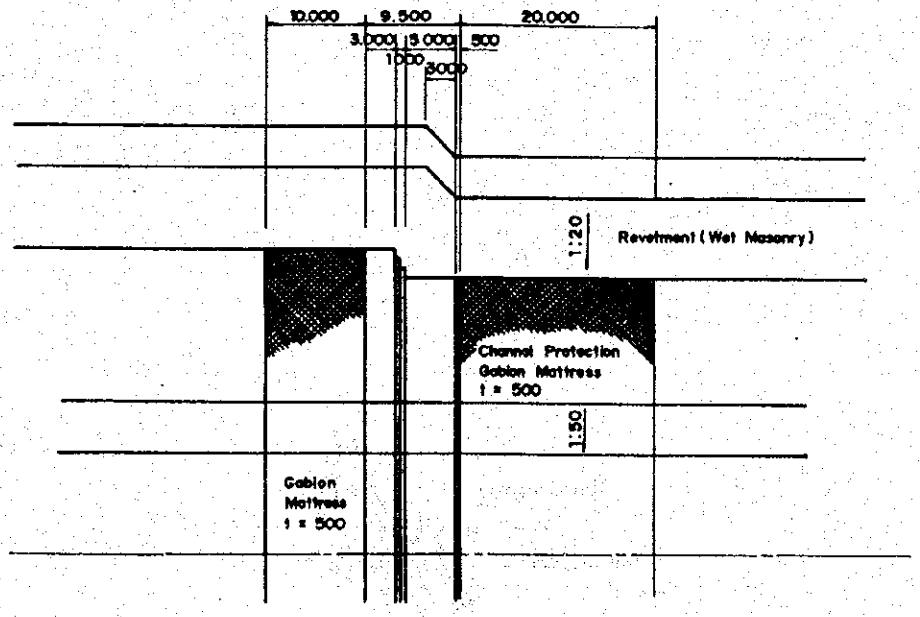


THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 5.4 Typical Section of Revetment Type B

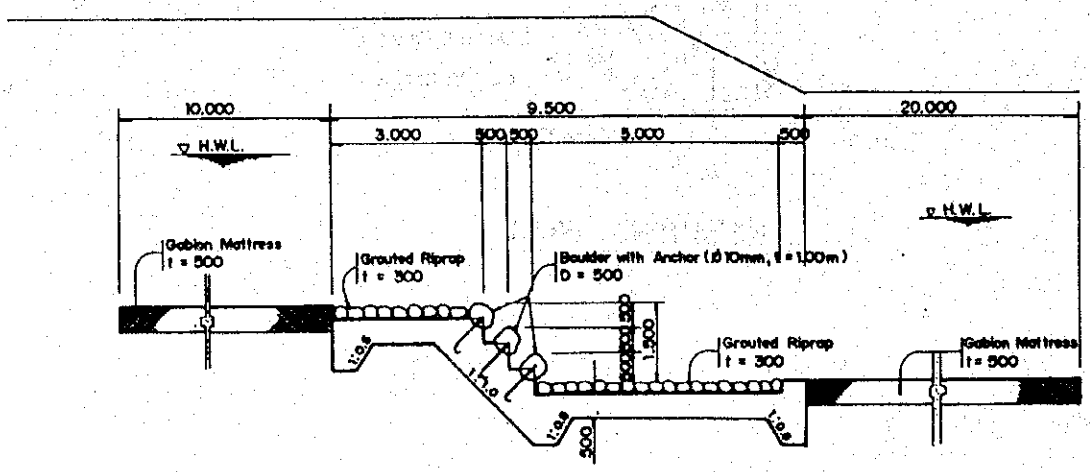


RETAINING WALL

THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS	Fig. 5.5 Typical Section of Retaining Wall
JAPAN INTERNATIONAL COOPERATION AGENCY	

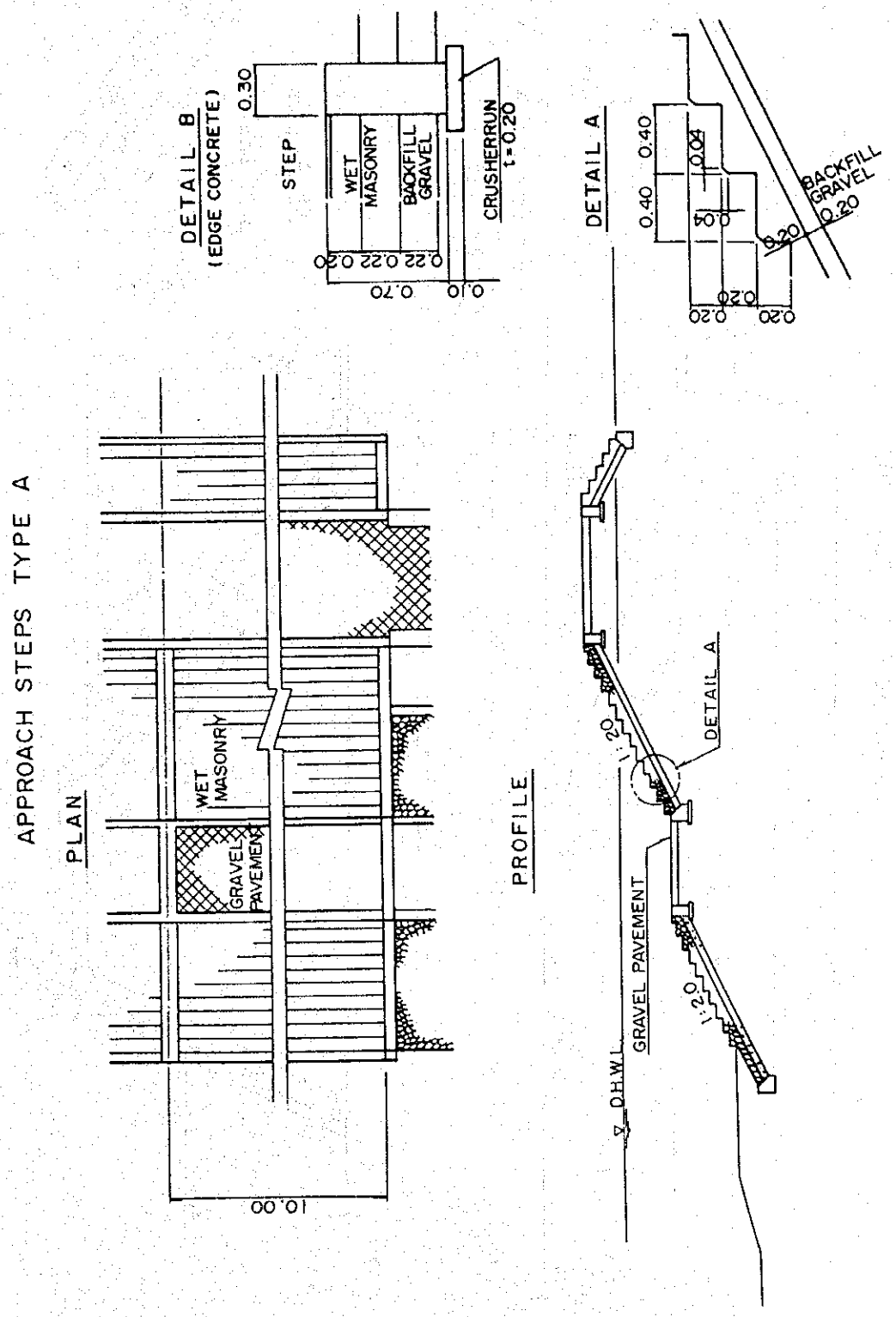


P L A N

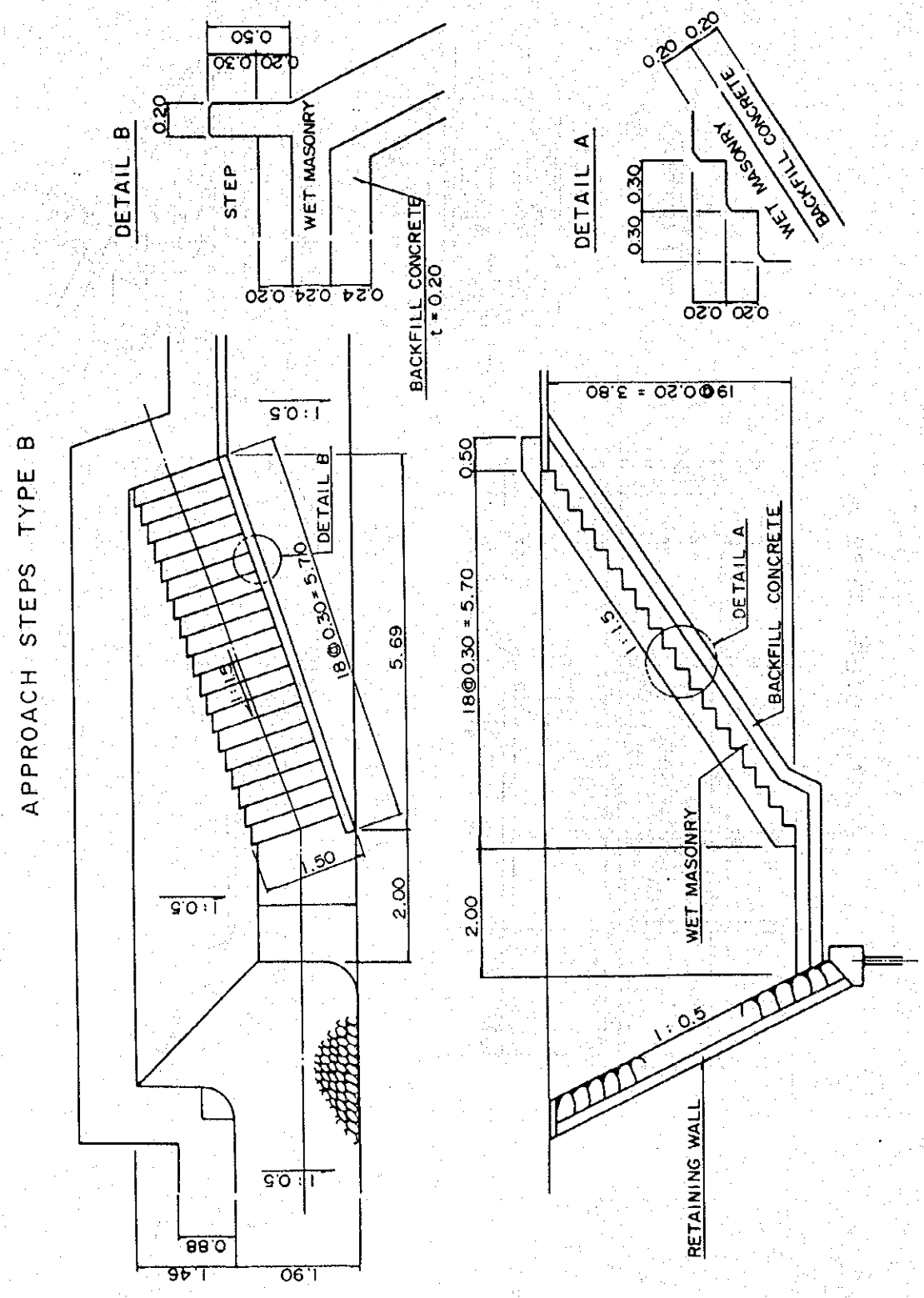


D R O P

THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 5.6 Standard Design of Drop



THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 5.7(1/2) Standard Design of Approach Steps Type A



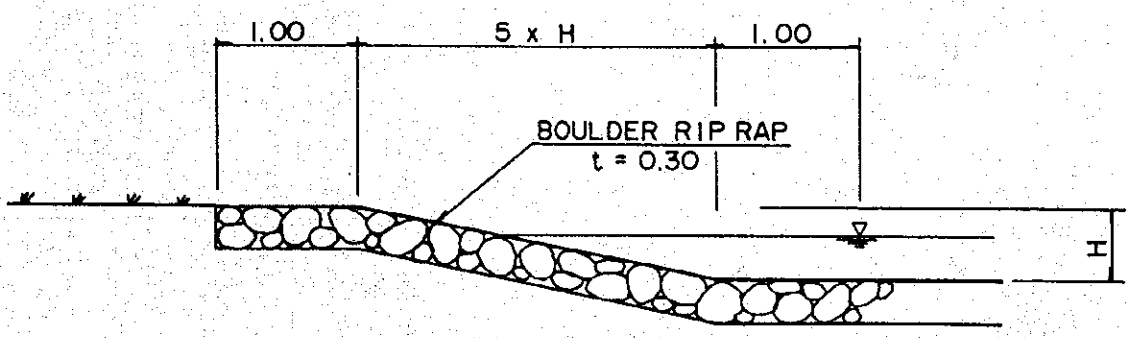
THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 5.7(2/2)
Standard Design of Approach Steps Type B

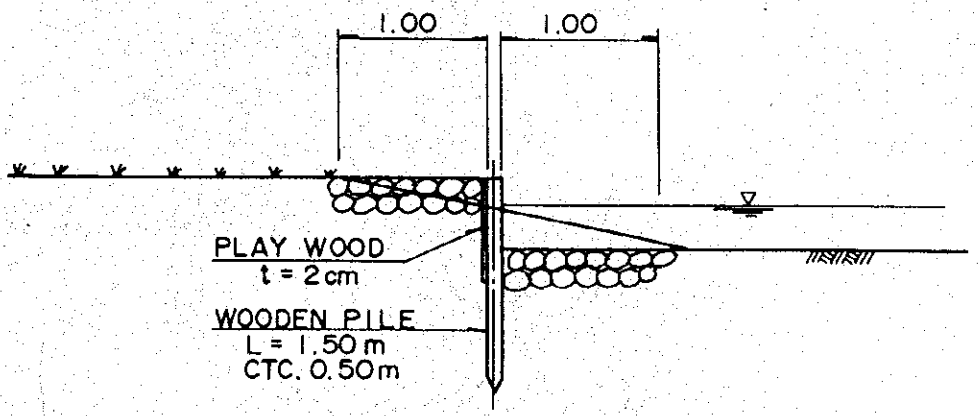
M F C. PROTECTION

TYPE A : BOULDER RIP·RAP

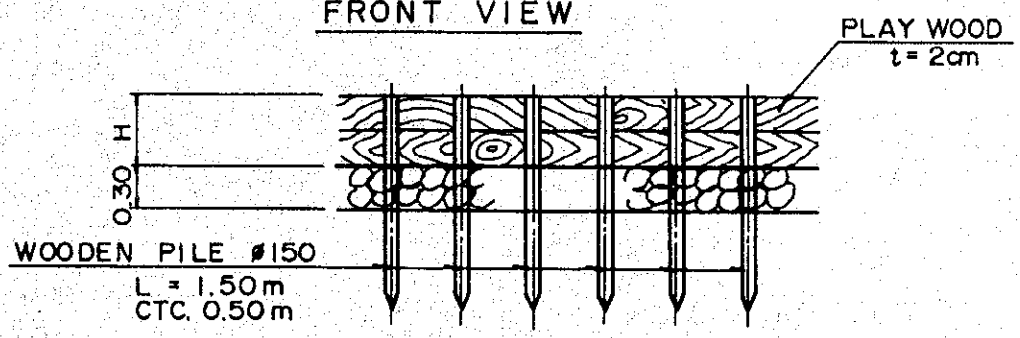


TYPE B : WOODEN PILE

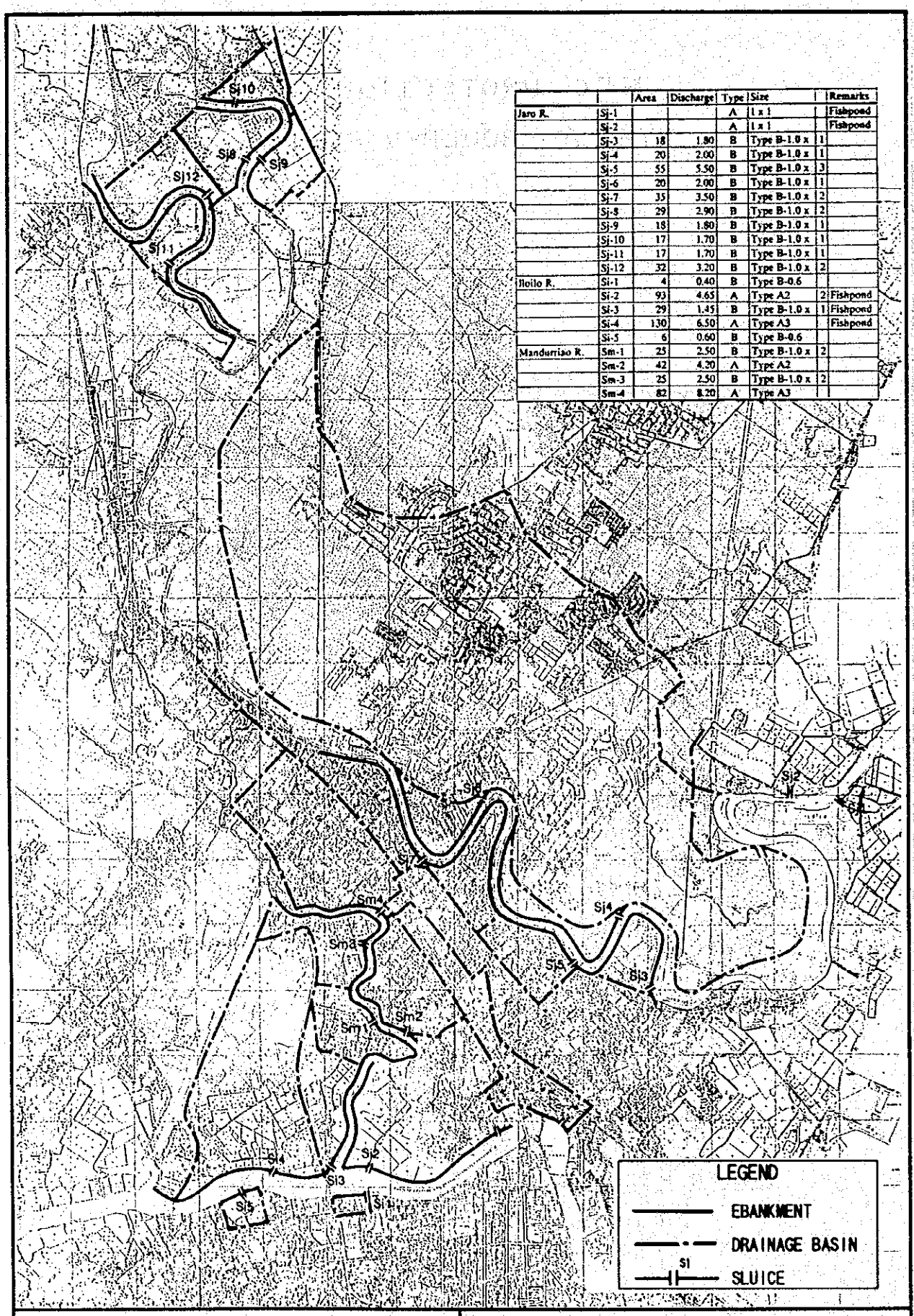
SECTION



FRONT VIEW



THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 5.8 Maintenance Flow Channel Protection

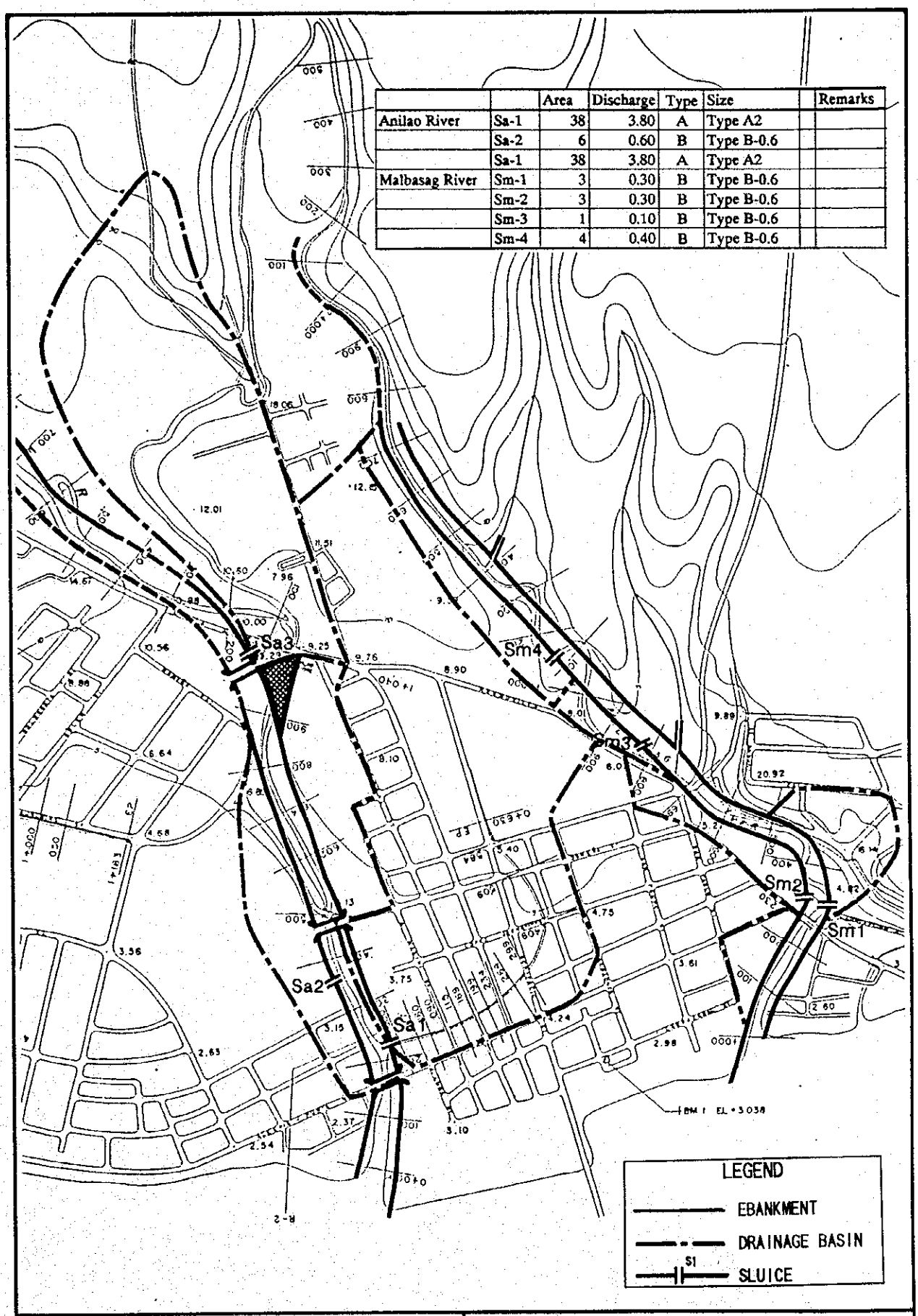


		Area	Discharge	Type	Size		Remarks
Jaro R.	Sj-1			A	1 x 1		Fishpond
	Sj-2			A	1 x 1		Fishpond
	Sj-3	18	1.80	B	Type B-1.0 x	1	
	Sj-4	20	2.00	B	Type B-1.0 x	1	
	Sj-5	55	5.50	B	Type B-1.0 x	3	
	Sj-6	20	2.00	B	Type B-1.0 x	1	
	Sj-7	35	3.50	B	Type B-1.0 x	2	
	Sj-8	29	2.90	B	Type B-1.0 x	2	
	Sj-9	18	1.80	B	Type B-1.0 x	1	
	Sj-10	17	1.70	B	Type B-1.0 x	1	
	Sj-11	17	1.70	B	Type B-1.0 x	1	
	Sj-12	32	3.20	B	Type B-1.0 x	2	
Iloilo R.	Si-1	4	0.40	B	Type B-0.6		
	Si-2	93	4.65	A	Type A2	2	Fishpond
	Si-3	29	1.45	B	Type B-1.0 x	1	Fishpond
	Si-4	130	6.50	A	Type A3		Fishpond
	Si-5	6	0.60	B	Type B-0.6		
Mandurriao R.	Sm-1	25	2.50	B	Type B-1.0 x	2	
	Sm-2	42	4.20	A	Type A2		
	Sm-3	25	2.50	B	Type B-1.0 x	2	
	Sm-4	82	8.20	A	Type A3		

THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 5.9(1/2)
Location of Sluices and Drainage Area (Iloilo)

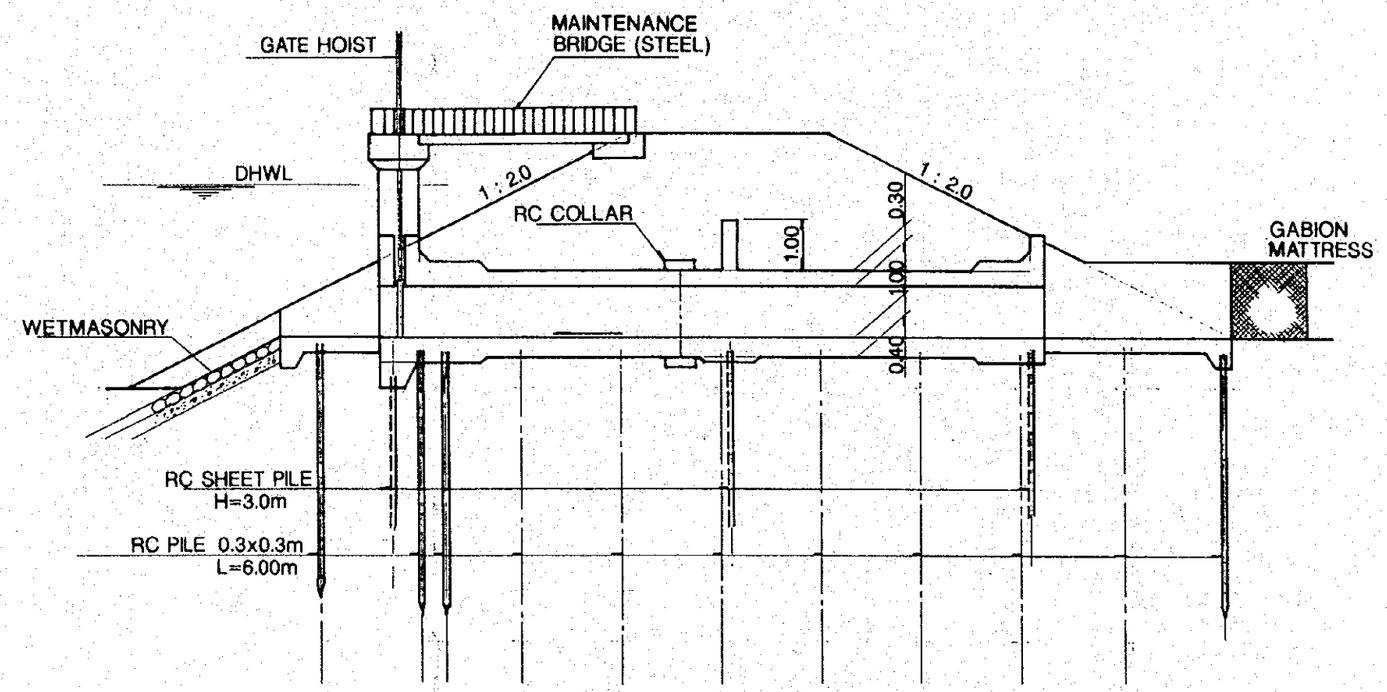


		Area	Discharge	Type	Size		Remarks
Anilao River	Sa-1	38	3.80	A	Type A2		
	Sa-2	6	0.60	B	Type B-0.6		
	Sa-1	38	3.80	A	Type A2		
Malbasag River	Sm-1	3	0.30	B	Type B-0.6		
	Sm-2	3	0.30	B	Type B-0.6		
	Sm-3	1	0.10	B	Type B-0.6		
	Sm-4	4	0.40	B	Type B-0.6		

THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 5.9(2/2)
Location of Sluices and Drainage Area (Ormoc)



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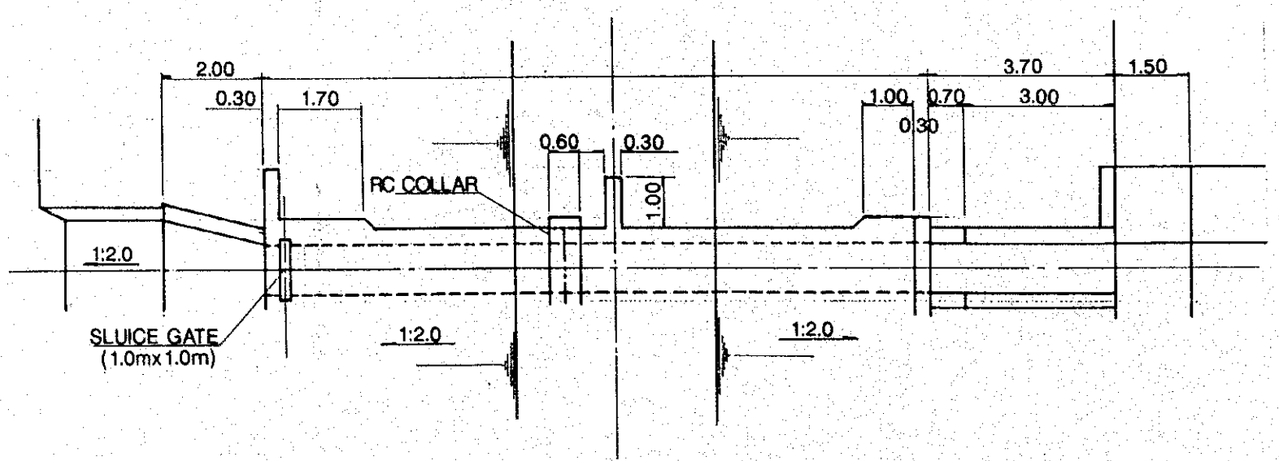
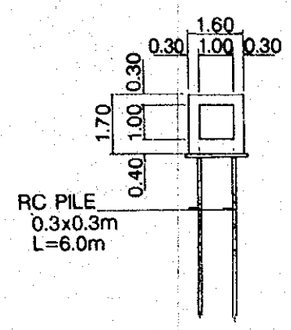
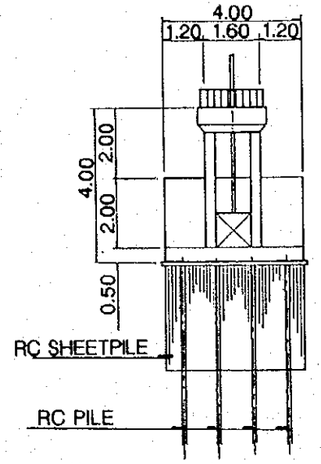


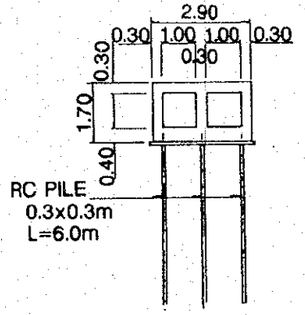
PLAN

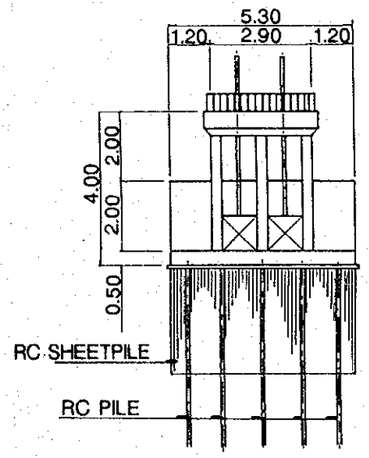
TYPE A1



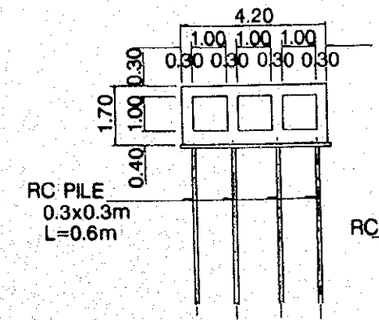


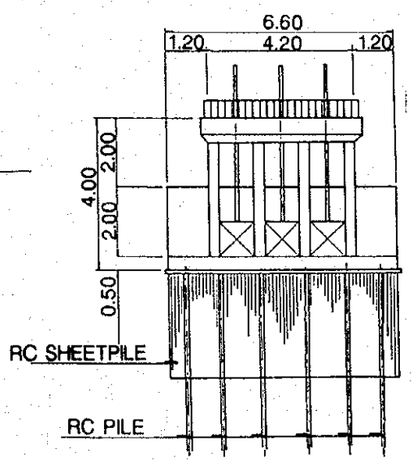
TYPE A2



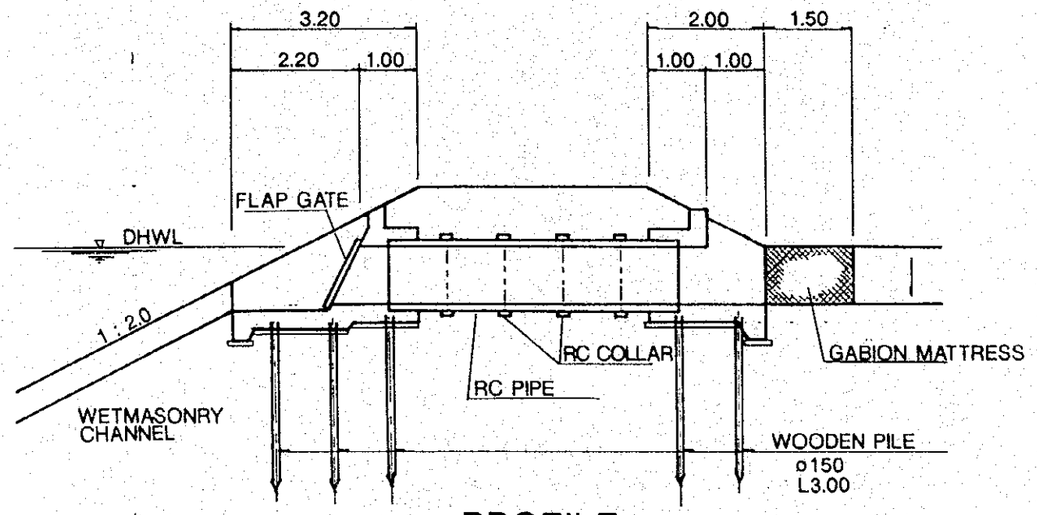


TYPE A3





THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS	Fig. 5.10 Standard Design of Sluice Type A
JAPAN INTERNATIONAL COOPERATION AGENCY	



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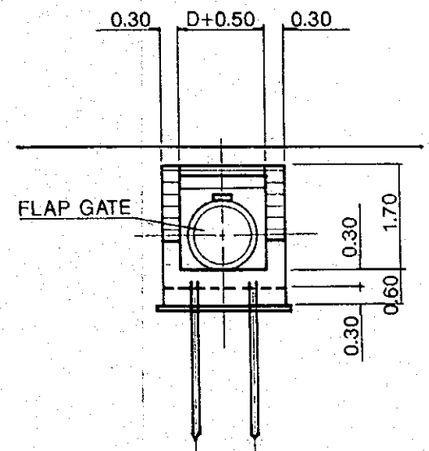
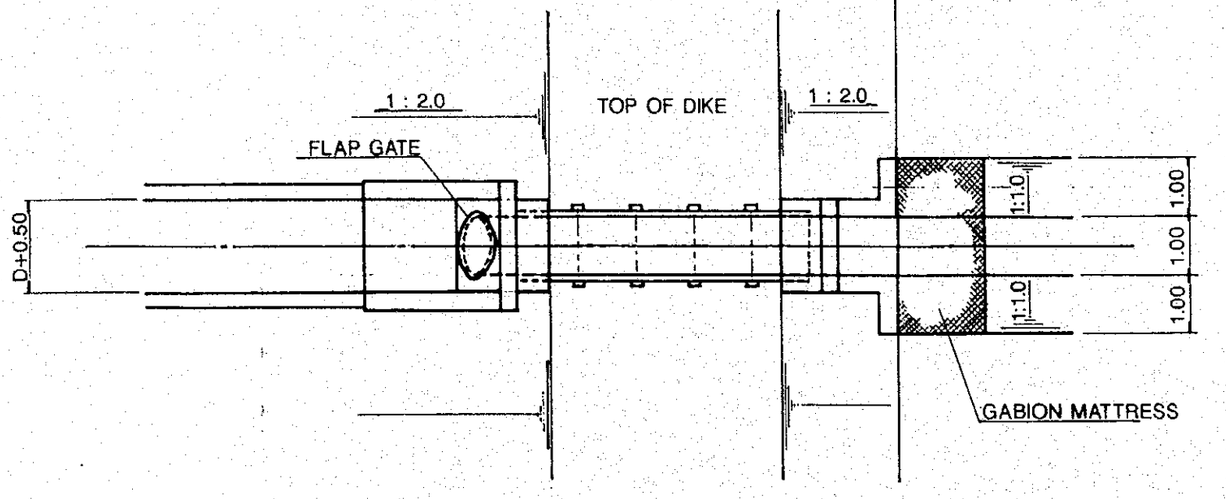


FRONT VIEW



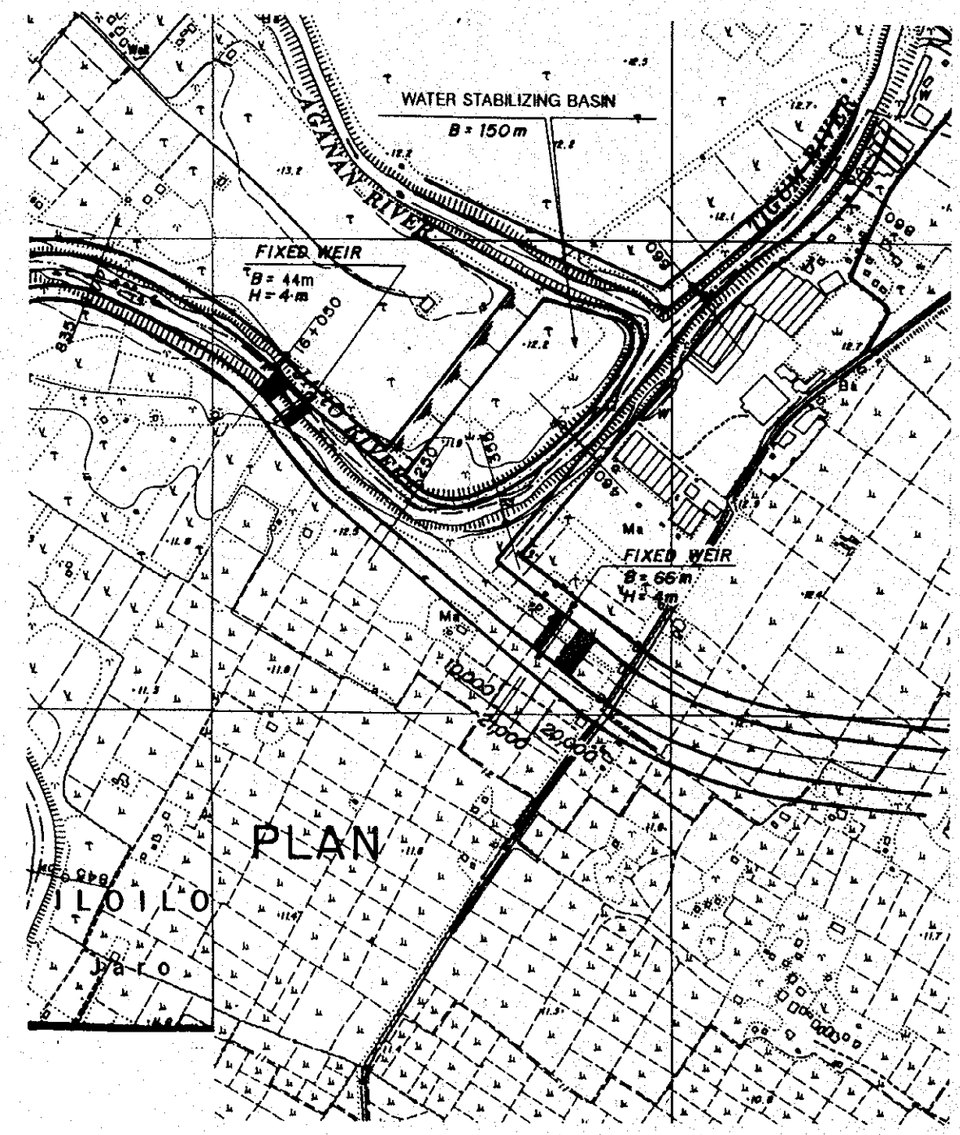
PLAN

		DIAMETER
Type	B0.6	600
Type	B0.8	800
Type	B1.0	1,000

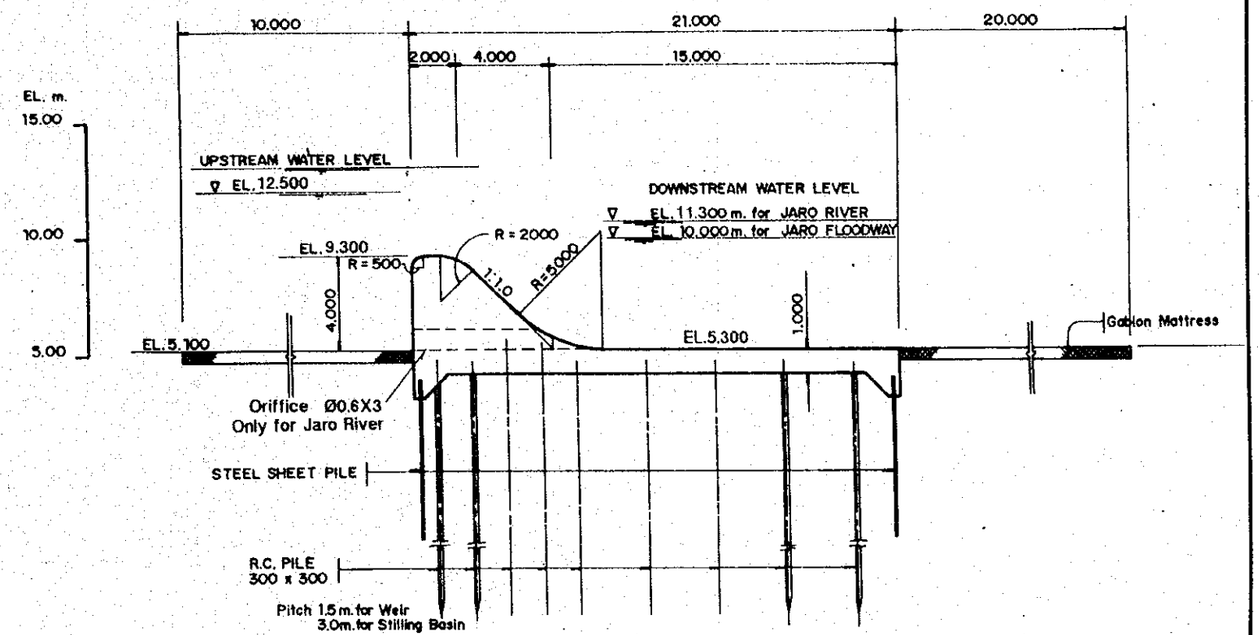
THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS

JAPAN INTERNATIONAL COOPERATION AGENCY

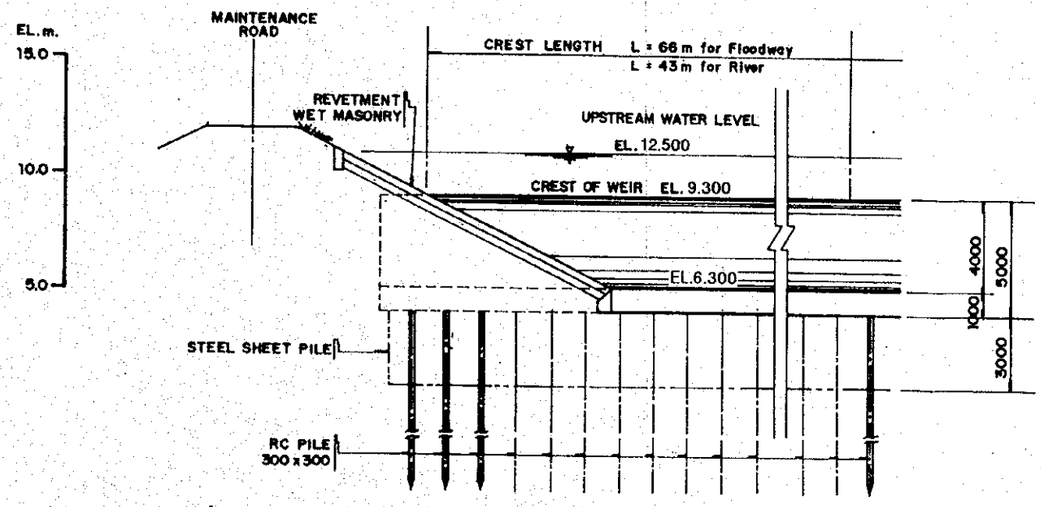
Fig. 5.11
Standard Design of Sluice Type B



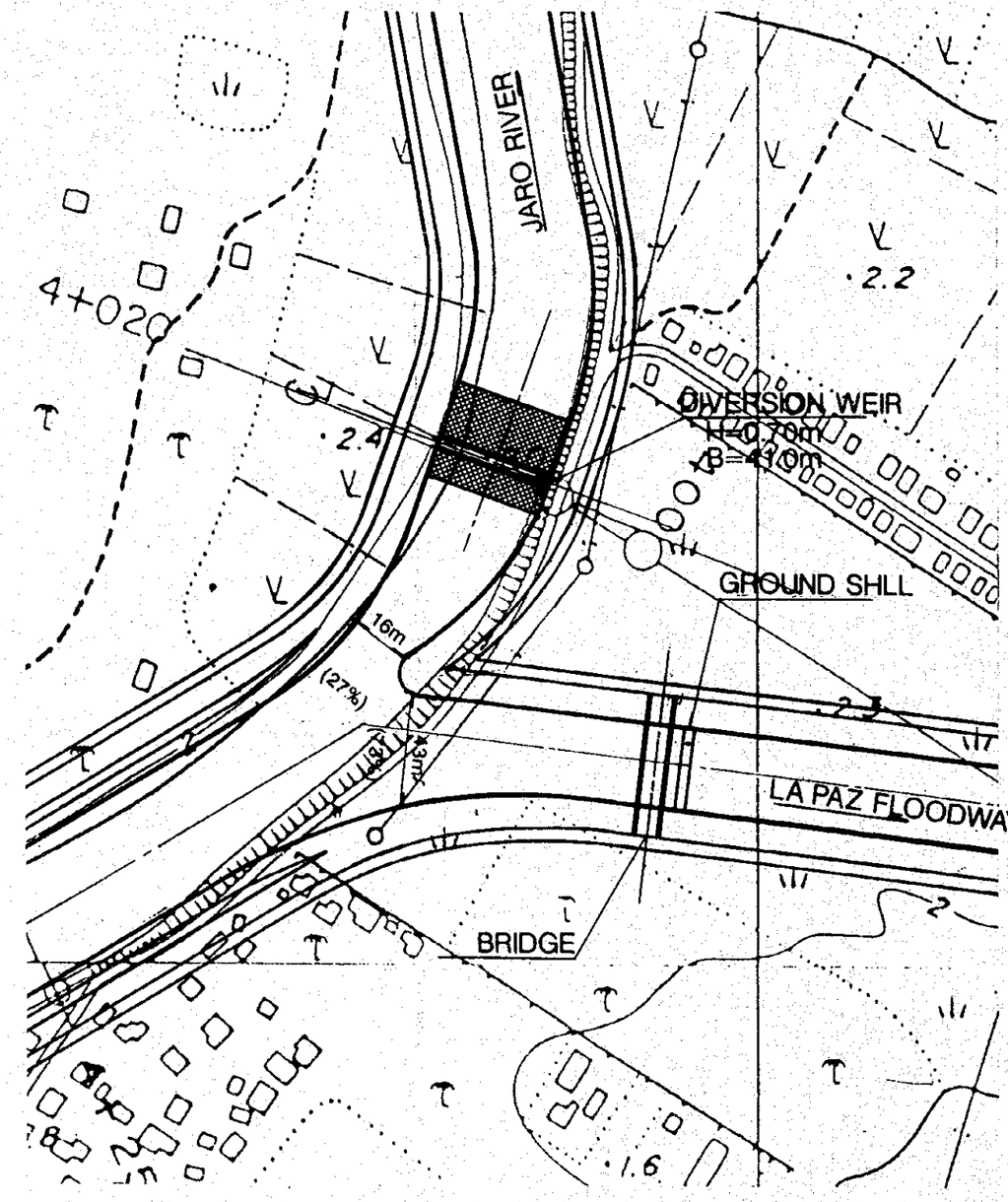
SECTION



FRONT VIEW



THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS	Fig. 5.12
JAPAN INTERNATIONAL COOPERATION AGENCY	Standard Design of Diversion Weirs for Jaro Floodway



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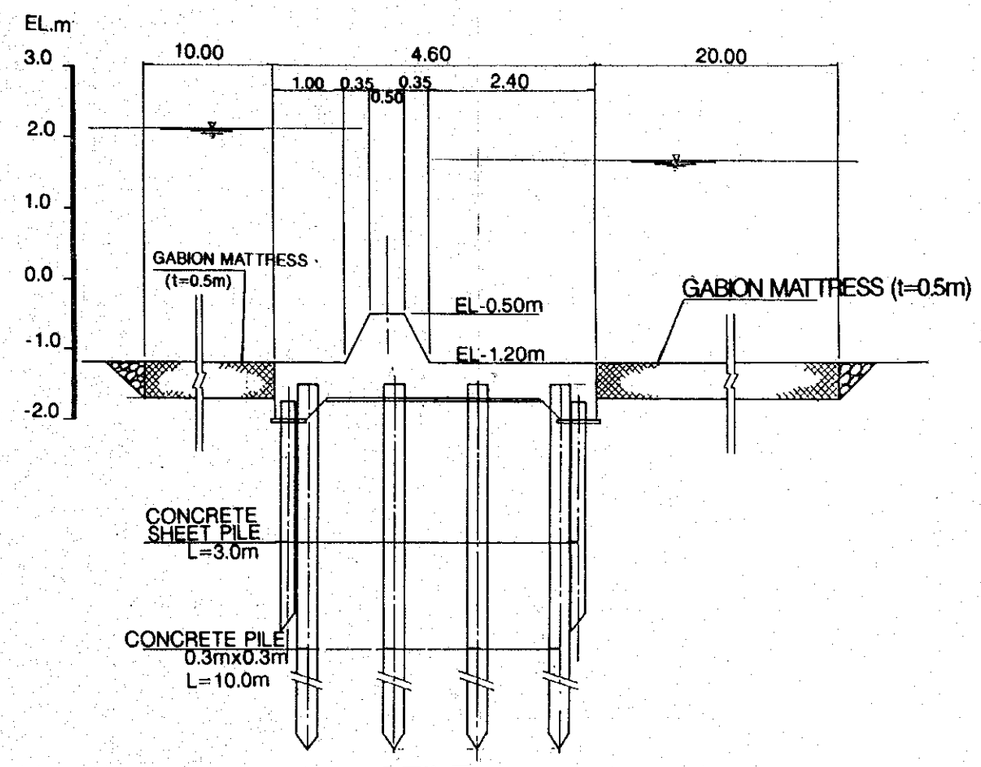

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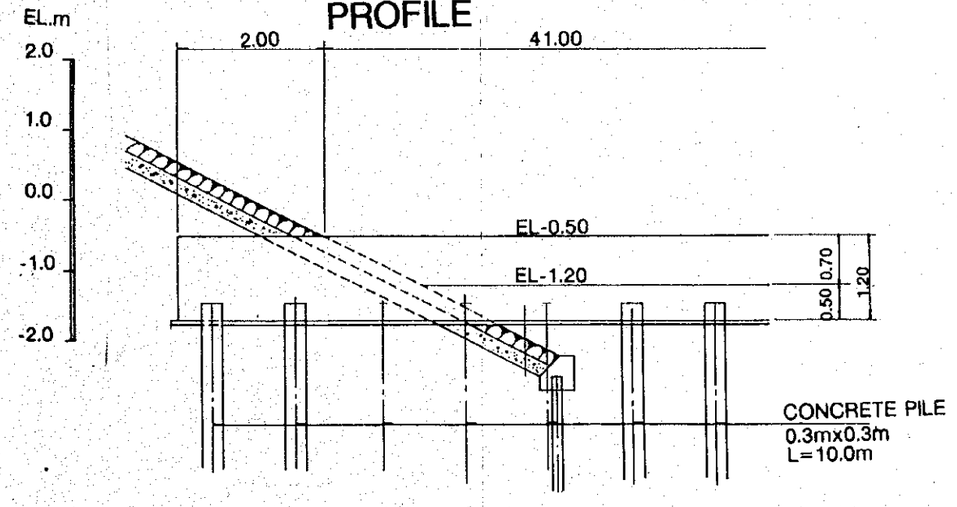
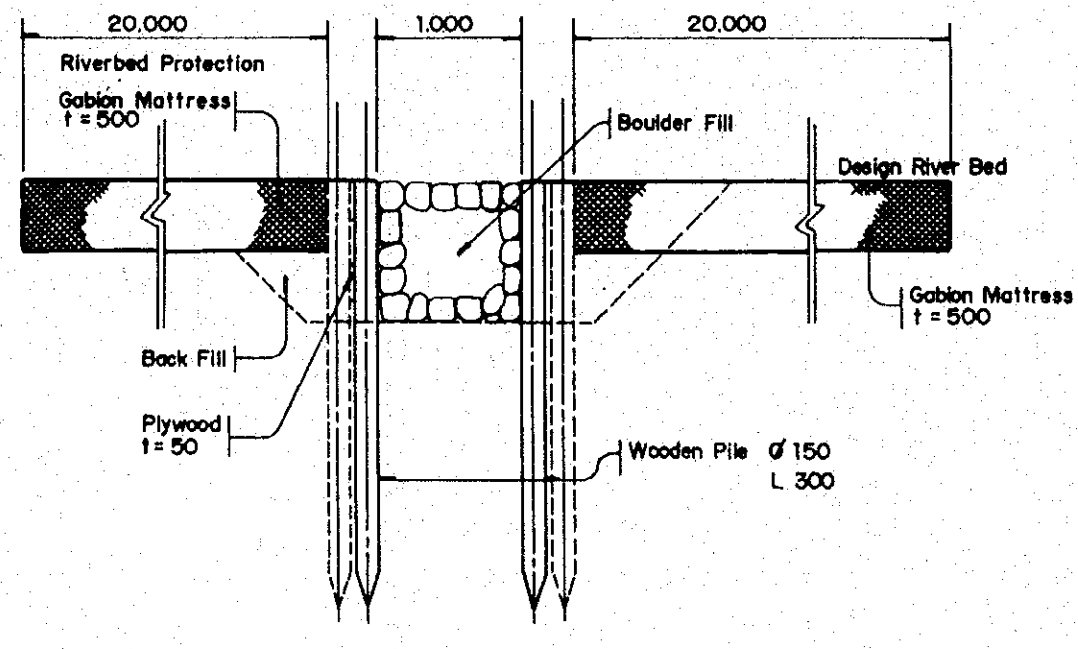


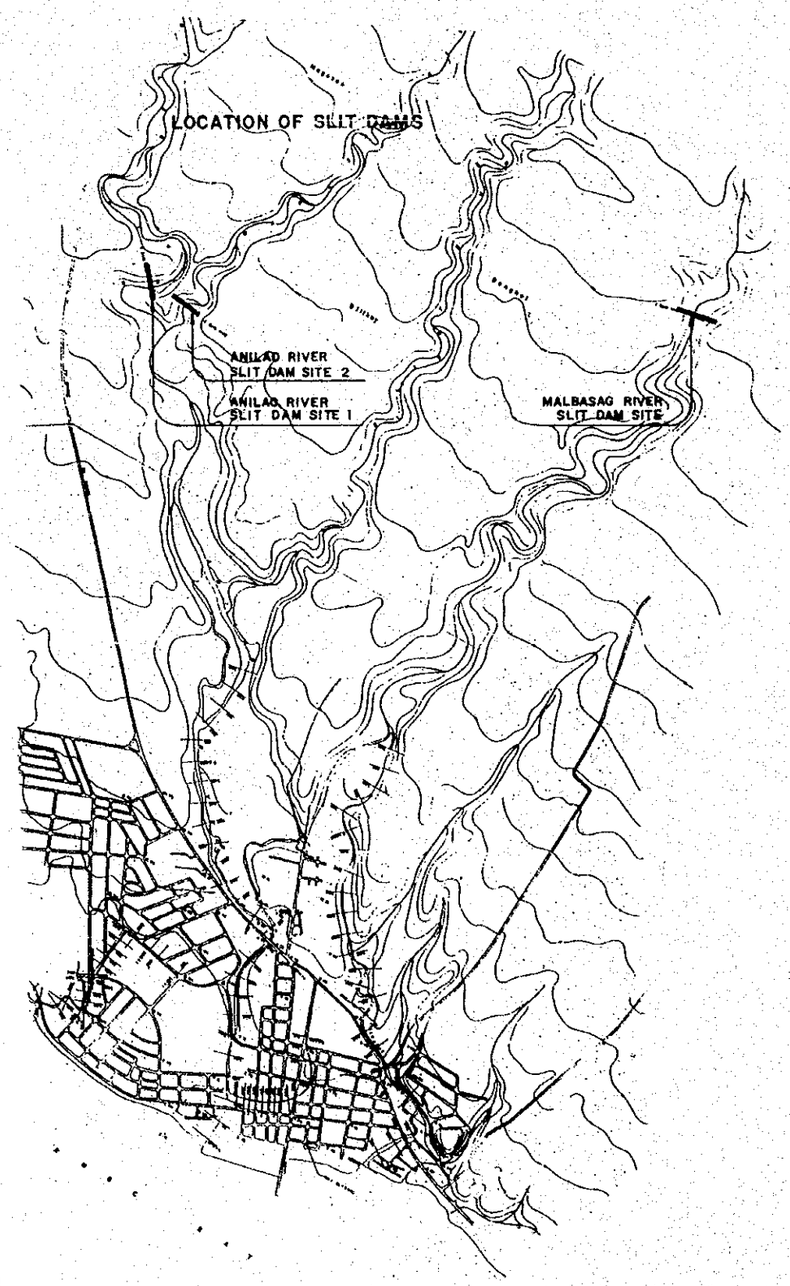
FRONT VIEW

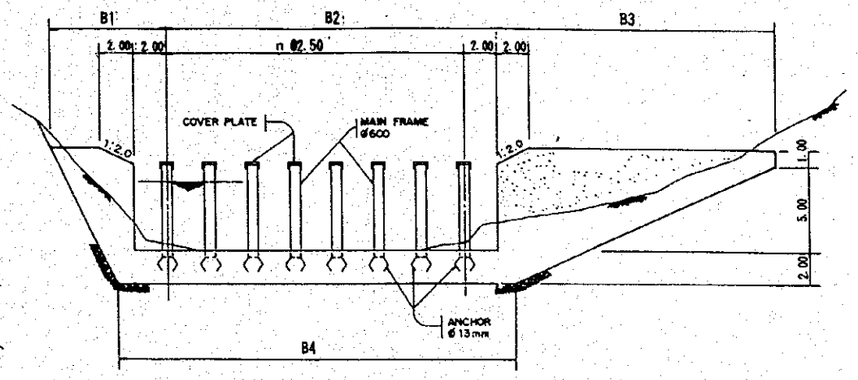
THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 5.13 Standard Design of Diversion Weir for La Paz Floodway



GROUNDSILL FOR FLOODWAY

THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 5.14 Typical Section of Groundsill





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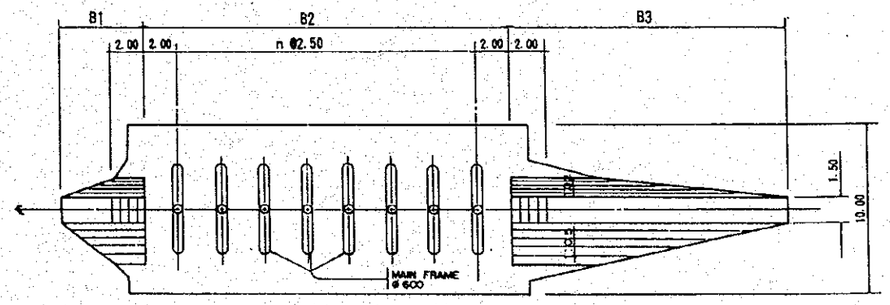

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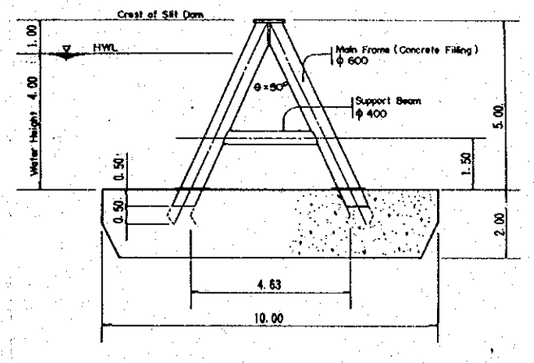


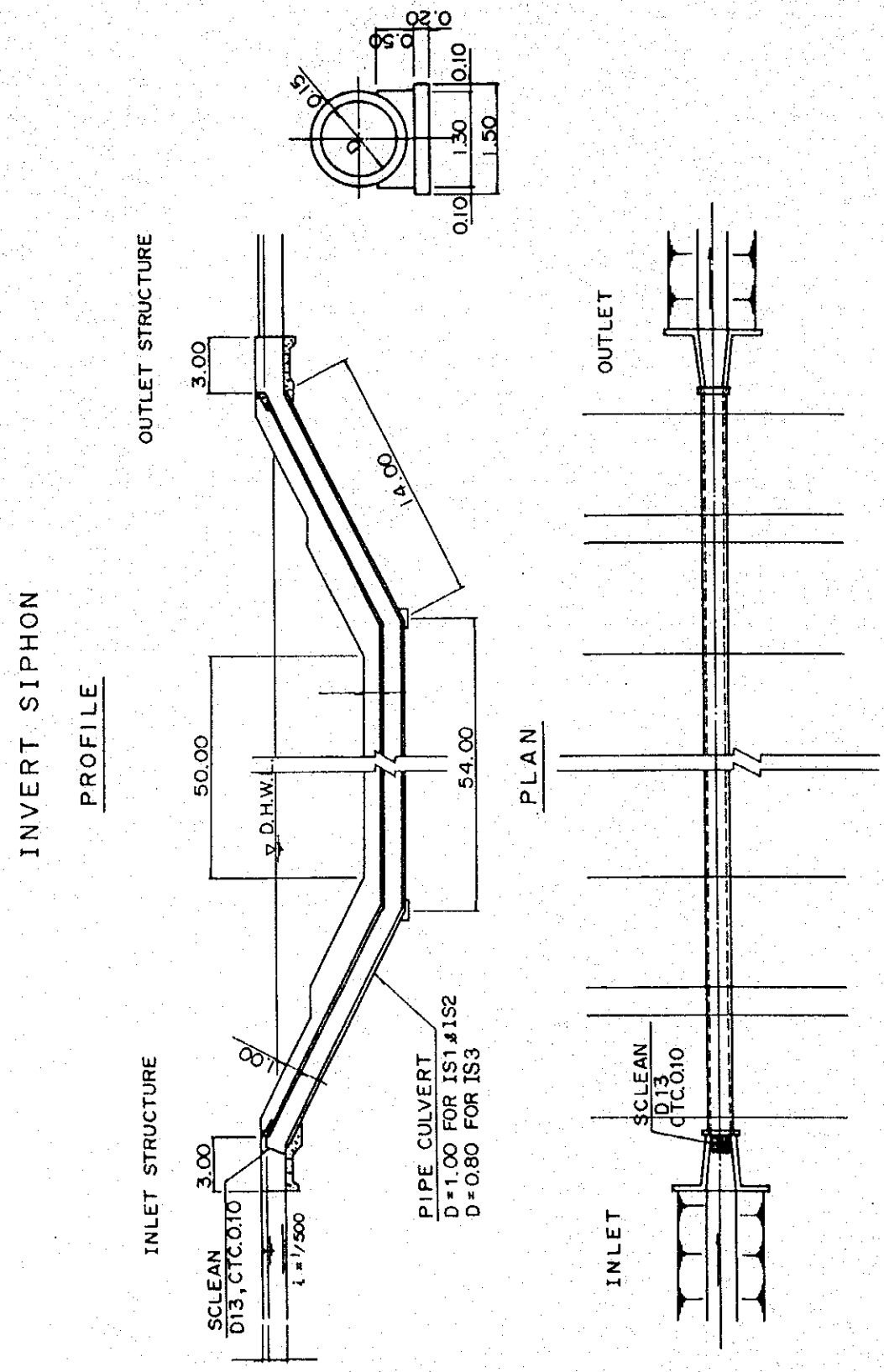
SECTION

DAM SITE	CREST ELEVATION (EL. m)	n (no.)	B1 (m)	B2 (m)	B3 (m)	B4 (m)
ANILAO 1	66.000	7	9.00	19.00	5.00	25.00
ANILAO 2	64.000	5	6.00	14.00	5.00	16.00
MALBASAG	135.500	8	5.00	21.50	16.50	23.00

THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS

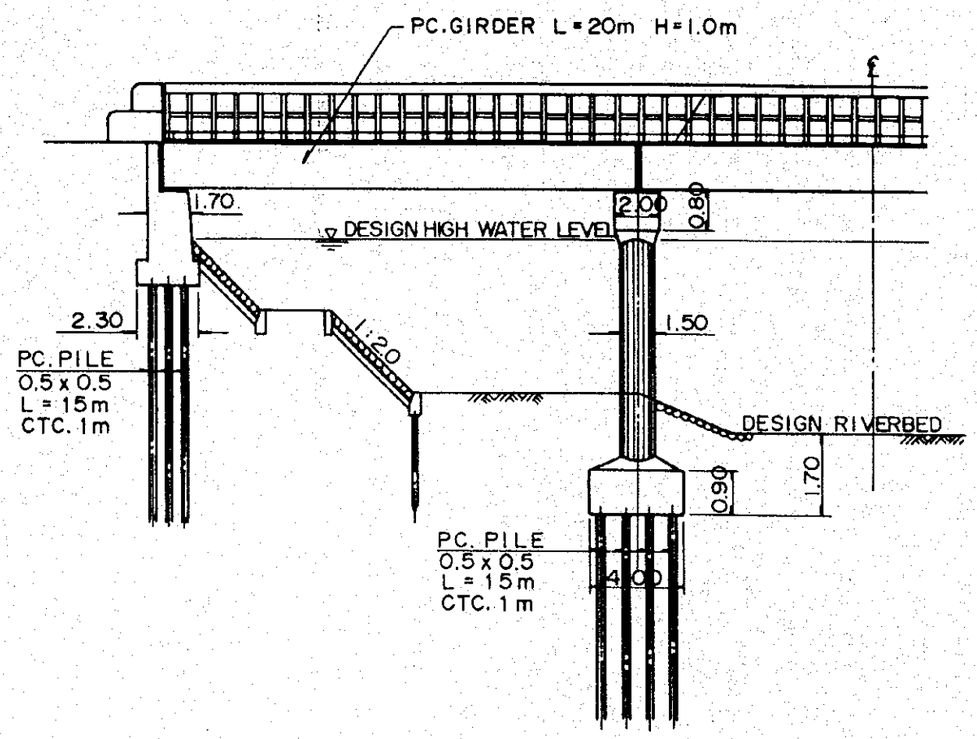
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 5.15
Location and Standard Design of Slit Dams

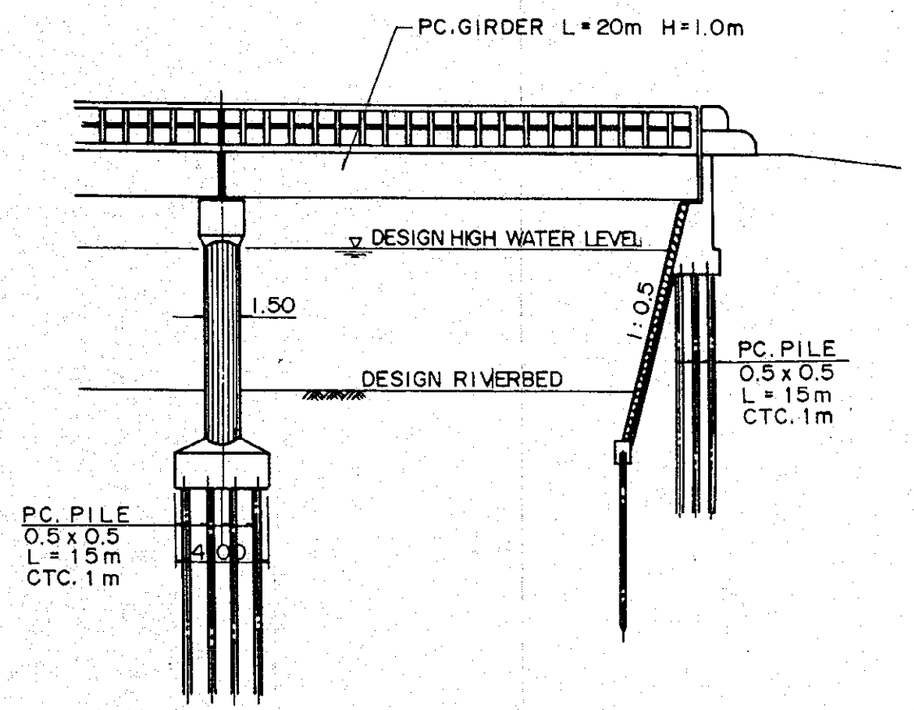


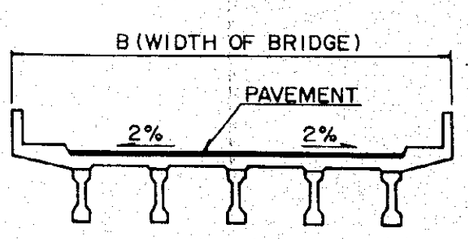
THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS	Fig. 5.16 Standard Design of Invert Siphon
JAPAN INTERNATIONAL COOPERATION AGENCY	

TYPE A : SIDE SLOPE H=1:2.0 V=1:1.0



TYPE B : SIDE SLOPE 1:0.5 H=1:2.0 V=1:1.0





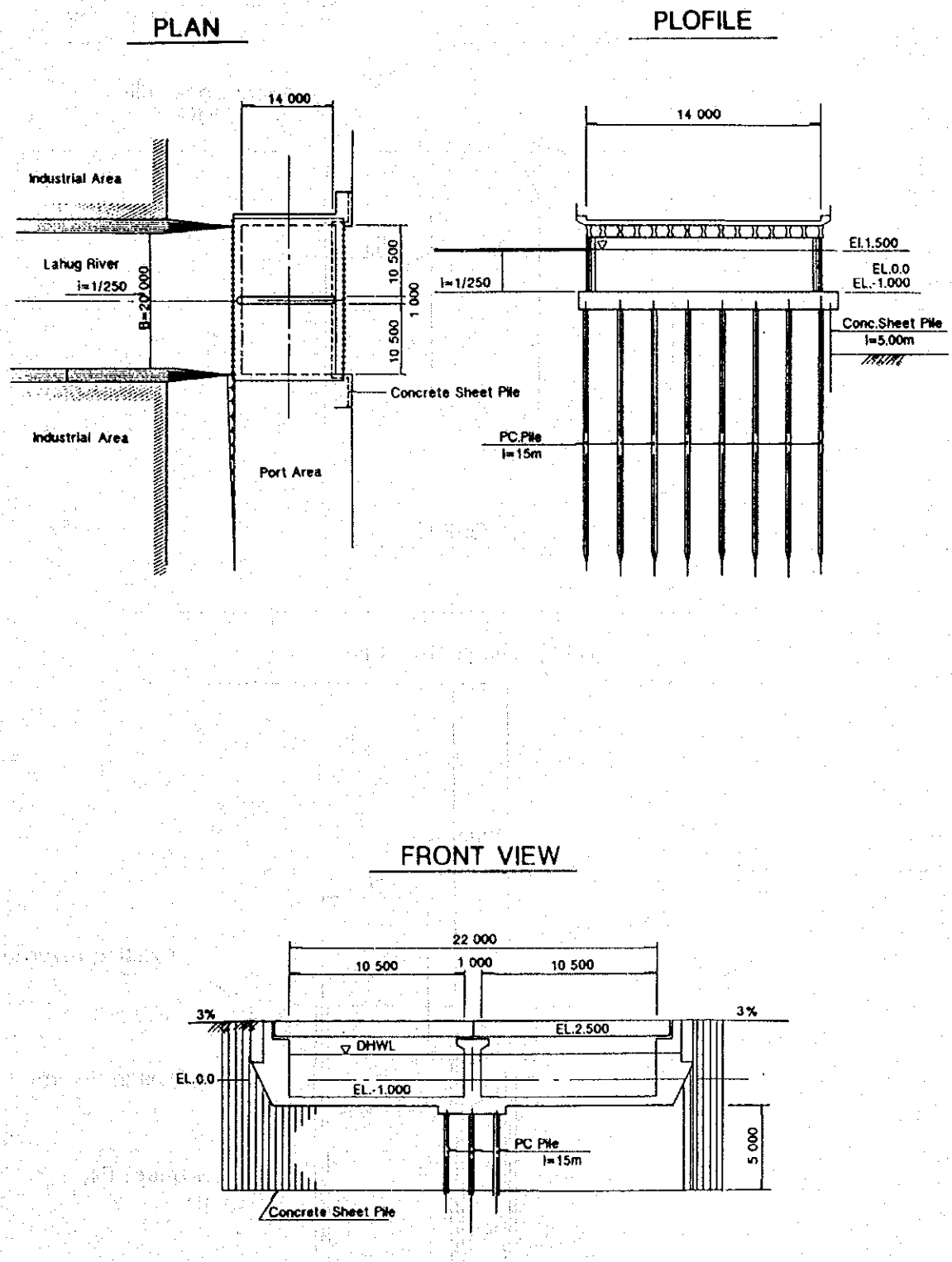
River	Name of Bridge/ Station No.	Length (m)	Width (m)	No. of Span	Type
Jaro	Ticud	60	7.00	3	TYPE A
	Ledesco	60	7.00	3	TYPE A
Jaro FW	STA. 0+300	70	7.00	4	TYPE A
	STA. 2+120	70	7.00	4	TYPE A
	STA. 4+090	70	7.00	4	TYPE A
La Paz FW.	STA. 0+400	70	7.00	4	TYPE A
Iloilo	Molo	110	7.00	6	TYPE A
Mandurriao	Seminer	40	7.00	2	TYPE A
	Street	40	7.00	2	TYPE A
	Sant Rose	40	7.00	2	TYPE A
Bulacao	Inawayan	48	7.00	3	TYPE A
Kinalumsan	STA. 0+300	26	7.00	2	TYPE B
	STA. 0+450	26	7.00	2	TYPE B
	STA. 0+680	26	14.00	2	TYPE B
	STA. 1+200	26	7.00	2	TYPE B
	STA. 1+750	22	7.00	1	TYPE B
	STA. 3+970	22	3.50	1	TYPE B
Guadalupe	STA. 0+420	30	7.00	2	TYPE B
	STA. 0+920	30	7.00	2	TYPE B
	STA. 1+210	32	14.00	2	TYPE B
	STA. 4+000	41	7.00	2	TYPE B

River	Name of Bridge/ Station No.	Length (m)	Width (m)	No. of Span	Type
Lahug	STA. 0+000	21	14.00	1	TYPE B
	STA. 0+110	23	7.00	1	TYPE B
	STA. 0+300	23	14.00	1	TYPE B
	STA. 0+620	23	14.00	1	TYPE B
	STA. 1+040	23	7.00	1	TYPE B
	STA. 1+800	14	7.00	1	TYPE B
	STA. 2+400	14	7.00	1	TYPE B
	STA. 2+560	14	14.00	1	TYPE B
	STA. 2+730	14	14.00	1	TYPE B
	STA. 3+200	23	7.00	1	TYPE B
Subang Daku	STA. 0+150	30	14.00	2	TYPE B
	STA. 1+350	30	14.00	2	TYPE B
	STA. 2+640	32	3.50	2	TYPE B
	STA. 2+688	30	3.50	2	TYPE B
	STA. 3+750	30	3.50	2	TYPE B
	STA. 4+060	32	3.50	2	TYPE B
	STA. 4+720	32	3.50	2	TYPE B
	STA. 4+840	41	14.00	2	TYPE B
Anilao	Alegria	57	7.00	3	TYPE A
	Osmena Ext.	57	7.00	3	TYPE A
	Anilao	57	7.00	3	TYPE A
Malbasag	Malbasag	33	7.00	2	TYPE B
	Spillway	33	7.00	2	TYPE B

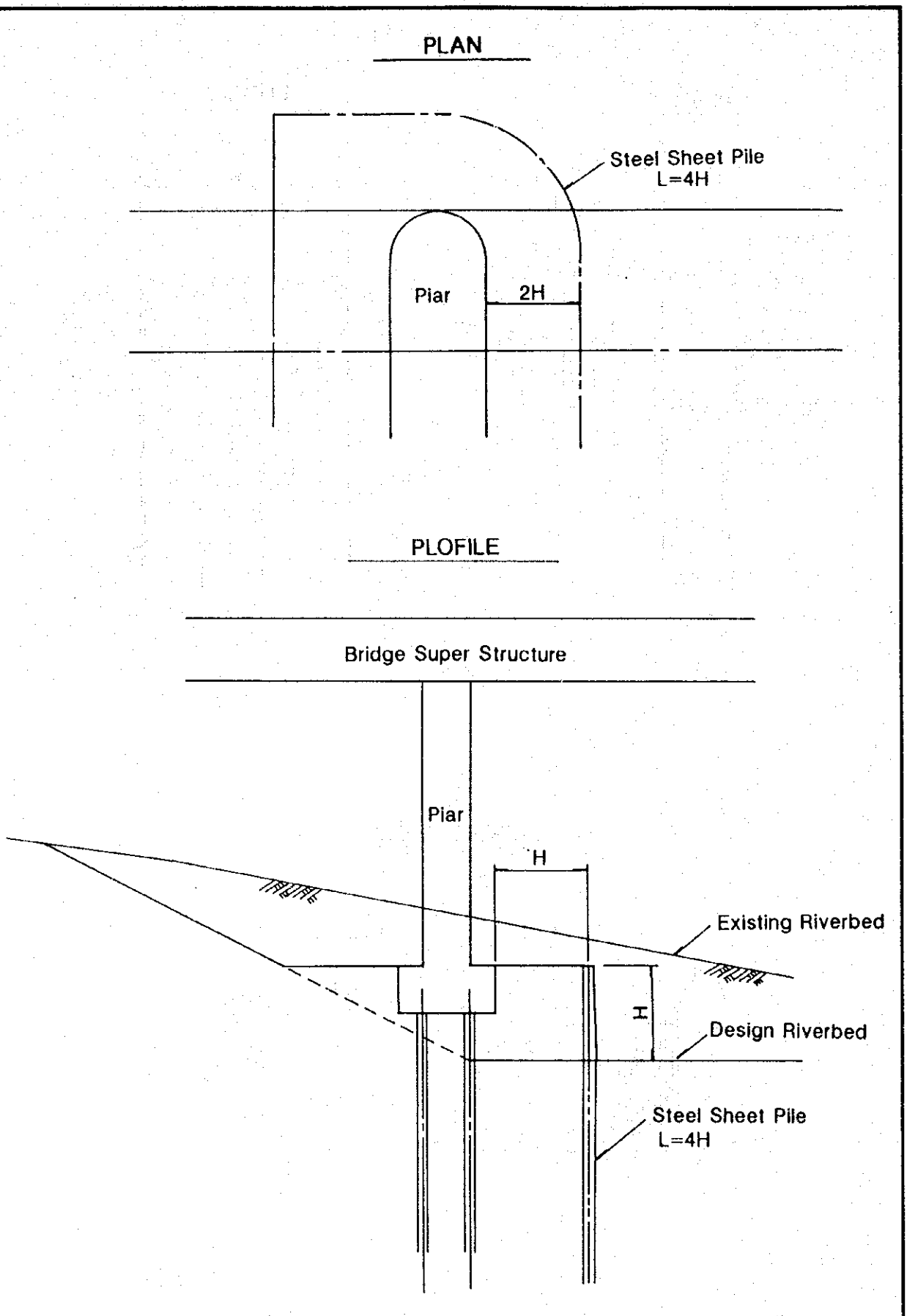
THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 5.17
Standard Design of Bridge



THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 5.18 Bridge at Lahug River Mouth



THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 5.19 Protection Works for Bridge Piers

SUPPORTING REPORT

ON

URBAN DRAINAGE PLAN

SUPPORTING REPORT
ON
URBAN DRAINAGE PLAN

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1. INTRODUCTION

This supporting report presents the results of the study on the drainage improvement in the study areas, with the aim of preparing the Master Plan for four cities: Iloilo, Cebu, Ormoc and Tacloban, and conducting the feasibility study on the urgent projects identified for two cities: Iloilo and Ormoc.

2. EXISTING DRAINAGE SYSTEM

2.1 Iloilo City

Urban areas of Iloilo composed of Iloilo City and the five municipalities of Lapaz, Jaro, Molo, Mandurriao and Arevalo are traversed by two main rivers and their tributaries. These watercourses constitute nine (9) drainage basins and subbasins delineated in Fig. 2.1, as follows:

No.	Drainage Basin	Area (km^2)
SB-1	Ingore Creek	8.02
SB-2	Jaro River Downstream	4.14
SB-3	Alangan Coastal	1.04
SB-4	Bo. Obrero Creek	3.89
SB-5	Rizal Creek	0.50
SB-6	Mandurriao Creek	5.81
SB-7	Iloilo River	12.21
SB-8	South City Proper	1.85
SB-9	Batiano River	3.43
Total		40.89

The stormwater collection and drainage systems have only been constructed in densely urbanized districts of the city proper at the right bank of the Iloilo river estuary, and Jaro-La Paz area between Mandurriao Creek and the Jaro main stream as shown in Fig. 2.2. Existing systems commonly use precast reinforced concrete pipes. The pipe sizes used are 400, 450, 600, 750, 900, 1,050 and 1,200 mm and the interval of manhole approximately ranges from 30 to 50 m. Open ditches are mostly unlined with various sizes and shapes. The following table gives a summary of the existing drainage length of the city core.

(Unit:m)

Primary Drainage Channel	Secondary Drainage				Total Length
	Ditch/Open Channel	RCP <900mm	RCP >1000mm	Box Culvert	
17,000	12,000	26,000	900	few	55,900

Since the drainage pipes have been installed several decades ago, functional damages are found in many places, even complete blockade due to sedimentation of soil or garbage and structural collapse. Consequently, a storm inundation frequently occurs even with normal rainfall. The drainage system, furthermore, performs the combined functions of sewage and stormwater collection.

Areas adjoining the city proper and Jaro-La Paz, which are Molo, Arevalo, Mandurriao, La Paz (coastal area) and Jaro (left bank area of Jaro River), have been considerably urbanized in recent years. However, the development of the drainage system has not coped with the urbanization. Although some villages and subdivisions have been provided with small scale drainage systems, they have been partially developed on a piecemeal basis without a comprehensive plan for the entire drainage area. Therefore, the stormwater in the areas drains to the nearest recipients depending on the ground surface runoff and/or are retained in depression ponds, etc.

In addition to the confined drainage system, the major drainage problem in the urban area is an inadequate drainage capacity of primary channels. The following table shows the flow capacities of three (3) primary channels lying in the serious inundation areas, and Table 2.1 and Fig. 2.3 show hydraulic features of the primary channels.

No.	Primary Channel	Drainage Area (km^2)	Drainage Capacity (m^3/s)	
			Range	Average
1.	Ingore Creek	8.02	2 - 70	15
2.	Bo. Obrero Creek			
	- Downstream	3.89	10 - 90	30
	- Upstream	1.20	1 - 3	1
3.	Rizal Creek	0.50	4 - 230	4

2.2 Cebu City

The urban area of Cebu is traversed by five (5) rivers, several creeks and drainage mains. These waterways constitute the basis for the formation of some 20 hydrologically independent drainage basins and subbasins. The independent drainage basins are delineated in Fig. 2.4, as follows:

No.	Drainage Basin	Area (km^2)
SB-1	Subang Daku River	4.85
SB-2	Mabolo Creek	2.78
SB-3	Lahug Tributary	0.65
SB-4	Lahug River Downstream	4.06
SB-5	Tinago Creek	1.10
SB-6	Central Proper	0.34
SB-7	Pahina Central-Kalubihan	1.00
SB-8	Guadalupe River Downstream	3.34
SB-9	Calamba	0.79
SB-10	Sta. Teresita Village	3.80
SB-11	Buhisan River	1.70
SB-12	Kinalumsan River Downstream	4.82
SB-13	Barangay Mambaling	0.30
SB-14	Basak-San Nicolas	0.67
SB-15	Basak-Pardo	0.90
SB-16	Basak Coastal	0.43
SB-17	Sto. Niño Creek	5.11
SB-18	Kinasang-an Creek	0.36
SB-19	Barangay Inayawan	1.29
SB-20	Bulacao River	3.13
Total		41.42

The existing urban stormwater drainage systems including collection facilities of inlet and gutter are found only in densely populated districts of the city, which are bounded approximately on the north by Subang Daku River, on the south by Kinalumsan River and confined within 2 to 4 km wide from the coastline as shown in Fig. 2.5. The rest of the districts is defined as natural drainage areas where the storm runoff depends largely on overland flow to the nearest river and sea, natural detention in depression areas, ground

infiltration and/or evaporation, except in some subdivisions and villages where collection and drainage systems have been developed.

The existing collection and drainage systems serving the combined functions of sewage and stormwater collection were constructed on the basis of the Drainage Master Plan in 1950. Precast reinforced concrete pipe is commonly used for the facilities with the typical pipe sizes of 450, 600, 750, 900, and 1,800 mm. The interval of manhole ranges from 25 to 50 m. Lengths of the primary and secondary drainage including parts of the five rivers within the urban drainage area are estimated, as shown below.

(Unit: m)

Primary Drainage Channel	Secondary Drainage				Total Length
	Ditch/Open Channel	RCP <900mm	RCP >1000mm	RC Box Culvert	
9,800	11,100	55,000	7,000	a few	82,900

Source: DPWH Region VII District Office

One of the significant causes to urban drainage problems is the inadequate drainage capacity of primary channel, as well as the confined service area of the drainage system. The drainage capacity of primary channels lying in the serious inundation areas are evaluated as shown below, and Table 2.2 and Fig. 2.6 show hydraulic features of the primary channels.

Item No.	Primary Channel/Drain	Drainage Area (km^2)	Drainage Capacity (m^3/s)	
			Range	Average
1.	Mabolo	2.78	2 - 40	8
2.	Lahug Tributary	0.65	1 - 50	9
3.	Tinago	1.10	1 - 26	4
4.	Pahina Central - Kalunbihan	1.00	1 - 7	6
5.	Calamba	0.79	2 - 3	2
6.	Sta. Teresita Village	3.80	2 - 3	3
7.	Basak - San Nicolas	0.67	1 - 2	1
8.	Sto, Niño	5.11	1 - 10	2
9.	Barangay Inayawan	1.29	2 - 4	4

2.3 Ormoc City

The urban area of Ormoc is divided into two; the city proper of 0.93 km^2 surrounded by Anilao River, Malbasag River, Hermosila Drive Street and the coastal line, and the new residential area of 2.68 km^2 adjoining the city proper, as shown in Fig. 2.7.

The city proper is densely urbanized being the commercial and residential center of Ormoc City and the urban stormwater collection and drainage systems are well developed. The existing system is hydrologically divided into four drainage basins within the city proper, which drain independently to the sea or the rivers.

No.	Urban Drainage Basin	Area (km^2)
City Proper Area		
SB-1	South City Proper	0.21
SB-2	North City Proper	0.32
SB-3	Anilao River Downstream	0.19
SB-4	Malbasag River Downstream	0.21
New Residential Area		
SB-5	Anilao River Upstream	0.70
SB-6	Malbasag River Upstream	0.43
SB-7	Lotao Creek	1.03
SB-8	Barangay Punta	0.52
Total		3.61

Existing systems were constructed on the basis of the Drainage Improvement Plan prepared by the City Engineering Office. Various types of drainage facilities such as RC-U-type with cover, RC-pipe, open channel, RC-box culvert are adopted for the systems. The following table shows lengths of the existing drainage systems in the city proper, and Fig. 2.8 shows coverage of the systems.

(Unit: m)

Primary Channel	Open Ditch	PC-Pipe	RC-U Type	RC-Box Culvert	Total
1,200	6,000	7,000	2,300	a few	16,500

During the flood caused by Typhoon Uring in November 1991, some drainage facilities were damaged and clogged due to sand and silt brought by the flood. Although some rehabilitation works were carried out, several places in the city core area will have stormwater inundation by downpour during the rainy season.

The new residential area is divided into four drainage areas which drain directly to Malbasag River, Anilao River, Lotao Creek and Ormoc Bay. These areas have been rapidly developing in recent years, however, the construction of the stormwater drainage system is not coping with the development and has not yet been completed. Even though unlined open drainage channels and ditches are provided along the district roads, these are frequently intermittent and lack of discharge capacity, especially at the culvert openings under the road. Furthermore, in Brgy. Punta located in the coastal drainage area, there is no proper drainage outlet.

To assess the existing drainage systems, the discharge capacities of the Lotao and City Proper creeks functioning as primary drainage channels in the urban area is calculated as shown below, and Table 2.3 and Fig. 2.9 show hydraulic features of the primary channels.

Item No.	Primary Drainage Channel	Drainage Area (km^2)	Drainage Capacity (m^3/s)	
			Range	Average
1.	Lotao Creek			
	- Downstream	1.03	1 - 10	10
	- Upstream	0.44	0.5 - 1	1
2.	City Proper Creek	0.32	1 - 18	4

2.4 Tacloban City

The drainage area of Tacloban City covering 22.95 km^2 in total is divided into ten (10) hydrologically independent drainage areas where stormwaters are drained directly to the sea through traversing rivers, primary drainage channels, and mains. The independent drainage areas are delineated in Fig. 2.10 and indicated as follows:

No.	Drainage Basin	Area (km^2)
SB-1	Abucay River	2.38
SB-2	Naga-Naga Creek	1.21
SB-3	Naga-Naga Coastal	0.31
SB-4	Mangonbangon River	5.12
SB-5	City Proper	1.26
SB-6	Langhas-Lirang Creek	4.38
SB-7	Sagkahan Creek	0.14
SB-8	Pleasantville Creek	1.25
SB-9	Burayan Tributary	1.41
SB-10	Burayan River	5.49
Total		22.95

The existing urban stormwater collection and drainage system is found only in the most densely built-up area being the city commercial center which is bounded on the West by Mangonbangon river and on the south by the Langhas-Lirang Creek, as shown in Fig. 2.11. The rest of the urban area depends largely on natural overland drain to the nearest recipients of the watercourses and the sea.

The existing pipe drainage systems in the city proper were constructed in 1975 based on the drainage master plan in 1954 by the City Engineering Office. The total length of drainage pipe is nearly 5.3 km and open channel is 2.4 km. Reinforced concrete pipes ranging in size from 400 mm to 1,400 mm and open channels are commonly used as drainage systems.

Due to inadequate drainage capacity as well as the confined coverage of the drainage system, the urban area suffers from frequent inundation. As shown in the table below, the drainage capacities of primary channels, where five (5) major inundation areas are located, are obviously small compared to the expected design discharges. Table 2.4 and Fig. 2.12 show hydraulic features of the primary channels.

No.	Primary Drainage Channel	Drainage Area (km^2)	Drainage Capacity (m^3/s)	
			Range	Average
1.	Naga-Naga Creek	1.21	1 - 4	2
2.	Langhas-Lirang Creek	4.38	1 - 9	3
3.	Pleasantwille Creek	1.25	1 - 10	1
4.	Sagkahan Creek	0.14	0.4 - 10	1
5.	Burayan Tributary	1.41	0.1 - 2	2

To solve inundation problems, the Tacloban City Drainage Master Plan prepared in 1987 proposed the improvement of the watercourses and construction of drainage mains. Due to budgetary constraints, however, only some drainage pipe improvement works were implemented up to present.

3. DRAINAGE INUNDATION PROBLEMS

3.1 Iloilo City

The flood-prone areas in the urban area of Iloilo City experience regular inundation brought about by the inadequate drainage systems. The DPWH District Engineering Office has identified the habitual inundation areas at some 11 places with 100 ha in total area as shown in Table 3.1 and Fig. 3.1. The major inundation areas and conditions are listed as follows:

Location of Inundation	Inundation Condition			
	Area (ha)	Depth (m)	Duration (hours)	Frequency (times/yr)
(1) City Proper-Molo (5 places)	53.8	0.1 - 0.3	1 - 2	3 - 5
(2) Jaro-Lapaz (4 places)	18.6	0.2 - 0.3	2	5
(3) Ingore Creek Upstream (2 places)	42.4	0.3 - 1.0	2 - 12	2
Total	114.8	-	-	-

(1) City Proper Inundation Area

The area is fully urbanized, and has a well-developed stormwater collection and drainage system. However, frequent inundations still occur in various places, i.e., Gen. Hughes Street, J.M. Basa Street, Rizal Street, De Leon Street, Fuentes Street, Gen. Juan Luna Street, Timawa Avenue, etc. Major causes of these problems are various degrees of structural damage and clogging of underground facilities brought about by unconventional production and constructional practices. This was substantiated during site reconnaissance by inspecting the water levels in the manholes on a drainage line, i.e., completely clogged condition was evident from an upstream manhole filled with water while an adjacent downstream manhole had no water at all. In addition, tide effects reduce drainage capacity in many parts of the city proper.

(2) Jaro-La Paz Inundation Area

The area is situated between the Dugon Creek and Jaro main stream. Inundation is most severe at Samuel Area, Commission Civil Street and Huervana Street. The side channel flow along the streets is obstructed by heavy sedimentation and encroachment of private passages, especially at Lopez Jaena Street in Samuel Area, where open drainage channels are constructed.

Inundations along Commission Civil St. and Burgos St. are caused by the long outlet to Bo. Obrero Creek. The railway was closed in 1980's, and Bo. Obrero Creek was then connected to Burgos Street along the north side of the railway. At present, the upstream stretch of Bo. Obrero Creek between Arroyo and J. Avel streets are filled with soil and garbage and the stormwater is diverted by extending the drainage pipeline with a limited capacity through Arroyo Street to the creek.

In the inundation area along Huervana Street adjoining the La Paz Public Market, there are two primary drainage channels: Rizal Creek draining to Iloilo River and Bo. Obrero Creek to the Iloilo Strait. Due to the sedimentation and wastes, encroachment of squatter's shanties and private passages, frequent inundations