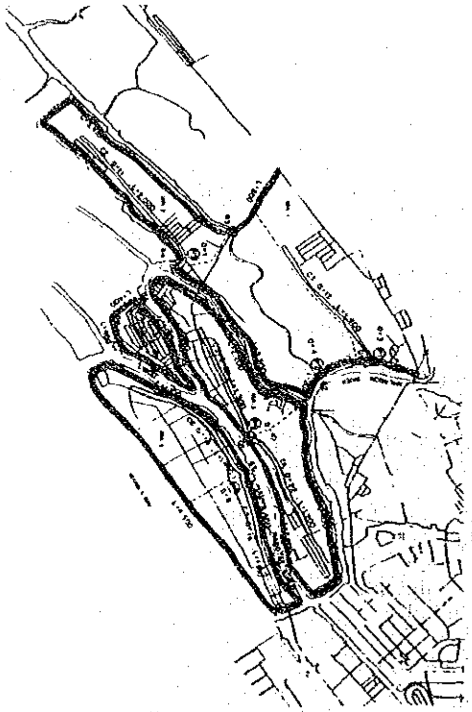
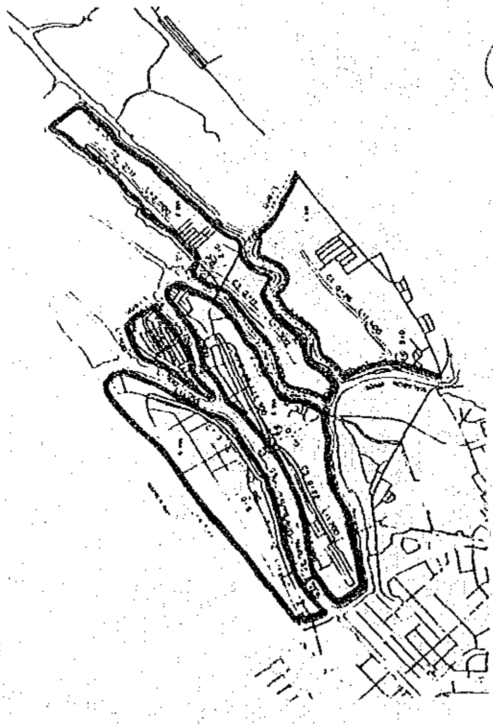
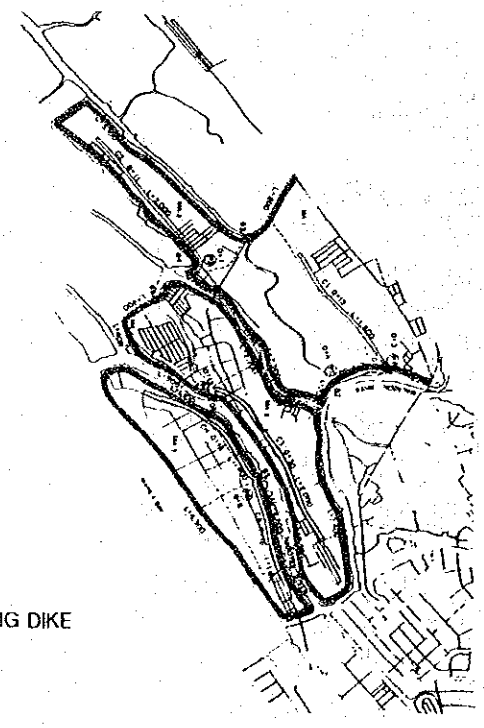


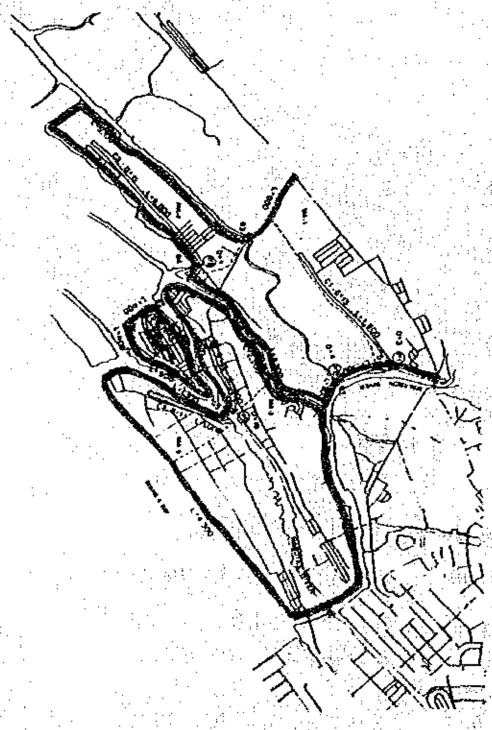
ALTERNATIVE CASE 1



ALTERNATIVE CASE 2



ALTERNATIVE CASE 3



ALTERNATIVE CASE 4

LEGEND

—— : RING DIKE

SCALE

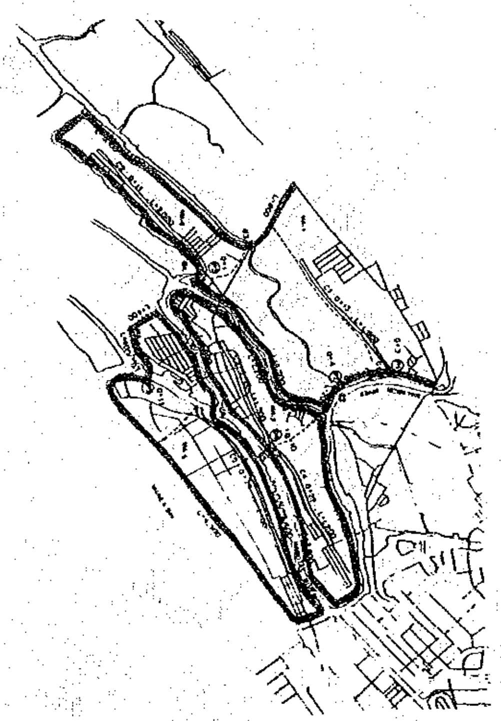
0 1 2 3 km

THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES

JAPAN INTERNATIONAL COOPERATION AGENCY

ALTERNATIVE DRAINAGE SYSTEMS FOR NORTH BANK OF MALABON RIVER

Fig.5-5-10(1/5)



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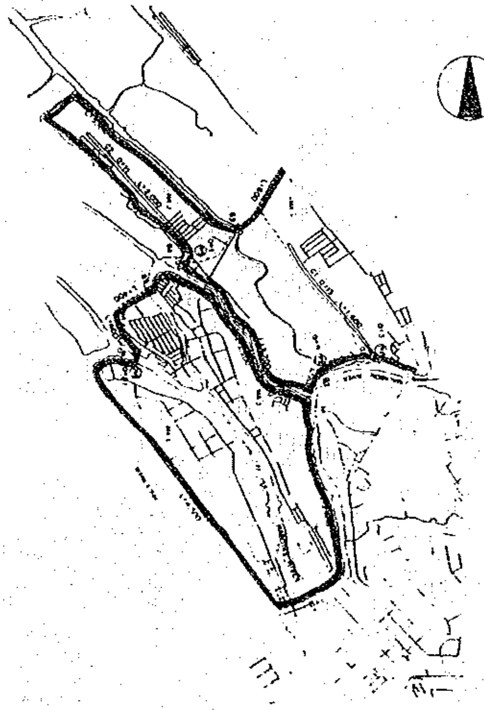

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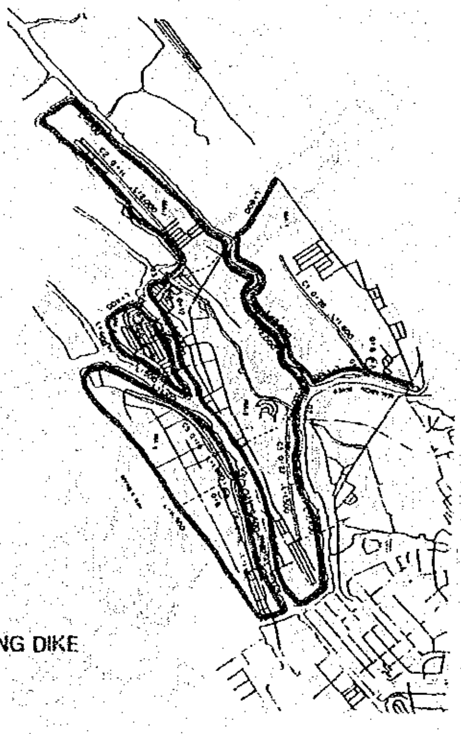
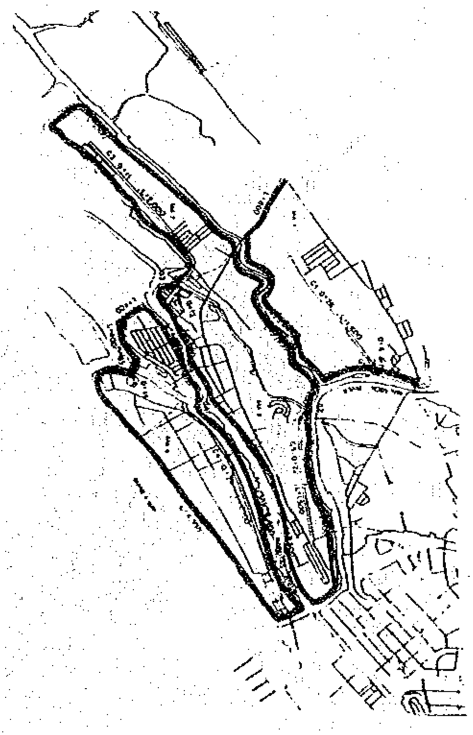


ALTERNATIVE CASE 7



ALTERNATIVE CASE 8

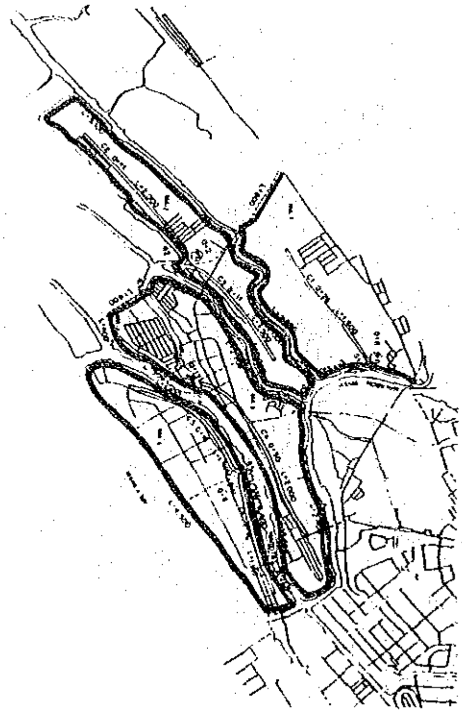
LEGEND

——— : RING DIKE

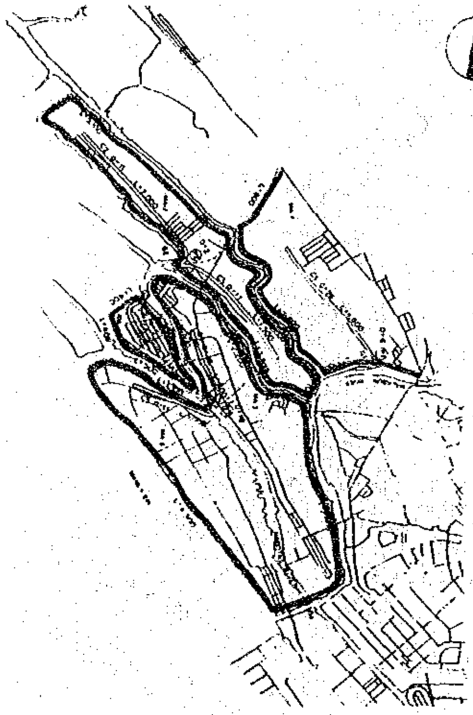
SCALE

0 1 2 3 km

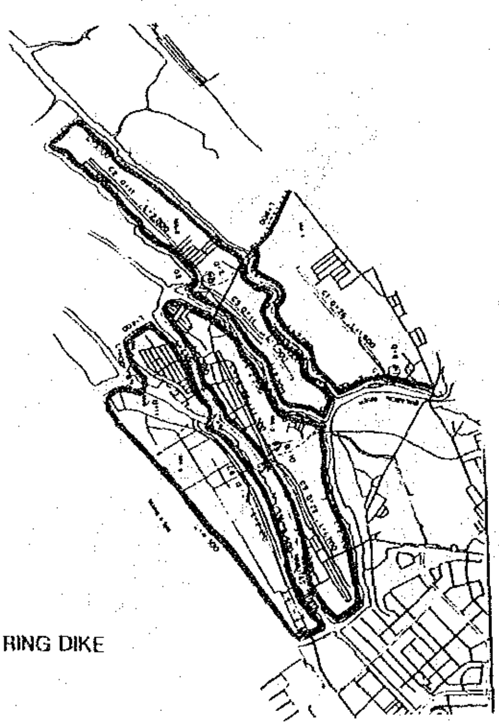
THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES	ALTERNATIVE DRAINAGE SYSTEMS FOR NORTH BANK OF MALABON RIVER
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig.5-5-10(2/5)



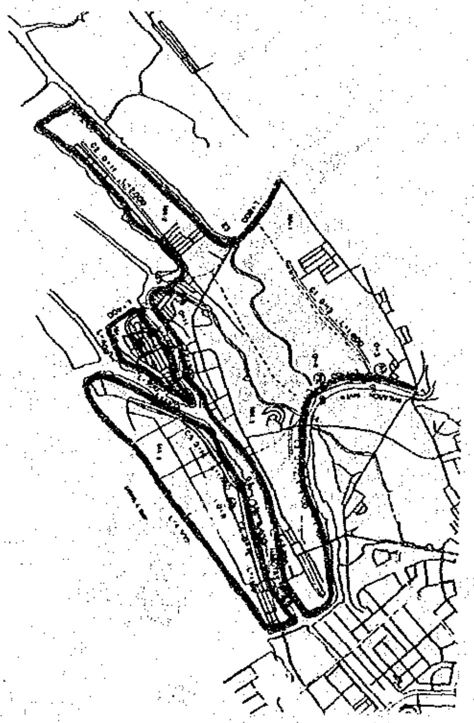
ALTERNATIVE CASE 9



ALTERNATIVE CASE 10



ALTERNATIVE CASE 11



ALTERNATIVE CASE 12

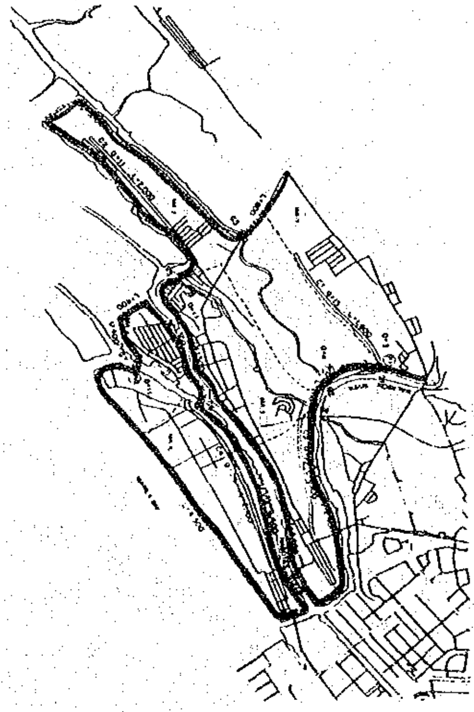
LEGEND

——— : RING DIKE

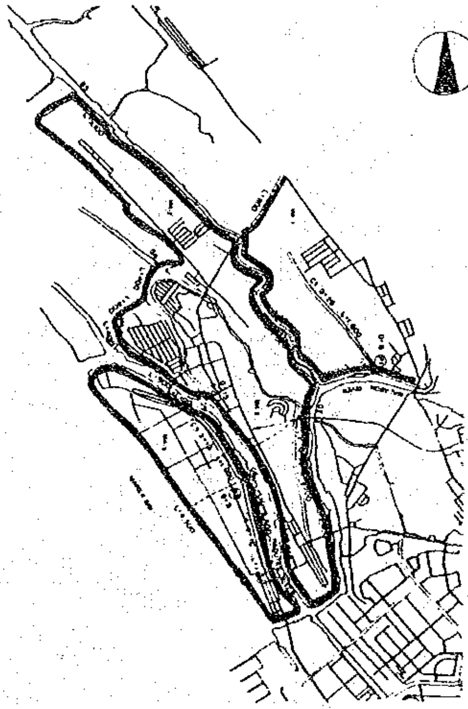
SCALE

0 1 2 3 km

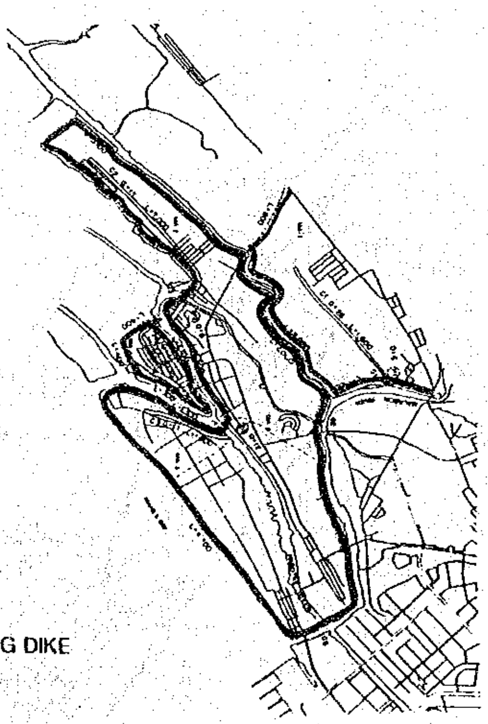
THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES	ALTERNATIVE DRAINAGE SYSTEMS FOR NORTH BANK OF MALABON RIVER
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig.5-5-10(3/5)



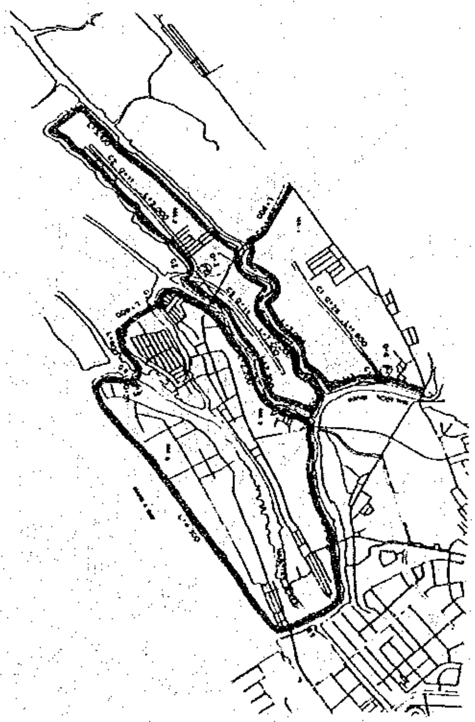
ALTERNATIVE CASE 13



ALTERNATIVE CASE 14



ALTERNATIVE CASE 15



ALTERNATIVE CASE 16

LEGEND

——— : RING DIKE

SCALE

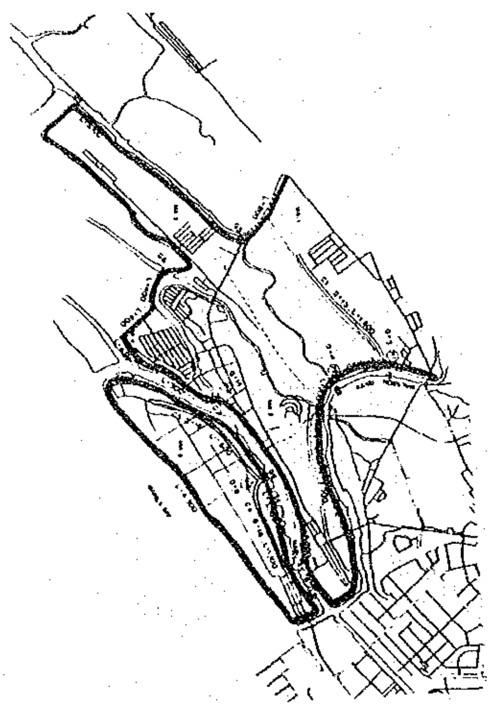
0 1 2 3 km

THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES

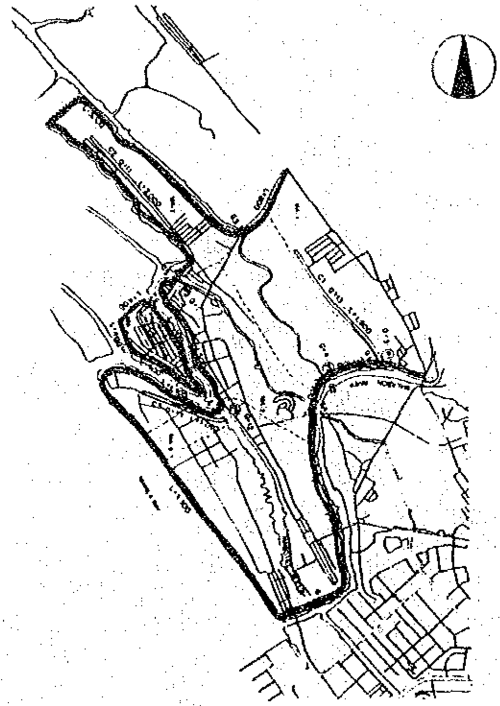
JAPAN INTERNATIONAL COOPERATION AGENCY

ALTERNATIVE DRAINAGE SYSTEMS FOR NORTH BANK OF MALABON RIVER

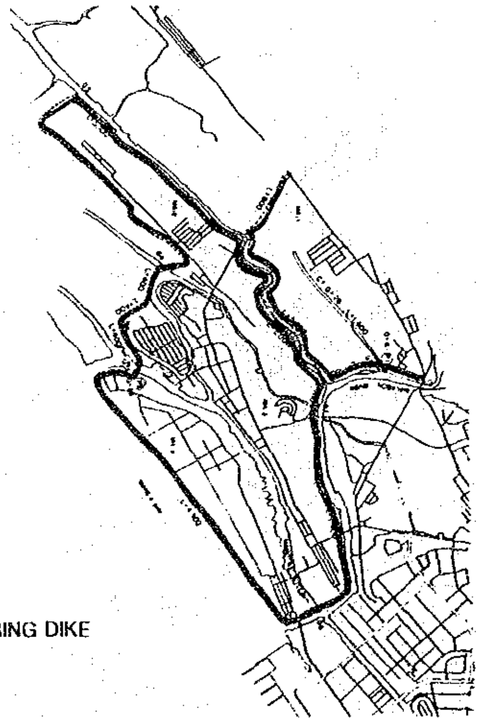
Fig.5-5-10(4/5)



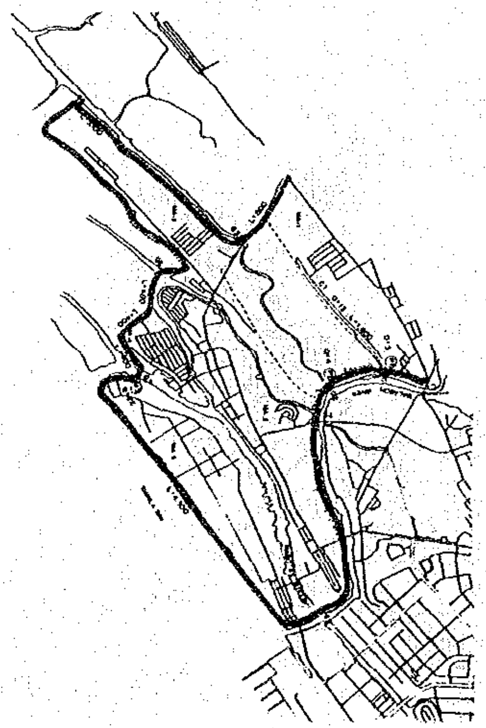
ALTERNATIVE CASE 17



ALTERNATIVE CASE 18



ALTERNATIVE CASE 19



ALTERNATIVE CASE 20

LEGEND

——— : RING DIKE

SCALE

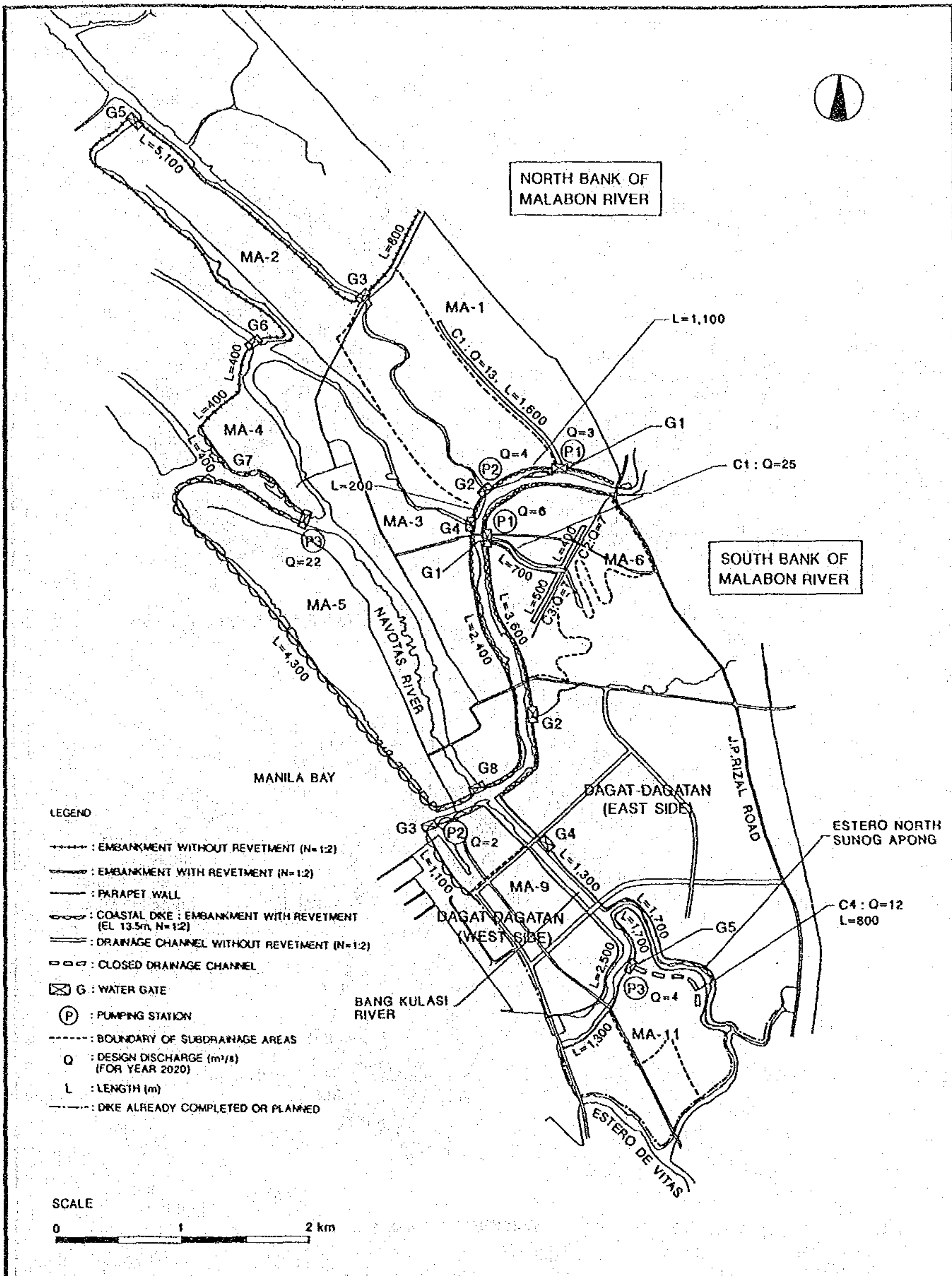
0 1 2 3 km

THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES

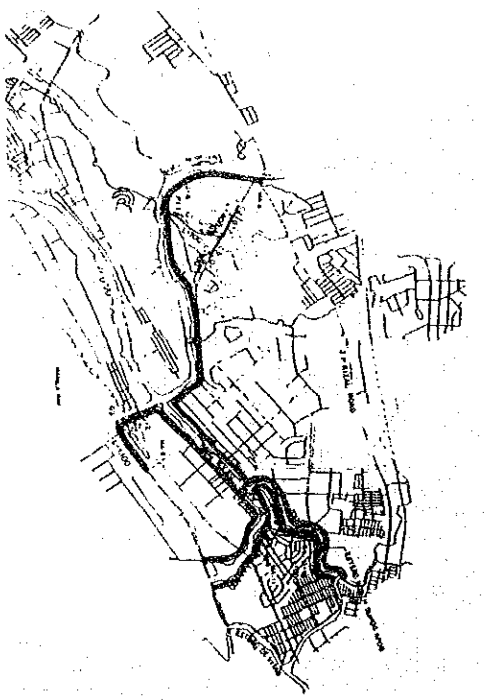
JAPAN INTERNATIONAL COOPERATION AGENCY

ALTERNATIVE DRAINAGE SYSTEMS FOR NORTH BANK OF MALABON RIVER

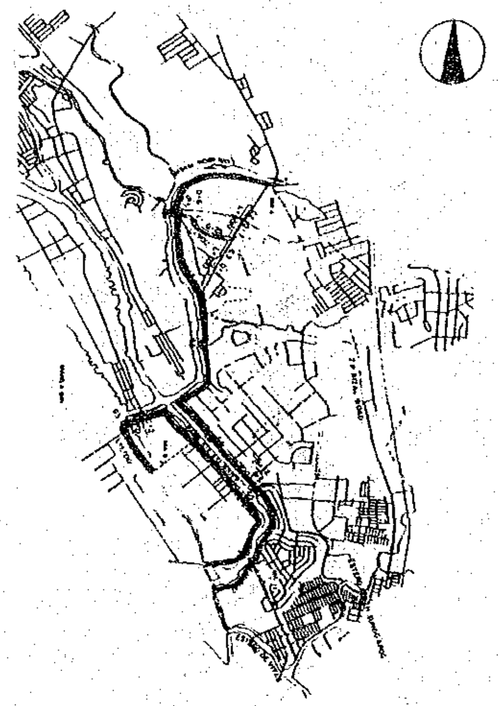
Fig.5-5-10(5/5)



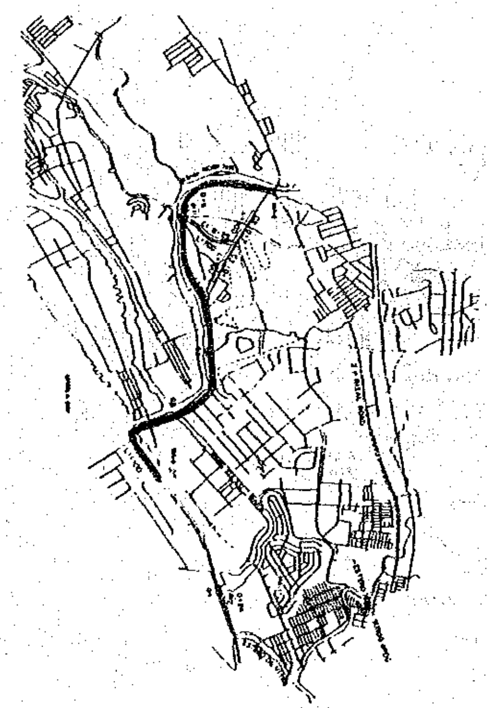
THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES	OPTIMUM DRAINAGE SYSTEMS FOR MALABON - NAVOTAS
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig.5-5-11



ALTERNATIVE CASE 1



ALTERNATIVE CASE 2



ALTERNATIVE CASE 3

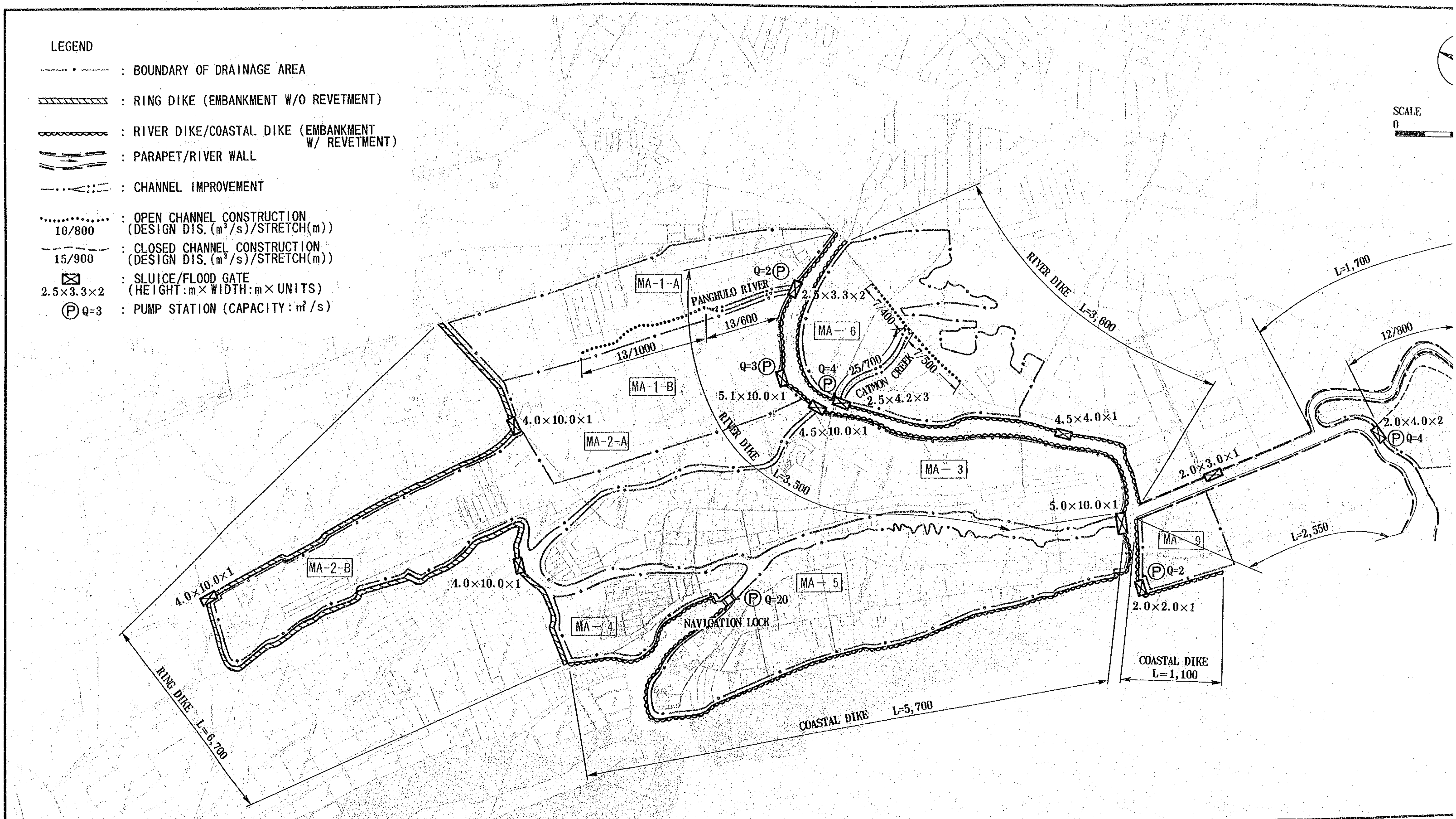
LEGEND

—— : RING DIKE

SCALE

0 1 2 3 km

THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES	ALTERNATIVE DRAINAGE SYSTEMS FOR SOUTH BANK OF MALABON RIVER
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig.5-5-12

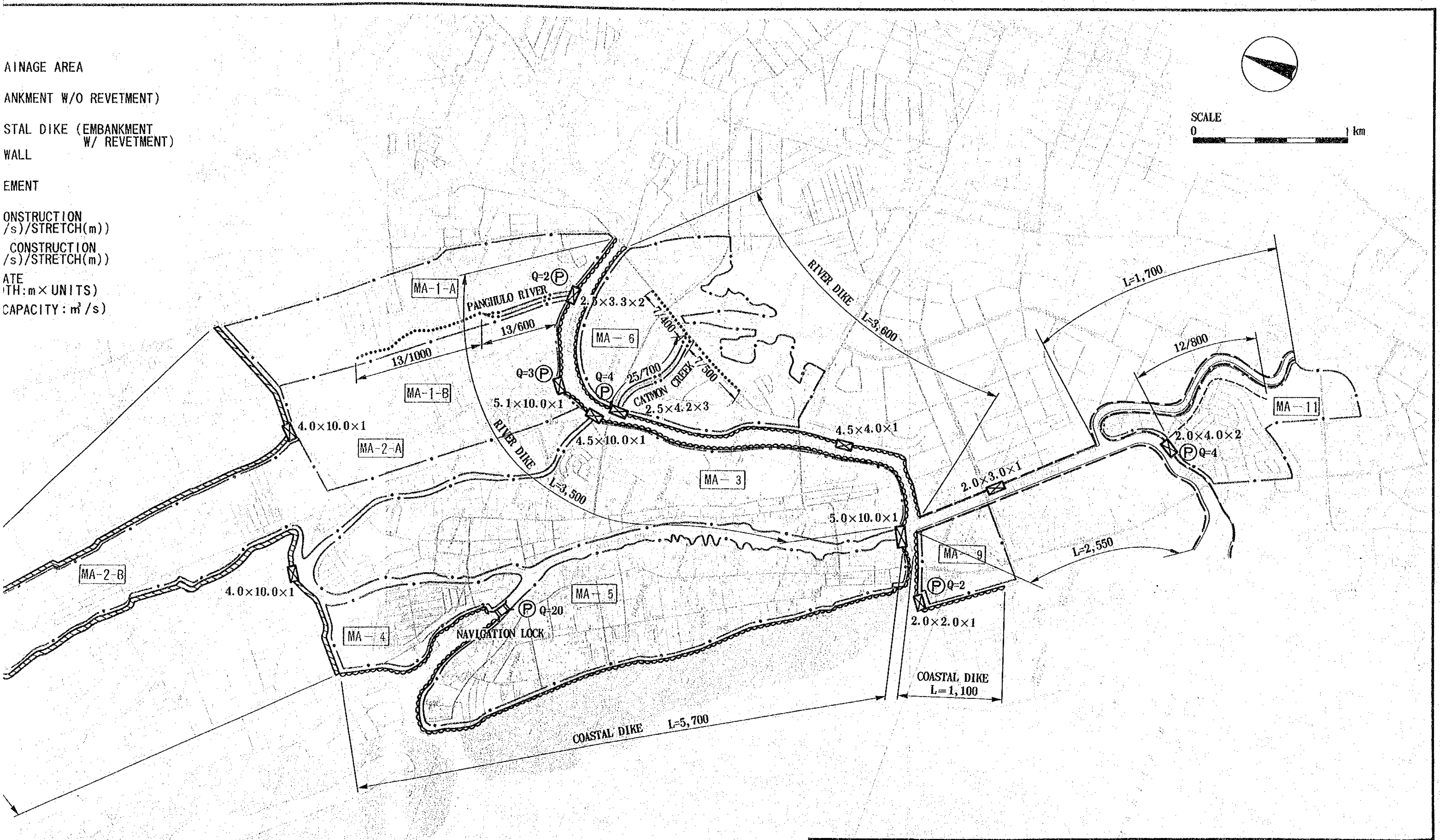


THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES

JAPAN INTERNATIONAL COOPERATION AGENCY

LAYOUT OF FACIL

MALABON-NAVOT

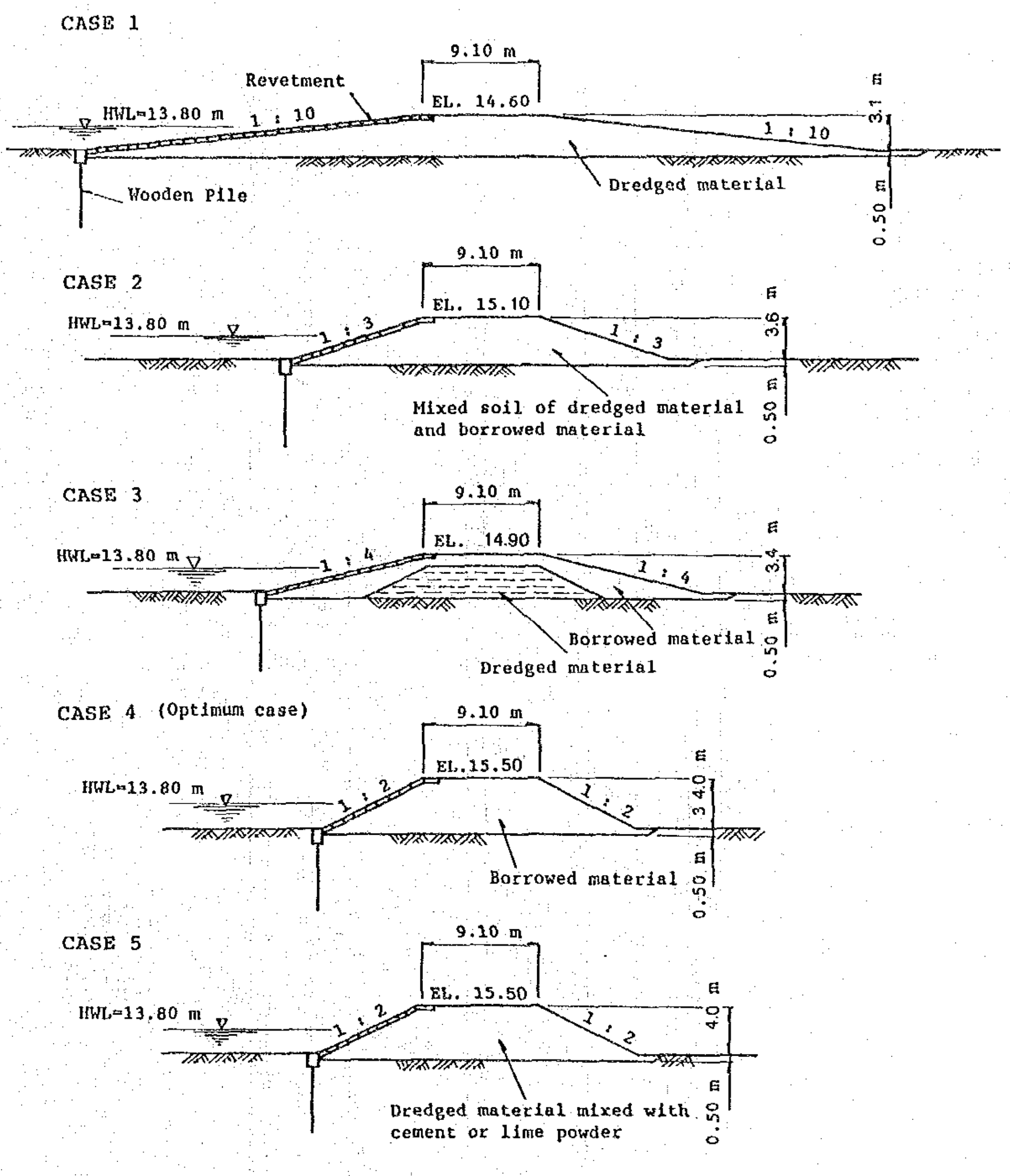


THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES

JAPAN INTERNATIONAL COOPERATION AGENCY

LAYOUT OF FACILITIES FOR MALABON-NAVOTAS

Fig.5-5-13



THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES	TYPICAL SECTONS FOR THE LAKESHORE DIKE FOR ALTERNATIVES
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig.5-6-1

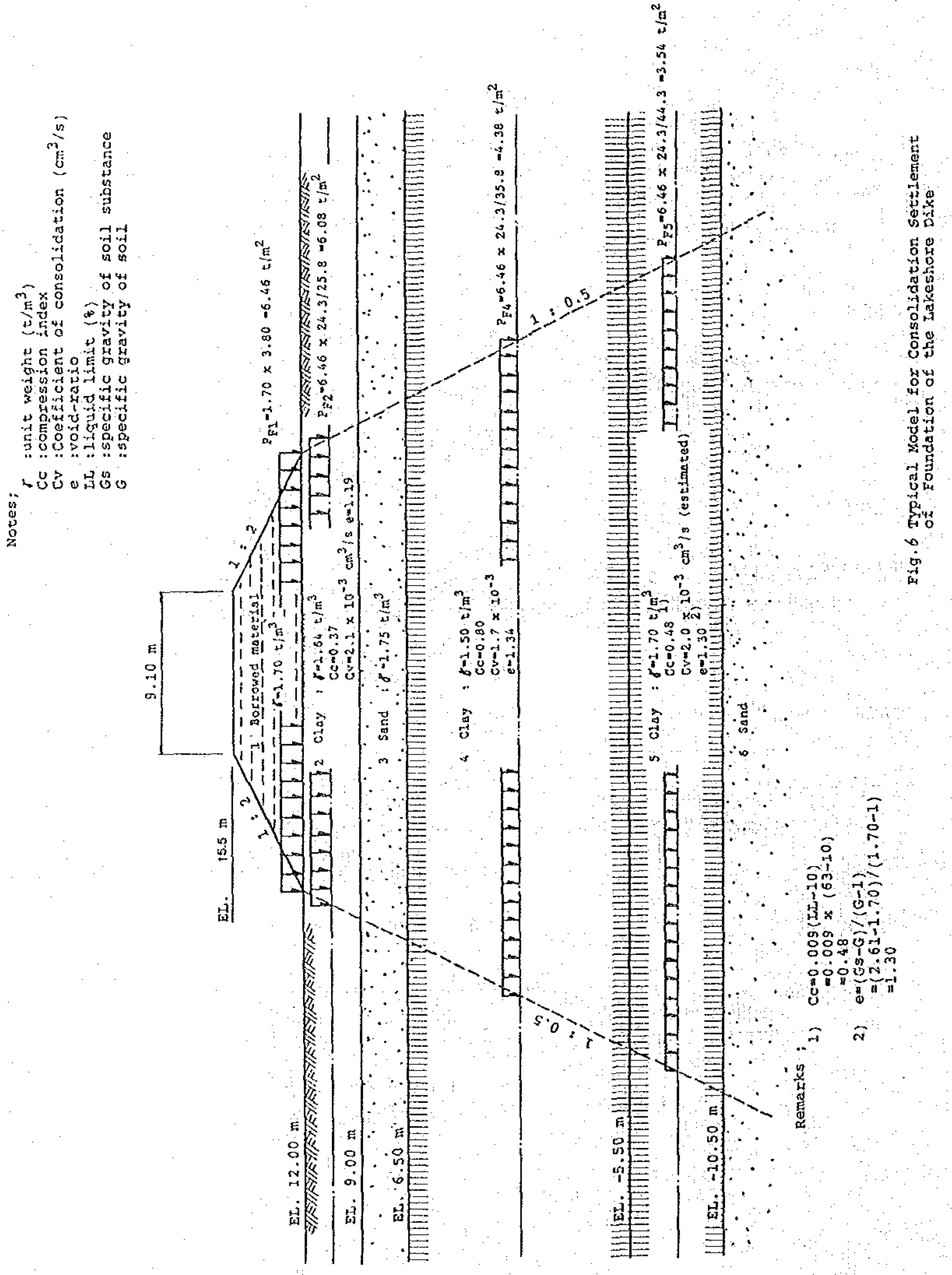
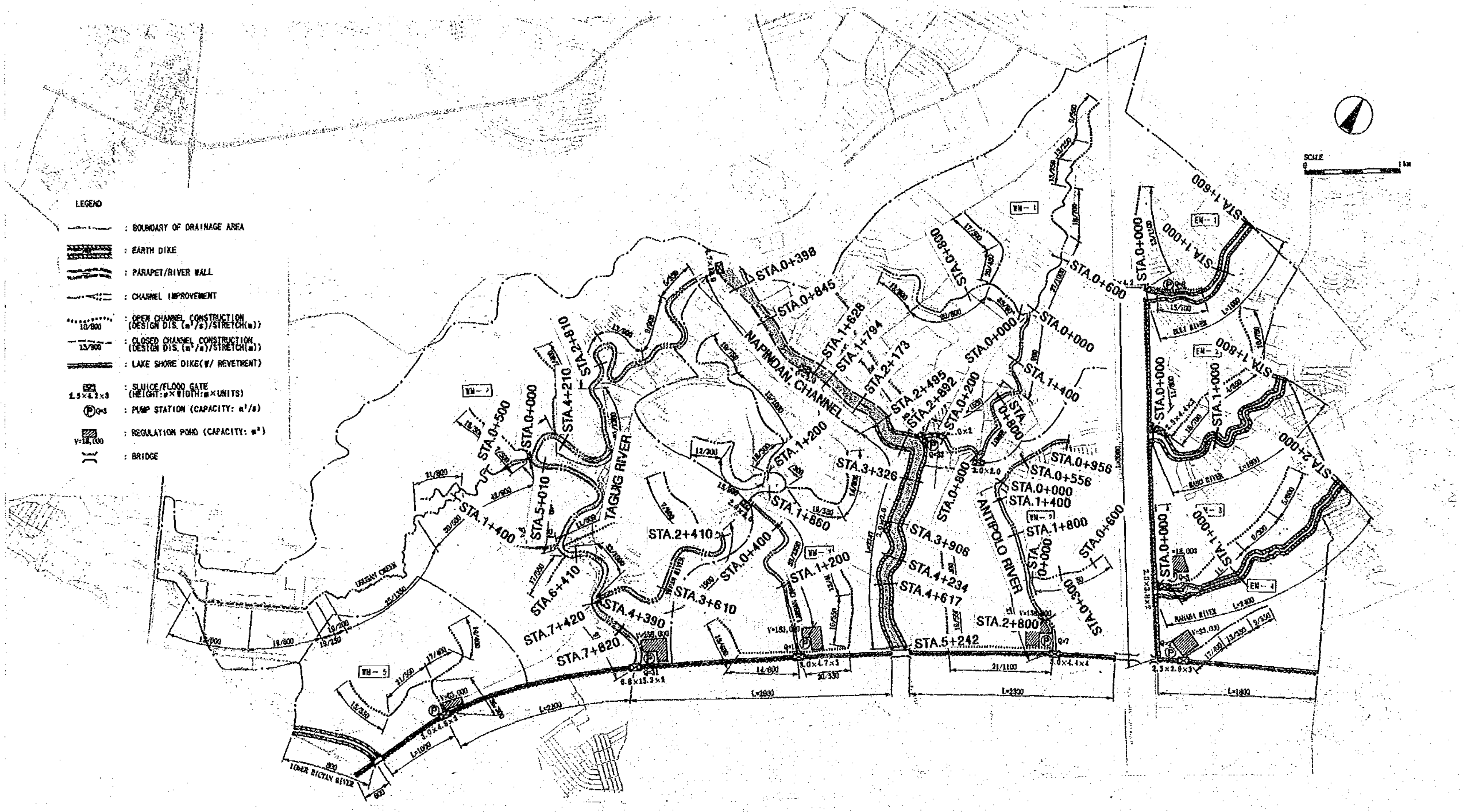
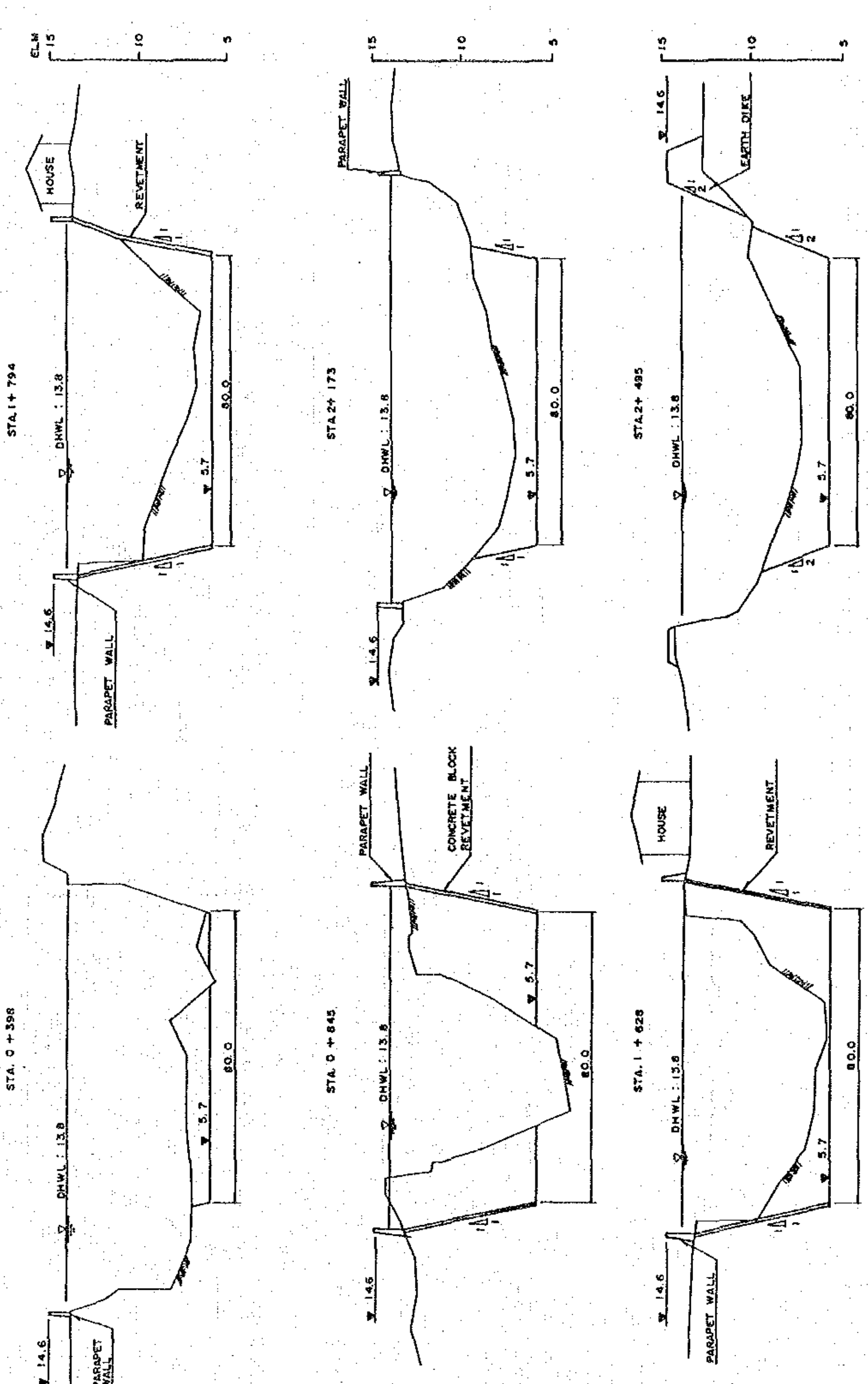


Fig.6 Typical Model for Consolidation Settlement of Foundation of the Lakeshore Dike

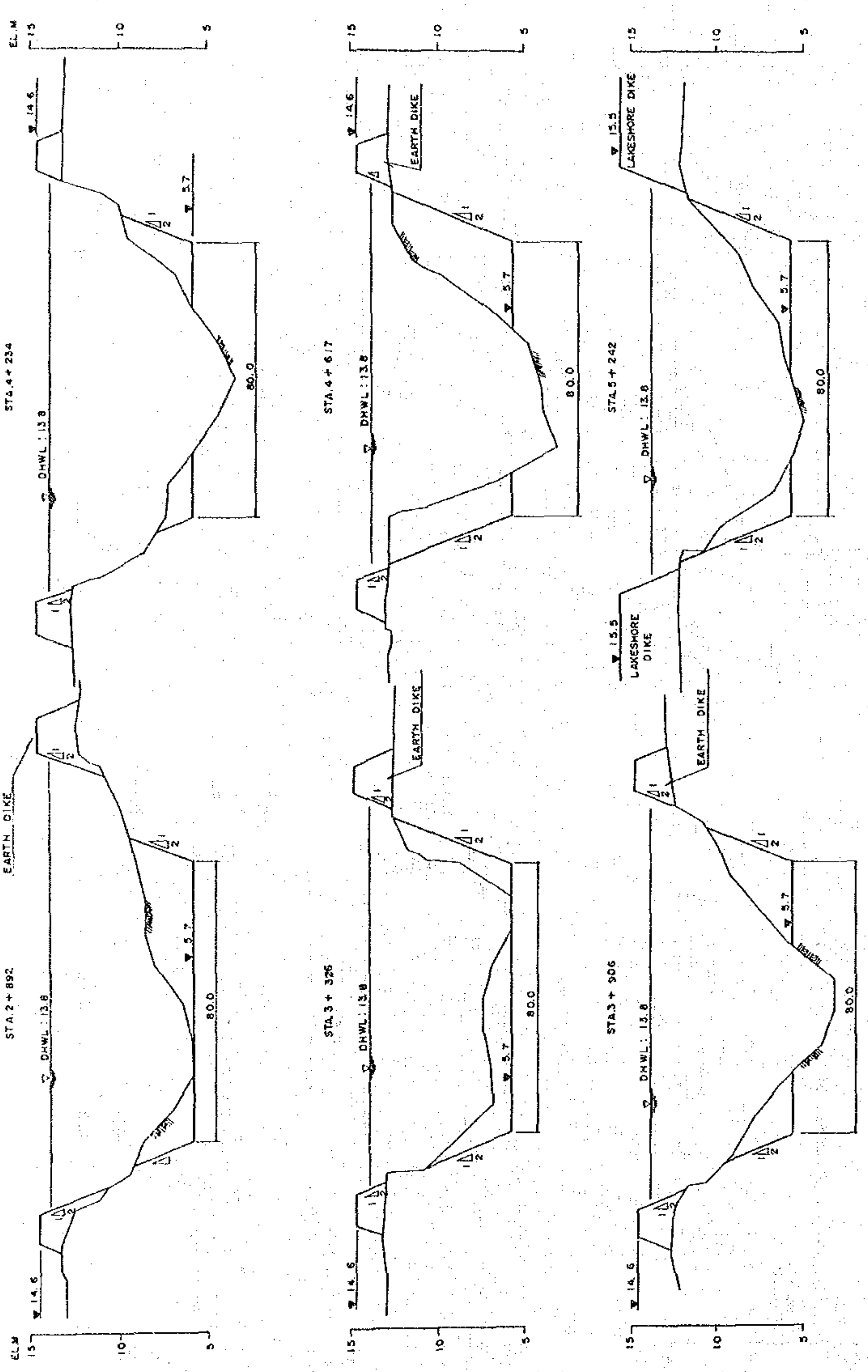
THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES	TYPICAL MODEL FOR CONSOLIDATION SETTLEMENT OF FOUNDATION OF THE LAKESHORE DIKE Fig.5-6-2
JAPAN INTERNATIONAL COOPERATION AGENCY	



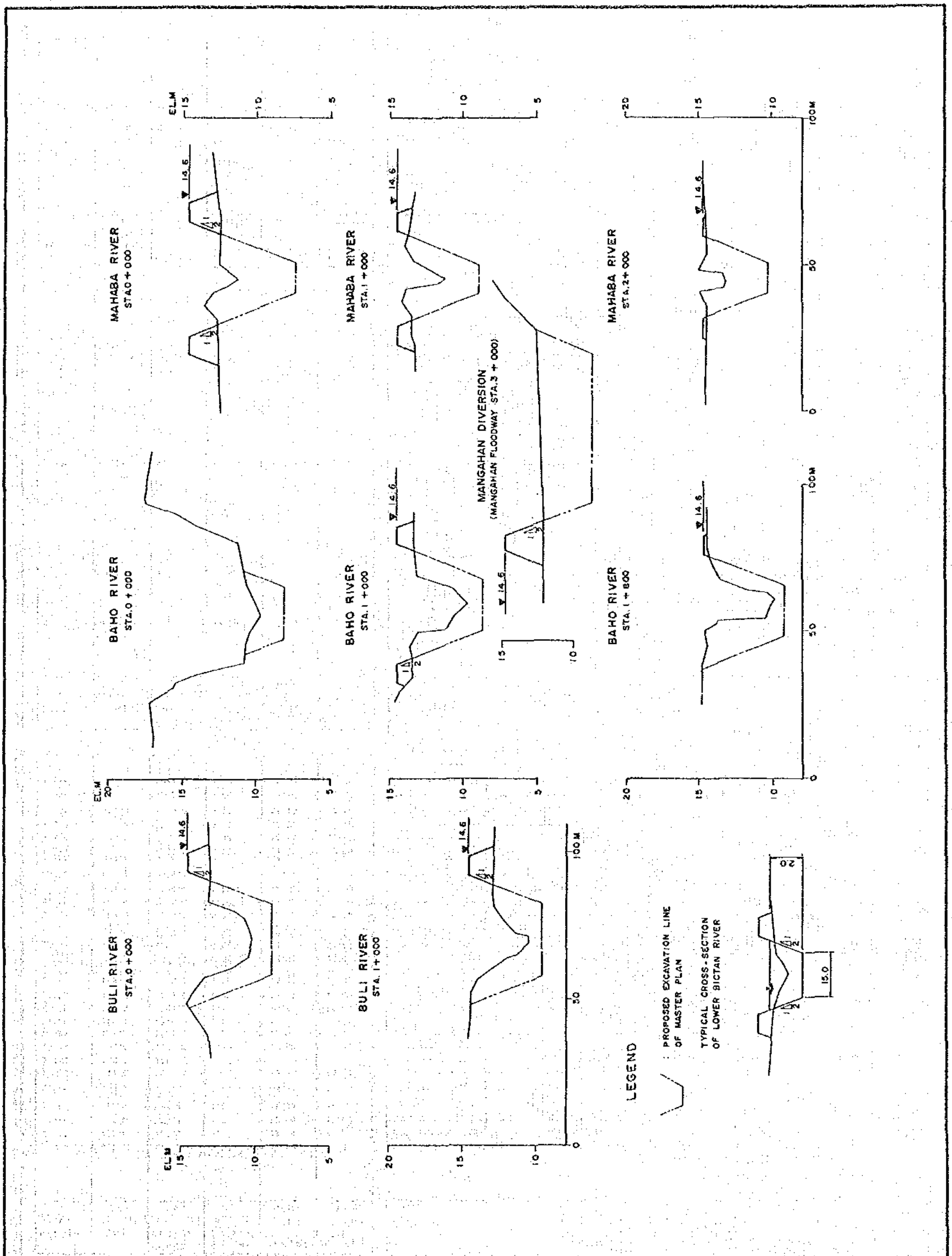
THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES	LOCATIONS OF PROPOSED STRUCTURES FOR EAST AND WEST OF MANGAHAN
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig.5-6-3



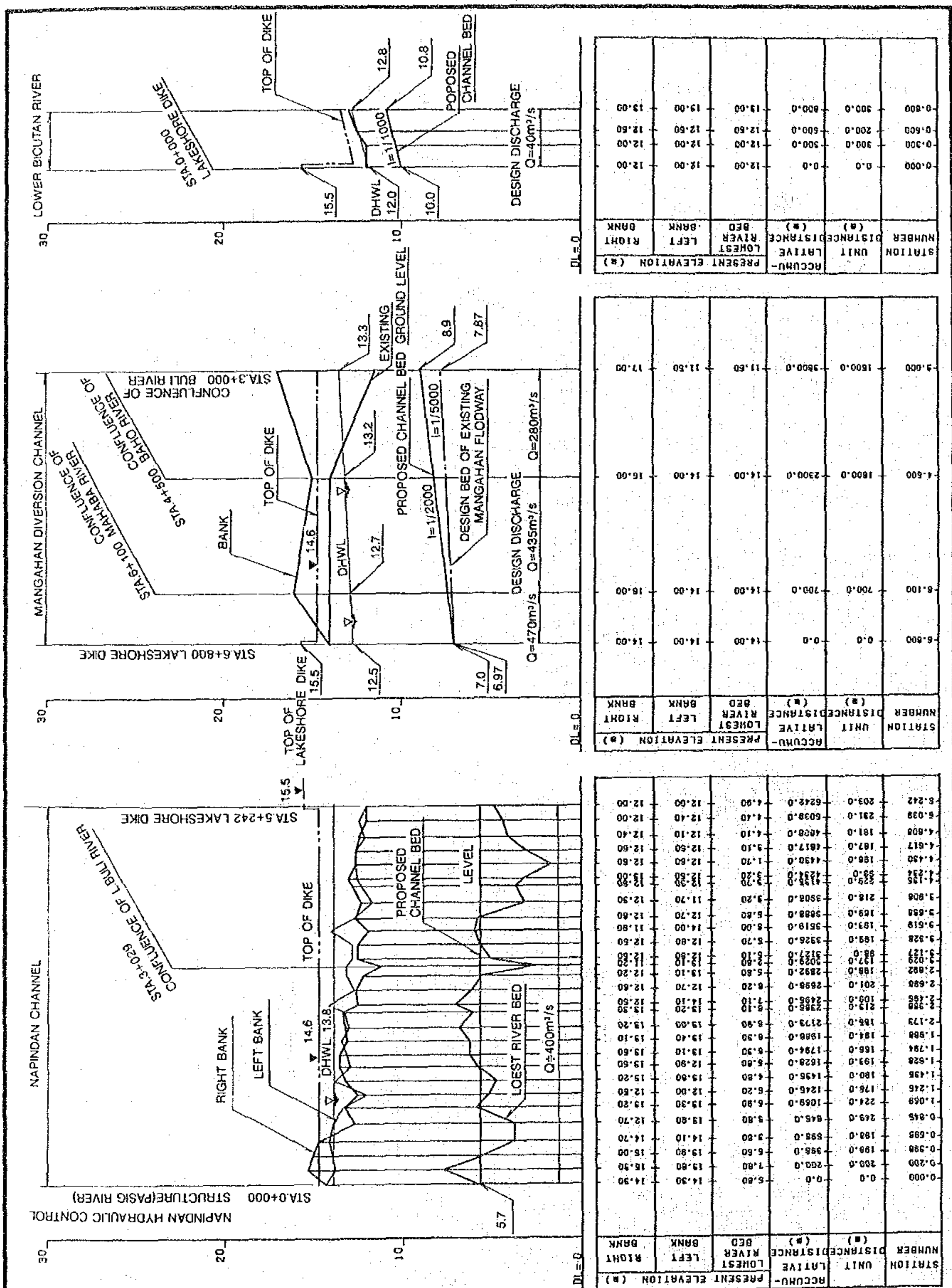
THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES	PROPOSED CROSS-SECTIONS OF BACKWATER DIKE
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig.5-6-4(1/3)



THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES	PROPOSED CROSS-SECTIONS OF BACKWATER DIKE
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig.5-6-4(2/3)



THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES	PROPOSED CROSS-SECTIONS OF BACKWATER DIKE
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig.5-6-4(3/3)

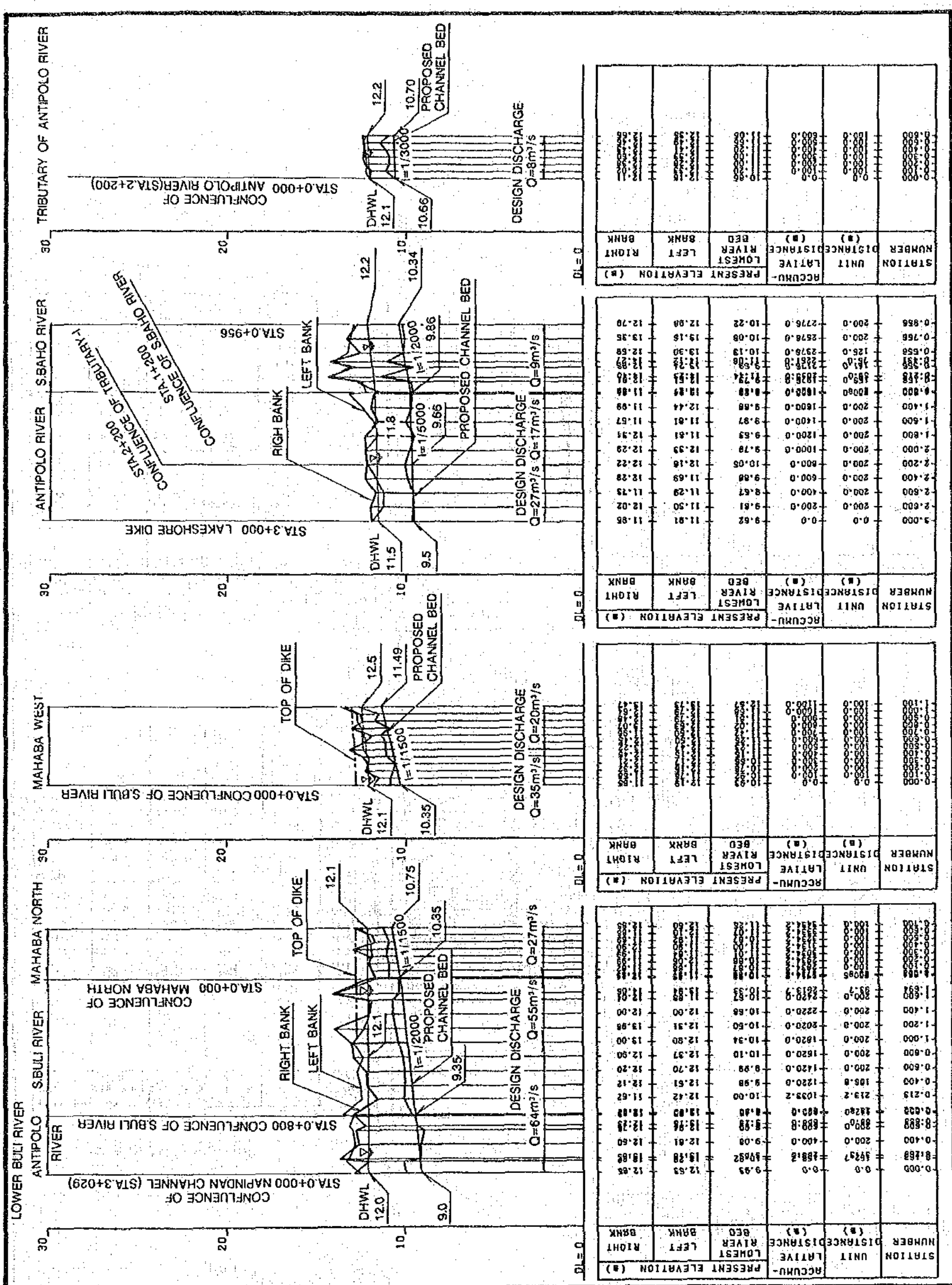


THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES

JAPAN INTERNATIONAL COOPERATION AGENCY

PROPOSED LONGITUDINAL PROFILE OF DRAINAGE CHANNELS

Fig.5-6-5(1/4)

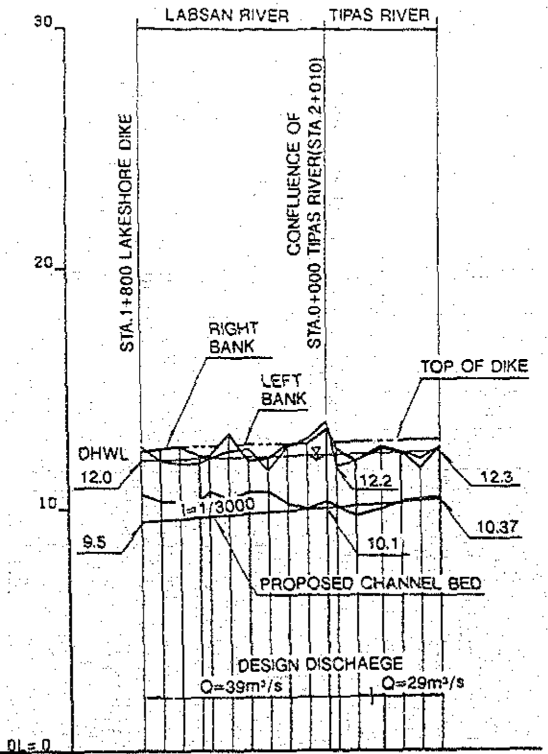


THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES

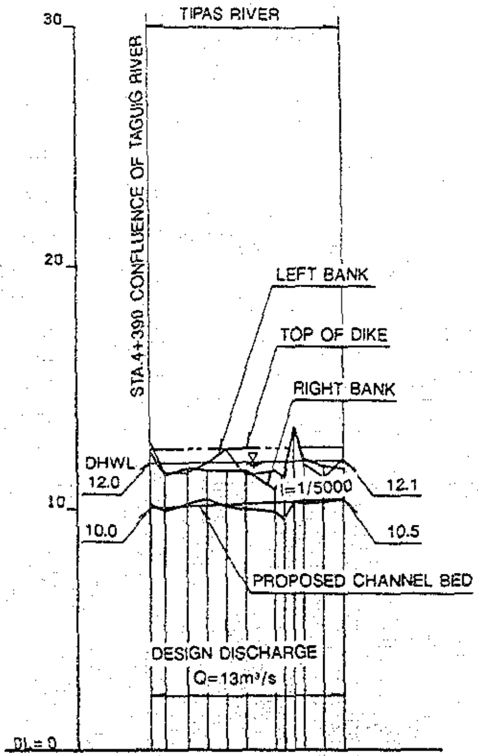
JAPAN INTERNATIONAL COOPERATION AGENCY

PROPOSED LONGITUDINAL PROFILE OF DRAINAGE CHANNELS

Fig.5-6-5(2/4)



STATION NUMBER	UNIT DISTANCE (m)	ACCUMULATIVE DISTANCE (m)	PRESENT ELEVATION (m) LOWEST RIVER BED	LEFT BANK	RIGHT BANK
1.800	0.0	0.0	10.60	12.60	12.40
1.600	200.0	200.0	10.50	12.00	12.60
1.400	200.0	400.0	10.30	11.90	12.60
1.300	200.0	600.0	10.30	11.90	12.20
1.200	100.0	700.0	10.10	12.10	12.20
1.000	200.0	900.0	10.40	12.40	13.10
0.800	200.0	1100.0	10.70	12.50	12.00
0.600	200.0	1300.0	10.70	11.50	12.10
0.400	200.0	1500.0	10.20	12.60	12.70
0.200	200.0	1700.0	10.00	12.80	12.70
0.000	200.0	1900.0	10.30	13.60	13.30
1.[illegible]	100.0	2000.0	10.10	11.80	12.60
1.660	200.0	2200.0	9.70	12.00	12.00
1.400	280.0	2480.0	10.00	12.50	12.60
1.200	200.0	2680.0	10.50	12.40	12.40
1.000	200.0	2850.0	10.40	12.10	11.70
0.800	200.0	3080.0	10.60	12.60	12.80



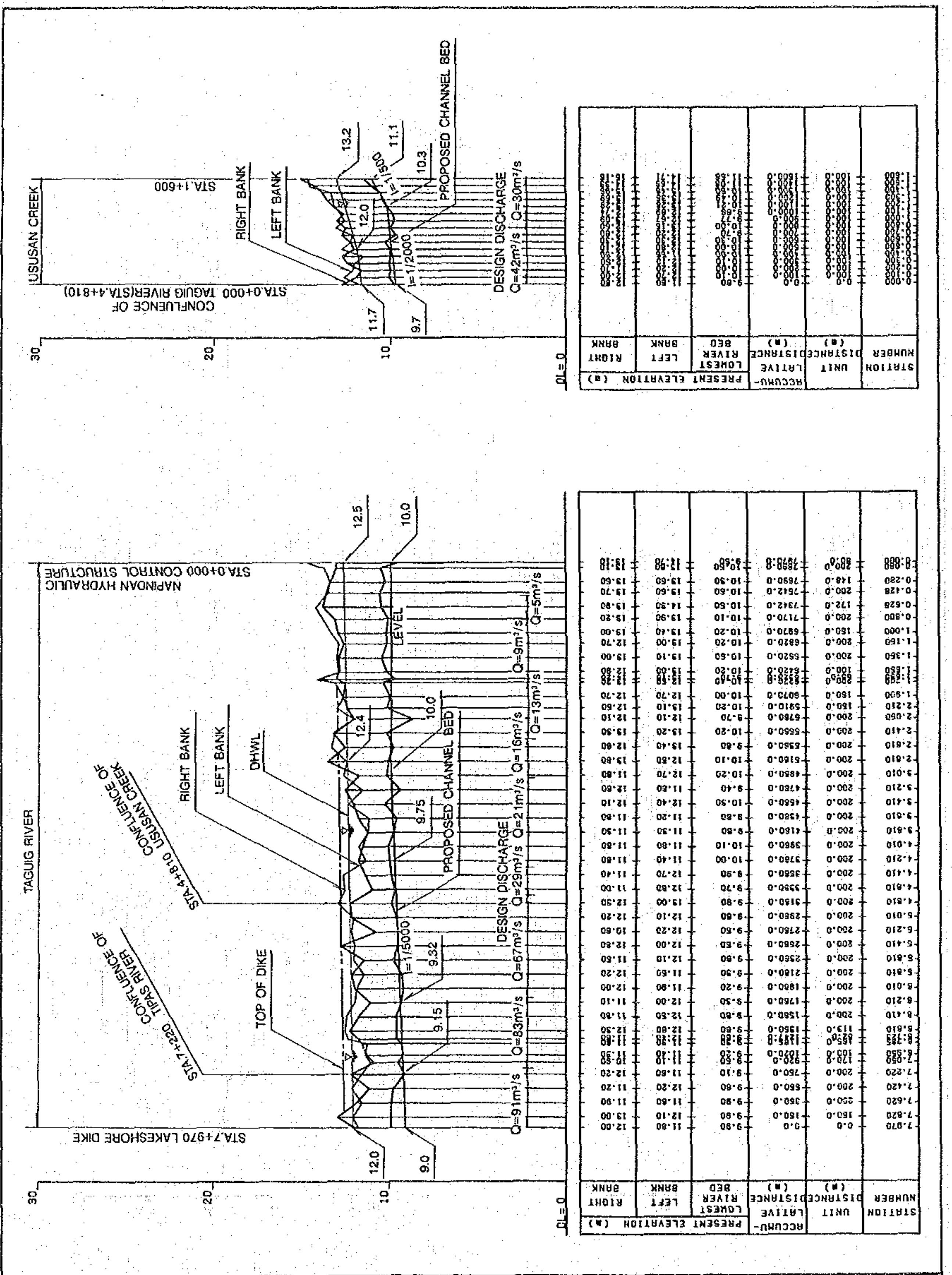
STATION NUMBER	UNIT DISTANCE (m)	ACCUMULATIVE DISTANCE (m)	PRESENT ELEVATION (m) LOWEST RIVER BED	LEFT BANK	RIGHT BANK
4.390	0.0	0.0	10.20	12.80	12.40
4.240	150.0	150.0	9.90	11.60	11.40
4.010	230.0	380.0	10.20	11.60	11.70
3.810	200.0	580.0	10.40	11.90	11.60
3.610	200.0	780.0	10.10	12.60	11.60
3.410	200.0	980.0	10.00	11.40	11.60
3.110	300.0	1280.0	9.80	11.60	10.80
3.010	100.0	1380.0	[illegible]	[illegible]	[illegible]
2.910	100.0	1480.0	10.30	[illegible]	[illegible]
2.810	100.0	1580.0	10.20	11.80	12.10
2.610	200.0	1780.0	10.30	11.30	11.80
2.400	210.0	1990.0	10.40	12.10	11.70

THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT
IN METRO MANILA, PHILIPPINES

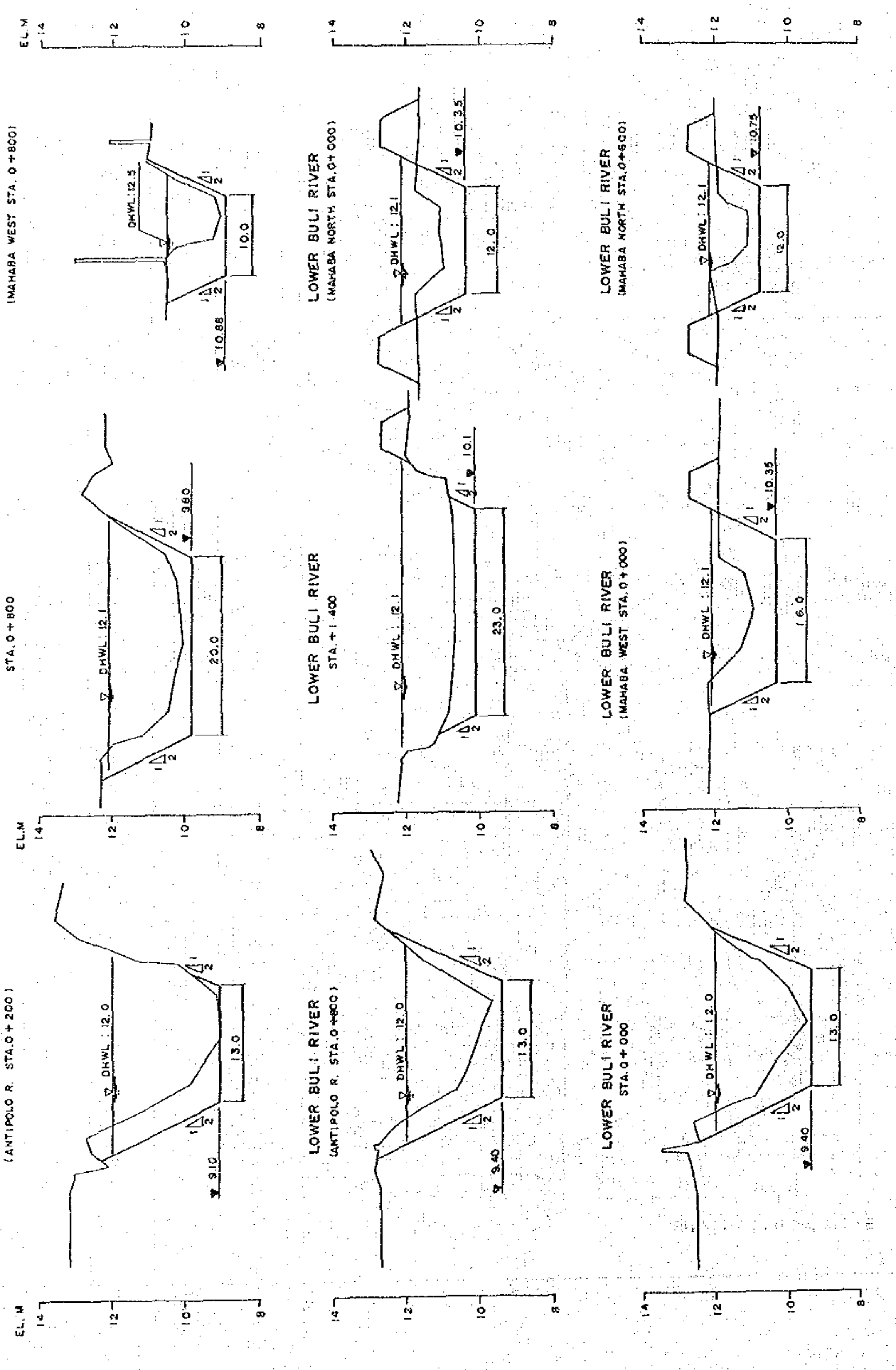
JAPAN INTERNATIONAL COOPERATION AGENCY

PROPOSED LONGITUDINAL PROFILE OF DRAINAGE CHANNELS

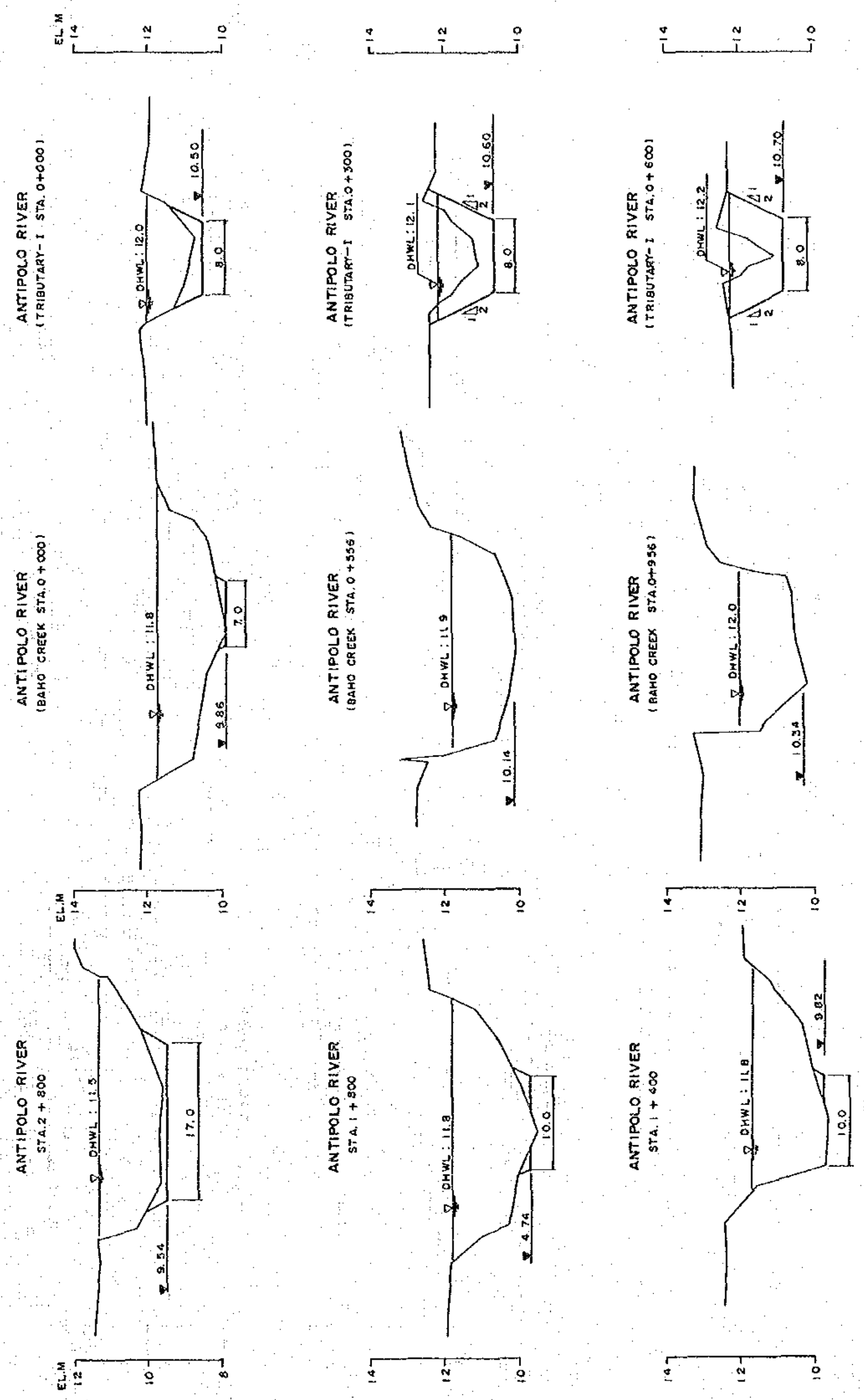
Fig.5-6-5(3/4)



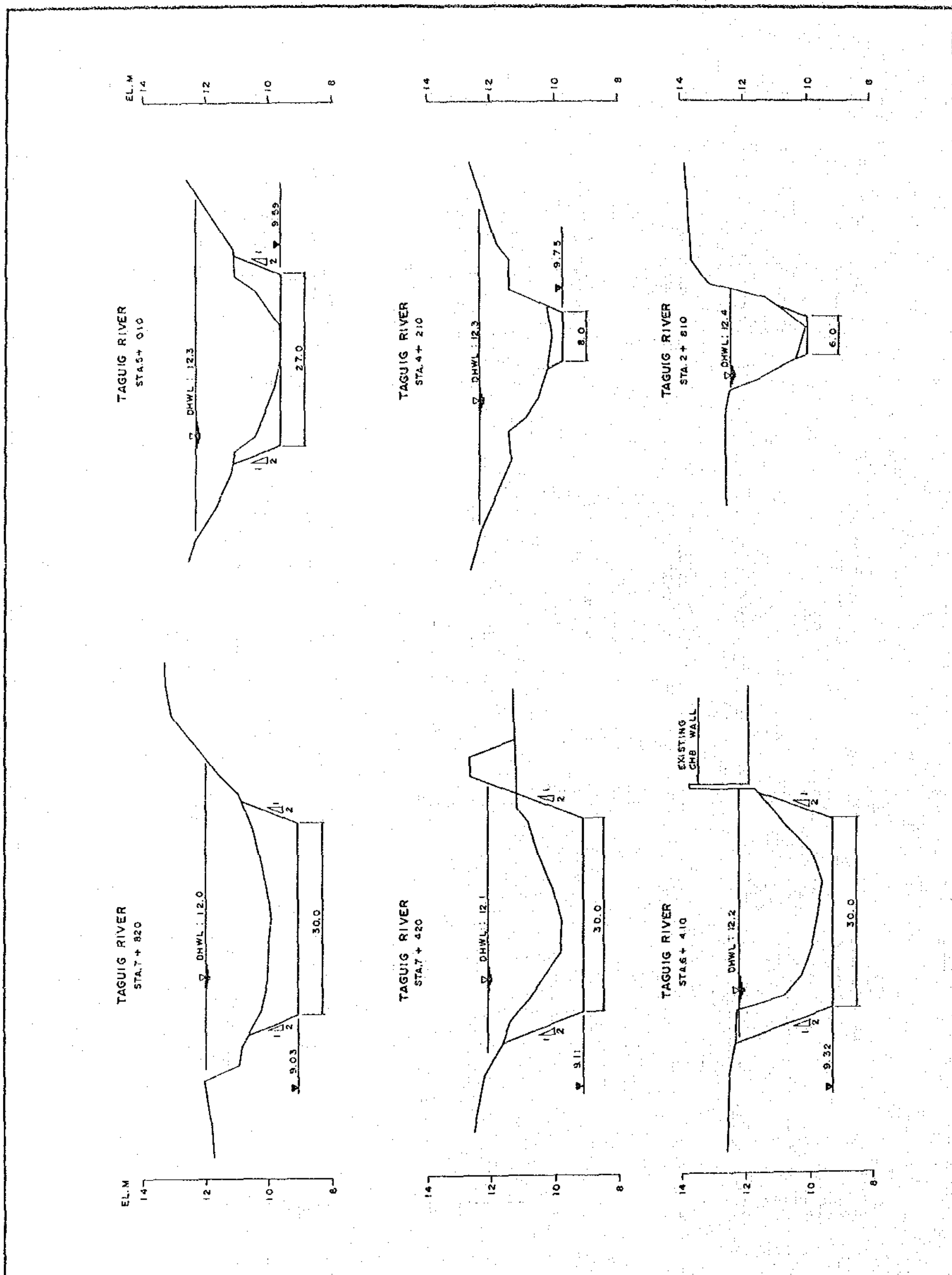
THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES	PROPOSED LONGITUDINAL PROFILE OF DRAINAGE CHANNELS
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig.5-6-5(4/4)



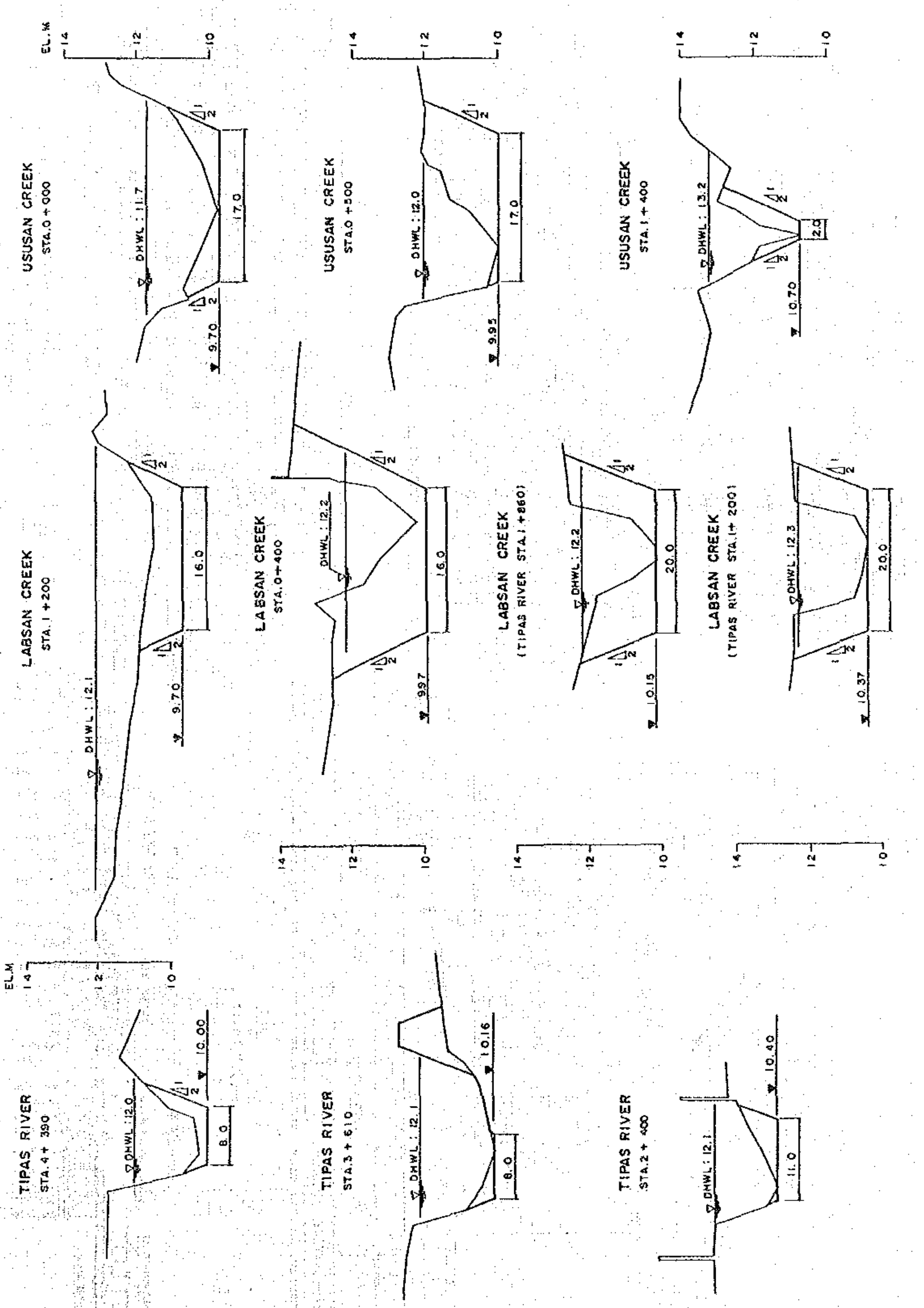
THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES	PROPOSED CROSS-SECTIONS OF DRAINAGE CHANNELS
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig.5-6-6(1/4)



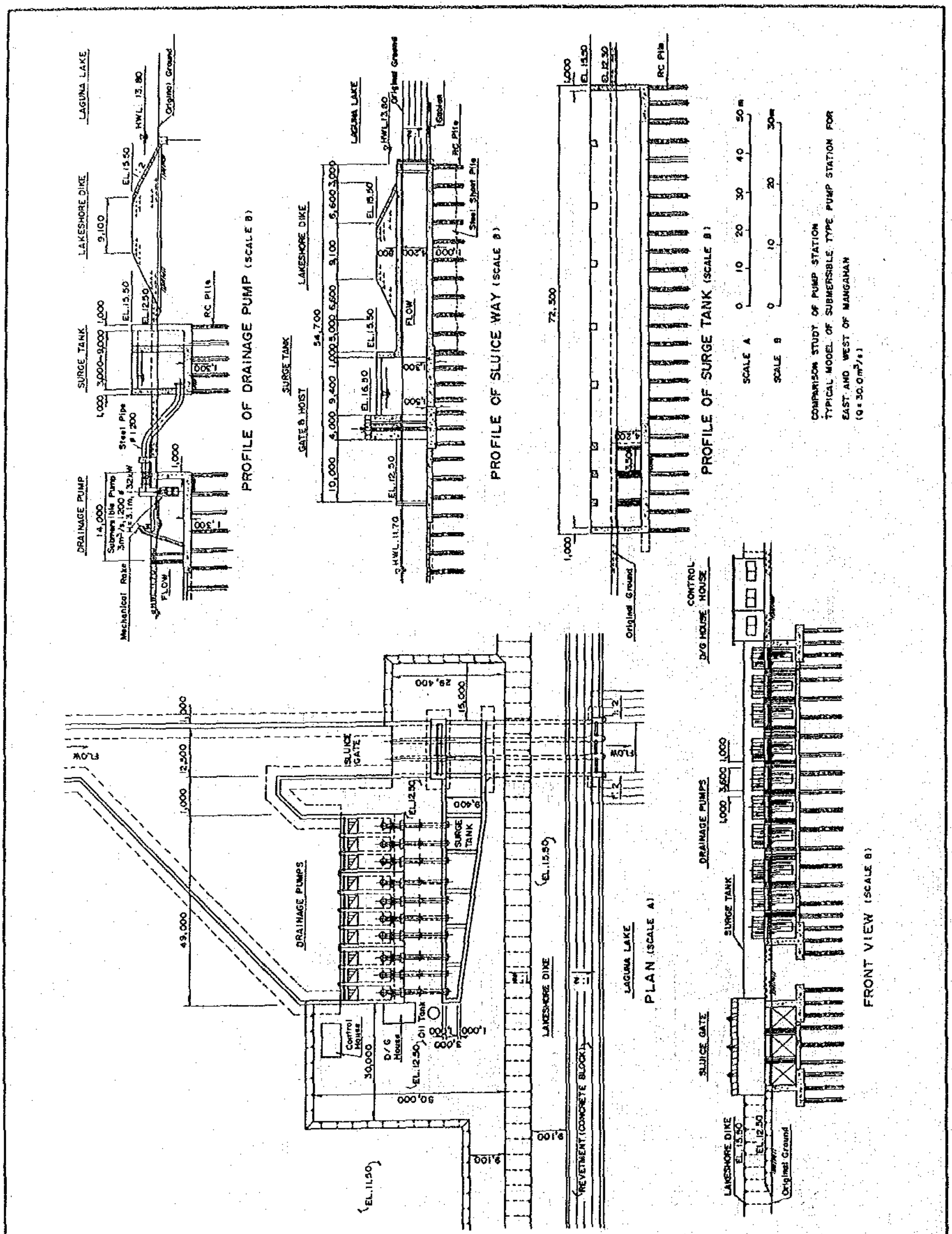
THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES	PROPOSED CROSS-SECTIONS OF DRAINAGE CHANNELS
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig.5-6-6(2/4)



THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES	PROPOSED CROSS-SECTIONS OF DRAINAGE CHANNELS
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig.5-6-6(3/4)



THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES	PROPOSED CROSS-SECTIONS OF DRAINAGE CHANNELS
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig.5-6-6(4/4)

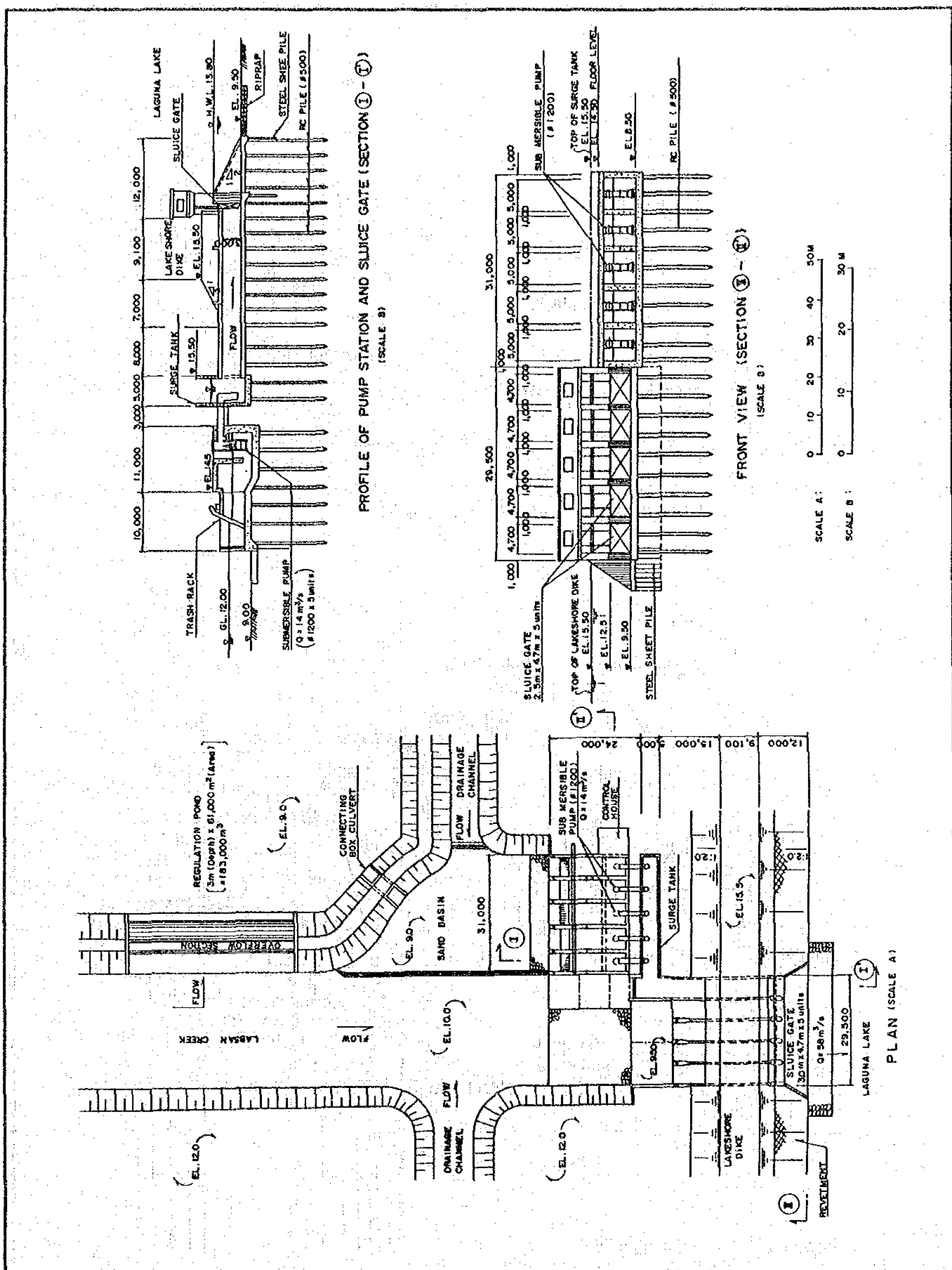


THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES

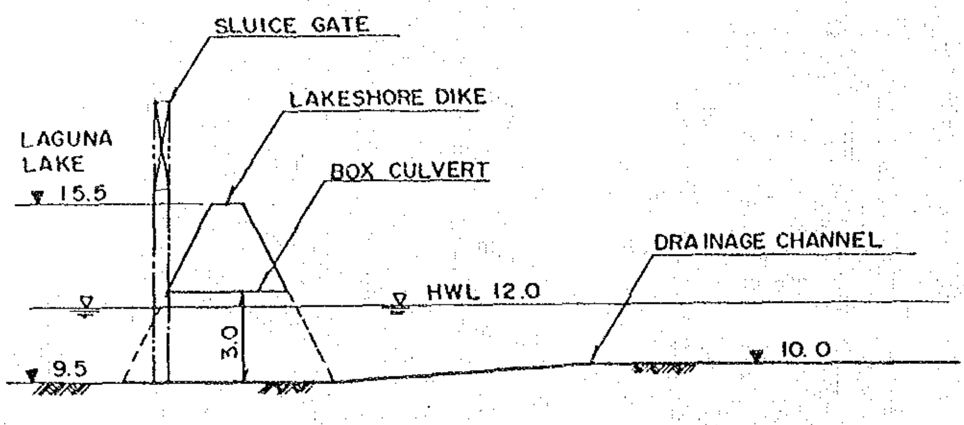
JAPAN INTERNATIONAL COOPERATION AGENCY

TYPICAL LAYOUT OF PUMP SATION (EAST AND WEST OF MANGAHAN)

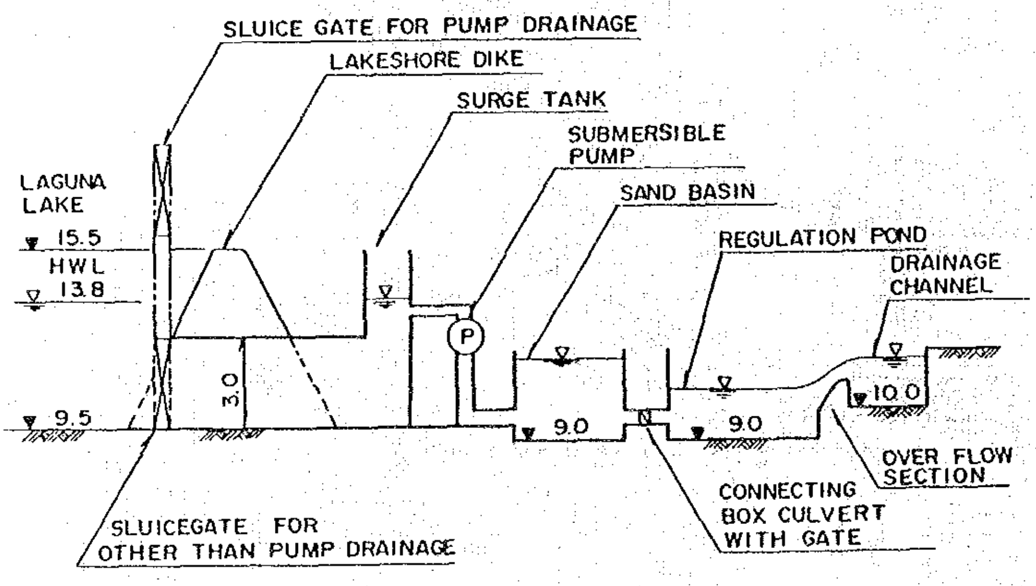
Fig.5-6-7



THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES	GENERAL ARRANGEMENT OF REGULATION POND, PUMP STATION AND SLUICE GATE
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig.5-6-8

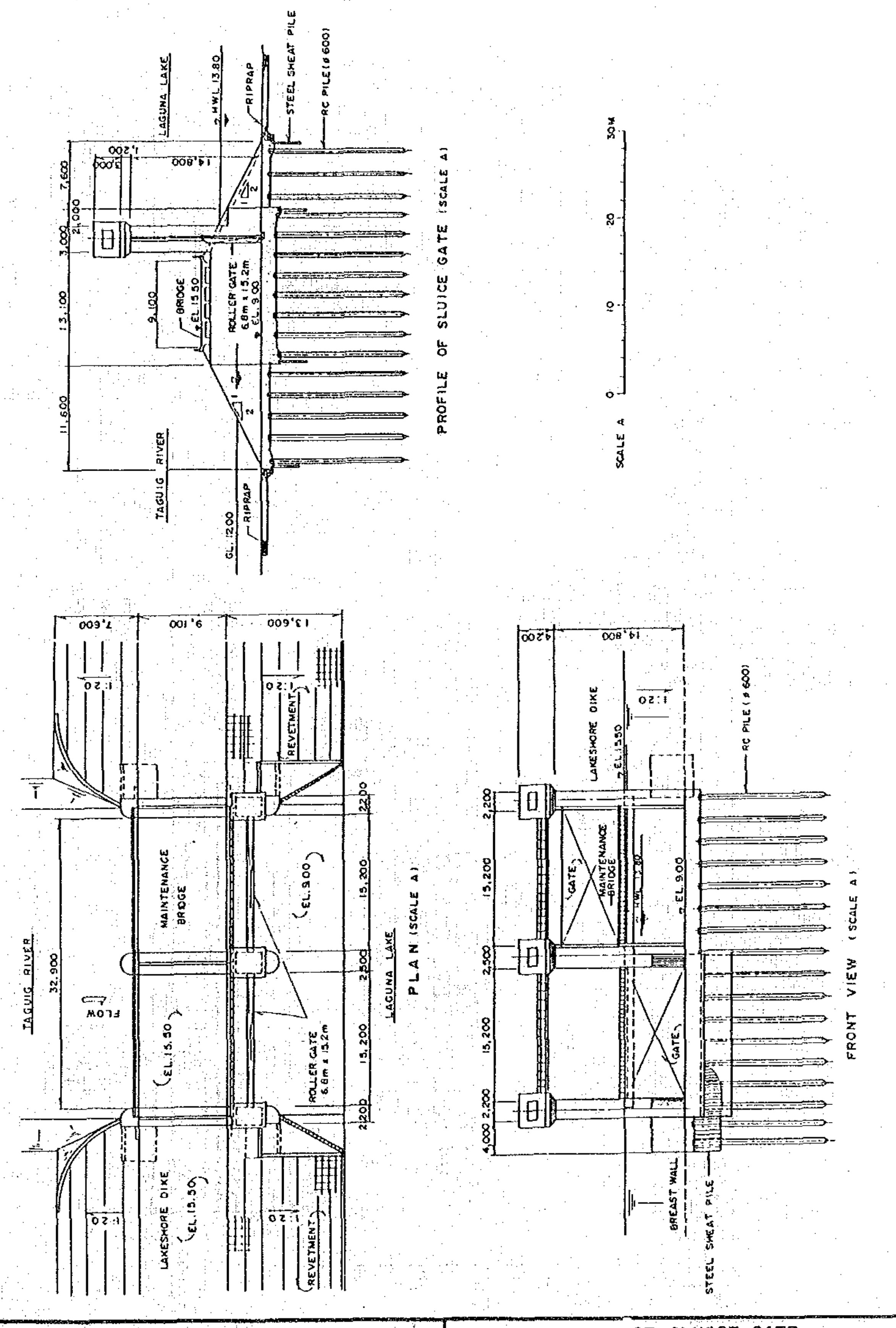


GRAVITY FLOW DRAINAGE



PUMP DRAINAGE

THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES JAPAN INTERNATIONAL COOPERATION AGENCY	SCHEMATIC PROFILE OF REGULATION POND, PUMP STATION AND SLUICE GATE Fig.5-6-9

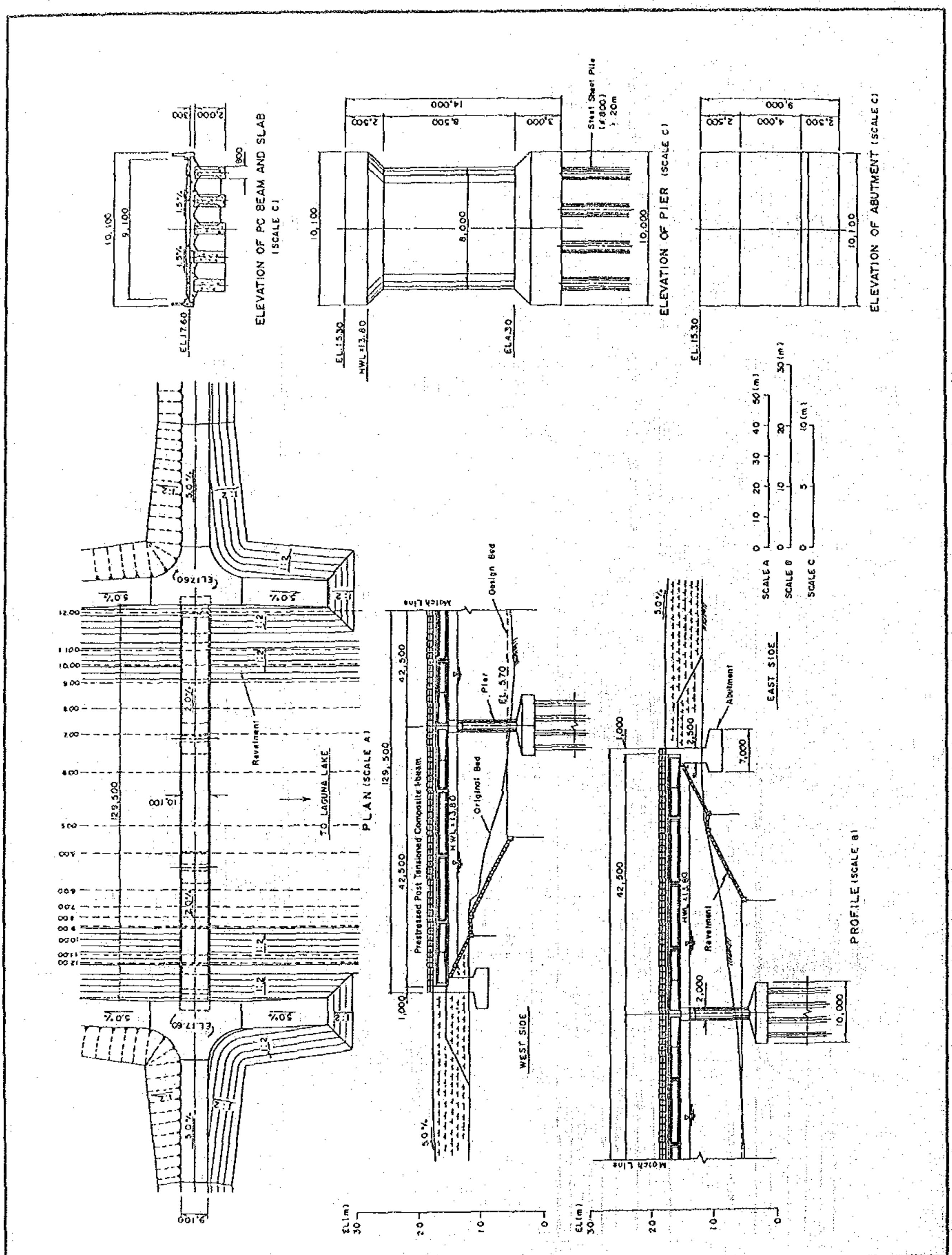


THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES

JAPAN INTERNATIONAL COOPERATION AGENCY

TYPICAL LAYOUT OF SLUICE GATE (EAST AND WEST OF MANGAHAN)

Fig.5-6-10

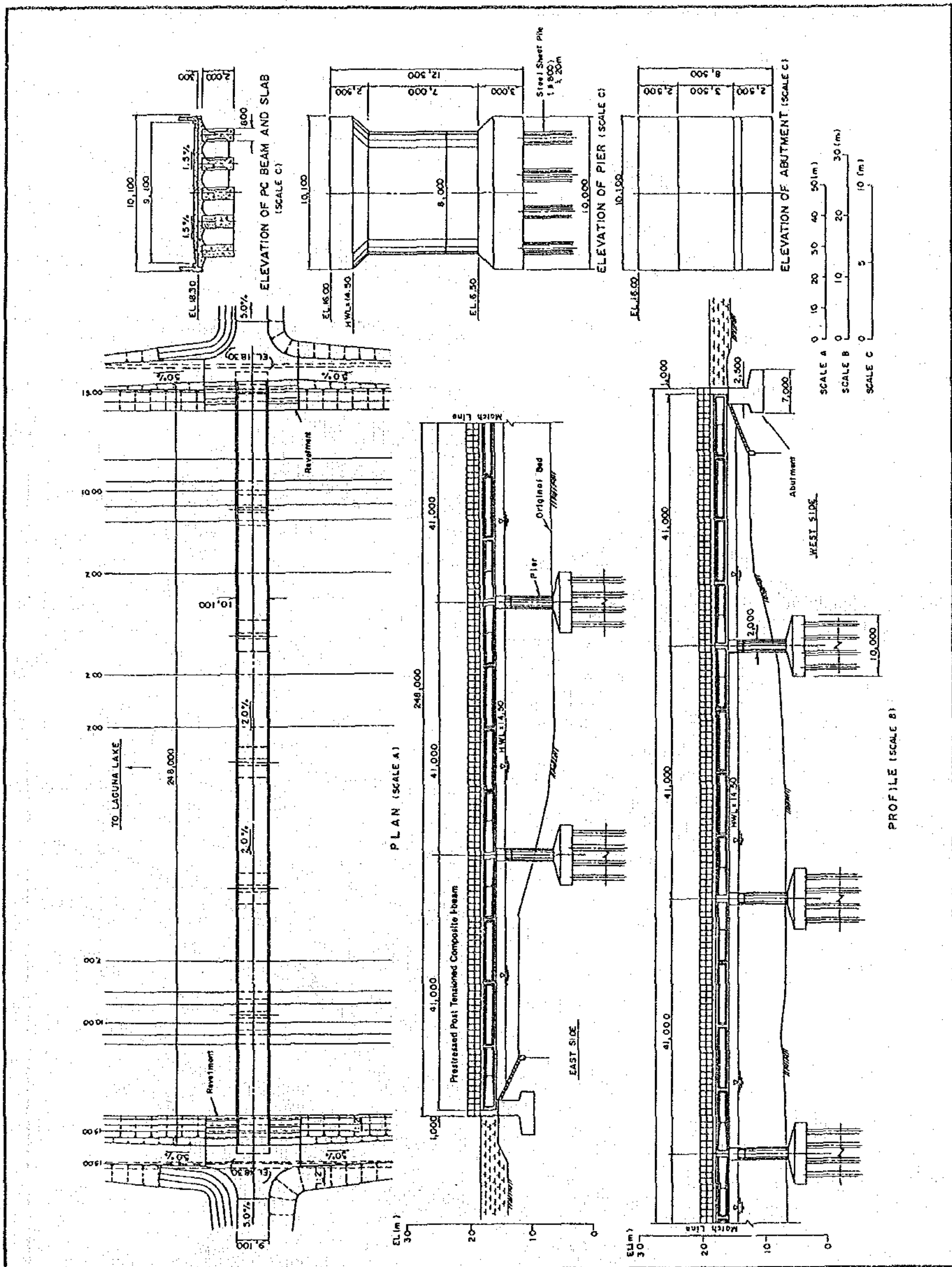


THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES

JAPAN INTERNATIONAL COOPERATION AGENCY

GENERAL DRAWING OF BRIDGE (NAPINDAN CHANNEL)

Fig.5-6-11(1/2)

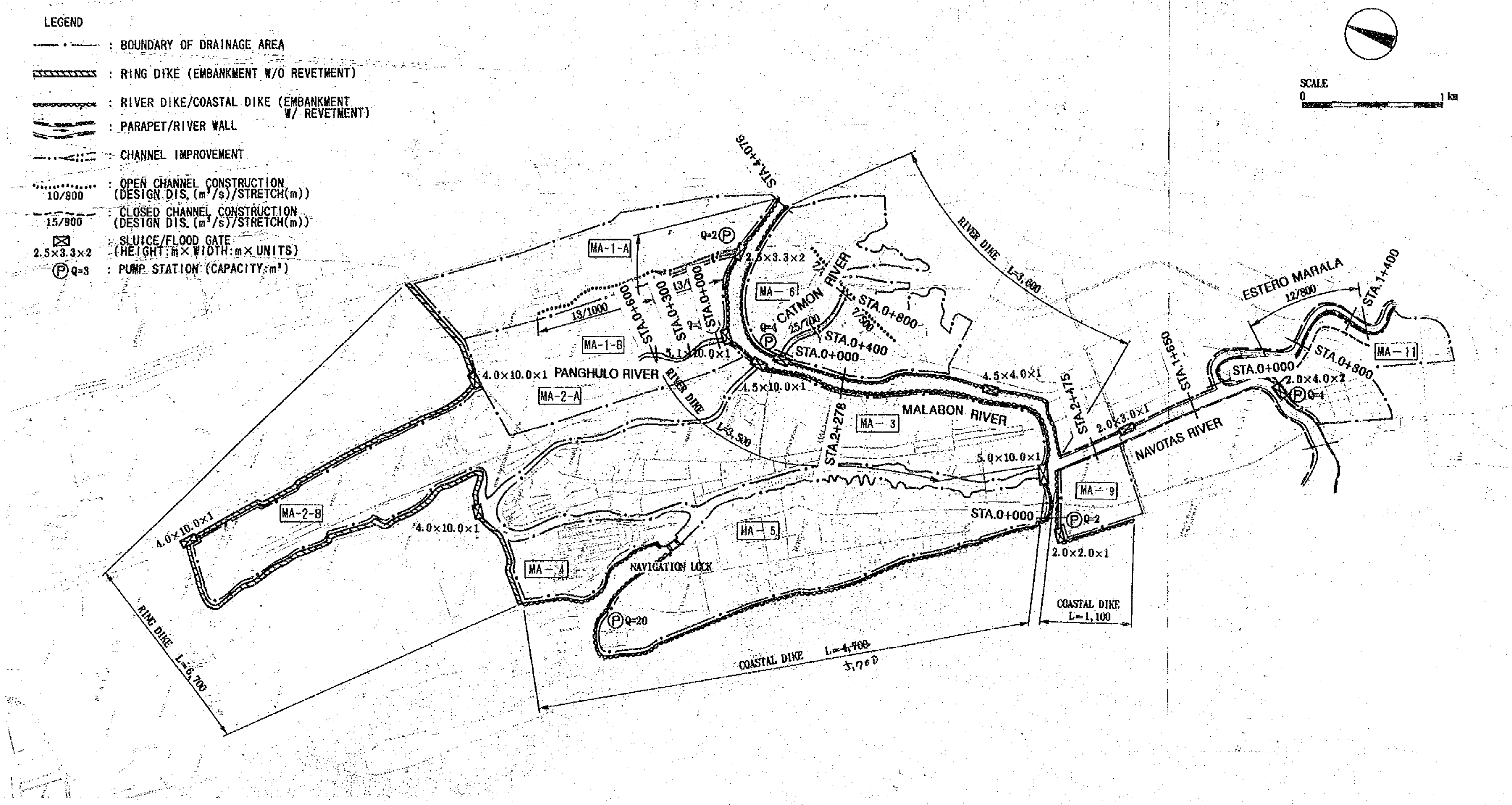


THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES

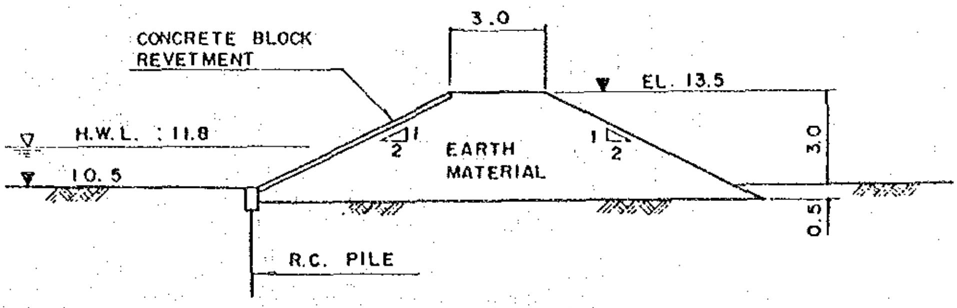
JAPAN INTERNATIONAL COOPERATION AGENCY

GENERAL DRAWING OF BRIDGE (MANGAHAN FLOODWAY)

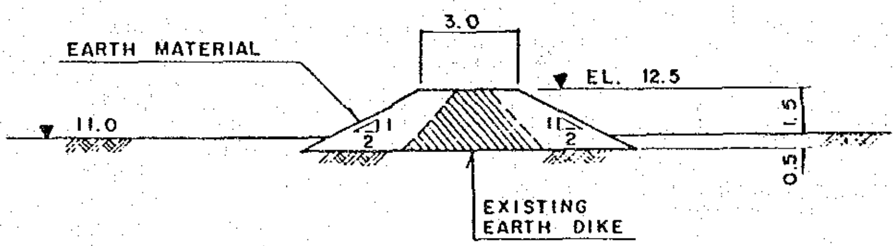
Fig.5-6-11(2/2)



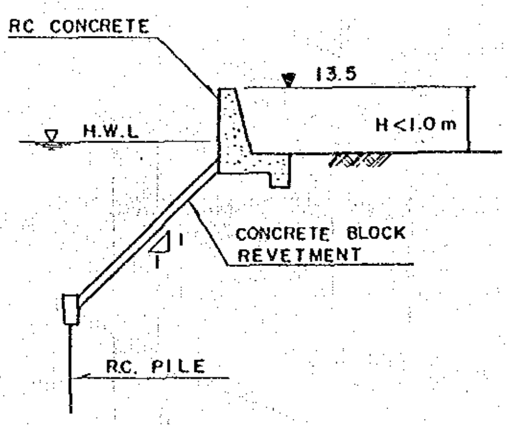
THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES	LOCATIONS OF PROPOSED STRUCTURES FOR MALABON-NAVOTAS
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig.5-6-12



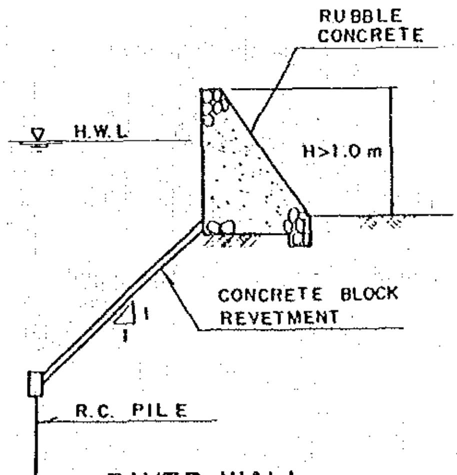
COASTAL DIKE



RING DIKE

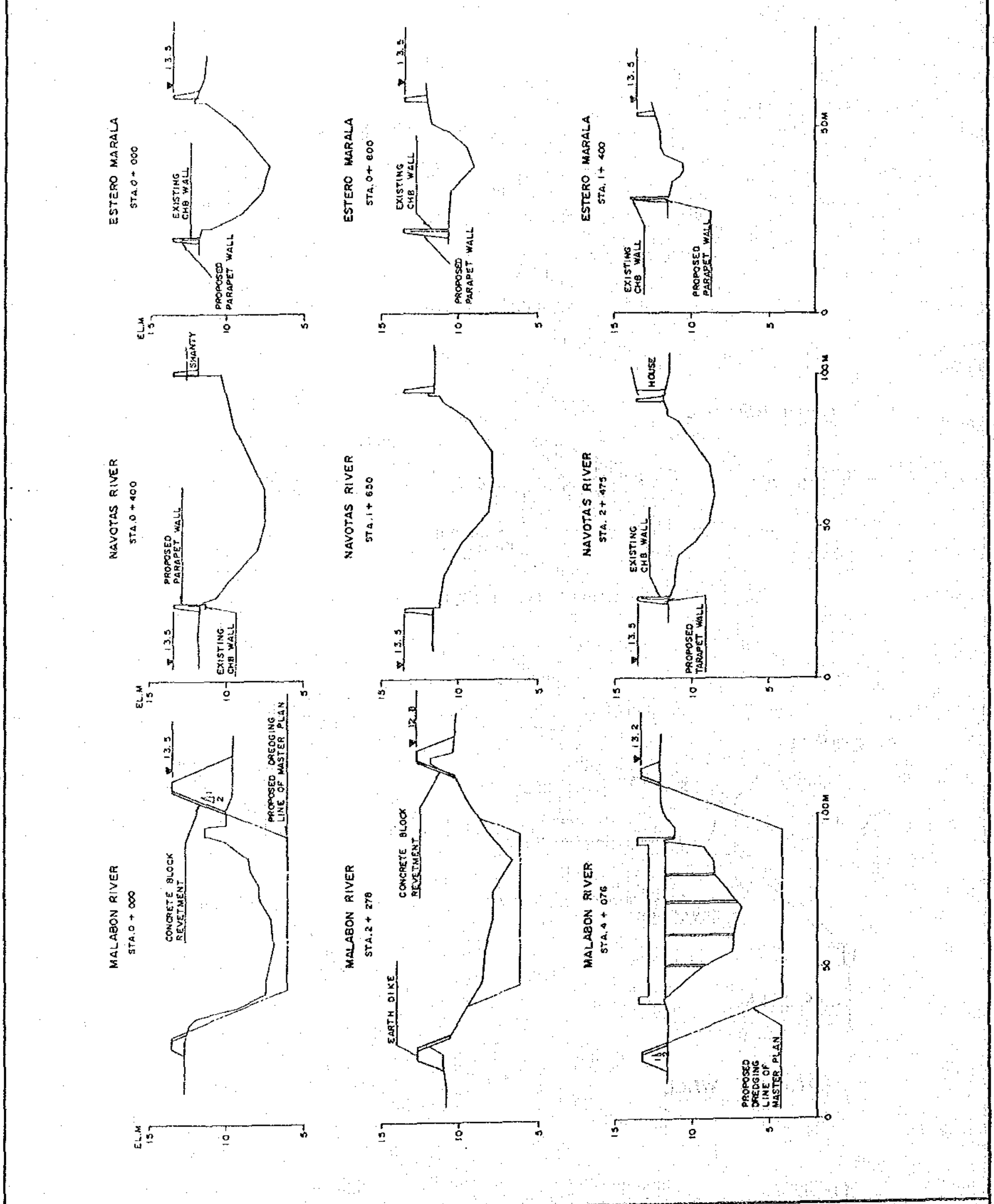


PARAPET WALL

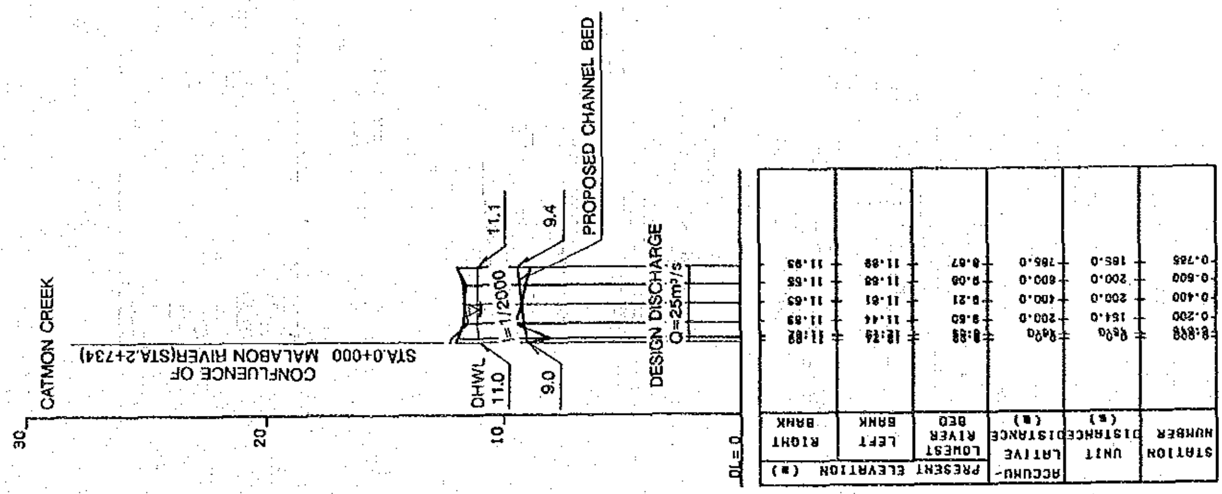


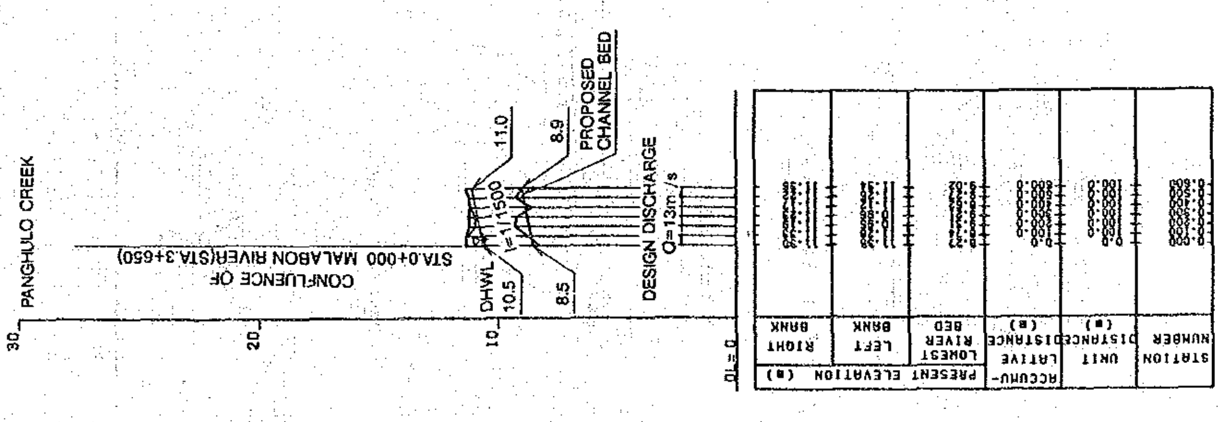
RIVER WALL

THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES JAPAN INTERNATIONAL COOPERATION AGENCY	TYPICAL CROSS-SECTIONS OF RING DIKE (MALABON-NAVOTAS) Fig.5-6-13

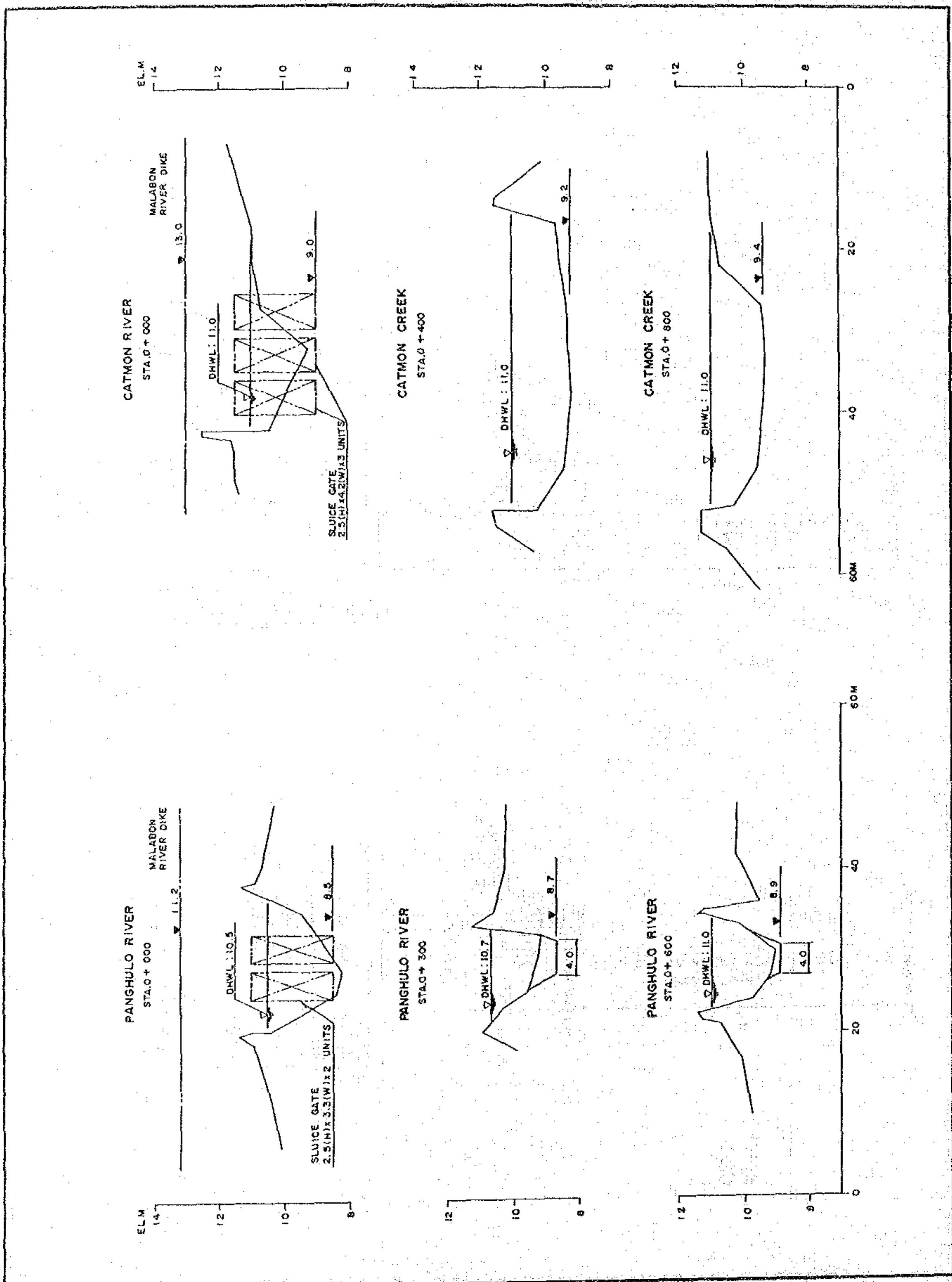


THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES	PROPOSED RIVER DIKE AND PARAPET WALL
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig.5-6-14

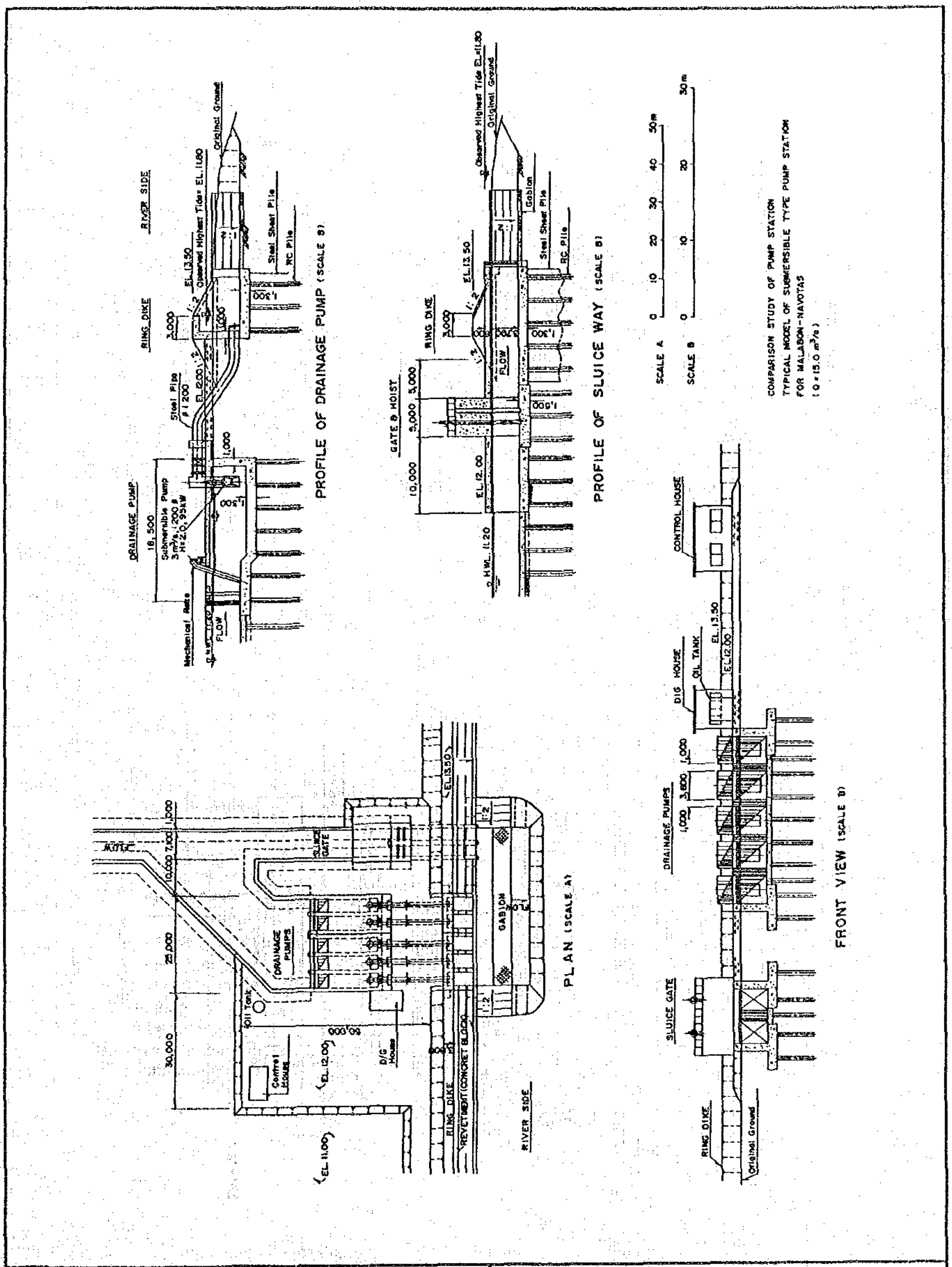




THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES	PROPOSED LONGITUDINAL PROFILE OF DRAINAGE CHANNELS
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig.5-6-15



THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES	PROPOSED CROSS-SECTIONS OF DRAINAGE CHNNELS
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig.5-6-16

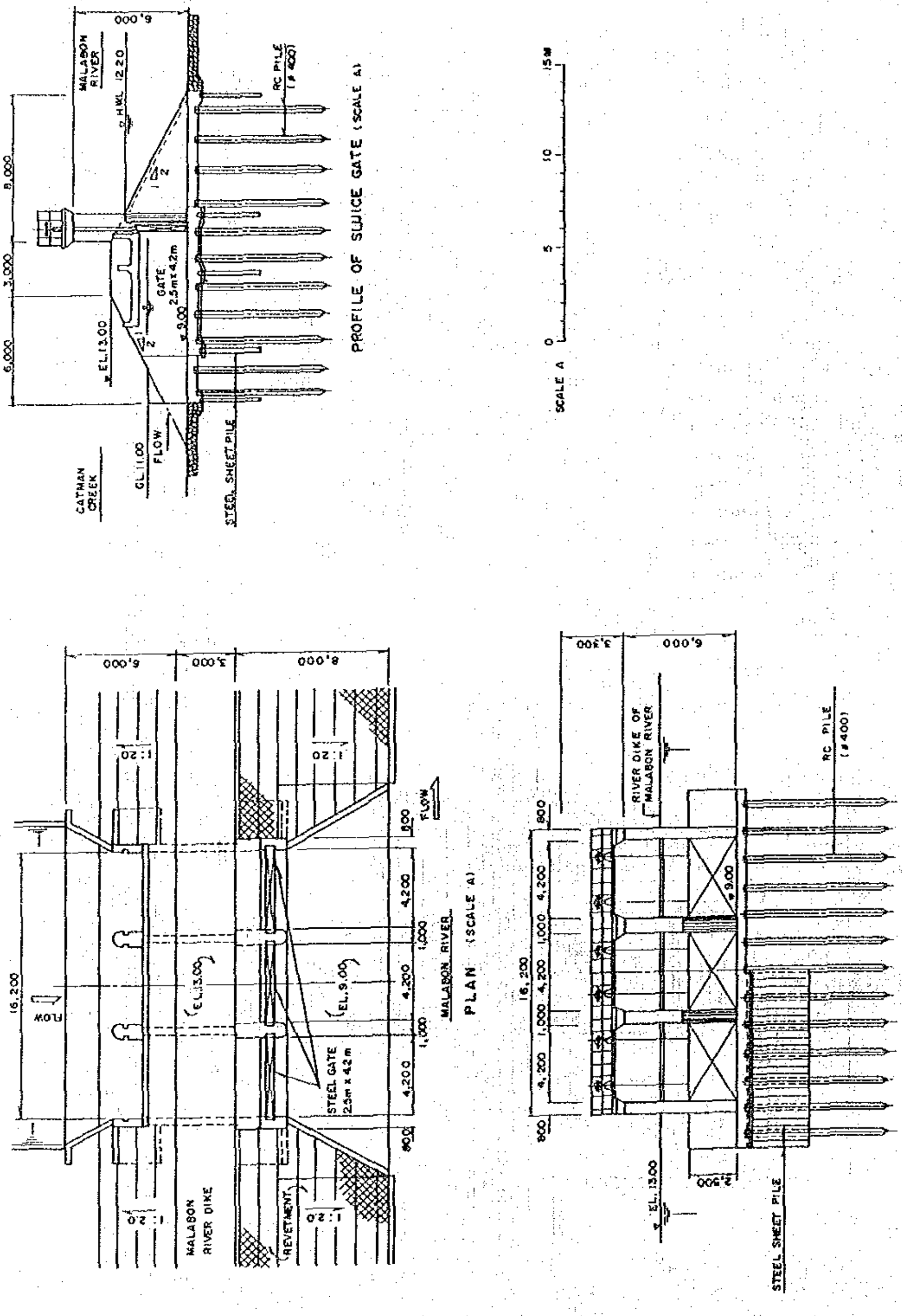


THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES

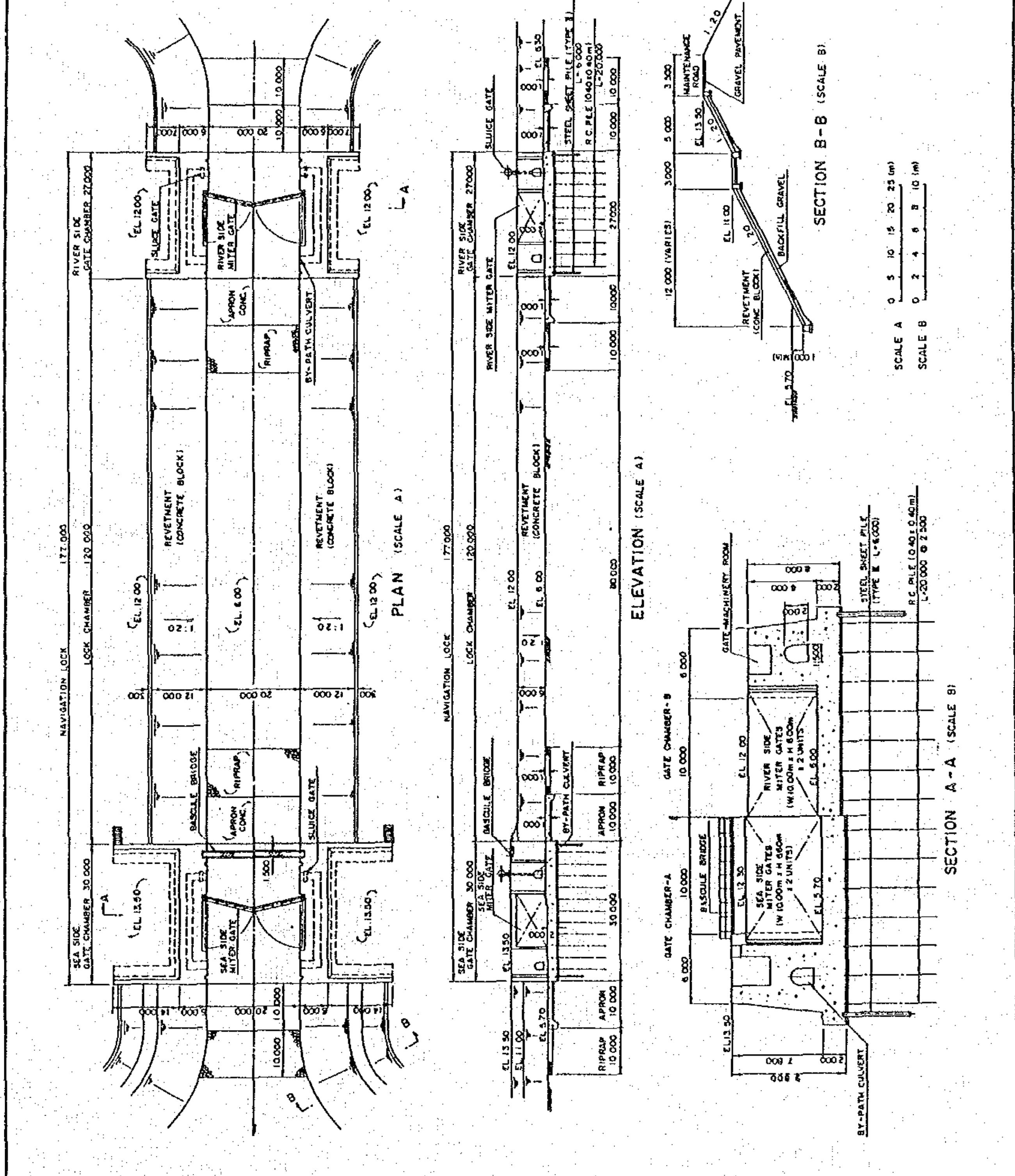
JAPAN INTERNATIONAL COOPERATION AGENCY

TYPICAL LAYOUT OF PUMP STATION (MALABON-NAVOTAS)

Fig.5-6-17



THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES	TYPICAL LAYOUT OF SLUICE GATE (MALABON-NAVOTAS)
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig.5-6-18



THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES

JAPAN INTERNATIONAL COOPERATION AGENCY

GENERAL DRAWING OF NAVOTAS NAVIGATION LOCK

Fig.5-6-19

ANNEX

COMPARATIVE STUDY FOR SELECTION OF PUMP TYPE

1. PUMP STATION FOR EAST AND WEST OF MANGAHAN

Nine (9) pump stations are proposed. The pump capacities of four (4) pumps in East of Mangahan are 2.0, 5.0, 8.0 and 8.0 m^3/s, respectively; while, the five (5) pumps in West of Mangahan are 4.0, 7.0, 14.0, 31.0 and 32.0 m^3/s, respectively.

Submersible type of pump is employed for the pump facility which can be operated by diesel generator. In addition, mechanical rake and truck crane are also provided.

The type selection was made by comparing the characteristics and cost of the submersible type and the conventional (non-submersible) type of pump. Figs. 5-A-1 and 5-A-2 show the typical design of submersible and the conventional (non-submersible) type of pump for comparative study.

(a) Characteristics of Pump Facility

Usually, the conventional (non-submersible) type of pump having a vertical or horizontal shaft with axial or mixed flow type is used for drainage pump stations. In Metro Manila, all pump stations have been constructed using the conventional (non-submersible) type of pump.

In recent years, a submersible type of pump with a relatively big capacity has been adopted for mechanical drainage system, since economical cost for not only initial but also operation and maintenance are expected with the advance of technology. In Bangkok, Thailand, there is a pump station with a capacity of 45 m^3/s which is composed of 15 units of 3.0 m^3/s submersible type of pump. In Japan, some removable type of pump stations using the submersible type of pump are beginning to be planned and the draft design standard has been published.

The advantage of employing the submersible type of pump is its low construction cost for civil, mechanical and electrical works. Ready made submersible type of pump is available, and a full-scale pump building is not necessary.

The disadvantage of employing the submersible type of pump is that it has been used only for the recent 15 years. Therefore, its reliability is generally smaller than that of the conventional (non-submersible) type of pump.

(b) Cost Comparison

Cost comparison between the submersible and the conventional (non-submersible) types of pump was made as shown in Table 5-A-1. The table shows that the submersible type of pump is more economical than the conventional (non-submersible) type.

(b) Optimum Type

The submersible type of pump station is selected according to the results of the comparative study, as shown in Table 5-A-2. However, its reliability must be examined in detail in the detailed design stage.

2. PUMP STATION FOR MALABON-NAVOTAS

Six (6) pump stations are proposed. Their pump capacities are 2.0, 2.0, 3.0, 4.0 and 20.0 m^3/s, respectively.

The type of pump station was determined by comparing the characteristics and cost of the submersible type and the conventional (non-submersible) type of pump. Figs. 5-A-3 and 5-A-4 show the typical design of a submersible type and a conventional (non-submersible) type of pump for comparative study.

Table 5-A-3 shows the construction cost of both types of pump. As a result of the study, the submersible type of pump is selected for the six pump stations. The general advantage and disadvantage of the submersible type of pump and the conventional (non-submersible)type of pump are described in the preceding section.

Table 5-A-1(1/2) COST COMPARISON OF SUBMERSIBLE TYPE PUMP STATION AND NON-SUBMERSIBLE TYPE PUMP STATION OF EAST AND WEST OF MANGAHAN

Item	Unit	Q=30 cms Quantity	Q=30 cms Unit Cost (p)	Q=30 cms Cost (1000 p)	Q=15 cms Quantity	Q=15 cms Unit Cost (p)	Q=15 cms Cost (1000 p)	Q=3 cms Quantity	Q=3 cms Unit Cost (p)	Q=3 cms Cost (1000 p)
1. Preparatory Works				28,308			16,842			7,999
2. Civil Works										
1). Excavation,common	cum	48,000	30	1,440	33,600	30	1,008	15,600	30	468
2). Backfill,common	cum	12,600	30	378	11,300	30	339	7,600	30	228
3). Embankment,common	cum	2,900	105	305	2,400	105	252	2,500	105	263
4). Reinforced concrete	cum	7,760	3,000	23,280	4,980	3,000	14,940	3,200	3,000	9,600
5). R.C. pile	m	4,880	900	4,392	3,120	900	2,808	1,520	900	1,368
Sub-total				29,705			19,347			11,927
3. Mechanical and Electrical Works										
1). Submersible pump	set	10 (Q=3 cms,H=3.1 m, 1200 mm, 132 kw)	3,500,000	35,000	5 (Q=3 cms,H=3.1 m, 1200 mm, 132 kw)	3,500,000	17,500	2 (Q=1.5 cms,H= 3.1 m, 900 mm, 75 kw)	1,800,000	3,600
2). Electrical valve	set	10 (1200 mm)	1,530,000	15,300	5 (1200 mm)	1,530,000	7,650	2 (900 mm)	850,000	1,700
3). Flap valve	set	10 (1350 mm)	410,000	4,100	5 (1350 mm)	410,000	2,050	2 (1,100 mm)	290,000	580
4). Stoplog (1 set)	ton	10	34,000	340	10	34,000	340	8	34,000	272
5). Mechanical rake	set	1	20,400,000	20,400	1	15,300,000	15,300	1	12,200,000	12,200
6). Steel pipe	m	150 (1200 mm)	21,000	3,150	75 (1200 mm)	21,000	1,575	30 (900 mm)	13,600	408
7). Low-tention distibution panel	set	7	680,000	4,760	5	680,000	3,400	3	680,000	2,040
8). Auxiliary pump and ancillary facilities	l.s.			500			500			240
9). Cable and miscellaneous materials	l.s.			2,400			2,000			1,200
10). Diesel generator	set	2 (1000 kVA)	10,200,000	20,400	2 (500 kVA)	5,100,000	10,200	1 (250 kVA)	2,600,000	2,600
11). Control panel	set	1	2,600,000	2,600	1	1,700,000	1,700	1	1,400,000	1,400
12). Oil tank	ton	6.6 (21.0 cum x 2)	200,000	1,320	4.4 (11.4 cum x 2)	200,000	880	1.5 (6.6cum x 1)	200,000	300
13). Day oil tank	ton	2.8 (3,500 l x 2)	200,000	560	2.0 (1,900 l x 2)	200,000	400	0.8 (1,100 l x 1)	200,000	160
14).Track crane(20 t class)	set	1/3	4,100,000	1,367	1/3	4,100,000	1,367	1/3	4,100,000	1,367
Sub-total				112,197			64,862			28,057
4. Direct Cost				170,390			101,051			47,993
5. Engineering Service and Administration				8,520			5,053			2,400
6. Contingency				17,891			10,610			5,039
7. Grand Total				196,801			116,714			55,432

Note :1). Q means the design drainage capacity of a pump station.
2). Preparatory works is 20 % of (2. +3.)
3). Engineering service and administration is 5 % of 4.
4). Contingency is 10 % of (4. +5.)
5). Cost of pump station does not include that of sluiceway.

Table 5-A-1(2/2) COST COMPARISON OF SUBMERSIBLE TYPE PUMP STATION AND NON-SUBMERSIBLE TYPE PUMP STATION OF EAST AND WEST OF MANGAHAN

Item	Unit	Q=30 cms Quantity	Q=30 cms Unit Cost (p)	Q=30 cms Cost (1000 p)	Q=15 cms Quantity	Q=15 cms Unit Cost (p)	Q=15 cms Cost (1000 p)	Q=3 cms Quantity	Q=3 cms Unit Cost (p)	Q=3 cms Cost (1000 p)
1. Preparatory Works				34,177			22,180			12,507
2. Civil Works										
1). Excavation,common	cum	32,800	30	984	24,500	30	735	19,600	30	588
2). Backfill,common	cum	11,000	30	330	9,100	30	273	8,600	30	258
3). Embankment,common	cum	3,300	105	347	3,200	105	336	3,100	105	326
4). Reinforced concrete	cum	9,900	3,000	29,700	7,200	3,000	21,600	5,500	3,000	16,500
5). R.C. pile	m	4,640	900	4,176	3,280	900	2,952	2,960	900	2,664
Sub-total				35,537			25,696			20,336
3. Mechanical and Electrical Works										
1). Horizontal shaft axial flow pump	set	5 (Q=6 cms,H=3.1 m, 1,650 mm)	8,000,000	40,000	3 (Q=5 cms,H=3.1 m, 1,500 mm)	7,200,000	21,600	2 (Q=1.5 cms,H= 3.1 m, 900 mm)	2,900,000	5,800
2). Diesel engine	set	5 (375ps-900rpm)	4,800,000	24,000	3 (325ps-1,000rpm)	4,800,000	14,400	2 (100ps-900rpm)	2,400,000	4,800
3). Reduction gear	set	5 (900/160 rpm)	1,500,000	7,500	3 (1,000/180 rpm)	1,400,000	4,200	2 (900/330rpm)	1,300,000	2,600
4). Electrical valve	set	5 (1,650 mm)	2,600,000	13,000	3 (1,500 mm)	2,000,000	6,000	2 (900 mm)	850,000	1,700
5). Flap valve	set	5 (2,000 mm)	1,200,000	6,000	3 (1,800 mm)	770,000	2,310	2 (1,100 mm)	290,000	580
6). Stoplog (1 set)	ton	15	34,000	510	15	34,000	510	10	34,000	340
7). Mechanical rake	set	1	19,600,000	19,600	1	17,000,000	17,000	1	13,700,000	13,700
8). Overhead crane	set	1 (8 ton class)	5,100,000	5,100	1 (5 ton class)	3,700,000	3,700	1 (5 ton class)	3,200,000	3,200
9). Steel pipe	m	90 (1,650 mm)	43,000	3,870	54 (1,500 mm)	34,000	1,836	36 (900 mm)	13,600	490
10).Electrical facilities for auxiliary equipment	l.s.			3,400			3,400			2,000
11). Diesel engine for auxiliary equipment	set	2 (75 kVA)	1,200,000	2,400	2 (75 kVA)	1,200,000	2,400	2 (50 kVA)	850,000	1,700
12). Auxiliary pump and ancillary facilities	l.s.			1,700			1,500			1,000
13). Cable and miscellaneous materials	l.s.			3,400			2,600			1,400
14). Control panel	set	1	2,600,000	2,600	1	1,700,000	1,700	1	1,400,000	1,400
15). Day oil tank	ton	4.5 (1,300 l x 5)	200,000	900	2.4 (1,100 l x 3)	200,000	480	0.6 (370 l x 2)	200,000	120
16).Track crane(20 t class)	set	1/3	4,100,000	1,367	1/3	4,100,000	1,367	1/3	4,100,000	1,367
Sub-total				135,347			85,003			42,197
4. Direct Cost				205,061			133,079			75,040
5. Engineering Service and Administration				10,253			6,654			3,752
6. Contingency				21,531			13,973			7,879
7. Grand Total				236,845			153,706			86,671

Note :1). Q means the design drainage capacity of a pump station.
2). Preparatory works is 20 % of (2. +3.)
3). Engineering service and administration is 5 % of 4.
4). Contingency is 10 % of (4. +5.)
5). Cost of pump station does not include that of sluiceway.

Table 5-A-2 COMPARISON OF SUBMERSIBLE TYPE PUMP STATION AND NON-SUBMERSIBLE TYPE PUMP STATION OF EAST AND WEST OF MANGAHAN

PUMP STATION	DRAINAGE CAPACITY	PUMP	FINANCIAL COST	PRESENT VALUE FOR FINANCIAL COST	ADVANTAGE AND DISADVANTAGE
1. Submersible Type	30 cms	Submersible pump Q=3 cms x 10 set	P 196,801,000	p 226,404,000	(1). Advantage 1). Construction cost is lower than non-submersible type. 2). Ready-made pump can be available. 3). Pump house is not necessary. (2). Disadvantage 1). Area for pump station is bigger than non-submersible type. 2). Submersible pump must be replaced every 10 year. 3). Experience is less than non-submersible type.
	15 cms	- do - Q=3 cms x 5 set	p 116,714,000	p 133,303,000	
	3 cms	- do - Q=1.5 cms x 2 set	p 55,432,000	p 61,892,000	
2. Non-submersible Type	30 cms	Horizontal shaft axial flow pump Q=6 cms x 5 set	p 236,845,000	p 261,403,000	(1). Advantage 1). Area for pump station is smaller than submersible type. 2). Non-submersible pump must be replaced every 20 year. 3). Experience is more than submersible type (2). Disadvantage 1). Construction cost is higher than submersible type. 2). Ready made pump cannot be available. 3). Pump house is necessary.
	15 cms	- do - Q=5 cms x 3 set	p 153,706,000	p 169,461,000	
	3 cms	- do - Q=1.5 cms x 2 set	p 86,671,000	p 95,185,000	

Notes; Present value for financial cost is calculated by the following assumption.
1). Construction period is one year.
2). Life time is 60 year.
3). Operation and maintenance cost is 1 % of total financial cost.
4).Replacement cost for submersible type pump station occurs every 10 year for pump and 20 year for other mechanical and electrical facilities.
5). Replacement cost for non-submersible type pump station occurs every 20 year for mechanical and electrical facilities.
6). Discount rate is 15 %.

Table 5-A-3(1/2) COST COMPARISON OF SUBMERSIBLE TYPE PUMP STATION AND NON-SUBMERSIBLE TYPE PUMP STATION OF MALABON-NAVOTAS

Item	Unit	Q=30 cms Quantity	Q=30 cms Unit Cost (p)	Q=30 cms Cost (1000 p)	Q=15 cms Quantity	Q=15 cms Unit Cost (p)	Q=15 cms Cost (1000 p)	Q=3 cms Quantity	Q=3 cms Unit Cost (p)	Q=3 cms Cost (1000 p)
1 Preparatory Works				27,957			16,795			7,692
2. Civil Works										
1). Excavation,common	cum	37,500	50	1,875	23,400	50	1,170	9,500	50	475
2) Backfill,common	cum	6,700	50	335	6,300	50	315	5,800	50	290
3). Embankment,common	cum	2,500	105	263	2,200	105	231	2,100	105	221
4). Reinforced concrete	cum	88,000	3,000	26,400	6,000	3,000	18,000	3,000	3,000	9,000
5). R.C. pile	m	5,800	900	5,220	2,830	900	2,547	1,630	900	1,467
6) Steel sheet pile	sqm	500	3,200	1,600	260	3,200	832	120	3,200	384
7). Revetment	sqm	160	600	96	160	600	96	160	600	96
8). Gabion	sqm	340	500	170	210	500	105	120	500	60
Sub-total				35,959			23,296			11,993
3. Mechanical and Electrical Works										
1). Submersible pump	set	10 (Q=3 cms,H=2.0 m, 1200 mm, 95 kw)	3,320,000	33,200	5 (Q=3 cms,H=2.0 m, 1200 mm, 95 kw)	3,320,000	16,600	2 (Q=1.5 cms,H= 2.0 m, 900 mm, 50 kw)	1,800,000	3,600
2). Electrical valve	set	10 (1200 mm)	1,530,000	15,300	5 (1200 mm)	1,530,000	7,650	2 (900 mm)	850,000	1,700
3). Flap valve	set	10 (1350 mm)	410,000	4,100	5 (1350 mm)	410,000	2,050	2 (1,100 mm)	290,000	580
4). Stoplog (1 set)	ton	10	34,000	340	10	34,000	340	8	34,000	272
5). Mechanical rake	set	1	20,400,000	20,400	1	15,300,000	15,300	1	12,200,000	12,200
6). Steel pipe	m	180 (1200 mm)	21,000	3,780	90 (1200 mm)	21,000	1,890	36 (900 mm)	13,600	490
7). Low-tention distibution panel	set	7	680,000	4,760	5	680,000	3,400	3	680,000	2,040
8). Auxiliary pump and ancillary facilities	l.s.			500			500			240
9).Cable and miscellaneous materials	l.s.			2,400			2,000			1,200
10). Diesel generator	set	2 (650 kVA)	6,800,000	13,600	2 (325 kVA)	3,400,000	6,800	1 (100 kVA)	1,000,000	1,000
11). Control panel	set	1	2,600,000	2,600	1	1,700,000	1,700	1	1,400,000	1,400
12). Oil tank	ton	5.2 (14.4 cum x 2)	200,000	1,040	3.6 (8.4 cum x 2)	200,000	720	1.2 (4.8 cum x 1)	200,000	240
13) Day oil tank	ton	2.2 (2,400 l x 2)	200,000	440	1.8 (1,400 l x 2)	200,000	360	0.7 (800 l x 1)	200,000	140
14).Track crane(20 t class)	set	1/3	4,100,000	1,367	1/3	4,100,000	1,367	1/3	4,100,000	1,367
Sub-total				103,827			60,677			26,469
4. Direct Cost				167,743			100,768			46,154
5. Engineering Service and Administration				8,387			5,038			2,308
6 Contingency				17,613			10,581			4,846
7. Grand Total				193,743			116,387			53,308

Note .1) Q means the design drainage capacity of a pump station.
2) Preparatory works is 20 % of (2. +3.)
3). Engineering service and administration is 5 % of 4.
4). Contingency is 10 % of (4 +5.)
5) Cost of pump station does not include that of sluiceway.

Table 5-A-3(2/2) COST COMPARISON OF SUBMERSIBLE TYPE PUMP STATION AND NON-SUBMERSIBLE TYPE PUMP STATION OF MALABON-NAVOTAS

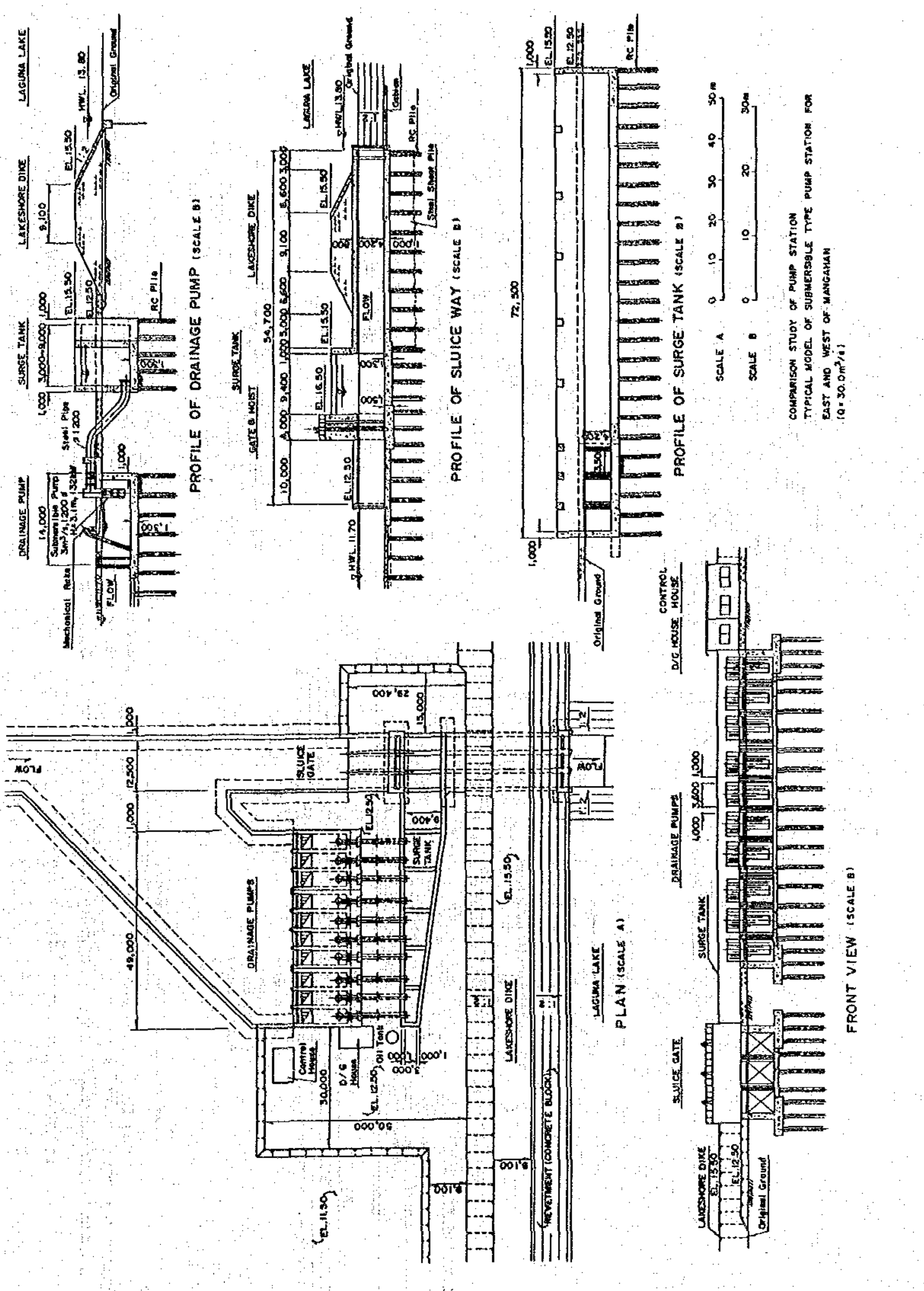
Item	Unit	Q=30 cms			Q=15 cms			Q=3 cms		
		Quantity	Unit Cost (p)	Cost (1000 p)	Quantity	Unit Cost (p)	Cost (1000 p)	Quantity	Unit Cost (p)	Cost (1000 p)
1. Preparatory Works				37,164			22,959			12,348
2. Civil Works										
1). Excavation,common	cum	34,500	50	1,225	22,800	50	1,140	15,800	50	790
2). Backfill,common	cum	7,200	50	360	6,000	50	300	2,700	50	135
3). Embankment,common	cum	2,600	105	273	2,500	105	263	2,400	105	252
4). Reinforced concrete	cum	9,300	3,000	27,900	5,600	3,000	16,800	4,600	3,000	13,800
5). R.C. pile	m	4,400	900	3,960	2,560	900	2,304	1,920	900	1,728
6). Steel sheet pile	sqm	310	3,200	992	190	3,200	608	100	3,200	320
7). Revetment	sqm	160	600	96	160	600	96	160	600	96
8). Gabion	sqm	280	500	140	170	500	85	140	500	70
Sub-total				34,948			21,596			17,191
3. Mechanical and Electrical Works										
1). Vertical shaft axial flow pump	set	5 (Q=6 cms,H=2.0 m, 1,650 mm)	12,200,000	61,000	3 (Q=3 cms,H=2.0 m, 1,500 mm)	11,000,000	33,000	2 (Q=1.5 cms,H=2.0 m, 900 mm)	4,400,000	8,800
2). Diesel engine	set	5 (250ps-900rpm)	3,600,000	18,000	3 (220ps-1,000rpm)	3,600,000	10,800	2 (80ps-900rpm)	2,200,000	4,400
3). Reduction gear	set	5 (900/100 rpm)	1,700,000	8,500	3 (1,000/110 rpm)	1,600,000	4,800	2 (900/200rpm)	1,200,000	2,400
4). Electrical valve	set	5 (1,650 mm)	2,600,000	13,000	3 (1,500 mm)	2,000,000	6,000	2 (900 mm)	850,000	1,700
5). Flap valve	set	5 (2,000 mm)	1,200,000	6,000	3 (1,800 mm)	770,000	2,310	2 (1,100 mm)	290,000	580
6). Stoplog (1 set)	ton	15	34,000	510	15	34,000	510	10	34,000	340
7). Mechanical rake	set	1	19,600,000	19,600	1	17,000,000	17,000	1	13,700,000	13,700
8). Overhead crane	set	1 (8 ton class)	5,100,000	5,100	1 (5 ton class)	3,700,000	3,700	1 (5 ton class)	3,200,000	3,200
9). Steel pipe	m	85 (1,650 mm)	43,000	3,655	51 (1,500 mm)	34,000	1,734	34 (900 mm)	13,600	462
10).Electrical facilities for auxiliary equipment	l.s.			3,400			3,400			2,000
11). Diesel engine for auxiliary equipment	set	2 (75 kVA)	1,200,000	2,400	2 (75 kVA)	1,200,000	2,400	2 (50 kVA)	850,000	1,700
12). Auxiliary pump and ancillary facilities	l.s.			1,700			1,500			1,000
13).Cable and miscellaneous materials	l.s.			3,400			2,600			1,400
14). Control panel	set	1	2,600,000	2,600	1	1,700,000	1,700	1	1,400,000	1,400
15). Day oil tank	ton	3.7 (930 l x 5)	200,000	740	1.9 (820 l x 3)	200,000	380	0.5 (300 l x 2)	200,000	100
16).Track crane(20 t class)	set	1/3	4,100,000	1,367	1/3	4,100,000	1,367	1/3	4,100,000	1,367
Sub-total				150,972			93,201			44,549
4. Direct Cost				223,102			137,756			74,088
5. Engineering Service and Administration				11,155			6,888			3,704
6. Contingency				23,426			14,464			7,779
7. Grand Total				257,683			159,108			85,571

Note :1). Q means the design drainage capacity of a pump station.
2). Preparatory works is 20 % of (2. +3.)
3). Engineering service and administration is 5 % of 4.
4). Contingency is 10 % of (4. +5.)
5). Cost of pump station does not include that of sluiceway.

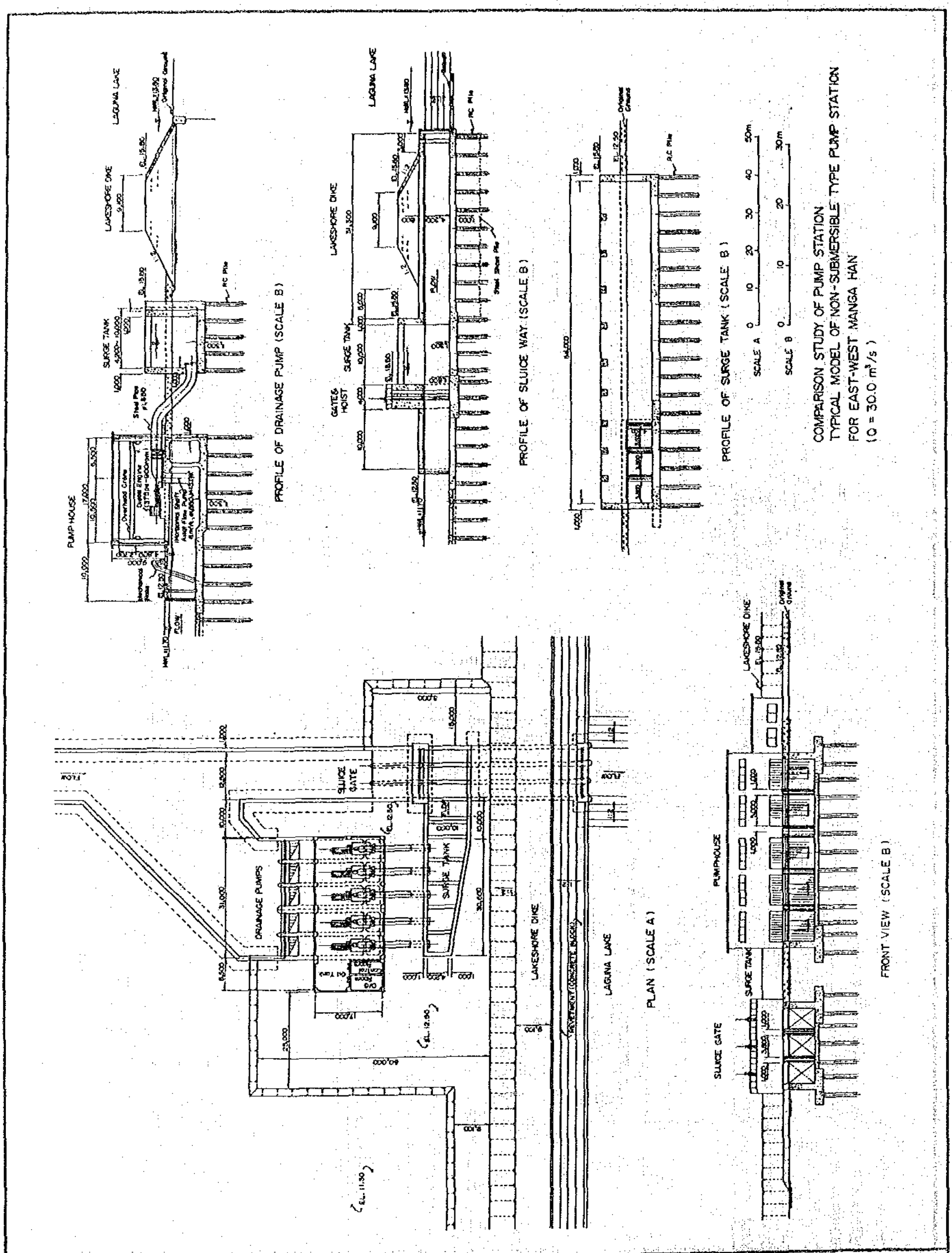
Table 5-A-4 COMPARISON OF SUBMERSIBLE TYPE PUMP STATION AND NON-SUBMERSIBLE TYPE PUMP STATION OF MALABON-NAVOTAS

PUMP STATION	DRAINAGE CAPACITY	PUMP	FINANCIAL COST	PRESENT VALUE FOR FINANCIAL COST	ADVANTAGE AND DISADVANTAGE
1. Submersible Type	30 cms	Submersible pump Q=3 cms x 10 set	p 193,743,000	p 222,123,000	(1). Advantage 1). Construction cost is lower than non-submersible type. 2). Ready-made pump can be available. 3). Pump house is not necessary. (2). Disadvantage 1). Area for pump station is bigger than non-submersible type. 2). Submersible pump must be replaced every 10 year. 3). Experience is less than non-submersible type.
	15 cms	- do - Q=3 cms x 5 set	p 116,387,000	p 132,448,000	
	3 cms	- do - Q=1.5 cms x 2 set	p 53,308,000	p 59,524,000	
2. Non-submersible Type	30 cms	Vertical shaft axial flow pump Q=6 cms x 5 set	p 257,683,000	p 284,647,000	(1). Advantage 1). Area for pump station is smaller than submersible type. 2). Non-submersible pump must be replaced every 20 year. 3). Experience is more than submersible type (2). Disadvantage 1). Construction cost is higher than submersible type. 2). Ready made pump cannot be available. 3). Pump house is necessary.
	15 cms	- do - Q=5 cms x 3 set	p 159,108,000	p 175,754,000	
	3 cms	- do - Q=1.5 cms x 2 set	p 85,571,000	p 94,164,000	

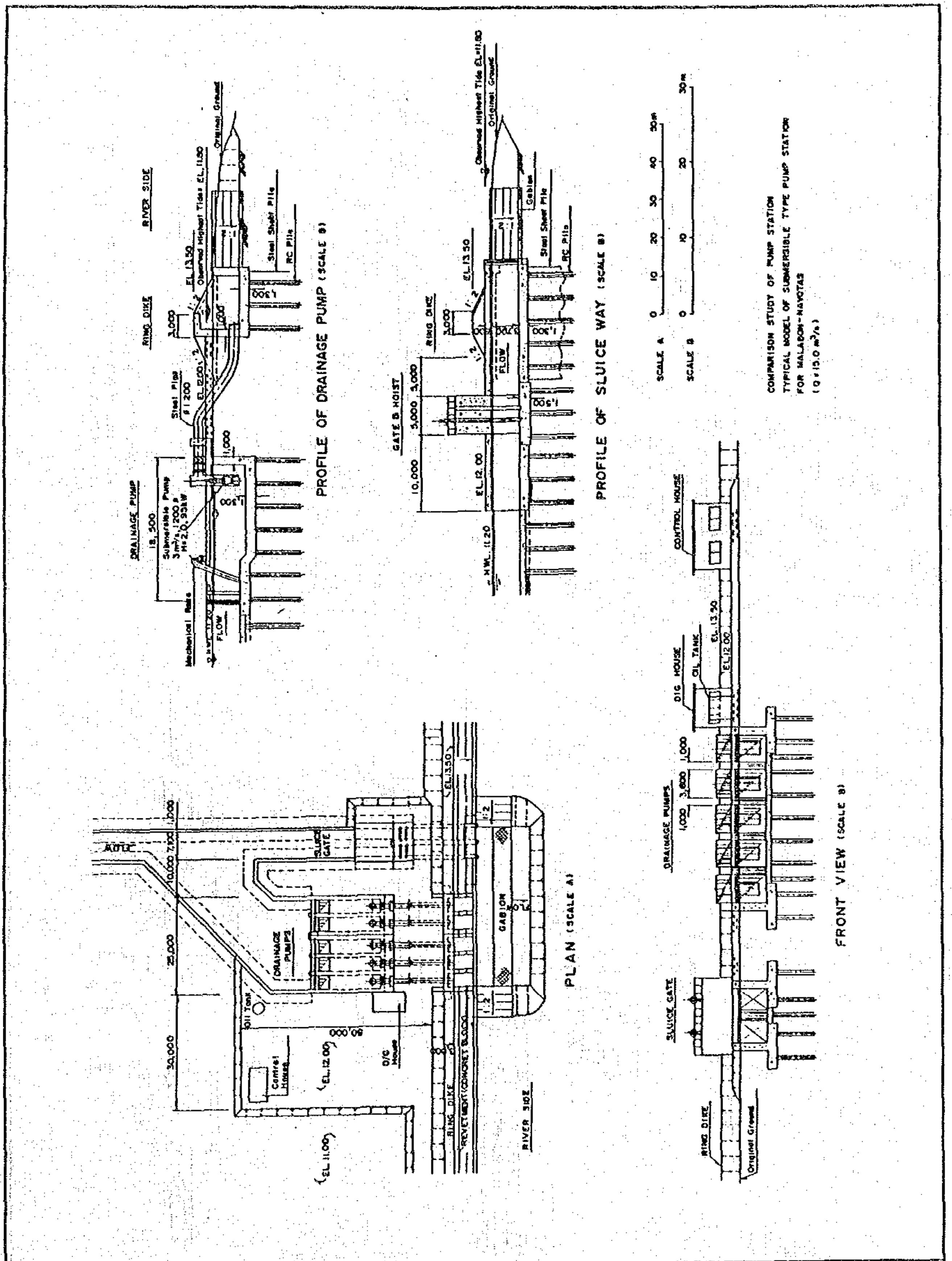
Notes; Present value for financial cost is calculated by the following assumption.
1). Construction period is one year.
2). Life time is 60 year.
3). Operation and maintenance cost is 1 % of total financial cost.
4).Replacement cost for submersible type pump station occurs every 10 year for pump and 20 year for other mechanical and electrical facilities.
5). Replacement cost for non-submersible type pump station occurs every 20 year for mechanical and electrical facilities.
6). Discount rate is 15 %.



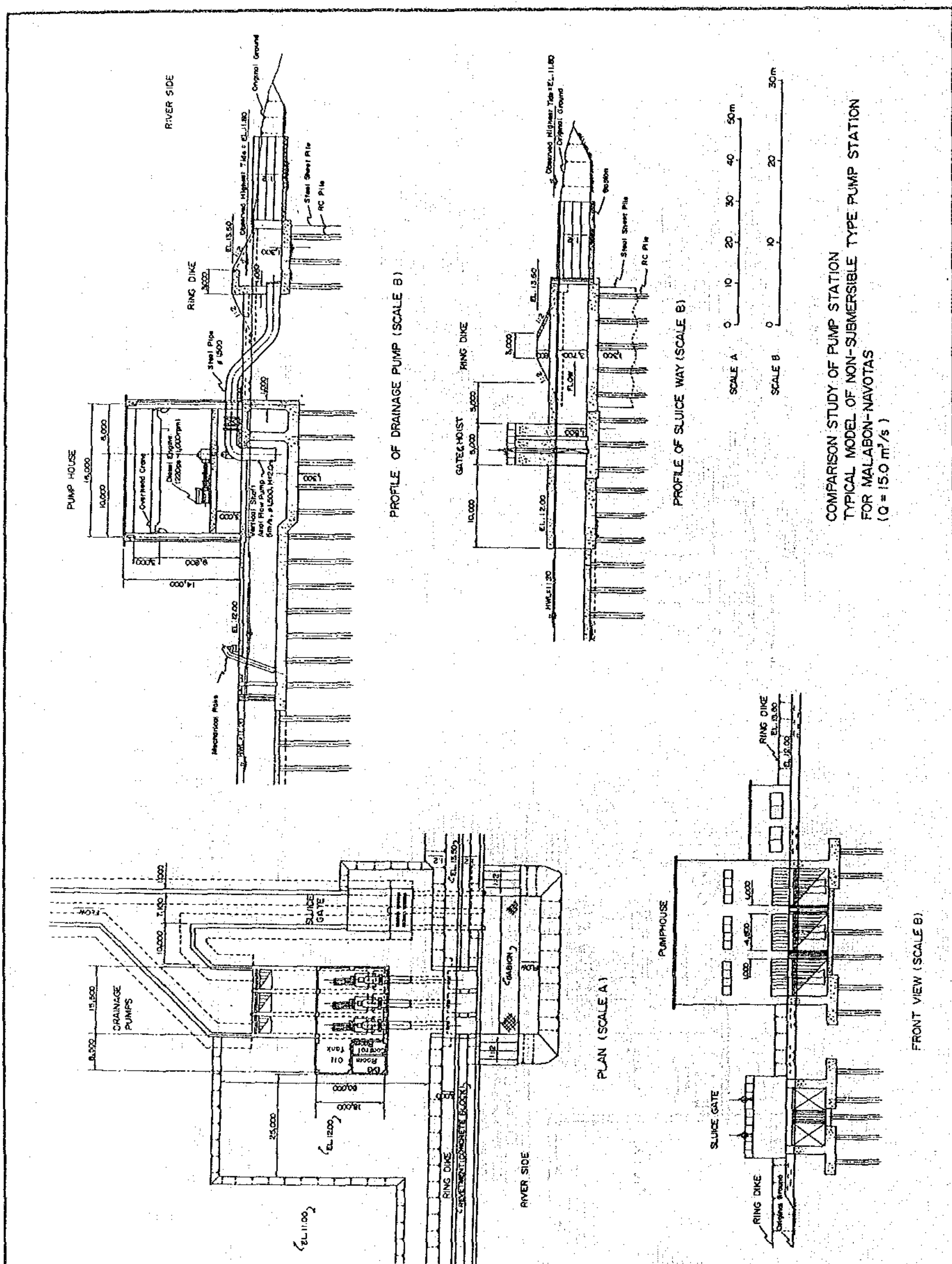
THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES	TYPICAL SUBMERSIBLE TYPE PUMP STATION FOR EAST AND WEST OF MANGAHAN
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig.5-A-1



THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES	TYPICAL NON-SUBMERSIBLE TYPE PUMP STATION FOR EAST AND WEST OF MANGAHAN
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig.5-A-2



THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT IN METRO MANILA, PHILIPPINES	TYPICAL SUBMERSIBLE TYPE PUMP STATION FOR MALABON-NAVOTAS
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig.5-A-3



THE STUDY ON FLOOD CONTROL AND DRAINAGE PROJECT
IN METRO MANILA, PHILIPPINES

JAPAN INTERNATIONAL COOPERATION AGENCY

TYPICAL NON-SUBMERSIBLE TYPE PUMP STATION FOR MALABON-NAVOTAS

Fig.5-A-4

VI. CONSTRUCTION PLANNING AND COST ESTIMATE

SUPPORTING REPORT

VI. CONSTRUCTION PLAN AND COST ESTIMATES

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1. GENERAL

This sector of the supporting report deals with the construction plan, construction schedule and cost estimate of the project. The proposed construction plan provides a guide to the basic understanding on construction works.

2. CONSTRUCTION PLAN AND TIME SCHEDULE

2.1 Conditions for Construction Planning

For the construction planning and scheduling, the following considerations have been taken as the basic concept of construction of the project.

(1) Mode of Construction

The construction shall be carried out by contractors selected through international competitive bidding.

(2) Working Days and Hours

Considering the climate, Sundays and national holidays, the annual workable days for construction works are set at 200 days for earth work except dredging and 250 days for dredging and concrete works.

Daily working hours is set at 9 hours with 1-hour overtime except dredging work in the Pasig-Marikina River, which shall be executed in 2-shift operation within 18 hours, considering the past working system in Metro Manila and the efficient operation of equipment.

(3) Temporary Facilities

No special planning on construction of the offices, quarters, warehouses, workshops, water supply system, electric power supply system, communication system, etc., is considered.

(4) Aggregate and Concrete Plants

No provision for aggregate and concrete plants is considered because sand and gravel, aggregates for concrete and ready mixed concrete are available in Metro Manila at high quality and reasonable prices.

(5) Construction Method and Type of Construction Equipment

The construction shall be principally carried out by applying improved conventional construction methods with standard type of equipment.

(6) Arrangement of Spoil Bank

The spoil banks for the dredged/excavated materials from the river/estero bed and foundation of the structures shall be arranged near the estuary of the Pasig, the West of Mangahan, the Malabon/Navotas, etc., in consideration with the reduction of hauling distance of materials.

2.2 Work Items and Quantities

In this study on flood control and drainage project in Metro Manila, the Framework Plan, Master Plan and three priority projects for feasibility study were formulated. The main works and earth works, concrete works and installation of pump equipment and steel gates.

The major work items are summarized as follows:

- Excavation, common
- Excavation, dredging
- Embankment, earth
- Revetment, rubble concrete
- Rip-rap
- Mass concrete
- Parapet wall, reinforced concrete
- River wall, rubble concrete
- River wall, reinforced concrete

- River wall, steel sheet pile
- Metal work, steel gates, pipeline, etc.
- Bridge, concrete and steel

In the Framework Plan and the Master Plan, a definitive construction plan was not prepared because there are various matters regarding project execution that are yet to be known. As for the three priority projects for feasibility study, an ordinary construction plan and work time schedule were prepared, considering the present situation in Metro Manila as described in the following section.

2.3 Construction Plan

<u>General</u>

The construction methods for major work items in the Feasibility Study, except those of the lakeshore dike, are planned as follows:

(1) Excavation, Common

The excavation of on-land works such as foundation of the lakeshore dike, pump station, sluice gate, etc., are planned to be carried out by using bulldozer, swampdozer, backhoe, clamshell, wheel loader, and/or dump truck. The typical combinations of construction equipment are shown in Fig. 6-2-1, Excavation/Dredging Methods and Combination of Construction Equipment. Equipment combination Nos. 1 to 9 are for on-land works.

For the smooth and effective operation of the equipment, supporting equipment and materials such as portable pumping equipment, sand and gravel, roadmats, etc., are planned to be used. A part of selected excavated materials is planned to be used for backfill or embankment directly or from the stockpile.

In case of excavation for submerged portions such as foundation of revetment, drainage pumping station, sluice gate, abutment of bridge, etc., coffering of the work site with earth dike and/or steel sheet piles shall be considered.

(2) Excavation, Dredging

The excavation of river/estero bed and regulating pond to be constructed in a swampy area shall be carried out by using a cutter suction dredger with enough length of floating and shore pipes, or floating type clamshell/backhoe (combination of crawler type clamshell and common type pontoon), anchor barge/dumping scow, tugboat and other tender-boats. The equipment combination Nos. 10 to 17 in Fig. 6-2-1 are for dredging works.

Dredging method by cutter suction dredger is planned to be employed for the excavation of a riverbed or pond having a large volume. The excavated materials are conveyed through the pipeline to the spoil bank or temporary spoil bank prepared on an open space near the riverbank. If there is no suitable ground for the temporary spoil bank, the materials have to be conveyed by the floating booster pump(s) to the nearest temporary spoil bank. The dewatered materials in the temporary spoil bank are loaded to the dump truck and/or barge/dumping scow using a wheel loader, backhoe or clamshell and hauled to the final spoil bank. In this case, the double or triple handling method of dredged materials may be reflected on the cost estimate.

The hauling distance to the spoil banks available for the dredged materials from the Pasig-Marikina is more than 15 km on average. On the other hand, the arrangement of temporary spoil banks on both banks of the river is difficult due to the congested areas.

The off-shore disposal of the dredged materials is not considered due to the environmental disturbance to the marine livelihood of surrounding areas.

(3) Embankment, Earth

The embankment for the dike/levee is planned to be principally carried out with the suitable materials from the borrow pit, except in special cases where embankment is done with the excavated/dredged materials after adjusting the water content.

The embankment work is carried out by using bulldozer, backhoe and/or wheel loader as the excavator/loader in borrow pit, dump truck as the hauling equipment, and bulldozer and compactor as spreading and compaction equipment, respectively.

In the dry season, water tanker may be required for adjusting the water content in the earth materials.

(4) Revetment, Rubble Concrete

The revetment work with rubble concrete is simple and common civil work if in the dry condition. However, in this project, almost all of the planned portion to be reveted is always under water.

For constructing the revetment for the river banks, coffering as a preparatory work is required for the portion under water. In case of revetment of the Pasig-Marikina and construction of the Marikina Control Gate Structure and the Navotas Navigation Lock, large scale coffering with steel pipe-sheet piles is required.

Coffering with steel pipe-sheet piles and removal is planned to be carried out by using a fleet (2-crawler type pile driver set with diesel pile hammer, or vibro pile extractor and diesel generator on the floating pontoon with meneuvering winches, 2-truck crane on the floating pontoon with pipe storing space and maneuvering winches and diesel generator, 1-barge for transporting the steel sheet piles and other necessary steel materials for coffering, 1-tug boat for the above barge/pontoon, 1 or 2 anchor barge/tender boat) from riverside and a fleet (1-crawler type crane with diesel pile hammer or vibro pile extractor, 1-truck crane for handling the steel materials) from bank side.

Portable type submersible pumping sets and diesel generator for unwatering are planned to be installed by the coffer pile-wall and on the bank, respectively. After unwatering the excavation for revetment is carried out by bulldozer, backhoe/clamshel, dump truck or barge/dumping scow

The revetment materials such as rubbles, ready mixed concrete or concrete aggregates and cement to be procured in Metro Manila are transported by using dump truck and/or mixer truck from the land side, or barge with tugboat from the riverside.

(5) Concrete, Mass Concrete and River Wall

The concrete works such as mass concrete, reinforced concrete for gate structures, pumping stations, parapet wall and river wall are planned to be carried out by using mixer truck and/or mixer barge for transporting the ready mixed (wet or dry mixed) concrete procured from the suppliers nearby, concrete pump and/or crawler or truck crane with concrete bucket for pouring, and electric driven concrete vibrator for compaction.

The concrete form is planned to be mainly used with steel forms and wooden forms for special case only.

(6) Metal Works and Pumping Equipment

After fabricating in factory, the gate leaf with hoist and pumping equipment are planned to be transported and installed by the suppliers by using truck/trailer, truck crane and/or crawler crane before removal of coffering for civil works.

Drainage Improvement in East and West of Mangahan

The major work items of the Drainage Improvement in East and West of Mangahan are (1) construction of the earth dike for lakeshore and sluice gates with maintenance bridges, (2) river channel works including excavation, embankment, parapet walls, revetment and bridge construction, and (3) construction of drainage system including regulating ponds, drainage channels, sluice gates and pumping station.

The construction planning for the major work items is executed in accordance with the construction methods described above.

Drainage Improvement in Malabon-Navotas

The major work items of the Drainage Improvement in Malabon-Navotas are (1) construction of ring dike for North of Malabon River including excavation, embankment and revetment, drainage channels and laterals, gates and pumping stations; (2) construction of ring dike for South of Malabon River including excavation, embankment, revetment, parapet walls, drainage channels and laterals, gates and pumping stations; and,