4.5.2 Weir Type Alternative

From the viewpoint of floods in the upstream reaches of the weir site, a movable type weir is desirable. The following two types of movable weir are applicable for the Lubukjambi Intake Weir.

- Roller Gate Type Intake Weir [refer to Fig. XIII.4.16(1/2)]
- Radial Gate Type Intake Weir [refer to Fig. XIII.4.16(2/2)]

Rubber gate and tilting gate types are excluded from the comparative study because the required gate height is too high for their availability. As a result of the comparative study tabulated in Table XIII.4.3, roller gate type is selected from the technical and economical viewpoints.

4.5.3 Preliminary Design of Weir

Lubukjambi Intake Weir is also designed for a 50-year return period flood and intake discharges of the overall plan. The proposed roller gate type weir is shown in Fig. XIII.4.17.

(1) Basic Design Conditions

The basic design conditions are as given in the table below.

(1)	Weir Type	Roller Gate Weir
(2)	Weir Sill Elevation	EL 55.3 m
(3)	Weir Crest Elevation	EL 60.0 m
(4)	Weir Height	4.7 m
(5)	Weir Length	144.6 m
(6)	Storage High Water Level	EL 60.0 m
(7)	Storage Low Water Level	EL 58.0 m
(8)	Storage Capacity Required	$2.2 \times 10^6 m^3$
(9)	Intake Discharge	$19.31\ m^3/s$ (Left Bank Area) $17.62\ m^3/s$ (Right Bank Area)
(10)	Design Flood Discharge	$3{,}200\ m^3/s$
(11)	High Water Level	EL 62.1 m
(12)	Dike Crest Elevation	EL 63.3 m
(13)	Riverbed Elevation	EL 54.3 m

(2) Spillway, Scouring Sluices, Aprons, Ripraps and Inlets

The functions of spillway, scouring sluices, aprons, ripraps and inlets are the same as those mentioned in Subsection 4.3.3 for Kuok Intake Weir.

(3) Foundation

According to the results of drillholes conducted in this study, gravel or claystone and sandstone layers will be the bed of shallower foundation for proposed structures. Sheet piling or blanketing will be needed to prevent seepage.

4.5.4 Main Irrigation Canal

Main canals proposed in the Initial Phase are shown in Fig. XIII.4.8 and Table XIII.4.2.

TABLES

XIII RIPARIAN STRUCTURE ENGINEERING

Table XIII.1.1 Major Existing Bridges

River	Bridge Name	Length	Width	Construction Year	Location from river mouth (from Pekanbaru)
Kampar	Langgam	5 @ 60 = 300 m	0.5+6.0+0.5 = 7.0 m	1990	168 km (84 km)
- do -	Taratakbuluh	3 @ 55 + 35 = 200 m	0.5+6.0+0.5 = 7.0 m	1970	283 km (18 km)
- do -	Danaubingkuang	40 + 120 + 40 = 200 m	0.5+6.0+0.5 = 7.0 m	ND	327 km (23 km)
- do -	Bangkinang	3 @ 60 = 180 m	0.5+6.0+0.5 = 7.0 m	1990	375 km (60 km)
- do -	Rantauberangin	40 + 120 + 40 = 200 m	1.0+6.0+1.0 = 8.0 m	1974	392 km (78 km)
Indragiri	Pasirringgit	20 + 5 @ 42 + 16 = 246 m	0.5+6.0+0.5 = 7.0 m	ND	215 km (185 km)
- do -	Benai	40 + 60 + 60 + 40 = 200m	0.5+6.0+0.5 = 7.0 m	1993	375 km (174 km)
- do -	Lubukjambi	5 @ 40 = 200m	0.5+6.0+0.5 = 7.0 m	ND	450 km (185 km)

ND : not defined

Table XIII.2.1 DESIGN CRITERIA OF MAIN IRRIGATION CANAL

(1) Flow Formula

Strickler Manning formula

$$Q=A\,V, \qquad V=K\,R^{2/3}\,I^{1/2} \qquad R=A/P$$

where, Q : canal discharge (m^3/s)
V : flow velocity (m/s)
A : wet cross-section (m^2)
R : hydraulic radius (m)
P : wet perimeter (m)
I : energy gradient (canal slope)
K : Stricker roughness coefficient ($m^{1/3}/s$) (Manning roughness coefficient N=1/K)

1) For earth canal

Design discharge, Q (m^3/s)	K
Q<1	35
1≦Q<5	40
5≦Q<10	42.5
10≦Q	45

2) For lined canal

- stone masonry lining K = 60
- concrete lining K = 70

In cross-sections with a combination of diffrent lining materials, the compound roughness coefficient should be calculated.

(2) Freeboard

Minimum freeboard values are given as below.

Design discharge, Q (m^3/s)	Embankment (m)	Lining (m)
Q<0.5	0.40	0.20
0.5≦Q<1.5	0.50	0.20
1.5≦Q<5.0	0.60	0.25
5.0≦Q<10.0	0.65	0.30
10.0≦Q<15.0	0.85	0.40
15.0≦Q	1.00	0.50

(3) Dike Crown Width

For the purpose of operation, maintenance and inspection, embankments along the canals have minimum width as given below.

Unit: m

Design discharge, Q (m^3/s)	Dike crown width without inspection road	Dike crown width with inspection road
Q<1	1.0	3.0
1≦Q<5	1.5	5.0
5≦Q<10	2.0	5.0
10≦Q<15	3.5	5.0
15≦Q	3.5	5.0

Table XIII.3.1 DIMENSIONS OF PROPOSED SLUICES

TYPE	DRAINAGE AREA (km^2)	DESIGN SPECIFIC DISCHARGE ($m^3/s/km^2$)*	DESIGN DISCHARGE (m^3/s)	SECTIONAL AREA (m^2)	SECTION (Height,m x Width,m x Span nos.)
A	less than 5	5.5	28	11.2	2.5 x 2.4 x 2
B	5 - 10	5.0	50	20.0	2.6 x 2.7 x 3
C	10 - 20	4.0	80	32.0	2.6 x 3.2 x 4
D	20 - 50	2.0	100	40.0	3.0 x 3.5 x 4
E	50 - 100	1.8	180	72.0	3.0 x 8.0 x 3
F	100 - 150	1.5	225	90.0	3.3 x 9.0 x 3
G	150 - 200	1.4	280	112.0	3.5 x 8.0 x 4
H	more than 200	1.4	350	140.0	3.5 x 8.0 x 5

Note : Design Velocity = 2.5 m/s
* 5-year return period

Table XIII.3.2 HYDRAULIC PARAMETERS OF PROPOSED MAIN IRRIGATION CANALS (OVERALL PLAN)

Area	(1) Rantauberangan Irrigation Development Project,Kampar Kanan River			(2) Lubukjambi Irrigation Development Project,Indragiri River		
	Left Bank		Right Bank	Left Bank		Right Bank
Design Discharge (m^3/s)	20.69	9.38	4.8	19.31	11.46	17.62
Velocity (m/s)	1.036	0.898	0.791	1.017	0.943	0.993
Flow Sectional Area (m^2)	20.1	10.4	6.2	19.1	12.2	17.8
Wet Perimeter (m)	16.8	10.8	7.8	16.4	12.2	15.8
Slope	1/3,000	1/3,000	1/3,000	1/3,000	1/3,000	1/3,000
Water Depth (m)	1.47	1.29	1.14	1.43	1.29	1.38
Bed Width (m)	11.50	6.20	3.70	11.20	7.50	10.80
Height of Lining (m)	1.97	1.59	1.39	1.93	1.69	1.88
Stricker roughness coefficient	50.3	50.4	50.7	50.3	51.6	50.3

Table XIII.4.1 Comparison of Weir Gate (Kuok Weir)

Kuok Weir

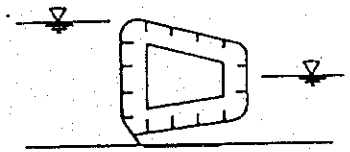
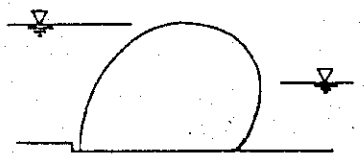
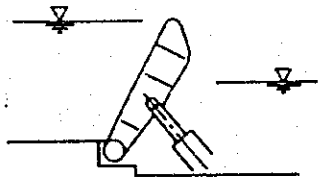
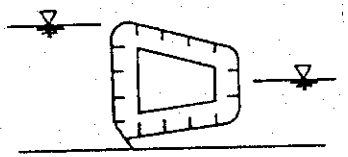
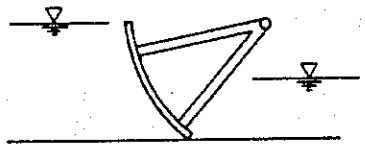
Item	Roller Gate	Rubber gate	Tilting Gate
General View			
Mechanical & Structural Character	Gate body is lifted vatically by Hoisting Device. Structure and mechanical system is so simple that reliability is high	Gate body is inflated by air or water. Gate body is made of synthetic rubber which is fragile against sharp edged matters. Mechanical system is simple.	Gate body is lifted by Hydraulic Hoist. Deck Slab must have a drop for the storing space.
Flood Control Ability	As gate body can be lifted up to the safety position during flood, control ability is better than other types.	There is possibility of incomplete open by sediment or boulder stone.	(The same as left)
Maintenance	Inspection of gate and parts exchange is difficult. Painting should be done in every seven years. Working Life: 50 years	Inspection of gate and parts exchange is difficult. Painting is unnecessary. Working Life: 25 years	Inspection of gate and parts exchange is difficult. Painting should be done in every seven years. Working Life: 50 years
Manufacture	Domestic manufacture in Indonesia is possible.	Gate body should be imported from abroad	Though domestic manufacture in Indonesia is possible, high grade manufacture technique is required.
Civil Structure	Because of the tall pier for gate operation, foundation is large scale	As the gate weight is small, civil structure can be simple.	As the weight of the structure is smaller than other steel gate, foundation can be small scale.
Construction Cost	Approx. 47.0 billion Rp.	Approx. 37.1 billion Rp.	Approx. 48.7 billion Rp.
Evaluation	Moderate	Adequate	Inadequate

Table XIII.4.2 HYDRAULIC PARAMETERS OF PROPOSED MAIN IRRIGATION CANALS (INITIAL PHASE)

Area	(1) Rantauberangan Irrigation Development Project,Kampar Kanan River		(2) Lubukjambi Irrigation Development Project,Indragiri River
	Left Bank	Right Bank	Left Bank
Design Discharge (m^3/s)	11.31	4.8	7.85
Velocity (m/s)	1.016	0.791	0.953
Flow Sectional Area (m^2)	11.2	6.2	8.2
Wet Perimeter (m)	10.7	7.8	8.8
Slope	1/3,000	1/3,000	1/3,000
Water Depth (m)	1.47	1.14	1.43
Bed Width (m)	5.40	3.70	3.60
Height of Lining (m)	1.97	1.39	1.93
Stricker roughness coefficient	54.0	50.7	54.4

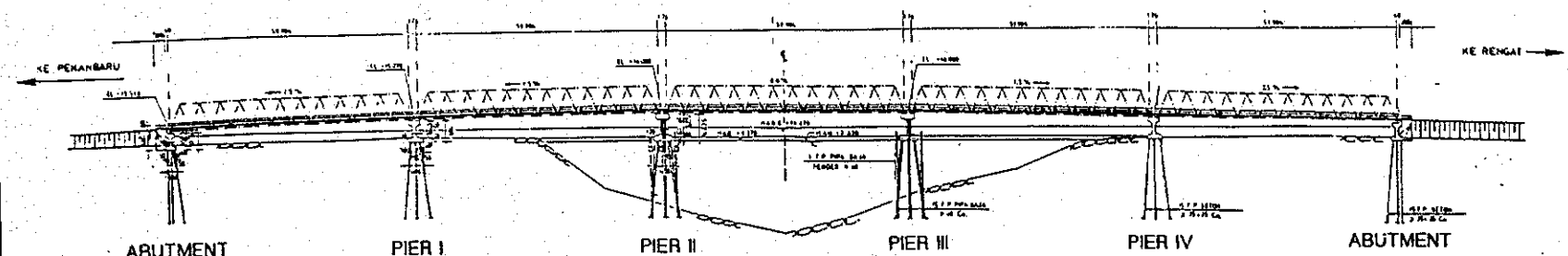
Table XIII.4.3 Comparison of Weir Gate (Lubukjambi Weir)

Lubuk Jambi Weir

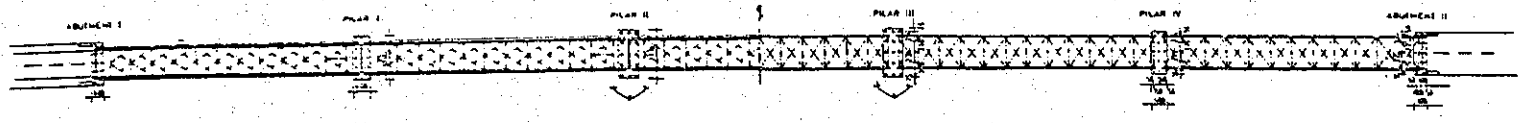
Item	Roller Gate	Radial Gate
General View		
Mechanical & Structural Character	Gate body is lifted vatically by Hoisting Device. Structure and mechanical system is so simple that reliability is high	Gate body is lifted by Hoisting Device and turn round Trunnion Axis. Mechanical system is complicated
Flood Control Ability	As gate body can be lifted up to the safety position during flood, control ability is better than other types.	Owing to the limitation of span length the possibility of the flow blocking by drift woods is high.
Maintenance	Inspection of gate and parts exchange is easier than Rubber and Tilting Gate. Painting should be done in every seven years. Working Life: 50 years	(the same as left)
Manufacture	Domestic manufacture in Indonesia is possible.	Though domestic manufacture in Indonesia is possible, high grade manufacture technique is required.
Civil Structure	Because of the tall pier for gate operation, foundation is large scale	As the whole loads concentrate to Trunnion Axis, designing and construction is complicated.
Construction Cost	Approx. 47.4 billion Rp.	Approx. 55.9 billion Rp.
Evaluation	Adequate	Inadequate

FIGURES

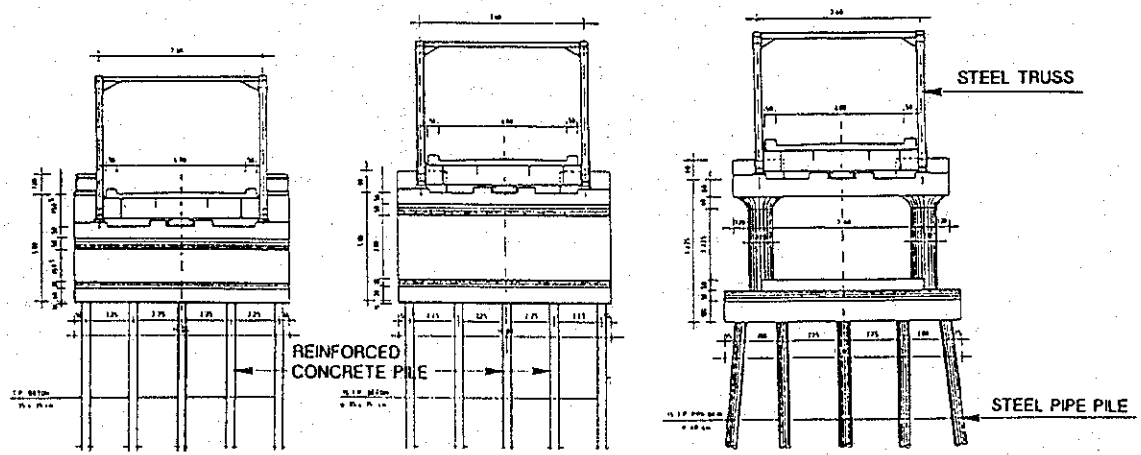
XIII RIPARIAN STRUCTURE ENGINEERING



ELEVATION



PLAN



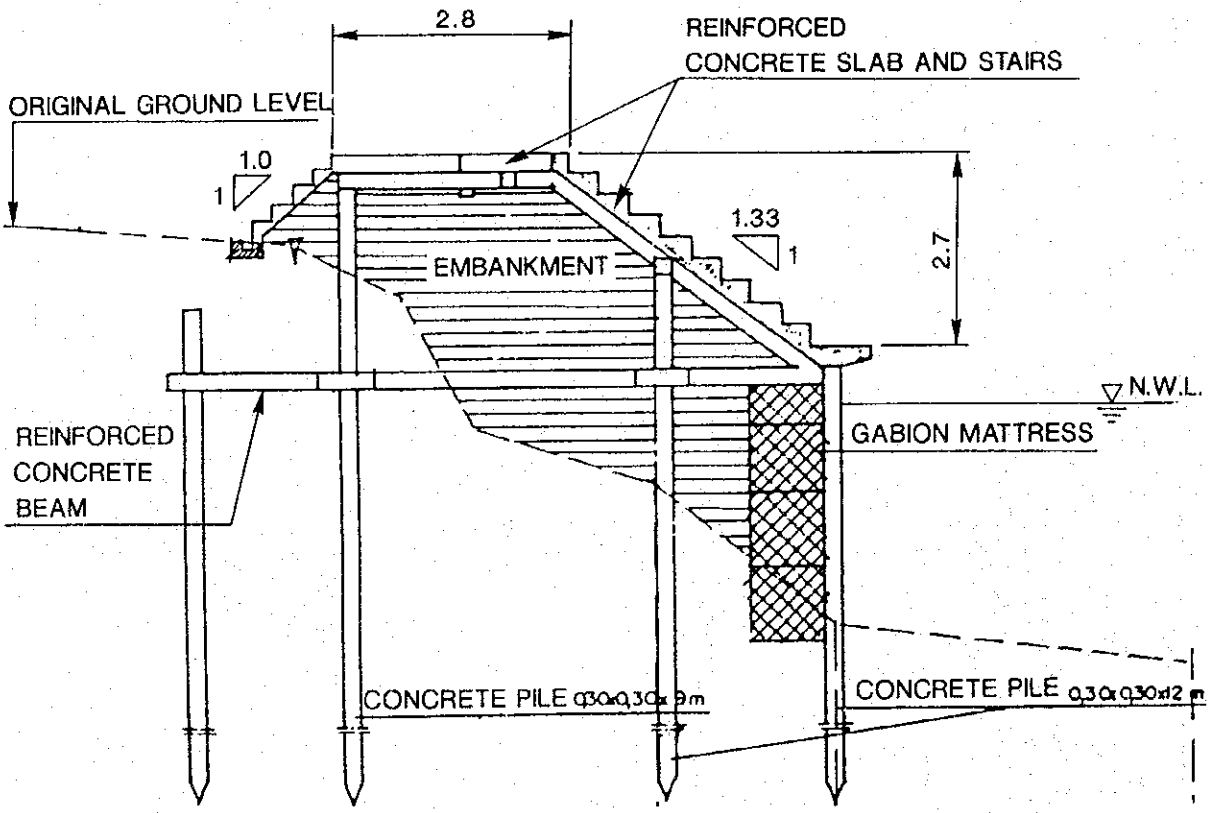
SECTION AT ABUTMENT | SECTION AT PIER I & IV | SECTION AT PIER II & III

SOURCE : AS BUILT DRAWINGS OF JEMBATAN LANGGAN BRIDGE, KAMPAR RIVER, PU.

Fig. XIII.1.1 TYPICAL EXISTING ROAD BRIDGE

THE STUDY ON KAMPAR-INDRAGIRI RIVER BASIN DEVELOPMENT PROJECT IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

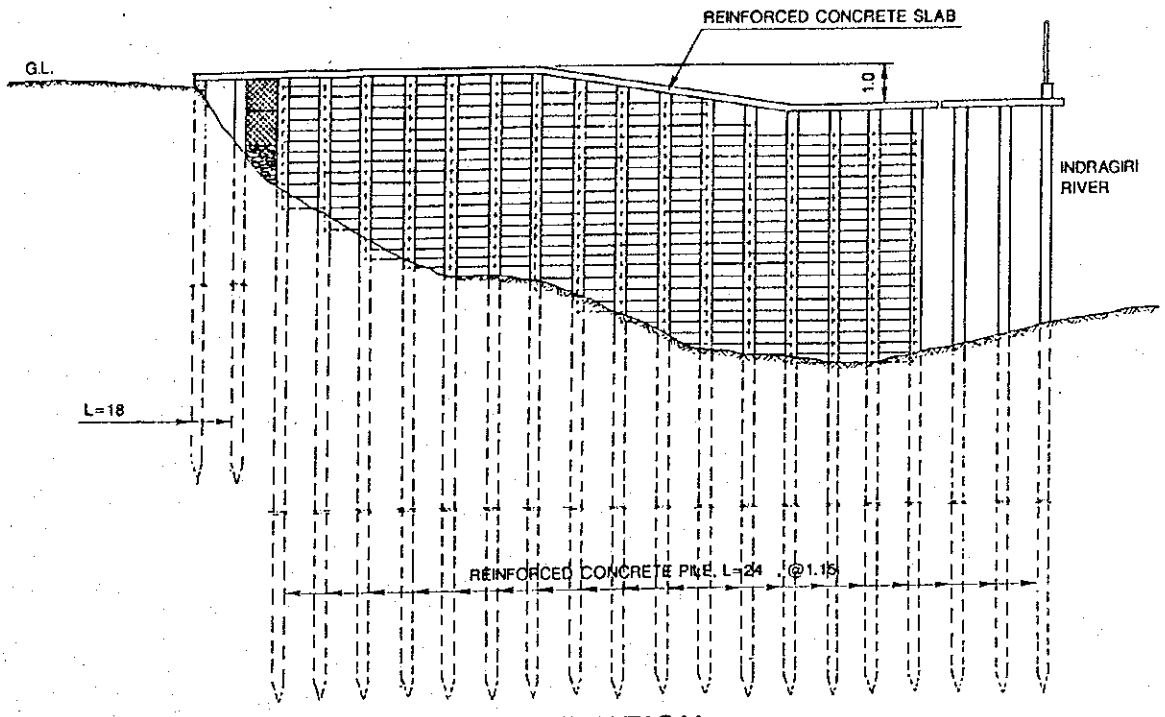


(UNIT : m)

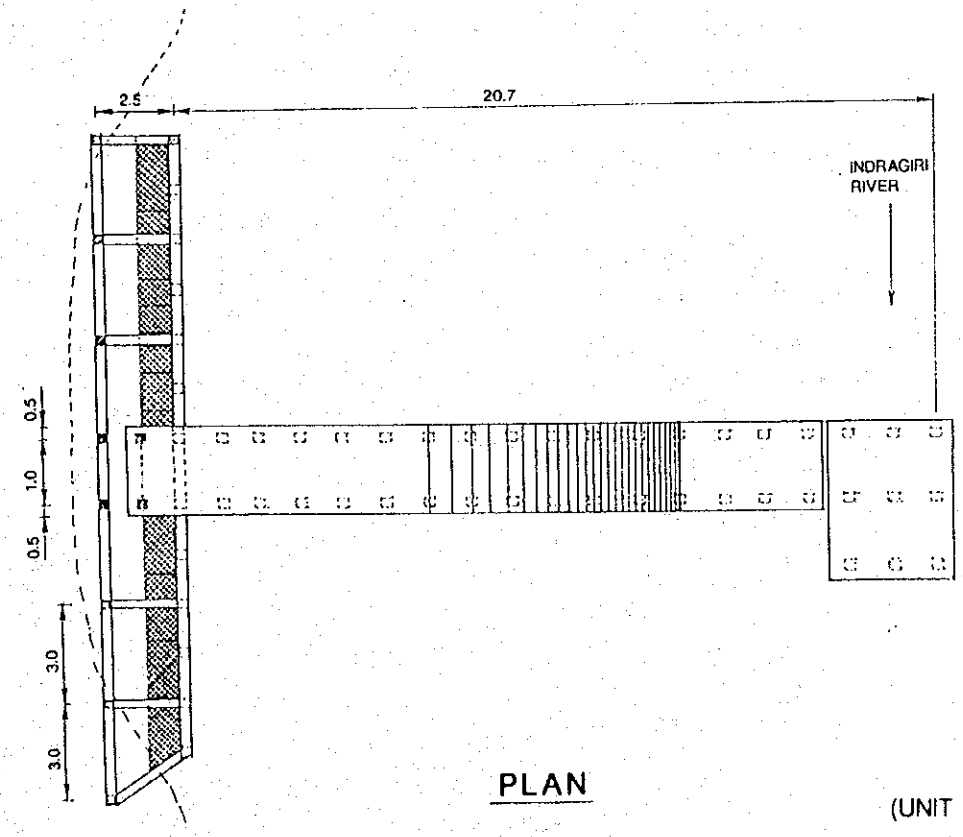
LOCATION : LEFT BANK OF INDRAGIRI RIVER
AT TULUKKUANTAN

SOURCE : PU DESIGN DRAWINGS

THE STUDY ON KAMPAR-INDRAGIRI RIVER BASIN DEVELOPMENT PROJECT IN THE REPUBLIC OF INDONESIA JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. XIII.1.2 TYPICAL EXISTING SLOPE PROTECTION WORKS



ELEVATION



PLAN

(UNIT : m)

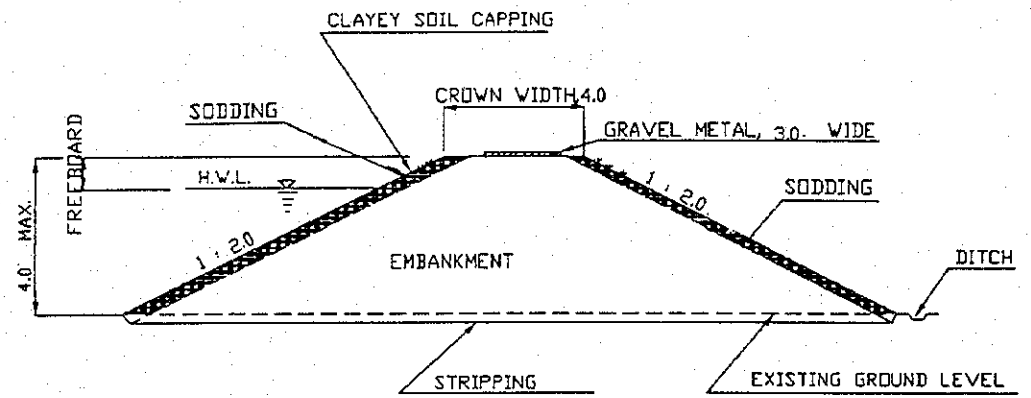
SOURCE : PU DESIGN DRAWINGS

NOTE : EXAMPLE OF EXISTING GROIN LOCATED AT RIGHT BANK OF INDRAGIRI RIVER AT RENGAT

THE STUDY ON KAMPAR-INDRAGIRI RIVER BASIN DEVELOPMENT PROJECT IN THE REPUBLIC OF INDONESIA JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. XIII.1.3 TYPICAL EXISTING GROIN

THE STUDY ON
KAMPAR-INDRAGIRI RIVER BASIN DEVELOPMENT PROJECT
IN THE REPUBLIC OF INDONESIA
JAPAN INTERNATIONAL COOPERATION AGENCY

(1) TYPICAL DIKE SECTION FOR RIVERS OF UPPER INDRAGIRI RIVER



(2) TYPICAL DIKE SECTION FOR LOWER/MIDDLE KAMPAR AND INDRAGIRI RIVERS

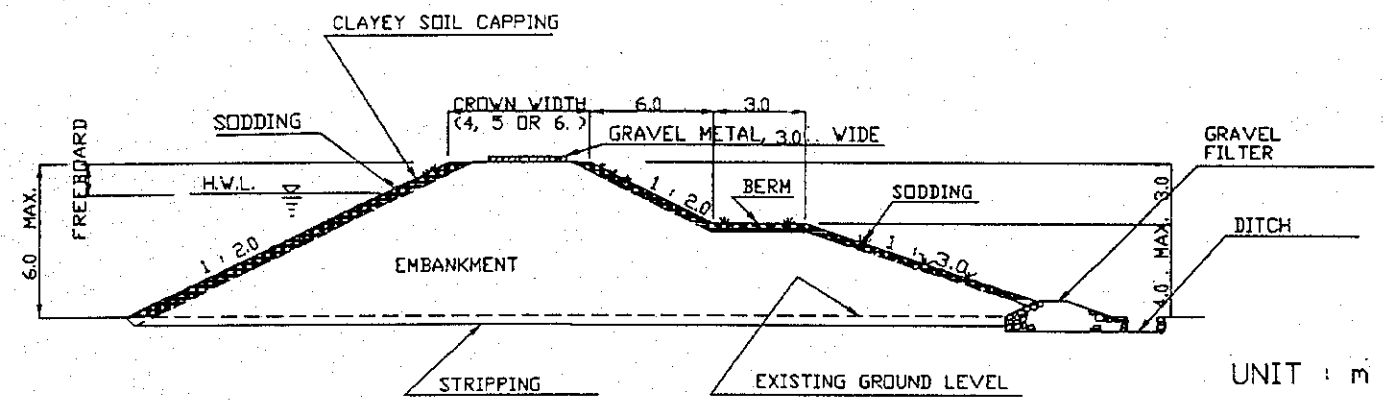
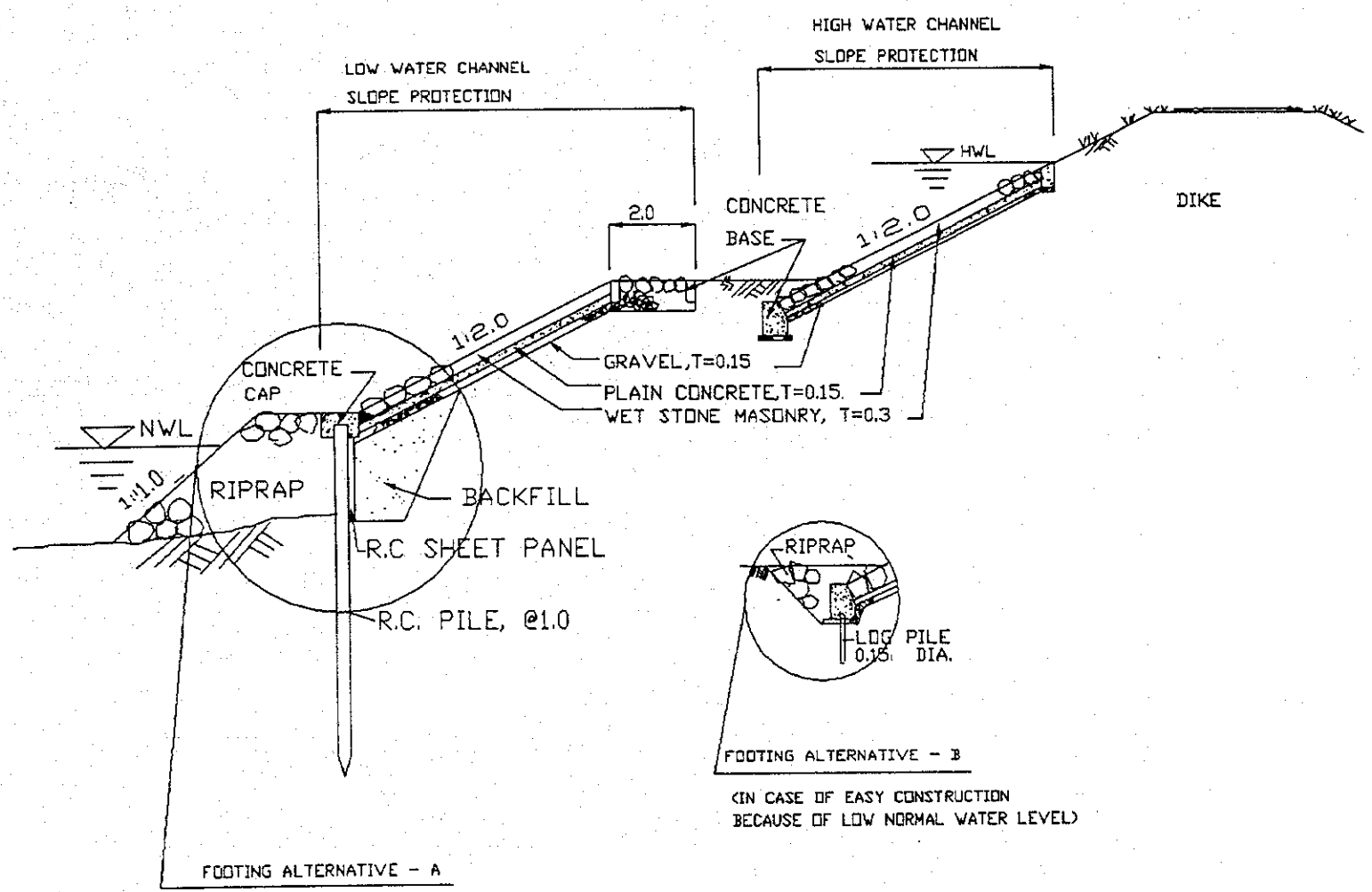


Fig. XIII.3.1 TYPICAL PROPOSED DIKE SECTIONS



THE STUDY ON
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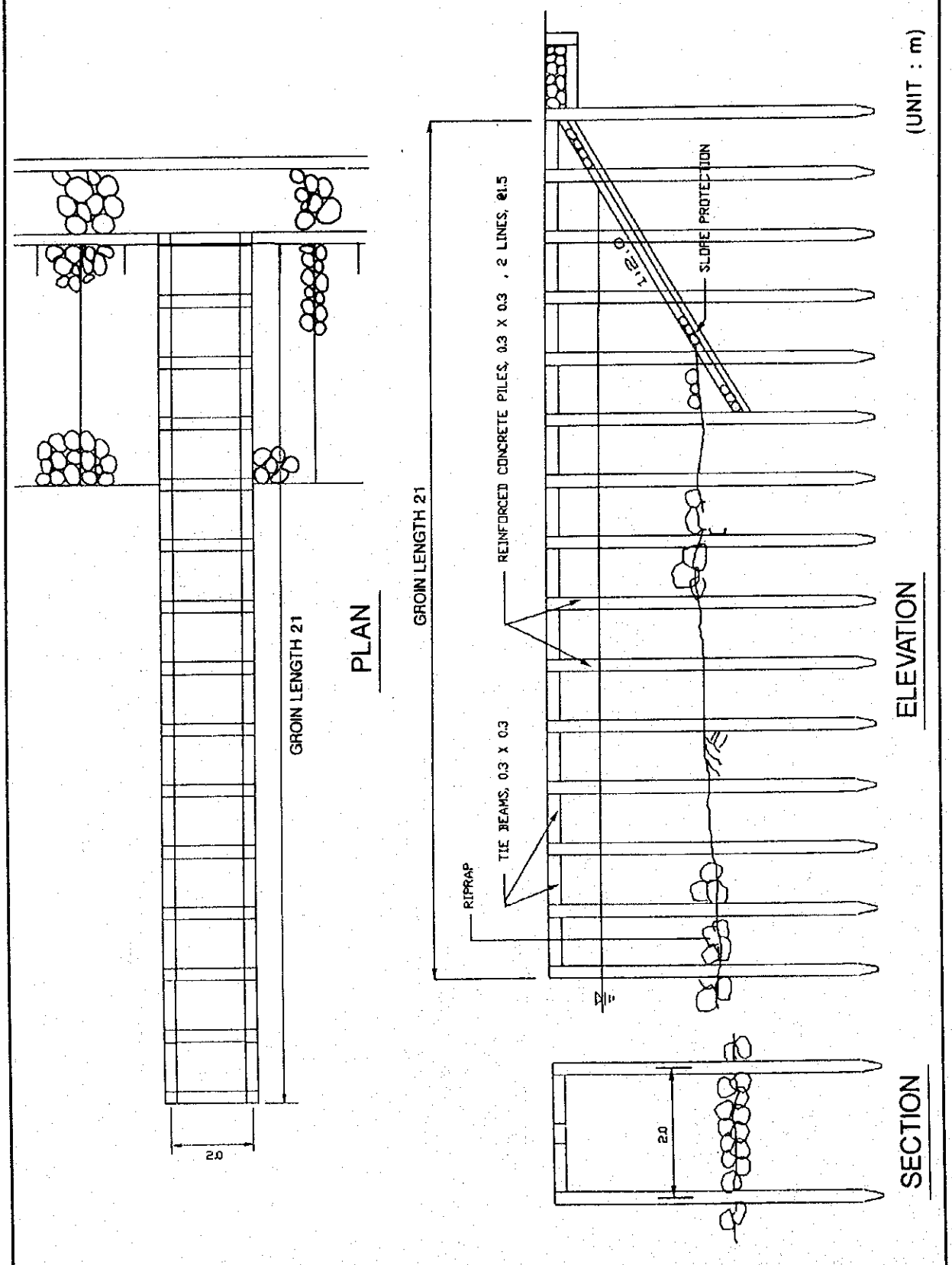
IN THE REPUBLIC OF INDONESIA
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. XIII.3.2 TYPICAL PROPOSED REVETMENT



THE STUDY ON
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IN THE REPUBLIC OF INDONESIA
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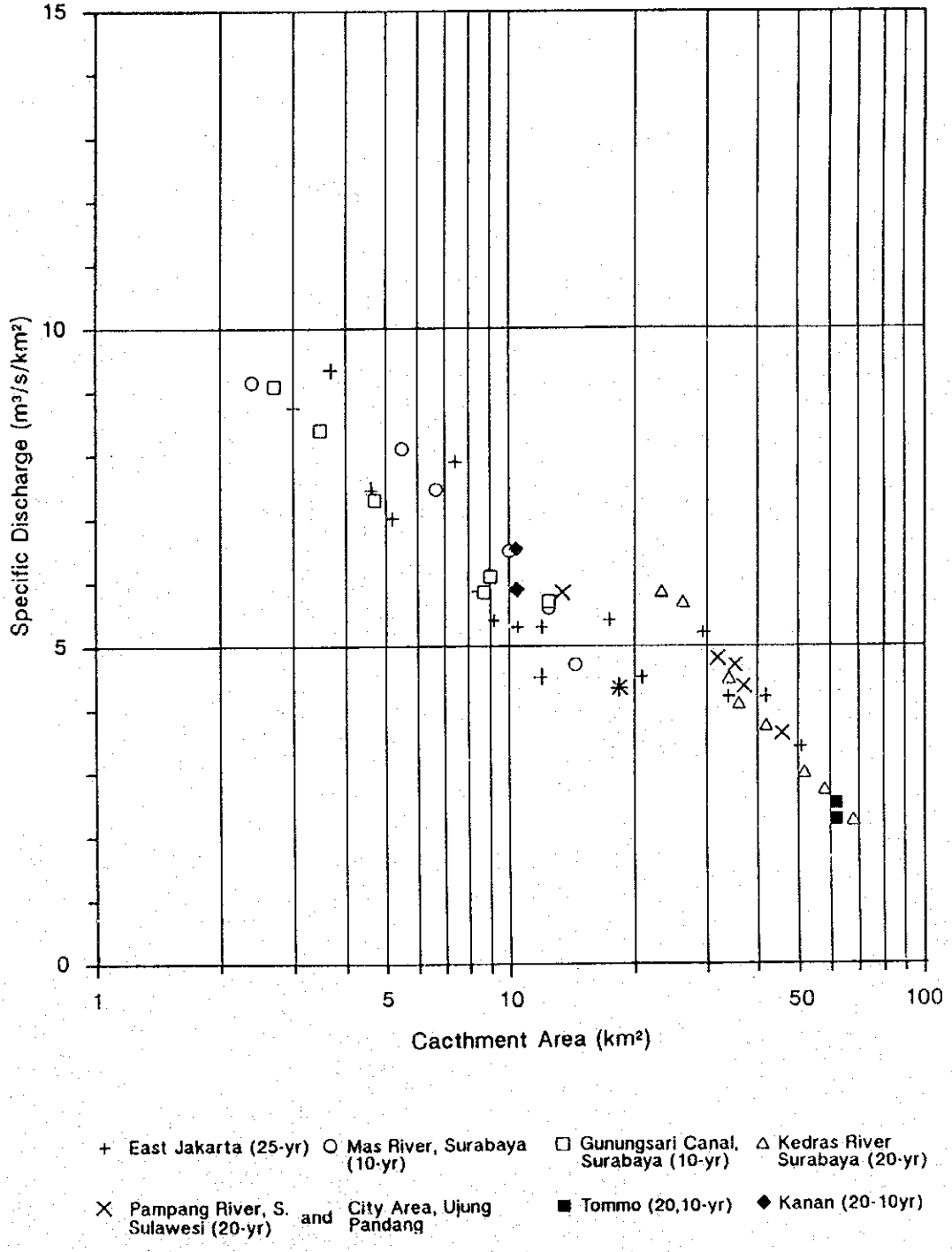
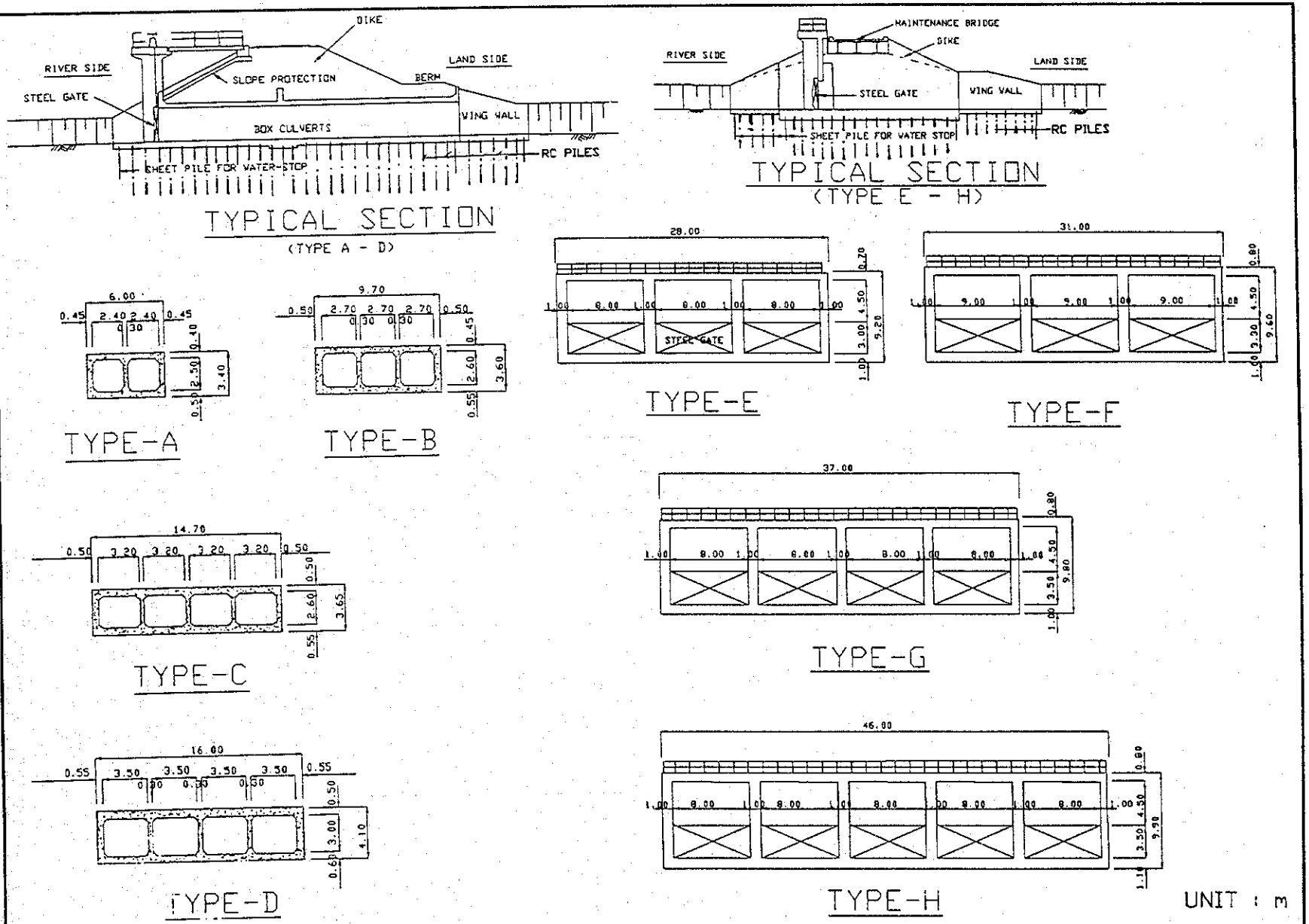
Fig. XIII.3.3 TYPICAL PROPOSED GROIN



THE STUDY ON KAMPAR-INDRAGIRI RIVER BASIN DEVELOPMENT PROJECT IN THE REPUBLIC OF INDONESIA JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. XIII.3.4 SPECIFIC DISCHARGE PLOTS OF PROJECTS IN INDONESIA



THE STUDY ON
KAMPAR-INDRAGIRI RIVER BASIN DEVELOPMENT PROJECT
IN THE REPUBLIC OF INDONESIA
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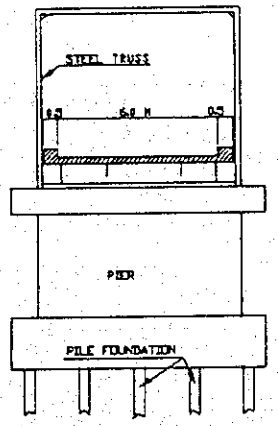
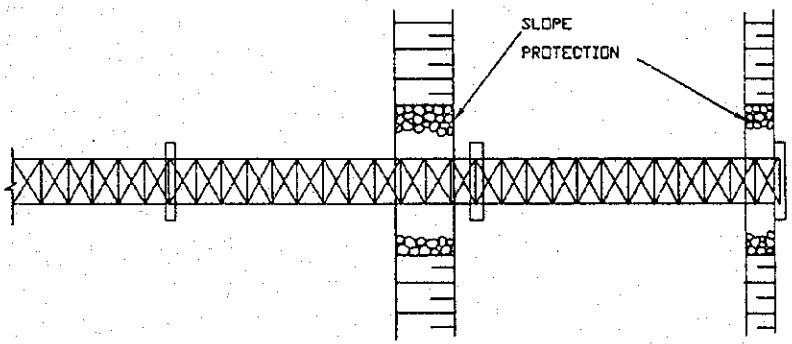
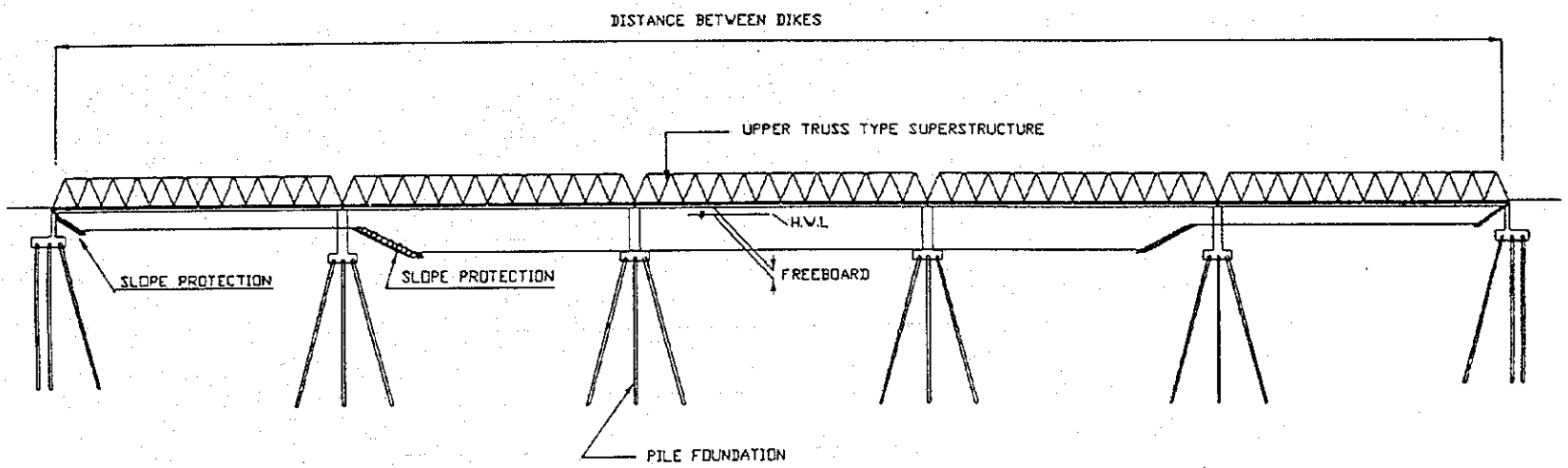
Fig. XIII.3.5 TYPICAL STRUCTURE OF PROPOSED SLUICES



SECTION



PLAN



ELEVATION

Fig. XIII.3.6 TYPICAL STRUCTURE OF PROPOSED STEEL BRIDGE

THE STUDY ON
KAMPAR-INDRAGIRI RIVER BASIN DEVELOPMENT PROJECT
IN THE REPUBLIC OF INDONESIA
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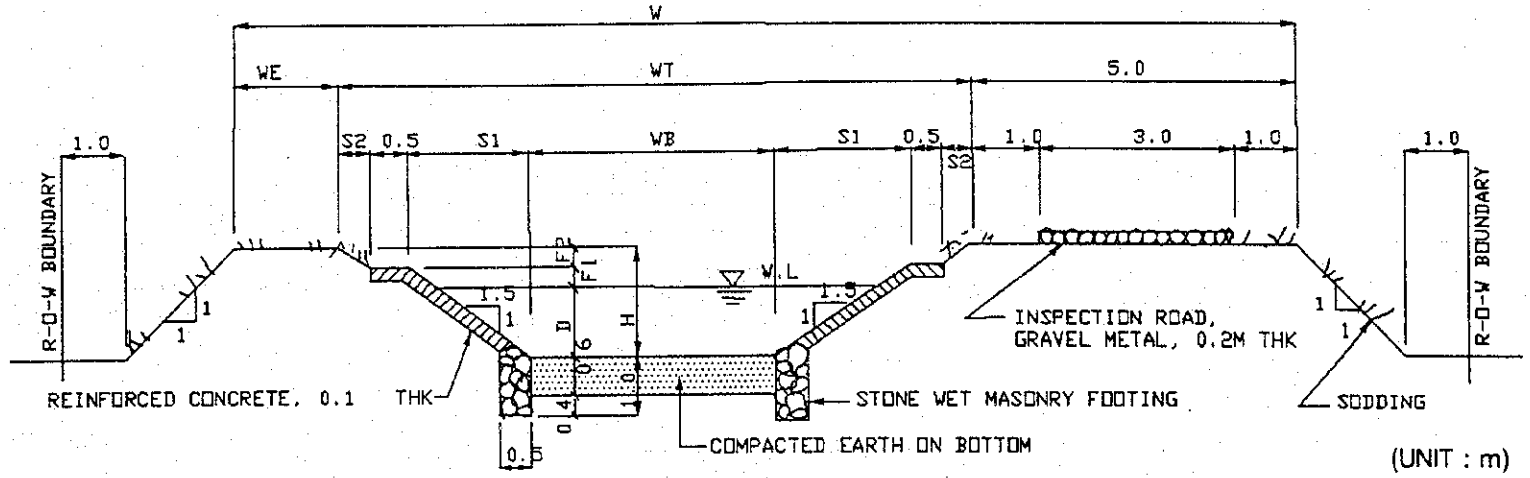


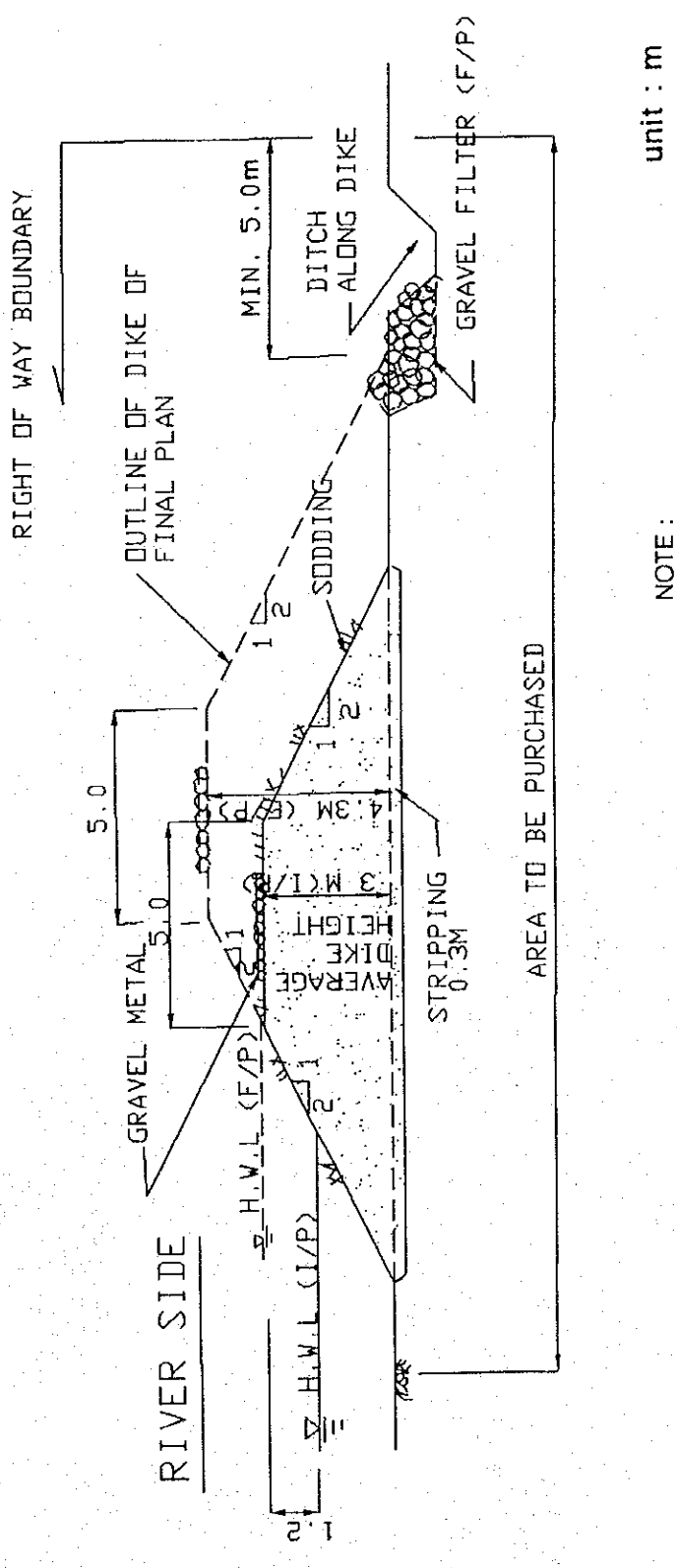
Fig. XIII.3.7 TYPICAL PROPOSED MAIN IRRIGATION CANALS OF OVERALL PLAN

(1) RANTAUBERANGIN IRRIGATION DEVELOPMENT PROJECT, KAMPAR RIVER BASIN

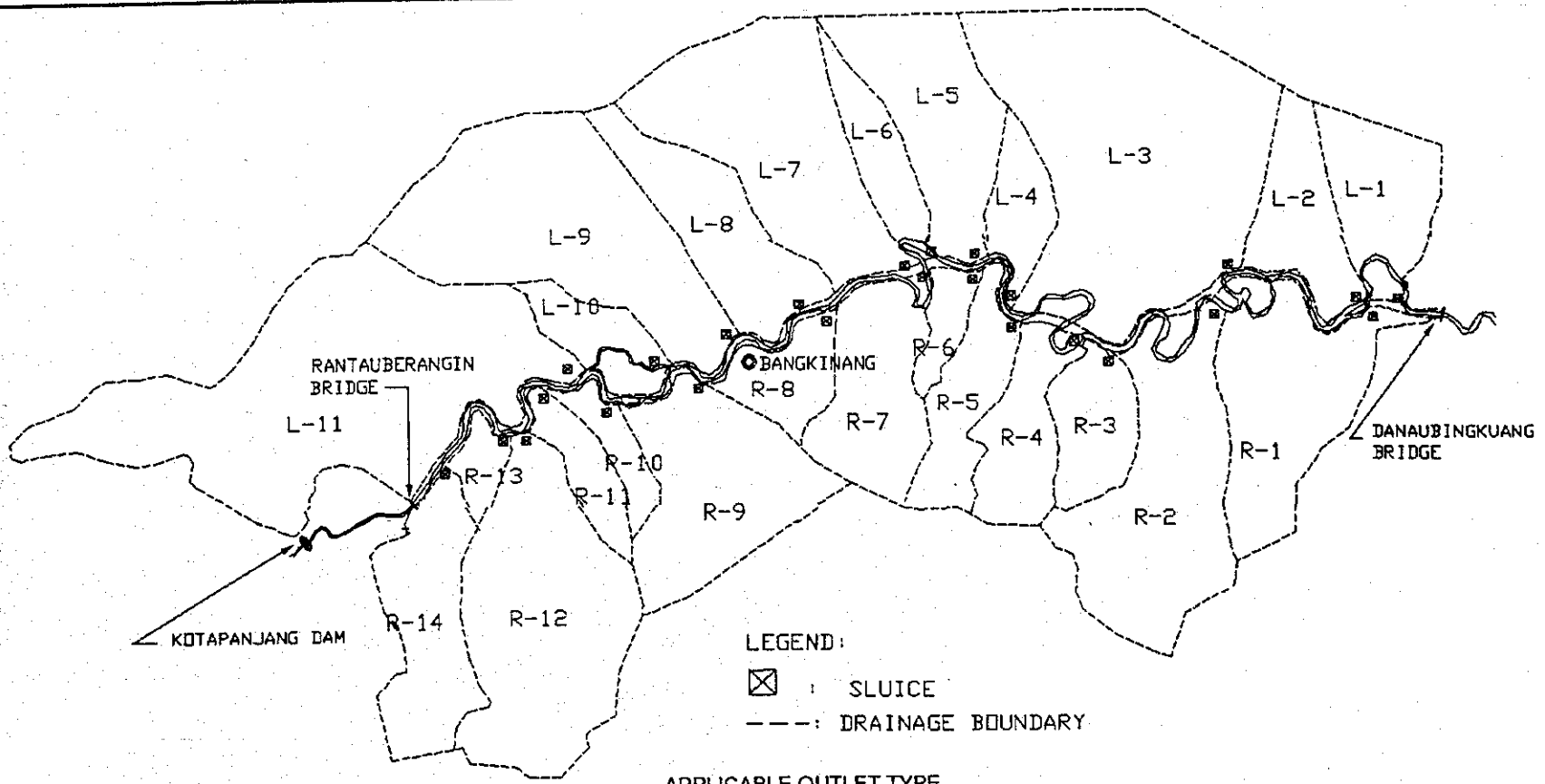
AREA	DESIGN DISCHARGE (m^3/s)	D	F1	F2	H	S1	S2	WB	WT	WE	W
LEFT BANK UPPER REACHES	20.69	1.47	0.50	0.50	2.47	2.96	0.75	11.50	19.91	3.50	28.41
LEFT BANK LOWER REACHES	9.38	1.29	0.30	0.45	2.04	2.39	0.68	6.20	13.32	2.00	20.32
RIGHT BANK	4.80	1.14	0.25	0.35	1.74	2.09	0.53	3.70	9.92	1.50	16.42

(2) LUBUKJAMBI IRRIGATION DEVELOPMENT PROJECT, INDRAGIRI RIVER BASIN

AREA	DESIGN DISCHARGE (m^3/s)	D	F1	F2	H	S1	S2	WB	WT	WE	W
LEFT BANK UPPER REACHES	19.31	1.43	0.50	0.50	2.43	2.90	0.75	11.20	19.49	3.50	27.99
LEFT BANK LOWER REACHES	11.46	1.29	0.40	0.45	2.14	2.54	0.68	7.50	14.92	3.50	23.42
RIGHT BANK	17.62	1.38	0.50	0.50	2.38	2.82	0.75	10.80	18.94	3.50	27.44



THE STUDY ON KAMPAR-INDRAGIRI RIVER BASIN DEVELOPMENT PROJECT IN THE REPUBLIC OF INDONESIA JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. XIII.4.1 TYPICAL PROPOSED DIKE OF BANGKINANG AREA IN INITIAL PHASE



APPLICABLE OUTLET TYPE

LEFT BANK

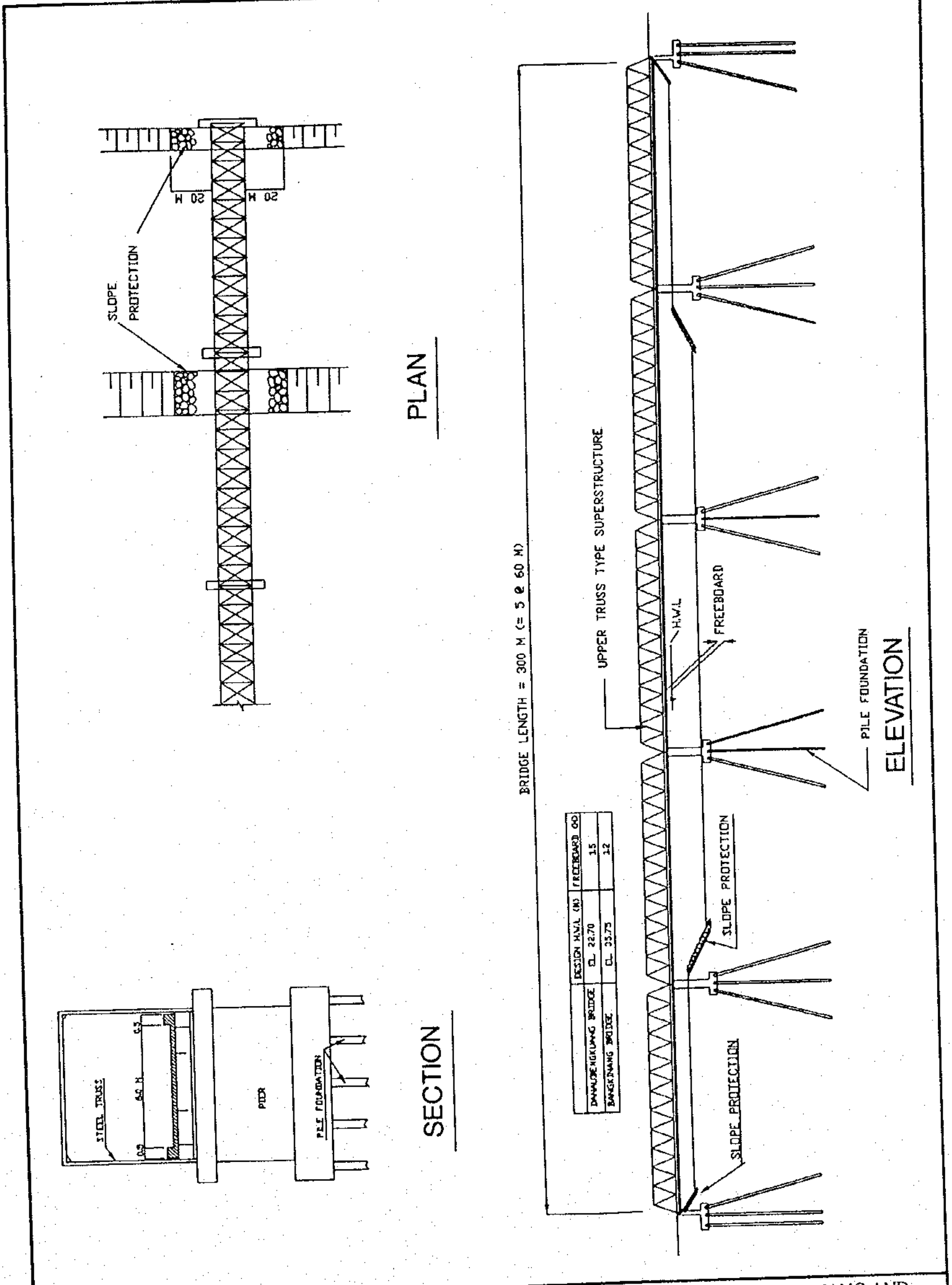
No.	DRAINAGE AREA (km²)	SLUICE
L-1	19.0	C
L-2	16.3	C
L-3	81.9	E
L-4	9.6	B
L-5	28.4	D
L-6	10.9	C
L-7	43.8	D
L-8	23.3	D
L-9	55.3	E
L-10	10.4	C
L-11	86.6	E

RIGHT BANK

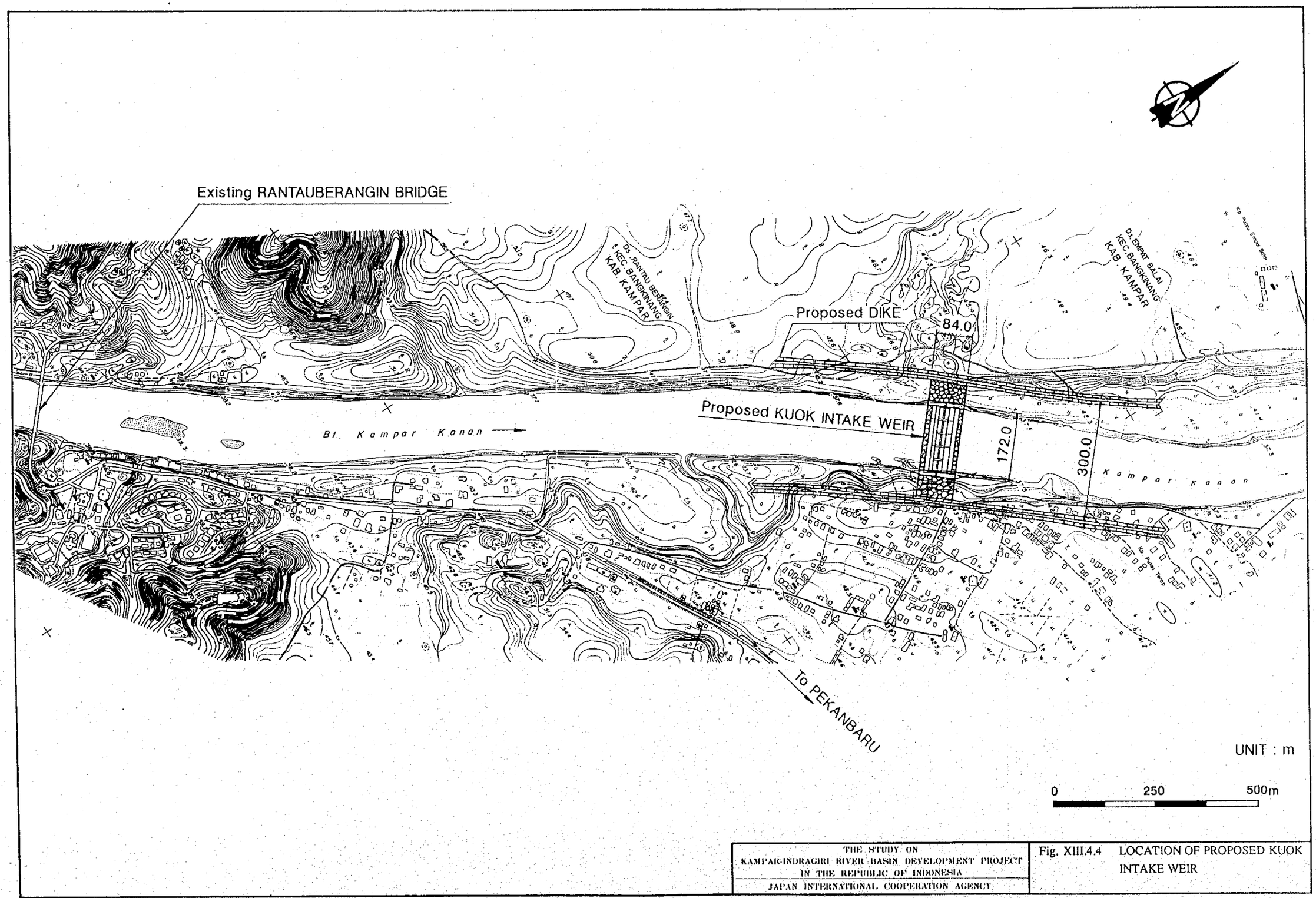
No.	DRAINAGE AREA (km²)	SLUICE	No.	DRAINAGE AREA (km²)	SLUICE
R-1	34.2	D	R-12	50.4	E
R-2	43.4	D	R-13	4.5	B
R-3	13.4	C	R-14	23.5	D
R-4	15.6	C			
R-5	14.9	C			
R-6	5.3	B			
R-7	23.3	D			
R-8	10.9	C			
R-9	33.0	D			
R-10	6.1	B			
R-11	8.9	B			

THE STUDY ON
KAMPAR-INDRAGIRI RIVER BASIN DEVELOPMENT PROJECT
IN THE REPUBLIC OF INDONESIA
JAPAN INTERNATIONAL COOPERATION AGENCY

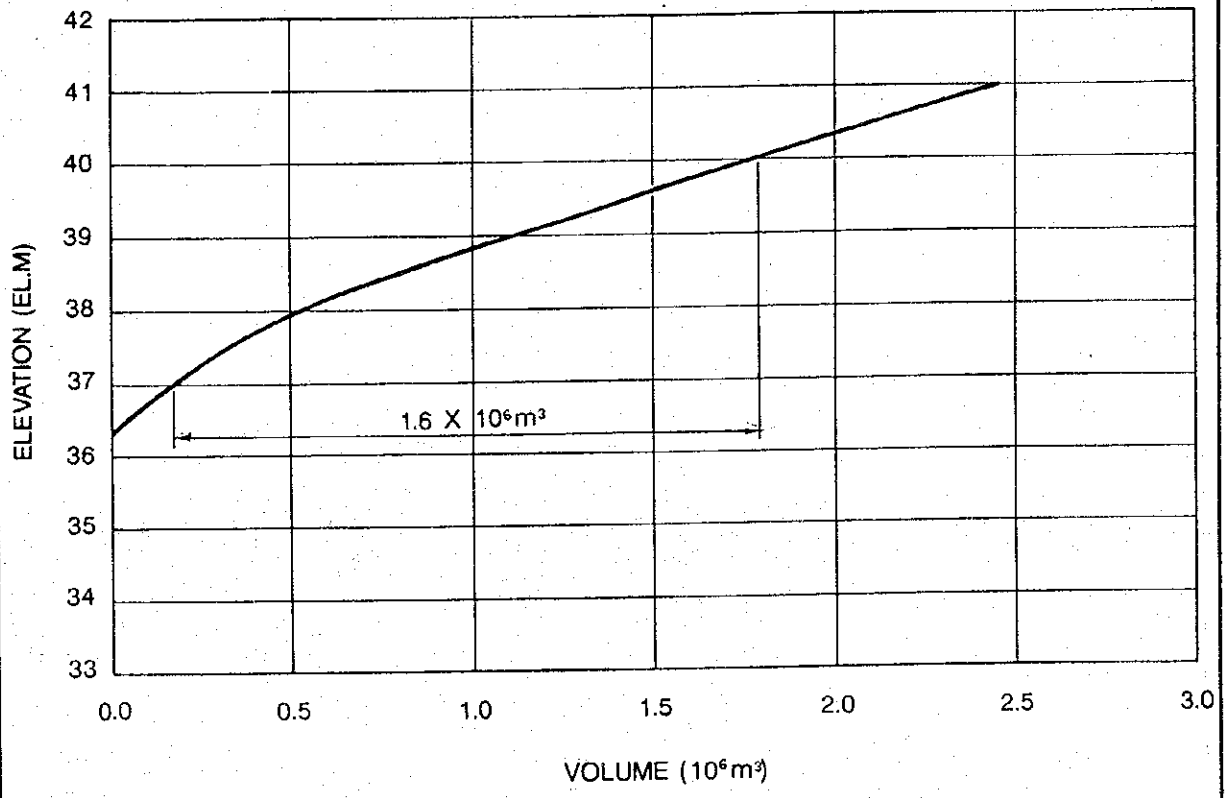
Fig. XIII.4.2 LOCATION OF PROPOSED SLUICES IN BANGKINANG AREA



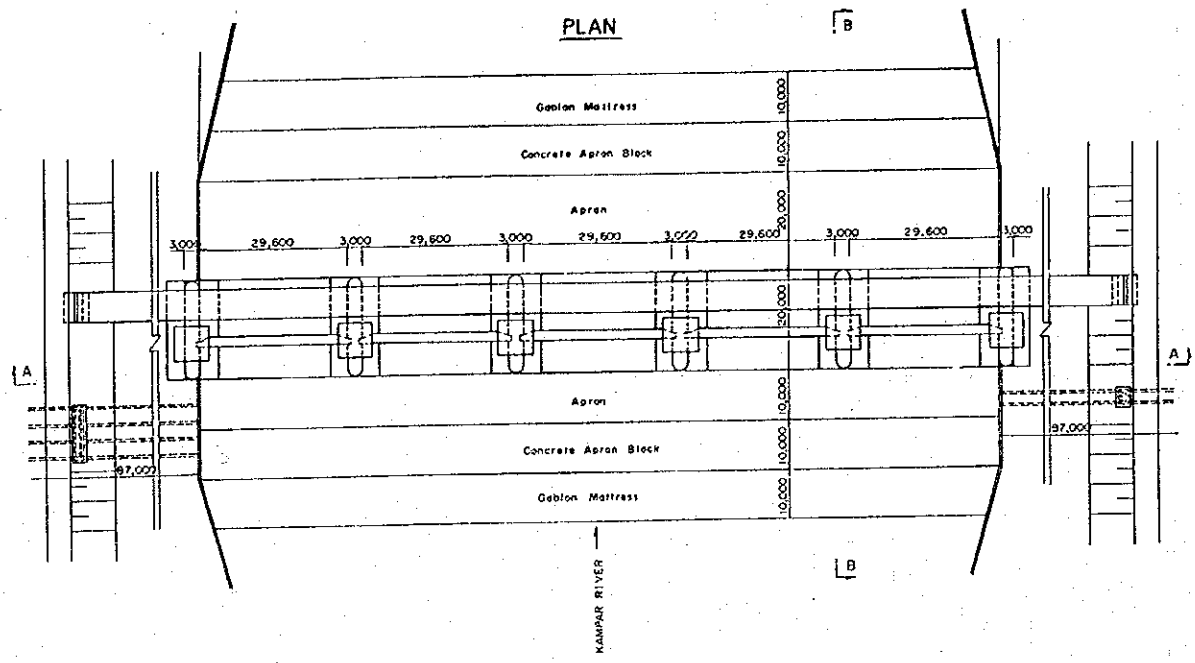
THE STUDY ON KAMPAR-INDRAGIRI RIVER BASIN DEVELOPMENT PROJECT IN THE REPUBLIC OF INDONESIA	Fig. XIII.4.3 PROPOSED BANGKINANG AND DANAU BINGKUANG BRIDGES
JAPAN INTERNATIONAL COOPERATION AGENCY	



THE STUDY ON KAMPAR-INDRAGIRI RIVER BASIN DEVELOPMENT PROJECT IN THE REPUBLIC OF INDONESIA JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. XIII.4.4 LOCATION OF PROPOSED KUOK INTAKE WEIR



THE STUDY ON KAMPAR-INDRAGIRI RIVER BASIN DEVELOPMENT PROJECT IN THE REPUBLIC OF INDONESIA JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. XIII.4.5 STORAGE CAPACITY CURVE (KUOK INTAKE WEIR)



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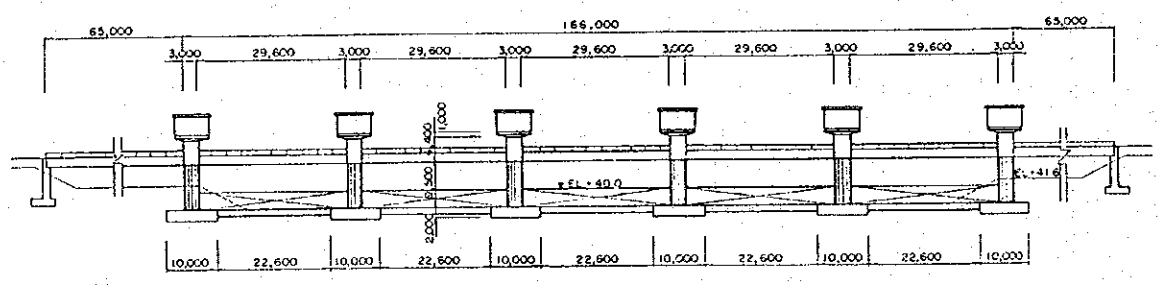

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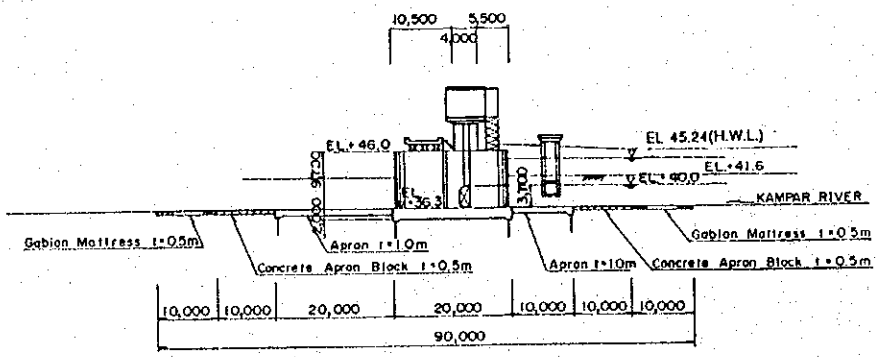
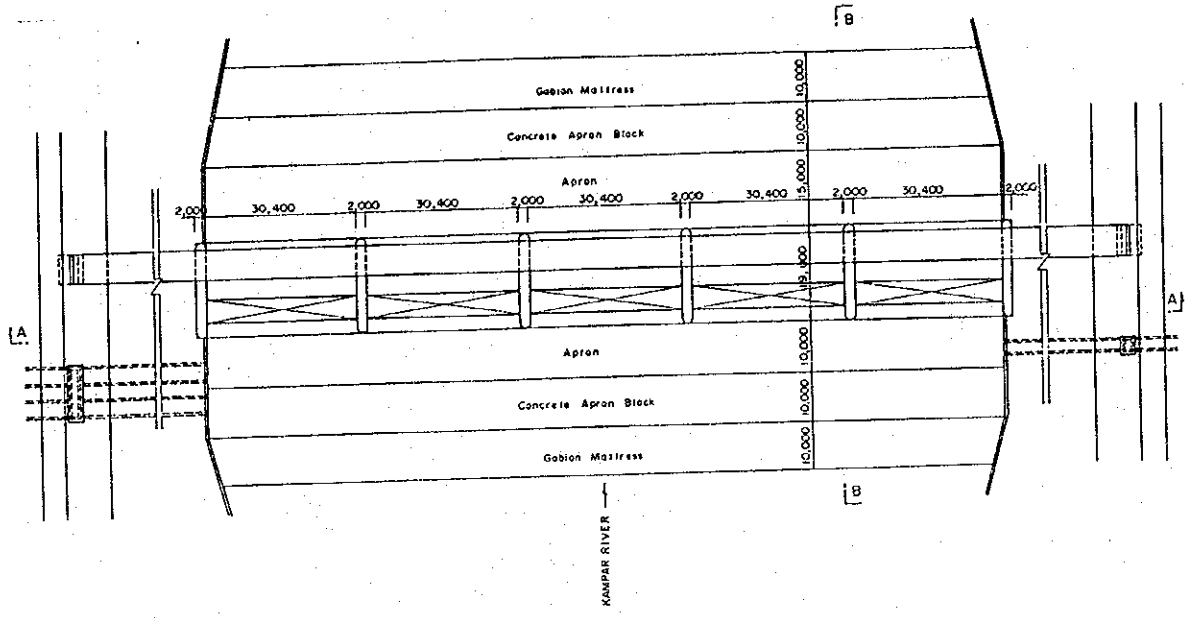


(Roller Gate)

THE STUDY ON KAMPAR-INDRAGIRI RIVER BASIN DEVELOPMENT PROJECT IN THE REPUBLIC OF INDONESIA JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. XIII.4.6 STRUCTURAL ALTERNATIVES (1/3) OF KUOK INTAKE WEIR

PLAN



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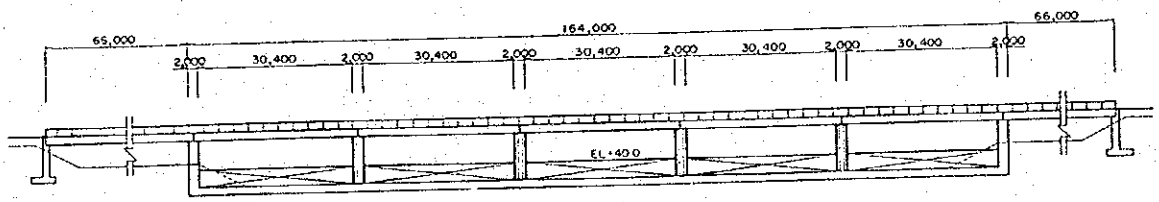

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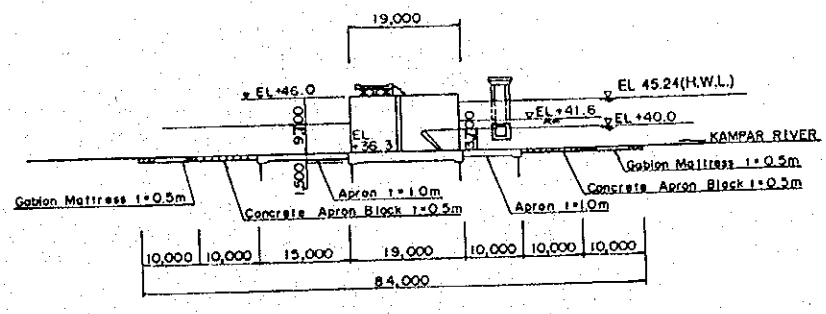
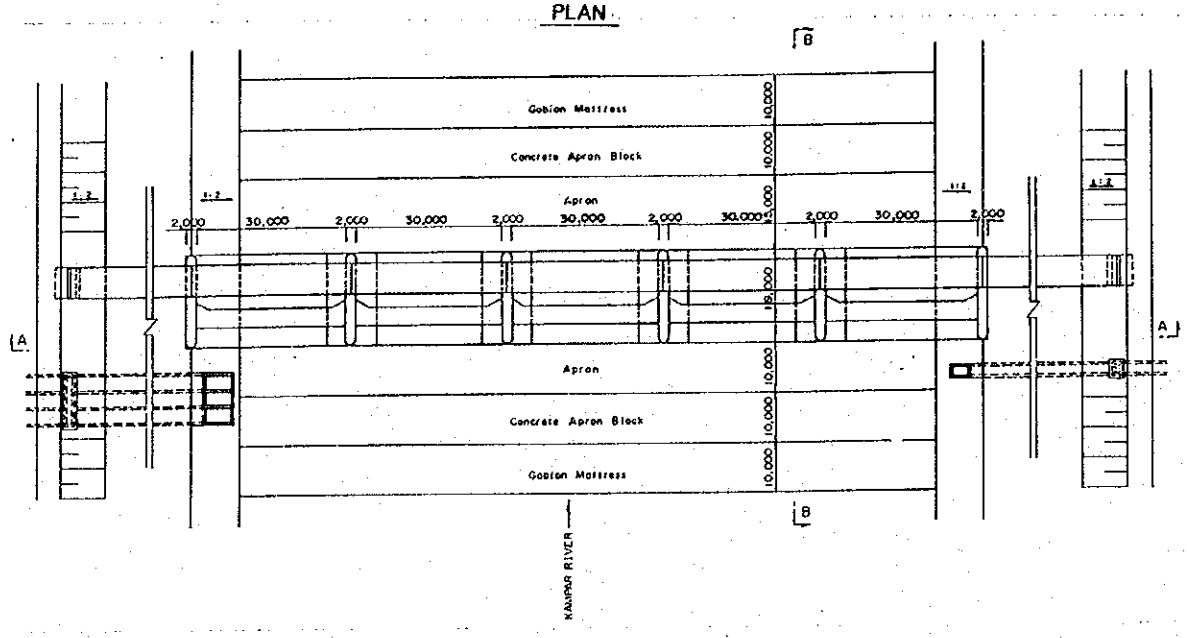


(Tilting Gate)

THE STUDY ON KAMPAR-INDRAGIRI RIVER BASIN DEVELOPMENT PROJECT IN THE REPUBLIC OF INDONESIA JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. XIII.4.6 (2/3) STRUCTURAL ALTERNATIVES OF KUOK INTAKE WEIR

PLAN



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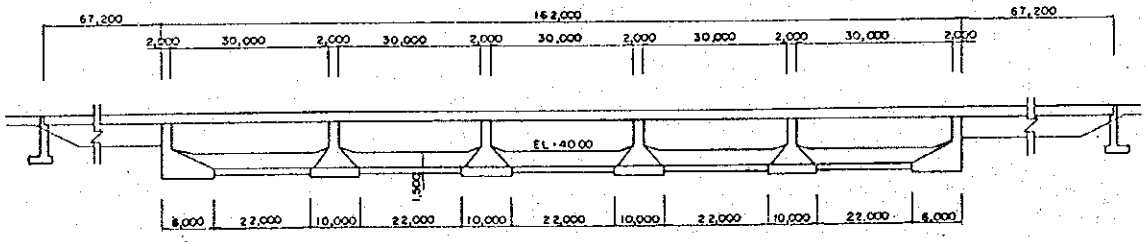

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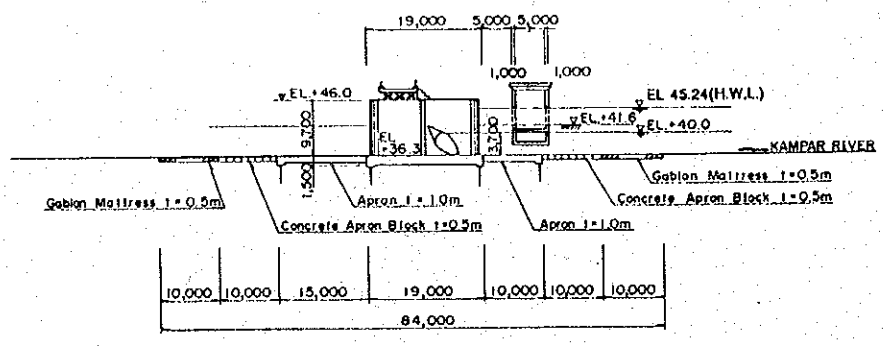

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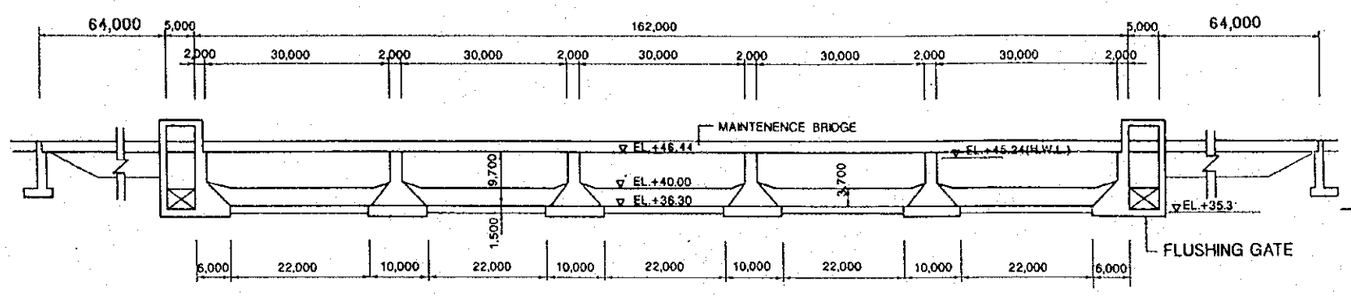
THE STUDY ON KAMPAR-INDRAGIRI RIVER BASIN DEVELOPMENT PROJECT IN THE REPUBLIC OF INDONESIA JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. XIII.4.6 STRUCTURAL ALTERNATIVES (3/3) OF KUOK INTAKE WEIR

SECTION A - A



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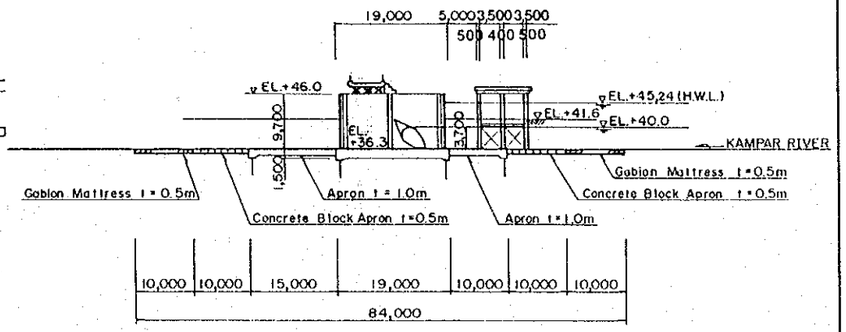
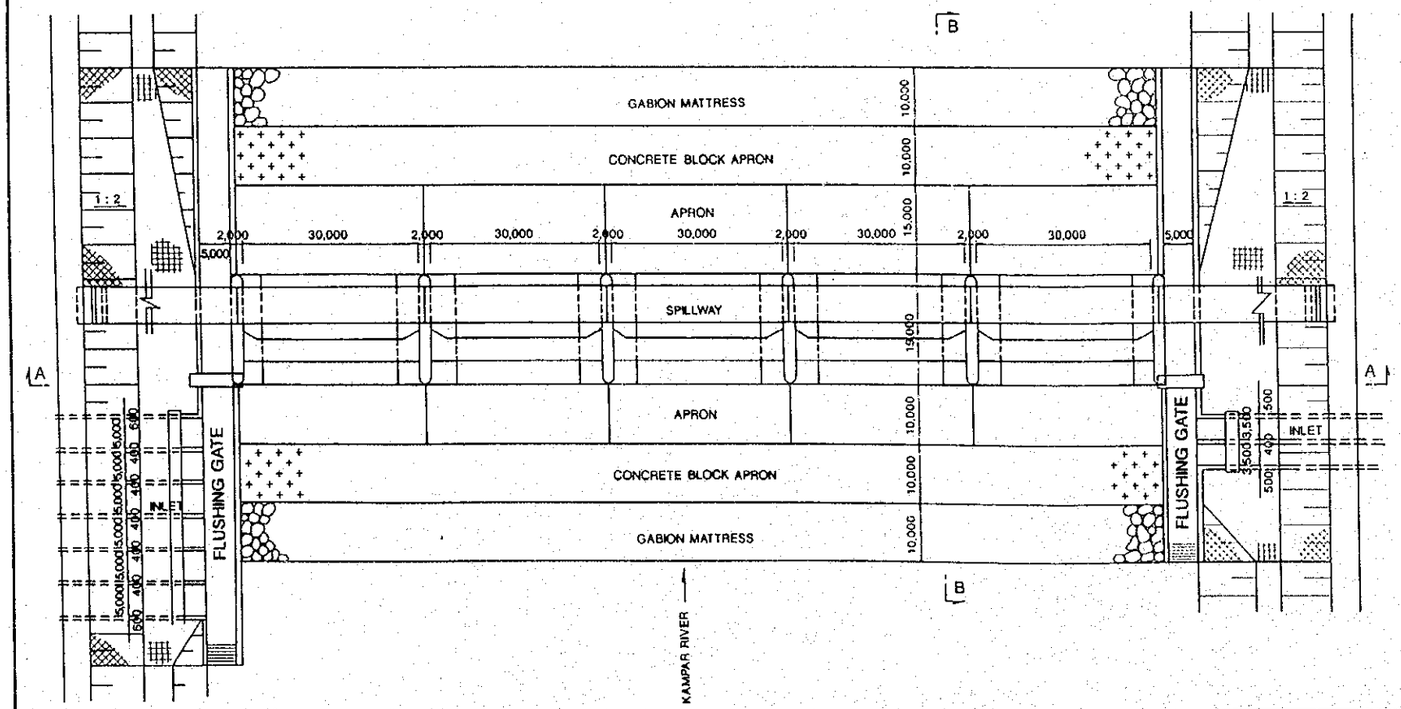


PLAN



SCALE: 1/1,000

(UNIT : m)

THE STUDY ON KAMPAR-INDRAGIRI RIVER BASIN DEVELOPMENT PROJECT IN THE REPUBLIC OF INDONESIA JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. XIII.4.7 PROPOSED KUOK INTAKE WEIR STRUCTURES

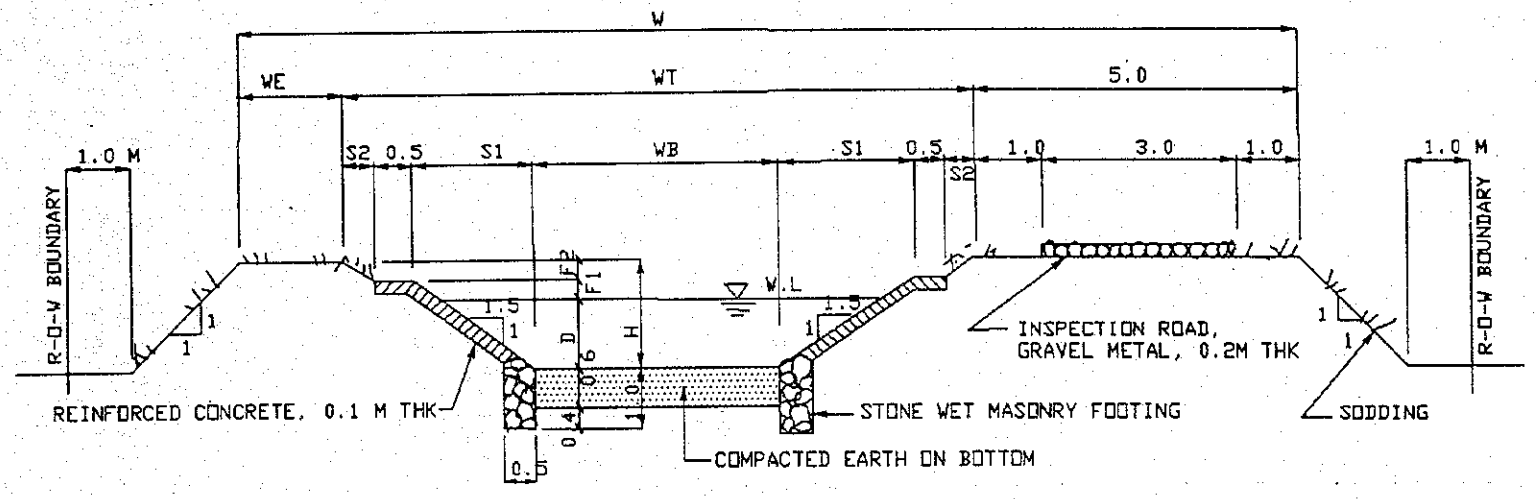


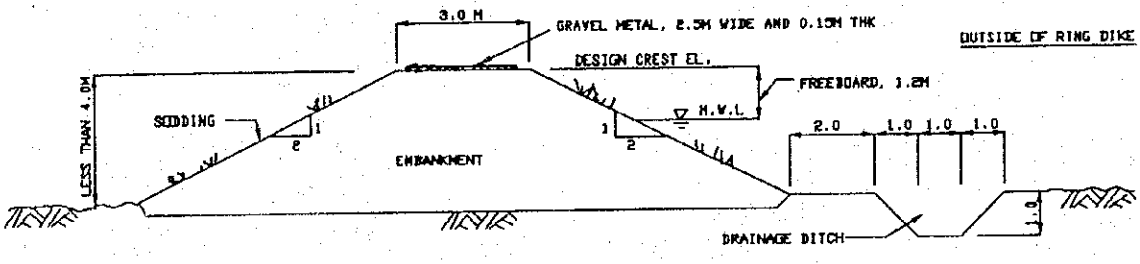
Fig. XIII.4.8 TYPICAL PROPOSED MAIN IRRIGATION CANALS OF INITIAL PHASE

(1) RANTAUBERANGIN IRRIGATION DEVELOPMENT PROJECT, KAMPAR RIVER BASIN

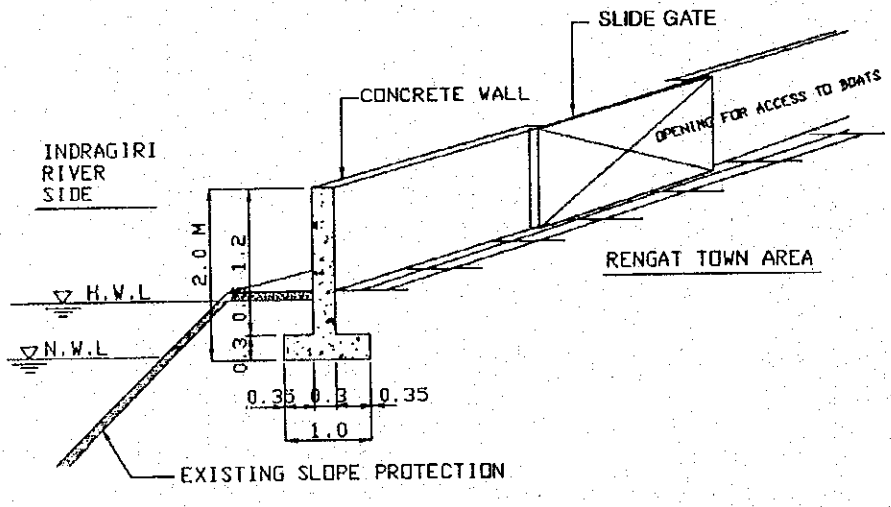
AREA	DESIGN DISCHARGE (m^3/s)	D	F1	F2	H	S1	S2	WB	WT	WE	W
LEFT BANK UPPER REACHES	11.31	1.47	0.50	0.50	2.47	2.96	0.75	5.40	13.81	3.50	22.31
RIGHT BANK	4.80	1.14	0.25	0.35	1.74	2.09	0.53	3.70	9.92	1.50	16.42

(2) LUBUKJAMBI IRRIGATION DEVELOPMENT PROJECT, INDRAGIRI RIVER BASIN

AREA	DESIGN DISCHARGE (m^3/s)	D	F1	F2	H	S1	S2	WB	WT	WE	W
LEFT BANK UPPER REACHES	7.85	1.43	0.50	0.50	2.43	2.90	0.75	3.60	11.89	2.00	18.87



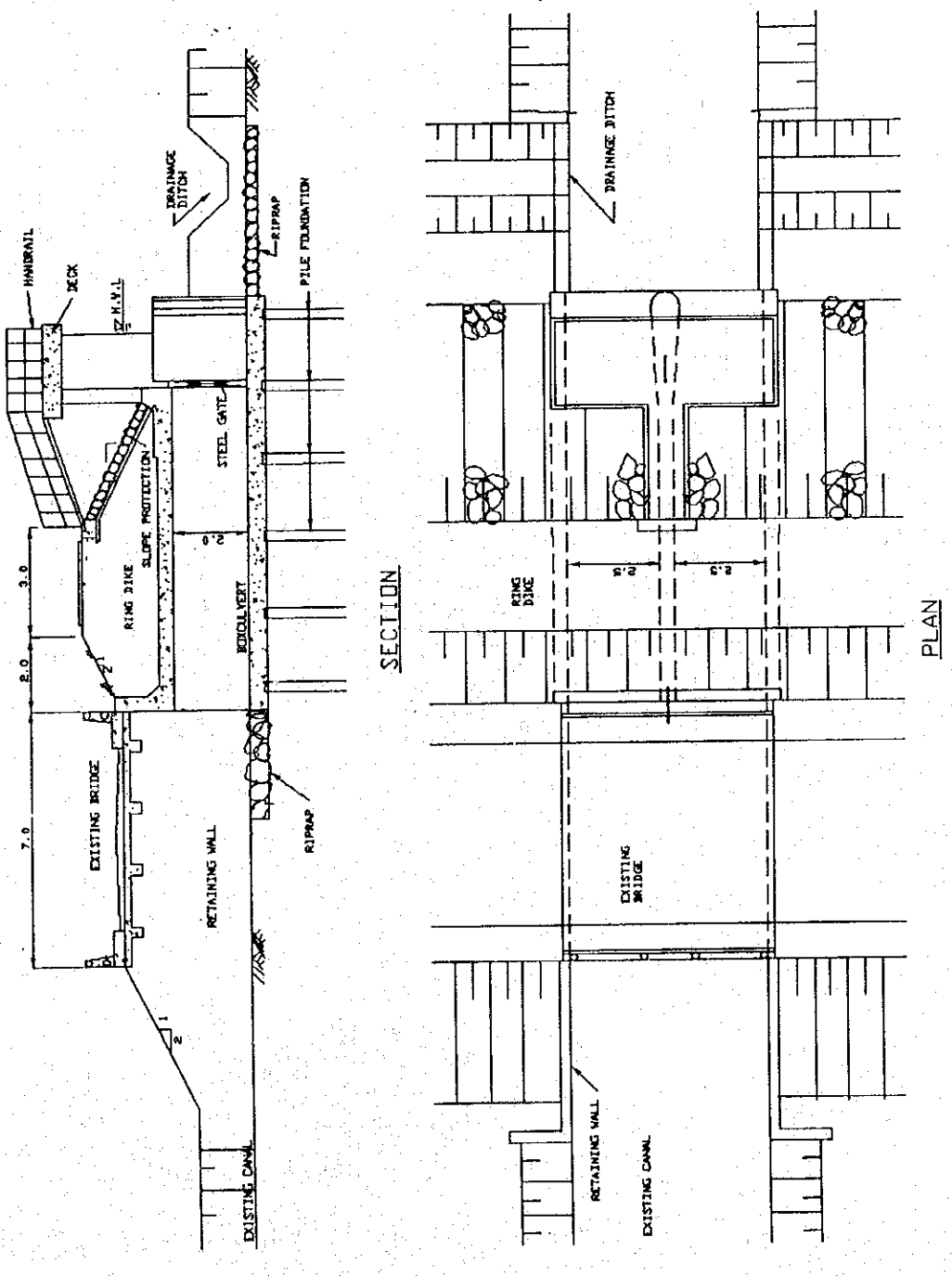
TYPICAL CROSS SECTION OF RING DIKE



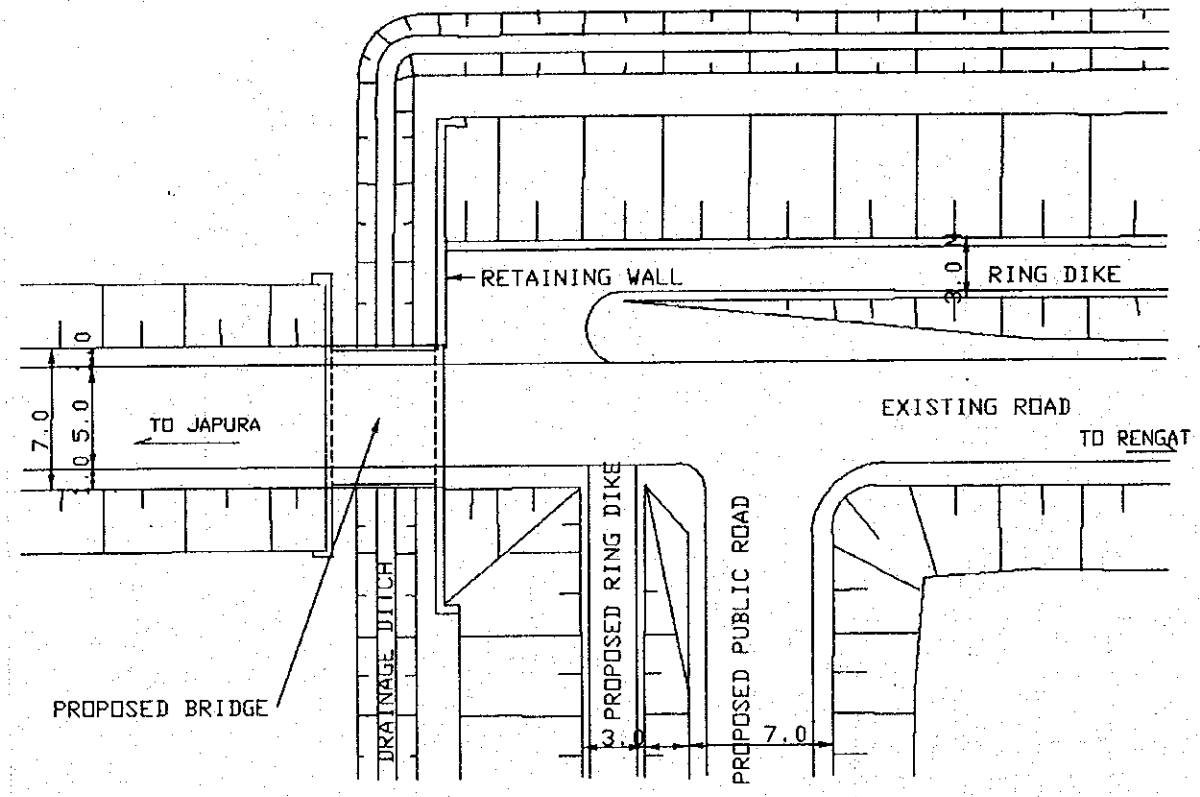
TYPICAL SECTION OF CONCRETE WALL AT RENGAT TOWN CENTER

THE STUDY ON KAMPAR-INDRAGIRI RIVER BASIN DEVELOPMENT PROJECT IN THE REPUBLIC OF INDONESIA JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. XIII.4.9 PROPOSED RING DIKES IN RENGAT AREA

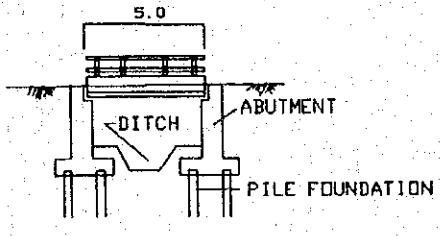
(UNIT : m)



THE STUDY ON KAMPAR-INDRAGIRI RIVER BASIN DEVELOPMENT PROJECT IN THE REPUBLIC OF INDONESIA JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. XIII.4.10 TYPICAL PROPOSED CONTROL GATE IN RENGAT AREA



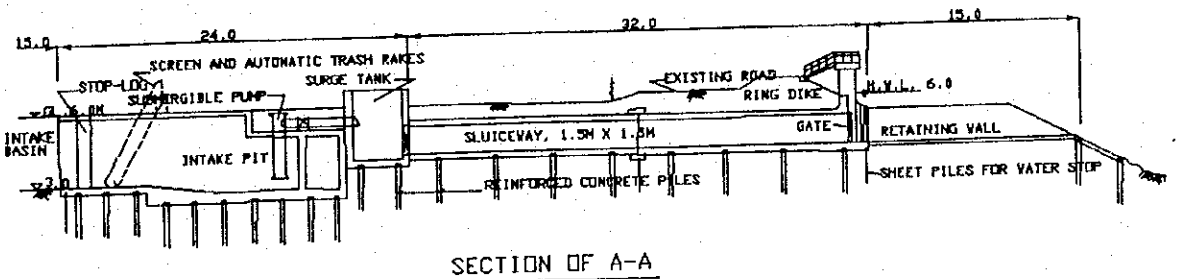
PLAN



BRIDGE SECTION

UNIT : m

THE STUDY ON KAMPAR-INDRAGIRI RIVER BASIN DEVELOPMENT PROJECT IN THE REPUBLIC OF INDONESIA JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. XIII.4.11 PROPOSED ROAD BRIDGE IN RENGAT AREA



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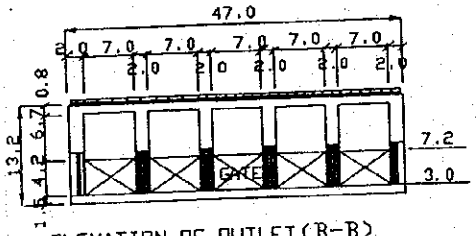
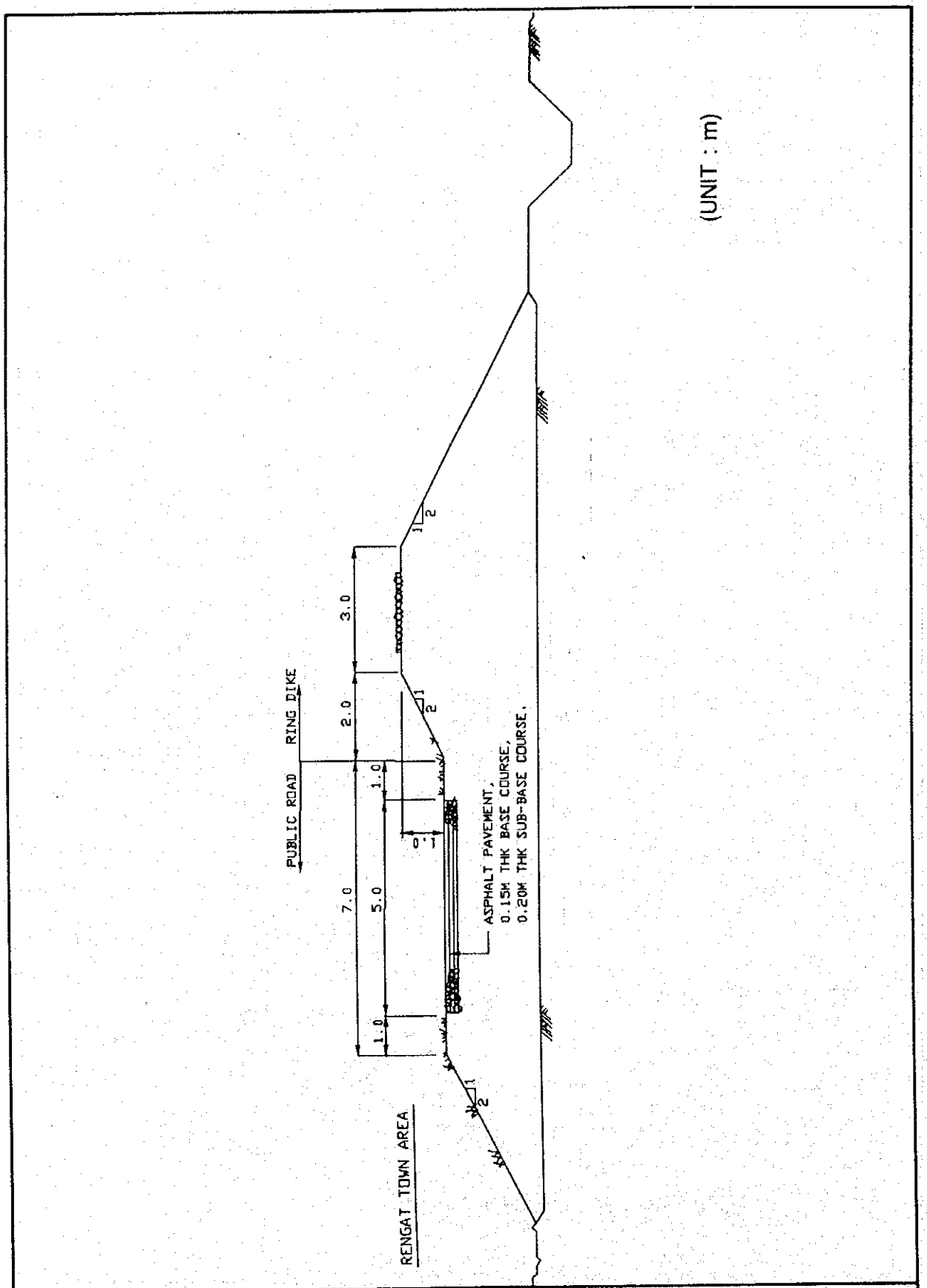


ELEVATION OF OUTLET(B-B)

PLAN OF PUMPING STATION AND OUTLET

(UNIT : m)

THE STUDY ON KAMPAR-INDRAGIRI RIVER BASIN DEVELOPMENT PROJECT IN THE REPUBLIC OF INDONESIA JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. XIII.4.12 PROPOSED PUMPING STATION AND SLUICE IN RENGAT AREA



THE STUDY ON
KAMPAR-INDRAGIRI RIVER BASIN DEVELOPMENT PROJECT
IN THE REPUBLIC OF INDONESIA
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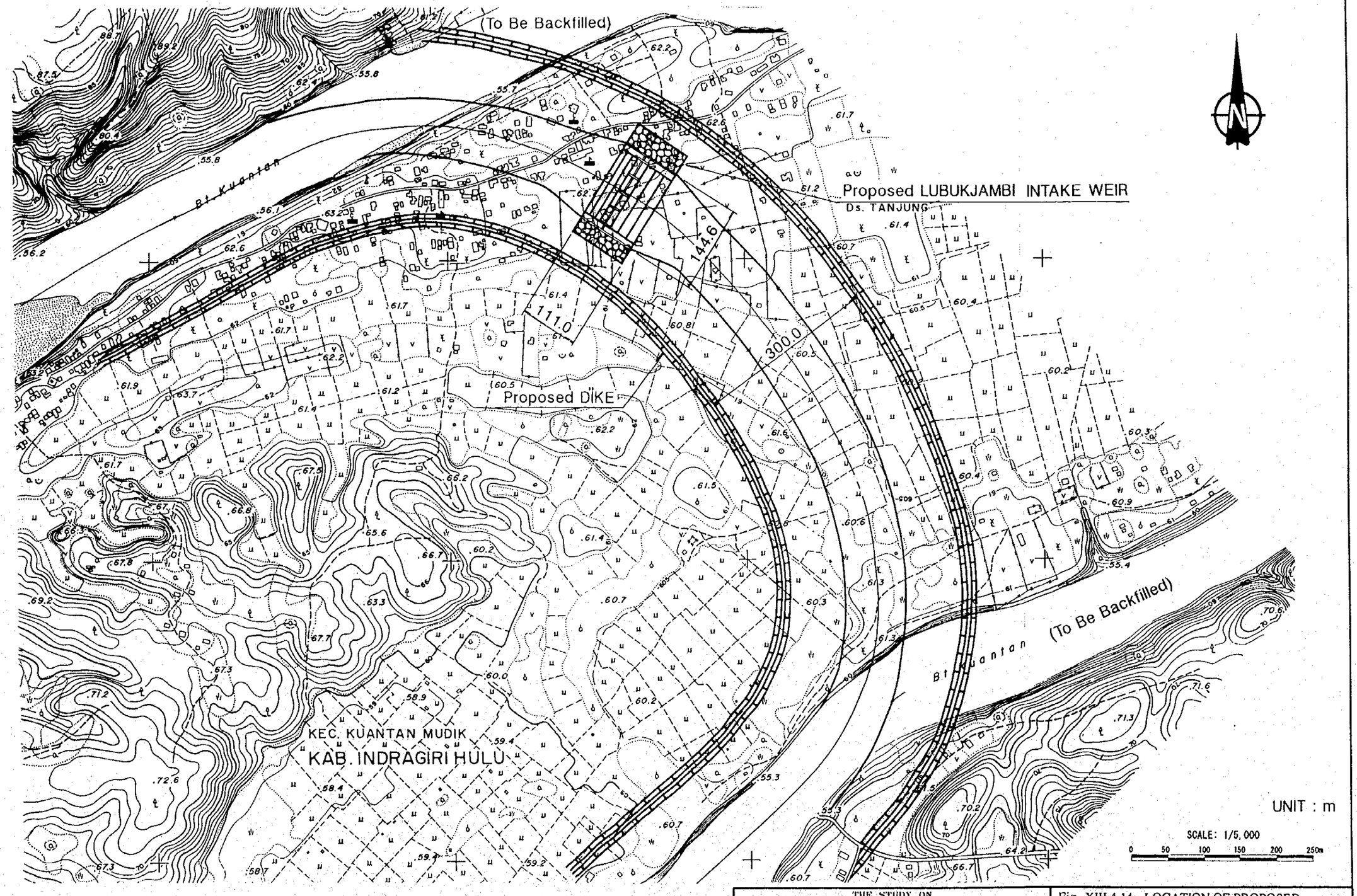
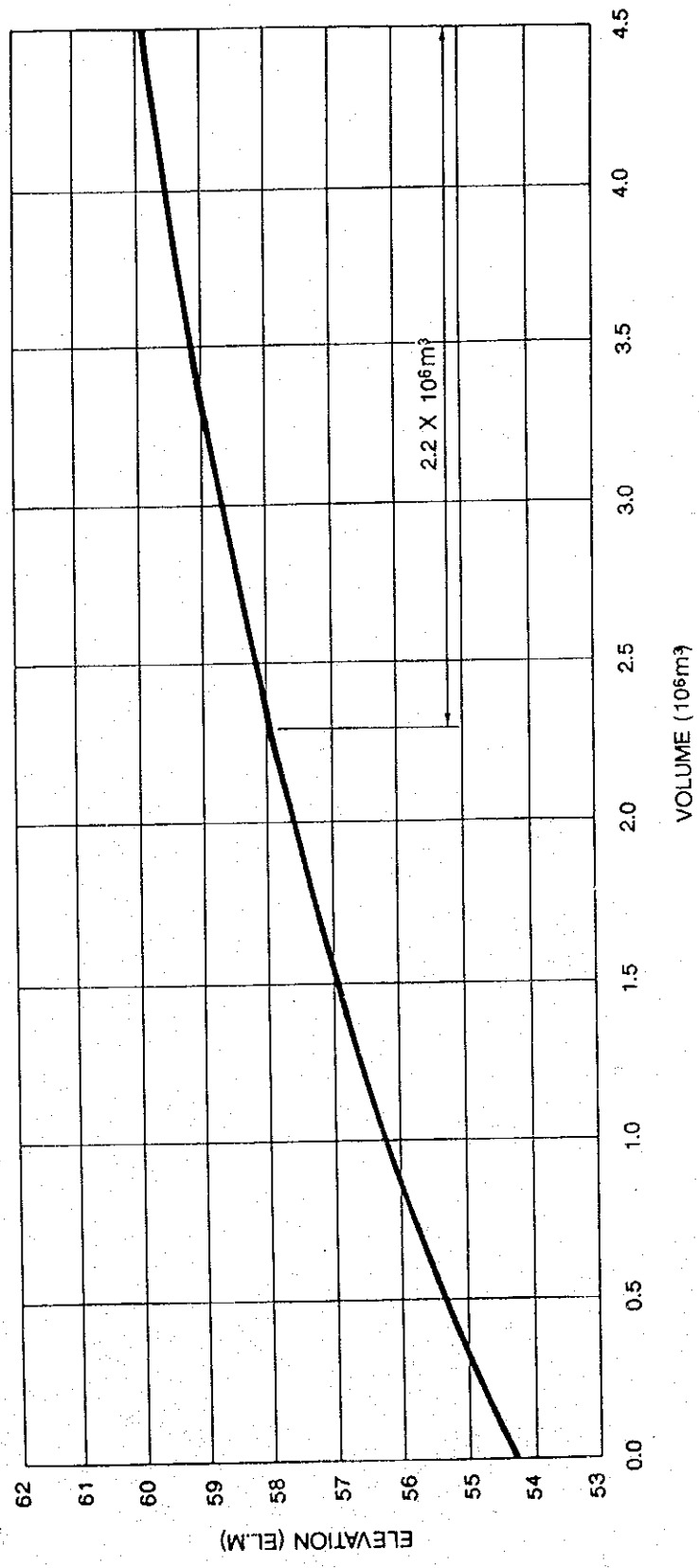
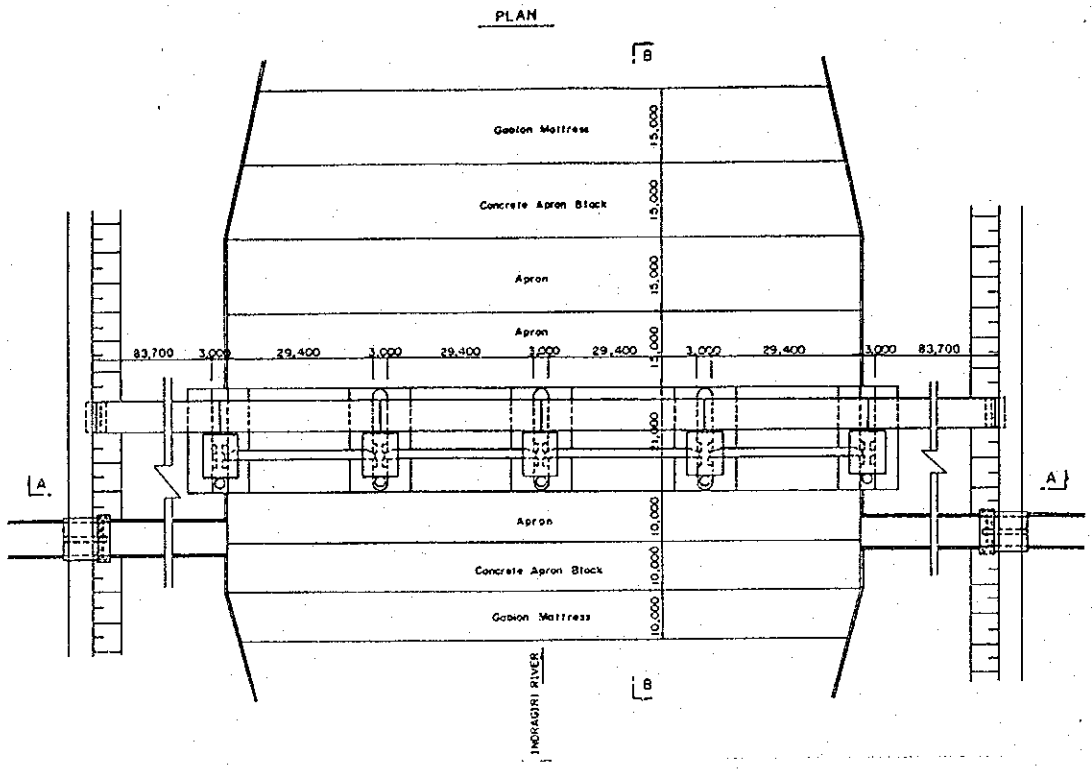
Fig. XIII.4.13 TYPICAL SECTION OF PROPOSED PUBLIC ROAD IN RENGAT AREA



THE STUDY ON KAMPAR-INDRAGIRI RIVER BASIN DEVELOPMENT PROJECT IN THE REPUBLIC OF INDONESIA JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. XIII.4.14 LOCATION OF PROPOSED LUBUKJAMBI INTAKE WEIR



THE STUDY ON KAMPAR-INDRAGIRI RIVER BASIN DEVELOPMENT PROJECT IN THE REPUBLIC OF INDONESIA JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. XIII.4.15 STORAGE CAPACITY CURVE (LUBUKJAMBI INTAKE WEIR)



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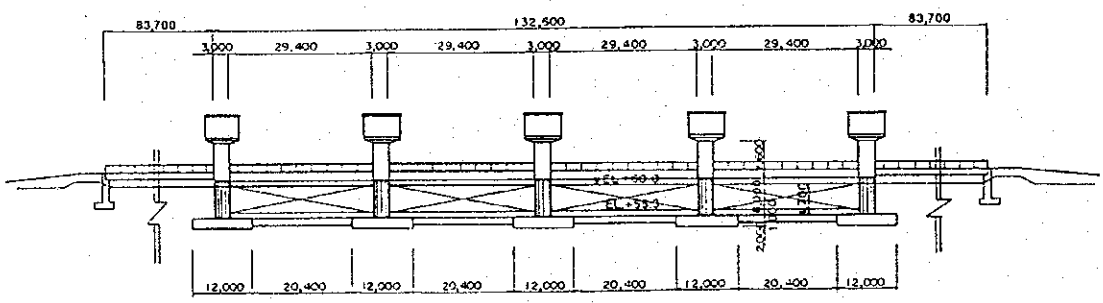

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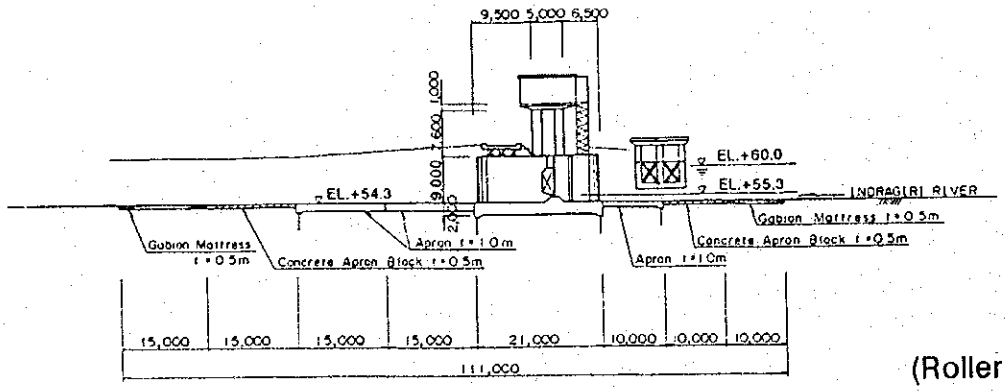
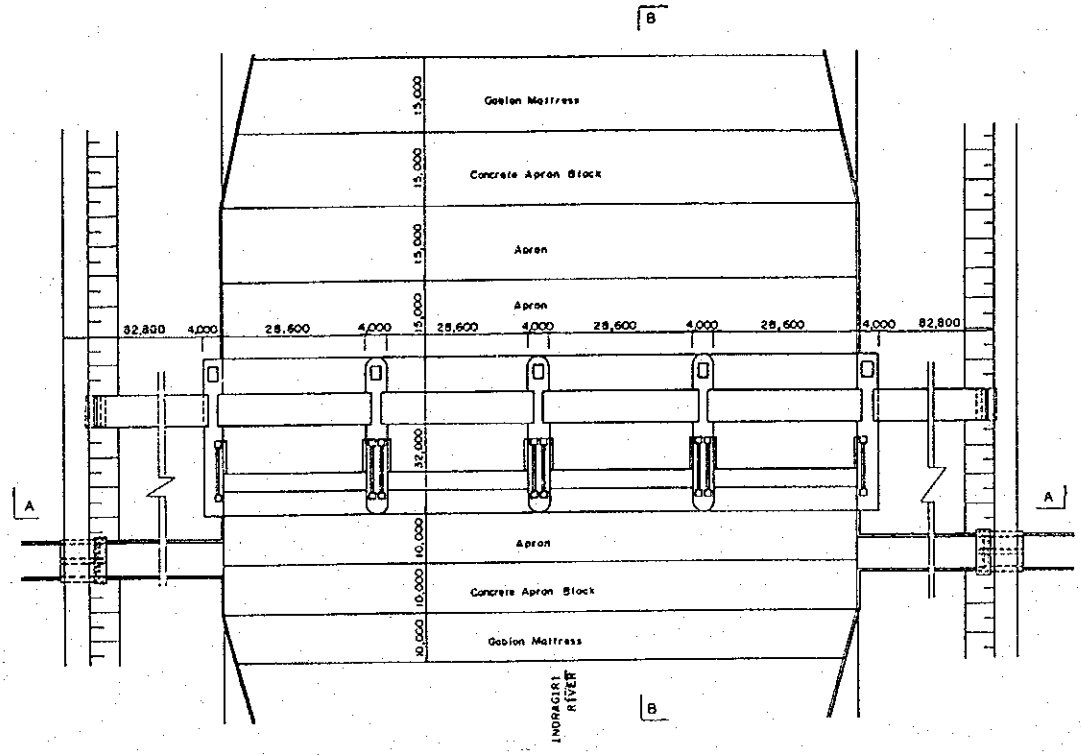


(Roller Gate)

THE STUDY ON KAMPAR-INDRAGIRI RIVER BASIN DEVELOPMENT PROJECT IN THE REPUBLIC OF INDONESIA JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. XIII.4.16 STRUCTURAL ALTERNATIVES (1/2) OF LUBUKJAMBI INTAKE WEIR

PLAN



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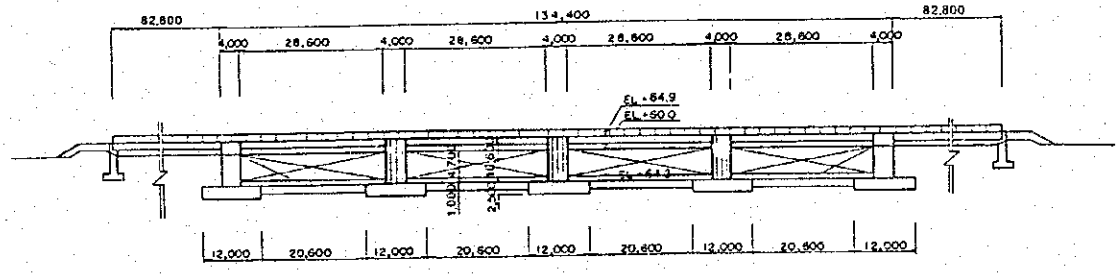

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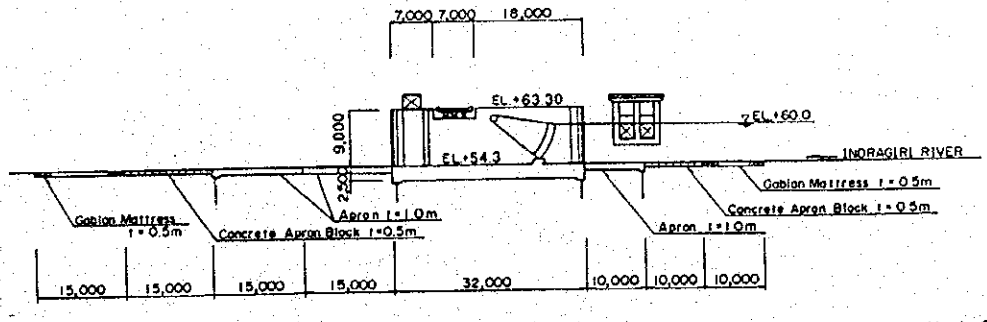
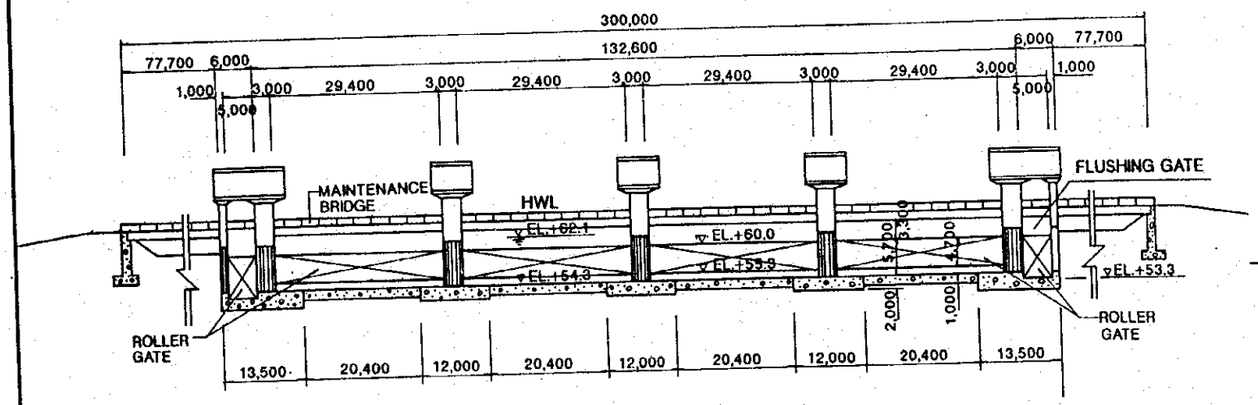


(Radial Gate)

THE STUDY ON KAMPAR-INDRAGIRI RIVER BASIN DEVELOPMENT PROJECT IN THE REPUBLIC OF INDONESIA JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. XIII.4.16 STRUCTURAL ALTERNATIVES (2/2) OF LUBUKJAMBI INTAKE WEIR

SECTION A - A



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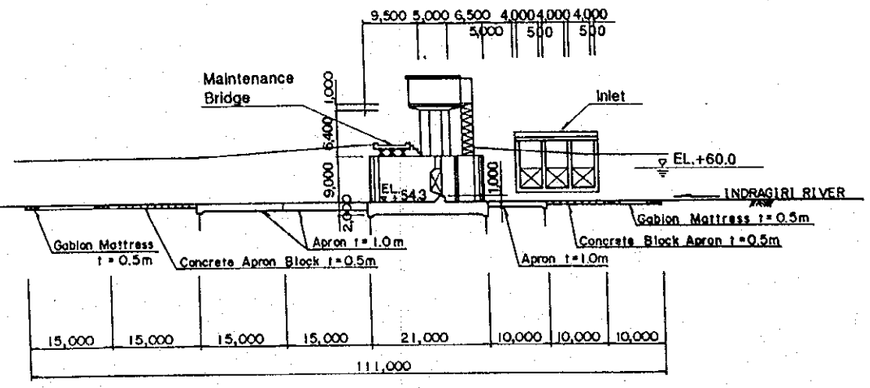

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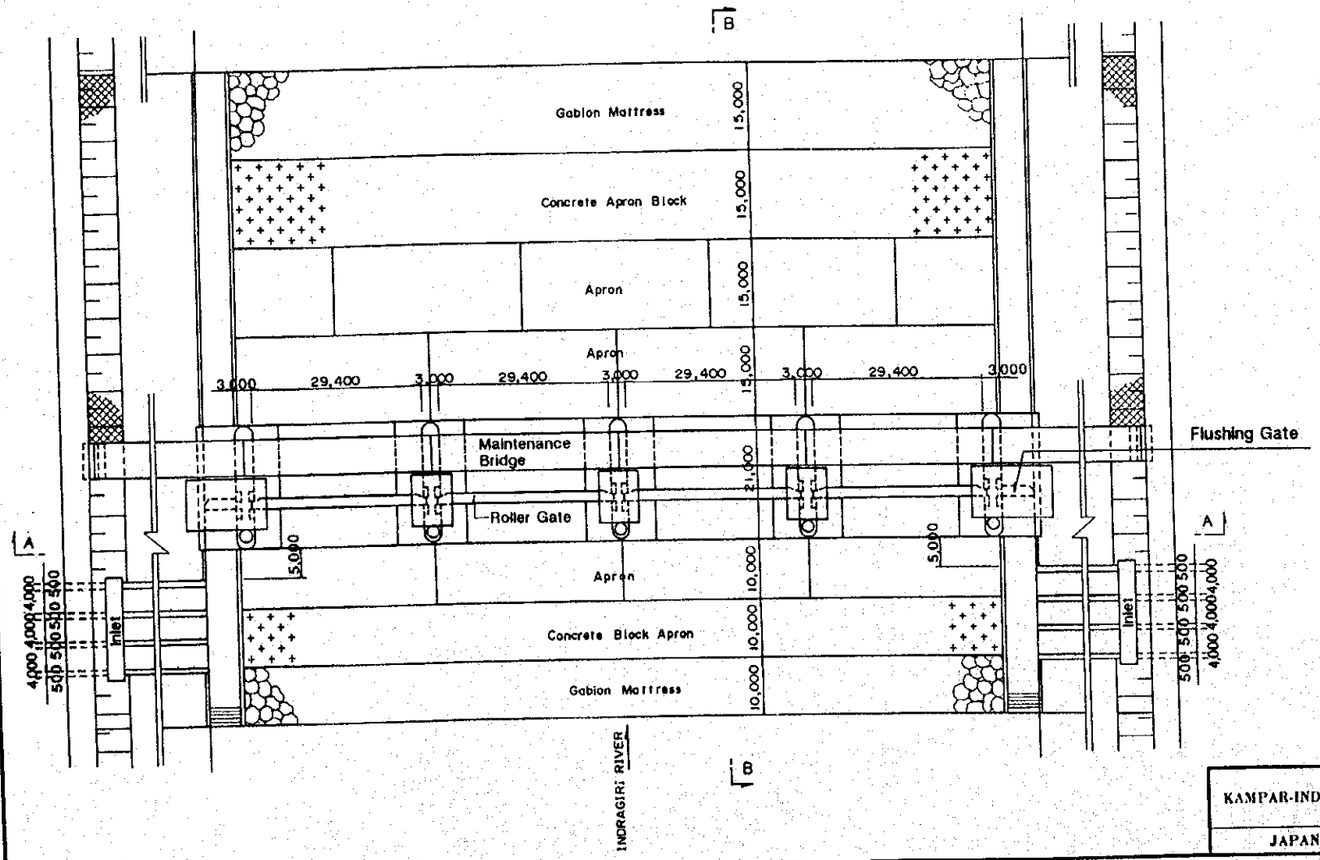

(UNIT : m)

THE STUDY ON KAMPAR-INDRAGIRI RIVER BASIN DEVELOPMENT PROJECT IN THE REPUBLIC OF INDONESIA JAPAN INTERNATIONAL COOPERATION AGENCY	Fig.: XIII.4.17 PROPOSED LUBUKJAMBI INTAKE WEIR STRUCTURES

XIV CONSTRUCTION PLAN

SECTOR XIV
CONSTRUCTION PLAN

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CHAPTER 1 OVERALL DEVELOPMENT PLAN

1.1 General

The Overall Development Plan consists of five major projects, three of which are located in the Kampar river basin and the other two are in the Indragiri river rasin. These major projects involve the construction of various facilities such as two intake weirs, two irrigation systems, three dams and ten river improvement works. Itemized below are the five major projects and their component works.

(1) Kampar Kanan Water Supply Project
   (a) Kuok Intake Weir Construction Works
   (b) Rantauberangin Irrigation System Construction Works

(2) Kampar Kanan River Improvement Project
   (a) Bangkinang Area River Improvement Works
   (b) Lower Kampar Kanan River Improvement Works

(3) Kampar and Kampar Kiri River Development Project
   (a) Kampar Kiri No.1 Dam Construction Works
   (b) Kampar Kiri No.2 Dam Construction Works
   (c) Kampar Kiri River Improvement Works
   (d) Kampar River Improvement Works

(4) Indragiri River Development Project
   (a) Kuantan River Multipurpose Development Project
      (i) Kuantan Dam Construction Works
      (ii) Lubukjambi Intake Weir Construction Works
      (iii) Lubukjambi Irrigation System Construction Works
   (b) Kuantan-Indragiri River Improvement Project
      (i) Lubukjambi-Peranap Area River ImprovementWorks
      (ii) Peranap-Japura Area River Improvement Works
      (iii) Rengat Area Flood Protection Works

(5). Upper Indragiri River Improvement Project
   (a) Payakumbuh Area River Improvement Works
   (b) Solok Area River Improvement Works
   (c) Sijunjung/Muara Area River Improvement Works

1.2 Basic Considerations in Planning Implementation Schedule

The construction plan is established in consideration of the scale of works, local conditions identified and information collected during field reconnaissance and through similar projects studied and implemented in and around the study area. Following are the basic considerations taken into account in preparing the implementation schedule.

(1) Number of Workable Days

The number of workable days is estimated based on rainfall data recorded in the vicinity of each project site. Sundays, national holidays and religious events are considered as non-workable days. National Holidays are listed in Table XIV.1.1.

The general climate of the two river basins is not clearly characterized by dry and rainy seasons because the data show that minimum monthly average rainfall in the dry season from May to October is more than 100 mm; while, in the rainy season from November to March, monthly average rainfall is more than 200 mm in both basins. Allowable workable days estimated are as follows:

Work Items	Workable Days
Concrete Works	250
Embankment Works	
• Embankment of Rockfill Dam	200
• Dike Embankment	220

Workable days are calculated based on the following data and assumptions:

(a) Rainfall Data

Seven rainfall gauging stations near the proposed project sites are selected and ten-year daily rainfall records are picked up for analysis. The selected stations are shown below.

Rainfall Station No.	Location	Project Site
19014	SIJUNJUNG	Sukam Dam
19015	BUO	Upper Sinamar Dam
20001	PASARKAMPAR	Kampar Kanan River
20002	SENTAJO	Kuantan River
20106	LIPATKAIN	Kampar Kiri River (No. 1 Dam)
20107	TALANGGERINJNG	Indragiri River (Rengat)
20108	MUARALEMBU	Kampar Kiri River (No. 2 Dam)

(b) Number of Rainy Day and Suspended Day

Daily rainfall of more than 5 mm is counted as the rainy day for both concrete works and earthworks. Suspended days are dependent on the amount of daily rainfall, as shown below.

Daily Rainfall (mm)	Suspended Day	
	Concrete Works	Earthworks
0-4	0	0
5-14	Rainy Day × 1.0	Rainy Day × 1.0
15-29	Rainy Day × 2.0	Rainy Day × 2.0
> 30	Rainy Day × 2.0	Rainy Day × 4.0

Monthly rainy days classified by the amount of daily rainfall of the selected stations are listed in Table XIV.1.2.

(c) Monthly Workable Day

Table XIV.1.3 is the summary of monthly workable days both for concrete works and earthworks. The detailed calculations are shown in Table XIV.1.4 for concrete works and Table XIV.1.5 for earthworks.

(2 Daily Working Hours and Work Shift

All construction works will be implemented under a single shift of 9-hour labor including 2 hours of overtime per day.

(3) Mode of Construction

Construction works will be carried out by the contract system. International and local competitive bidding for prequalified contractors will be carried out following the guidelines and regulations of the government, DPU, and financing agencies. The DPU will manage and administer the implementation of the project, while the DPU of Riau Province will supervise the construction works in collaboration with a consultant. Upon completion, the operation and maintenance will be handled by the DPU of Riau Province.

(4) Cement

PT. Semen Padang (Padang Cement Company), a state-owned company, is the major source of supply in and around the study area. The plant is located at Indarung, Padang City, West Sumatra Province, about 13 km. from the seaport, Teluk Bayur of Padang. The maximum annual production capacity of the plant is 3,300,000 tons and the average is 2,650,000 tons. The relation between supply and demand is generally balance in recent years. Padang Cement Company also supplies cement for the Kotapanjang Dam which is presently under construction by PLN.

(5) Port of Disembarkation

In Riau Province, there are four major ports for waterborne transportation as follows:

- The Dumai Port, the largest port in Riau Province, located around 200 km north of Pekanbaru City, is equipped with oil loading and public

loading piers. Heavy construction equipment and special construction materials from foreign countries are disembarked here. Extension work of a pier for mooring 20,000-ton class vessels has already been completed.

- The Pekanbaru Port, located on the Siak River, is equipped with public pier. Domestic materials such as reinforcement bars, iron products and light equipment are unloaded here. Vessels of 500-ton class can be entered from the estuary.
- The Rengat Port (Kualacinaku Port), located on the middle reaches of the Indragiri River, is newly relocated near the confluence of the Cinaku River. Used to unload domestic materials, though unloading facilities are not fully equipped, the port can also accommodate vessles of 1,000- to 2,000-ton class.
- The Tembilahan Port located on the lower reaches of the Indragiri River has a public pier. Domestic materials are unloaded here, although unloading facilities are not equipped. The range of delivery is very limited as the road condition from the port to Rengat, especially on the left bank of the Indragiri River is very poor.

(6) Road Condition

National and provincial roads in Riau and West Sumatra provinces are paved and sufficiently maintained except for some 6 km between Lubukjambi and Takunahiu. In West Sumatra Province, hairpin bend sections are often aligned on roads in steep mountains, especially from Solok to Padang and from Payakumbuh to Kotaalam.

Road distance from Pekanbaru and Padang to major towns is as folows:

Pekanbaru	- Dumai	201 km	**Padang**	- Solok	64 km
	- Rengat	217 km		- Bukittinggi	92 km
	- Tembilahan	314 km		- Payakumbuh	128 km
	- Talukkuantan	164 km		- Singkarak Lake	79 km
	- Bangkinang	64 km		- Pekanbaru	312 km

(7) Construction Conditions of Major Damsites

Reconnaissance to the proposed damsites of Kampar Kiri No. 1, Kampar Kiri No. 2 and Kuantan dams has been carried out in order to comprehend the location, accessibility, availability of construction materials, public utility and other relevant information. The results are described below and summarized in Table XIV.1.6.

(a) Kampar Kiri No. 1 Dam

The location map of Kampar Kiri No. 1 Dam is shown in Fig. XIV.1.1.

(i) Feeder Road

From Tumbang village, a road located on the left bank of the Sibayang River leads to Kuntu village, where ferry service is available. A road on the right bank of the river connects Gema and Ngaraijaya villages on the opposite bank of Kuntu.

(ii) Condition of Feeder Road

Road condition of each section is as follows:

Location	Distance	Width	Surface
Tumbang-Kuntu	14 km	3 m	paved, fair
Ngaraijaya-Gema	14 km	3 m	partially paved, poor

(iii) Ferry Crossing

Ferry service from Kuntu to Ngaraijaya is operated by the Department of Public Works and the boat operated manually can load only two cars. The river width at this crossing point is around 100 m and the water depth is less than one meter in the dry season. A new bridge is necessary in the vicinity of this point for the construction of the dam.

(iv) Bridges on Feeder Road

The two wooden bridges and one concrete bridge are as follows:

Location	Type	Length	Width	Condition
Domo Village	wood	15 m	2.5 m	very poor
Subangi River	concrete	20 m	5 m	good
Gema	wood	10 m	2.5 m	very poor

The wooden bridges should be replaced with new bridges for the construction works.

(v) Access to Damsite

On the right bank of the river, there is a track from Gema to the damsite through Tanjungbelit village. Boats with outboard engine are available on the Sibayang River at Tanjungbelit located at around 7 km downstream of the damsite. It takes about one hour from Tanjungbelit to Muarabio which is located 2 km upstream of the damsite where the left major tributary joins the Sibayang River.

(vi) Access road

The track on the right bank generally aligned at about 20 m above the water level has been constructed with around 2.5 m width, but

the villagers have barely used it because of its steep profile in several sections. Some wooden bridges and a suspension bridge with concrete abutments are identified. According to the interview survey at Muarabio, there is a road construction plan of 4 m width on the right bank, though the location and the year of commencement are not certain. In view of the location of river diversion works, possible quarry sites and borrow areas, and the existence of the track, the access road is to be aligned on the right bank. The required length of the new road from Gema to the damsite is around 12 km.

(vii) Availability of Construction Materials

Between Gema and Muarabio, several sandbars and banks where sand and gravel are abundant were identified along the Sibayang River. During dry seasons, these materials should be collected and stockpiled sufficiently prior to the major construction works. The location of borrow areas should be carefully selected to prevent river bank erosion. The riverbank at Tanjungbelit has been scoured seriously and a village mosque was washed away.

(viii) Public Utility

Electricity is supplied up to Gema by PLN. Tanjungbelit also has communal electricity through a diesel generator. No electricity is available at Muarabio.

Water supply and telecommunications are not available in Tanjungbelit and Muarabio. River water is used in both villages for domestic use. There is a clinic each in Tanjungbelit and Muarabio.

(ix) Relevant Information

The information obtained through the interview survey at Tanjungbelit and Muarabio are as follows:

Floods hit Tanjungbelit periodically, approximately once every five years. The biggest one reached around 1.5 m above the riverbanks where the village is located.

Muarabio village was reconstructed more than twenty years ago because the old one has been washed away by the biggest flood in the village's history. In 1978, a big flood reached more than 1.0 m above the riverbanks, and some houses were washed away. There are 14 families in Muarabio and 130 families in Batusanggan village located on the right bank and 2.5 km upstream. Batusanggan has a primary school. No historical monument can be found at the upstream of the damsite.

The people living upstream of the damsite depend on boats for transportation and their main products are rubber, rattan and river fish. These products are transported by boat to a market at Kuntu.

(b) Kampar Kiri No. 2 Dam

The location map of the Kampar Kiri No 2 Dam is shown in Fig. XIV1.2.

(i) Feeder Road

An old road from Muaralembu to Pangkalanindarun village, located 20 km from the damsite passing through the nearest village of Pulaupadang, is still in good condition and around 6 km of its section is to be used as a feeder road.

(ii) Condition of Feeder Road

The condition of roads to be used as feeder road is as follows:

Location	Distance	Width	Surface
Muaralembu-Lembu River	± 0.5 km	3 m	gravel, fair
Lembu River	-	± 100 m	not passable
Lembu River-Pulaupadang	1.5 km	4 m	gravel, fair
Pulaupadang-Access Road	4 km	2.5 m	paved, fair

(iii) Bridges on Feeder Road

A wooden bridge on the Lembu River, a major tributary of the Singingi River, is located around 400 m upstream of the confluence. The abutments of the bridge were washed away and reconstruction of anew one is indispensable. The required length would be about 100 m.

(iv) Alternative Feeder Road

A new alternative feeder road to Pulaupadang and Pangkalanindarung was constructed because the wooden bridge has been impassable for quite some time now. It crosses the riverbed of the Lembu River at around 1 km from the confluence, then continues generally on top of the ridge, which makes several steep sections. Its surface predominantly consists of gravel and some dirt. Around 6 km from the river, there is the T-junction of Pangkalanindarung and Pulaupadang. In view of the road condition, this road is not suitable for a feeder road.

(v) Access to the Damsite

Muaralembu is the town in Kec. Singingi where the Lembu River joins the Singingi River. The most convenient access to the

damsite is by boat with an outboard engine and it takes about one hour to the damsite which is located 10 km upstream of the confluence. The outboard engine is not usable at a few shallow sections of the river during the dry season. If travel by car is available, it will take about one hour drive from Muaralembu to the damsite.

An alternative access to the damsite is from Pangkalanindarung. It takes three hours by boat from Pangkalanindarung.

(vi) Access Road

On the right bank of the Singingi River, a new access road of around 4 km from Pulaupadang to the damsite is required for the construction works. The 1:500,000 map shows the abandoned railway route for coal transport from Sawahlunto to Pekanbaru along the right bank of the Singingi River.

(vii) Availability of Construction Materials

Several sandbars and banks with abundant deposits of sand and gravel are also identified in the Singingi River from Muaralembu to the damsite. These materials should be stockpiled during dry seasons. The Lembu River also has rich deposits of sand and gravel on its riverbed and banks.

(viii) Public Utility

Electricity is available in Muaralembu and Pulaupadang. The subdistrict branch of PLN in Muaralembu has one diesel generator with an installed capacity of 85 kVA that supplies electricity to 420 houses including those in Pulaupadang. A new feeder line is now under construction along the provincial road from Talukkuantan and it will be completed in fiscal year 1994/1995. The voltage of the line is stepped down from 20,000V to 220V.

Telecommunications is available only at the police station in Muaralembu. A doctor is stationed at a clinic in Muaralembu, while Pangkalanindarung has only an assistant doctor.

(ix) Relevant Information

The information obtained at Muaralembu are as follows:

Pulaupadang has been relocated to the right bank of the Singingi River because of frequent inundation of the old village with a population of around 800.

There is one primary school, two mosques and around 1,000 population in Pangkalanindarung. No historical monument is found in the upper reaches of the damsite.

The major products in the upper reaches are rubber, rattan, timber and fish. These products are transported to a market at Muaralembu either by boat or by truck.

(c) Kuantan Dam

The location map of the Kuantan Dam is shown in Fig. XIV.1.3.

(i) Feeder Road

Jake village, the entrance of the feeder road, is located along the provincial road. It is around 150 km from Pekanbaru and 12 km from Talukkuantan. A gravel road about 5 m wide and 20 km long with several steep sections leads to Kotokombu village, located on the left bank of the Kuantan River. According to the sub-district office of Kualtan Mudik in Lubukjambi, this route is planned to be upgraded in 1994/1995 to a metalled road 6 m wide.

(ii) Condition of Feeder Road

Road condition of each section is generally as follows:

Location	Distance	Width	Surface
Jake-Sarosa	7 km	5 m	gravel, fair
Sarosa-Ulo River *	7 km	4 m	gravel/dirt, poor
Ulo River- Kotokombu	6 km	4 m	gravel/dirt, poor

* Steep sections are mainly located between Sarosa and the Ulo River.

(iii) Bridges on Feeder Road

A wooden bridge on the Ulo River near Mundikulo village has been washed away just after its completion some years ago; thus, a temporary wooden path is laid on the riverbed for passing vehicles. During rainy seasons, cars cannot pass at this point. Other wooden bridges identified are as follows:

Location	Number	Width	Length
Sarosa-Ulo River	3	2.5 m	20, 5, 20 m
Ulo River-Kotokombu	3	2.5 m	5, 10, 15 m

(iv) Alternative feeder road

An alternative feeder road is the one from Lubukjambi to Lubukkambacang, the route of which is generally aligned along the right bank of the Kuantan River. Lubukjambi is a town in Kec. Kuantan Mudik located 190 km from Pekanbaru. Lubukkambacang is the nearest village downstream of the damsite and Kotokombu. Both villages are located just opposite of the

Kuantan River. The alternative feeder road, which has a distance of 11 km and a width of 3 m, is generally paved except 1 km from the entrance. A 30 m section of the road, located about 25 km from the entrance, has been seriously scoured due to a flood that occurred in December 1994 and rehabilitation works have just started.

(v) Bridges of Alternative Feeder Road

Five wooden bridges and one new concrete bridge are identified on the alternative road. One of the wooden bridges is in critical condition. The concrete bridge on the Antan River is 20 m long with a width of 5 m capable of a heavy load.

(vi) Access to the Damsite

Boats with outboard engine which can ferry motorcycles and people only to Kotokombu are available at Lubukkambacang. It takes about 30 to 45 minutes by boat to the damsite which is located 10 km upstream. The river is deep enough to sail even in dry seasons, though there are a few shallow sections on the river course.

(vii) Access Road

On the left bank of the Kuantan River, there is an abandoned railway route for coal transport from Sawahlunto to Pekanbaru through Kotokombu. The route identified is aligned at about 30 m from the riverbed, about 3 m wide and its gradient is almost the same as that of the river. This route is suitable for the access road in view of the possible location of the diversion tunnels and feeder road and its accessibility from Pekanbaru and in consideration of the project site's topography.

(viii) Availability of Construction Materials

From Lubukjambi to the damsite, there are several sandbars with sand and gravel deposits which seem to be insufficient to meet the whole demand of the construction works. Instead, rock materials suitable for aggregates are easily found at the vicinity of the damsite. Crushing plants shall be introduced to supplement the aggregates.

(ix) Public Utility

Electricity is not avialable in Kotokombu and Lubukkambacang. However, poles for feeder and distribution lines were already erected along the alternative feeder road from Lubukjambi to Lubukkambacang. According to the PLN branch office in Talukkuantan, power will be supplied to the area within 1994/1995. There are seven (7) diesel generators with total installed capacity of 1.8 MW in Talukkuantan. At present, the main

grid of power supply leads to Baserah and Lubukjambi where one (1) diesel generator of 100 kVA is also installed for emergency purposes.

Domestic water is supplied from shallow wells at Lubukkambacang. A new pump station with purification plant is almost completed on the right bank of the Kuantan River between Lubukkambacang and Lubukjambi that will supply water to 500 houses.

Telecommunications is not available at Kotokombu, Lubukkambacang, Lubukjambi and Talukkuantan. A clinic is available at Lubukjambi where two doctors are stationed.

(x) Relevant Information at Lubukkambacang and Mauro Sijunjung

No historical monument was seen at the proposed reservoir area, which lies mainly in a portion of the Sawahlunto/Sijunjung District of West Sumatra Province, the capital town of which is Muaro Sijunjung.

The upgrading works of the provincial road from Lubukjambi to Kiliran Jau in West Sumatra Province is to be completed within 1994/1995. A part of this upgraded section may be submerged depending on the dam height.

1.3 Implementation Schedule

A phased implementation schedule is considered for the Overall Development Plan taking urgent necessity of flood protection, water supply and budget availability into account. The Overall Development Plan is proposed to be implemented in 24 years until 2019, and shall include detailed design, land acquisition and tendering, as shown in Fig. XIV.1.4. Details of the implementation schedule of each project component are given below.

(1) Kampar Kanan Water Supply Project

The detailed implementation schedule of Kampar Kanan Water Supply Project is shown in Fig. XIV.1.5.

The Kuok Intake Weir is to be constructed to supply water to Pekanbaru and is scheduled for completion in 2003. The weir has a function of regulating water released from Kotapanjang Dam which is presently under construction, and is schedule for completion in 1997.

The Rantauberangin Irrigation System is to be phased into the Initial and Final Phase Projects. The Initial Phase Project is to be completed in 2004 and water

will be fed to its irrigation area to benefit immediately from the project. The Final Phase Project is to be started in 2006 and completed in 2009.

(2) Kampar Kanan River Improvement Project

The detailed implementation schedule of Kampar Kanan River Improvement Project is shown in Fig. XIV.1.6.

Two river channel sections located in Bangkinang area and Kampar Kanan lower reaches are to be improved. The former has a higher priority than the latter because of its location. Both of these river channel sections have a two-phase channel improvement, i.e., the Initial Phase and the Final Phase.

(3) Kampar and Kampar Kiri River Development Project

The detailed implementation schedule of Kampar and Kampar Kiri River Improvement Project is shown in Fig. XIV.1.7.

The project consists of two dam projects and two river improvement projects. The Kampar Kiri No. 1 Dam Construction Works will need six years to complete from 2004 to 2009, and the Kampar Kiri No. 2 Dam Construction Works will also need six years from 2010 to 2015. The Kampar and Kampar Kiri River Improvement Works will be commenced in 2010 and 2014, with completion in 2014 and 2019, respectively.

(4) Indragiri River Development Project

The Indragiri River Development Project is divided into two components, the Kuantan River Multipurpose Development Project and the Kuantan-Indragiri River Improvement Project, as described below.

(a) Kuantan River Multipurpose Development Project

The detailed implementation schedule of the Kuantan River Multipurpose Development Project is shown in Fig. XIV.1.8.

The Kauntan Dam Construction Works is to be commenced in 1996 and completed in 2004 to meet the irrigation water demand in Lubukjambi Irrigation Area and to protect the area from floods of less than 5-year return period.

The Lubukjambi Intake Weir Construction Works is scheduled for seven years from 1998 to 2004, to regulate the water released from Kuantan Dam for irrigation use.

The Lubukjambi Irrigation System Construction Works is divided into two phases, the initial and final phases; i.e., the left bank area of the Kuantan River is to be developed in the Initial Phase from 1999 to 2004, and the right bank area is to be developed in the Final Phase from 2006 to 2014.

(b) Kuantan-Indragiri River Improvement Project

The detailed implementation schedule of the Kuantan-Indragiri River Improvement Project is shown in Fig. XIV.1.9.

The objective river stretches consist of three sections, i.e., Lubukjambi-Peranap, Peranap-Japura and Rengat Area. The former two are to be implemented in single phases, while the Rengat Area is to be implemented in two phases, initial and final. Floods will be mitigated to a certain extent by the Kuantan Dam; therefore, the river channel improvement works will be executed after completion of the dam, except the Initial Phase of the Rengat Area where the effect of flood control by the Kuantan Dam is not expected due to the big residual catchment area downstream from the dam.

(5) Upper Indragiri River Improvement Project

The detailed implementation schedule of the Upper Indragiri River Improvement Project is shown in Fig. XIV.1.10. The objective area is divided into three, i.e, . Payakumbuh, Solok and Sijunjung/Muara, and a two-phased implementation is planned for each area.

CHAPTER 2 FEASIBILITY STUDY

2.1 General

Objective Project

The following four priority projects were recommended to be studied in the feasibility study:

(1) Kampar Kanan Water Supply Project
   (a) Kuok Intake Weir Construction Works
   (b) Rantauberangin Irrigation System Construction Works

(2) Bangkinang Area River Improvement Works

(3) Kuantan River Multipurpose Development Project
   (a) Kuantan Dam Construction Works
   (b) Lubukjambi Intake Weir Construction Works
   (c) Lubukjambi Irrigation System Construction Works

(4) Rengat Area Flood Protection Works

Work Items and Quantities

Based on the preliminary design of the four priority projects, work items and quantities are worked out, as shown in Tables XV.2.1 to XV.2.5 of SECTOR XV, PROJECT COST ESTIMATE.

2.2 Construction Method

2.2.1 Classification of Construction Method

In view of the type of work, scale of work and site conditions, the four priority projects are classified into the following two categories:

Type A	Intake Weir (Kuok, Lubukjambi)
	Irrigation System (Rantauberangin, Lubukjambi)
	River Improvement/Flood Protection (Bangkinang Area, Rengat Area)
Type B	Dam (Kuantan)

2.2.2 Construction Method of Type A Project

The common works for Type A, earthworks and concrete works, are as mentioned below.

(1) Earthworks

Hourly production rate of earthwork equipment and/or manpower to be employed are based on the following swell and shrinkage factors:

Item	Loose/Bank	Embankment/Bank
(1) Common	1.20	0.95
(2) Sand and gravel	1.20	0.90
(3) Weathered rock	1.40	1.13
(4) Rock	1.65	1.40

(a) Excavation

Excavation works are divided into three, depending on the ground condition. As for the excavation in rivers, a combination of backhoe and pontoon barge is adopted because using a dredger is not economical for small quantities.

Excavation 1 (On-land Works)	
Bulldozer	15-ton
Backhoe	0.6 m^3
Dump Truck	11-ton
Excavation 2 (Submerged Section Near Riverbank)	
Backhoe	0.6 m^3
Dump Truck	11-ton
Excavation 3 (Submerged Section Far from Riverbank)	
Backhoe	0.6-ton
Pontoon Barge	200-ton
Scow	150 m^3
Dump Truck	11-ton
Wheel Loader	0.8 m^3

(b) Embankment

Selected excavated materials are to be used for the embankment. A combination of the following major equipment is adopted for embankment works which include moisture content control, spreading and compaction of materials.

Bulldozer	15 ton
Tire Roller	8 ton
Wheel Loader	0.8 m^3

(2) Concrete Works

Concrete mixing plants are to be placed at each site, together with other necessary equipment. Diesel generators are also required because the electricity supply is not stable.

Concrete Plant	1.0 m^3
Diesel Generator	150 kVA
Wheel Loader	0.8 m^3
Truck Mixer	3.0 m^3
Crawler Crane	37 ton
Concrete Bucket	1.0 m^3

2.3 Kampar Kanan Water Supply Project

2.3.1 Kuok Intake Weir Construction Works

Layout plan of construction facilities is prepared, as shown in Fig. XIV.2.1.

(1) Location

Weir site is located around 13 km from Bangkinang and 2.2 km downstream from Rantauberangin Bridge on the Kampar Kanan River. The water course of the Kampar Kanan River at the weir site is almost straight and the national highway from Pekanbaru to Payakumbuh through Bangkinang is aligned on the right bank of the river.

(2) Access Road

An existing hauling road for gravel adjacent to the weir site is to be utilized as an access road. The road distance from the national highway to the weir site is around 1 km.

(3) Site Office

On the right bank of the river, upstream of the weir site, an area suitable for site offices is located.

(4) Plant Yard

In the vicinity of the weir site, aggregate stockpiles and a crushing plant exclusive for the Kotapanjang Dam are located and are now under operation. Water from Laki River which flows along this plant yard is available throughout the year for washing plant. After completion of the Kotapanjang Dam, this area is to be utilized as the plant yard for the weir construction.

(5) Construction Material

The river banks downstream of the weir site are some of the major sources of sand and aggregate supplied to Bangkinang, Pekanbaru and Kotapanjang Dam. At present, these river banks have an abundant amount of supply for large consumption unlike in the river bed from which only small amount of material can be collected and which will be decreased further to a great extent after the completion of the Kotapanjang Dam. Shortcut sections on the river bank will be utilized as the main source of materials for the construction of the weir.

(6) Diversion Works and Dewatering

One-half of the river channel at the weir site is to be enclosed by a temporary cofferdam and the inside must be dewatered in order to execute the work under dry condition. The remaining section is to be completed with the same method as that of the first half section after diverting the flow through this first half section.

(7) Spoil Bank

Spoil banks are to be located adjacent to the weir site. On the right bank, the river course of Sungai Laki, the downstream stretch, may be utilized as a spoil bank. On the left bank, the low-lying area adjacent to the weir site is to be allotted as a spoil bank. Excavated material from the river bed is mainly used as aggregate and backfilling materials.

(8) Land Acquisition and Evacuation

Land for site offices, plant yard, abutments of the weir, access roads and spoil bank is to be acquired or rented. Resettlement of local inhabitants is expected as necessary because of the dike construction and this is counted in the Bangkinang Area River Improvement Works.

(9) Gate

Rubber gates employed for this weir are to be installed properly and tested to confirm their satisfactory function.

(10) Construction Schedule

The construction schedule is shown in Fig. XIV.2.2. Irrigation intakes both on the left and right banks are also to be constructed.

2.3.2 Rantauberangin Irrigation System Construction Works

The Rantauberangin Irrigation System Construction Works is as described below.

(1) Location

The objective areas are located on both banks of the downstream of the Kuok Intake Weir on the Kampar Kanan River, as shown in Fig. VII 3.5 of SECTOR VII, IRRIGATION DEVELOPMENT PLAN. The irrigation area stretches from the intake weir to the Danaubingkuang Bridge.

(2) Access Road

On the right bank, village roads from the national highway can be utilized as access road. A provincial bridge crossing the Kampar Kanan River near Bangkinang is the major access to the left bank. However, only village roads are accessible on the way to the sites at the left bank.

(3) Site Office and Plant Yard

The project has a long stretch of work sites and several contractors will be involved in the construction. Site offices and plant yards will therefore be located at convenient places for each contractor. An administration office may be placed near Bangkinang.

(4) Construction Material

Riverbed material in the Kampar Kanan River along project sites is available as fine and coarse aggregates. Excavated material from the riverbank can also be utilized both as aggregate and embankment material.

(5) Spoil Bank

Swampy areas scattered in the vicinity of the headreaches and main canals can be used as spoil banks. Excavated materials are to be selected as much as possible, to be utilized as embankment material for the river improvement works.

(6) Land Acquisition and Evacuation

Right-of-way for headreaches and main canals is to be acquired and families to be affected have to be compensated and evacuated prior to construction.

(7) Construction Schedule

The construction schedule is shown in Fig. XIV.2.3.

2.4 Bangkinang Area River Improvement Works

The conditions for Bangkinang Area River Improvement Works are as described below.

(1) Location

The stretch downstream of the Kuok Intake Weir as far as the Danaubingkuang Bridge on the Kampar Kanan River is selected for the Bangkinang Area River Improvement Works. The national highway from Pekanbaru to Payakumbuh through Bangkinang is aligned on the right bank of this stretch.

(2) Access Road, Site Office, Plant Yard, Construction Material, Spoil Bank, Land Acquisition and Evacaution

The condition of these items is similar to that of the Rantauberangin Irrigation System Construction Works in the preceding section.

(3) Borrow Area

Soil material for the embankment is to be taken from the foot of the low undulating hills along the river.

(4) Construction Schedule

The construction schedule is shown in Fig. XIV.2.4.

2.5 Kuantan River Multipurpose Development Project

The layout plan of the temporary construction facilities is shown in Figs. XIV.2.5 and XIV.2.6.

2.5.1 Kuantan Dam Construction Works

The conditions for Kuantan Dam Construction Works are as described below.

(1) Location

The damsite is located on the Kuantan River at around 7.5 km from Kotokombu and accessible only by boat with outboard engine.

(2) Access Road

There are two alternative routes, one is on the right bank of the Kuantan River (from Lubukkambacang) and the other is on the left bank (from Kotokombu). The left bank has a steeper slope than the right bank. However, the former route is preferable considering the following advantages:

- Kotokombu has more space for locating relevant facilities such as base camp, plant yard and access road.
- River crossing is less than that of the right bank route and therefore, road length is shorter.

- Abandoned railway route is partially found on the left bank at the elevation of around 75 m and this route is to be utilized.

A bridge is required to approach the right bank of the damsite, where site offices and plant yard are to be located because of the topographical advantage. A narrow section of the river, around 1.3 km downstream of the damsite will be selected for this crossing.

Barges may also be used for transportation, especially for hauling sand and aggregate after dredging the river channel.

Feeder road from Jake to Kotokombu should be upgraded, especially enroute to bridges, by the District Public Works prior to construction.

(3) Site Office

In view of the accessibility of the damsite and the sequence of construction works, a base camp is required at Kotokombu. Site offices are to be situated on the right bank, downstream of the damsite. A bridge crossing the Kuantan River downstream of the damsite is required to aproach the site offices, plant yard and spoil banks. This bridge will be used as an access for the maintenance of the power station and relevant facilities on the right bank.

(4) Plant Yard

For construction of access road and diversion tunnel, one plant yard is located near the base camp at Kotokombu. Another plant yard is to be located on the right bank downstream of the damsite. Temporary pier is to be built at the Kuantan River near the plant yards to facilitate unloading riverbed and other construction materials.

(5) Construction Material

Downstream of the damsite, on the Kuantan River, there are several sandbars and river banks with abundant volume of fine and coarse aggregates. These materials should be collected and stockpiled prior to the dam construction. Selected materials derived from excavation of diversion tunnel and dam foundation are to be utilized for the dam concrete aggregate after crushing.

(6) Spoil Bank

Spoil banks are to be allotted on the right bank downstream of damsite, where the slope is mild and a valley is formed by a small tributary.

(7) Land Acquisition and Evacuation

Such spaces as base camp, plant yard and access roads in Kotokombu village are to be acquired or rented. No evacuation is anticipated for the construction of the dam and relevant facilities except the reservoir area.

(8) River Diversion Works

(a) Diversion Tunnel

Tunnel works are commenced from open excavation of both portal areas on the right abutment. The construction period for open excavation is one month. The excavation is carried out at average output of 460 m^3/day. A combination of 15-ton bulldozer and 0.6 m^3 backhoe, and light equipment such as leg drills and pick hammers for blasting is used for the excavation.

Two diversion tunnels, having a length of 460 m and 510 m and a round-shaped concrete lined inside diameter of 8.8 m, are aligned. The tunnel works are to be carried out by 2 shifts because they are in a critical pass for the river diversion. The tunnels are driven from the outlet portal toward the inlet portal side for 5 months. Average excavation progress rate of the tunnel heading is, therefore, 3.9 m/day. It is proposed that the tunnels be excavated by the full face method.

The excavated materials are to be hauled to the stockyard by a combination of two 1.6 m^3 tractor shovels and three 11-ton dump trucks and used as aggregate materials for concrete.

H-shaped steel supports are to be installed at 1.2 m or 1.5 m intervals both at the inlet and outlet sides of the diversion tunnel considering rock conditions. Additional steel support may be required for poor geological condition encountered in actual excavation.

Immediately after tunnel excavation, concrete lining is carried out from the outlet portal toward the inlet portal side for 5 months. Lining is carried out by a sliding form and concrete pump.

Backfill grout and curtain grout are done by 5.5 kW boring machines and 11 kW grout pump for one month.

(b) Cofferdam

Upstream primary cofferdam and downstream cofferdam are constructed by earth embankment for river diversion. The embankment volume of 7,200 m^3 for the cofferdams is obtained from both banks and is embanked by a combination of a 15-ton bulldozer and a 5-ton vibrating roller.

After river diversion, excavation of main cofferdam is commenced. The excavation is carried out for one month by a combination of 0.6-m^3 backhoe, 15-ton bulldozer, and light blasting equipment with average output of 300 m^3/day. The excavated materials are disposed to the spoil bank by using 1.4-m^3 dozer shovel and 15-ton dump trucks.

The concrete of $16.6 \times 10^3 m^3$ for main cofferdam is placed at an average volume of 250 m^3/day with 0.75 m lift by a combination of 15-ton dump truck, 11-ton bulldozer and 5 ton vibrating roller.

(c) Diversion Tunnel Closure

Prior to closure of the diversion tunnels, the intake structure of river outlet shall be completed. The diversion tunnels are closed by diversion gates (roller gate).

After closing the roller gates, the diversion tunnels are plugged with concrete. Cooling of the plug is done by circulating river water through cooling pipes embedded in the plug concrete. The contact grouting is finally carried out to seal the joint between the tunnel lining and plug concrete segments. The plug works are done for 2 months.

Major equipment for the plug works is a combination of 3.2-m^3 agitator trucks and concrete pump for plug concrete and 11-kW grout pump and 200-ltr. × 2 grout mixers for contact grout.

(9) Foundation Excavation

The foundation excavation is started at both abutment walls before the river diversion. The riverbed portion is carried out concurrently with the construction of cofferdam after river diversion. An average output of 300 m^3/day is carried out by a combination of 11-ton and 15-ton bulldozers, 21-ton bulldozers with a ripper and light equipment such as leg drills and pick hammers for blasting.

Excavated materials are disposed to spoil banks by using a 1.4-m^3 dozer shovel, a 2.1-m^3 wheel loader, 8-ton and 15-ton dump trucks.

(10) Foundation Treatment

The bedrock of the gravity dam is treated by consolidation and curtain groutings to attain the required strength and watertightness.

The consolidation grouting is commenced on the riverbed and carried out toward the abutments before covering rock surface with concrete. The curtain grouting is carried out through the upstream filet after the rock foundation is covered with concrete. Total grouting length of 15,300 m for consolidation and curtain grouts is carried out for 5 months with an average progress of 150 m/day.

(11) Cable Crane

A total of $339.1 \times 10^3 m^3$ dam concrete volume is scheduled to be placed for 30 months considering the time of the river diversion and diversion closure. Concrete placement works for dam are to be carried out in two shifts because they are also critical pass for the dam construction. The estimated workable day is 625 days, so average concrete placement is 11,300 m^3/month.

The monthly peak requirement of concrete placement is assumed to be 1.3 times the average concrete placement which is calculated at 14,690 m^3/month, and the placement capacity is:

$$\frac{14,690}{20 \times 9 \times 2 \times 0.7} = 58 m^3/hr$$

(Note: Monthly operation day = 20; one shift working hours = 9; number of shifts = 2; operation efficiency = 0.7)

Assuming that a cycle time of concrete placement is 3.0 minutes, bucket capacity is:

$$\frac{58 \times 3}{60} = 2.9 m^3$$

Thus, a 3.0 m^3 concrete bucket is adopted. Considering the site condition of both abutments, a 9.0-ton rail-rope-type cable crane is selected.

(12) Batching Plant

Total concrete volume for the construction except for diversion tunnel is about $439.8 \times 10^3 m^3$. The required hourly production capacity of the plant is 60 m^3/hr.

A batching plant (3.0 m^3, 1.0 m^3 and 0.75 m^3 mixer) with the total capacity of 62 m^3/hr is installed on the right abutment of the main dam.

(13) Crushing Plant

Assuming that a crushing plant produces one-half of the required concrete aggregate, the peak requirement of crushed stone is estimated to be 11,000 tons/month. Assuming that operation hour, day and efficiency is 7 hours, 25 days and 0.80, respectively, and production loss is 20 percent, the required plant capacity is:

$$\frac{11,000 \times 1.20}{25 \times 7 \times 0.80} = 95 tons/hr$$

Two crushing plants with capacity of 50 ton/hr each are installed near the batching plant on the right abutment.

(14) Reservoir Area

The resettlement of local inhabitants and relocation of roads and relevant structures in the reservoir area formed by the Kuantan Dam which lies mainly in West Sumatra Province are necessary before the commencement of the construction works.

(a) Evacuation

The following villages are to be partially or completely submerged depending on the reservoir water level:

(i) Kecamatan Sijunjung

- Durian Gadang

(ii) Kecamatan Tanjung Gadang

- Padang Tarap, Pintu Batu, Tanjung Keling, Air Amo, Lubuk Kapiek, Mudik Kimik, Banjar Tengah.

(iii) Kecamatan Perwakilan Tanjung Gadang

- Batang Karing, Sungai Mandar, U.P.T. (Unit Penempatan Transmigrasi) Timpeh IV.

A topographic map on the scale of 1:10,000 developed by JICA and covering the reservoir area is available, and the number of houses to be submerged is counted and summarized in Table XIV.2.1.

(b) Road Relocation

Between Lubukjambi and Kiliranjao, the Trans-Sumatra Highway crosses the Karing River, a tributary of the Kuantan River, and a few kilometers of this section is to be submerged. Road relocation is required on this section. District and village roads, logging roads and bridges are also to be inundated. The length of such road sections and number of structures are estimated from the topographic map of 1:10,000 and summarized in Table XIV.2.2.

(16) Construction Schedule

The construction schedule is shown in Fig. XIV.2.7.

2.5.2 Lubukjambi Intake Weir Construction Works

The layout plan of temporary construction facilities for the Lubukjambi Intake Weir Construction Works is shown in Fig. XIV.2.8.

(1) Location

The weir site is located in a shortcut on the right bank of the Kuantan River around 13 km upstream from Lubukjambi. A small hill with the height of around 80 m extends from the south and recedes near the site. The perimeters of the site have no particular village name because they seem to have moved from the two adjacent villages, Sungai Alah and Sungai Pinang.

(2) Access Road

A village road aligned along the right river bank of the Kuantan River leads to the village between the Alah and Pinang rivers. Around 200 m from this village, the weir site is located in the middle of the paddy field. Two wooden bridges are identified on the village road and required to be replaced for heavy loads. The road of 2.9 km from the entrance to the weir site is to be widened and metalled for use as access road.

The feeder road from Lubukjambi to the entrance of the access road is to be upgraded by the District Public Works prior to construction.

(3) Site Offices

On the right bank of the river, upstream of the weir site, site offices are to be located.

(4) Plant Yard

Plant yard is also to be located adjacent to the site offices in consideration of the access road and construction material.

(5) Construction Material

Material from sandbars in the Kuantan River and excavated materials from both the weir site and the shortcut are to be utilized as fine and coarse aggregates. Debris of coal washed down from coal mines upstream can be found along the riverbank and such kind of material should be excluded from the aggregates.

(6) Location of Weir Site

With reference to the implementation schedule, the construction of the Kuantan Dam will be commenced one year earlier than the weir and both structures are to be completed simultaneously in 2004. Therefore, during the construction of the weir, there are no flood control facilities upstream and the vicinity of the weir site is flood prone area. Flood water sometimes reaches above riverbanks where the weir site is to be located. Thus, the temporary cofferdam method to enclose the work sites in the river channel is not suitable here. The right bank paddy fields are selected for the weir site and connecting channels to make dry construction possible. After completion of these structures, the original river will be diverted through the new channel.

(7) Spoil Bank

Spoil bank is to be allotted in the valley at the foot of the hill near the site.

(8) Land Acquistion and Evacuation

Land to be acquired as right-of-way for the shortcut including the weir site is around 30 ha, of which 9.7 ha are residential area, 14.1 ha are wet paddy

fields and 6.2 ha are orchard farms. Such spaces as site offices, plant yard and spoil bank are also to be reserved.

The number of houses to be relocated is around 80, including small huts.

After completion of the shortcut, the existing river course may be utilized as a resettlement area, if it is reclaimed.

(9) Construction Schedule

The construction schedule is shown in Fig. XIV.2.9. Irrigation water intakes on the left and right banks are also to be constructed.

2.5.3 Lubukjambi Irrigation System Construction Works

The conditions for the Lubukjambi Irrigation System Construction Works are as described below.

(1) Location

The project area is on the left bank of the Indragiri River, from the downstream of the Lubukjambi Intake Weir down to Kampung Baru.

(2) Access Road

A national highway from Talukkuantan and a provincial road from Talukkuantan to Japura are the major access to the project sites. Village roads from the major access are also utilized.

(3) Site Office and Plant Yard

The project has a long stretch of work sites and several contractors will be involved in the construction. Site offices and plant yards will therefore be located at convenient places for each contractor. An adminstration office may be placed near Talukkuantan.

(4) Construction Material

Material from sandbars at the Kuantan River will be utilized as fine and coarse aggregates.

(5) Spoil Banks

Swampy areas scattered in the vicinity of the headreaches and main canals are to be allocated as spoil banks.

(6) Land Acquisition and Evacuation

Right-of-way for headreaches and main canals is to be acquired and families to be affected have to be compensated and evacuated prior to the construction.

(7) Construction Schedule

The construction schedule is shown in Fig. XIV.2.9.

2.6 Rengat Area Flood Protection Works

The conditions for Rengat Area Flood Protection Works are as described below.

(1) Location

From Pekanbaru to Rengat, a new national highway of around 280 km through Japura is available. The town of Rengat faces the Indragiri River and its surrounding area is mainly swampy land; therefore, a ring dike is to be constructed around this area as urgent flood protection in consideration of the Rengat Development Plan and other relevant requirements.

(2) Access Roads

No access road is required in view of the location of national highway and project sites and the sequence of construction works.

(3) Site Office and Plant Yard

Site offices and plant yard are to be located near the project sites. The administration office may be placed at Rengat town.

(4) Construction Material

Only sand is available in Rengat. Other construction materials such as coarse aggregates and soil materials for embankment should be hauled from outside of Rengat.

(5) Quarry and Borrow Areas

The nearest quarry where granite is supplied is located at Talanglakat, 7 km away from the national highway to Jambi. The hauling distance will be around 75 km.

A borrow area is currently being operated at Pematangreba, around 2 km south from the intersection, for the embankment material of road construction. In the vicinity of this area, a new borrow area can be exploited in accordance with the town development plan.

(6) Spoil Bank

Low-lying areas in the vicinity of the project site are to be allocated as spoil banks.

(7) Construction Schedule

The construction schedule is shown in Fig. XIV.2.10.