DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
REPUBLIC OF THE PHILIPPINES

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR REHABILITATION OF THE FLOOD CONTROL OPERATION AND WARNING SYSTEM IN METRO MANILA
IN
THE REPUBLIC OF THE PHILIPPINES

MARCH 2000

JAPAN INTERNATIONAL COOPERATION AGENCY
CTI ENGINEERING INTERNATIONAL CO., LTD.

PREFACE

In response to a request from the Government of the Republic of the Philippines, the Government of Japan decided to conduct a basic design study on the Project for Rehabilitation of the Flood Control Operation and Warning System in Metro Manila and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to the Philippines a study team from September 2 to October 16, 1999.

The team held discussions with the officials concerned of the Government of the Philippines, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to the Philippines in order to discuss a draft basic design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of the Philippines for their close cooperation extended to the teams

March 2000

Kimio FUJITA
President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

March 2000

We are pleased to submit to you the basic design study report on the Project for Rehabilitation of the Flood Control Operation and Warning System in Metro Manila in the Republic of the Philippines

This study was conducted by CTI Engineering International Co., Ltd., under a contract to JICA, during the period from August 20, 1999 to March 23, 2000. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of the Philippines and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Kazuyoshi KAGEYAMA
Project Manager
Basic design study team on
the Project for Rehabilitation of the Flood Control Operation and Warning System in Metro Manila
CTI Engineering International Co., Ltd.

PROJECT AREA MAP

ABBREVIATIONS

ORGANIZATIONS/AGENCIES

DANIDA	:	Danish International Development Agency
DENR	:	Department of Environmental and Natural Resources
DIC	:	Data Information Center of the PAGASA
DPWH	:	Department of Public Works and Highways
ICC	:	Investment Coordination committee
JICA	:	Japan International Cooperation Agency
LGU	:	Local Government Unit
LLDA	:	Laguna Lake Development Authority
MMDA	:	Metro Manila Development Authority
NCR	:	National Capital Region, DPWH
NEDA	:	National Economic and Development Authority
NHCS	:	Napindan Hydraulic Control Structure
NTC	:	National Telecommunications Commission
OCD	:	Office of Civil Defense, Department of National Defense
PAGASA	:	Philippine Atmospheric, Geophysical and Astronomical Services Administration
PMO-MFCP	:	Project Management Office for Major Flood Control Projects

ACRONYMS

ECC	:	Environmental Compliance Certificate
EFCOS	:	Nationwide Flood Control and Dredging Project, Part B, An Effective Flood Control Operation System Including Telemetering and Flood Warning System in the Pasig-Marikina-Laguna Lake Complex
IEE	:	Initial Environmental Examination
ITU-R	:	International Telecommunication Union-Receiver
ITU-T	:	International Telecommunication Union-Transmitter
MPT	:	Ministry of Post and Telecommunication
UHF	:	Ultra High Frequency

Table of Content

List of Figures

CHAPTER 1. BAKGROUND OF THE PROJECT

Metro Manila is vulnerable to flooding because of the insufficient drainage facilities and the improper maintenance of the existing drainage system. The flooding situation varies according to the rainfall intensity, that is, with 50 mm of hourly rainfall, roads are inundated in many places, and with 100 mm in 3 to 4 hours, the situation becomes worse resulting in heavy traffic congestion. Moreover, if the 24-hour rainfall reaches 150 mm, urban facilities are paralyzed. These unfavorable situations have prompted the Government of the Philippines to undertake various flood control projects; however, floods are still a menace to Metro Manila with a great impact on the socioeconomic activities. The flood disaster in 1997 is still fresh in people's memory since it struck the capital city of Manila claiming the lives of 43 inhabitants.

Under these circumstances, the Government of the Philippines has been urged to tackle the flooding problem with top priority projects emphasizing the necessity of non-structural measures in addition to enhancing the structural measures, such as the Pasig River Improvement Project and the Drainage System Improvement Project. Since the Effective Flood Control and Operation System (EFCOS) was established in 1993 with yen loan financing, it has been playing an important role as a non-structural flood control measure to facilitate operation of floodgates and the warning system. The gate operation of Rosario Weir has been conducted based on the hydrological data in the upper river basin ever since, and on-site observation of the water level is no longer used.

The existing EFCOS system was designed in 1985 as an analogue telemetry system, and it is practically unable to function as a flood forecasting system. At present, the data is input manually into the computer to calculate water discharge and, therefore, no time allowance is made to provide for advanced flood information. Furthermore, the hydrological observation network is inadequate for the Pasig-Marikina river basin.

To cope with small/medium-sized floods, it is absolutely necessary to collect as many data as possible in the objective river basin to establish a proper flood forecasting system. It should be noted that with the spread of mobile phones in Metro Manila, radio communication has become hardly usable particularly at flood time due to interference.

Taking the above into consideration, the Government of the Philippines has formulated a project to improve and enhance the overall function of the existing EFCOS system and made a request to the Government of Japan for its implementation under Japan's Grant Aid program. The plan includes (1) the installation of hydrological observation stations for collecting more accurate data on rainfall and water level; (2) the introduction of digitized telemetry system as well as on-line data processing system by computers; and (3) the deployment of radio communication equipment at pumping stations along the Pasig River as a means of strengthening flood control management.

CHAPTER 2. CONTENTS OF THE PROJECT

2.1 Objectives of the Project

The recurrent floods in Metro Manila occur due to the combined effect of water outflow from Pasig-Marikina River basin, Laguna Lake basin and the improperly established urban drainage system. Recently, population growth has increased due to urbanization. The floods have hampered socioeconomic activities, a very serious problem requiring urgent and timely solution.

The Government of Japan had dispatched a study team through the Japan International Cooperation Agency (JICA) in accordance with a request from the Government of the Philippines. For 3 years from 1988, the JICA Study Team formulated a master plan, with the target year 2020, to effectively settle the flood and storm water drainage problems. In addition to the master plan, feasibility studies were carried out for high priority projects such as the improvement works on Pasig River, as well as the East and West Mangahan drainage system. Based on the plans and studies, structural measures have been implemented as part of the integrated flood control project in Metro Manila, namely, the construction of pumping stations, the improvement of main drainage systems and the West Mangahan Flood Control Project. The inventory survey of drainage systems in Metro Manila by JICA is now underway, and the Pasig River Improvement Project is expected to start soon with financing under the 23rd yen loan program.

The Government of the Philippines has been making serious efforts to implement not only the structural measures mentioned above but also nonstructural measures such as flood forecasting and warning systems. In 1993, the Effective Flood Control and Operation System (EFCOS) was completed with yen credit financing. The objectives of the project were to install rainfall and water level gauging stations in the river basin and to transmit the observed data to the Rosario Master Control Station using the telemetry system. The transmitted data are then analyzed for the purpose of mitigating flood damage in Metro Manila. The data are used for the effective operation of the gate of the diversion weir to the Mangahan Floodway, which effectively contributes to flood mitigation. Through this system, flood warnings are also disseminated to residents along the floodway.

However, the present system is seriously deficient for accurate flood forecasting because of the poor observation network. It is not compliant to the small and middle-sized floods caused by the progress of urbanization with a higher population density. Moreover, the progress of data transmission devices is eminent. For instance, the management of radio waves is getting more difficult with the proliferation of mobile phones in Metro Manila and the interconnection of services. To settle these issues, it is necessary to consider an overall EFCOS and to implement a more accurate flood forecasting operations. The major objectives of the proposed Project are to improve the system itself and to procure the necessary equipment for its better functioning to meet the necessary standard.

2.2 Basic Concept of the Project

The project includes (1) the construction of hydrological observation stations, (2) the installation of digitized telemetry system as well as on-line data processing system, and (3) the introduction of flood forecasting system. The data collected and computed as such is converted into visual images for display. In addition, the radio communication system needs to be installed at pumping stations, LGUs and other agencies concerned for sharing flood-forecasting information. With regard to the proper operation of the established system under the grant aid, technical guidance services need to be provided to the Philippine counterparts through on-site-job training and lecture.

System expansion of EFCOS to Laguna Lake basin is not involved in this Project. However, the study has been conducted to determine the necessity of future expansion of the system, and its result is included in this section. The basic concept of the Project is further described as follows:

2.2.1 Improvement of Hydrological Observation Network

(1) Location of Hydrological Observation Station

New hydrological observation stations will be installed under the Project, namely, two (2) water level gauging stations and five (5) rainfall gauging stations. Their locations are as shown in Figure 2-1, taking into account the following:

(a) Water level gauges are necessary on major tributaries, the Nangka and San Juan rivers, respectively.

(b) Accessibility to the gauging stations is one of the most important factors for maintenance work.

(c) A water level gauge shall be placed just downstream of a bridge, where discharge measurement can be conducted easily.

(d) The rainfall gauging stations are to be distributed uniformly in the whole Pasig-Marikina River basin; hence, one rainfall gauging station is necessary in the San Juan River basin.

(e) Compounds of public facilities are preferable in urban areas to minimize land acquisition.

(f) Radio propagation between the proposed telemetry stations and the Master Station/the relay station is to be verified through field tests.

Location of New Telemetry Stations

Gauging Station	Name of Station	Latitude	Longitude
Rainfall	Mt. Campana Aries Napindan Nangka Science Garden	14°40'01" N 14°39'41" N 14°33'27" N 14°40'28" N 14°38'43" N	121°17'34" E 121°10'14" E 121°04'04" E 121°06'33" E 121°02'40" E
Water Level	Nangka San Juan	14°40'28" N 14°36'26" N	121°06'33" E 121°01'28" E

(2) Introduction of Event Reporting System

Telemetry data (water level and rainfall) are collected every hour in normal times under the existing system. However, the San Juan River and the upstream reaches of the Pasig-Marikina River are so steep that flush floods take place very often. The hourly data collection seems to be ineffective to catch information on the swelling floodwaters rapidly and correctly, and it is feared that a coming flash flood might be missed by the system leading to a delay in flood forecasting and warning activities.

The event reporting system needs to be incorporated into the telemetry system as a solution against such flash floods. In this event reporting system each telemetry station will report to the monitoring station the occurrence of water level or rainfall exceeding a certain preset level. The monitoring station receiving the report will then automatically change the collection frequency from every hour to every 10 minutes.

2.2.2 Telecommunication System

With the existing flood control operation and warning systems in Metro Manila, the Rosario Master Control Station collects rainfall and water level at the upstream of Marikina River through a radio circuit (UHF). The data are used to estimate the flow rate and water elevation, to operate the gate of Rosario Weir together with that of Napindan HCS, and to give a flood alarm of the Mangahan Floodway. With the data processing system, the Rosario Master Control Station also computes river discharge for gate operations, using the data on rainfall and water level, which are collected automatically by the telemetry system and fed manually into the system.

The plan is to improve the information system, i.e., it intends to introduce a telemetry system and implement a computer network system that enables prompt flood alarm and opening/closing of the gate. In addition, this will also improve the radio communications system between the drainage system constructed along the Pasig River and at the Rosario Master Control Station, so that the drainage system in Metro Manila can be operated/managed efficiently.

With the popularization of mobile telecommunications, there is interference in the frequency band of 2GHz in the radio circuit network that links the Rosario Master Control Station (the center of flood control and warning system for Metro Manila) to individual monitoring stations. Therefore, the National Telecommunication Commission (NTC) is obliged to change the band to 7.5GHz and 22GHz in which no interference occurs with cellular phones.

As a result of the study and analysis on problems with the flood warning system for Metro Manila, which should be harmonized with the nationwide flood warning system, the telecommunications system needs to be improved as follows:

(1) Telemetry System for Rainfall and Water Level Gauging Stations

The telemetry system of the existing rainfall and water level stations has been installed to comply with Telemetry Standard Specifications No. 1 of the Ministry of Construction of Japan issued in 1977. However, as the basic concept for the system to be introduced by this proposed Project, the updated specification, Telemetry System Specification No. 21, shall be applied to adjust the existing system. With this Project, the system will be improved by enhancing the data transfer speed and flood forecasting as well.

(2) Water Discharge Warning System

Devices comprising the existing water discharge warning system must follow the "Discharge Warning Equipment Standard Specifications" of the Ministry of Construction which was issued in 1977. With this proposed project, the system will be improved/rehabilitated and digitized in order to implement a water discharge warning system of high reliability. Therefore, it is important to note that the specification should be applicable to the existing facility and materials.

(3) Emergency Radio Communication Network System

The emergency radio communication network system is a new system, which will be introduced at the request of the Philippine Government. This system, in consideration of easy network operation, will be built up for broadcasting commands at a commanding radio station and group instructions.

(4) Multiplex Communication System

There are two (2) multiplex communication systems: a 24-channel capacity model installed at EFCOS and a 30-channel model of dual type. In this proposed project, the 30-channel model of dual type will be introduced in consideration of systems expandability and maintainability.

The existing flood warning system in Metro Manila consists of three (3) subsystems: rainfall/water level telemeter subsystem, water discharge-warning subsystem, and multiplex communication subsystem. To introduce the system, rehabilitation of these subsystems and expandability of functions for the emergency radio communications network system must be taken into consideration. The basic concept of this system is as follows:

(a) For future expandability, increased will be channels for the multiplex communication network connecting the Rosario Master Control Station to the existing and new control stations in parallel with the frequency change.

(b) In consideration of local climatic conditions, an event reporting system will be introduced, which automatically reports the information to the Rosario Master Control Station when a monitoring station senses extraordinary rainfall or a pre-decided water level.

(c) A function will be added, which monitors opening/closing status of gates for Rosario Weir and Napindan HCS.

(d) Collected data concerning water will be entered in the computer automatically.

(e) Observation equipment (rainfall and water level) must generate digital data, which the monitoring station can pick up and send to a computer automatically.

(f) The telemeter monitoring system must be a system that can shorten data collection time.

(g) The digital warning system must be highly reliable.

(h) The communications network linking pump sites will have the following functions:

- Emergency phone call function (phone call having priority in an emergency)

- Text data communication (having control and phone call channels with which text data communication is available without interference of the phone call)

- Control management function (broadcasting commands and calling a specific group)

2.2.3 Data Processing System

There exist some problems with the current data processing system that includes flood forecasting: (1) displaying information is only numerical figures, (2) the flood forecasting software is poor in function, and (3) data is input manually. To solve these problems, data processing systems will be integrated. This will improve the reliability of information and the information transmission speed, and will establish an efficient operations scheme. The basic concepts are summarized as follows:

(1) The Rosario Master Control Station will have basic processing functions including flood forecasting. As a result, the two monitoring stations, the DPWH Central Office and the NCR will only receive image information

transmitted from a control station. Part of information will be transferred to the LAN (Road Information Management System: RIMS) in the DPWH Central Office to share information in wide use.

(2) Data to be collected are telemeter rainfall/water level as well as gate information of Rosario Weir and Napindan HCS. They will be collected, processed, and accumulated in a database automatically. Then the processed data will be converted into visual images and transferred to the monitoring stations and partially RIMS.

(3) A new flood forecasting system will be introduced. It will retrieve information from the above database, compute and convert results into visual images for display, which will also be transferred to the monitoring stations. Water level estimation will be made available at the following points: Pasig-Marikina River, Mangahan Floodway, Napindan Floodway, and San Juan River. Further, gate operation will be incorporated in a computing model.

2.2.4 Deployment of Emergency Radio Equipment

Deployment of emergency radio equipment has two purposes: (1) to transfer information related to flood forecasting quickly to the pumping stations in a city in order to establish a monitoring system for improving the efficiency of pumping operation; and (2) to share information with local government units and related organizations, so that measures to prevent floods are reinforced at the civic level.

(1) Deployment at Pumping Stations

Pumps in pumping stations in a city have been working independently of the water level of rivers. To make matters worse, the initial start of pumps has not always been quick because the flooding condition in the city could not be grasped. This situation can be improved with the deployment of exclusive-use radio equipment at each pumping station. The equipment will also enable dissemination of flood forecasting information and improve drainage efficiency.

As described in Subsection 2-2-1, Setup and Improvement for Water Monitoring Network, a total of 15 pumping stations exist in Metro Manila at present (refer to Figure 2-3). Eleven out of these 15 facilities are installed along the Pasig River and the rest (Libertad, Tripa de Gallina, Balut and Vitas), outside the coverage area of this plan. These four (4) pumping stations will not be incorporated into this plan since these are not directly affected by the Pasig River and not involved with the EFCOS system.

From the above considerations, emergency radio equipment is to be deployed in eleven (11) pump stations.

(2) Deployment in Local Government Units and Related Organizations

The Philippine Government sets up the Calamities and Disaster Preparedness Plan according to the Presidential Decree and the Disaster Coordinating

Council in each level of country, province, city/municipal and barangay. Each council makes effort to reinforce the support system for disasters. Flood forecasting information must promptly reach residents living in dangerous locations and appropriate preventive measures are applied at the community level. Especially, if disaster such as typhoon and torrential rain spreads in a wide area, telephones and mobile radios usually get into a mess and are unusable. Therefore, radio equipment will be the communication means at the time of emergency. Each station will be connected via PAGASA Monitoring Station through dedicated lines to the Rosario Master Control Station (refer to Figure 2-8).

With this plan, twenty-seven (27) units of radio equipment are additionally required to be deployed in the following places:

<u>Local Governments Units (15)</u>

Montalban (Rodriguez), San Mateo, Marikina City, Pasig City, Taguig, Pateros, Muntinlupa City, Cainta, Taytay, Angono, Mandaluyong City, Makati City, Quezon City, San Juan, Manila

<u>NCR District Offices (7)</u>

North Manila Office, South Manila Office, Quezon City Office, First Metro Manila Office, Second Metro Manila Office, Third Metro Manila Office, Quezon City Branch Office

<u>Related Organizations (3)</u>

Laguna Lake Development Authority (LLDA), Office of Civil Defense (OCD), Metro Manila Development Authority (MMDA)

<u>EFCOS Project Office (1)</u>

Rosario Master Control Station

<u>DPWH Central Office (1)</u>

Flood Forecasting Office (Penthouse)

In the above list, Muntinlupa is located nearby the Laguna Lake but outside of the flood forecasting coverage of this Project. Thus, it will be ruled out of the list. On the other hand, one unit of radio equipment needs to be installed at NCR main office as a base station for emergency communication with pumping stations. As a result, it is concluded that 27 locations will be subject to the radio equipment deployment.

Based upon the basic concept of the Project as discussed above, a comprehensive system for flood forecasting and information dissemination can be as illustrated in Figure 2-9.

2.2.5 Facility Installation

Basic concept for the installation or construction of required facilities is as follows:

(1) Contents of Proposed Facilities

In this project, the following are proposed as new facilities:

(a) Rainfall Gauging Station (5 in number)

Aries, Mt. Campana, Napindan, Science Garden, Nangka

(b) Water Level Gauging Station (2 in number)

Nangka, San Juan

(c) Antenna Tower

NCR

(2) Basic Concept of Facility Design

The basic concept of facility design is as outlined below:

(a) Access Road for Construction Work

Facility sites are selected in consideration of the condition of access roads. However, in urban areas, it is very difficult to maintain access roads through heavily crowded housing areas. Therefore, new water level gauge stations are to be located near the existing bridges. Then, approach road between the nearest main road and the new facility is to be included in the facility design.

(b) Land Acquisition

Facility sites are basically selected from among lands owned by public organizations to avoid any trouble with private landowners.

Land acquisition is necessary to be approved by the owner shown below:

Name of Site	Landowner	Area Required
Aries	Private person	50 m^2
Mt. Campana	DENR	200 m^2
Napindan	DPWH	-
Science garden	PAGASA	-
Nangka	Private person	70 m^2
San Juan	DECS	-
NCR (Antenna Tower)	DPWH	-

(c) Facility Scale/Grade

In accordance with the results of survey on existing similar facilities, especially those of the currently existing EFCOS, the same scale and grade are to be adopted for the proposed Project. Furthermore, construction materials are to be procured, basically, nearby the project site.

(d) Environmental Compliance Certificate (ECC) Application

Before commencement of the Project, Initial Environmental Examination (IEE) covering the seven (7) project sites mentioned above has to be conducted to apply for the Environmental Compliance Certificate (ECC) from DENR.

2.2.6 Soft Component

In accordance with the improvement of the system, the technical guidance service seems to be an indispensable component of the project to train the personnel assigned for the system. It needs to be provided in two different fields: the management assistance service (overall system management and operation) and the engineering assistance service (hydrological analysis). The contents of activities in each field are as follows:

(1) Management Assistance Service

Upon the completion of EFCOS system in 1993, the Operation and Maintenance Manual was prepared as part of technical guidance services. The present system has been operated ever since following such an instruction manual. In the Project, however, it is necessary to update the manual to cope with a newly introduced system for operation and management. The technical guidance service will certainly help improve technical capability of EFCOS personnel to properly handle automatic data processing system as well as flood control and warning system. The new manual will involves the following:

(a) Institutional Arrangement

- Clear description of function and responsibility for each section of EFCOS office at normal time and flood time,
- Role and function of monitoring stations, i.e., DPWH, NCR, DIC(PAGASA)

(b) Manual for System Operation and Warning at Flood Time

- Understanding of hydraulic conditions such as tide level, water level, flow capacity of the river and so on,
- Establishment of control points and critical water level,

- Rules and regulations for the gate operation, work procedures and flood forecasting,

- Operation rules for flood warning system,

- Checking method and proper measures to be taken in case of event report,

- Manpower arrangement and essential works for system operation and warning, and

- Record and report on system operation and warning.

(b) Manual for Operation and Maintenance

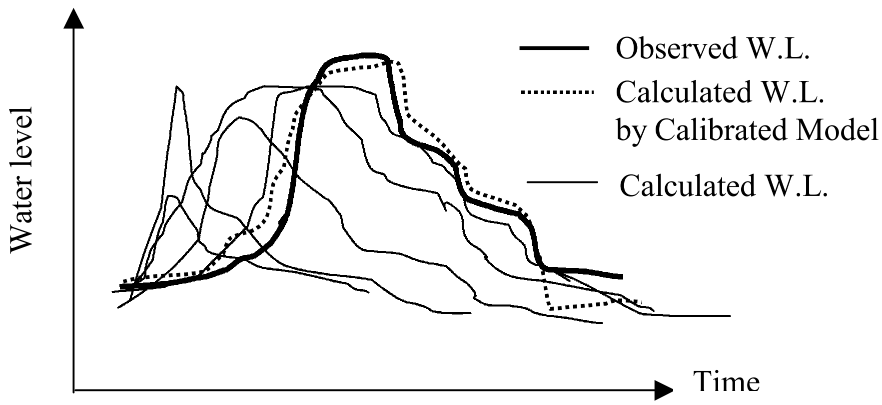
- Method of data checking and filing,

- Gate operation and management in dry season, and

- Manpower arrangement and its function.

(2) Engineering Assistance Service

Flood forecasting model has to be developed to take various physical parameters into consideration such as topographic and geographic features, characteristics of vegetation, river channel, riverbank height and so on. It can be established in such a way that the trial calculation is repeatedly carried out to determine parameters making approach to the real flood data (model calibration).



Development of Flood Forecasting Model

Flood phenomenon may vary depending on its scale, rainfall duration and spatial distribution so that it is desirable to use as many data as possible for making model calibration. It can be used as flood forecasting model for a certain period of time if the calibration is successfully done. However, if the output does not meet the observed value, the model needs to be checked and then modified or updated for maintaining equal accuracy. This work shall be undertaken by the Philippine counterparts after the system or equipment has been officially handed over to the Government of the Philippines.

Under the above circumstances, following engineering services will be provided to the Philippine counterparts for improving technical knowledge in terms of model modification and updating:

(a) Updating of Flood Forecasting Model

Based on the latest information and data, the model will be modified or updated for the sake of accuracy. Following work items are proposed to be carried out through on-the-job-training

- Data arrangement and analysis (rainfall, water level and gate operation),
- Modification and updating of flood forecasting model (rainfall runoff model and hydraulic model), and
- Updating of rating curve (modification of software in server).

(b) Operating Manual for Flood Forecasting Model

Besides delivering lecture, technical guidance service includes the preparation of operating manual, which consists of the following:

- Explanation on model structure (division of river basin, cross section of river channel, structures, boundary conditions, etc.),
- Explanation on determined parameters (runoff analysis, hydraulic analysis and structure's parameter),
- Introduction of optional conditions (rainfall forecast, determination of water level of Laguna Lake and gate operation), and
- Evaluation of difference between calculated value and observed value including suggestive idea for updating of the model.

2.2.7 Perspective for Future Expansion of EFCOS to Laguna Lake Basin

According to the original request from the Government of the Philippines, EFCOS is proposed to expand over the Laguna Lake basin with three (3) telemetry rainfall and four (4) telemetry water level gauging stations newly installed. It has been agreed that the Project will be limited to the existing EFCOS project area, the Pasig-Marikina River basin, but the study on the necessity of future expansion of EFCOS over the Laguna Lake basin will instead be made. The following are the results of the study:

(1) Telemetry Rainfall Station

Experts concerned have been saying that rainstorms in Metro Manila generally come from the northwest since most typhoons approach Luzon in that direction. If so, rainfall in the Laguna Lake basin, which is located southeast of Metro Manila, could be an indicator of a coming rainstorm. It means that rainfall forecast for Metro Manila could be possible by installing a telemetry system in rainfall gauging stations in the basin. At present, however, available rainfall data are still too scarce to examine this hypothesis.

The Laguna Lake (catchment area: 3,350 km^2; water surface area: 800 to 900 km^2) had no rainfall gauge in its catchment area for a long time. For the first time in November 1998, LLDA installed five (5) rainfall gauging stations in this area, as shown in Figure 2-2. The purpose of these stations is to study water balance in the lake. Since the rainfall gauges are all automatic recording systems and not telemeterized systems, they are not used directly for flood forecasting purposes. After a few years' observation, however, the accumulated rainfall data could be used for the study on movement of rainfall areas and may provide ideas to determine the necessity of telemetry rainfall stations. Hence, this issue needs to be discussed further after a few years.

Below is an example of trial studies to examine the movement of rainfall area. Figures 2-4 and 2-5 present the results of a regression analysis of existing EFCOS and PAGASA rainfall data during floods after 1994. As far as the used rainfall data are concerned, rainfall varies independently from each other, and no close relation among the rainfall stations was found. It seems not effective to forecast rainfall from that of adjacent stations. However, it is emphasized that a further study is still worth conducting because only a limited data have been used for the regression analysis.

Correlation Coefficient of Hourly Rainfall Data between Mt. Oro and Boso-Boso

Time Difference DT	-3 hrs.	-2 hrs.	-1 hr.	0 hr.	+1 hr.	+2 hrs.	+3 hrs.
Correlation Coefficient R	0.25	0.28	0.29	0.35	0.31	0.24	0.22

Note: DT means time difference between hourly rainfall data of Mt. Oro and Boso-Boso for the regression analysis. If DT = +2 hours, Mt. Oro is 2 hours ahead of Boso-Boso.

Correlation Coefficient of 3-Hour Rainfall Data (No Time Difference)

Station	Mt. Oro	Boso-Boso	S. Garden	Port Area	NAIA
Mt. Oro		0.53	0.48	0.38	0.32
Boso-Boso	0.53		0.57	0.51	0.58
Sc. Garden	0.48	0.57		0.52	0.54
Port Area	0.38	0.51	0.52		0.70
NAIA	0.32	0.58	0.54	0.70	

(2) Telemetry Water Level Station

There are two (2) water level gauges on the Laguna Lake besides the Angono Station of EFCOS. Both are staff gauges, located at Angono (NCR) and Looc (LLDA). Manual observation is made three times a day (8:00, 12:00 and 20:00 hours) at Angono and two times a day (8:00 and 17:00 hours) at Looc.

One of the typhoon-induced problems along the lakeside areas is seiche, which is a sudden fluctuation of water level caused by storing winds and/or low atmospheric pressure. In November 1995, the worst seiche took place in the lake during Typhoon Rosing. Figures 2-6 and 2-7 present fluctuation of the lake water level and the track of Typhoon Rosing from November 2 to 4, 1995. At Angono the lake water began to be forced back into the lake by strong winds and low atmospheric pressure around 3:00 a.m. on the 3rd of November. The water level which was 12.6 m at 0:00 a.m. went down to the minimum level, 10.8 m at 11:00 a.m. Then, the lake water began to return towards Angono, and rose to reach 13.5 m at 3:00 p.m. The fluctuation range on this day was as large as 2.7 m. According to EFCOS officials, the sudden water level rise had caused severe damage to lakeside areas in the Laguna and Rizal provinces. However, water level data have been so scarce that fluctuation of water level in the lake in general could not be identified.

The Philippines is one of the countries in the world most affected by typhoon. About 20 typhoons pass over the Philippines in a year, and a seiche like the one in 1995 would possibly occur again. However, the existing Angono telemetry water level gauge cannot cover all the 800 to 900 km^2 surface area, and it is very difficult to monitor such a seiche by only one telemetry gauging station. Even in Lake Biwa in Japan with a water surface area of 670 km^2, which is slightly smaller than that of the Laguna Lake, there are six (6) telemetry water level gauges. It is recommended that the telemetry system for water level gauges in the Laguna Lake be augmented in the future.

2.3 Basic Design

2.3.1 Design Concept

(1) Telecommunication Facility

(a) Rehabilitation of Existing Metro Manila Flood Control Operation and Warning System

i) Rainfall and Water Level Telemeter System

System Expansion

Water observation networks in the existing Metro Manila flood warning system will be improved to offer reliable meteorological information. To do so, the following stations will be added: three (3) rainfall gauge stations, one (1) water level gauge station, and two (2) rainfall/water level gauging stations (a rainfall gauge to be added to Napindan HCS Station).

Reinforcement of System Functions

Floods reach the Pasig-Marikina and San Juan river basins very quickly. Observation on the hourly basis may miss out a starting flood, which may lead to the initial motion of flood warning action. To cover such a defect, an observatory station should provide the master station with information. Such an information will inform that a water level of the river has exceeded a specific point, or it has started raining, and will activate the event reporting system where the data collection interval can be shortened to 10 minutes, for example.

Introduced will be a function where a monitoring station can keep an eye on the opening/closing states of the gates of Rosario Gate and Napindan Gate through multiplex lines. The configuration of the electric communication system is presented in Figure 2-10.

Rehabilitation of the Existing EFCOS System

For rehabilitation of the existing EFCOS system, the Project will adopt "Telemetry System Specification No. 21" of the Ministry of Construction, Japan, which is applicable to the existing facility, as the basic specification. In line with this Project, the Study Team intends to digitize this system, shorten data collecting time, and improve system reliability as well. In addition, the data recording system for rainfall/water level gauge station will be changed from analog to digital. This will enable recorded data entry into a computer with ease.

GPS equipment will be added to the master station to synchronize all clocks in the current EFCOS system and keep the correct time with the received time from the GPS satellite.

ii) Water Discharge Warning System

For rehabilitation of the existing water discharge warning system, this Project will adopt "Discharge Warning System Specification No. 27" of the Ministry of Construction, Japan, which is applicable to the existing facility, as the basic specification. In line with this Project, the Study Team intends to digitize the system.

iii) Multiplex Communication System

Radio Frequency Change

In 1994, the International Telecommunication Union (ITU) approved that the frequency for mobile radio equipment can be changed to 2GHz from 800 MHz in the near future. NTC also gave notice to the enterprises that a fixed ground circuit of 2GHz band should be changed to 7.5GHz or higher frequency as quickly as possible.

In consideration of this NTC recommendation, the radio frequency of this existing multiplex communication system will be changed to 7.5GHz. However, the Study Team will adopt the multiplex radio equipment of 22GHz band between NCR and DPWH since the distance is short and the transmission capacity is also small.

Devices comprising the system must follow the ITU-T and ITU-R as basic specification

Circuit System

The existing multiplex radio equipment of 2GHz will be replaced with that of 7.5GHz, as presented in Figure 2-11 (System Configuration for Metro Manila Flood Forecasting).

- Antipolo Relay Station Route

  The existing multiplex radio equipment of 2GHz will be replaced with that of 7.5GHz.

  Subject Stations: Antipolo Relay Station
  Rosario Master Control Station
  Napindan HCS Station
  PAGASA Monitoring Station (Science Garden)

- PAGASA (Science Garden) – DPWH Central Office Route

  The existing multiplex radio equipment of 2GHz will be replaced with that of 7.5GHz.

  Subject Stations: PAGASA Monitoring Station (Science Garden)

  DPWH Central Office

- DPWH Central Office – NCR Monitoring Station Route

  The existing SCR radio circuit of 230MHz will be replaced with multiplex radio equipment of 22GHz.

  Subject Stations: DPWH Central Office

  NCR Monitoring Station

- PAGASA (Science Garden) – DIC Route

  At present, PAGASA Science Garden is connected to DIC through a cable with the FDM analog transmission. This Project will replace it with the PCM digital transmission and refurbish the current cable.

Radio Equipment

This Project adopts the capacity of multiplex radio equipment of 2Mb/s X4 (equivalent to 120 CHs of telephone) in preparation for large capacity transmission of data and image in the future.

Terminal Station Equipment

In accordance with the digitized multiple circuit over the entire system, this Project adopts the digitized equipment at the individual terminal stations. This digital equipment for terminal stations is to have a function that will enable channel drop, insert, and exchange within it.

This Project uses part of the existing digital equipment at terminal stations. Primary group-terminal station equipment (1-stMUX) and telephone repeater equipment will be turned over to the terminal stations of DIC and the Napindan HCS Station. The primary group terminal station equipment will be moved from the PAGASA Monitoring Station (Science Garden) to the DIC Monitoring Station.

Key Telephone Equipment

Through the field study, the Study Team found out that the primary telephone equipment installed at the Rosario Master Control Station has broken down. Thus, this Project will include replacement with a new one.

Steel Tower

According to the field study, trees are rampant on the routes between the Antipolo Relay Station and the Rosario Master Control Station/Napindan HCS Station; therefore, it is difficult to build line of sight links. In this Project, the trees are cut off to a certain height instead of raising the existing antenna. In addition, a new tower of 35m will be constructed at the NCR Monitoring Station.

Channel Plan

In Figure 2-12, listed are the channels to be changed in accordance with the rehabilitation of multiplex radio circuits.

(c) Emergency Radio Communication Network System

The system has to be built up in accordance with the MPT1327 and MPT1343 protocols of the international standard.

i) Efficient Operation for In-water Drainage Facility

The emergency radio communications network system will link the 11 pumping stations via the PAGASA Monitoring Station (Science Garden). Operational status of the 11 pumping stations will be transmitted through telephone and text data communication measures. If an emergency arises, the control management function can execute the broadcasting command or call specific pumping stations for information transmission.

ii) Emergency Radio Communication System

An emergency radio communication system will be introduced to local governments and related organizations with a view to giving prompt and precise information to inhabitants in the Pasig and Marikina river basins in the event of flood. With this emergency radio, information can be disseminated accurately to each local government unit (LGU). The information will include the operational status of the gates of Rosario Weir and Napindan HCS and flood forecasting. As a result, leading or evacuating inhabitants around there can be done to safety zones promptly; thus, victims of the flood may be reduced.

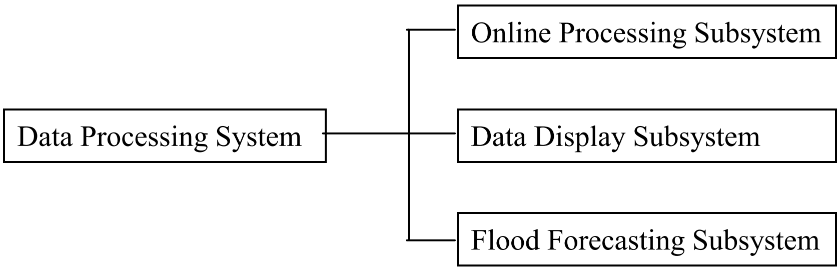
The emergency radio communications system will link Rosario Master Control Station with the 26 LGUs, NCR district offices and related organizations via PAGASA (Science Garden) Repeater Station, and flood forecasting information can be disseminated through phone and text data communication. If an emergency such as flood arises, the control management function can execute the broadcasting command or call a specific group of LGUs for information transmission.

System configuration of the emergency radio communications network is illustrated in Figure 2-13. The functions of the system are outlined as follows:

- Voice communication function between individual terminals
- Voice communication function between group terminals
- Status report function between individual terminals
- Short data report function between individual terminals
- Short data report function between group terminals
- Data communication function between individual terminals
- Data communication function between group terminals
- Tripartite phone call function
- Transfer-Entry function
- Voice communication function between terminal and telephone
- Emergency voice communication function

(2) Data Processing System

The data processing system will serve: (1) to collect telemeter and gate information online, (2) to forecast the possibility of flood on an as-needed basis using the information, (3) to create a visual image for display, and (4) to transfer it to the monitoring stations or into RIMS in DPWH. This data processing system is roughly divided into three subsystems function-wise.



To implement this data processing system, the following points should be taken into account:

(a) The computers to be introduced must be PCs (OS: Windows NT) in view of maintenance services at site and familiarization with DPWH staff.

(b) Flood phenomena are very fast in especially the San Juan and Marikina river basin. To monitor such a flash flood and forecast a flood, a quick response of the system is necessary. The processing should be done automatically with reduced manual intervention.

(c) A backup system will be implemented to cope with system breakdown and failure, which could be caused by power failure because of a typhoon, heavy rain, earthquake, etc. and by miss-operation.

(d) The information display subsystem will have a Web form, which the DPWH staff have been accustomed with the Internet. Among the Rosario Master Control Station, DPWH Central Office, and NCR Monitoring Station an intranet will be build , where a homepage will be also prepared to disseminated flood information to the monitoring stations. Some of the information will be accessible from RIMS, but the system must be on the defensive about computer virus prevailing in the Philippines nowadays.

(e) The flood forecasting system can be developed based on the available software for hydraulic analysis, and it could also be developed as an original program. In selecting proper software for this Project, it will be necessary to understand characteristics of each product in terms of basic functions required for the system. The comparison of software is presented in the table below.

It is desirable that the software to be used for this Project covers as many functions as possible to meet requirement for flood forecasting in the Pasig-Marikina River basin. If it does not cover some basic functions, more cost will be required for the program development to cover missing functions. Should an original program be developed as an alternative way, the investment cost will be further jumped up being as an unrealistic option.

Furthermore, it is important to note that the software should be selected to satisfy requirements in terms of model matching and data compatibility with other relevant projects such as Pasig River Improvement Project by DPWH and Pasig River Rehabilitation Project by DENR.

From the above considerations it is desirable to use MIKE 11, developed by the Danish Hydraulic Institute (DHI), as the most reasonable software for this Project.

Comparison of Software for Flood Forecasting

Item		Software for Hydraulic Analysis				Original Program	
		MIKE11 (DHI)	ISIS (HR Wall-ingford)	SOBEK River (DELFT)	HEC-RAS (BOSS Internl.)	*Foreast-ing Model for Dam (OECF)	**Forecast-ing Model for Tsurumi River
Basic Function	Unsteady-flow Analysis	○	○	○	X	X	○
	Runoff Analysis	○	○	○	X	○ (Storage Function)	○
	Flood Forecasting	○	X	X	X	○	○
	Gate Operation	○	○	○	X	X	X
	Visual Display	○	○	○	○	△	○
Compatibility of Software for Related Projects		○	X	X	X	X	X
Experience in the Philippines		○	X	X	X	○	X

○ : Yes, △ : Partially Yes, X: No

* Program developed on the basis of Storage Function Method for the Project of Flood Forecasting System for the Dam in the Philippines financed by OECF.

** Program developed under contract with the Keihin District Office of the Ministry of Construction, Japan for flood forecasting system of Tsurumi River.

Actually, MIKE11 is introduced to the above relevant projects and some hydraulic models have been already established. The number of trained personnel in this software is gradually increasing so that if some modifications and system expansion are needed in the future, the support system for inquiring software is locally available. In view of these facts, DPWH is strongly desirous of using this software for creating a suitable hydraulic model in this Project.

The flood forecasting model will be developed on the contract basis between a Japanese contractor and DHI. In this regard, the intellectual property right will be given from DHI to DPWH.

(3) Design Concept of Facilities

(a) Concept for Natural Conditions

Construction Term

To construct both the Campana and Aries rainfall gauging stations that are located in the mountainside, unpaved public roads have to be used for access during construction. In rainy season, however, these roads are unavailable due to their slippery and erosive condition. Likewise, water level gauging stations such as Nangka and Aries are located at the riverside; therefore, to construct both stations, the lowest river water level with no possibility of floods has to be strictly required. For these reasons, principally, the construction term should avoid the rainy season.

Soil Replacement

In accordance with the result of the site survey for the San Juan Station, surface layers at the construction site are organic materials including decomposed garbage. Therefore, this layer has to be replaced with appropriate materials.

Wind Load/Seismic Load

The antenna tower at the NCR compound shall be 35 m in height, more or less. Therefore, wind and seismic loads have to be considered in the structural design calculation for this tower.

Settlement Prevention

The foundation of the antenna tower has to be designed not to cause settlement.

(b) Concept for Social Conditions

Some equipment of the existing facilities had been stolen, according to their maintenance records. For prevention against thieves, the installation of steel-net fence around the station shall be considered.

(c) Concept for Facility Arrangement and Grade

Arrangement Plan

If there is no special problem on land acquisition for the water level gauge station, water level gauge and telemetry building shall be designed separately to facilitate construction and save on construction cost.

However, land for the Nangka Station is owned by a private person, therefore, to reduce the area of land acquisition, water level gauge and telemetry building shall be combined at the same location. Further, the rainfall gauge shall be set on the roof of the telemetry building considering convenience of location and maintenance of the rainfall gauge station.

Grade and Scale of Building

Grade and scale of station building for this Project shall follow those of the existing building of the current EFCOS, as below:

Building volume	: 2.5m x 2.5m x 2.5m = 15.625 m^3
Floor area	: 2.5m x 2.5m = 6.25 m^2
Structure Grade	: Reinforced concrete
Building Scale	: 1 storey, Flat roof

2.3.2 Basic Design

(1) Equipment Plan

This section summarizes purposes, specifications, and quantity for the major equipment.

(a) Data Processing and Monitoring Systems

The online data processing equipment, a pivotal device of the data processing system and calculation equipment, will be installed at the Rosario Master Control Station. However, the data display equipment will be placed at the same station and at the other two master stations (DPWH Central Office and NCR Monitoring Station). It is pointed our that two (2) data processing servers are to be installed to provide the backup function in terms of failsafe. The specifications for the major equipment are listed in the following table.

Purposes, Specifications, and Quantity of Data Processing Equipment

Main equipment	Purpose	Specifications	Rosario Master Control Station	DPWH	NCR	Napindan	Total
1. Online data processing	Automation for water monitor-ing data (creating graphics and tables)	Year-round operation Intel Pentium III Hard disk capacity: 8GB, with display and UPS	2				2
2. Calculation	Flood forecasting computation	Intel Pentium III Hard disk capacity: 6GB, with display and UPS	1				1
3. Data display							
a. Data display device	Data display (graphs)	Plasma display: 50”	1	1	1		3
b. Data display control	Display control of graphs	Intel Pentium III Hard disk capacity: 6GB, with display and UPS	1	1	1		3
c. Color laser printer	For graphics	Dry electrophotography system	1	1	1		3
d. Laser printer	For tables and maintenance	Dry electrophotography system	1				1
4. Gate informa-tion input	Input for gate opening/closing information	Modem and interface conversion device	1			1	2

Major devices for the monitoring equipment are monitor control equipment for the telemeter system, a console, and telemeter data display board. Existing devices will be remodeled and deployed at the master stations. These devices are listed in the following table.

Purposes, Specifications, and Quantity of Monitor Equipment

Main equipment	Purpose	Specification	Rosario Master Control Station	DPWH	NCR	Napindan	Pagasa	Total
Monitor control	Intercepting device for the telemeter system	Telemetry System Specification No. 21 of Ministry of Construction	1	1	1	1	1	5
Remodeled console	Calling operation of telemeter data	Telemetry System Specification No. 21 of Ministry of Construction	1					1
Data display board	Displaying telemeter data	Displaying add-on stations	1	1	1		1	4
Print record	Printing telemeter data	Displaying add-on stations (matrix)	1				1	2
GPS receiver	Synchronizing system clocks	GPS specifications		1	1	1	1	4

(b) Telemeter Equipment for Hydrological Observation

The new hydrological observation facilities consist of four (4) rainfall gauging stations, one (1) rainfall combined with water-level gauging station, and one (1) water-level gauging station. Main devices for the stations are listed in the following table. Since it is difficult to obtain auto-recording paper in the Philippines, the Study Team recommends that a data memory pack (IC card) should be used. For the new rainfall gauging station at the Napindan HCS Station, the existing radio equipment, antennas, and power devices can be used.

Purposes, Specifications, and Quantity of Equipment for New Hydrological Station

Main equipment	Purpose	Specification	Rainfall gauge St.	Combined St.	Water-level St.	Total
Hyetometer	Rainfall gauging	Upset Box type (1mm upset)	4	1		5
Water-level meter	Water-level gauging	Float type		1	1	2
Rainfall (water-level) monitoring	Real time data collection	Telemetry System Specification No. 21 of Ministry of Construction,	4	1	1	6
Data memory pack	Data recording	40MB, Durable not less than 3 months	4	1	1	6
Radio equipment, Antenna	Data transfer	400MHz band	3	1	1	5
Solar cells	Power unit	12V, 12W, 24W, 54.5W	3	1	1	5

The existing hydrological observation facilities consist of two (2) rainfall gauging stations and five (5) water level gauging stations. The main devices must be replaced since the telemeter specification has been changed to "Telemetry System Specification No. 21" of the Ministry of Construction, Japan. The following table presents the new devices to be obtained. In line with the frequency change, radio equipment and antennas must be replaced. However, radio equipment for the multiplex system and parabolic antennas can be used at the Rosario Master Control Station and the Napindan HCS Station.

Purposes, Specifications, and Quantity of Equipment for Existing Hydrological Station

Main equipment	Purpose	Specification	Rainfall gauge St.	Water-level St.	Total
Rainfall gauging (water-level) observation	Real time data collection	Telemetry System Specification No. 21 of Ministry of Construction	2	7	9
Data memory pack	Data recording	40MB, Durable not less than 3 months	2	9	11
Radio equipment, Antenna	Data transfer	400MHz band	2	5	7
Solar cells	Converting sun lights into electric energy	12V, 12W/24W/54.5W	2	5	7

In line with the construction of new telemeter stations, two (2) repeater stations will be necessary (PAGASA and Boso-Boso rainfall gauging stations). Boso-Boso rainfall gauging station may be a station with a simple antenna distributor, which does not need a repeater device.

It is pointed out that two (2) units of radio equipment will be necessary at PAGASA Repeater Station to provide the backup function based on "Telemetry System Specification No. 21" of the Ministry of Construction, Japan. The major devices for the repeater station are listed in the following table.

Purposes, Specifications, and Quantity of Equipment at Repeater Station

Main equipment	Purpose	Specification	Boso-Boso rainfall gauge St.	Pagasa	Total
Antenna, antenna distributor	Radio wave transmission	400MHz band	1		1
Antenna, antenna distributor	Radio wave transmission	400MHz band		1	1
Radio wave device	Data transmission/ reception	400MHz band		2	2

(c) Warning Equipment

Although the warning equipment well satisfies its functions, no product meeting the specification has been manufactured since 1993. In the light of this situation, "Discharge Warning System Specification No. 27" of the Ministry of Construction, Japan, must be adopted to build up the warning system to remove a drawback from maintenance and management of the system. The following table lists specifications for the major devices of the master station (Rosario Master Control Station) and substations (9 stations).

Purposes, Specifications, and Quantity of Warning Equipment

Equipment	Purpose	Specification	Parent Station	Child Station	Total
Warning control monitor	Remote control of a warning station	Warning System Specification No. 27 of the Ministry of Construction	1		1
Remodeled console	Warning operation		1		1
Radio device, antenna	Sending/receiving data and phone calls	400MHz band	1	8	9
Device at warning station	Siren, broadcast through microphone	Warning System Specification No. 27 of the Ministry of Construction	1	8	9

(d) Multiplex Radio Equipment

In connection with the frequency change of the multiplex radio system, it is mandatory to replace the radio equipment and antennas at the Rosario Master Control Station, other four master stations (DPWH Central Office, NCR, Napindan, PAGASA), and Antipolo Relay Station. At the DPWH Central Office, two (2) sets of radio equipment and antennas will be needed so as to secure two frequency bands of 7.5GHz and 22GHz. Two (2) and three (3) sets are necessary at PAGASA and Antipolo, respectively, owing to the direction of parabolic antennas.

The number of circuits must be increased since processed data (graphics) at the Rosario Master Control Station will be transferred to the DPWH Central Office and the NCR Monitoring Station via the Antipolo Relay Station. The number of circuits would also increase, provided PAGASA Monitoring station and DPWH Central Office have the exchange function of emergency radio communication. Thus, terminals that can carry out 30 channels of digital conversion at a time are necessary at DPWH Central Office, Rosario Master Control Station, NCR, PAGASA, and Antipolo. Especially, DPWH Central Office needs two (2) sets, while other stations need one (1) set each. Furthermore, at the Rosario Master Control Station, fifteen (15) telephone sets have been out of order because of lightning and they must be replaced. For the NCR Station, four (4) telephone sets will be provided. The major devices to be obtained are listed in the following table.

Purposes, Specifications, and Quantity of Multiplex Radio Equipment

Equipment	Purpose	Specification	QTY
Multiplex radio equipment (7.5GHz) antenna	Phone call Data transmission	Transmission capacity: 2Mb/s Parabolic antenna: 1.2m in diameter (separated from the radio equipment)	8
Multiplex radio equipment (22GHz) antenna	Phone call Data transmission	Transmission capacity: 2Mb/s Parabolic antenna: 1.2m in diameter (integral with the radio equipment)	2
Digital terminal	Converting analog voice signal to digital signal		6
Telephone set	Phone call for multiplex radio communication	Rosario Master Control Station: 15 NCR: 4	19

It is pointed out that DPWH Central Office and NCR will have emergency power supply units.

(e) Emergency Radio Equipment

Emergency radio equipment will be installed at Rosario Master Control Station, DPWH Central Office, NCR Main Office, Pumping Station (11 locations), NCR Engineering District Office (7 locations), local government unit (14 locations), OCD, MMDA, and LLDA. PAGASA has the repeater station function. The following table presents major devices.

Purposes, Specifications, and Quantity of Emergency Radio Equipment

Equipment	Purpose	Specification	QTY
Radio equipment antenna	Emergency communication	Broadcasting command function, 300MHz	38
Radio equipment for transfer	Radio equipment's transfer function	Broadcasting command function, 300MHz	1
Thunder resistant transformer	Prevention of damage by thunder	0.5kVA	38

(f) Equipment for Operation and Maintenance

The operation and maintenance equipment includes measuring instruments, vehicles (boats) for maintenance/warning, and spare parts. The following lists present purposes, specifications and quantity for each instrument and/or equipment.

The currently used maintenance/alarm vehicles (including a boat), obtained in 1992, have almost reached non-durable years.

Measuring Instruments

Measuring Instrument	Purpose	Specification	QTY
Radio equipment checker	Checking radio equipment operation	300MHz band	1
Telemeter checker	Checking telemeter operation	Warning System Specification No. 27 of Ministry of Construction	1
Signal generator, Modem checker, Frequency shifter, Frequency counter, Power meter	Test and maintenance of multiplex radio circuits	For 7.5GHz band For 22GHz band	1 set

Equipment for Maintenance and Alarm

Equipment	Purpose	Specification	QTY
Patrol car (4WD)	For system checkup for maintenance and emergency alarm at flood time	Having a radio set, siren, loud speaker Diesel engine with 3L turbo, 4-cylinder OHC, 2892cc, 5-speed manual shift	2
Hovercraft	For system checkup for maintenance	Having a radio set, 1900cc, 4-sheet boat	1

Spare parts must be prepared in consideration of the following conditions. They are listed in the table below.

- Office supplies that cannot be available locally, such as recording paper and data memory pack.
- Spare units to be replaced most frequently in the existing EFCOS system or in light of similar systems in Japan.
- Units required for the pivotal part of the system

Spare Parts

Spare units	Purpose	Specification	QTY
Spare units for data processing system	System maintenance and checkup	A set of replacing units for a server	1 set
Spare units for telemeter system	System maintenance and checkup	PCB, sensor, solar cell power unit	1 set
Spare units for alarm system	System maintenance and checkup		1 set
Spare units for multiplex radio system	System maintenance and checkup		1 set
Spare units for emergency radio system	System maintenance and checkup	A set of units for repeater station, Radio set	1 set

(2) Data Processing System

The hardware system configuration, which consists of data processing equipment and monitor equipment and described in the previous material plan, is shown in Figure 2-14. The software configuration is described in the following section and presented in Figure 2-15. The operating system (OS) shall be Windows NT.

(a) Online Processing Subsystem

The following functions are necessary for the online processing subsystems:

(i) This subsystem automatically collects and processes information on the telemeter system, Rosario Weir, and NHCS Gate operations. It also computes rainfall in 10, 15 and 30 minutes, 1 hour, and accumulative rainfall and converts the water level to the discharge. In addition, it has an automatic computing function for their statistical data, such as minimum, average and maximum in day, month, and year.

(ii) This subsystem accumulates processed data into three kinds of database files and automatically renews the database when new data are collected.

(iii) This subsystem reads data in a memory pack in which raw observed rainfall or water level data are stored as a backup of the telemetry system and compensates/corrects missing data in the basic database.

(iv) This subsystem works out reports (daily, monthly, annual reports and operation logs) based on the processed data and sends them to laser printer.

Data to be Collected

Data	Nos. Data	Collection Frequency	Information
Rainfall	7	Usually, the data collection interval is every hour. The interval can be changed to every 10, 15, or 30 minutes.	• Time of observation: year, month, day, hour, minute. • Total rainfall from the previous observation.
Water-level	11	Usually, the data-collecting interval is every hour. The interval can be changed to every 10, 15, or 30 minutes.	• Time of observation: year, month, day, hour, minute. • Total rainfall from the previous observation.
Gate information* (Rosario weir: 8 gates, Napindan weir: 4 gates)	12	At gate operation	• Time of gate operation: year, month, day, hour, minute. • Status after operation

* There are two states for the gates of Rosario Weir: full open and half open. On the other hand, there are four states for the gates of Napindan Weir: full open, pause hook open, pause hook closed and full closed.

Database Files

Database	Data Amount	Accumulated Data
Basic data	Data for 2 years	• Observed values of rainfall and water level. • Computed rainfall (10 minutes, 1 hour, and accumulated value) • Computed water level (above sea level, DPWH standard). • Statistic information (day/month/year, maximum/average/minimum)
Gate information	100 items	• Time of gate operation: year, month, day, hour, minute • Status after operation
Flood forecasting (Data exchange)	240 hours (10 days)	• Rainfall • Computed water level (DPWH standard) • Computed flow rate

(b) Data Display Subsystem

The data display subsystem is to offer in real time hydrological information (rainfall, water level, flow rate), gate information, and flood forecasting information, which have been processed, in user-friendly visual image. The information is to be presented in the home page of the intranet connecting the Rosario Master Control Station, DPWH Central Office, and NCR Monitoring Station. Part of this information will be transferred to RIMS in the DPWH Central Office.

Information to be Displayed

Item	Information	Receiving Station *
Status diagram at present 1	The river basin diagram shows up-to-date water level and rainfall.	DPWH Central Office, NCR RIMS
Status diagram at present 2	The schematic diagram shows up-to-date water level and rainfall.	DPWH Central Office, NCR RIMS
Graph	The graph displays the last 24-hour status on rainfall, water level, discharge, and gates.	DPWH Central Office, NCR RIMS
Gate information	This information displays the latest gate status, water level, and flow rate.	DPWH Central Office, NCR
Flood forecasting	This displays the latest flood forecasting information (water level graphs at every water level observation station).	DPWH Central Office, NCR

* Information transmitted to each Station will be decided through discussions with the Philippine side in the course of project implementation.

(c) Flood Forecasting Subsystem

Data processing equipment as shown in Figure 2-14 will be used mainly for flood forecasting. The forecasting can also be done with the data display computer, which is a backup computer for the data processing equipment.

Specifications of Flood-Forecasting-Computing Model

The basic specifications for the flood forecasting-computing model are as follows:

- The model covers the Pasig Marikina River basin (634 km^2) including Napindan Floodway and Mangahan Floodway (not including the Laguna Lake basin) to forecast water levels in the following river sections.

Sections Subject to Water-level Forecasting

River	Downstream	Upstream	Length (km)
Pasig-Marikina R.	Estuary	Montalban	45.7
San Juan R.	Pasig River	Quezon Avenue	5.6
Mangahan Floodway	Laguna Lake	Marikina River	8.8
Napindan Channel	Laguna Lake	Pasig River	8.2

- The estimated time must be up to six (6) hours.

- Observed rainfall, water level, flow rate and gate information to the present time are read from the database in the server.

- The applied model (runoff model) is used for runoff analysis, where one of the three patterns can be selected for estimated rainfall: (1) the rain stops, (2) the rain of present rate continues, and (3) manual input.

- Flood routing will be made through an one-dimensional-dynamic-flow-computation. Data at Fort Santiago and Laguna Lake are used as the boundary condition; the sea level is used in a forecasting period, which is estimated from an actually measured water level at the Fort Santiago observatory station. The estimated water level at Laguna Lake can be selected from one of the three patterns: (1) the current water level continues, (2) the current water level trend continues, and (3) manual input.

- Gate operation will be incorporated into the flood routing. The gate operation can be selected from one of the three patterns: (1) the current state continues, (2) operation based on the operation rules, and (3) manual input.

- Computed result can be modified or updated with actually measured data.

- A graph for the estimated water level at a water-level observatory station can be converted into a GIF file and transferred to the home page in the server.

- To save time, first computing conditions (an estimated rainfall, an estimated water level of Laguna Lake, gate operations) will be established, and then the process from data reading to forecasting computation will be automated.

<u>Necessary Modules</u>

The following modules are necessary to meet the requirements of this subsystem. The flood forecasting system will be established with these modules combined or expanded (customized).

Necessary MIKE11 Modules

Module	Function
Flood Watch (FW)	Data input, processing, and display
Rainfall Runoff (RR)	Runoff analysis
Hydraulic Dynamics (HD)	One-dimensional-arbitrary-flow-computing
Structure Operation (SO)	Gate operation computing
Flood Forecasting (FF)	Flood forecasting processing
ArcView*	GIS analysis for flood
ArcView Spatial Analyst*	Mapping

* GIS software of ESRI Co.

(3) Basic Design for Facilities

(a) Design Standard and Manuals

Design of facilities such as rainfall gauging station, water level gauging station, retaining wall and drainage shall follow Philippine standards in principle. However, if no applicable standards are found, those of US or Japan shall be used. The following may be applicable to the design standard for this Project.

- Japan Architectural Standard, Japan Architectural Authority

- River Erosion Control and Torrential Improvement Standard, Japan River Authority

- River Control Facilities Design Standard, Japan River Authority

- National Structural Code of the Philippines, Volume 1, 4th Edition, ASEP
- The National Building Code of the Philippines and Its Implementing Rules and Regulations, PLG
- Structural Design Data and Specifications, A. B. Carrillo
- American Society for Testing Materials (ASTM)
- Philippine National Standard, PNS

(b) Location Plan

In accordance with the site survey, the most appropriate location plan for each station site shall be determined considering hydrological, topographical and geological aspects and also the results of radio wave propagation test. These plans are shown in Figure 2-16 to Figure 2-22.

(c) Construction Plan

Basic design drawing for each station shall be as described below:

<u>Rainfall Gauging Station (Aries, Mt. Campana, Science Garden)</u>

In accordance with the results of the site survey, there are no particular differences among these three stations. Therefore, basically, the same design shall be applied. Basic design drawings of these three (3) stations are shown in Figure 2-23.

<u>Water Level Gauging Station (San Juan)</u>

This station is to be located in the elementary school compound owned by DECS near the San Juan River. In accordance with the boring data, surface layer of about 80 cm shall be replaced with appropriate materials during the construction period to secure enough bearing strength on the ground. Therefore, telemetry building and water level gauge observation well shall be designed separately. Diameter of observation well shall be wide enough to allow cleaning inside by manual labor. Basic design drawings of this station are shown in Figure 2-24.

<u>Water Level Gauging Station (Nangka)</u>

This station is to be located at the right-bank side, which is owned by a private person, downstream of Nangka Bridge. Therefore, telemetry building and water level gauging station shall be a combined structure to minimize the area required. Basic design drawings of this station are shown in Figure 2-25.

In determining the location of this station, the conditions below need to be considered:

- Further expansion plan of the road including Nangka Bridge (6 m wide from the existing bridge).

- Effect of existing bridge against new water level gauge (20m distance from the existing bridge).

Summary of basic design for rainfall gauging station and water level gauging station are shown in the table below.

Summary of Design for Gauging Stations

Station name	Volume & Floor area	Structure type	Scale	Water level gauge
Aries (R.F.G.) Mt. Campana (R.F.G.) Sc. Garden (R.F.G.)	2.5×2.5×2.5=15.625m^3 Floor area: 6.25m^2	Reinforced concrete and concrete block wall	1 F, Flat roof	
San Juan (W.L.G)	ditto	ditto	ditto	Plain concrete 900mm dia.
Nangka (W.L. & R.F.G.)	ditto	ditto	ditto	Reinforced concrete 900mm dia.

*R.F.G.: Rain fall gauge station, W.L.G.: Water level gauge station

NCR Antenna Tower

A new antenna tower, 35m high, shall be provided to link DPWH to NCR by a multiplex system. The area for this tower is not wide enough for an ordinary size of tower; therefore, self-support triangulate typed tower has to be adopted to minimize the area required. Further, the foundation has to be designed as spread foundation on hard layer in N-value 15 to prevent the tower from settlement. Basic standard drawing of this tower is shown in Figure 2-26.

Riverbank Protection Wall and Drainage Structure in Nangka

For construction of water level gauging station and telemetry building, riverbank protection wall and drainage structure are required to protect these facilities and the land itself from erosion caused by flood. Riverbank protection wall has to be designed as a concrete structure that has enough strength against back soil pressure and should be embedded at 2m deep from the riverbed level. Drainage structure has to be designed as a reinforced concrete structure following the existing drainage design.

(i) Riverbank Protection Wall

Type: Supported type retaining wall

Structure Grade: Concrete structure

(ii) Drainage Structure

Type: Open type drainage with strut

Structure Grade: Reinforced concrete structure

Standard drawings of these structures are shown in Figure 2-27.

(d) Finishing Plan

Finishing of telemetry building has to have the same quality as that of the existing building of the current EFCOS. The finishing plan has to be as follows:

Roof: waterproof mortar finish with grade

Interior wall: cement mortar finish

Exterior wall: cement mortar finish

Ceiling: exposed concrete

Floor: cement mortar finish

Steel fence: galvanized

(e) Material Procurement Plan

Materials for the construction of facilities have to be procured from the countries mentioned below:

Gravel: Philippines

Ready-Mix Concrete: Philippines

Reinforcement Steel: Philippines

Mortar: Philippines

Concrete Block: Philippines

Steel Members of Antenna Tower in NCR: Japan

CHAPTER 3. IMPLEMENTATION PLAN

3.1 Implementation Plan

The issues to be clarified and taken into consideration so as to implement the Project under the Japan's Grant Aid Program are as presented below.

3.1.1 Implementation Concept

The implementing agency for the Project is the Project Management Office-Major Flood Control and Drainage Projects (PMO-MFCDP), Department of Public Works and Highways (DPWH), which is in charge of flood control projects throughout the country. The Effective Flood Control Operation System Office (EFCOS Office) under the National Capital Region (NCR), however, will be in charge of operation and maintenance after provision of the equipment and systems by Japan's grant aid. The structural organizations of DPWH, NCR and EFCOS are shown in Figures 2-28 to Figure-30 respectively.

After the ratification of the Exchange of Notes (E/N) between the Government of Japan and the Government of the Philippines, DPWH has to enter into a contract with a Japanese Consultant for the tender administration and construction supervision of the Project. The Consultant will provide the necessary consulting services for the effective duration of the contract between the Government of the Philippines (DPWH) and the successful Tenderer/Contractor who will be declared in a fair and legal tendering process.

The contract with the Contractor for the Project has to be awarded to a qualified Japanese firm with a local office and/or a subsidiary or agent at the project area in the Philippines. As to the procurement/provision of equipment, the Contractor has to have enough experience in this field.

The Project consists of the provision of equipment, as well as civil works that occupy a small fraction of the whole project and hence, sophisticated technology is not required and local contractor(s) can be employed. With regard to equipment procurement, it should be properly provided for the improvement of the existing telecommunication systems and data processing by computers. Hence, it may be necessary to dispatch Japanese experts/engineers to the Philippines for the equipment installation and adjustment, because special skills are needed for these work processes.

In addition, technical guidance services need to be provided to the local government counterparts after the equipment has been properly installed, with a view to upgrading their technical capability on operation and maintenance of the whole system.

3.1.2 Implementation Conditions

Based on the implementation concept presented above, the following conditions should be fully considered for the smooth implementation of the Project.

(1) Agreement of ICC

For the smooth implementation of the Project, it is imperative to obtain the prior agreement of ICC (Investment Coordination Committee) under NEDA (National Economic and Development Agency), Government of the Philippines.

(2) Environmental Compliance Certificate (ECC)

The results of the mandatory IEE (Initial Environmental Examination) study should be submitted to DENR to obtain ECC before the implementation of the Project.

(3) Arrangement of Responsible Personnel for Operation and Maintenance of Data Processing System

DPWH as well as NCR and EFCOS offices should arrange responsible personnel and clarify guidelines/rules for operation/maintenance of the computer-assisted data processing system.

(4) Land Acquisition

Regarding the project sites at Nangka, Aries and Mt. Campana, the required land should be acquired from the owners beforehand and land ownership need to be relinquished officially to DPWH.

(5) Preparation of Access Road (Before and During Construction)

The access roads to the rainfall gauging stations at Mt. Campana and Aries should be assured, because there are no alternative access roads to these sites.

(6) Removal of Collapsed Bridge

The collapsed bridge located at the right-bank in the downstream section from Nangka Bridge (approx. 40m away from the bridge) should be removed.

(7) Construction at the Elementary School Ground

The impact of construction as well as safety measures for school children should be taken into consideration during the construction of San Juan water level gauging station.

(8) Waterproofing Works

At San Juan water level gauging station, waterproofing works should be properly carried out as a temporary measure because it is necessary to make a hole on the existing wall.

3.1.3 Scope of Work

The work shall begin with the tender administration (preparation of tender documents, tendering, contracting) and will include equipment supply, civil works, and operation and maintenance services. The scope of work of both the Japanese side and the Philippine side is summarized as follows:

(1) Undertaking of the Government of Japan

(a) Engineering services including preparation of tender documents, tendering and construction supervision of the works.

(b) Procurement of equipment and materials (including shipment by sea, but excluding storage at port of disembarkation in the Philippines and inland transportation).

(c) Equipment installation and civil works (except the preparation of access roads and removal of obstacles from project sites).

(d) Test run and O/M guideline services for the system and equipment

(e) Technical guidance services with respect to management and operation of the system procured under the Project (Soft Component).

(2) Undertaking of the Government of the Philippines

(a) Land acquisition, land leveling and fencing of the site for the construction/installation of facilities.

(b) Administrative support to implement the Project smoothly and efficiently such as tax exemption, smooth procedures for customs clearance, provision of various documentation, etc.

(c) Rehabilitation of access road to the project site and removal of collapsed bridge from the site.

(d) Institutional arrangement for personnel, financing, and proper operation/maintenance to make the system effective, functional and sustainable.

(e) Smooth procedures for immigration, tax exemption and safety assurance during the stay in the Philippines of Japanese experts assigned to the Project.

3.1.4 Consultant's Supervision

(1) Supervision of the Works

The Consultant will provide construction supervision services to ensure the proper time scheduling and quality control of the work to be executed by the Contractor. Long-term and short-term stay engineers, who have various technical backgrounds in each of the required works, are to be assigned to the Project as supervisors. The supervisors will play the important role of inspecting the quality of equipment, materials, construction works and even the smooth functioning of systems installed. Since various offices and agencies are involved in this project, the supervisors will be required to keep in touch with them as coordinators. From the above considerations the level and number of supervisors will be determined according to the work content and volume. The major tasks of the supervisors are as follows:

(a) Meeting and discussion with the project implementing agency and the other institutions concerned of the Government of the Philippines.

(b) Field survey management

(c) Control of work progress

(d) Quality control of construction materials

(e) Inspection of equipment, materials and construction works

(f) Issuance of certificates as described in the contract

(g) Submission of reports, documents, etc.

(2) Main Issues to be Considered

From the above considerations, particular attention needs to be paid to the following:

(a) Prior to the commencement of the work, a meeting has to be held with the Philippine counterparts to confirm the progress of the work that should be undertaken by the Philippine side.

(b) Field survey management shall include checking and confirmation of control points, bench marks and site boundaries.

(c) Control of work progress shall be made with confirmation of the following items:

(i) Work schedule

(ii) Quality control

(iii) Work progress rate

(iv) Photographs taken at each progress stage of invisible sections after the completion of work and also for disasters which may occur during implementation.

(d) Quality control of equipment shall be made on the basis of data on quality guarantee provided by the manufacturer(s).

(e) Inspection shall be carried out for the following cases:

   (i) To confirm works for the approval of interim payment

   (ii) To indicate works to be restored before the completion

   (iii) To make procedures for the approval of completion of works

(f) Certificate shall be issued to the Contractor for the payment, completion of works and termination of guarantee period.

(g) Monthly report, as-built drawings and photographs of the work shall be submitted to the Government of the Philippines and JICA. Furthermore, work completion report shall be addressed to JICA.

(3) Engineers for the Supervision Services

The Project would consist of facilities construction and equipment supply that will take four (4) and six (6) months, respectively. It includes the installation work for the telemetry system and radio equipment. In addition, at the latter half of the installation work, system establishment of the equipment and inspection of the flood forecasting model will be made to facilitate the technical guidance services as a soft component. Accordingly, engineers will be assigned from time to time with full consideration on their suitability for each work, and there is no plan to place a long-term supervisor throughout the project period.

The number of engineers who will provide the supervision services, and their assignment periods are described below.

(a) Team Leader

The Team Leader is to be dispatched to the project site for the meeting and negotiations with the Client or the Contractor in the preparatory stage, at the commencement and completion of major works, and also at the completion of the whole project.

(b) Telecommunication Engineer A

The major tasks in Japan of Telecommunication Engineer A are as follows:

   (i) To give directions to the equipment manufacturer(s) before production.

   (ii) To confirm and approve equipment drawings.

   (iii) To inspect the equipment during and at the completion of production.

In addition, Telecommunication Engineer A will be dispatched to the project site as a spot service engineer to support Telecommunication

Engineer B in the inspection of installation works for the telecommunication equipment.

(c) Telecommunication Engineer B

Telecommunication engineer B is to supervise the installation work for telecommunication equipment and will stay in the Philippines until the work is properly done. In addition, he is tasked to inspect the equipment or system after one (1) year from the completion of the works to assure operation and management conditions.

(d) Civil Engineer

The Civil Engineer will be assigned, as a supervisor of the civil works, to stay in the Philippines for as long as the construction work of facilities continues.

(e) Hydrologist

The hydrologist will be tasked to supervise the development of computer program for the flood forecasting model and system. Upon the completion of the model development, he will be assigned for one (1) month in Japan and another one (1) month for the test run in the Philippines.

3.1.5 Procurement Plan

(1) Basic Plan for the Procurement of Equipment and Materials

(a) Telecommunication Equipment

The telemetry and warning systems, major components of this project, shall conform to the telecommunication standards 21 and 27 established by the Ministry of Construction, Japan. The multiplex radio systems shall conform to the worldwide standard of ITU-T and ITU-R. The telemetry and multiplex radio systems are to function as one unit system because a part of telemetry data will be transmitted by way of the multiplex radio wave circuit.

On the other hand, the standard specification of the emergency radio system is the worldwide standard MPT1327 and MPT1343 communication protocol. The emergency radio system and multiplex radio system can be considered as a single integrated system because these two radio wave networks can be accessed and extended to the existing PAGASA-DPWH transmission networks, which cover the whole area of Luzon Island.

From the above considerations it is important to note that major equipment of the telecommunication system can be procured from a Japanese manufacturer who is well versed in the telecommunication standard of the Ministry of Construction, Japan. In this regard, the following should be taken into account for the system establishment: (i) integration of telemetry, multiplex radio and emergency radio systems; (ii) easy approach to upgrade the existing system; and (iii) operation and management capability of the implementing agency.

There are five (5) manufacturers in Japan with experience in the supply of telemetry and warning systems in accordance with the telecommunication standards of the Ministry of Construction, Japan, and multiplex radio or emergency radio systems for disaster control. Among them, there are three (3) manufacturers with experience in a similar equipment supply in the Philippines. Each of them has a branch office and/or subsidiary in the Philippines. Therefore, it would be more convenient to the implementing agency in terms of operation and maintenance services.

On the other hand, the core fields of data processing in this project, such as the development of online data processing (automatic data input and drawings) as well as computing operation process (flood forecasting), will be implemented by various experts such as the hydrologist, computer system engineer and programmer. The special expertise on flood forecasting is also required in this connection. The development of such a system should be executed in Japan, as it is necessary to use real computer system to be procured for the development.

Data processing is done with the employment of data processing server and personal computers. Although it is preferable that the personal computers (English version) are procured in the Philippines, the data processing server (English version) should be imported from a third country.

Since the computer operating system is Windows NT, the required system can be developed using personal computers (Japanese version) and the data processing server (English version) procured in Japan. Hence, the data processing server (English version) will be imported from Japan, while the personal computers and other appurtenant equipment (printer, emergency power supply, etc.) will be procured in the Philippines.

(b) Telecommunication Materials

Electric wires and their installation metals are mainly imported in the Philippines and usually there are not enough stocks. Therefore, uncertainties arise as to supply for the considerable amount of orders and as to shipment on time. If materials are procured in the Philippines, it might be possible to find out some products of poor quality or lower durability. For instance, the cover of electric wire such as coaxial cable, etc. is made of vinyl in the Philippines instead of polyethylene in Japan. Moreover, the installation metal is easily deformed and the quality of electric wire tube is sometimes found to be inferior because of the irregular projection inside that may cause serious damage to the electric wire itself.

From the above considerations, wires, electric wire tubes and installation metals shall be, in principle, procured in Japan to ensure the availability and shipment regardless of quantity.

The 35-meter high tower to be constructed at the DPWH-NCR compound should be less than 2m in bottom width due to land space limitation. In the Philippines, there is no supply record of such a type of tower. Also, the quality of melting zinc coating is too poor to cope with the specification and standard required. This fact would lead to the increment of cost for operation and maintenance. To avoid the above-mentioned problems, the iron tower shall be of Japanese product to ensure quality.

In case of direct installation of iron pole for antenna to the ground, the panzermast (5 to 10m in height) can be adopted to satisfy such requirements as the efficient utilization of small land, shallow depth of the underground basement and easy installation. Also, in case of installation of iron pole on the roof of existing building, the dependent antenna pole (5 to 10m in height) will be used for securing a large space available for the installation.

Since the panzermast is manufactured in Japan, it will be certainly imported from Japan. Although the antenna pole is available in the Philippines, it will be, however, supplied from Japan to ensure a better quality and uniformity of the melting zinc coating.

(c) Construction Materials

Basically, the construction materials for the telemetry station, river embankment, etc. shall be supplied in the Philippines.

(2) Procurement of Equipment and Materials

The major equipment and materials that can be supplied in the Philippines are as follows. Other equipment and materials are basically supplied from Japan.

Major Equipment	Materials
Personal computers, liquid crystal display, emergency power supply kits and printers	Construction materials (except iron tower, iron poles and telecommunication materials)

(3) Shipment Route

The products to be supplied from Japan shall be shipped by sea from the Yokohama Port to the Manila Port. For the equipment, ground transportation is to be used from Manila Port to the Rosario Master Control Station where all equipment will be temporarily stored. Then, these will be delivered to each installation place according to the work schedule.

The Japanese products such as iron tower, iron poles, etc. are to be delivered from the Manila Port to the designated places as much as possible. If the spaces to store the products in related offices or institutions are too small, these can be sent to the Rosario Master Control Station and then delivered to the respective places based on the construction schedule.

The road networks from the Manila Port to the various destinations are shown in Figure 3-1.

(4) Repair and Maintenance Services

The damages of existing equipment and systems are mainly attributed to lightning and rainwater leakage in the DPWH head office. The pressure-type water level gauges have been broken by the navigation of ships, and some parts have been replaced after being stolen. All these consumable products, which cannot be made available in the Philippines, are to be supplied through the local office of the system supplier.

Since 1994, there have been approximately 40 times of parts replacement by the technicians in DPWH and local engineers specialized in the systems. So far Japanese experts have never repaired or replaced the parts except some technical advice over the phone.

Therefore, the procurement of parts for repairing this system can be made through the local office or subsidiary of the foreign supplier who is familiar with the system specifications. The local engineers will be able to repair this system if technical support is available from Japanese engineers through E-mail and phone calls. If it is hardly possible for local engineers to solve any problem, damaged parts of the equipment should be sent to the Japanese supplier for repair which should be sent back immediately after that to be replaced by the local engineers.

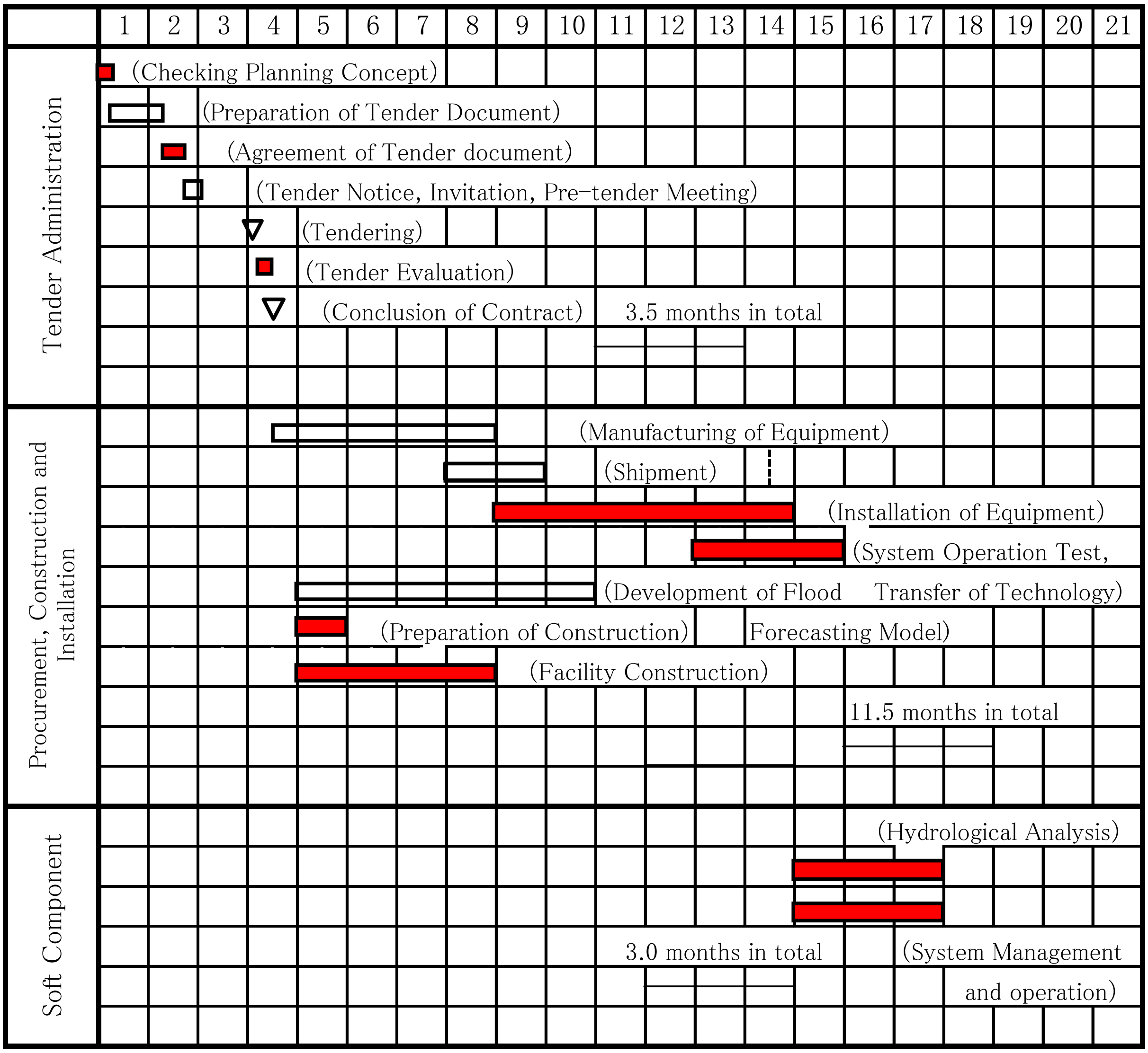
Consumable products that cannot be made available in the Philippines may be easily supplied through the local office or subsidiary of the Japanese supplier. With regard to the locally available equipment, it will be even easier to provide after-sales services such as provision of spare parts, repair and maintenance.

The developed program has to be backed up to avoid risk on software, and it can be re-installed in case of trouble on customized software or malfunction of flood forecasting model. However, this problem should be solved under the supplier's responsibility if defective in the developed software, so that it is suggested that DPWH make a contract with a software developer in security for the unexpected trouble after one-year guarantee period. A Japanese contractor is responsible for any defect during such a guarantee period.

It should be noted that the software is properly selected to cope with future version-up, and service availability should be taken into consideration if customization is needed again.

3.1.6 Implementation Schedule

This Project will be implemented under the Japan's Grant Aid after the Exchange of Notes (E/N) has been concluded between the Government of Japan and the Government of the Philippines. The total project period is estimated at seventeen (17) months including tender administration, supervision phase and soft component as shown below. For a smooth project implementation, it is necessary to avoid the rainy season (May to October) for the construction of facilities including river works.



3.2 Project Cost Estimation

For the smooth implementation of the Project, works previously described in Scope of Work have to be undertaken without delay. In this regard, the Government of the Philippines will bear the cost of 37.4 million pesos to complete the required work. The details are as follows:

	Work Item	Cost
(a)	Land acquisition, land leveling and fencing of the site	0.8 million pesos (2.3 million yen)
(b)	Access road improvement or rehabilitation	1.4 million pesos (3.9 million yen)
(c)	Removal of obstacles from the site	1.0 million pesos (2.8 million yen)
(d)	Customs duties and inland transportation	34.2 million pesos (96.1 million yen)
	Total Cost	37.4 million pesos (105.1 million yen)

Note: As of January 2000, one (1) Philippine peso is equivalent to 2.81 Japanese yen

3.3 Operation and Maintenance Costs

Operation and maintenance costs of Rosario Master Control Station (EFCOS Office) for the last five (5) years are presented in the table below.

(Unit: Million pesos)

Item	1994	1995	1996	1997	1998	Average
1. Office management	2.47	2.44	5.89	7.61	7.86	5.25
2. O/M for facility and equipment	1.53	2.02	3.09	2.78	2.19	2.32
a) Building and weir	1.53	0.35	1.17	1.28	0.64	0.99
b) EFCOS equipment	0.00	1.67	1.92	1.50	1.55	1.33
3. O/M for river channel	2.84	15.34	10.65	6.61	4.95	8.08
Total	6.84	19.80	19.63	17.00	15.00	15.65

If the system is improved through the Project, each constituent item of the operation and maintenance cost can be explained as follows:

(1) Office Management Cost

The increase of EFCOS personnel from 1994 to 1998 is presented below.

Year	1994	1995	1996	1997	1998
Nos. Staff	8	12	26	30	31

The same number of staff engaged in EFCOS office in 1998 will be sufficient to manage and operate the new system to be introduced under the Project. It will be, therefore, necessary to estimate about 7.8 million pesos, nearly the same amount as that of 1998 for the office management.

(2) Operation and Maintenance Cost for Building and Weir

The following tables present buildings and weirs currently under the control of the Rosario Master Control Station (EFCOS office) and also additional buildings to be constructed for the Project.

EFCOS-Controlled Buildings at Present

Item	Floor Space (m^2)
1. Rosario master control station and weir	950
2. Monitoring office in DPWH central office	160
3. Napindan monitoring station	74
4. Warning stations (8)	32
5. Telemetry stations (7)	44
6. Relay station	50
Total	1,311

Additional Buildings to be Controlled for the Project

Item	Floor Space (m^2)
1. NCR monitoring station	78
2. Telemetry stations (5)	31
Total	109

From the above table, it is noted that the buildings will increase by ten percent (10%) in terms of floor space from the present condition. In consequence, the operation and maintenance cost is estimated at 1.1 million pesos, which is corresponding to about 10 percent of increase over an annual average cost of 0.99 million pesos.

(3) Operation and Maintenance Cost for EFCOS Equipment

The number of stations will be increased according to the plan of installation of equipment for telemetry, flood warning, radio communication and data processing systems. The details are shown in the table below.

Number of EFCOS-Related Stations

Classification	Before Project	After Project	Remarks
Telemetry station	9	14	5 new stations added
Multiplex station, Relay station	5	6	NCR monitoring station included
Warning station	9	9	Including Rosario station
Emergency radio station	-	39	All newly established radio station

Operation and maintenance cost for equipment is mainly used for the purchase of computer-related materials, spare-parts and other consumables such as a record paper. It is also spent for the repair and replacement of damaged equipment due to rainwater leakage, lightning, navigation ship and theft. Same trouble may happen after completing the Project.

In view of the fact that the total number of stations for telemetry, multiplex and warning will increase to 29 accounting for nearly 30 percent up from the present case. Accordingly, O/M cost will increase by 30 percent from the average of the last five years, so that it will be jumped up to 1.7 million pesos from 1.33 million.

For emergency radio, on the other hand, an annual O/M cost is estimated at 0.4 million pesos assuming that 4 out of 39 units, that is to say about 10 % of the total units, need to be replaced due to the damage by water leakage, lightning and theft.

After one year of contractor’s liability, DPWH (EFCOS) will make a contract with a software developer to guarantee the function of flood forecasting model. The annual cost for this purpose will be 0.2 million pesos.

In consequence, the total cost for operation and maintenance of equipment is estimated to be 2.3 million pesos.

(4) Operation and Maintenance Cost for River Channel

This Project is not directly affected by the operation and maintenance for Mangahan floodway and Pasig River channel. However, the Rosario Master Control Station is in charge of dredging of such a river channel in dry season as part of its operation and maintenance activities. Therefore, it will be necessary to allocate about 8 million pesos, an amount equivalent to the average of last five years.

(5) Operation and Maintenance Cost for the Project

From the above discussion and analysis, it is estimated that the total amount required for the operation and maintenance is 19.2 million pesos (54 million yen). Judging from the approved budget from 1995 to 1998, this amount is reasonable and justifiable to be allocated for this Project.

Operation and Maintenance Cost

Item	O/M Cost (Million pesos)
1. Office management	7.8
2. Facility and equipment	3.4
a) Building and weir	1.1
b) EFCOS equipment	2.3
3. River channel (dredging)	8.0
Total	19.2

For the reference, the annual budget for operation and maintenance of the Rosario Master Control Station is presented below.

Budget for Operation and Maintenance (1994-2001)

(Unit: Million pesos)

Budget	1994	1995	1996	1997	1998	1999	2000	2001
1. Requested	7.20	23.00	25.00	20.00	20.00	20.00	25.00	30.00
2. Approved	7.20	18.70	19.50	20.00	20.00	-	-	-
3. Disbursed	6.84	19.80	19.63	17.00	15.00	-	-	-

CHAPTER 4. PROJECT EVALUATION AND RECOMMENDATION

4.1 Project Effect

The project aims at installing rainfall and water level stations in the Pasig-Marikina river basin for collecting a more accurate hydrological data and to strengthen the flood control system by improving or rehabilitating the existing facilities. The project is characterized as a non-structural flood control measure which has not been highlighted before; therefore, it is expected to play an important role in considering the future flood control strategy in Metro Manila.

The optimum project scale as well as the specification of equipment has been determined after due consideration on the operation and maintenance capability of the Philippine side. In this regard, special care has also been taken to properly coordinate with the present EFCOS system. Moreover, the project is designed to cope with even the present EFCOS situation in terms of budget and manpower. With regard to the overall system operation, it seems to be important to provide technical guidance services to the Philippine counterparts through a special technical supporting scheme under Japan's Grant Aid (so-called "Soft Component").

The project will contribute to the mitigation of flood damage to 1.9 million residents in approximately 63 km^2 of low-lying areas. However, the population benefiting indirectly from the project is estimated to be 9.5 million as the retrieval area covers the core of Metro Manila where a large number of the population are engaged in socioeconomic activities. The details of the impact upon completion of the project are as follows:

(1) With the expansion of the hydrological observation network and the establishment of on-line data processing system, a flood forecasting system will be introduced to facilitate the gate operation system of Rosario Weir. It will certainly help improve the function of the Mangahan Floodway to divert flood discharge to the Laguna Lake and will reduce the flood damage in the middle and lower basins of the Pasig-Marikina River as a result.

(2) The development of a flood forecasting system will contribute to the reduction of casualties and minimization of the loss of public and private properties if the emergency radio equipment is deployed in the Local Government Units (LGUs) and other related agencies in order to establish an information dissemination system as well as a warning system to the residents.

(3) Upon completion of the project, sanitary environment will be improved as an impact of flood mitigation that may reduce foul odor and wastes.

(4) The serious traffic congestion resulting from long-term inundation will be reduced, and it will lead to the revival of socioeconomic activities.

The flooding problem is considered as one of the major issues for public discussion nationwide. The President of the Republic of the Philippines called a meeting, so-called "Flood Summit" in July 1997, and cabinet members, mayors and representatives of other authorities concerned participated in the meeting to discuss effective measures against flooding. Therefore, public attention is drawn to the implementation of this project since it is expected to mitigate flood damage in Metro Manila.

Besides the project effects as mentioned above, the operation and maintenance plan seems to be reasonable and realistic under the present financial condition. Judging from the above considerations, it is significant for the project to be implemented under Japan's Grant Aid.

4.2 Recommendation

This Grant Aid Project is significant because it is expected to reduce flood damage to the people of Metro Manila and contribute to the minimization of negative impact on socioeconomic activities. In addition, it is confirmed that the Department of Public Works and Highways (DPWH) will make an adequate preparation for its operation and maintenance. However, for the smooth implementation of the project, it is recommended to confirm the following items at the earliest time possible:

(1) An official endorsement from the Investment Coordination Committee (ICC) concerning project implementation;

(2) Timely completion of the required works as an undertaking of the Government of the Philippines; and

(3) Land acquisition for the establishment of hydrological observation stations (rainfall and water level gauges).