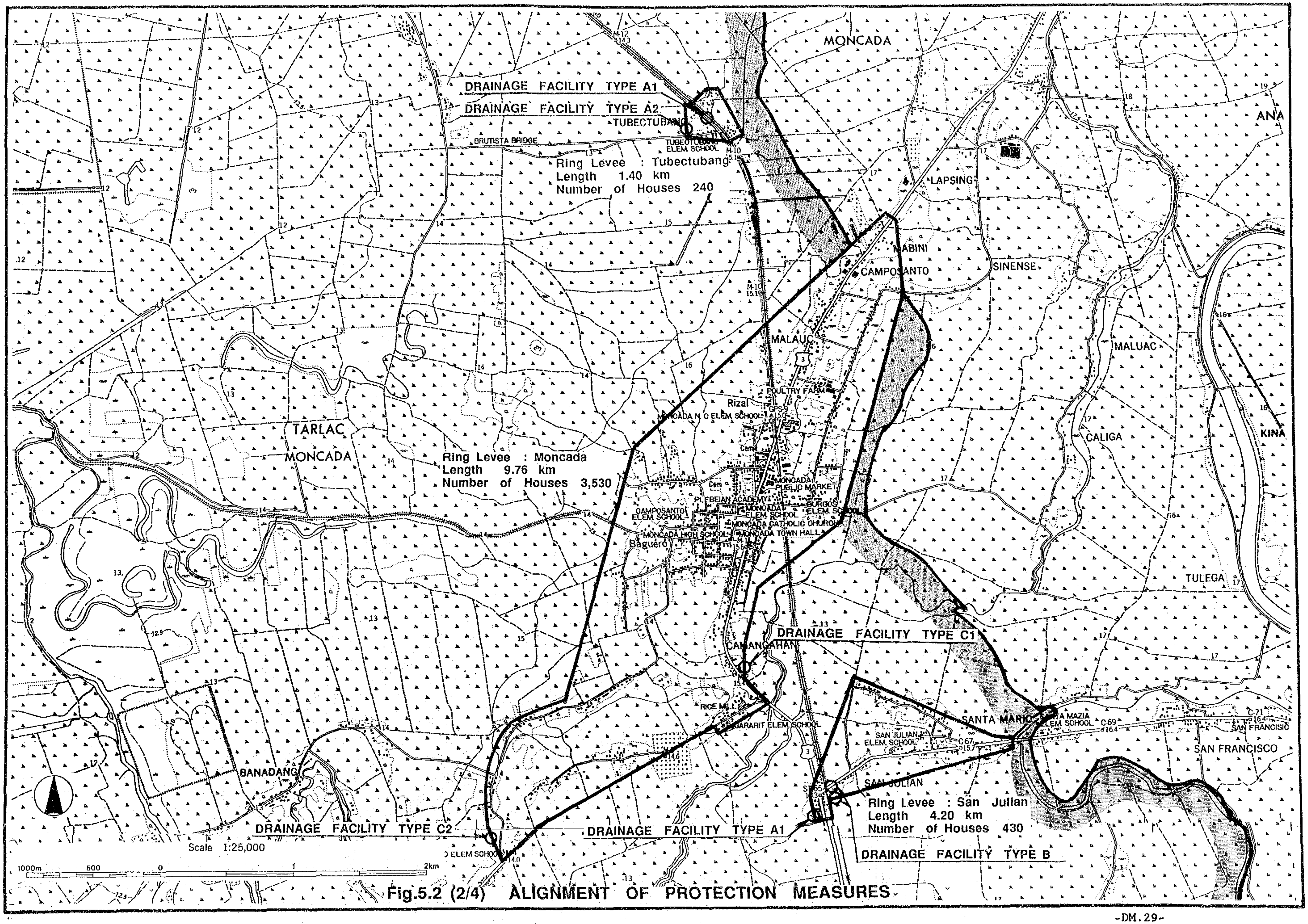


Fig.5.2 (2/4) ALIGNMENT OF PROTECTION MEASURES

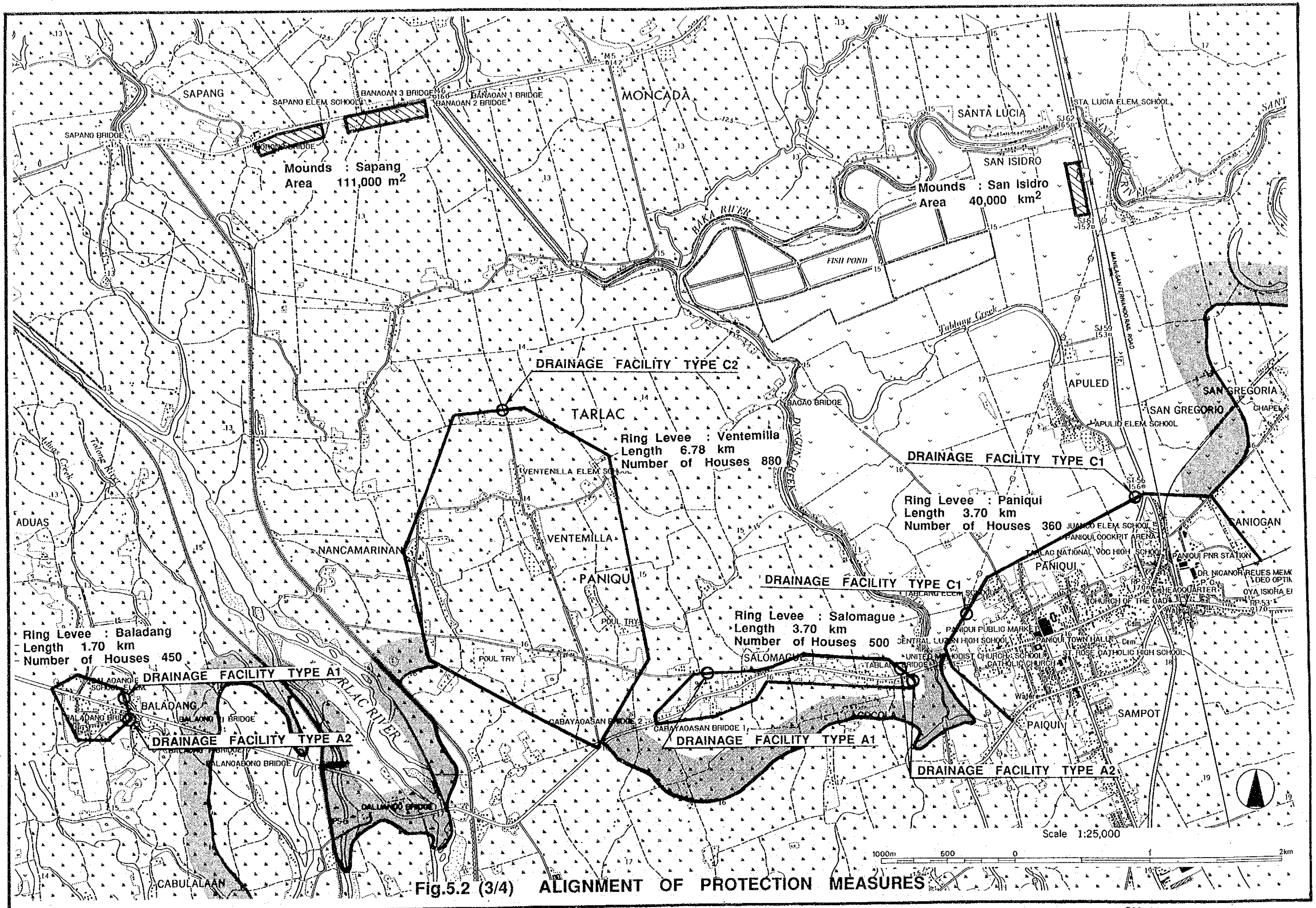


Fig.5.2 (3/4) ALIGNMENT OF PROTECTION MEASURES

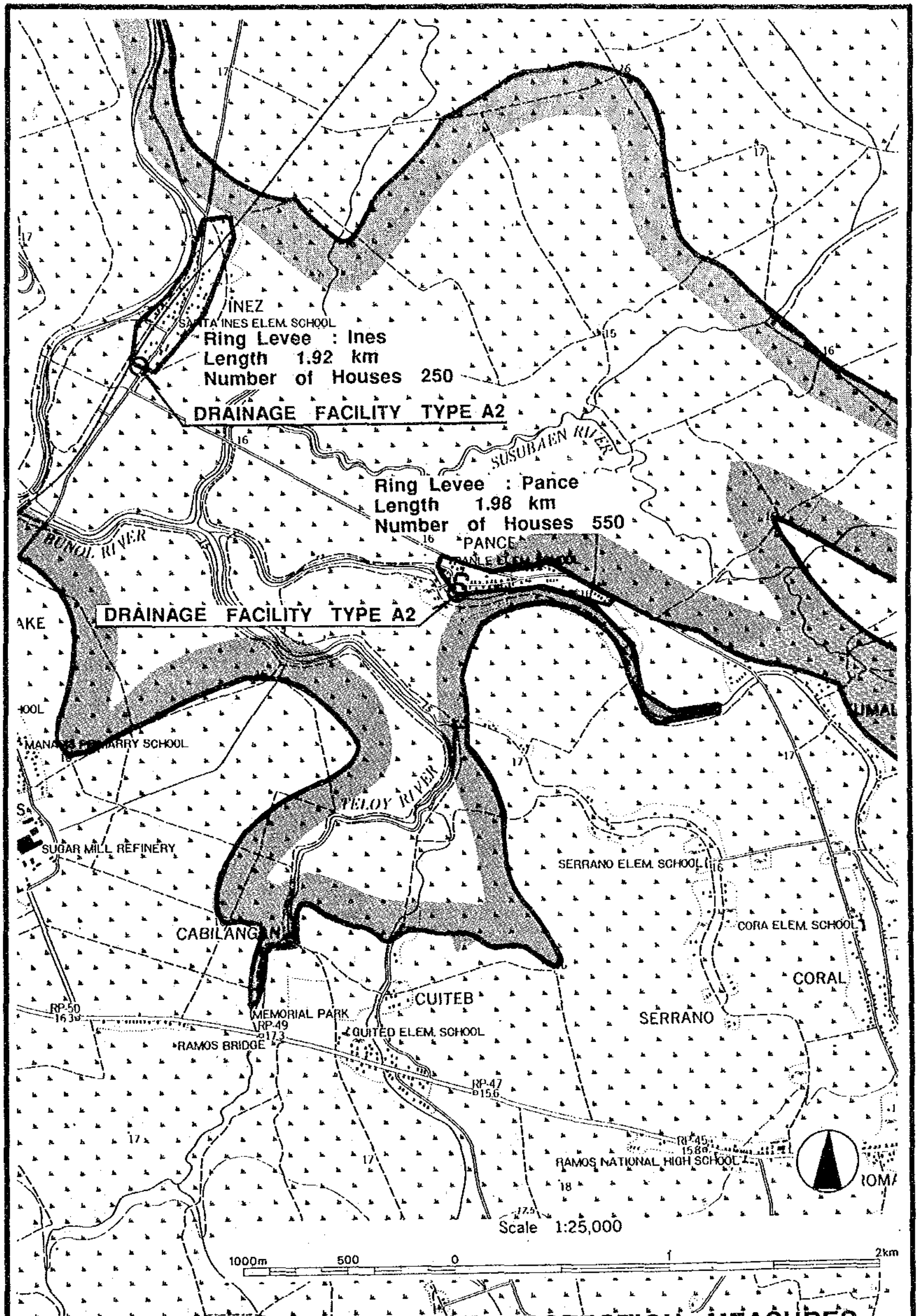


Fig.5.2 (4/4) ALIGNMENT OF PROTECTION MEASURES

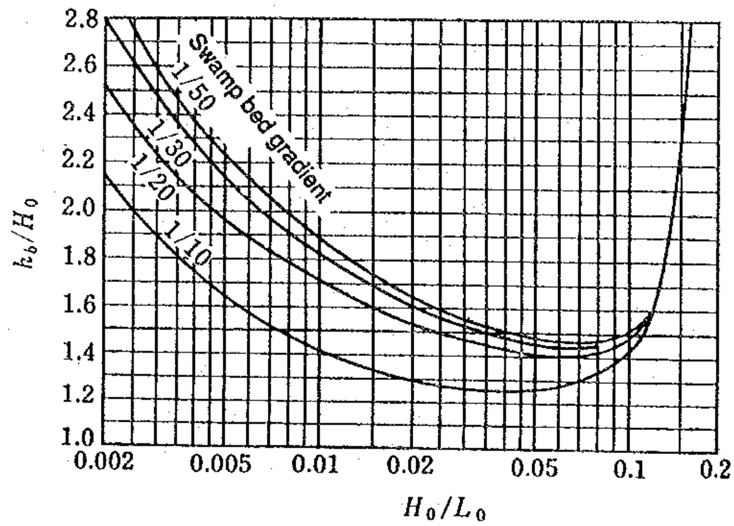
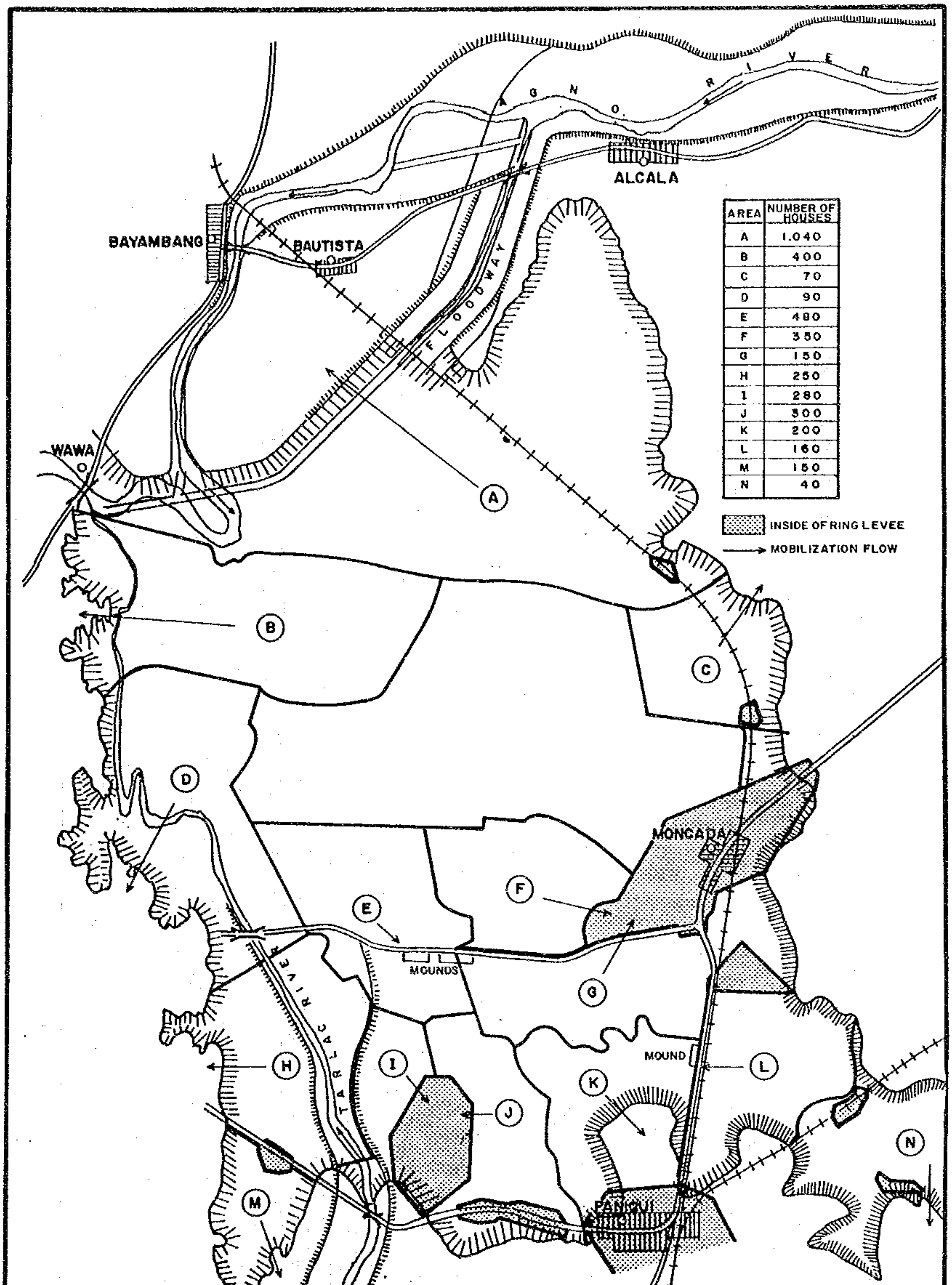


FIG. 5.3 WATER DEPTH OF WAVE SMASH



AREA	NUMBER OF HOUSES
A	1.040
B	400
C	70
D	90
E	480
F	350
G	150
H	250
I	280
J	300
K	200
L	160
M	150
N	40

Fig. 5.4 THE MOBILIZATION FLOW OF THE RESETTLEMENT

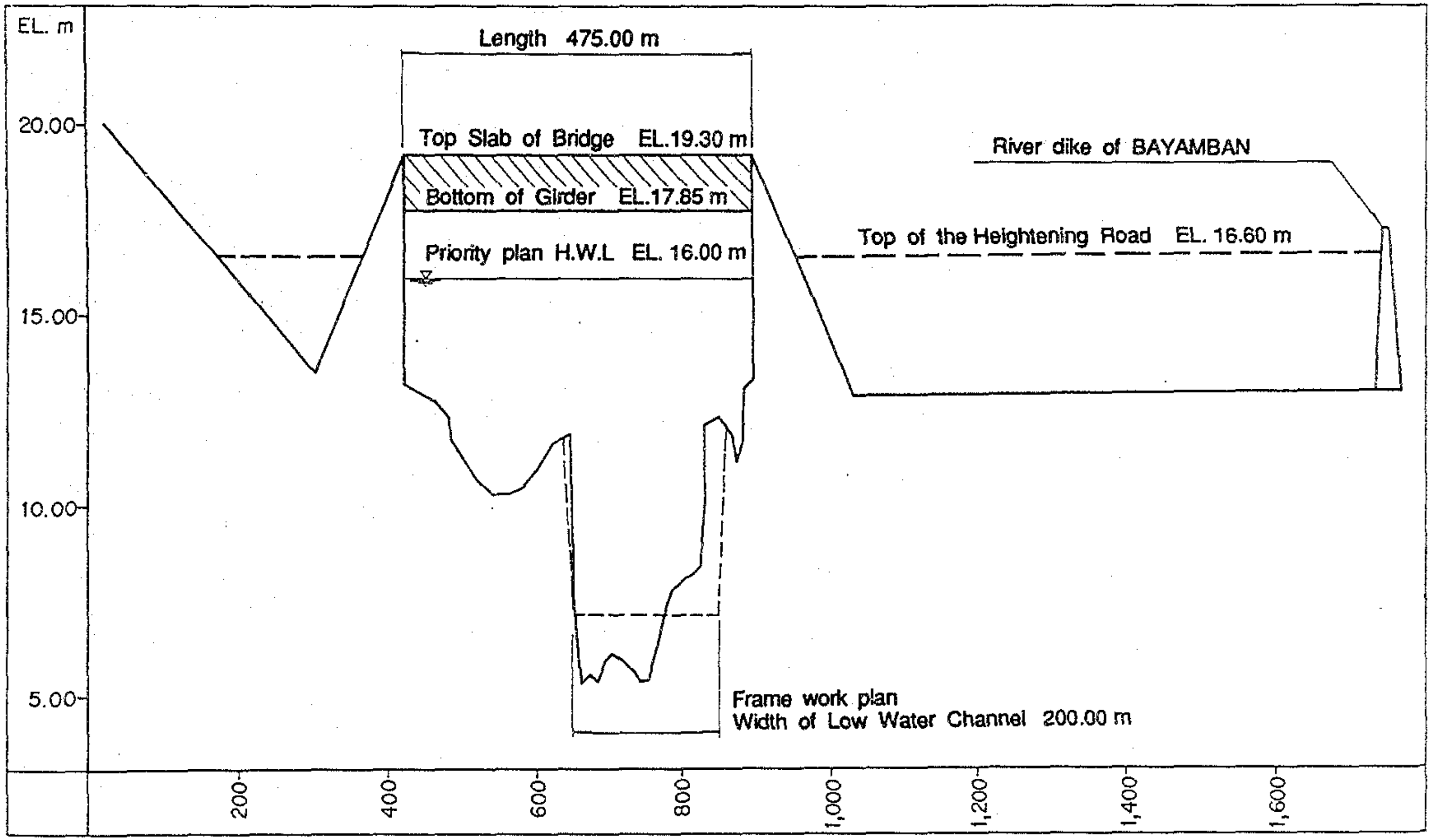


Fig. 5.5 RIVER CROSS SECTION AT WAWA BRIDGE SITE

11. FF

11. FF

FLOOD FORECASTING AND WARNING SYSTEM

FF. FLOOD FORECASTING AND WARNING SYSTEM

SUMMARY

1. The flood forecasting and warning system (FFWS) is defined as one of the non-structural component of the Flood Control Plan. The FFWS Framework Plan which was planned at the Master Plan Stage aims to upgrade the existing system and achieve and integrated basinwide FFWS which fulfills the following objectives:

(i) FFWS for Residents Protection from Flood Incident
(ii) FFWS for Flood Operation
(iii) FFWS for Basinwide Flood Management

2. The FFWS for the Priority Project Plan considers mainly the function for Flood Operation i.e., flood control operation and maintenance of the prospective flood control facilities selected in the Priority Project Plan.

3. The FFWS for the Priority Project Plan is planned as "Flood Control Operation and Maintenance System" based on the following basic concept:

(1) DPWH/AFCS (Agno River Flood Control System) will takes the responsibility of operation and maintenance of the prospective new communication and operation system and safety of the flood control facilities.

(2) Required information for flood control operation will be supplied by the existing FFWS which is managed by PAGASA.

(3) Telecommunication network between DPWH/AFCS and prospective flood control facilities will be established to exchange the required information for the flood control operation.

(4) The system will requires institutional arrangement that PAGASA will allow DPWH/AFCS to install new data communication and monitoring equipment in the AFCS office which is to be connected with the existing telemetry system of the Agno River FFWS in Rosales FFWS sub-center.

4. The unit components of the proposed system are described below:

(1) AFCS Control Office
AFCS Control Office will be located at Rosales and all the activities for flood operation and maintenance of facilities will be managed by this office.

(2) Dagupan Flood Control Office
This office will be newly established to task the activities for the System in and around Dagupan city.

(3) Respective Flood Control Facilities
The objective major facilities will be selected as follows:

(a) Diversion weir at the inlet of the Alcala-Popont floodway
(b) Water gate to release maintenance flow to the Marusay stretch
(c) Water gate at in Marusay river at confluence of Dagupan river

(4) Data Communication and Monitoring System
Data communication and monitoring equipment will be introduced to AFCS control office.The meto-hydrological condition which is observed by the existing telemetry system of Agno River FFWS will be monitored at AFCS.

(5) Telecommunication Network
Multiplex radio communication system will be introduced between the AFCS Control Office and Dagupan Flood Control Office. Radio telephone equipment will be installed at each office and respective flood control facilities.

5. The total cost for the proposed system is estimated at some 188 million Yen.

FF. FLOOD FORECASTING AND WARNING SYSTEM

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1. INTRODUCTION

1.1 Existing FFWS in Agno River Basin

The existing FFWS in Agno river basin includes the Agno River FFWS which has been installed in 1982 as the part of ABC (Agno, Bicol, Cagayan) System, and the Binga-Ambuklao System which is the one of the sub-system of on-going FFWSDO project II. The existing and on-going FFWS in Agno river basin are summarized on Table 1.1. The rehabilitation works for Agno River FFWS is also proceeded in the FFWSDO Project II. Facilities and system network of both the systems are shown in Fig. 1.1 and Fig. 1.2, respectively.

1.2 Master Plan of Agno River FFWS

The Master Plan Study for FFWS in Agno river basin pointed out the technical and institutional problems involved in the existing system. The Integrated FFWS Plan was formulated to give the solution for the problems and to realize the basinwide FFWS which fulfills the following objectives:

(1) FFWS for Resident's Protection from Flood Incident

It aims to secure the life of people and minimize flood damages in the flood prone area by enhancing prompt flood protection activities which furnish sufficient and accurate information through agencies and organization concerned. This can achieved through advanced forecast of extreme floods which exceed the capacity of existing river facilities.

(2) FFWS for Flood Operation

It aims to execute promptly effective operation of the flood control facilities such as dams, floodways, retarding basins by forecasting the magnitude of flood inflow into the said facilities in advance. In also aims to avoid artificial flood disasters by informing in advance the affected people concerning flood releases from the said facilities.

(3) FFWS for Basinwide Flood Management

It aims to execute effective basinwide flood management and administration by integrated real time operation of all the flood control facilities in the basin through proper coordination with agencies concerned with river and basin conditions.

The principal features and network plan of the Integrated FFWS Plan are shown in Table 1.2 and Fig. 1.3. respectively.

The Long Term FFWS Plan, which is the stagewise plan out of the Integrated FFWS Plan, aims at the improvement of flood forecasting accuracy of the existing system and the effective warning activity by means of the expansion of telecommunication network. The target year of completion of the Long Term FFWS Plan is set at 2010. The Long Term FFWS Plan is summarized on Table 1.3 and Fig. 1.4.

1.3 Objective of FFWS for the Priority Project Plan

The FFWS for the Priority Project Plan considers mainly the function for Flood Operation; i.e., flood control operation and maintenance of the prospective flood control facilities selected in the Priority Project Plan.

The flood control facilities will be improved or newly constructed by implementation of the Priority Project Plan of Agno river flood control. Operation and maintenance of the prospective flood control facilities will be considered as one of the significant objectives of the flood control measures, especially to avcid the disasters caused by failure of the flood control operation of the facilities.

2. BASIC CONCEPT

2.1 Flood Control Operation and Maintenance System

The FFWS for the Priority Project Plan is planned as "Flood Control Operation and Maintenance System" (hereinafter called the System) based on the following basic concept:

(1) Responsible Agency for the System Management

DPWH is responsible to the structural flood control measures at present in Philippines. The operation and maintenance of the existing flood control facilities are carried out by DPWH. The System which will be newly applied for Agno River Flood Control is also expected to be managed by DPWH/AFCS as the river management agency for the Agno river and Allied rivers.

(2) Collaboration with the Existing FFWS

The System requires the information to recognize the meteo-hydrological condition during flood. Since the relevant data and information are collected by the existing FFWS, the System will be incorporated with the existing FFWS to supply the available data and information. The conceptual procedure and information flow of the System is illustrated in Fig. 2.1 in relation with the existing Agno River FFWS.

(3) Telecommunication Network

Telecommunication network between AFCS and respective flood control facilities will be established to exchange the information such as general condition of flood, rainfall and waterlevel condition, operating condition of the facilities, etc..

(4) Institutional Arrangement

Rosales FFWS sub-center is located in the same compound of AFCS. On the other hand, no monitoring equipment for meteo-hydrological information is set up in AFCS at present. For the requirement to monitor the meteo-hydrological condition, PAGASA allows AFCS/DPWH to install new data communication and monitoring equipment in the AFCS office which is to be connected with the existing telemetry system in Rosales FFWS sub-center.

2.2 Relevant Facilities of the Existing FFWS

The System to be proposed for the Priority Project Plan is planned as an extension of the existing FFWS. Main system components related to the Agno River FFWS are described as follows:

(1) Rosales FFWS Sub-center

Rosales FFWS Sub-center is the master station of telemetry system for Agno River FFWS. Rainfall and waterlevel records are collected from the telemetry gauging station by 150 MHz band radio link. The same data are transmitted to National Flood Forecasting Center (NFFC) by 800 MHz multiplex radio link.

(2) National Flood Forecasting Center (NFFC)

ABC system has been operated by National Flood Forecasting Center of PAGASA. All the relevant data and information are gathered at NFFC. Flood forecasting is carried out at NFFC based on the collected weather and hydrological information. NFFC also disseminates the flood bulletin, which includes the flood information, to the other relevant agencies.

(3) Monitor Station

DPWH, OCD and NWRC are selected as monitoring agencies for the FFWS managed by PAGASA. DPWH has the monitor station for ABC system. DPWH monitor station is connected with NFFC by 800 MHz band multiplex link.

(4) Data Information Center (DIC)

Under the FFWSDO Project II, Data Information Center (DIC) will be newly established as an integrated center of the flood forecasting and warning system composed of the FFWSDO, Pampanga and ABC system. NFFC will be housed in DIC after completion of the FFWSDO Project II.

2.3 Objective Flood Control Facilities

Flood control facilities are planned by the alternative study of structural flood measures for the Priority Project Plan. The objective facilities for the System are described below:

- Diversion channel at the bifurcation point of the Poponto floodway leading to the Bayambang stretch
- New Poponto floodway
- Ring dikes in the Poponto retarding basin
- Diking gate systems in Dagupan city
- Other major facilities planned as Priority Project

3. PROPOSED PLAN OF THE SYSTEM

3.1 Components of the Proposed System

The network plan and corresponding unit components of the System for the prospective flood control facilities are shown in Fig. 3.1. The unit components of the System are described below:

(1) AFCS Control Office

Control office of the System is proposed at AFCS. Functions of the control office are:

(a) To exchange the data and information with Agno River FFWS
(b) To direct all the activities for the System
(c) To monitor the operating condition of respective flood control facilities

(2) Dagupan Flood Control Office

Dagupan flood control office is proposed to task the activities for the System in and around Dagupan city. Diking system in and around Dagupan city includes several numbers of facilities such as water gates and sluice gates. Main purposes of these facilities are prevention of backwater flood and drainage in Dagupan city. The residential staffs in Dagupan city will be required to conduct effective operation and maintenance of the said facilities.

(3) Flood Control Facilities

A operation room is established for the large scale flood control facility such as control gate weir, water gate, etc.. Measuring equipments such as waterlevel gauge, gate opening gauge etc. are installed as component of the flood control facilities.

(4) Data Communication and Monitoring System

The data and information for Agno River FFWS shall be monitored to conduct the flood control operation by AFCS. Available data and information to be provided from PAGASA to AFCS are described below:

Data / Information	Source
Telemetry Observation	
3-hourly rainfall	Rosales FFWS sub-center
3-hourly water level	Rosales FFWS sub-center
Flood Forecasting Information	
Flood Bulletin	NFFC / DIC
Meteorological Information	NFFC / DIC

(5) Telecommunication Network

Telecommunication network will be newly established to supervise the flood control activities. AFCS directs overall activities for the System during flood based on the data and information related to the meteo-hydrological conditions in Agno river basin. Information exchange for the System is described below:

(a) AFCS

- Give the general information of meteo-hydrological condition
- Request the preparation of flood control operation to Dagupan Flood Control Office
- Direct and instruct the flood control operation at respective site of flood control facilities.

(b) Dagupan Flood Control Office

- Request the general information of meteo-hydrological condition to AFCS
- Direct and instruct the flood control operation at respective site of flood control facilities in and around Dagupan city.

(c) Operation Room of Flood Control Facilities

- Inform the operating condition to the control office

3.2 Staff Organization

Since the System is a newly attached function of AFCS, the staff organization will be modified to meet the additional duties for the respective activities for the System. The prospective roles of the personnel assigned for the management of the System are described below:

(1) Director

- Direction of all the activities for the System
- Close coordination with the Agno River FFWS regarding flood forecasting activities undertaken by PAGASA

(2) Hydrological Engineer

- Monitoring the available meteo-hydrological information
- Evaluation of the river condition during flood

(3) Telecom Engineer

- Supervision of the operation and maintenance work for telecom equipments
- Monitoring closely the performance of the equipment during flood

(4) Operators

- Operation of flood control facilities

(5) Patrol / Maintenance Staffs

- Patrol for the flood control structures to be safety during flood
- Maintenance work for the flood control structures and telecom facilities

3.3 Preliminary Design and Cost Estimate

Preliminary design of the proposed System provides the case of extension to the existing FFWS in order to minimize facilities cost.

(1) AFCS

The following equipments will be newly installed at AFCS.

(a) Data communication and monitoring equipment which is connected with the telemetry equipment in Rosales FFWS sub-center

(b) Telephone and facsimile equipment for the communication with the FFWS Central System in Manila by using the existing multiplex communication system

(c) Radio telephone equipment to direct the operation of flood control facilities

(d) Multiplex equipment for communication with Dagupan Flood Control Office (in additon to the existing multiplex communication system of Rosales FFWS Sub-center)

(e) Patrol / Maintenance cars

(3) Dagupan Flood Control Office

This office will be newly established in Dagupan city. Equipments to be provided for this office are:

(a) Radio telephone equipment to direct the operation of flood control facilities

(b) Multiplex equipment for communication with AFCS

(c) Patrol / Maintenance cars

(4) Respective Flood Control Facilities

Radio telephone equipments are installed at the following three (3) flood control facilities proposed by the Priority Project Plan.

(a) Diversion weir at the inlet of the Alcala-Poponto floodway

(b) Water gate to release maintenance flow to the urban stretch

(c) Drainage gate in Marusay river at confluence of Dagupan river

Major items of the equipmets for the System are shown in Table 3.1. Total cost for the proposed System is estimated at some 188 million Yen as shown in Table 3.2.

3.4 The System with the Long Term FFWS Plan

The Long Term FFWS Plan includes the following up-graded functions from that of the existing FFWS.

(1) Flood forecasting is conducted at Agno River Flood Forecasting Center which will be up-graded from the existing Rosales FFWS Sub-center.

(2) Flood control accuracy is improved by installation of additional telemetry stations.

(3) River hydrological condition of whole Agno river basin is recognized at Agno River Flood Forecasting Center by monitoring Binga-Ambuklao FFWSDO.

AFCS can take advantage of the up-graded functions of the Long Term FFWS Plan to perform more prompt activities for flood control operation. It is also possible for AFCS to get the waterlevel forecasted at Agno River Flood Forecasting Center during flood. Fig. 3.2 illustrates the case for post Long Term Plan which provides the System as an extension to the proposed Long Term FFWS Plan. The unit components of the extension to the Long Term FFWS Plan need to be further elaborated.

TABLES

TABLE 1.1 PRINCIPAL FEATURES OF THE EXISTING FFWS IN AGNO RIVER BASIN

SYSTEM COMPONENT	ITEM	
1. Agno River FFWS		
(1) FFWS Sub-center	Rosales FFWS Sub-center	
(2) Telemetering System	Rain Gauge Station	: 1 Station
	Waterlevel Gauge Station	: 1 Station
	Rain/Waterlevel Gauge Station	: 6 Stations
(3) Central System (Manila)	PAGASA	: Data Information Center (DIC)
		National Flood Forecasting Office (NFFO)
	DPWH	: Monitor Starion
(4) Telecommunication System	Trunk Line	
	(Rosales - DIC/NFFO - DPWH)	: 800 MHz band Multiplex Link
	Telemetering	: 150 MHz Band Simplex Link
	Repeator Station	: 1 Station
2. Binga - Ambuklao FFWS Sub-system		
(1) FFWS Dam Office	Binga Dam FFWS Office	
	Ambuklao Dam FFWS Office	
(2) Telemetering System	Rain Gauge Station	: 4 Stations
	Waterlevel Gauge Station	: 1 Station
	Rain/Waterlevel Gauge Station	: 1 Station
(3) Warning System	Fixed Station	: 18 Stations
	-Type A (Speaker and Radio Tel.)	(7 Stations)
	-Type B (Speaker)	(11 Stations)
	Mobile Station	: 27 Stations
	-Warning Vehicle	(6 Stations)
	-Portable Radio Telephon	(21 Stations)
(4) Central System (Manila)	PAGASA	: Data Information Center (DIC)
	NAPOCOR	: FFWS Center
(5) Telecommunication System	Trunk Line	
	-Dam Offices - NAPOCOR	: 7GHz Band Multiplex Link
	-NAPOCOR - PAGASA	: 2GHz Band Multiplex Link
	Telemetering	: 150 MHz Band Simplex Link
	Warning	: 150 MHz Band Simplex Link (Multiplex Voice Channel)
	Repeator/Reflector Station	: 3 Stations

TABLE 1.2 PRINCIPAL FEATURES OF THE INTEGRATED FFWS PLAN

SYSTEM COMPONENT	ITEM	
(1) FFWS Sub-center	Agno River FFWS Center, Rosales	
(2) Telemetering System	Rain Gauge Station	: 25 Stations
	Waterlevel Gauge Station	: 6 Stations
	Rain/Waterlevel Gauge Station	: 12 Stations
(3) Warning System	Warninng Network to Local Agencies	: 29 Agencies
	-Local Radio Station	(3)
	-OCD Regional Office	(2)
	-National Police	(2)
	-Municiparity	(21)
	-DPWH Branch	(1)
	Warning Station	: 31 Stations
(4) Monitoring System	Monitor in Agno River FFWS Center	: 4 Monitors
	-Binga-Ambuklao FFWSDO Sub-system	
	-Balog-Balog Dam Flood Operation *	
	-San Roque Dam Flood Operation *	
	-Moriones Dam Flood Operation *	
(5) Central System (Manila)	PAGASA	: Data Information Center (DIC)
	DPWH	: Monitor Station
(6) Telecommunication System	Trunk Line	
	-Rosales - PAGASA - DPWH	: 800MHz Band Multiplex Link
	Telemetering	: 150 MHz Band Simplex Link
	Warning	
	-Local Agencies	: 150 MHz Band Simplex Link
	-Warning Stations	: 150 MHz Band Simplex Link (Multiplex Voice Channel)
	Monitoring	: 800 MHz Band Multiplex Link
	Repeator Station	: 2 Stations

Note : * Depend on the structural flood control plan

TABLE 1.3 PRINCIPAL FEATURES OF THE LONG TERM FFWS PLAN

SYSTEM COMPONENT	ITEM	
(1) FFWS Sub-center	Agno River FFWS Center, Rosales	
(2) Telemetering System	Rain Gauge Station	: 8 Stations
	Waterlevel Gauge Station	: 1 Station
	Rain/Waterlevel Gauge Station	: 7 Stations
(3) Warning System	Warninng Network to Local Agencies	: 29 Agencies
	-Local Radio Station	(3)
	-OCD Regional Office	(2)
	-National Police	(2)
	-Municiparity	(21)
	-DPWH Branch	(1)
(4) Monitoring System	Monitor in Agno River FFWS Center	: 1 Monitor
	-Binga-Ambuklao FFWSDO Sub-system	
(5) Central System (Manila)	PAGASA	: Data Information Center (DIC)
	DPWH	: Monitor Station
(6) Telecommunication System	Trunk Line	
	-Rosales - PAGASA - DPWH	: 800MHz Band Multiplex Link
	Telemetering	: 150 MHz Band Simplex Link
	Warning	
	-Local Agencies	: 150 MHz Band Simplex Link
	Monitoring	: 800 MHz Band Multiplex Link
	Repeator Station	: 2 Stations

TABLE 3.1 MAJOR EQUIPMENTS FOR THE PROPOSED SYSTEM

Office / Facilities	Equiptment
1. Agno River Flood Control System / Rosales FFWS Sub-center	Data Communication and Monitoring Equipment - Personal Computer with Keyborad and Printer Multiplex Communication Equipment * - Multiplex Radio Equipment - Carrier Terminal Equipment - Antenna Equipment - Telephone and Facsimile Equipment Telecommunication Equipment for O&M - Radio Telephone Equipment - Antenna Equipment - Patrol Car - Portable Radio Tel. Equipment Power Supply Equipment
2. Dagupan Flood Control Office	Data Communication and Monitoring Equipment - Personal Computer with Keyborad and Printer Multiplex Communication Equipment - Multiplex Radio Equipment - Carrier Terminal Equipment - Antenna Tower and Equipment - Telephone and Facsimile Equipment Telecommunication Equipment for O&M - Radio Telephone Equipment - Antenna Equipment - Patrol Car - Portable Radio Tel. Equipment Power Supply Equipment
3. Flood Control Facilities	Radio Telephone Equipment Antenna Equipment Power Supply Equipment

Note : * In addition to the existing multiplex communication equipment in Rosales FFWS Sub-center

TABLE 3.2 COST ESTIMATE FOR THE PROPOSED SYSTEM

ITEM		COST (1,000 Yen)
I	DIRECT COST	
1.	TELECOMMUNICATION WORKS	
1.1	Agno River Flood Control System / Rosales FFWS Sub-center	35,799
1.2	Dagupan Flood Control Office	69,421
1.3	Flood Control Facilities	8,133
1.4	Measuring Equipments	11,300
1.5	Spare Parts	9,100
	SUB-TOTAL OF TELECOM. WORKS	133,753
2.	CIVIL AND BUILDING WORKS	
2.1	Agno River Flood Control System / Rosales FFWS Sub-center	4,950
2.2	Dagupan Flood Control Office	10,900
2.3	Flood Control Facilities	3,000
2.4	Measuring Equipments	2,000
2.5	Spare Parts	2,000
	SUB-TOTAL OF CIVIL AND BUILDING WORKS	22,850
	TOTAL OF DIRECT COST	156,603
II	INDIRECT COST (20% of Direct Cost)	31,300
	TOTAL COST	187,903

TABLE 3.3 (1/4) BREAKDOWN OF DIRECT COST FOR THE PROPOSED SYSTEM

A. TELECOMMUNICATION WORKS

	Item	Unit	Quantity	Unit Price (Yen)	Amount (Yen)
1.	Agno River Flood Control System / Rosales FFWS Sub-center				
1.1	Data Communication and Monitoring Equipment				
1.1.1	Personal Computer with Keyborad and Printer	set	1	800,000	800,000
1.1.2	Modem Equipment	set	1	30,000	30,000
1.1.3	Communication Cable	m	60	1,000	60,000
1.1.4	Terminal Board	set	1	10,000	10,000
1.2	Multiplex Equipment				
1.2.1	Multiplex Radio Equipment (800MHz)	set	1	4,360,000	4,360,000
1.2.2	Carrier Terminal Equipment	set	1	3,266,000	3,266,000
1.2.3	Key Telephone Master Unit	set	1	590,000	590,000
1.2.4	Key Telephone	set	5	63,000	315,000
1.2.5	Facsimile Equipment	set	1	640,000	640,000
1.2.6	Parabolic Antenna	set	1	1,250,000	1,250,000
1.2.7	Coaxial Cable with Connecter	set	1	224,000	224,000
1.2.8	Coaxial Arrester	set	1	50,000	50,000
1.2.9	D/C Power Supply Equipment	set	1	4,025,000	4,025,000
1.2.10	Isolation Transformer	set	1	1,280,000	1,280,000
1.2.11	Automatic Voltage Regulator	set	1	716,000	716,000
1.3	Telecommunication Equipment for O&M				
1.3.1	Radio Equipment (10W)	set	1	630,000	630,000
1.3.2	Radio Telephone (10W)	set	1	180,000	180,000
1.3.3	Antenna (8-element Yagi)	set	1	51,000	51,000
1.3.4	Coaxial Cable	set	1	32,000	32,000
1.3.5	Coaxial Arrester	set	1	74,000	74,000
1.3.6	Antenna Pole (15m)	set	1	656,000	656,000
1.3.7	Patrol Car	set	2	3,730,000	7,460,000
1.3.8	Portable Radio Tel. Equipment	set	10	200,000	2,000,000
1.4	Materials				1,400,000
1.5	Installation Works and A/T				5,700,000
	SUB-TOTAL OF 1.				35,799,000

TABLE 3.3 (2/4) BREAKDOWN OF DIRECT COST FOR THE PROPOSED SYSTEM

A. TELECOMMUNICATION WORKS

	Item	Unit	Quantity	Unit Price (Yen)	Amount (Yen)
2.	Dagupan Flood Control Office				
2.1	Data Communication and Monitoring Equipment				
2.1.1	Personal Computer with Keyborad and Printer	set	1	800,000	800,000
2.1.2	Modem Equipment	set	1	30,000	30,000
2.1.3	Communication Cable	m	60	1,000	60,000
2.1.4	Terminal Board	set	1	10,000	10,000
2.2	Multiplex Equipment				
2.2.1	Multiplex Radio Equipment (800MHz)	set	1	4,360,000	4,360,000
2.2.2	Carrier Terminal Equipment	set	1	3,266,000	3,266,000
2.2.3	Common Battery Telephone Repeator	set	1	358,000	358,000
2.2.4	Key Telephone Master Unit	set	1	590,000	590,000
2.2.5	Key Telephone	set	5	63,000	315,000
2.2.6	Facsimile Set	set	1	640,000	640,000
2.2.7	Parabolic Antenna	set	1	1,250,000	1,250,000
2.2.8	Coaxial Cable with Connectors	set	1	224,000	224,000
2.2.9	Coaxial Arrester	set	1	50,000	50,000
2.2.10	Antenna Tower (30m, Square)	L. S.		16,800,000	16,800,000
2.2.11	D/C Power Supply Equipment	set	1	4,025,000	4,025,000
2.2.12	Diesel Engine Generator	set	1	9,664,000	9,664,000
2.2.13	Isolation Transformer	set	1	1,280,000	1,280,000
2.2.14	Automatic Voltage Regulator	set	1	716,000	716,000
2.3	Telecommunication Equipment for O&M				
2.3.1	Radio Equipment (10W)	set	1	630,000	630,000
2.3.2	Radio Telephone (10W)	set	1	180,000	180,000
2.3.3	Antenna (8-element Yagi)	set	1	51,000	51,000
2.3.4	Coaxial Cable	set	1	32,000	32,000
2.3.5	Coaxial Arrester	set	1	74,000	74,000
2.3.6	Antenna Pole (15m)	set	1	656,000	656,000
2.3.7	Patrol Car	set	2	3,730,000	7,460,000
2.3.8	Portable Radio Tel. Equipment	set	10	200,000	2,000,000
2.4	Materials				2,800,000
2.5	Installation Works and A/T				11,100,000
	SUB-TOTAL OF 2.				69,421,000

TABLE 3.3 (3/4) BREAKDOWN OF DIRECT COST FOR THE PROPOSED SYSTEM

A. TELECOMMUNICATION WORKS

	Item	Unit	Quantity	Unit Price (Yen)	Amount (Yen)
3.1	Telecommunication with F/C Office				
3.1.1	Radio Equipment (10W)	set	1	630,000	630,000
3.1.2	Radio Telephone (10W)	set	1	180,000	180,000
3.1.3	Antenna (8-element Yagi)	set	1	51,000	51,000
3.1.4	Coaxial Cable	set	1	32,000	32,000
3.1.5	Coaxial Arrester	set	1	74,000	74,000
3.1.6	Antenna Pole (15m)	set	1	656,000	656,000
3.1.7	Solar Cells	set	1	268,000	268,000
3.1.8	Storage Battery	set	1	320,000	320,000
3.2	Materials				100,000
3.3	Installation Works and A/T				400,000
	SUB-TOTAL OF 3. (x 3)				8,133,000
4.	Measuring Equipment	L. S.			11,300,000
5.	Spare Parts	L. S.			9,100,000
	TOTAL OF TELECOM. WORKS				133,753,000

TABLE 3.3 (4/4) BREAKDOWN OF DIRECT COST FOR THE PROPOSED SYSTEM

B. CIVIL AND BUILDING WORKS

Item	Unit	Quantity	Unit Price (Yen)	Amount (Yen)
1. Agno River Flood Control System / Rosales FFWS Sub-center				
1.1 Modification of Office Building	set	1	2,500,000	2,500,000
1.2 Mechanical Works	set	1	500,000	500,000
1.3 Electrical Works	set	1	750,000	750,000
1.4 Miscellaneous Works	lot	1	1,200,000	1,200,000
SUB-TOTAL OF 1.			4,950,000	4,950,000
2. Dagupan Flood Control Office				
2.1 Office Building	set	1	5,000,000	5,000,000
2.2 Mechanical Works	set	1	1,000,000	1,000,000
2.3 Electrical Works	set	1	1,500,000	1,500,000
2.4 Antenna Foundation	set	1	1,000,000	1,000,000
2.5 Miscellaneous Works	lot	1	2,400,000	2,400,000
SUB-TOTAL OF 2.			10,900,000	10,900,000
3. Flood Control Facilities	lot	3	1,000,000	3,000,000
4. Measuring Equipment	L. S.			2,000,000
5. Spare Parts	L. S.			2,000,000
TOTAL OF CIVIL WORKS				22,850,000
GRAND TOTAL (A + B)				156,603,000

FIGURES

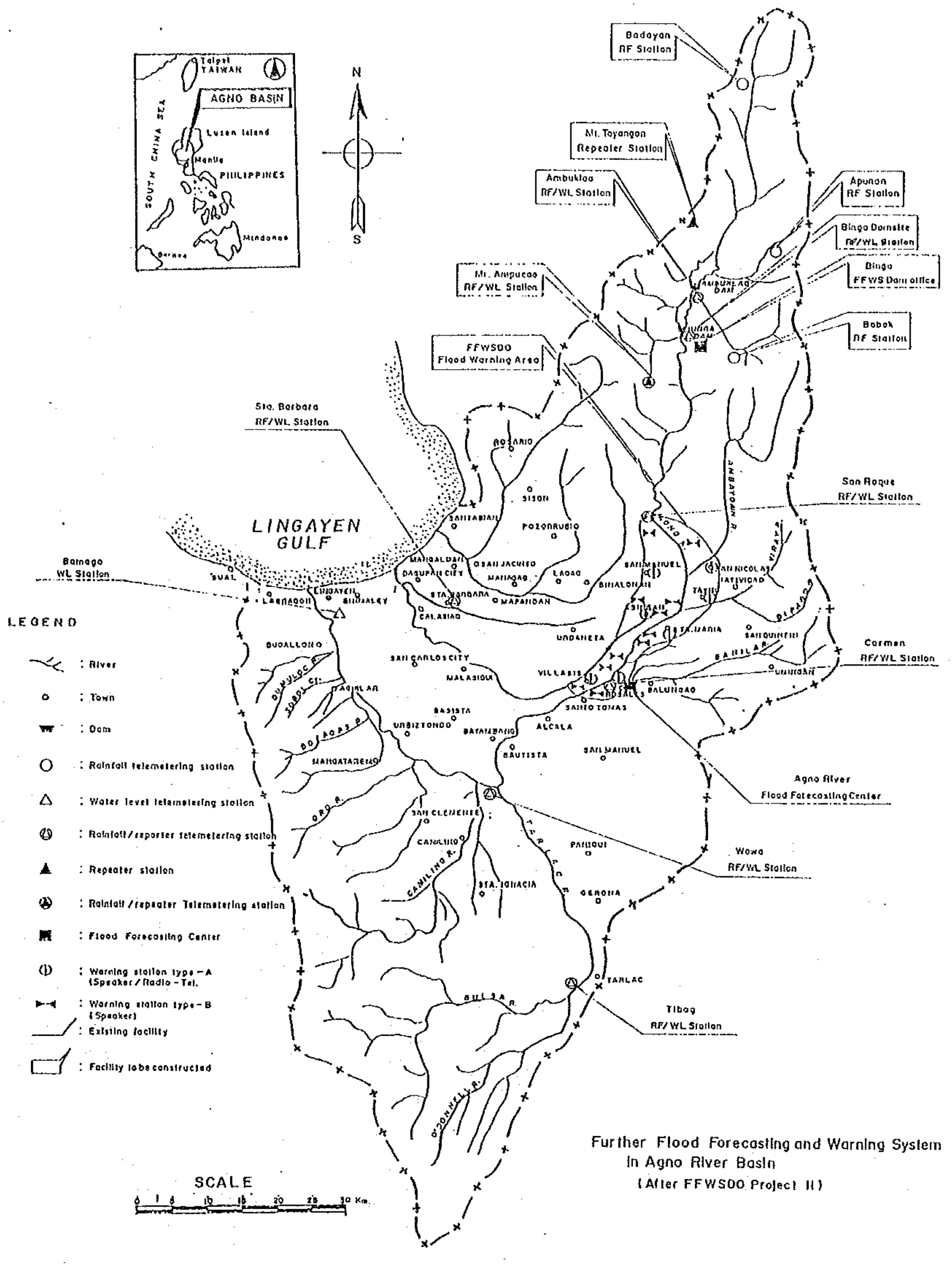


FIG. 1.1 FACILITIES OF THE EXSITING FFWS IN AGNO RIVER BASIN

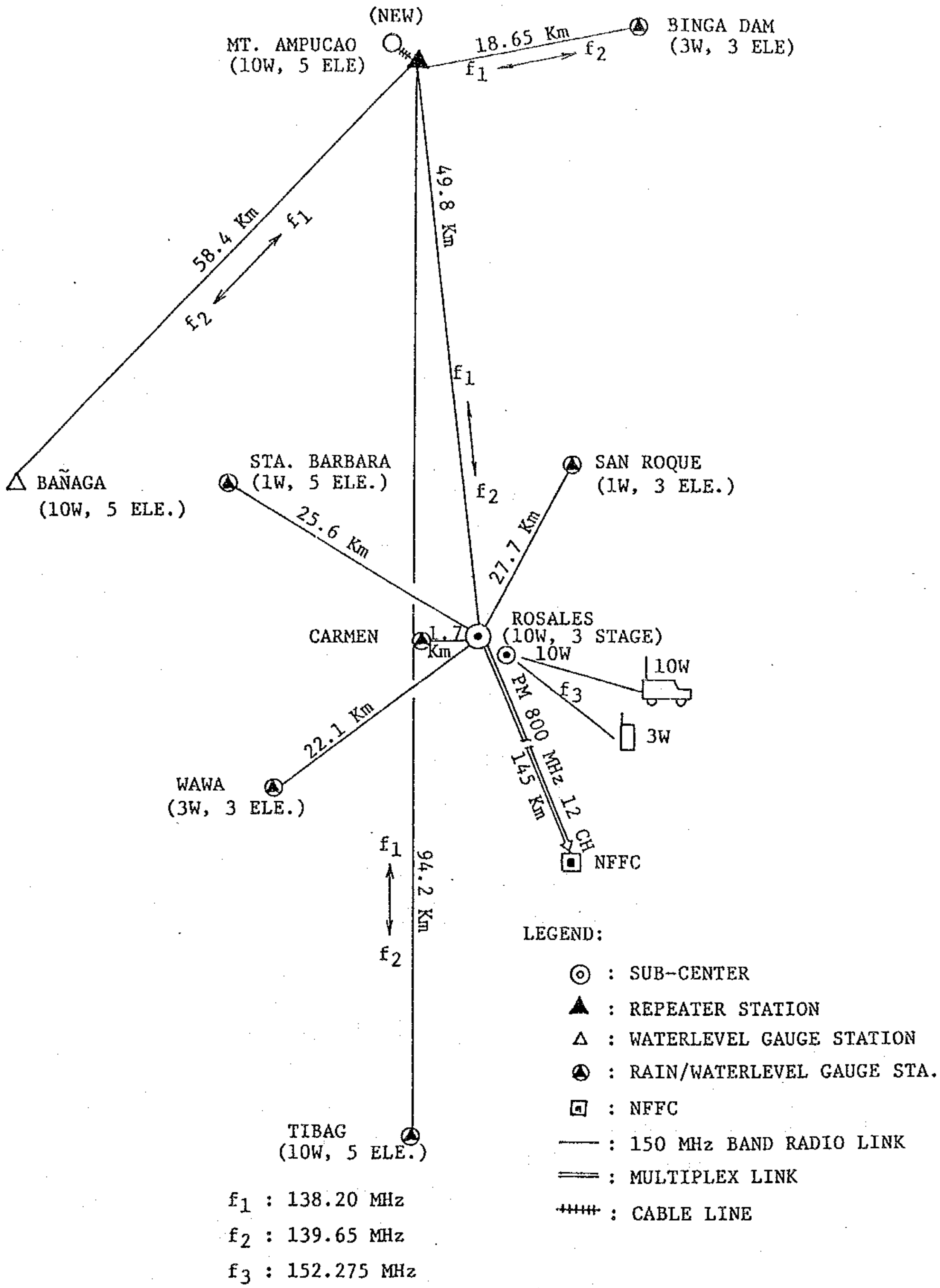


FIG. 1.2 (1/3) SYSTEM NETWORK OF AGNO RIVER FFWS

Binga Sub-System		Antenna Type	Antenna Height(m)	Transmitting Power(W)
Binga FFWS Dam Office		5-Ele. Yagi	20	10.0
- Mt. Toyangan (Repeater Station)		3-stages Collinear	30	10.0
- Binga Dam	(W)	3-Ele. Yagi	7	1.0
Mt. Toyangan (Repeater Station)		3-stages Collinear	30	10.0
- Badayan	(R)	5-Ele. Yagi	15	10.0
- Apunan	(R)	3-Ele. Yagi	10	1.0
- Bobok	(R)	3-Ele. Yagi	10	1.0
- Ambuklao Dam	(R/W)	3-Ele. Yagi	7	1.0

f_1 : 138.075 MHz

f_2 : 139.500 MHz

f_3 : 164.300 MHz

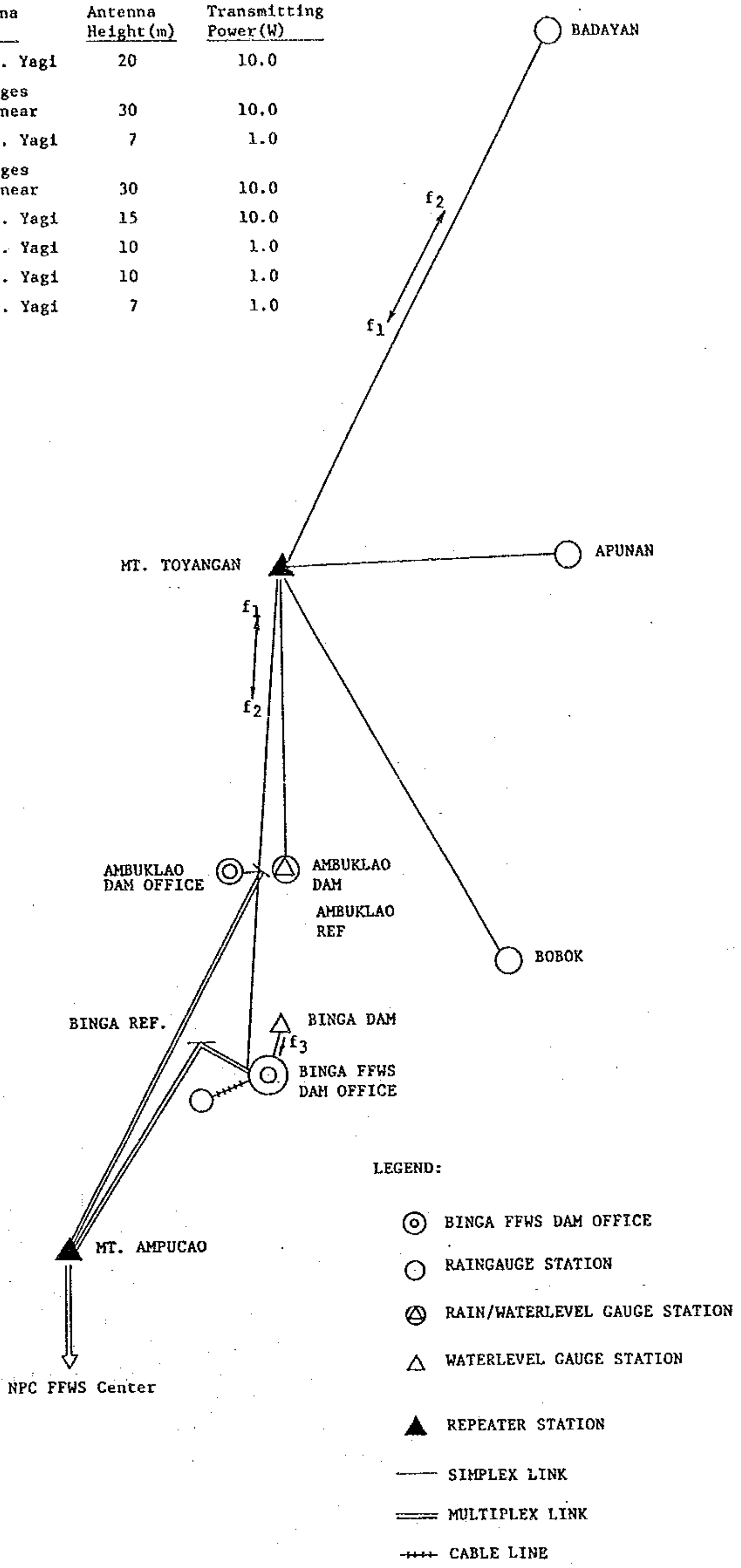
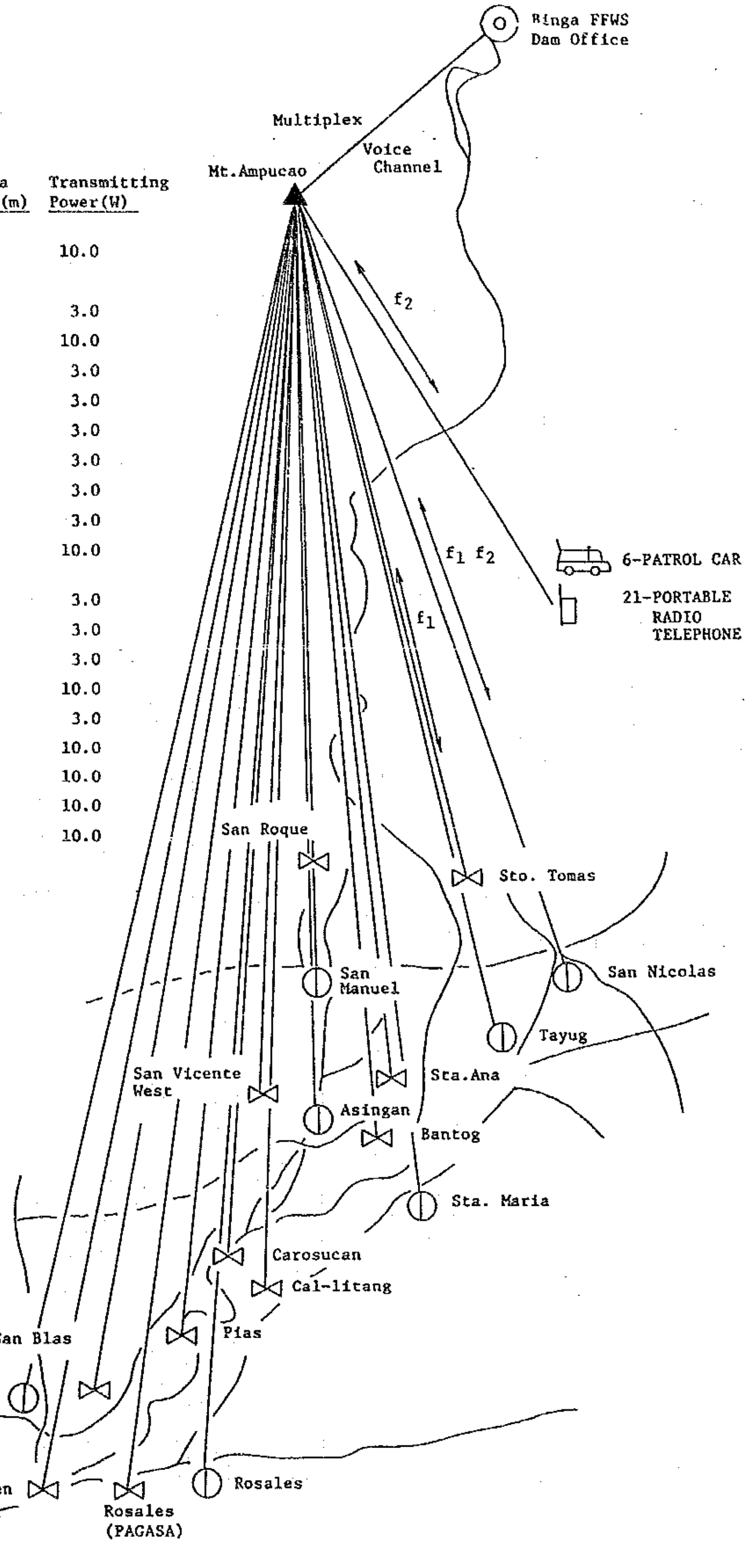


FIG. 1.2 (2/3) SYSTEM NETWORK OF BINGA-AMBUKLAO FFWSDO (TELEMETERING SYSTEM)

Binga Sub-System		Antenna Type	Antenna Height(m)	Transmitting Power(W)
Binga Ampucao (Repeater Station)		3-Ele.Yagi	17	10.0
- FFWS Dam Office				
- San Manuel	(A)	3-Ele.Yagi	15	3.0
- San Nicolas	(A)	5-Ele.Yagi	15	10.0
- Tayug	(A)	3-Ele.Yagi	15	3.0
- Asingan	(A)	3-Ele.Yagi	15	3.0
- Sta. Maria	(A)	3-Ele.Yagi	15	3.0
- Villasis	(A)	3-Ele.Yagi	15	3.0
- Rosales	(A)	3-Ele.Yagi	15	3.0
- San Roque	(B)	3-Ele.Yagi	15	3.0
- Sto. Tomas	(B)	5-Ele.Yagi	15	10.0
- San Vicente West	(B)	3-Ele.Yagi	15	3.0
- Sta. Ana	(B)	3-Ele.Yagi	15	3.0
- Bantog	(B)	3-Ele.Yagi	15	3.0
- Carosucan	(B)	3-Ele.Yagi	15	10.0
- Cal-litang	(B)	3-Ele.Yagi	15	3.0
- Pias	(B)	5-Ele.Yagi	15	10.0
- San Blas	(B)	5-Ele.Yagi	15	10.0
- Rosales PAGASA	(B)	5-Ele.Yagi	28	10.0
- Carmen	(B)	5-Ele.Yagi	15	10.0

f_1 : 171.775 MHz

f_2 : 169.825 MHz



LEGEND:

- FFWS Dam Office
- Repeater Station
- Type A Warning Station (Radio Tel. 8 Speaker)
- Type B Warning Station (Speaker)

FIG. 1.2 (3/3) SYSTEM NETWORK OF BINGA-AMBUKLAO FFWSDO (WARNING SYSTEM)

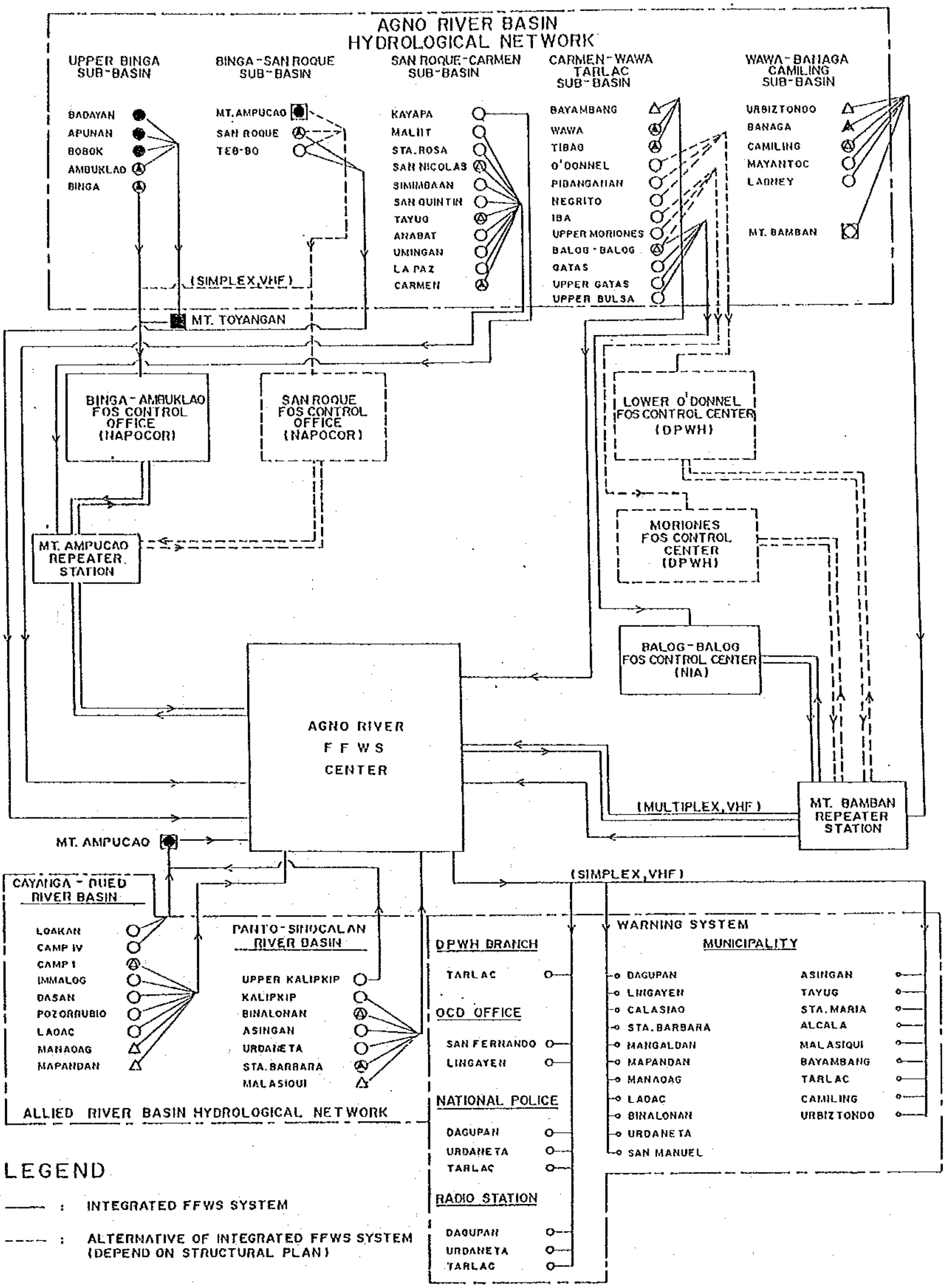


FIG. 1.3 NETWORK PLAN OF THE INTEGRATED FFWS

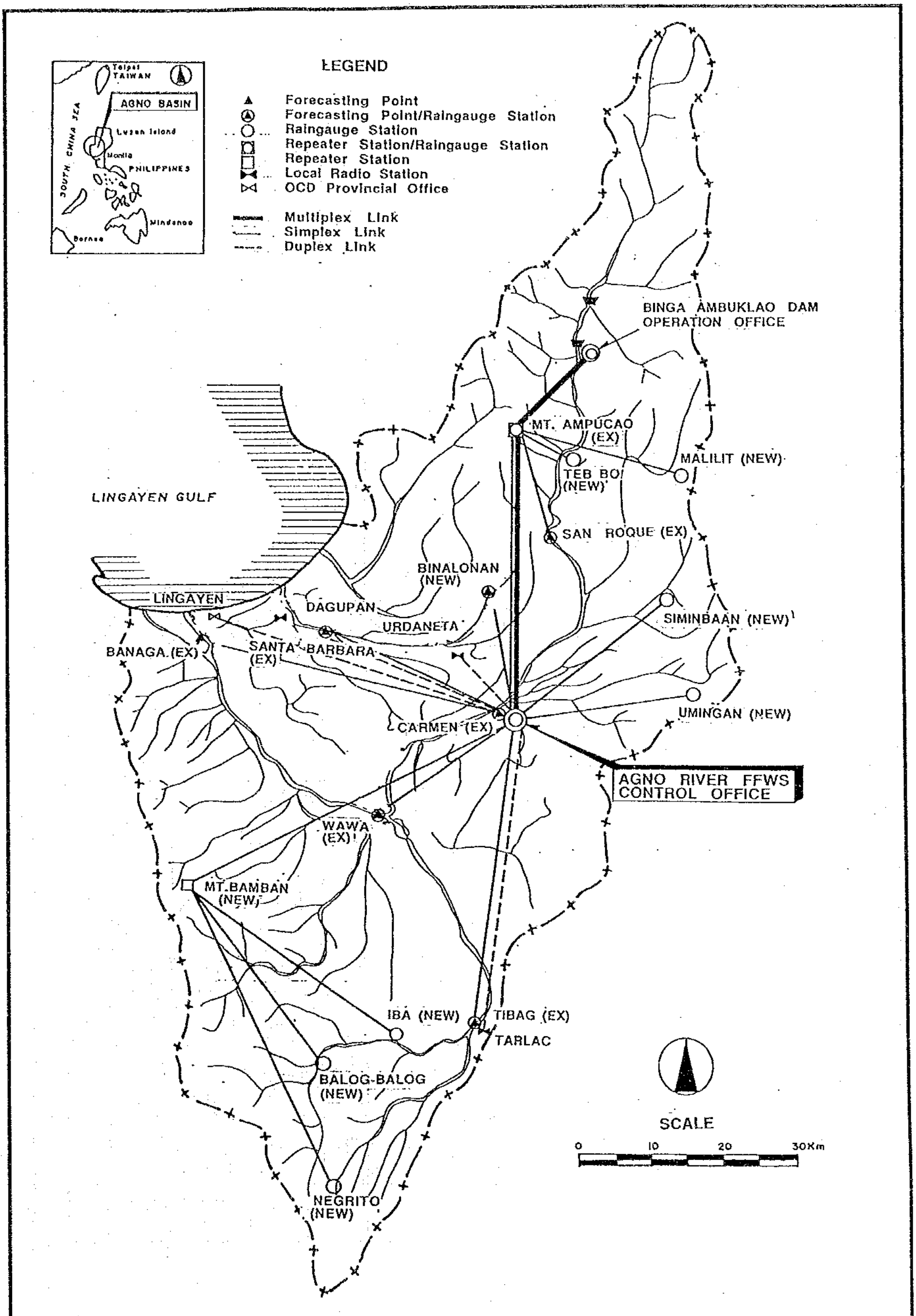


FIG. 1.4 NETWOK PLAN OF THE LONG TERM FFWS

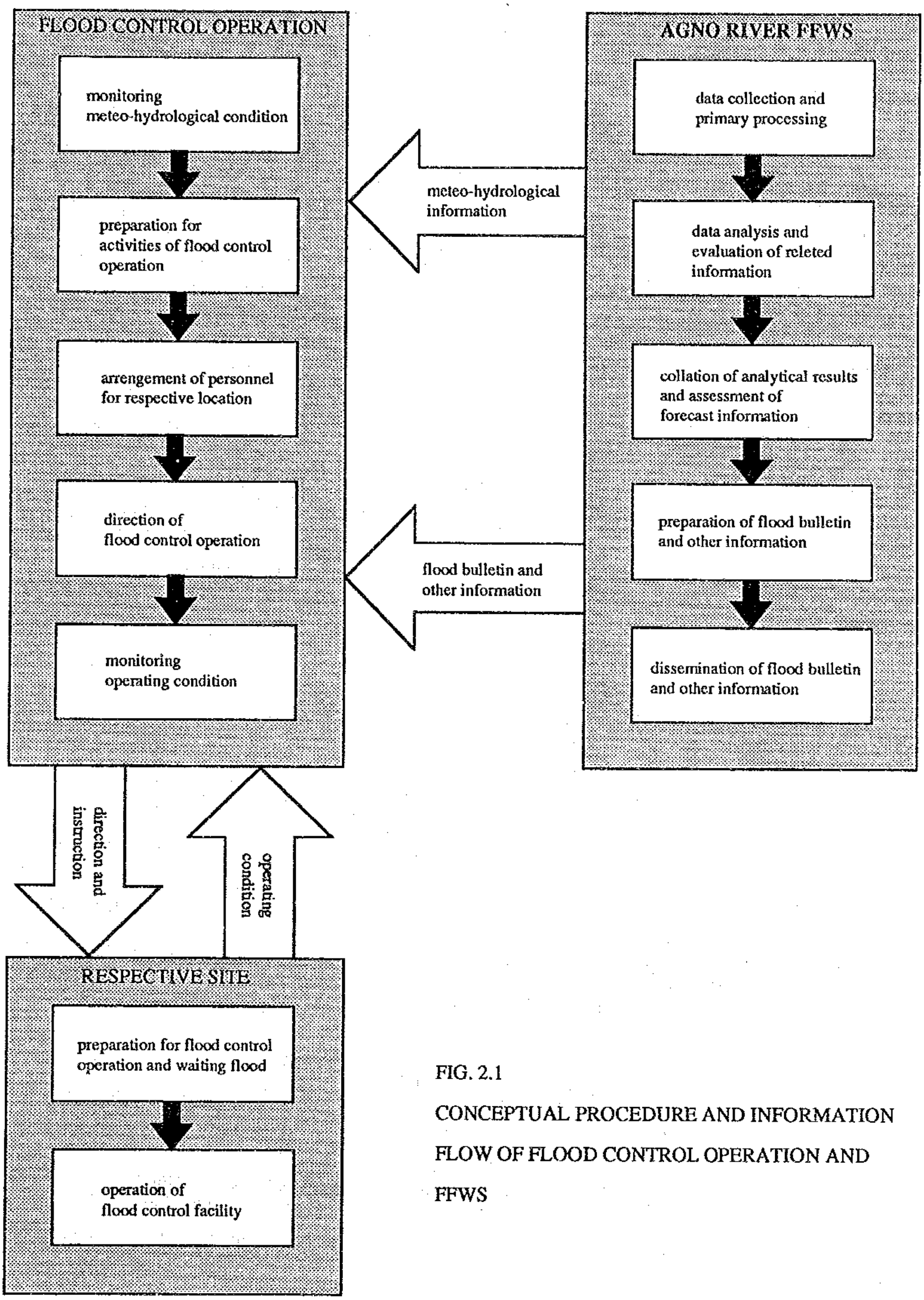


FIG. 2.1

CONCEPTUAL PROCEDURE AND INFORMATION FLOW OF FLOOD CONTROL OPERATION AND FFWS

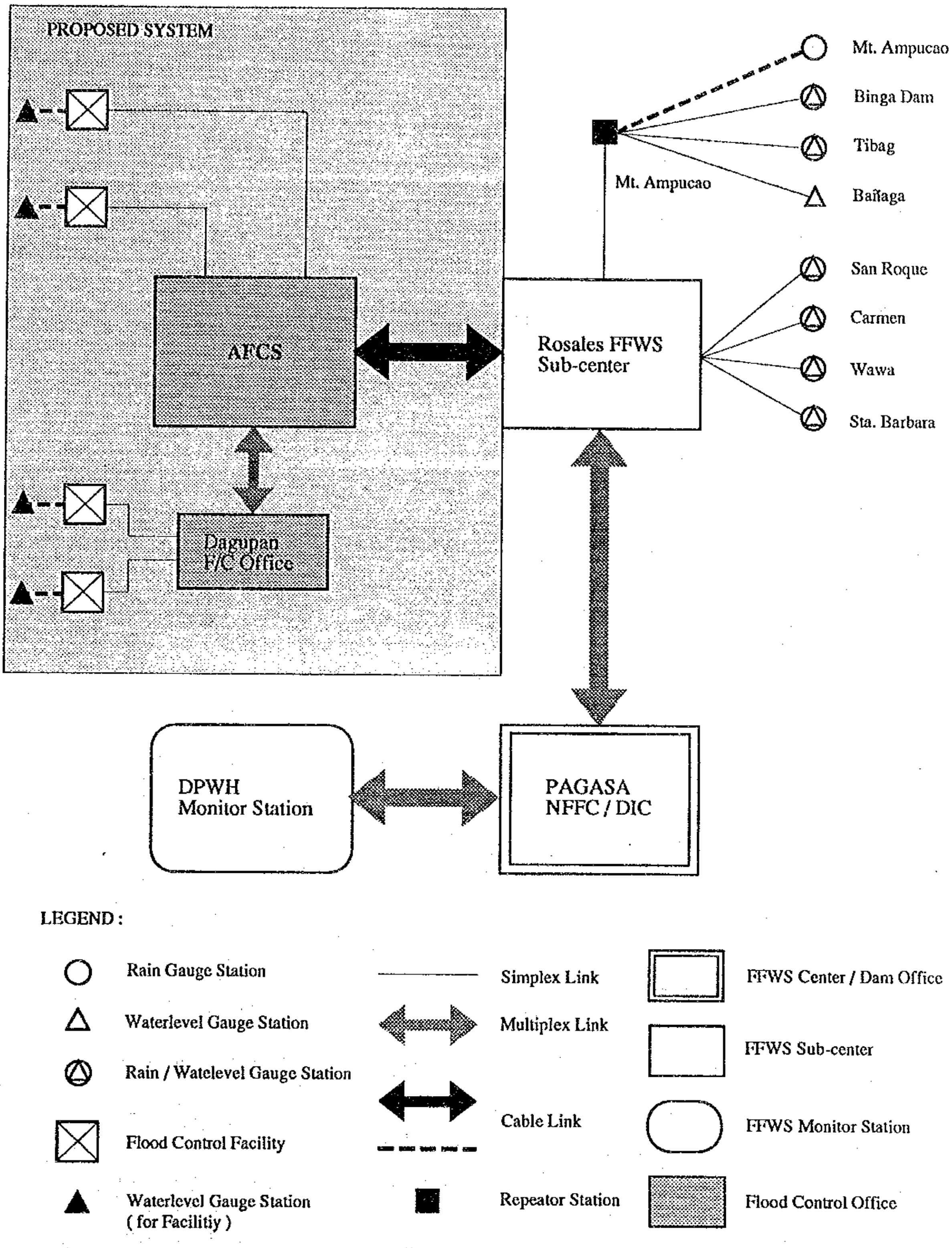


FIG. 3.1

NETWORK PLAN OF THE PROPOSED SYSTEM AND FFWS (WITH EXISTING FFWS)

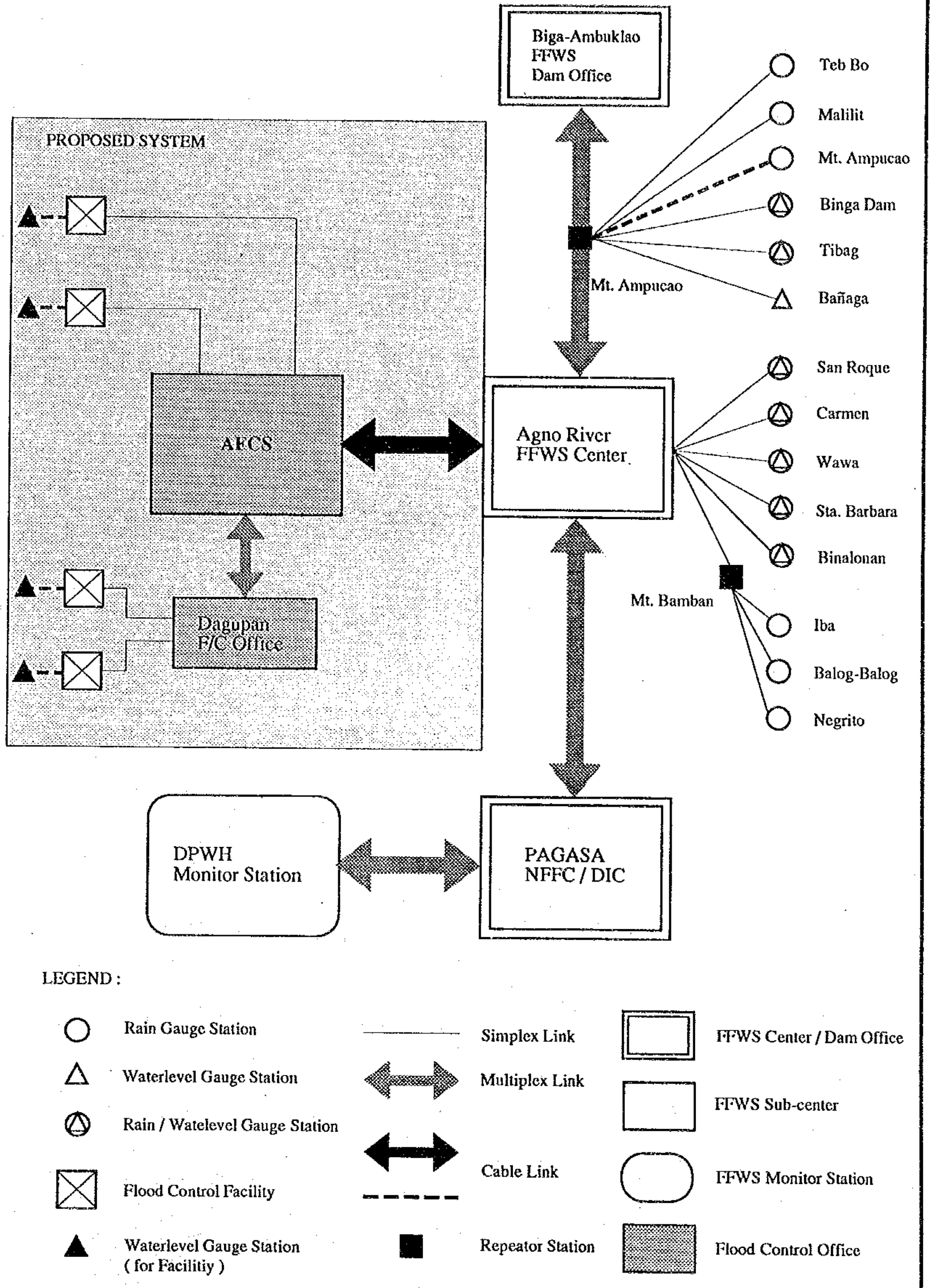


FIG. 3.2

NETWORK PLAN OF THE PROPOSED SYSTEM AND FFWS
(WITH LONG TERM FFWS PLAN)

12. DS

12. DS

DESIGN OF STRUCTURES

DS: DESIGN OF RELATED STRUCTURES

SUMMARY

(1) Flood control facilities and related structures proposed in the Upper Agno River and the Pantal-Sinocalan River priority improvement plans are as follows:

(a) Upper Agno River Improvement Plan

River dikes including heightening of existing dike and modification of existing flood wall dike, ring levee, revetment and groyne, drainage and intake gates, diversion channel, bridge, road heightening, road pavement and box culvert.

(b) Pantal-Sinocalan River Improvement Plan

River dikes including closing dike, revetment and groyne, drainage and intake gates, groundsill, bridge, road relocation and pavement.

(2) Structures follow the standard design conditions, and the following basic design concepts were applied:

(a) Structural design is based on a 10-year flood probability, except bridge design which is based on a 100-year flood probability.

(b) Countermeasures against liquefaction are considered for structures susceptible to earthquake.

(c) The Design Guidelines, Criteria and Standards prepared by the DPWH and the Technical Standard for River and Sabo Facilities prepared by the Ministry of Construction of Japan are applied to the structural design.

(d) The structural design shall consider the use of locally available structural materials to a great extent. The design features of the proposed structures are presented in Fig. 3.1 to Fig. 3.36.

(e) Review and reevaluation of the existing flood control facilities such as the earth dikes which were damaged by the earthquake in July 1990 will be done in planning and estimating quantities of works.

(3) Work quantities for the subject projects were estimated as shown in Table 4.1 to Table 4.6. Work quantities for the stepwise plan are also presented.

(4) There were some issues in question in establishing the Upper Agno River improvement plan. These were solved by setting up alternative plans and by cost comparison study. The results are as follows:

(a) Diversion Facilities on Bayambang Closing Dike

Diversion channel type was selected.

(b) Alignment of Bayambang Closing Dike

The alignment bended perpendicular to the main river course being connected with the right floodway dike was selected.

(c) Right Dike Alignment in Carmen Stretch

The new setback levee alignment was selected.

(d) Right Dike Alignment in San Manuel Stretch

The new setback levee alignment was selected.

DS: DESIGN OF RELATED STRUCTURES

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ABBREVIATIONS

1. NAME OF PHILIPPINE GOVERNMENT AGENCIES

AFCS	Agno River Flood Control System
ARIS	Agno River Irrigation System
DENR	Department of Environment and Natural Resources
DOTC	Department of Transportation and Communication
DPWH	Department of Public Works and Highways
GOP	Government of the Philippines
LATRIS	Lower Agno and Totonogen River Irrigation System
NAPOCOR	National Power Corporation
NAMRIA	National Mapping and Resource Information Authority
NIA	National Irrigation Administration
OCD	Office of Civil Defense
PENRO	Provincial Environment and Natural Resources Office
PM	Project Manager
PMO	Project Management Office
PNR	Philippine National Railways
TASMORIS	Tarlac River and San Miguel - O'Donnel River Irrigation System

2. NAME OF JAPANESE GOVERNMENT AND OTHER OFFICIAL AGENCIES AND ORGANIZATION

GOJ	Government of Japan
JICA	Japan International Cooperation Agency
MOC	Ministry of Construction, Japan
OECF	Overseas Economic Cooperation Fund, Japan
UN	United Nations

3. MEASUREMENT UNITS

(Length)		(Weight)	
mm	millimeter(s)	gr(grs)	gramme(s)
cm	centimeter(s)	kg(kgs)	kilogramme(s)
m	meter(s)	ton(s)	ton(s), eq'vt to 1,000kg
km	kilometer(s)		

(Area)

mm^2	square millimeter(s)
cm^2	square centimeter(s)
m^2	square meter(s)
km^2	square kilometer(s)
ha(has)	hectare(s)

(Volume)

cm^3	cubic centimeter(s)
m^3	cubic meter(s)
ltr	liter(s)

(Time)

sec	second(s)
min	minute(s)
hr(hrs)	hour(s)
dy(dys)	day(s)
mth(mths)	month(s)
yr(yrs)	year(s)

DS: DESIGN OF RELATED STRUCTURES

1. INTRODUCTION

The basic planning for flood control facilities and related structures was carried out in the study on river improvement for feasibility target areas. In line with the basic plan, a specific structural plan and the preliminary design for the proposed structures were performed to obtain the work quantities which served as the basis for the cost and benefit analysis. In addition, comparative study regarding the issues in question such as the alignment of Bayambang closing dike and the setback levee in Carmen and San Manuel stretches were made to decide the most preferable alternative.

The following sections present the basic design concept, preliminary structural plan and design, quantities of the project works and the comparison results of the issues in question.

2. BASIC DESIGN CONCEPT OF RELATED STRUCTURES

2.1 Scope of Basic Design

Basic design was carried out for all the structures related to flood control facilities of the priority project formulated in the feasibility study. The proposed structures are as follows:

a) Related Structures for the Agno River Priority Project, including the Poponto Swamp Improvement

River dike, ring levee, flood wall dike, revetment and groyne, drainage and intake gates, diversion channel, bridge, road heightening, road pavement and box culvert.

b) Related Structures for the Pantal-Sinocalan River Priority Project

River dike including closing dike, revetment and groyne, groundsill, drainage and intake gates, bridge, and road relocation and pavement.

The structures were designed following the standard design conditions to meet the requirements of the feasibility study. Detailed computation for structural analysis was not made, except the stability analysis of dikes.

2.2 Basic Design Concept

The following basic design concepts were applied for the structures:

a) Proposed structures will be designed based on a 10-year flood probability, except bridges which will be designed on a 100-year flood probability.

b) Some countermeasures against liquefaction will be taken for structures such as the earth dikes which were affected by 1990's earthquake or those to be built in areas prone to liquefaction.

c) The following design criteria and standards are to be applied; mainly the first, supported by the second:

- Design Guidelines, Criteria and Standards (Vol. I and II) prepared by the DPWH.

- Technical Standard for River and Sabo Facilities prepared by the Ministry of Construction of Japan.

d) The standard design of the Agno river dike established in the master plan stage is revised as the design section mentioned in Section 3.1.1, taking the existing dike system practiced by the AFCS into consideration.

e) In designing structures, locally based structural materials will be used as much as possible.

f) Review and reevaluation of the existing flood control facilities such as the earth dikes which were damaged by the earthquake in July 1990 will be done in planning and estimating quantities of works.

3. STRUCTURAL PLAN AND DESIGN OF FLOOD CONTROL FACILITIES

3.1 Flood Control Facilities and Related Structures in the Agno River

3.1.1 River Dikes

In accordance with the proposed river dike alignment in the priority area, construction of new dikes and heightening of the existing dike are to be carried out. The dike along the Agno River shall be principally an earth dike, except a part of the concrete flood wall in the Carmen stretch.

The river dikes are described hereunder, focusing on the earth dikes in the Asingan-San Manuel stretch, concrete flood wall in the Carmen stretch, and the closing dikes in the Bayambang-Alcala stretch.

a) Earth Dike

The standard section of the earth dike in the priority area, together with the counterweight fill against liquefaction, is shown in Fig. 3.1. The crown width of the dike and the slope gradient were determined according to the existing banking system taken by the AFCS. A freeboard of 1.20 m against a 10-year flood and berms along the slope are also provided to assure the safety of the dike against flood flow and other probable forces.

Earth dikes which are to be built on permeable foundation ground, especially those in the Asingan-San Manuel stretch, need to be enlarged in section by adding extra embankment as required to cope with seepage problem. As the result of the seepage analysis of the foundation ground, counterfill with a width of about 5.0 m is necessary on the landside slope. (Refer to Fig. 3.5, Type I)

As mentioned in the "Seismic Resistance Survey" extra embankment at the toe portion of the earth dike is provided as countermeasure against liquefaction in the specified area. The standard design of the counterfill is shown in Fig. 3.2.

b) Concrete Flood Wall

Through the comparative study between a new earthfill dike and the modification of the existing concrete gravity wall, the latter was selected as the suitable method from the economic and technical aspects. Thus, in the Carmen stretch, the modified concrete flood wall shown in Fig. 3.3 is proposed. This wall is reinforced concrete made and attached to the existing concrete gravity wall at the riverside, so that both can work in coordination against flood flow. It also requires sheet piles to block seepage flow under the wall and boulder apron to prevent the toe portion from scouring. This type of wall is applied for the down reaches from the Carmen bridge; while, the partially constructed concrete gravity dikes in the upper reaches from the bridge are replaced by earth dikes because of difficulty of modification.

c) Closing Dike

This dike is provided perpendicularly across the original river course in the Alcala-Bayambang stretch, forming a big bend. It is approximately 4 to 8 m high above the riverbed. The foundation material is fine to coarse sand and hence, it is identified as permeable ground. Considering foundation seepage, scouring and liquefaction problems, the dike section will be enlarged by providing counterfill to ensure dike stability. Besides, steel sheet piles are used for the existing low water channel portion to obstruct seepage flow. The standard design sections are illustrated in Fig. 3.4.

3.1.2 Protection Works for River Dike and Low Water Channel Bank

Protection works, as used in this section, refer to revetment and groyne provided at river dikes and low water channel banks.

The river in the priority project area consists of the rapid flow river courses in the upper reaches and the mild flow river courses in the lower reaches. Depending on the flow conditions in the river course, protection works for dikes and low water channel banks are designed as follows.

a) Asingan-San Manuel Stretch

Designing of protection works in this stretch focuses on the scouring and foundation seepage problems.

To cope with heavy scouring, wet stone masonry type of revetment with base concrete embedded deep enough and foot protections composed of boulders and gabions are proposed as shown in Fig. 3.6 for the dike and in Fig. 3.9 (Type D) for the channel bank. In addition, spurdikes having a resistance against swift flow are placed in front of river banks (refer to Fig. 3.9, Type C). A combination of revetment and spurdikes will be provided for most portions.

Although swift flow is not expected to occur along the new setback dikes, some minor turbulent flow is expected during floods. Taking this condition into account, dry boulder riprap facing with boulder apron is suitable as protection works for the dike. (Refer to Fig. 3.5, Type I).

For the water colliding front in the stretch between AGR-415 and AGR-456, the wet stone masonry type of revetment and foot protection groyne as shown in Fig. 3.5 (Type II) are employed to confront the swift flow force. The boulders used for the foot protection groyne require a sufficient weight to stay put under the flood flow.

Regarding the foundation seepage problem, counterfill with a width of 5.0 m is provided at the landside slope of the setback dike.

b) Asingan-Carmen Stretch

For the protection works of the dike, the wet stone masonry type of revetment shown in Fig. 3.5 (Type III) and the boulder riprap shown in Fig. 3.5 (Type I) are adopted. The places to be provided, the extension and the structural type are decided in consideration of the river regime, water flow impact, soil properties, construction cost and so on.

There exist some weak portions of dike slope against scouring. To prevent progressive erosion, the spurdike as shown in Fig. 3.7 is adopted.

The low water channel bank subject to heavy erosion will be protected chiefly by the gabion cylinder type of revetment. In case the low water channel bank is close to the river dike, the wet stone masonry type is employed. The standard features are illustrated in Fig. 3.8.

Groynes are provided along both the dikes and the low water channel bank to deflect or repel the flow and to protect the dikes and channel banks from scouring by inducing siltation in the area. To meet the above purposes the pile type groyne shown in Fig. 3.10 is adopted in consideration of the riverbed gradient and riverbed materials in this river stretch. The arrangement of the groynes is as follows:

- Type: Permeable type using concrete pile.

- Direction: The groyne is arranged upward at an angle of 10 degrees.

- Length: About 10 percent of the channel width is employed.

- Interval: The relation between interval (D) and length (L); D/L = 2.0 to 3.0

c) Bayambang-Alcala Stretch

The main protection works are focused on the closing dike and the diversion channel.

As the protection measure for the closing dike, a combination of wet stone masonry type of revetment and foot protection groyne (boulder apron) is proposed as shown in Fig. 3.4 to cope with scouring and seepage. Besides, steel sheet piles anchored with tie rod and concrete piles are provided to block the seepage flow and to prevent scouring for the dike built on the existing low water channel.

To maintain the sectional shape of the diversion channel under any flood, the channel bank is protected by wet stone masonry type of revetment. (Refer to Fig. 3.8, Type A)

3.1.3 Bayambang Diversion Channel

In deciding the type of diversion facilities on the Bayambang closing dike, a comparative study between diversion channel type and fixed weir type was made from the economic and technical aspects (refer to Fig. 3.11, Fig. 5.1 and Table 5.1). As the result of this study, the diversion channel as illustrated in Fig. 3.11 was selected.

A rectangular section with a width of 23.0 m and a height of 7.9 m is proposed from the aspect of hydraulics and the efficiency of channel maintenance during flood and non-flood seasons. To allow the diversion flow with a high velocity through the closing dike, reinforced concrete open channel is designed. The length of the channel is the same as the closing dike section. The approach channel up and downstream of the reinforced concrete channel is well protected with revetment against severe scouring of flow.

For the foundation of the channel, mat foundation type is adopted because subbase ground has enough supporting capacity against the weight of the concrete channel. Sheet piling is necessary to prevent seepage flow.

3.1.4 Drainage and Intake Gates

Drainage and intake gates (sluiceway) are provided in accordance with the dike construction including heightening of existing dikes. The number and location of gates are listed in Table 3.1.

a) Hydraulic Dimensions

Through the study on drainage system, the design discharge for each drainage gate was estimated to determine the hydraulic dimensions of the sluiceway. The results are shown in Table 3.1. As for the intake gate which needs reconstruction, the dimensions of the existing gate are applied for the design of the new gate.

b) Structure

The type of gate and structure is determined based on not only the hydraulic dimensions but also the gate function such as easy operation and prompt and precise water stop. To meet the above requirements, the slide gate and the flap gate type are proposed. The basic structure is composed of a box culvert, an operation deck, wing and breast walls, and concrete pile foundation.

The types of sluiceway are as follows:

Type A1: One flap gate, one RC pipe of 0.80 m diameter (for Poponto Swamp).

Type A2: Two flap gates, two RC pipes of 0.80 m diameter (for Poponto Swamp).

Type B: One slide gate, one box culvert of 1.50 m x 1.50 m.

Type C1: One slide gate, one box culvert of 2.00 m x 2.00 m.

Type C2: Two slide gates, two box culverts of 2.00 m x 2.00 m.

Type C4: Four slide gates, four box culverts of 2.00 m x 2.00 m.

Type D: Two slide gates, two box culverts of 2.50 m x 2.50 m.

Type E: One flap gate, one RC pipe of 0.80 m diameter (for Agno River).

As the foundation measure for the sluiceway against differential settlement and probable liquefaction, concrete piles are provided at the foundation, except the sluiceways along the ring levee in the Poponto Swamp. Concrete piles shall be embedded into the supporting layer.

The standard design of sluiceways are illustrated in Fig. 3.12 to Fig. 3.16.

3.1.5 Bridge

Regarding bridges, the following works are to be executed:

- Extension of the New Carmen Bridge and the Alcala Bridge according to the implementation of the setback levee.

- Reconstruction of the Calvo Bridge, because of the lack of freeboard, to the design high water level.

- Reconstruction of the San Isidro and Camangahan bridges in accordance with the road heightening.

a) Structural Dimensions

The length and width of the bridges are decided as listed in Table 3.2 in consideration of the existing bridge dimensions, the road classification, and the alignment of the setback levee.

b) Bridge Type

From the structural consideration and construction cost, PC made simple composite girder type is employed for the design of superstructure, except the New Carmen Bridge. The girder length of 20.0 m to 30.0 m is recommended for this bridge type. The standard design drawing is presented in Fig. 3.17.

c) New Carmen Bridge

The elevation of the girder of the New Carmen Bridge which is now under construction meets the requirement of a 10-year flood, but does not meet that of a 100-year flood. In this priority project, reconstruction of the bridge will not be done to avoid double investment.

For the extension of the bridge length by 250.0 m, 50.0 m long prestressed box girder is used, and four piers and one abutment supported by concrete piles are necessary.

3.1.6 Box Culvert

The existing box culverts built across the roads will be reconstructed due to the heightening of the existing roads. The dimensions and number of box culverts are as follows:

Dimensions	Number
4.5 m x 2.2 m	9
4.0 m x 2.0 m	5
2.4 m x 1.8 m	3
1.5 m x 1.2 m	1
5.0 m x 2.0 m	2

The standard design drawing applied to the proposed box culverts is presented in Fig. 3.18. The structure is made of reinforced concrete without any gate. Mat foundation is adopted because the load to the subbase is rather small compared to the bearing capacity of the subbase.

3.1.7 Road Heightening and Pavement

Heightening of roads is planned as follows:

Road Class	Route	Length (m)	Width (m)	Type of Pavement	Maximum Heightening (m)
National	Moncada-Paniqui	5.3	7.3	Asphalt	1.40
Provincial	Babilang-Paniqui	4.4	6.1	Concrete	1.45
Provincial	Aman Casiling-San Vicente	1.6	7.3	Asphalt	3.60
Municipal (Barangay)	Sapang-Moncada	6.9	5.5	Gravel	2.60

The length, width and type of pavement for the proposed roads will be the same as the existing ones. Method of road heightening and pavement will be as shown in the standard drawings in Fig. 3.19. Pavement design was made depending on the road type or class based on the design guideline, criteria and standards for highways in the Philippines.

3.2 Flood Control Facilities and Related Structures in the Pantal-Sinocalan River

3.2.1 River Dikes

The diking system along the Pantal-Sinocalan River and its tributaries, the Dagupan River and the Ingalera River, was established. The embankment of the dikes will be in accordance with the standard design section presented in Fig. 3.20. This diking system include closing dikes across the existing river channel and the river mouth dike. In principle, the proposed dikes are earthfill type and are provided with gravel pavement on the dike crown and sodding on the slope.

As the result of the liquefaction study, counterweight fill is proposed for the stability of the dikes. The standard design of the counterweight fill is shown in Fig. 3.21.

a) Closing Dike

The major closing dikes are provided across the Bolosan, Marusay and Caloocan rivers which join the main river near the river mouth. Fig. 3.22 shows the closing dike sections, together with the dike protection works. In addition, minor closing dikes are also built along the shortcut channels in the area where the river channels meander (refer to Fig. 3.23).

The cross section of the dikes is designed large enough to ensure the dike stability against liquefaction, scouring and sliding. Concrete and steel sheet piles are also used to prevent seepage flow in the dike body.

b) River Mouth Dike

This dike will be provided in the river mouth area down from Section S-2. Since the probable high tide in the river mouth is lower than the design high water level, the standard dike section is applied, except that the berm is provided at the elevation of +1.00 m. The standard section is shown in Fig. 3.24.

3.2.2 Revetment and Groyne

a) Revetment

For designing revetment, the places to be provided, the extension and the structural type are decided in consideration of river regime, longitudinal and cross sectional forms, slope gradient of dike, property of soil and construction cost.

<u>Location</u>

Revetment is provided at the following places:

- Concave side of the river channel where the river course remarkably meanders and flood flow directly attacks;
- Closing dike portions;
- Junctions of Pantal-Sinocalan River with tributaries; and
- River mouth portion that is susceptible to erosion due to wave action.

<u>Selection of Type</u>

- The wet stone masonry type revetment (refer to Fig. 3.25) is employed as the protection works for the dikes to be newly built considering strength of flow, slope gradient of dike, embankment material, availability of construction materials and so on. The toe portion of the revetment is well protected by gabion mattress in due consideration of its flexibility against scouring.
- Riprap type revetment is provided for the low water channel banks from the economic and technical viewpoints. (Refer to Fig. 3.25)
- The river mouth dike is protected from both the river flood flow and wave action. To meet the requirements, the wet masonry type of revetment and an anchored concrete sheet pile is adopted as shown in Fig. 3.24. In addition to the above, riprap using heavy

boulders is provided in front of the sheet pile to weaken the wave action.

b) Groyne

Groynes are provided in the Pantal river mouth portion and the concave sides of the Dagupan River where bank erosion has been occurring. These river channels have a gentle slope of water surface which is less than 1/1500 and the riverbed material consists mainly of fine sand. For such a river channel, the pile type of groyne shown in Fig. 3.10 is judged to be suitable. Gabion mattress is provided around the foundation of the piles to prevent scouring.

3.2.3 Groundsill

A groundsill is proposed at the point where the bypass channel joins the Dagupan River in order to prevent the riverbed from scouring and to stabilize the riverbed in the area. The groundsill is composed of a main body of rubble stone concrete, an apron made of gabion mattress, ripraps on the riverbed and revetment as shown in Fig. 3.26.

3.2.4 Water Gate

Water gates are provided to protect the branch catchment area from backwater flood flow of the main river. Water gate is applied to the closing point in which the hydraulic section necessary to drain the design discharge of the tributary is larger than 5.0 m in width, while sluiceway is employed if the hydraulic section is smaller than 5.0 m.

a) Location and Dimensions of Gate

The proposed water gates are listed, together with gate dimensions, in the following table. Eight of the water gates are provided at closing points of the tributaries and one is provided as the intake gate at the diversion channel from the bypass.

Name of Tributary	Location	Width (m)	Height (m)	Number of Gates
Caloocan R.	S2+200m (L)	10.0	8.0	1
Bolosan R.	S3+350m (R)	10.0	8.0	2
Marusay R.	S6+120m (R)	10.0	8.0	1
Bingco Creek	S29+120m (L)	7.5	8.5	2
Balagan R.	D16+350m (L)	7.5	7.0	2
Tributaries of Dagupan R.	D12B+250m (L) D14+250m (L)	5.0 5.0	7.0 5.0	1 1
Tributary of Ingalera R.	I3+400m (L)	5.0	6.0	1
Diversion Channel of Bypass	P6+300m (R)	10.0	8.0	1

The dimensions of the gates were determined based on the hydraulic section necessary for the drain of runoff from the tributaries. Besides, the dike height, river utilization, structural conditions and cost of gate were also taken into consideration.

b) Structure

Roller gates are employed to keep the gate operation easier and more precise during floods. Since most of the ground in the target area has been proven to be prone to liquefaction by the past earthquake, some earthquake countermeasures will be taken in designing the foundation of the structure. In this connection, prestressed concrete piles having a strong resistance will be used to transmit the forces that will arise on upper structures into the supporting layer. The bearing PC piles are embedded in the thick sand layer whose N value is more than 30. Concrete sheet piles 3.00 m long are provided for the purpose of percolation control. The standard designs are presented in Fig. 3.27 to Fig. 3.30.

3.2.5 Drainage and Intake Gate

Sluiceways for drainage and for intake purposes are proposed as listed in Table 3.3. The dimensions of the drainage gates were determined by dividing the design discharge by an allowable flow velocity, for which 1.5 m/s is applied to prevent sand deposition and also abrasion thereon. As for the intake gate, the standard dimensions (1.50m x 1.50m) is applied.

As for the type of gate, a slide gate and a flap gate are adopted aiming at easy operation, precise water stop and reasonable cost. A flap gate is used for a small scale and round shape sluiceway with a diameter of less than 1.0 m, while a slide gate is applied for a sluiceway having a width of between 1.0 m and 5.0 m. This type of sluiceway is composed of box culverts, steel gates, operation deck, wing and breast walls, maintenance bridge and foundation piles. To ensure the structural stability against differential settlement and liquefaction, bearing piles made of reinforced concrete will be embedded into the supporting layer whose N value is 30 or more. The standard designs are shown in Fig. 3.31 to Fig. 3.35.

3.2.6 Bridge

Bridges subject to reconstruction under this project, together with the proposed bridge dimensions, are listed in Table 3.4.

a) Length

The length of bridges to be reconstructed are classified into five groups depending on the river width (the distance between right and left dikes); namely, 100.0 m, 120.0 m, 200.0 m, 220.0 m and 230.0 m.

b) Width

The width of a bridge is decided based on the road classification which are national road, provincial road and barangay road. In this case, the proposed width of bridge will be more than the existing road width.

c) Bridge Type

From the economical construction cost and requirements of the river channel, PC made simple composite girder type is most feasible. The girder length of 25.0 m to 30.0 m is recommended for this type of bridge.

d) Foundation

To ensure the stability of the bridge piers and abutment under probable external forces, bearing pile foundation using PC piles is employed. The design features are shown in Fig. 3.36.

3.2.7 Road Relocation and Pavement

Parts of the existing roads in Calasiao area will be relocated due to the new dike construction and the bypass channel excavation. The plan for road relocation is illustrated in the Design Plan of Pantal-Sinocalan River made in the part of River Improvement.

The design of road and road pavement will be carried out based on the design standard shown in Fig. 3.19, which was prepared by following the design guidelines, criteria and standards for highways in the Philippines.

4. WORK QUANTITIES

4.1 River Improvement Plan for Upper Agno River

The improvement stretch is about 56.5 km long from the lower end of the Wawa Bridge to the uppermost end of Section AG-474. Work quantities subject to the river improvement are apportioned into the following four stretches:

a) Bayambang and Floodway Stretch (Wawa Bridge to AG-322);

b) Alcala-Asingan Stretch (AG-322 to AG-405);

c) Asingan-San Manuel Stretch (AG-405 to AG-474); and

d) Poponto Swamp area.

Total work quantities with breakdowns for the above stretches are shown in Table 4.1. According to the project implementation, the river improvement works will be done in two stages. Work quantities for each stage are shown in Table 4.2 and Table 4.3.

4.2 River Improvement Plan for Pantal-Sinocalan River

The Pantal-Sinocalan River will be improved from the river mouth up to Section S-58+1000 m, and the total improvement length comes to about 26.0 km. In addition, two tributaries, the Dagupan and the Ingalera rivers will also be improved for 20.0 km long and for 10.5 km long from the confluence, respectively.

The total work quantities for each river are summarized in Table 4.4. Two-staged development plan is applied for the Pantal-Sinocalan improvement project. Work quantities for each stage are shown in Table 4.5 and Table 4.6.

5. COMPARATIVE STUDY

5.1 Study Items

A comparative study regarding the following items was made to decide the most suitable alternative.

a) Diversion Facilities Planned on the Closing Dike to Control Flood Distribution in Alcala-Bayambang Stretch

Alternative I : Diversion Channel Type (Fig. 3.11)

Alternative II : Fixed Weir Type (Fig. 5.1)

b) Alignment of Bayambang Closing Dike

Alternative I : The alignment bended perpendicular to the Agno main river course being connected with the right floodway dike (refer to the Design of Upper Agno River).

Alternative II : The alignment drawn across the Agno River at Section AG302 (refer to Fig. 5.2).

c) Right Dike Alignment in Carmen Stretch

Alternative I : The new setback levee alignment shown in the Design Plan of Upper Agno River.

Alternative II : The existing dike improvement plan (refer to Fig. 5.3).

d) Right Dike Alignment in San Manuel Stretch

Alternative I : The new setback levee alignment shown in the Design Plan of Upper Agno River.

Alternative II : The existing dike improvement plan (refer to Fig. 5.4).

In comparing the proposed alternatives, a 10-year design flood was adopted. For the dike alignment in the Carmen Stretch, a 100-year design flood was used as well.

5.2 Comparative Study

5.2.1 Diversion Facilities Planned on the Closing Dike

Requirements of the diversion facilities are as follows:

- Secure control of flood distribution during floods (500 m^3/s under a 10-year design flood).
- Stable passage of maintenance flow into the Bayambang Stretch during non-flood season (about 15% of the dry season stream flow).
- Structural stability.
- Easy operation and maintenance of facilities, and reasonable construction cost.

To fulfill the above requirements, the following two Alternative plans were set up. Of these the most suitable Alternative was selected through the comparative study.

Alternative (I) .... Diversion Channel Type
Alternative (II) .... Fixed Weir Type

a. Alternative I (Diversion Channel Type)

This plan aims for the natural distribution of flood through the open channel extended from the main low water channel. To pass the flood flow allocated, a part of the closing dike will be opened. The amount of flood distribution depends on the water stages of up and down streams of the closing dike. The high water level of upstream (Station 320 B) is EL. 19.90 which compares to EL. 16.00 in the down-stream (Bayambang Stretch) under a 10-year probable flood.

Estimation of the hydraulic dimensions of the open channel was made as follows:

* Distribution discharge .... 500 m^3/s
* Difference in water stage .... 5.85 m
  (EL. 19.90 upstream D.H.W.L., EL. 14.05 m downstream channel bed)
* Estimation formula adopted
  $Q = 1.55 \times B \times h^{3/2}$ (Honma's formula, in rectangle section)
  $B = 500/1.55/5.85^{3/2} = 22.8 = 23$ m

This open channel can also enable easy passage of river maintenance flow in dry season.

b. Alternative (II) (Fixed Weir Type)

Flood distribution will be made by the side overflow weir which is fixed type weir installed at the lower portion of the closing dike. Structural features are illustrated in Fig. 5.1. Hydraulic dimensions of the weir were determined by using Honma's Formula assuming that the front overflow is applicable.

* Length of the weir : 120 m
* Height of the weir : 5.0 m
* Overflow depth : 1.8 m

In addition to the above, for the passage of maintenance flow the passage way as shown on Fig. 5.1 is provided through the weir body.

c. Distinctive Features of Alternatives

- Alternative (I)

  * There are some unknown factors in estimating discharge by empirical formula. The relation between discharge and hydraulic dimensions (channel width and water depth) must be verified through the hydraulic model test in the detailed design stage.
  * Stable maintenance flow passage can be realized throughout a year.

* Operation and maintenance of the facilities can be done without any difficulties.
* From the economical view point this plan is more feasible than Alternative (II).

- Alternative (II)

* The mechanism of the side overflow at the lower portion of the bend is difficult to grasp. The detailed hydraulic study using the side overflow method and model test are necessary to decide hydraulic dimensions.
* Sedimentation inside and outside the passage way is not avoidable during and after floods.
* To obtain stable passage of river maintenance flow regular maintenance works are needed after floods.
* From the economical aspect, this plan is more costly.
* Considering future expansion for over-all plan, construction will be more complicated and costly.

d. Main Works and Cost Estimate

Main works for both alternatives are described in Table 5.1 together with direct construction cost.

5.2.2 Alignment of Bayambang Closing Dike

As the method of closing the Bayambang river channel, two alternative plans are conceivable. One is to close with the alignment bended perpendicular to the Agno main river course being connected with the right flood way dike. The other is to close at about 3 km downstream portion from the existing bifurcation point. Of these the most suitable alternative is decided by comparing such aspects as flood flow conditions, channel stability and maintenance, stability of closing the dike, cost improvement etc.

a. River Hydraulics

- Alternative (I)

Since the smooth channel bend is formed, smooth flood flow along the bend will be expected. This channel bend will not induce any aggravating turbulent flows around the dike. However, this bend will become a water colliding front causing heavy scouring. To protect the dike body from heavy scouring, the rigid type revetment (wet masonry type) and foot protection works are required.

- Alternative (II)

This dike alignment system forms a dead water area in front of the closing dike during big floods. The closing dike itself is not subject to direct flood flow attack. However, many other portions of dike will be affected by complicated flood flow such as drift current, turbulent flow, eddy flow and so on. In addition, river bed features will be changed by sedimentation and degradation during floods.

b. Channel Stability and Maintenance

- Alternative (I)

The channel bed is more stable than that of Alternative (II). Least channel maintenance is necessary.

- Alternative (II)

The low water channel is difficult to maintain without structural protection works. Furthermore, periodical dredging/excavation will be needed after flood season to keep the water flow during dry season.

c. Dike Stability

- Alternative (I)

Deep sand layer spreads under the proposed closing dike. So a treatment work against seepage is necessary. For this work sheet piling is proposed. Besides, the dike section must be enlarged to cope with seepage in the dike body. As for the countermeasure against liquefaction, counterfill at both dike slope is effective.

- Alternative (II)

As to the dike stability, the same points discussed in Alternative (I) are applied for Alternative (II).

d. Necessary Works

Necessary works are described in Table 5.2.

e. Improvement Cost

As can seen in Table 5.2, Alternative (I) is less costly than Alternative (II).

5.2.3 Right Dike Alignment in Carmen Stretch

Alternatives (I) and (II) were compared through the aspects such as river hydraulics, dike stability, social impacts and construction cost.

a. River Hydraulics

- Alternative (I)

The design flood will be confined in the river channel without causing any hydraulic problems. Besides, this plan is effective in lowering water level by about 0.5 m under a 100-year probable flood.

- Alternative (II)

Although the design flood can be confined in the river channel, the progress of riverbed degradation cannot be avoided. Local scouring around bridge piers and revetment foundation will be accelerated as well. Consequently, some protective measures against riverbed degradation will have to be taken. Groundsill, riverbed protection, protection for bridge piers etc. are necessary.

b. Dike Stability

- Alternative (I)

The flood velocity will be lowered to less than 2.0 m/s owing to the expanded river cross sectional area after the completion of the set-back levee. As the result simple type revetment (Riprap type) is enough applicable for the dike protection. Seepage in the dike foundation is not so critical because the cross sectional shape is well designed against seepage flow. Counter weight fill is adopted to assure the dike stability against liquefaction.

- Alternative (II)

  High strength revetment will be employed for the dike protection because of high flood velocity in the bottle-neck stretch. Stability against sliding is lowered in parts of the existing dike because of heavy scouring in front of the dike. Some portions already collapsed during the last earthquake. As the appropriate countermeasures, steel sheet piling in front of the dike is proposed.

c. Social Impact

- Alternative (I)

  Land acquisition and house evacuation in the commercial area are not avoidable. Number of houses and area of land to be purchased area shown in Table 5.4 to 5.6.

- Alternative (II)

  No social impact is expected.

d. Main Work

Main work for Alternatives (I) and (II) are shown in Table 5.4 to 5.6. For the comparison study, both a 100 rear and a 10 year probable flood are adopted.

e. Improvement Cost

Comparing both cost, Alternative (II) is more reasonable under a 10-year flood base. However, from the long term view point Alternative (I) is judged to be more feasible.

5.2.4 Right Dike Alignment in San Manual Stretch

Planning concepts of Alternative (II) is to follow the existing dike alignment and to make the dike body resistant against destructive flood flow. On the other hand, Alternative (I) aims to build the dike safely avoiding the flood flow impact.

a. River Hydraulics

- Alternative (I)
Moderate flood flow will be anticipated in the front area of the set-back dike because flood flow spreads wide along the dike alignment. Therefore, simple type revetment (Riprap type) is applicable.

- Alternative (II)
Destructive flood flow having a flow velocity of about 4.0 m/s arises along the dike during the design flood. To protect the dike slope and toe portion from the severe scouring, rigid type revetment and foot protection is required. Groyne having a heavy weight is also necessary. Furthermore, the dike slope should be steeper than that of the other portion to reduce the force of flow.

b. Dike Stability

- Alternative (I)
Since the dike will be built on the high permeable ground made up of sand and gravel, countermeasure against seepage must be taken. Considering the flood duration time and coefficient of permeability of the materials, counterfill with a width of more than 5.0 m is proposed to provide at the land side slope. For the river side slope, boulder riprap facing and boulder apron shown in Fig. 3.5 is effective to keep the dike stable. Both earth counter fill and boulder apron are also effective against liquefaction.

- Alternative (II)
Seepage problems are more severe than that of Alternative (I) because the foundation ground is more permeable containing gravel and boulders. Cut-off wall is to be embedded at the toe portion of the dike to block the seepage flow. The dike slope surface also will have to be covered with impermeable wet masonry. Counter fill at the land side slope is also necessary.

c. Social Impact

Alternative (I) requires the compensation works such as a land acquisition of about 600 ha. and house evacuation (710). On the other hand none of the compensation work is necessary for Alternative (II).

d. Major Protection Works

Major works are described in Table 5.6 and Fig. 5.4.

e. Improvement Cost

Alternative (I) is advantageous costwise even if cost for compensation works is included. Protection work for dike in Alternative (II) are far more costly.

5.3 Comparison Results

Comparing each alternative from many aspects collectively, the following results have been concluded:

a. Diversion Facilities on Bayambang Closing Dike

Diversion channel type (Alternative I) is preferable.

b. Alignment of Bayambang Closing Dike

The alignment bonded perpendicular to the main river course from AG.323 to the right floodway dike (Alternative I) is adopted.

c. Right Dike Alignment in Carmen Stretch

The new setback dike alignment (Alternative I) is recommendable from the viewpoint of long term improvement cost and the river channel stability.

d. Right Dike Alignment in San Manuel Stretch

The new setback dike alignment (Alternative I) is proposed.

TABLES

TABLE 3.1 LIST OF DRAINAGE FACILITIES IN AGNO RIVER

Strecth	Location (sta.)	Drainage Area (km2)	Facility		
			Type	B x H x Pcs.	Gate Type
Bayambang	AG (R)	4.2	Sluice way	2.0 x 2.0 x 2	Sluice gate
	AG (L)	0.6	Sluice way	D = 0.8	Flap gate
	AG 293 + 100m (R)	1.3	Sluice way	1.5 x 1.5 - 1	Sluice gate
	AG 298 (L)	1.8	Sluice way	2.0 x 2.0 x 1	Sluice gate
	AG 299 (R)	3.3	Sluice way	2.0 x 2.0 x 2	Sluice gate
Floodway	AG 286 + 1200m(R)	9.2	Sluice way	2.0 x 2.0 x 4	Sluice gate
	FW 314 (R)	2.7	Sluice way	2.0 x 2.0 x 2	Sluice gate
Floodway-Asingan	AG 309 + 100m (L)	0.7	Sluice way	1.5 x 1.5 x 1	Sluice gate
	AG 325 + 350m (L)	1.4	Sluice way	1.5 x 1.5 x 1	Sluice gate
	AG 326 + 300m (L)	0.4	Sluice way	D = 0.8	Flap gate
	AG 350 + 500m (L)	-	Sluice way	1.5 x 1.5 x 1	Sluice gate
	AG 351 (L)	-	Sluice way	1.5 x 1.5 x 1	Sluice gate
	AG 352 (L)	2.0	Sluice way	2.0 x 2.0 x 1	Sluice gate
	AG 359 + 200m (L)	0.8	Sluice way	1.5 x 1.5 x 1	Sluice gate
	AG 368 + 200m (L)	3.4	Sluice way	2.0 x 2.0 x 2	Sluice gate
	AG 368 + 400m (R)	0.3	Sluice way	D = 0.8	Flap gate
	AG 402 + 150m (L)	Intake	Sluice way	2.5 x 2.5 x 2	Sluice gate
Asingan	AG 409 (R)	3.8	Sluice way	2.0 x 2.0 x 2	Sluice gate
-San Manuel	Banila R.	0.5	Sluice way	D = 0.8	Flap gate
Tributary	Banila R.	0.3	Sluice way	D = 0.8	Flap gate

NOTE : B: width (m), H: Height (m), D: Diameter (m)

TABLE 3.2 LIST OF BRIDGES TO BE CONSTRUCTED (AGNO RIVER)

RIVER	NAME OF BRIDGE	LOCATION	TYPE	ROAD CLASSIFICATION	NECESSITY OF CONSTRUCTION	PROPOSED BRIDGE DIMENSION		REMARKS
						LENGTH (m)	WIDTH (m)	
Agno R.	Calvo Br.	AG.297	Truss	Provincial	To be reconstructed	160.0	7.32	
	Carmen Br.	AG.344	Concrete	National	To be extended	(250)	12.72	
	Alcala Br.	AG.308	Concrete	National	To be extended	500.0	11.30	
Poponto Swamp	San Isidro	-	Concrete	National	To be reconstructed	57.0	11.30	
	Camangahan	-	Concrete	National	To be reconstructed	20.4	11.30	

TABLE 3.3(1/2) LIST OF DRAINAGE AND INTAKE FACILITIES IN PANTAL-SINOCALAN RIVER

Name of River	LOCATION (Sta.)		Purpose	Drainage Area (km2)	Facility		Type of Gate
					Type	B x H - Pos.	
Pental R.	S-2 + 200m	(L)	D,F,N	31.0	Water gate	10m x 5m	Roller gate
	S-3	(R)	D,F,N	2.8	Sluice way	2.0 x 2.0 - 2	Sluice gate
	S-3 + 350m	(R)	D,F,N	73.0	Water gate	20m x 5m	Roller gate
	S-4 + 130m	(L)	F	-	Sluice way	1.5 x 1.5 - 1	Sluice gate
	S-6 + 120m	(R)	D,F,N	6.3	Water gate	10m x5m	Roller gate
Old Dagupan R.	D-1 + 50m	(R)	F	-	Sluice way	1.5 x 1.5 - 1	Sluice gate
	D-1 + 350m	(L)	F	-	Sluice way	1.5 x 1.5 - 1	Sluice gate
	D-2 + 400m	(R)	D,F	1.7	Sluice way	2.0 x 2.0 - 1	Sluice gate
By-Pass	P-3 + 250m	(L)	D	1.1	Sluice way	1.5 x 1.5 - 1	Sluice gate
	P-5 + 400m	(L)	D	2.0	Sluice way	2.0 x 2.0 - 1	Sluice gate
	P-6 + 300m	(R)	M,F	-	Water gate	10 x 3 - 1	Roller gate
Sinocal R.	S-21 + 550m	(L)	D	0.8	Sluice way	1.5 x 1.5 - 1	Sluice gate
	S-24	(L)	D	0.3	Sluice way	DIA. 0.8m	Flap gate
	S-24 + 200m	(R)	D	0.5	Sluice way	DIA. 0.8m	Flap gate
	S-27	(R)	D	1.5	Sluice way	2.0 x 2.0 - 1	Sluice gate
	S-29 + 120m	(L)	D	55.0	Water gate	15m x 4.0m	Roller gate
	S-34 + 700m	(R)	D	0.1	Sluice way	DIA. 0.8m	Flap gate
	S-40 + 100m	(L)	D	0.3	Sluice way	DIA. 0.8m	Flap gate
	S-42	(R)	Intake(NIA)	-	Sluice way	2.0 x 2.0 - 2	Sluice gate
	S-46 + 250m	(L)	D	1.2	Sluice way	1.5 x 1.5 - 1	Sluice gate
	S-55	(L)	D	1.6	Sluice way	2.0 x 2.0 - 1	Sluice gate
	S-58 + 600m	(L)	D	0.4	Sluice way	DIA. 0.8m	Flap gate
Dagupan R.	D-4 + 400m	(L)	F	-	Sluice way	1.5 x 1.5 - 1	Sluice gate
	D-5 + 150m	(L)	F	-	Sluice way	1.5 x 1.5 - 1	Sluice gate
	D-5 + 250m	(L)	F	-	Sluice way	1.5 x 1.5 - 1	Sluice gate
	D-6 + 100m	(R)	D,F	2.4	Sluice way	2.0 x 2.0 - 1	Sluice gate
	D-9 + 100m	(R)	D,F	6.0	Sluice way	2.0 x 2.0 - 1	Sluice gate
	D-11 + 200m	(R)	F	-	Sluice way	1.5 x 1.5 - 1	Sluice gate
	D-11 + 200m	(L)	F	-	Sluice way	1.5 x 1.5 - 1	Sluice gate
	D-12 B + 250m	(R)	F	-	Sluice way	1.5 x 1.5 - 1	Sluice gate
	D-12 B + 250m	(L)	F,N	-	Water gate	5.0 x 3.0 - 1	Roller gate
	D-13 A + 500m	(L)	F	-	Sluice way	1.5 x 1.5 - 1	Sluice gate
	D-14 + 250m	(R)	F	-	Sluice way	1.5 x 1.5 - 1	Sluice gate
	D-14 + 200m	(L)	D,F	3.1	Sluice way	2.0 x 2.0 - 2	Sluice gate
	D-14 + 1000m	(R)	D,F	10.0	Water gate	5.0 x 3.0 - 1	Roller gate
	D-15 A + 150m	(L)	D,F	3.8	Sluice way	2.0 x 2.0 - 2	Sluice gate
	D-15 B + 250m	(R)	F	-	Sluice way	1.5 x 1.5 - 1	Sluice gate
	D-15 B + 250m	(L)	F	-	Sluice way	1.5 x 1.5 - 1	Sluice gate
	D-15 B + 400m	(R)	D	7.5	Sluice way	2.0 x 2.0 - 3	Sluice gate
	D-16 + 350m	(L)	D	57.0	Water gate	15 x 4.0m	Roller gate

NOTE: R: Right Bank L: Left Bank
D: Drainage F: Intake for Fish Pond
N: Navigation M: Intake for Maintenance Flow
B: Width (m) H: Height (m)

TABLE 3.3(2/2) LIST OF DRAINAGE AND INTAKE FACILITIES IN PANTAL-SINOCALAN RIVER

Name of River	LOCATION (Sta.)		Purpose	Drainage Area (km2)	Facility		Type of Gate
					Type	B x H - Pos.	
Dagupan R.	D-17 + 200m	(R)	F	-	Sluice way	1.5 x 1.5 - 1	Sluice gate
	D-18 + 50m	(L)	F	-	Sluice way	1.5 x 1.5 - 1	Sluice gate
	D-18 + 550m	(R)	F	-	Sluice way	1.5 x 1.5 - 1	Sluice gate
	D-19	(L)	F	-	Sluice way	1.5 x 1.5 - 1	Sluice gate
	D-20 + 350m	(R)	D	0.5	Sluice way	DIA. 0.8m	Sluice gate
	D-22 + 250m	(R)	D	4.5	Sluice way	2.0 x 2.0 - 1	Sluice gate
	D-22 + 350m	(L)	F	-	Sluice way	1.5 x 1.5 - 1	Sluice gate
	D-24 + 200m	(L)	D	3.0	Sluice way	2.0 x 2.0 - 2	Sluice gate
	D-24 + 900m	(R)	D	2.6	Sluice way	2.0 x 2.0 - 1	Sluice gate
Ingalera R.	I-2 + 500m	(R)	D	1.5	Sluice way	2.0 x 2.0 - 1	Sluice gate
	I-3 + 400m	(L)	D	12.2	Water gate	5.0 x 3.0 - 1	Sluice gate
	I-4 + 1900m	(R)	D	4.5	Sluice way	2.0 x 2.0 - 2	Sluice gate
	I-13	(R)	D	6.0	Sluice way	2.0 x 2.0 - 3	Sluice gate

NOTE: R: Right Bank L: Left Bank
D: Drainage F: Intake for Fish Pond
N: Navigation M: Intake for Maintenance Flow
B: Width (m) H: Height (m)

TABLE 3.4 LIST OF BRIDGES TO BE CONSTRUCTED (PANTAL-SINOCALAN RIVER)

RIVER	NAME OF BRIDGE	LOCATION	TYPE	ROAD CLASSIFICATION	NECESSITY OF CONSTRUCTION	PROPOSED DIMENSIONS		REMARKS
						LENGTH (m)	WIDTH (m)	
Sinocalan R.	New Bridge 1	P.2 + 200m	Concrete	National	New	220.0	11.30	
	New Bridge 2	P.2 + 270m	Concrete	Provincial	New	220.0	8.10	
	Gov. Estrada Br.	P.22 + 450m	Concrete	National	To be reconstructed	200.0	11.30	
	Railway	P.24		-	To be demolished	-	-	
	Maramba	P.39	Concrete	National	To be reconstructed	200.0	11.30	
	Sinocalan Br.	P.43	Concrete	National	To be reconstructed	200.0	11.30	
Dagupan R.	Manato Br.	D.12B	Steel	National	To be reconstructed	230.0	11.30	
	Calomboyon Br.	D.20	Concrete	Barongay	To be reconstructed	100.0	5.80	
	Pang-Pang Br.	D.24+1500m	Concrete	Barongay	To be reconstructed	100.0	5.80	
	Palris Br.	D.26	Concrete	National	To be reconstructed	100.0	11.30	
Ingalera R.	San Pablo Br.	I.1	Concrete	Barongay	To be reconstructed	120.0	5.80	
	Doyong Br.	I.4	Concrete	National	To be reconstructed	120.0	11.30	
	Foot Bridge	I.5	Bamboo	Barongay	To be reconstructed	120.0	5.80	
	Macabito Br.	I.7	Concrete	Provincial	To be reconstructed	120.0	8.10	

Table 4.1 SUMMARY OF WORK QUANTITY (AGNO RIVER;1/10 YEAR)

WQ-AG-1

Work Items	Type	Ref.No	Unit	Bayambang	Carmen	San Manuel	Popont Swamp	Total
Earth Works								
Excavation				5,938,900	2,473,895	0	4,800	8,417,595
	Common		m3	5,938,900	2,473,895	0	4,800	8,417,595
		EX-1	m3	4,522,448	2,288,556	0	4,800	6,815,804
	Gravel	EX-2	m3	0	0	0	0	0
Dredging		DW	m3	0	0	0	0	0
Embankment			m3	1,487,503	1,161,006	501,441	1,851,810	5,298,295
(Excavated)	Right	EM-1-R	m3	1,122,640	290,216	0	0	1,551,226
	Left	EM-1-L	m3	293,813	645,305	0	0	1,097,283
	Counterwegiht		m3	71,050	225,485	0	0	296,535
	Popont	EM-1-P	m3	0	0	0	1,851,810	1,851,810
(Borrow)	Right	EM-2-R	m3	0	0	479,081	0	479,081
	Left	EM-2-L	m3	0	0	0	0	0
	Counterwegiht		m3	0	0	22,360	0	22,360
Concrete Dike		AG.R-12	m	0	2,500	0	0	2,500
Revetment				9,694	26,900	17,450	719	52,263
	Type-A-1	AG.R-1	m	1,880	1,680	0	0	3,560
	Type-A-2	AG.R-2	m	470	420	0	0	890
	Type-B-1	AG.R-3	m	2,920	4,160	0	0	7,080
	Type-B-2	AG.R-4	m	730	1,040	0	0	1,770
	Type-C	AG.R-5	m	0	0	2,500	0	2,500
	Type-D	AG.R-6	m	0	0	2,000	0	2,000
	Type-I	AG.R-7	m	0	8,050	6,650	0	14,700
	Type-II	AG.R-8	m	0	3,650	4,200	0	7,850
	Type-III	AG.R-9	m	3,694	3,500	0	0	7,194
	Spurdike	AG.R-10	m	0	1,900	0	0	1,900
	Type-IV	AG.R-11	m	0	0	2,100	0	2,100
	Popont R-1	AG.R-13	m	0	2,500	0	600	600
	Popont R-2	AG.R-14	m	0	0	0	119	119
Groyne		GR-2	pcs.	15	91	9	0	115
Sluice				9	9	3	13	34
		AG.S-1-1	pcs.	1	2	2	4	9
		AG.S-1-2	pcs.	0	0	0	5	5
		AG.S-1-3	pcs.	0	0	0	0	0
		AG.S-2	pcs.	2	4	0	1	7
		AG.S-3-1	pcs.	1	1	0	1	3
		AG.S-3-2	pcs.	5	1	1	1	8
		AG.S-4	pcs.	0	1	0	0	1
		AG.S-5	pcs.	0	0	0	0	0
Diversion Channel	Conc.Channel	PDS	pcs.	1	0	0	0	1
	Closing Dike	AG.R-15	m	120	0	0	0	120
Box Culvert		BXC	pcs.	0	0	0	20	20
Drainage Ditch	0.5*0.5m	DT	m	0	0	0	0	0
Others								
Sodding		SO	m2	602,314	1,296,383	397,429	477,373	2,773,499
Pavement	Concrete	PC	m2	0	11,250	0	26,780	38,030
	Asphalt	PA	m2	0	0	0	53,482	53,482
	Gravel	PG	m2	62,535	75,837	44,775	33,000	216,147
Bridge		BC	m2	6,515	3,180	0	875	10,570
Demorishment	Concrete	DC	m3	5,000	2,320	0	400	7,720
Well		WE	pcs.	0	0	0	793	793

WQ-AG-S1

Table 4.2 SUMMARY OF WORK QUANTITY (AGNO RIVER;1ST STAGE)

Work Items	Type	Ref.No	Unit	Bayambang	Carmen	San Manuel	Popont Swamp	Total
Earth Works								
Excavation				4,519,000	264,770	0	0	4,783,770
	Common		m3	4,519,000	264,770	0	0	4,783,770
		EX-1	m3	3,102,548	79,431	0	0	3,181,979
	Gravel	EX-2	m3	0	0	0	0	0
Dredging		DW	m3	0	0	0	0	0
			m3					
Embankment			m3	1,487,503	1,161,006	501,441	1,405,364	4,851,849
(Excavated)	Right	EM-1-R	m3	1,122,640	290,216	0	0	1,551,226
	Left	EM-1-L	m3	293,813	645,305	0	0	1,097,283
	Counterwegiht		m3	71,050	225,485	0	0	296,535
	Popont	EM-1-P	m3			0	1,405,364	1,405,364
(Borrow)	Right	EM-2-R	m3	0	0	479,081	0	479,081
	Left	EM-2-L	m3	0	0	0	0	0
	Counterwegiht		m3	0	0	22,360	0	22,360
Concrete Dike		AG.R-12	m	0	2,500	0	0	2,500
Revetment				9,494	10,350	14,750	119	32,213
	Type-A-1	AG.R-1	m	1,880	800	0	0	2,680
	Type-A-2	AG.R-2	m	470	200	0	0	670
	Type-B-1	AG.R-3	m	2,760	1,440	0	0	4,200
	Type-B-2	AG.R-4	m	690	360	0	0	1,050
	Type-C	AG.R-5	m	0	0	1,300	0	1,300
	Type-D	AG.R-6	m	0	0	500	0	500
	Type-I	AG.R-7	m	0	1,350	6,650	0	8,000
	Type-II	AG.R-8	m	0	2,200	4,200	0	6,400
	Type-III	AG.R-9	m	3,694	1,500	0	0	5,194
	Spurdike	AG.R-10	m	0	0	0	0	0
	Type-IV	AG.R-11	m	0	0	2,100	0	2,100
	Popont R-1	AG.R-13	m	0	2,500	0	0	0
	Popont R-2	AG.R-14	m	0	0	0	119	119
Groyne		GR-2	pcs.	15	30	9	0	54
Sluice				9	7	3	9	28
		AG.S-1-1	pcs.	1	2	2	4	9
		AG.S-1-2	pcs.	0	0	0	3	3
		AG.S-1-3	pcs.	0	0	0	0	0
		AG.S-2	pcs.	2	3	0	1	6
		AG.S-3-1	pcs.	1	0	0	1	2
		AG.S-3-2	pcs.	5	1	1	1	8
		AG.S-4	pcs.	0	1	0	0	1
		AG.S-5	pcs.	0	0	0	0	0
Diversion Channel	Conc.Channel	PDS	pcs.	1	0	0	0	1
	Closing Dike	AG.R-15	m	120	0	0	0	120
Box Culvert		BXC	pcs.	0	0	0	2	2
Drainage Ditch	0.5*0.5m	DT	m	0	0	0	0	0
Others								
Sodding		SO	m2	602,314	1,296,383	397,429	352,194	2,648,320
Pavement	Concrete	PC	m2	0	11,250	0	0	11,250
	Asphalt	PA	m2	0	0	0	14,642	14,642
	Gravel	PG	m2	62,535	75,837	44,775	33,000	216,147
Bridge		BC	m2	5,344	3,180	0	0	8,524
Demorishment	Concrete	DC	m3	5,000	2,320	0	200	7,520
Well		WE	pcs.	0	0	0	715	715

Table 4.3 SUMMARY OF WORK QUANTITY (AGNO RIVER;2ND STAGE)

WQ-AG-S2

Work Items	Type	Ref.No	Unit	Bayambang	Carmen	San Manuel	Popont Swamp	Total
Earth Works								
Excavation				1,419,900	2,209,125	0	4,800	3,633,825
	Common		m3	1,419,900	2,209,125	0	4,800	3,633,825
		EX-1	m3	1,419,900	2,209,125	0	4,800	3,633,825
	Gravel	EX-2	m3	0	0	0	0	0
Dredging		DW	m3	0	0	0	0	0
			m3					
Embankment			m3	0	0	0	446,446	446,446
(Excavated)	Right	EM-1-R	m3	0	0	0	0	0
	Left	EM-1-L	m3	0	0	0	0	0
	Counterwegiht		m3	0	0	0	0	0
	Popont	EM-1-P	m3			0	446,446	446,446
(Borrow)	Right	EM-2-R	m3	0	0	0	0	0
	Left	EM-2-L	m3	0	0	0	0	0
	Counterwegiht		m3	0	0	0	0	0
Concrete Dike		AG.R-12	m	0	0	0	0	0
Revetment				200	16,550	2,700	600	20,050
	Type-A-1	AG.R-1	m	0	880	0	0	880
	Type-A-2	AG.R-2	m	0	220	0	0	220
	Type-B-1	AG.R-3	m	160	2,720	0	0	2,880
	Type-B-2	AG.R-4	m	40	680	0	0	720
	Type-C	AG.R-5	m	0	0	1,200	0	1,200
	Type-D	AG.R-6	m	0	0	1,500	0	1,500
	Type-I	AG.R-7	m	0	6,700	0	0	6,700
	Type-II	AG.R-8	m	0	1,450	0	0	1,450
	Type-III	AG.R-9	m	0	2,000	0	0	2,000
	Spurdike	AG.R-10	m	0	1,900	0	0	1,900
	Type-IV	AG.R-11	m	0	0	0	0	0
	Popont R-1	AG.R-13	m	0	0	0	600	600
	Popont R-2	AG.R-14	m	0	0	0	0	0
Groyne		GR-2	pcs.	0	61	0	0	61
Sluice				0	2	0	4	6
		AG.S-1-1	pcs.	0	0	0	1	1
		AG.S-1-2	pcs.	0	0	0	2	2
		AG.S-1-3	pcs.	0	0	0	0	0
		AG.S-2	pcs.	0	1	0	0	1
		AG.S-3-1	pcs.	0	1	0	0	1
		AG.S-3-2	pcs.	0	0	0	0	0
		AG.S-4	pcs.	0	0	0	0	0
		AG.S-5	pcs.	0	0	0	0	0
Diversion Channel	Conc.Channel	PDS	pcs.	0	0	0	0	0
	Closing Dike	AG.R-15	m	0	0	0	0	0
Box Culvert		BXC	pcs.	0	0	0	18	18
Drainage Ditch	0.5*0.5m	DT	m	0	0	0	0	0
Others								
Sodding		SO	m2	0	0	0	125,179	125,179
Pavement	Concrete	PC	m2	0	0	0	26,780	26,780
	Asphalt	PA	m2	0	0	0	38,840	38,840
	Gravel	PG	m2	0	0	0	0	0
Bridge		BC	m2	1,171	0	0	875	2,046
Demorishment	Concrete	DC	m3	0	0	0	200	200
Well		WE	pcs.	0	0	0	78	78

Table 4.4 SUMMARY OF WORK QUANTITY (PANTAL-SINOCALAN RIVER;1/10 YEAR)

WQ-PS-S1

Work Items	Type	Ref.No	Unit	Pantal-Sinocalan	Ingarela R.	Dagupan R.	Total
Earth Works							
Excavation	Common		10^3m3	1,498,000	1,187,000	663,700	3,348,700
		EX-1	10^3m3	608,450	948,450	199,110	1,756,010
Dredging		DW	10^3m3	159,800	20,000	0	179,800
Embankment			10^3m3	2,314,500	293,150	1,680,100	4,287,750
(Excavated)	Right	EM-1-R	10^3m3	904,350	112,900	777,200	1,794,450
	Left	EM-1-L	10^3m3	1,059,900	125,650	794,000	1,979,550
			10^3m3	350,250	54,600	108,900	513,750
Revetment				15,640	2,520	5,760	23,920
	River Mouth	PS.R-1	m	850	0	0	850
	Closing D'L	PS.R-2	m	300	0	0	300
	Closing D'H	PS.R-3	m	700	0	0	700
	Dike on R.-bed	PS.R-4	m	300	0	0	300
	Closing Dike	PS.R-5	m	880	360	600	1,840
	H.L.Revetmwnt.	PS.R-6	m	7,310	1,160	3,000	11,470
	L.W.R.(Type B)	PS.R-7	m	5,050	1,000	1,960	8,010
	L.W.R.(Type A)	AG.R-1	m	250	0	200	450
Groyne	L = 50 m	GR-1	pcs.	0	0	39	39
Sluice				17	3	24	44
	Type-A	PS.S-1	pcs.	7	0	15	22
	Type-B-1	PS.S-2-1	pcs.	4	1	3	8
	Type-B-2	PS.S-2-2	pcs.	1	1	4	6
	Type-B-3	PS.S-2-3	pcs.	0	1	1	2
	Type-C	PS.S-3	pcs.	5	0	1	6
Water Gate				5	1	3	9
	10mx 5mx 1	WG-1	pcs.	2	0	0	2
	20mx 5mx 1	WG-2	pcs.	1	0	0	1
	15mx 4mx 1	WG-3	pcs.	1	0	1	2
	5mx 3mx 1	WG-4-2	pcs.	1	1	2	4
Graund Sill		PS.GS	pcs.	1	0	0	1
Others							
Sodding		SO	m2	727,350	125,390	799,000	1,651,740
Pavement	Concrete	PC	m2	8,250	0	5,250	13,500
	Asphalt	PA	m2	0	0	0	0
	Gravel	PG	m2	144,840	78,000	124,500	347,340
Bridge		BC	m2	11,048	3,720	4,889	19,657
Demorishment	Concrete	DC	m3	2,500	1,500	2,000	6,000

Table 4.5 SUMMARY OF WORK QUANTITY (PANTAL-SINOCALAN RIVER;1ST STAGE)

WQ-PS-S1

Work Items	Type	Ref.No	Unit	Pantal-Sinocalan	Ingarela R.	Dagupan R.	Total
Earth Works							
Excavation	Common		10^3m3	1,243,300	0	0	1,243,300
		EX-1	10^3m3	529,700	0	0	529,700
Dredging		DW	10^3m3	159,800	0	0	159,800
Embankment			10^3m3	1,705,710	0	99,800	1,805,510
(Excavated)	Right	EM-1-R	10^3m3	902,800	0	28,600	931,400
	Left	EM-1-L	10^3m3	523,580	0	49,400	572,980
			10^3m3	279,330	0	21,800	301,130
Revetment				11,970	0	0	11,970
	River Mouth	PS.R-1	m	850	0	0	850
	Closing D'L	PS.R-2	m	300	0	0	300
	Closing D'H	PS.R-3	m	0	0	0	0
	Dike on R.-bed	PS.R-4	m	300	0	0	300
	Closing Dike	PS.R-5	m	750	0	0	750
	H.L.Revetmwnt.	PS.R-6	m	5,970	0	0	5,970
	L.W.R.(Type B)	PS.R-7	m	3,600	0	0	3,600
	L.W.R.(Type A)	AG.R-1	m	200	0	0	200
Groyne	L = 50 m	GR-1	pcs.	0	0	0	0
Sluice				14	0	0	14
	Type-A	PS.S-1	pcs.	6	0	0	6
	Type-B-1	PS.S-2-1	pcs.	3	0	0	3
	Type-B-2	PS.S-2-2	pcs.	1	0	0	1
	Type-B-3	PS.S-2-3	pcs.	0	0	0	0
	Type-C	PS.S-3	pcs.	4	0	0	4
Water Gate				4	0	0	4
	10mx 5mx 1	WG-1	pcs.	1	0	0	1
	20mx 5mx 1	WG-2	pcs.	1	0	0	1
	15mx 4mx 1	WG-3	pcs.	1	0	0	1
	5mx 3mx 1	WG-4-2	pcs.	1	0	0	1
				0	0	0	0
Graund Sill		PS.GS	pcs.	1	0	0	1
Others				0	0	0	0
Sodding		SO	m2	527,500	0	0	527,500
Pavement	Concrete	PC	m2	3,000	0	0	3,000
	Asphalt	PA	m2	0	0	0	0
	Gravel	PG	m2	103,030	0	0	103,030
Bridge		BC	m2	11,048	0	0	11,048
Demorishment	Concrete	DC	m3	2,500	0	0	2,500
	Metal	DM	ton	0	0	0	0