2-7 Background and Contents of the Request

2-7-1 Background

In 1782, the capital of the Kingdom of Thailand was transferred to Bangkok which is on the delta at the mouth of the Chao Phraya River.

Bangkok, together with the reclamation of the great plain of the Chao Phraya River, has been developed as the center city for international trade and as the accumulation place for agricultural products, mainly rice.

Since 1960, the population increase and the expansion of the city area in Bangkok have been extraordinary. Bangkok is called the "Exploding City." It has been changing into a modern city befitting the capital of a modern country.

Modernization, however, has brought on flooding problems. During the past few years frequent urban-type floodings have occurred. It is said that the floodings resulted from the following human and social causes:

- Sudden land subsidence caused by ground water pumping.
- Decrease of discharge retarding and water storing capacities due to the conversion of farmland into housing lots.
- Instruction of outer water through canals (water from the Chao Phraya River or rice fields in the eastern areas).
- Insufficient flood protection facilities.
- Concentration of properties due to population concentration, expansion of the city area, and economic development.

The 1980 flood inundated a part of the city for more than two months. The 1983 flood inundated a part of the city for more than three months. The National Statistical Office estimated the flood damage to be 66 billion yen.

By making the 1983 flood the turning point, the Government of Thailand urgently established the "National Flood Prevention Committee" and implemented the Urgent Flood Prevention Project

with a budget of 13 billion yen. The project was based on the preliminary design study for the Urban Drainage Development Plan in Bangkok City that had been made previously by JICA.

The mainstays of the project were:

. Green belt plan (levee construction to prevent water intrusion from the rice fields in the eastern areas).
. Drainage capacity increase plan (nine pumping stations were planned to be constructed along the Chao Phraya River).

It was evaluated that the project would reduce flood damages by one-third of that caused by a flood having the same magnitude as the one that assaulted the area in 1983.

JICA proceeded with the design study for the Urban Drainage Development Plan in Bangkok City, made the master plan study and the plan's feasibility study, and proposed a comprehensive flood prevention plan. The proposal covers two aspects: one is the construction of inner polder levees, canal and drainage culvert improvement, etc.; the other is the establishment of non-structural measures, such as flood plain management, by reexamining the land use plan for maintaining the lands' discharge retarding capabilities, anti-flooding buildings, and the urban planning, and by announcing flood danger levels.

Currently in progress is the construction of the inner polder levees, gates, and pumping stations that were proposed in JICA's feasibility study, and the construction of the gates and pumping stations that were based on NEDECO's feasibility study of the City Core Project in Bangkok.

Including the existing facilities, there will be twenty (20) pumping stations and eleven (11) gates (excluding the auxiliary gates for pumping stations) that will be the major flood protection facilities after the above construction completion.

The management of flood and drainage data in Bangkok City is still performed by an off-line method, making it extremely

difficult to centrally manage the many flood protection facilities. Thus, the operations of these facilities are not efficient and gate opening and closing troubles occur due to insufficient data management.

Judging from the complexities of the natural conditions and the maintenance and management of each flood control facility, and from the problems related to the competency of various agencies, the present management system will encounter extreme difficulty in collecting accurate pertinent data and in making effective and efficient use of the flood protection facilities. For this reason, JICA strongly proposed in its feasibility study report to establish a new centralized management system.

The aim of the new centralized management system is to:

- Establish a Telemetering System to collect hydrologic data.
- Establish an observation system for pump and gate operations.
- Establish a management system of systematic, efficient flood protection facility operations.
- Improve the reliability of the data to be collected, and to analyze and make effective use of the data.

The idea for the Project originated when JICA emphasized the establishment of a flood control center in the study report for the Urban Drainage Development Plan in Bangkok City that was prepared during the 1983-1985 period. After that time, DDS made further investigations. Then, with the completion of the new BMA building in July of 1988, it became easier to secure the space necessary for the establishment of the Flood Control Center.

In August of 1987, the Government of Thailand requested grant aid cooperation from the Government of Japan for the Project to establish the Flood Control Center.

In response to the request, the Government of Japan conducted the preliminary study for the Project in March of 1988 and confirmed its propriety and worthiness.

Based on the preliminary study, the Study Team was dispatched to Thailand on June 6, 1988 to conduct the field surveys for the Basic Design Study on the Project for the Procurement of Equipment for the Flood Control Center in Bangkok and Its Vicinity.

2-7-2 Contents of the Request

1) Objectives

One objective of the request is to install precipitation, water level, and water quality observation stations at major flood protection and drainage facility locations in the Bangkok City core and in the eastern area on the left bank of the Chao Phraya River and to install monitoring stations for checking the operating conditions of the gates and pumping stations.

Another objective is to establish a master station in the new BMA building to centrally monitor the changes of precipitation, water levels, and water quality, and the operating conditions of the flood protection and drainage facilities in the Project, and to issue necessary operation orders to minimize flood damage and to keep canal water clean.

2) Requested Major Items

① Master Station (1 station)

. Central data processing equipment, data indicating equipment, signal processing equipment, uninterruptible alternating current power supply unit, system/application software, cables, etc.

② Monitor Stations (22 stations)

. Rain gauge installation at 22 locations, water level gauge installation at 44 locations, installation of one set of water quality measuring devices at locations yet to be decided upon, one set of facility

operations monitoring equipment (equipment details not yet decided upon), signal processing equipment, system/application software, cables, etc.

③ Sub-monitor Stations at RID and MD (2 stations)

. Signal processing equipment, system/application software, cables, etc.

④ Others

. One set of spare parts, test equipment and cables.

3) Project Implementation Agency

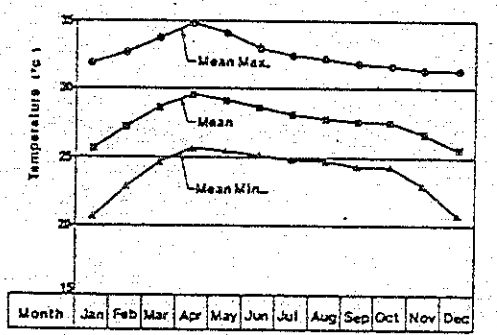
Project implementation will be undertaken by the Department of Drainage and Sewerage of BMA.

4) Project Area

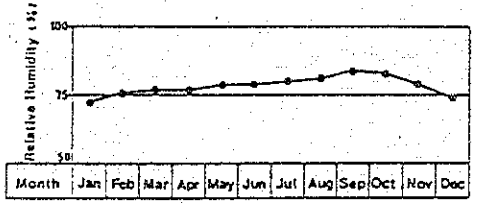
The Bangkok Metropolitan Administration area consists of 24 districts and covers and area of 1,596 km^2.

The Project Area covers eight districts in the City's core area and four districts that are east of the core area on the left bank of the Chao Phraya River. The Project Area is approximately 600 km^2.

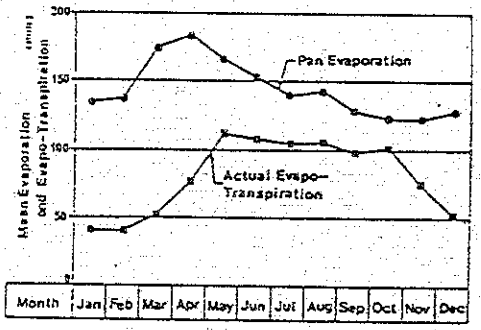
Fig. 2.1 Meteorology in Bangkok



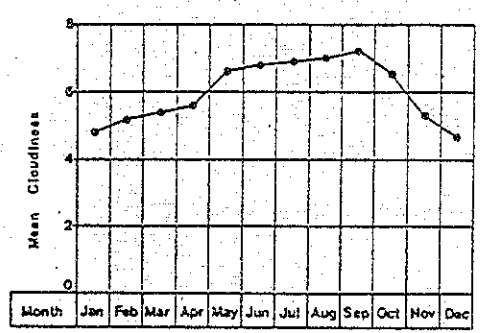
Temperature



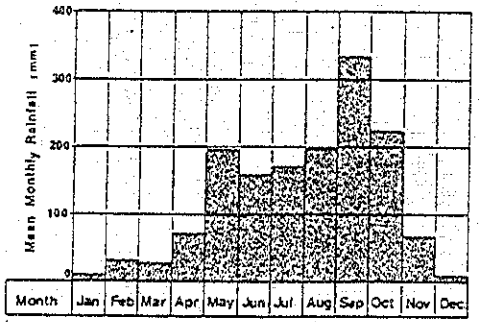
Humidity



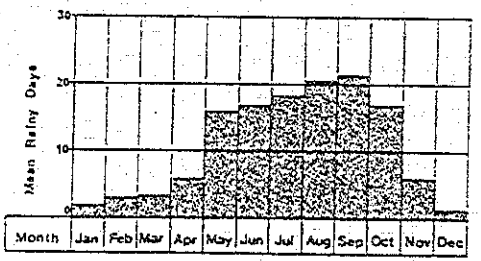
Evaporation and Evapotranspiration



Cloudines



Monthly Rainfall



Rainy Days

Note

1. Source

Evaporation: AIT, Rainfall and Evaporation Analysis of Thailand, 1980 12.

Evapotranspiration : NEB, Groundwater Resources in Bangkok Area Development and Management Study, 1982

Others: Meteorological Department

2. Period

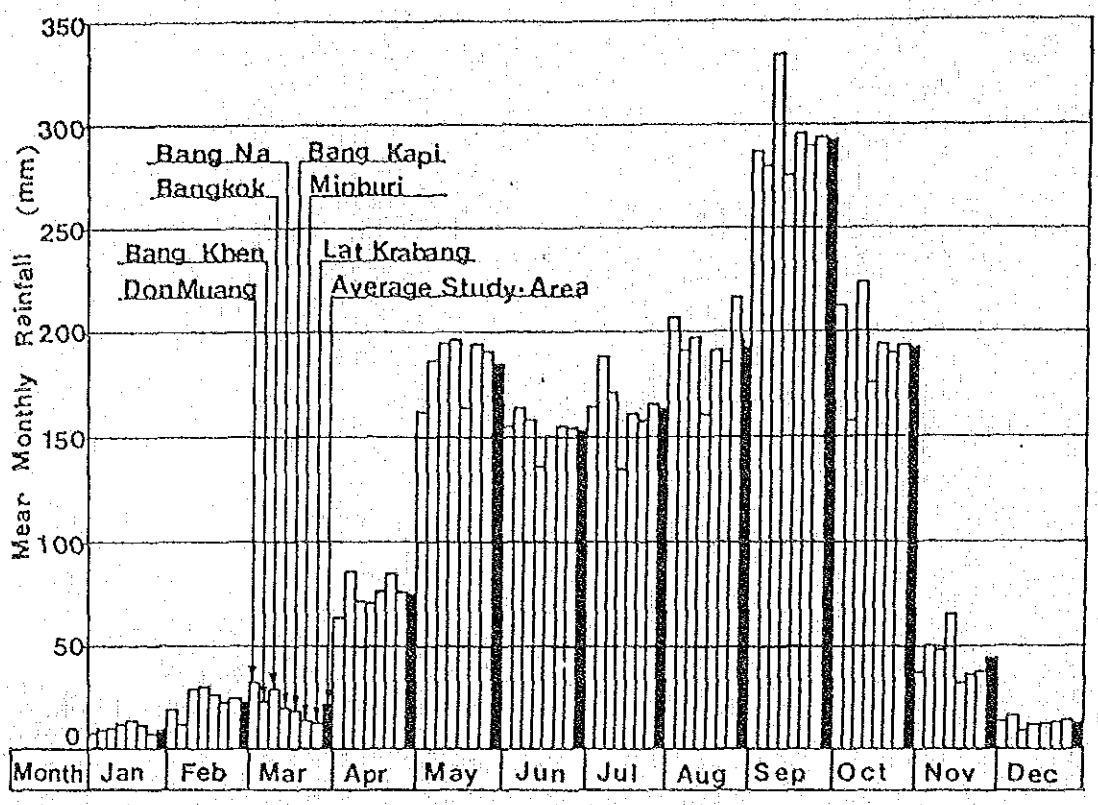
Evaporation: 17 years

Evapotranspiration : 1956 - 1974

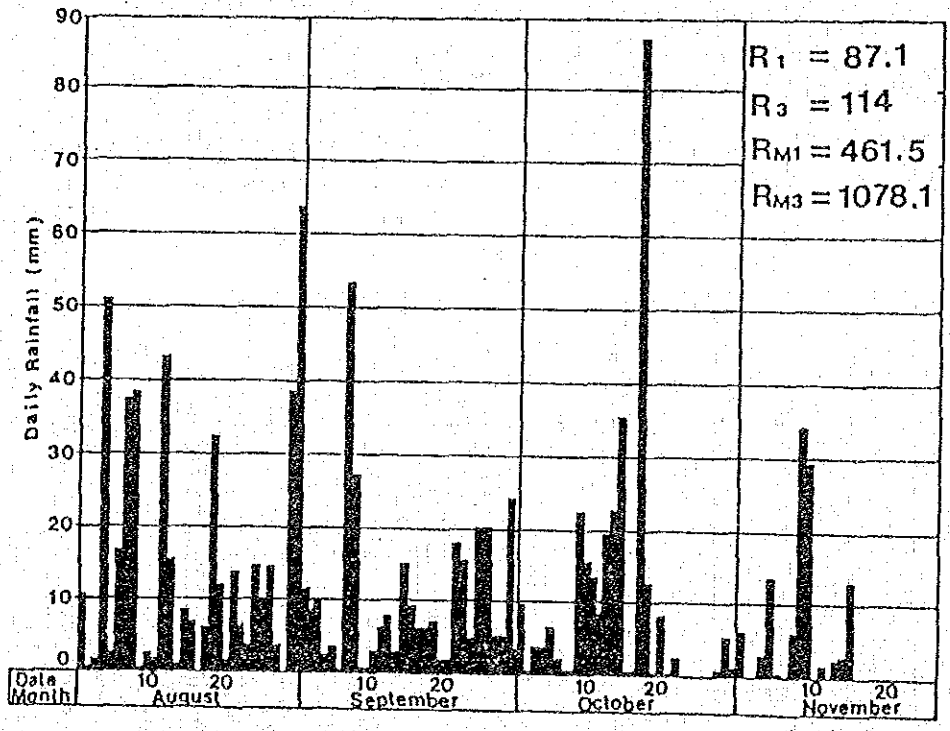
Rainfall and Rainy Days: 1951 - 1982

Others: 1951 - 1980

Fig. 2.2 1980 and 1983 Rainfall in Bangkok



AVERAGE POINT AND AREAL MONTHLY RAINFALL DURING PAST 30 YEARS



AVERAGE AREAL DAILY RAINFALL IN FLOOD SEASON IN 1983

Legend

R_1 : Maximum Daily Rainfall (mm)

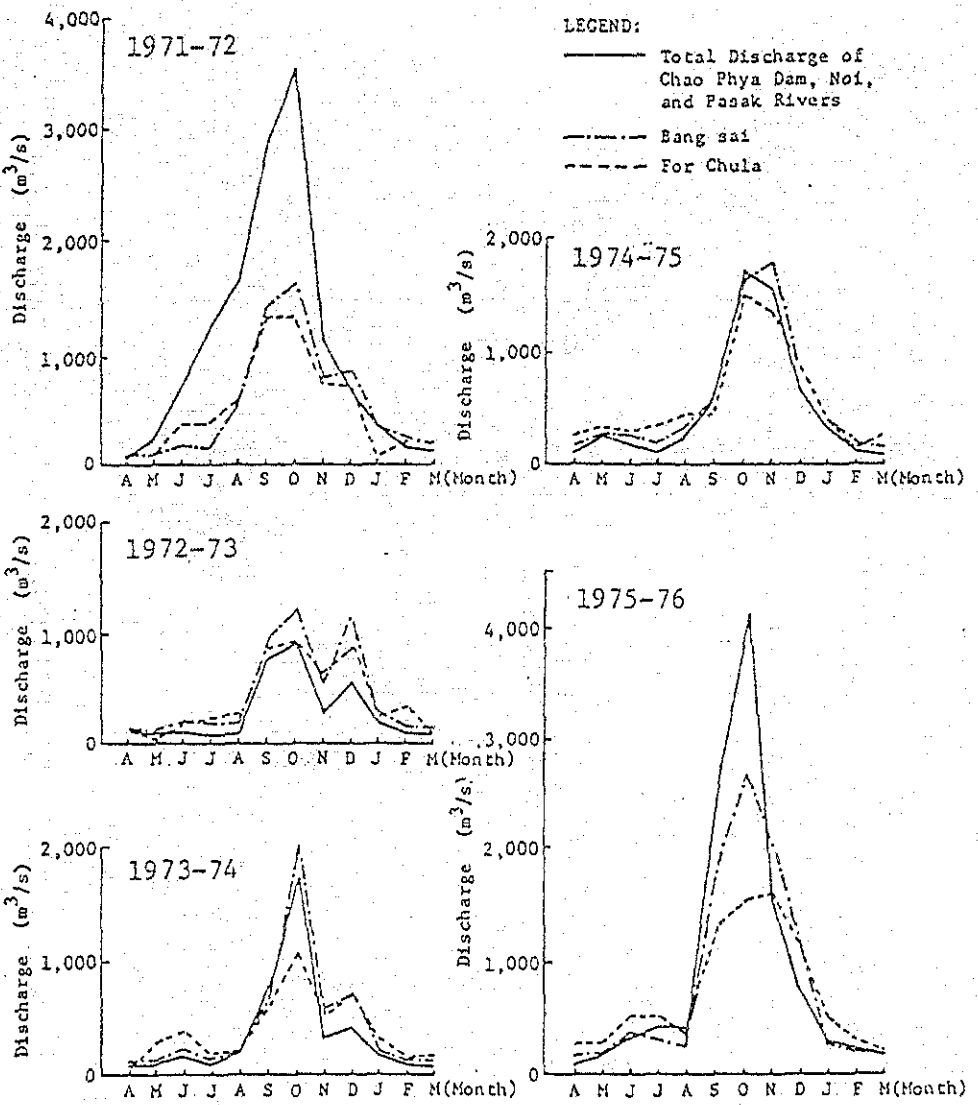
R_3 : Maximum 3-Day Rainfall (mm)

Rm_1 : Maximum Monthly Rainfall (mm)

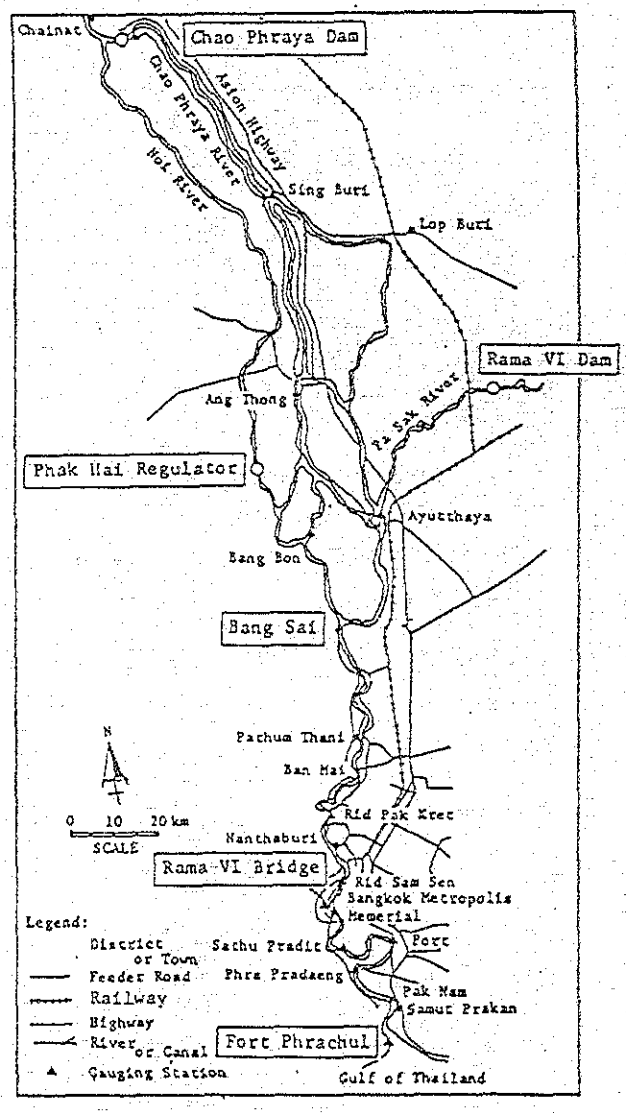
Rm_3 : Maximum 3-Month Rainfall (mm)

Source :Meteolorogical Department

Fig. 2.3 Discharge of the Chao Phraya river



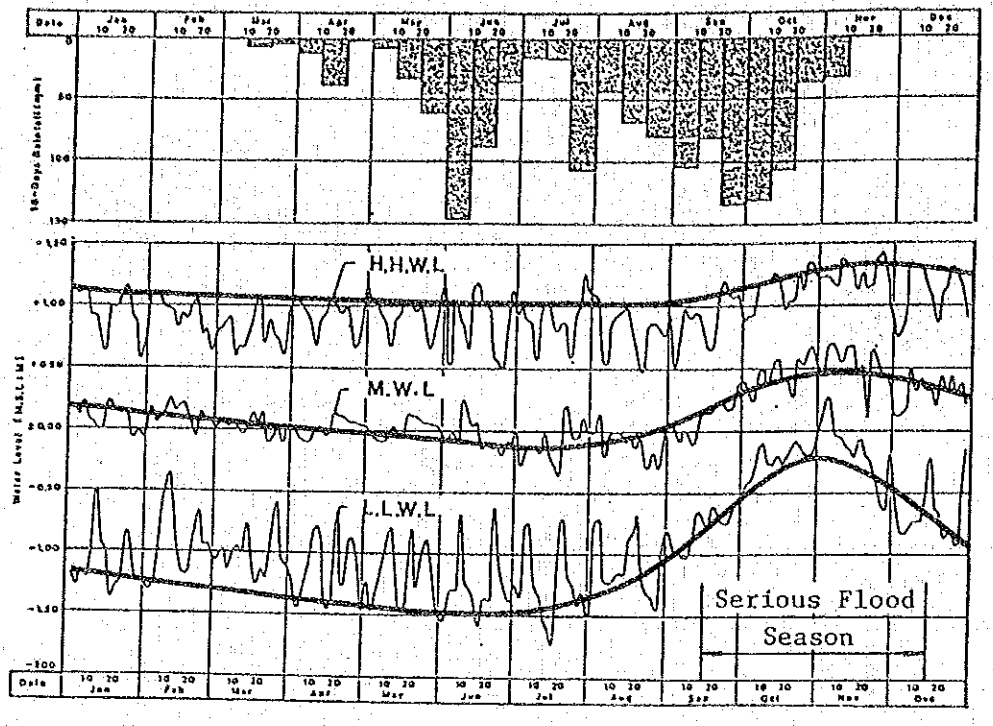
(1) Observed Discharge of the Chao Phraya River



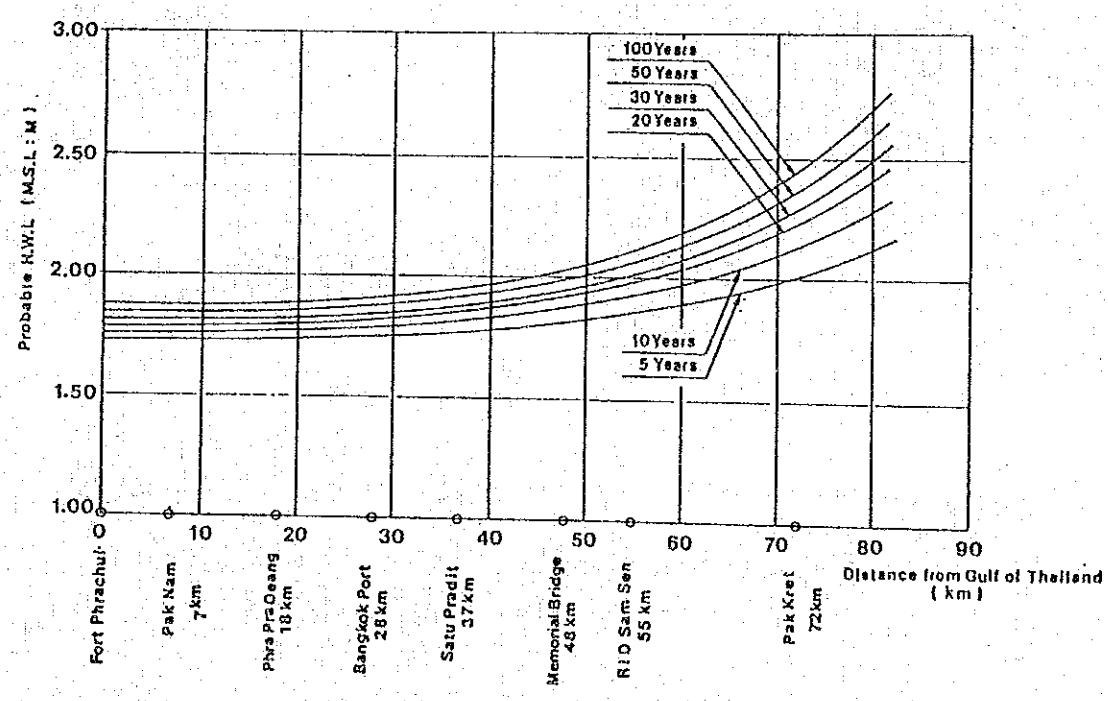
(2) Location of Gauging Stations along the Chao Phraya River at Its Tribu

Source: Salinity Inotrusion in the Chao Phraya River and Mae Klong Rivers March, 1978. AIT

Fig. 2.4 Water Level Changes and Probable Flood Water of the Chao Phraya River



SEASONAL CHANGES OF RAINFALL IN THE MASTER PLAN AREA AND WATER LEVEL AT BANGKOK PORT IN 1980

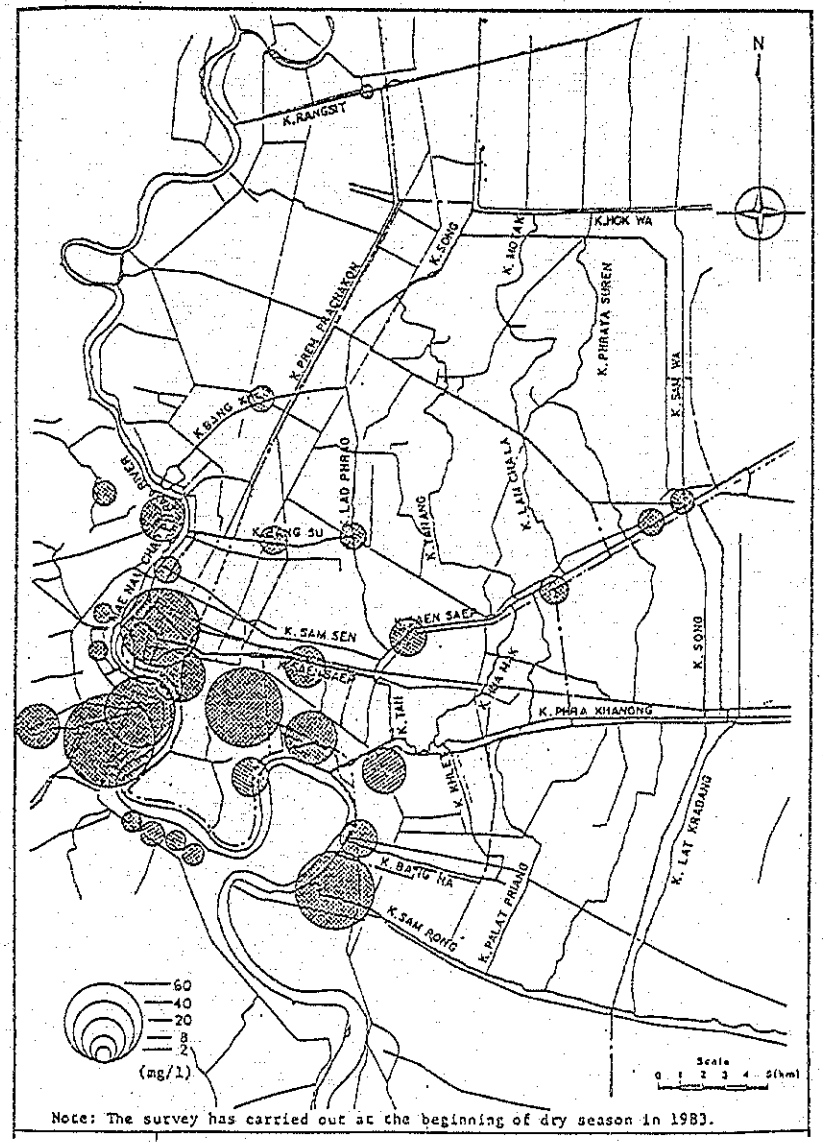


PROBABLE FLOOD WATER LEVEL OF CHAO PHRAYA RIVER

Source : Meteorological Department and Port Authority of Thailand

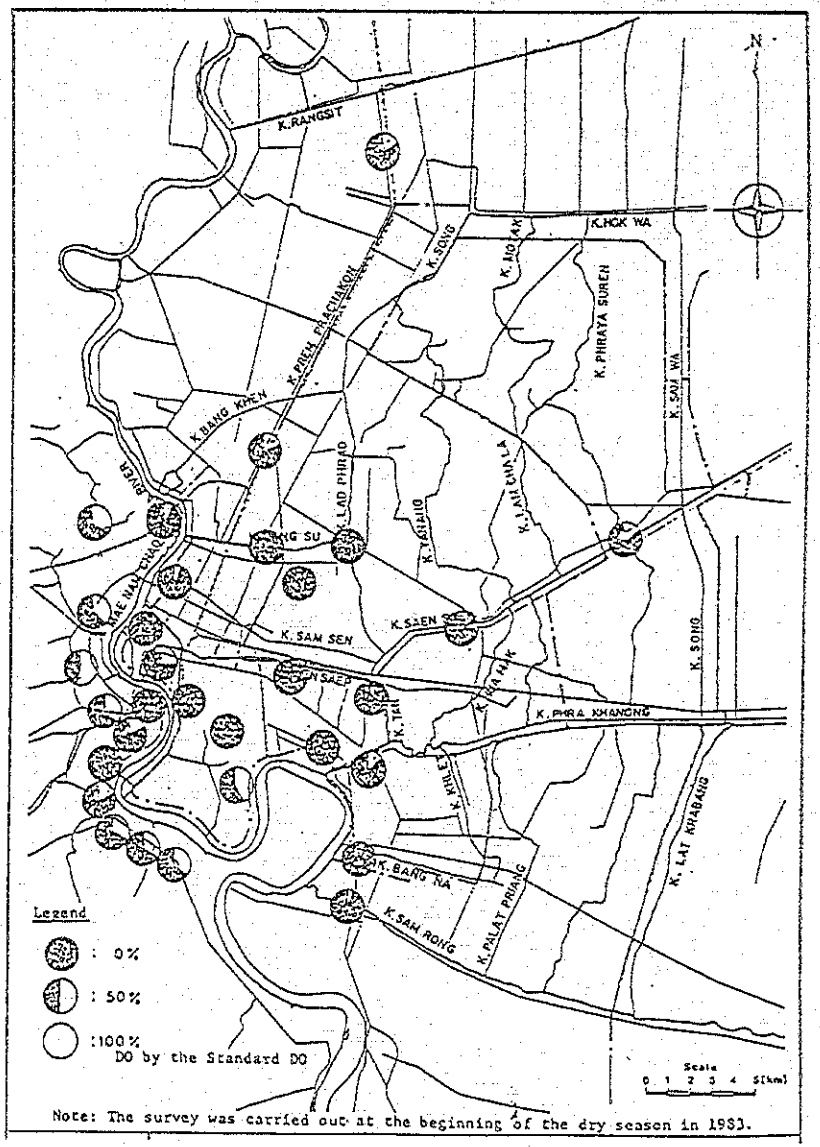
Fig. 2.5 Water Quality of Canals in Bangkok City (1983)

(B O D)



Note: The survey has carried out at the beginning of dry season in 1983.

(D O)



Note: The survey was carried out at the beginning of the dry season in 1983.

Fig. 2.6 Present Ground Elevation in the Project Area

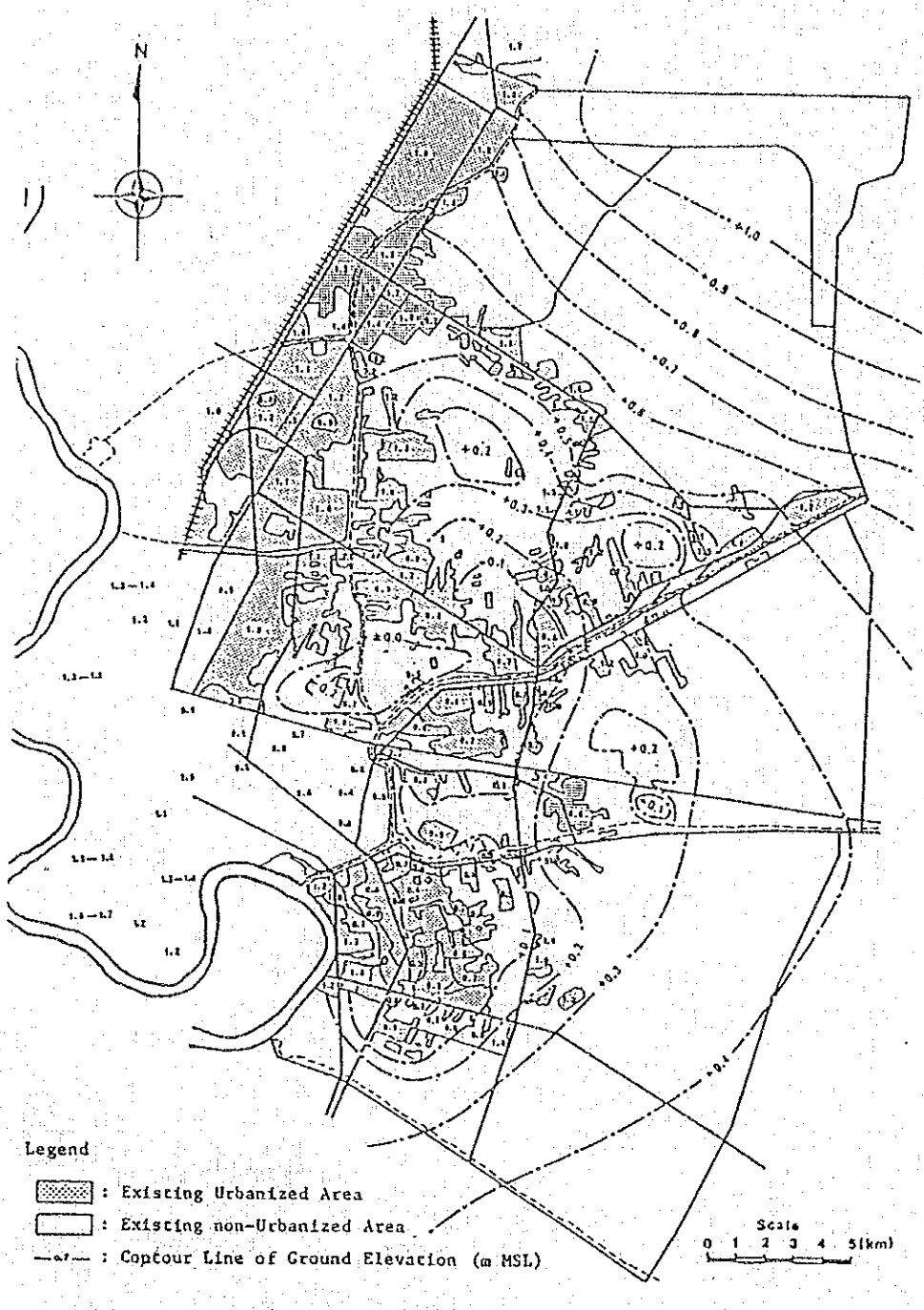


Fig. 2.7 Geological Formation of the Lowland in the Downstream Region of the Chao Phraya River

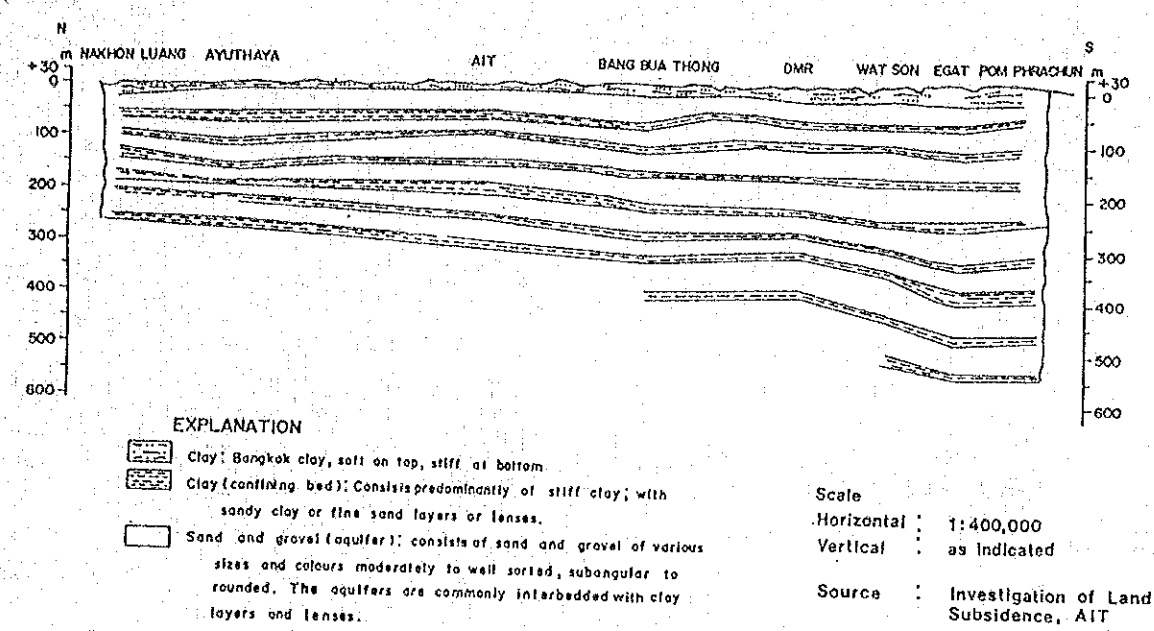


Fig. 2.8 Geology Near of Ram Kamhaeng University

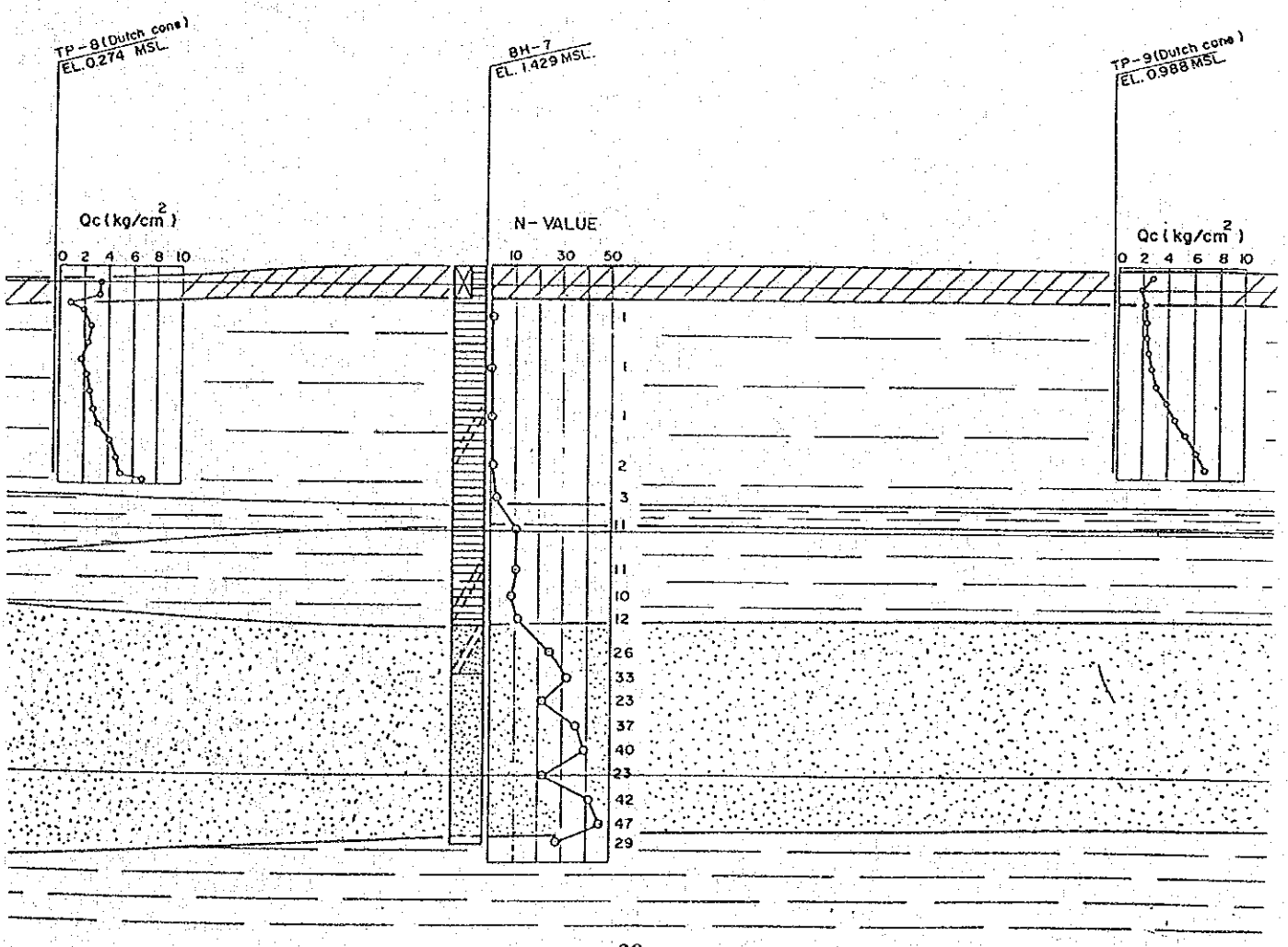
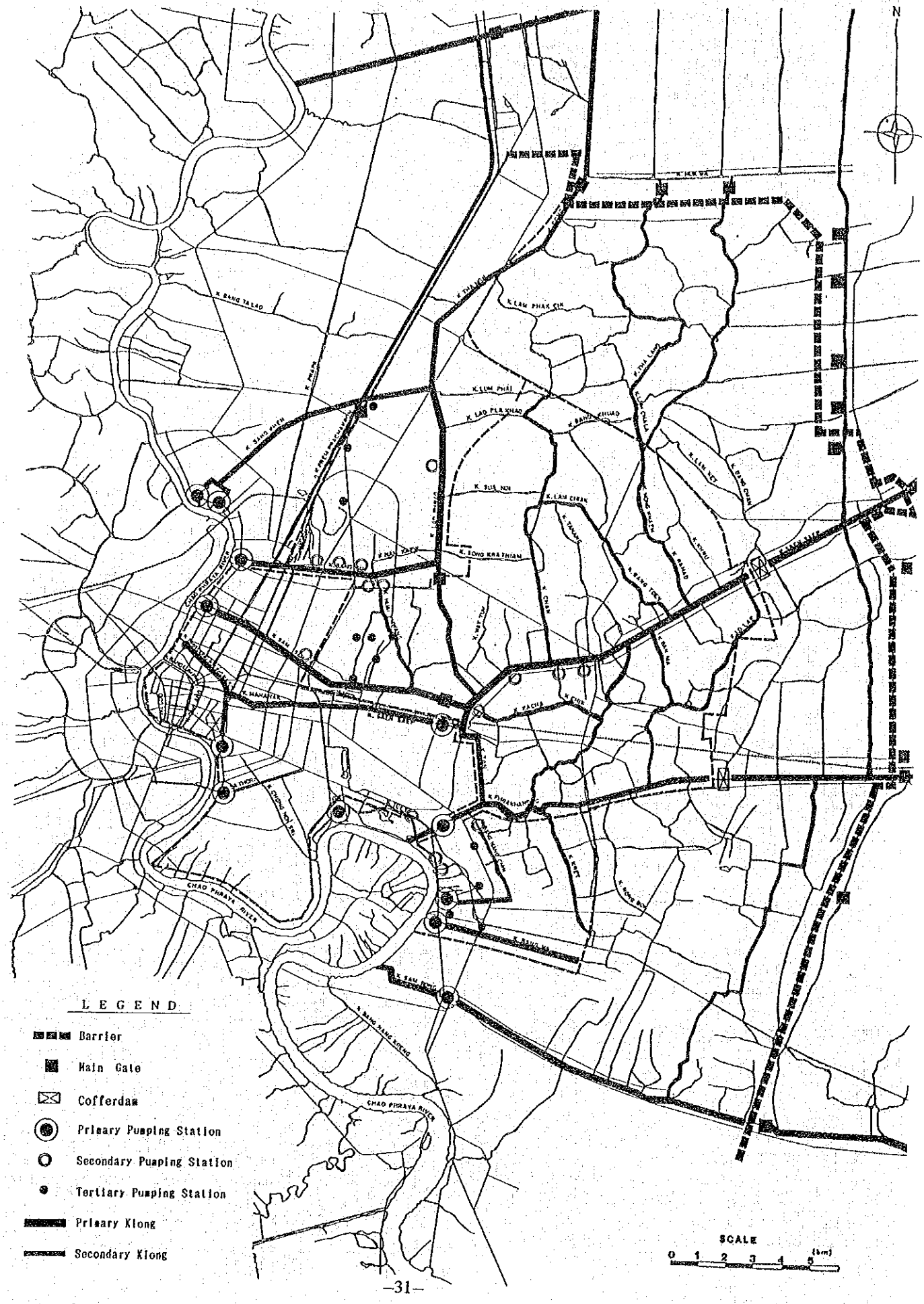


Fig. 2.9 Existing Major Flood Protection and Drainage Facilities



CHAPTER 3 CONTENTS OF THE PROJECT

CHAPTER 3 CONTENTS OF THE PROJECT

3-1 Objectives of the Project

3-1-1 Objectives

Bangkok City's flood and drainage data management is currently being carried out using an off-line system. However, centralized data management using an on-line system is necessary for the efficient operational management of the facilities. Furthermore, it is necessary to conduct close communications and to make frequent data exchanges between related agencies during flood seasons. For this reason, it is essential to revise the present data management system drastically and to adopt the centralized management system combined with an on-line telemeter and computer. This centralized management system (Flood Control Center) will have the following three basic functions:

- Monitoring and collection of hydrologic data (rainfall and water level), facilities' operating conditions, flood damage situations, and water quality data by telemeter.
- Various data processing, publicity, and the establishment of overall facility operation policies in the Center.

  Message transmission from the Center (information service) and issuing orders related to facility operations and flood fighting activities.

The materials and equipment necessary for Project completion are mostly electronic items that are not obtainable in Thailand.

Judging from the system design and manufacturing and on the technical know-how of system operations, it is appropriate to provide these materials and equipment under grant aid cooperation of the Government of Japan.

3-2 Necessity for the Flood Control Center

The basic objectives of the existing flood protection and drainage facilities in the Project Area are (1) to prevent outer water intrusion, and (2) to drain inner water.

Outer water prevention can be accomplished by closing gates. Inner water can be drained by pumps and gravity flow into the Chao Phraya River through opened gates during periods of low tide. However, as described in Section 2-2, the capacities of the existing facilities are small and flood control is presently being made by backing up these facilities by temporarily storing rain water into canals where water levels have been pre-lowered.

Safety factors of the existing facilities can be estimated as follows:

- Capacities of the main pumping stations (Σ Qp - 350 m^3/sec): h_1 = approx. 50 mm/day
- Storage capacities of the present canals and retarding basins: h_2 = approx. 25 mm
- Two-year probability rainfall (area average) R_2 = 60 mm/day
- Five-year probability rainfall (area average) R_5 = 80 mm/day

Judging from the requirement of $Ri - h_1 \leq h_2$, the existing facilities have a safety factor of R = 75 mm/day, ie., equivalent to approximately a 4-year probability rainfall.

If the water levels of the canals are kept high due to the improper water level control, h_2 will be 0 mm and, as a result, even a 2-year probability rainfall may cause flood damage. Furthermore, if the gate closing control is improperly operated, the outer water may flow into the polder or, if existing pump troubles are not thoroughly understood, significant flood damage may occur.

Since the canals are used for waterborne transportation throughout the year, their water levels cannot be lowered below certain points. Therefore, the water storage capacities of these

canals can be increased only by improving the canal channels or by enlarging the retarding basins. For this purpose it is necessary to introduce a flood plain management method that is based on an effective land use plan.

It is necessary to take the following measures to control flood damage:

- To measure canal water levels and rainfall amounts
- To know the pump and gate operating conditions.
- To forecast flood dangers.
- To take pre-planned action, such as operating pumps in advance or opening gates during low tide periods in order to drain inner water, dispatching flood fighting teams, announcing flood warnings, etc.

To take the above measures, it is essential to establish the Flood Control Center that will be able to centrally monitor and collect water level and precipitation data and facility operating information by an on-line telemetering system, accurately analyze possible flood situations, and issue appropriate facility operating orders.

3-3 Examination of the Request Contents

3-3-1 Role of the Flood control Center and the Changes of Equipment

The objectives of the Project described in the Government of Thailand's request are to establish the three basic functions as described in Section 3-1-1. For this purpose, the Flood Control Center must play the role of centralized management by utilizing a computer supported on-lined telemeter system. Therefore, for designing the equipment that will be used for collecting, processing, and monitoring hydrologic data and facilities operating conditions, it is necessary to fully understand how the collected data and information will be utilized at the Flood Control Center.

In accordance with the feasibility study report prepared in 1986 by JICA for the "Urban Drainage Development Plan in Bangkok City", the concept of the Flood Control Center were shown as Fig. 3.1. As the Fig. 3.2 shows, the inner water drainage will be carried out in the following sequence: ① shut off outer water, ② store rain water temporarily in canals and retarding basins, and ③ drain water by pumps. This concept is extremely important for facility operations management. Thus, equipment design must be made by taking into account the kind of information that is required for facility operations.

The equipment requested by the Government of Thailand was very carefully examined several times based on the contents of the request made in August 1987, field surveys, and on the series of discussions held with Thai officials concerned, and, finally, the equipment to be provided by the Project was decided upon.

The course of the equipment changes is shown in Table 3.1.

The course of the equipment changes was successively made based on the discussions and examinations of the following subjects: overall system's basic structure; monitoring system; data transmission system; data receiving system from other agencies; data processing and indicating system; and collected data's

utilization methods. These subjects are described in the following sections.

3-3-2 Examination of the Overall System's Basic Structure

The computer supported on-line telemetering system consists of the following three sub-systems that take care of each function of the entire system:

- Monitoring system:
  - . Observation of hydrologic data and facility operation data.
  - . Digital signal processing of analogue data.
- Data transmission system:
  - . Transmission of observed data signals.
- Processing and indicating systems:
  - . Transmitted data collecting control.
  - . Data processing, indicating, and storing.

3-3-3 Examination of Monitoring System

1) Monitoring Indexes

It is necessary to know the inner/outer water level to judge whether gates are to be opened or closed in order to prevent the inflow of the outer water.

Inner water drainage is decided upon based on the water level conditions of the canals which is then carried out by pump operations and gate opening operations. The canal water levels are related to the sizes of the catchment areas and on the pump and gate capacities.

It can not be interpreted as a centralized management system if the pump operations and gate opening conditions are not continuously monitored at a centrally located flood control center.

Canals' low water level management during no rain days is very important for maintaining the canals' rain water storage

capabilities. On the other hand, if canal water levels are kept too low, problems of organic soft soil floatation might arise. It is planned to draw outer water into the canals during dry seasons in order to maintain their water quality. For this case, it is necessary to know the water quality of the canals to evaluate the relationship between facility operation conditions and the water quality improvement effect.

Water quality can easily be measured by a fixed type water quality meter. It was decided upon to measure the electrical conductivity (EC) and the disolved oxygen (DO) as the indexes that would represent the water quality of the canals.

Based on the above considerations, it was decided to monitor the five indexes: rainfall; water level; gate opening; pump operations; and water quality (EC and DO).

2) Basic Concept of the Arrangement of Monitoring Stations

a. As a general rule, to install the stations at the facility locations.
b. To install the stations at locations where electric power (commercial source) is easily obtainable.
c. To install the stations at locations where TOT telephone lines are easily accessible.
d. To install the stations at locations where more than one type of data is obtainable.
e. The stations shall be installed only for flood protection and drainage facilities; not for other types of facilities.

3) Arrangement of Rain Gauges

In Japan, one rain gauge is installed, in general, every 50 km^2 for river management purposes. However, the Project is concerned with inner water drainage in an urban area; thus, one rain gauge is to be installed every 5 km^2 mesh area.

4) Arrangement of Water Level Gauges

Water level gauges are to be installed at major flood protection and drainage facility locations where both levels can be measured. However, only one gauge shall be installed at such locations where two major facilities are located close to each other.

5) Arrangement of Gate Opening Gauges

As a general rule, gate opening gauges shall be installed on the gates of all major flood protection and drainage facilities. However, no gate opening gauge shall be installed on such gates that are not used for discharge control purposes or on gates not having much discharge control capabilities hydraulically.

6) Pump Operation

As a rule, operating information for every major flood protection and drainage facility pump shall be obtained. However, such pumps that are not effective for inner water drainage shall be excluded from the plan.

7) Arrangement of Water quality Meters (EC and DO)

Based on JICA's study for the Canals' Water Quality Improvement Plan in Bangkok City, water quality meters are to be installed at such locations where the meter maintenance and management work will be easy to carry out and at locations that represent the water quality degradation in the City area.

Arrangement of monitoring stations are as shown on Fig. 3.3 and the monitoring indexes at each monitoring station are shown in Table 3.2.

3-3-4 Examination of Transmission System

1) Examination of Transmission Links

In general, the following five types of data transmission links are available:

(1) Private Wire circuit
(2) TOT general telephone lines
(3) TOT leased lines
(4) Simplex radio links (VHF/UHF)
(5) Multiplex radio links

Project requirements are as follows:

(a) The longest distance is approximately 30 km.
(b) Widely distributed 26 monitoring stations are needed.
(c) Transmission lines must be surely obtained when needed.
(d) Transmission lines will be used only for data collection purposes; they will not be used for telecontrol purposes.

The above requirement items and the types of transmission links were examined as shown in the following table:

Examination of Data Transmission Links

Communication Line / Type / Requirement	(1)	(2)	(3)	(4)	(5)
(a)	x	o	o	o	o
(b)	x	o	o	o	x
(c)	o	x	o	o	o
(d)	o	o	o	o	o

o: Advantageous
x: Disadvantageous

From the above table, the following two types of data transmission links will be suitable for project use:

- TOT leased lines
- Simplex radio links (VHF/UHF)

Further examination of the leased lines and simplex radio links was made based on the discussions made with the

TOT and Frequency Distribution Management Divisions of PTD, inspections of the SCADA System of MEA and the Telephone Line Utilization Plan of MD, and the discussions made with personnel of MEA and MD. As a result, it was decided upon to use TOT leased lines for the data transmission links of the Project.

Reasons for the Selection:

It is possible to secure TOT leased lines and it is very easy to connect up to the Project's system. PTD has requested to change the presently used MEA radio frequency (800 MHz band multiplex). If radio links will be used for the Project, its frequencies may be changed in the future by PTD, and DDS will have to bear a substantial amount of expenditures as a result of the frequency change.

In Bangkok City, high-rise buildings are mushrooming. If radio links (UHF band) are adopted for the Project, it is highly possible that the buildings will interfere with Project transmissions. As a matter of fact, MEA had to relocate one of its radio towers.

If a TOT leased lines happen to malfunction, TOT will fix it at its own expense. But, if the simplex radio link happens to malfunction, DDS will have to bear the cost of repairs.

TOT line improvements have progressed considerably. Thus, it will be very easy to connect the lines to the Project's monitoring stations.

Procedures for obtaining TOT leased lines are very simple. However, the following steps must be taken to use radio links: ①request for radio frequency use, ② examination of equipment to be used, ③ radio frequency allotment, ④ equipment design, ⑤ equipment manufacturing, ⑥ facility construction, and ⑦ equipment installation. Therefore, it will be very difficult to install simplex radio links for Project use under the rules of the Japanese grant aid program.

3-3-5 Examination of Information Receiving System from Other Agencies

1) Information Receiving System from RID

The computer center of IEC (RID) has five super minicomputers. However, these computers are not used as a system for telemetering hydraulic and hydrologic data collecting.

Hydrologic data (water level) is collected by verbally over telephones or by written messages. The collected data is not inputted into computers.

The gates and pumping stations managed by RID in the Bangkok City area will be transferred to DDS for management within the year. Thus, it is believed that it will not be necessary to collect hydrologic data directly from RID for a while in the future. Further, the necessity for collecting RID's hydrologic data (mainly for the upstream areas of the Chao Phraya River) by a real-time on-lined system will be very small for the Project that aims at managing inner water drainage facilities. For this reason, it was decided to use facsimile equipment as the information receiving system from RID until the time when the Chao Phraya River's flood forecasting and warning system of RID materializes.

2) Information Receiving System from MD

MD began using a computer this past May. Computer access weather information service by telephone line was scheduled to commence this July. For this reason, a Multi Modem 224 unit was previously installed to convert the digital signal of the computer into the analog signal of the telephone lines and vice versa.

Therefore, it was understood that the information receiving system from MD could be easily connected to on-line by installing a modem unit in the Flood control Center. And so, the provision of a facsimile unit, as specified in the Minutes of Discussions signed June 14, 1988, was changed to provide a modem unit.

3-3-6 Examination of Data Processing Indication System

Various data shall be collected by a telemeter and inputted into the signal processing equipment in the Control Center by the on-line system through TOT leased lines. The inputted data shall be processed by the computer that will have pre-patterned programs for the following purposes:

- Indication for system mimic panel
- Image indication for CRT. Further, the system shall be able to take care of the following processes for data transmission, distribution and data base preparation
- Indication on the 70-inch projector
- Making prints with the color hard copier
- Data filing on magnetic tape
- Print filing with the printer

The system shall be of such a type to allow the operator to make data collection, processing, indication, transmission, distribution, and data base preparation by operating the CRT on the operator console.

3-3-7 Examination of Collected Data's Utilization Method

Collected data can be classified into the following two groups depending upon their use time:

1) Immediate use:

. To issue pump or gate operation orders from real-time data.
. To issue flood fighting activity orders from real-time data.

Necessary orders will be given immediately by comparing the preset warning, or emergency level, and the real level on the system indicator board and on the CRT image monitor.

2) Long-term use:

Sufficient data to Judge the correlation between water level, amount of precipitation, facility operation, and flooding level (flood damage) will be required in order to revise pump and gate operation rules, flood fighting activity starting announcement rules, and to set up flood warning water levels and emergency water levels.

After a certain amount of data is stored, data analyses and hydraulic and hydrologic data's numerical analyses will be conducted by utilizing the engineering work station consisting of a scientific technique calculating computer as its main system.

A plan was made to install all equipment related to data processing, indicating system, and engineering work station in the Flood Control Center (Master Station).

It would be desirable for data to be utilized on a long term basis in the Flood Control Center in accordance with the following five steps:

- Step 1: Data collection and storing in a prearranged order.
- Step 2: Data analyses (rainfall analysis, various statistical analyses, discharge analysis)
- Step 3: Hydraulic and hydrologic numerical simulation analyses.
- Step 4: Preparation of flood forecasting and warning models and facility operation management standards.
- Step 5: Information offering services to other related organizations and agencies.

3-4 Contents of the Project

3-4-1 Project Implementation Agency

The Project request was made by BMA. The reasons why the Project request was made by BMA was because the Project Area is located within BMA's administrative area and DDS, one of BMA's departments, is in charge of the public services related to the flood, drainage, and sewerage in the Project Area.

As it is planned to transfer RID's gates and pumping stations to BMA, the actual management of all flood control and drainage facilities in the Project Area will be carried out by DDS.

In view of the above background, Project implementation will be undertaken by BMA (DDS).

3-4-2 Outline of the Materials and Equipment Necessary for Project Completion

Materials and equipment necessary for the Project's computer supported on-line telemetering system were confirmed as shown in the following lists based on the discussions and examination of the request contents.

1) Equipment for master Station

	Name of Item	Q'ty
1	Main Computer	1 ea
2	Man Machine Interface	1 set
	Mimic Panel	(1)
	70" Projector	(1)
	Operator Console W/CRT	(1)
	Color Hard Copier	(1)
	Printer	(3)
	VTR & TV Camera	(1)
	Modem (for MD)	(2)
	Facsimile (for RID)	(2)
3	Transmission Equipment	1 set
4	Uninterruptible Power Supply Unit	1 set
5	Air Conditioner	1 ea
6	Free Access Floor (200 m^2)	1 set
7	Cables	1 set
8	Miscellaneous Equipment	1 set

2) Materials and Equipment for Monitoring Stations

	Name of Item	Q'ty
1	Rain Gauge	21 ea
2	Water Level Gauge	41 ea
3	Water Quality (DO & EC) meter	2 ea
4	Gate Opening Gauge	30 ea
5	Modification of Existing pump Control Panel	118 ea
6	Foundation Works for Gauging Station & OTU House	1 set
7	OTU & Cabinet	26 ea
8	Power Supply Unit	26 ea
9	OTU House	18 ea
10	Cables	1 set

3) Other Equipment

	Name of Item	Q'ty
1	Spare Parts	1 set
	Rain Gauge	(3 ea)
	Water Level Gauge	(2 ea)
	OUT Cabinet & House	(1 set)
	Computer Soft Module	(1 set)
2	4WD Car	2 ea
3	Copy Machine	1 ea
4	Engineering work Station	1 set
	Computer	(1 ea)
	X-Y Plotter	(1 ea)
	Digitizer	(1 ea)
5	Test Equipment (Tester Synchroscope Level Meter, etc.)	1 set

3-4-3 General Description of the Project Area

It is planned to install the Flood Control Center on the sixth floor of the new BMA building that was built in the Huay Kwang District of Bangkok City. The space for the Center has already been secured; thus, it will be relatively easy to carry in and install the necessary equipment.

One of the 26 monitoring stations will be installed on the roof of the new BMA building; the other 25 stations will be arranged at the existing pump stations and gate locations, and at major canal points.

It was already confirmed during the field survey period that the locations planned for monitoring station construction had sufficiently wide access roads or are in such areas where barges can navigate in the canals. No problem should be encountered when bringing in and installing the necessary equipment for the monitoring stations.

3-4-4 Technical Cooperation

The Project requires the following special technologies: ① telecommunications; ② data processing and system design; ③ hydraulic and hydrologic numerical analyses (programming). In particular, the technologies of ② and ③ above are indispensable for making effective use of collected data.

After the installation of the equipment that is to be provided under the Project, it is planned to train engineers for the above purpose, as well as for equipment maintenance and management purposes, through an on-the-job training program.

Presently, there are several engineers among DDS personnel who have the basic capabilities for mastering the above technologies. It will be essential to provide technical cooperation to train personnel by making these engineers its core.

The planned fields of technical cooperation are as follows:

① Telecommunications:

- Management techniques of signal processing equipment.

② Data processing system design:

- Received data's image processing and filing process techniques.
- Entire equipment system and software application.
- Design techniques

③ Hydraulic and hydrologic numerical analyses:

- . Rainfall data analyses
- . Discharge analyses
- . Flooding analyses (including flood forecasting).

The planned activities of technical cooperation are as follows:

1	Training in Japan	Two (2) or three (3) engineers of DDS personnel will be trained for on-site management of relevevant systems in Japan. Further, they will be trained for operation skill of planned equipment of the Project at equipment supplyer's office. The training will take about three (3) or four (4) month during computer system manufacturing.
2	Long term dispatch of expert	One (1) expert as "Drainage Control System Engineer" will be dispatched to BMA about two (2) years after finish of installation of planned equipment. He will teach development of applicable software, data service and flood forecasting system.

These technical cooperations mentioned above, are not included in this Project of Japan's Grant Aid. Therefore, these technical cooperations will be requested to the Government of Japan by the Government of Thailand according to justifiable reasons and procedures.

Fig. 3.1 Concept of the Flood Control Center

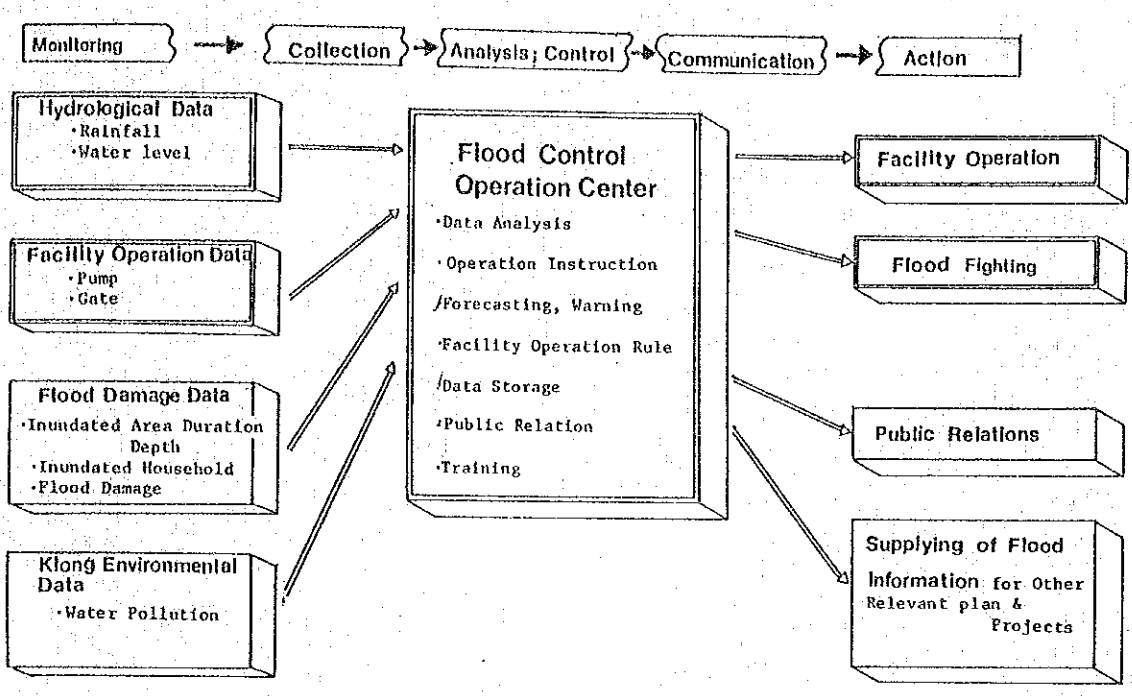
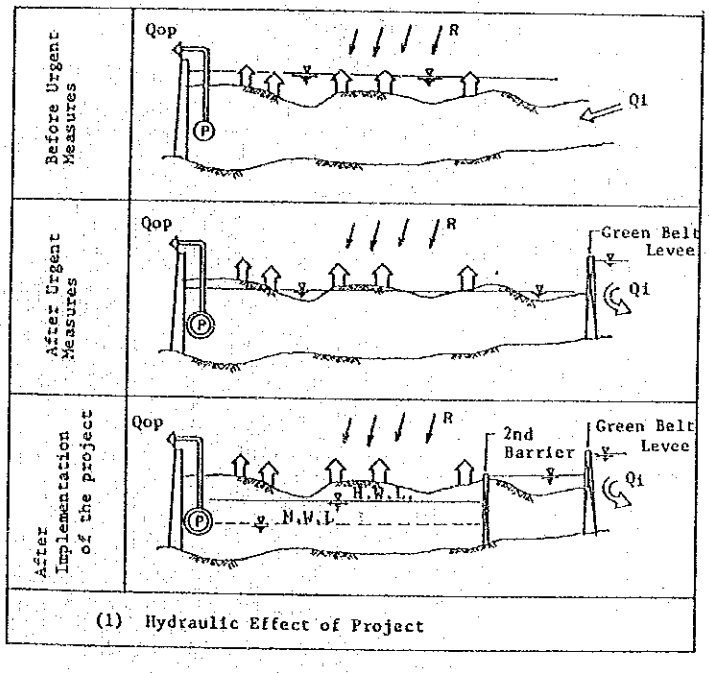
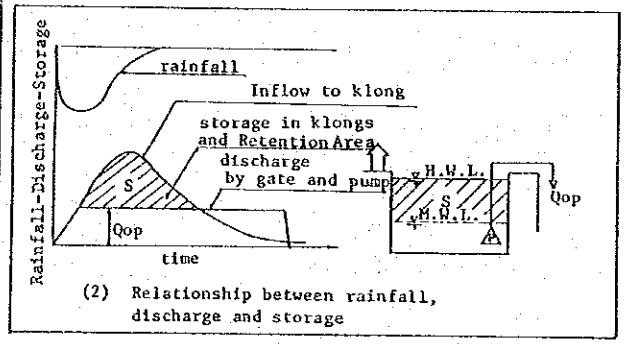


Fig. 3.2 Concept of Inner Water Drainage System





Legend

Qi:	Inflow from outer area
Qo:	Drain by pumping station and gate
R:	Rainfall
S:	Storage in klong and retention area
Ri:	Accumulated rainfall
H.W.L.:	High water level
M.W.L.:	Maintenance water level

Table 3.1 Course of Equipment Changes

I T E M S	Request by DDS (1987.8)	Minutes of Discussions (1988.3.24)	Minutes of Discussions (1988.6.14)	Technical Note (1988.6.30)	Final Report
(I) Master Station					
1- 1 Main Computer	1 Lot	1 Lot	1 Lot	1 Lot	1 Lot
1- 2 Man Machine Interface	1 〃	1 〃	1 〃	1 〃	1 〃
1- 3 Transmission Equipment	1 〃	1 〃	1 〃	1 〃	1 〃
1- 4 Uninterruptible Power Supply Unit	1 〃	1 〃	1 〃	1 〃	1 〃
1- 5 Airconditioner	1 〃	1 〃	1 〃	1 〃	1 〃
1- 6 Free Access Floor	1 〃	1 〃	1 〃	1 〃	1 〃
1- 7 Cables	1 〃	1 〃	1 〃	1 〃	1 〃
1- 8 Miscellaneous Equipment (Auto Door, Partition Wall, etc.)	—	—	1 〃	1 〃	1 〃
(II) Monitor Station					
2- 1 Rain Gauge	20 sets	20 sets	21 sets	21 sets	21 sets
2- 2 Water Level Gauge	44 〃	44 〃	46 〃	41 〃	41 〃
2- 3 Water Quality (DO & EC) Meter	—	—	2 〃	2 〃	2 〃
2- 4 Gate Opening Gauge	—	—	1 Lot	32 〃	30 〃
2- 5 Modification of Existing Pump Operation Panel	1 Lot	1 Lot	1 〃	118 〃	118 〃
2- 6 Foundation Works for Gauging Station & OTU House	1 Lot	1 Lot	1 〃	1 Lot	1 Lot
2- 7 OTU & Cabinet	22 sets	22 sets	26 sets	26 sets	26 sets
2- 8 Power Supply Unit	22 〃	22 〃	26 〃	26 〃	26 〃
2- 9 OTU House	1 Lot	1 Lot	26 〃	26 〃	26 〃
2-10 Cables	1 〃	1 〃	1 Lot	1 Lot	1 Lot
2-11 OTU Software	1 〃	1 〃	26 sets	26 sets	26 sets
(III) Monitor Station for RID & MD					
3- 1 OTU & Cabinet	2 sets	2 sets	—	—	—
3- 2 OTU Software	2 〃	2 〃	—	—	—
3- 3 Power Supply Unit	2 〃	2 〃	—	—	—
3- 4 Multi Modem	—	—	—	1 pair	1 pair
3- 5 Facsimile	—	—	2 pairs	1 〃	1 〃
(IV) Others					
4- 1 Spare Parts (3-RG, 2-WL, 1-OTU)	1 Lot	1 Lot	1 Lot	1 Lot	1 Lot
4- 2 Test Equipment	1 〃	1 〃	1 〃	1 〃	1 〃
4- 3 TOT Line Installation & Electric Distribution Line	1 〃	1 〃	1 〃	1 〃	1 〃
4- 4 4WD Car	—	—	2 cars	2 cars	2 cars
4- 5 Copy Machine	—	—	1 set	1 set	1 set
4- 6 Engineering Work Station			1 Lot	1 〃	1 〃

Fig. 3.3 Monitoring Stations' Arrangement Map

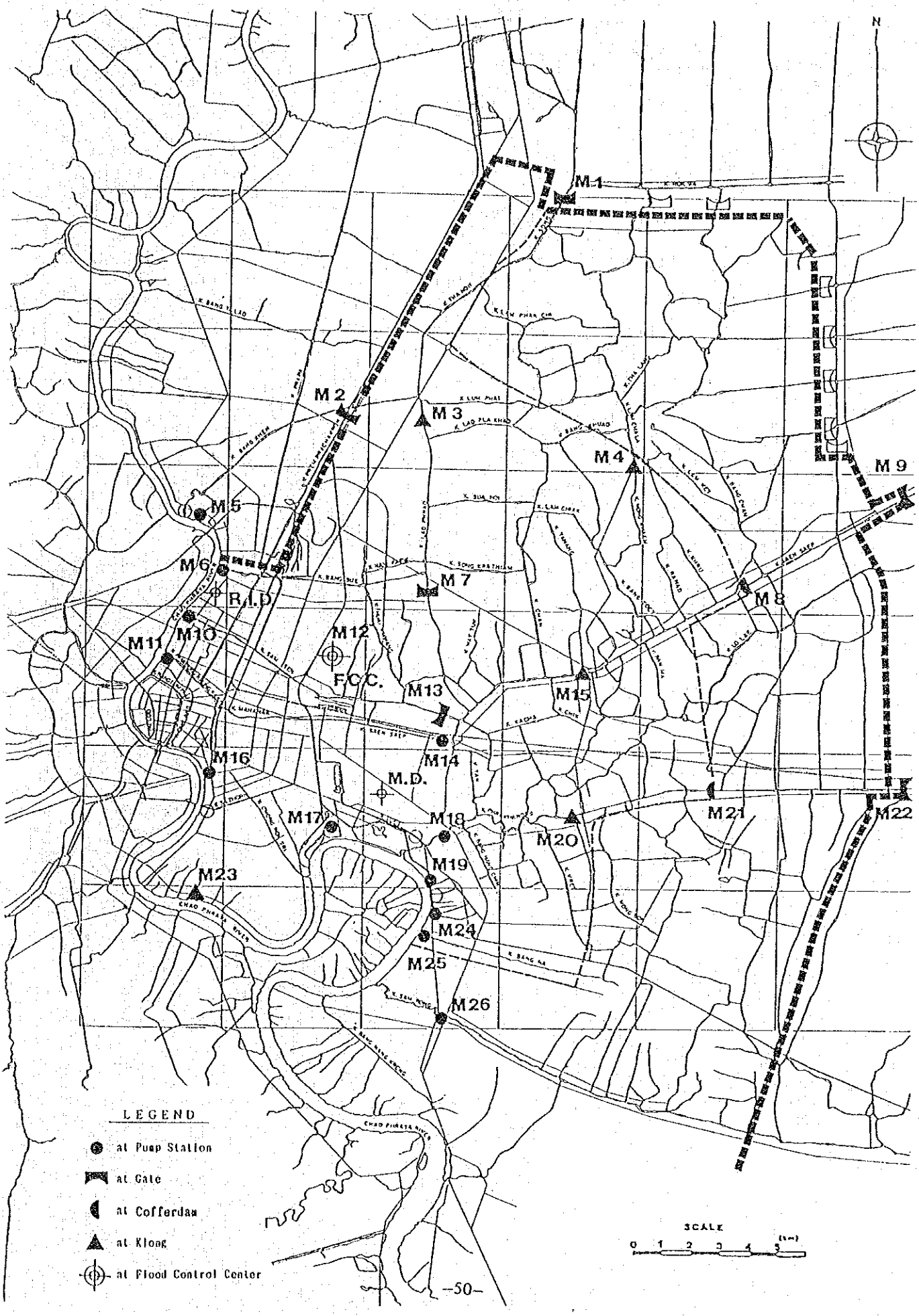


Table 3.2 Monitoring Stations and Monitoring Indexes

No.of Monitoring Station	Location Of Monitoring Station		Monitoring Indexes						
			Rainfall	Water Level		Gate Opening	Pump Operation	Water Quality	
				Inside	Outside			D.O.	Conductance
M 1	K.Song (Don Muang)	W.D.	○	○	○	1			
M 2	K.Prem Prachakorn	W.G.	○	○	○	1			
M 3	K.Lat Phrao		○	○					
M 4	K.Lam Charat		○	○					
M 5	K.Bang Khen (South)	P.S.	○	○	○	1	4		
M 6	K.Bang Sue	P.S.		○		2	12		
M 7	K.Lat Phrao	W.G.	○	○	○	1			
M 8	K.Saen Saep (Wat Banphen Tai)	C.D.	○	○	○				
M 9	K.Saen Saep (Minburi)	W.G.	○	○	○	1			
M10	K.Sam Sen	P.S.		○	○	2	10		
M11	K.Krung Kasem	W.G.	○	○	○		5		
M12	Flood Control Center		○						
M13	K.Sam Sen	W.G.		○	○	2			
M14	K.Saen Saep	P.S.	○	○	○	2	5	○	○
M15	K.Saen Saep (Bang Kapi)		○	○					
M16	K.Krung Kasem	P.S.	○	○	○	1	5	○	○
M17	Rama IV	P.S.	○				4		
M18	K.Phrakanong	P.S.	○	○	○	6	35		
M19	K.Bang Jek	P.S.		○	○	2	2		
M20	K.Phrakanong (Wat Khachon Siri)		○	○					
M21	K.Phrakanong (Wat Krathum Sua Pra)	C.D.	○	○	○				
M22	K.Phrakanong (Lat Krabang)	W.G.	○	○	○	1			
M23	K.Wat Sai	C.D.	○		○				
M24	K.Bang Oa	P.S.	○	○		2	6		
M25	K.Bang Na	P.S.		○	○	2	5		
M26	K.Sam Rong	P.S.	○	○	○	3	25		
	M. D.								
	R. I. D.								
	Total		21	41		30	118	2	2

CHAPTER 4 BASIC DESIGN

CHAPTER 4 BASIC DESIGN

4-1 Basic Design Requirements

4-1-1 Basic Composition of the Overall System

As shown in Fig. 4.1, the overall system that will be composed of monitoring stations, transmission lines, and a master station was decided upon.

4-1-2 Monitoring Stations

The major basic design requirements for the monitoring equipment were decided upon as follows:

1) All gauges and meters, except gate opening gauges and pump operation indicators, must have recorders for the system's backup purposes.

2) The recorders must be one month self recording types.

3) If a monitoring gauge is to be installed outside a monitoring station house, countermeasures must be taken to prevent lightning from damaging the equipment.

4) Water quality meters, except measuring tips, must be arranged so that they will not be submerged even during flood periods.

5) Certain measures must be taken to protect each gauge from the heavily degraded water quality of the Klongs.

6) Each gauge must be of a type that will allow for easy repairs, mainteancne, and management.

7) Each gauge must be an energy saving type.

8) Monitoring stations and outer terminal unit (OTU) stations' structure types shall be as follows:

. Rain gauge stations:
Ground installation type (Type-RA) and OTU house installation type (Type-RB)

. Water level gauge stations:
Submerged pile foundation platform type (Type-WA) and concrete wall bracket platform type (Type-WB).

. Water quality meter stations:
The sensor supports shall be directly installed on the existing pump stations' concrete walls. The recorders shall be installed next to the other recorders in the management offices of the pump stations.

. Gate opening gauges:
The gauges shall be installed directly to the hoist shafts of existing gates.

. Pump operation indicators:
The indicators shall be installed on the existing pump operation consoles by partially modifying them.

. OTU stations:
Ground installation type (Type-OA), area office installation type (Type-OB), and submerged pile foundation platform type (Type-OC).

Structure types for each monitoring and OTU stations are listed in Table 4.1.

4-1-3 Data Transmission System

1) Countermeasures Against Lightning:

Countermeasures must be taken to prevent lightning from damaging equipment. The countermeasures must be applied at the following inputs:

(a) Electric power inputs (Commercial Source)
(b) TOT line inputs
(c) Inputs of water level and rain gauges

2) Countermeasures Against Power Supply Failures:

By taking into account the power supply conditions in the Project Area, all monitoring stations, except water quality meters, must be backed up by batteries on a 24 hour a day basis.

3) Standard Intervals for Data Sampling and Transmission Times:

By taking into account the actual examples and necessary capacities of the data processing and indications systems in Japan, the standard intervals for data sampling and transmission times were decided upon (see Table 4.2).

4-1-4 Information Receiving System from Other Agencies

1) Facsimile between RID and DDS

Directly connected dedicated TOT leased lines shall be used for the facsimile transmission route.502

Recorded water level data in the Bangkok City area will be transmitted from RID once a day.

The type of facsimile must be decided upon by taking into consideration the simplicity of repair and maintenance, and the material supply situation in Bangkok City.

2) Modem Between MD and DDS

Directly connected dedicated TOT leased lines shall be used for the modem transmission route. Thus, MD's information service will be accessible with top priority over dedicated TOT lines.

MD's information service is managed by an emulated IBM 3720 computer. IBM 2780/3780 emulator requires a 2,400 baud modem. Thus, the access terminal computer must satisfy this requirement.

4-1-5 Data Processing Indication System

Various data shall be collected by a telemeter and inputted into the signal processing equipment in the Control Center by the on-line system through TOT leased lines. The inputted data shall be processed by the computer that will have pre-patterned programs for the following purposes:

. Indication for system indicator board (Mimic Panel)
. Image indication for CRT

Further, the system shall be able to take care of the following process for data transmission, distribution, and data base preparation:

. Indication on the 70-inch projector
. Making prints with the color hard copier
. Data filing on magnetic tape
. Print filing with the printer

The system shall be of such a type to allow the operator to make data collection, processing, indication, transmission, distribution, and data base preparation by operating the CRT on the control board.

4-1-6 Others

Special attention shall be paid to the monitoring station and cable installation so that the quipment related to the OTU system wiull not be flooding during rainy seasons.

Station houses will be structures able to withstand the gas produced from decomposed materials in the Klongs. In such locations where station houses have to be built close to public roads or houses, protecting fences shall be installed around the station houses to prevent possible destruction by humans.

Specific items for the following purposes:

1) OTU Houses:

Countermeasures must be taken against temperature rises in the houses. Further, measures shall be taken to prevent the intrusion of small animals, insects, etc.

2) Cable Installation Method:

Cables that are installed above the ground shall be protected by conduits, etc. in order to prevent them from being damaged by humans.

The cables installed underground must be guarded by conduits to prevent possible cutting and deterioration, and to protect them against load pressures.

3) Standards for cables to be used shall be conventional types as shown below:

a.	Control power cable:	600V X LPE insulated cable
b.	Signal cable:	600V PVC insulated with CU tape shield cable
c.	Control cable:	600V PVC insulated cable
d.	Specifications for the above cables:	JIS C-3605, JIS C-3401, IEC Pub 502

Fig. 4.1 Overall System's Structure Diagram

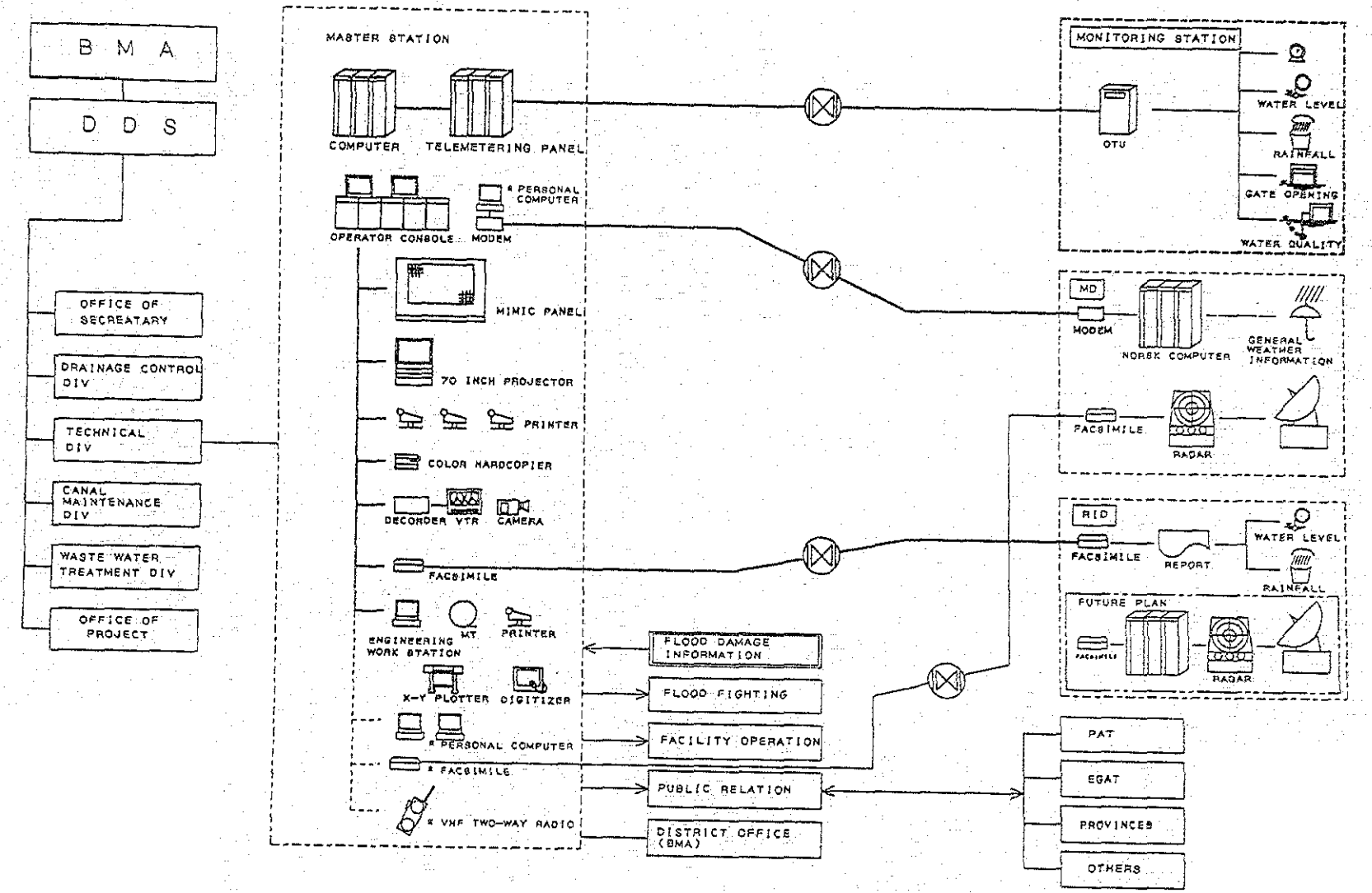


Table 4.1 Structure Type for Each Monitoring and OTU Station

No.of Monitoring Station	Location Of Monitoring Station		Type of Gauging Station & OTU House							
			Rain Gauge	Water Level Gauge		Gate Opening Gauge	Pump Operation Indicator	D.O. Meter	Conductance Meter	OTU & Data Recorder
				Inside	Outside					
M 1	K.Song (Don Muang)	W.D.	RA	WA	WA	○				OB
M 2	K.Prem Prachakorn	W.G.	RB	WA	WA	○				OA
M 3	K.Lat Phrao		RB	WA						OC
M 4	K.Lam Charat		RB	WA						OC
M 5	K.Bang Khen (South)	P.S.	RA	WA	WA	○	○			OB
M 6	K.Bang Sue	P.S.		WA		○	○			OB
M 7	K.Lat Phrao	W.G.	RB	WA	WA	○				OA
M 8	K.Saen Saep (Wat Banphen Tai)	C.D.	RB	WA	WA					OA
M 9	K.Saen Saep (Minburi)	W.G.	RA	WA	WA	○				OB
M10	K.Sam Sen	P.S.		WA	WA	○	○			OB
M11	K.Krung Kasem	W.G.	RB	WA	WA		○			OA
M12	Flood Control Center		RA							OA
M13	K.Sam Sen	W.G.		WA	WA	○				OA
M14	K.Saen Saep	P.S.	RA	WA	WA	○	○	○	○	OB
M15	K.Saen Saep (Bang Kapi)		RB	WA						OC
M16	K.Krung Kasem	P.S.	RB	WA	WA	○	○	○	○	OA
M17	Rama IV	P.S.	RB				○			OA
M18	K.Phrakanong	P.S.	RB	WA	WA	○	○			OA
M19	K.Bang Jak	P.S.		WA	WA	○	○			OA
M20	K.Phrakanong (Wat Khachon Siri)		RB	WA						OC
M21	K.Phrakanong (Wat Krathum Sua Pra)	C.D.	RB	WA	WA					OC
M22	K.Phrakanong (Lat Krabang)	W.G.	RA	WA	WA	○				OB
M23	K.Wat Sai	C.D.	RB		WA					OC
M24	K.Bang Oa	P.S.	RB	WA		○	○			OA
M25	K.Bang Na	P.S.		WA	WB	○	○			OA
M26	K.Sam Rong	P.S.	RA	WA	WA	○	○			OB

○ : Cable Connection Only

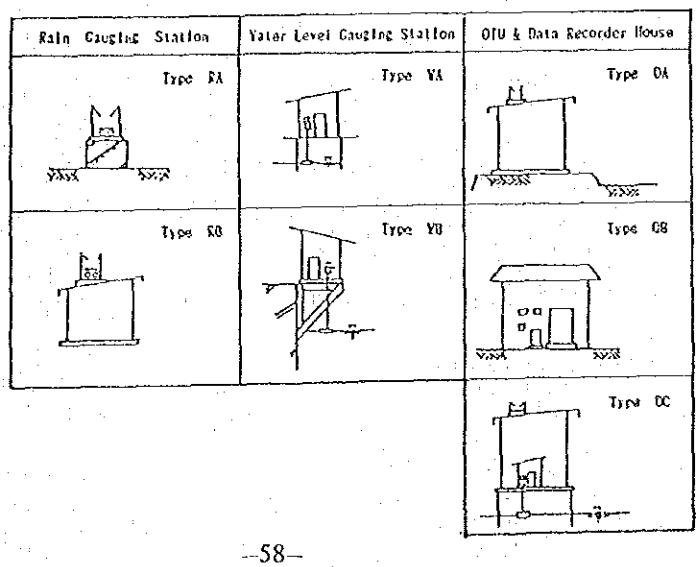


Table 4.2 Standard Intervals for Data Sampling and Transmission Times

Time Interval / Monitoring Indexes	Sampling time intervals	Data Transmission time intervals to Master Station	Remarks
Rainfall	15 minutes	15–60 minutes (Variable)	21 Rain Gauges
Water Level	30 minutes	30–60 minutes (Variable)	41 Water Level Gauges
Water Quality (DO)	6 hours	6–24 hours (Variable)	2 DO meters
Water Quality (Conductance)	6 hours	6–24 hours (Variable)	2 Conductance meters
Gate Openning Condition	30 minutes	30–60 minutes (Variable)	30 Gates
Pump Operating Condition	30 minutes	30–60 minutes (Variable)	118 Pumps (ON/OFF Condition)

4-2 Design of Monitoring System

4-2-1 Rain Gauges

1) Gauge Selection

Two types of rain gauges are widely used -- the storage type and the tipping bucket type. The storage type rain gauge is used for making visual readings; it is not usable as a telemeter. Thus, it was decided to use tipping bucket type rain gauges for the Project. The tipping bucket type rain gauges will tip after 1 mm of rainfall; they will have long-term self-recorders.

2) Rain Gauge Installation

Rain gauge installation shall be of the following two types:

(a) Roof installation type (Type-RA) on OTU station houses:

Rain gauges shall be installed on the roofs of the OTU station houses that will be constructed under the Project.

(b) Ground installation type (Type-RB)

Rain gauges shall be installed at locations where OTU stations will be installed at existing field offices.

An outline of a rain gauge is shown in Fig. 4.2 for reference purposes.

4-2-2 Water Level Gauges

1) Gauge Selection

The following types of water level gauges are generally used for river or channel water level monitoring:

(a) Float type
(b) Pole type
(c) Water pressure type
(d) Ultrasonic type
(c) Electrostatic capacity type

The specifications to meet the Project's basic design requirements shall be as follows:

- Type: Float type self-recording gauge
- Measuring range: 0 to 10 m
- Accuracy: ±1 cm
- Telemeter output: BCD 3-digit output by shaft encoder

2) Gauge Installation

Water level gauge installtion shall be submerged pile foundation platform type (Type-WA) and concrete wall bracket platform type (Type-WB).

An outline of the gate opening gauge is shown in Fig. 4.4 for reference purposes.

4-2-3 Water Quality Meters

1) DO meter:

- Measuring range: 0 to 20 ppm
- Accuracy: Within ±1% at full scale

2) Electric Conductivity:

- Measuring range: 0 to 1,000 μs/cm
- Accuracy Within ±5% at full scale

3) Meter Installation

- Measuring tips:
  Water quality meter shall be installed on concrete wall bracket platforms in the same manner as water level gauges.
- Main bodies and recorders:
  The main bodies and recorders of the water quality meters shall be installed on shelves in OTU stations.

4-2-4 Gate Opening Gauges

Gate opening gauges shall be of a type that can detect the gate's up and down moving distance by the number of gate shaft rotations:

- Structure: Completely sealed type
- Oscillator: Mechanical A/D converter (shaft encoder)
- Output: BCD 3-digit output with parity check bit

An outline of the gate opening gauge is shown in Fig. 4.4 for reference purposes.

4-2-5 Pump Operation Indicators

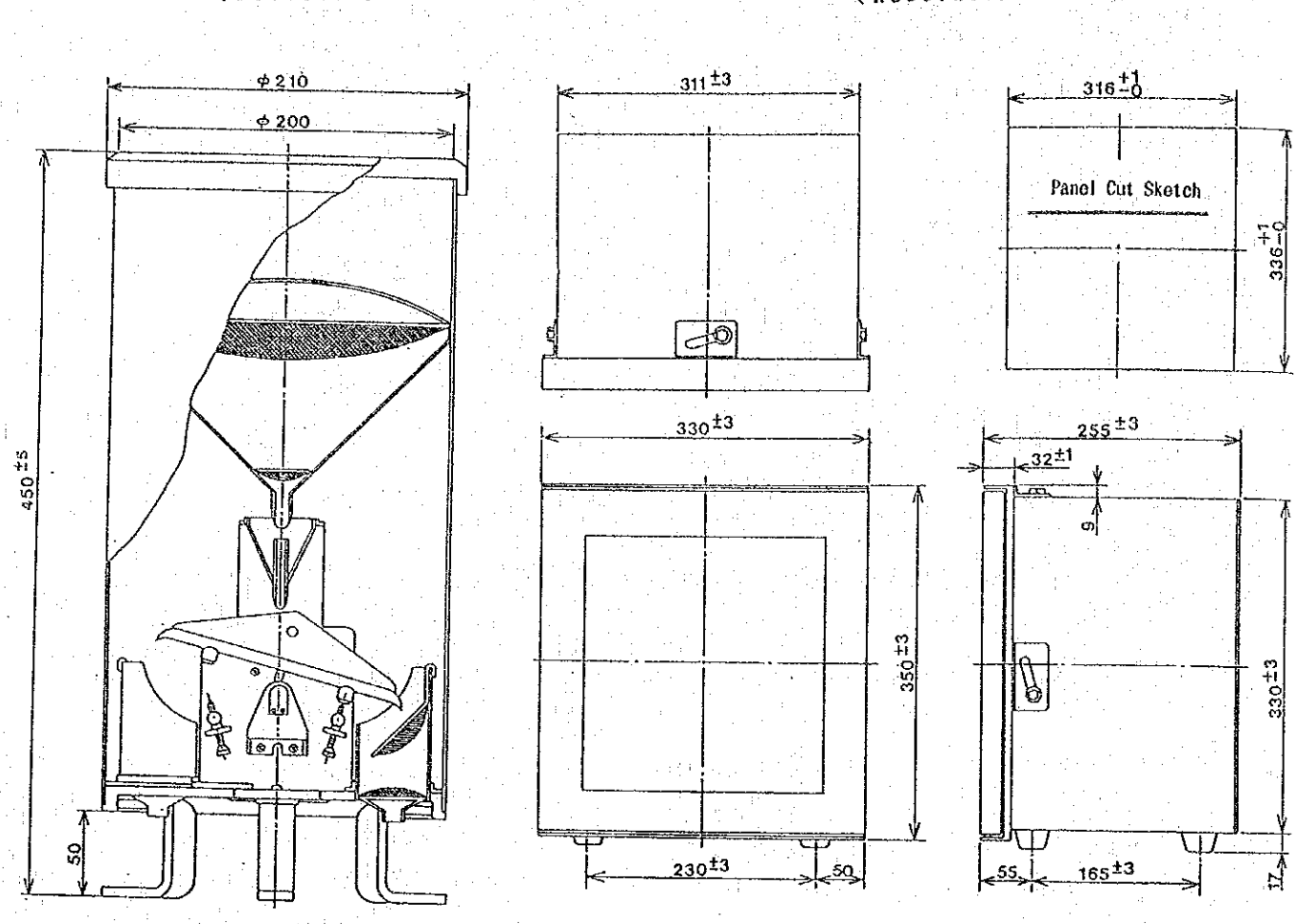
The pump operation indicating method shall be of a type that can pick up each pump's starting and stopping signals. Thus, existing pump control panels shall be modified.

4-2-6 Monitoring Station Structure

Each monitoring station shall consist of an observation station (for recording rainfall, water levels, water quality, gate openings and pump operations) and an OTU station that will transmit the data signals received from each observation station via TOT leased lines.

The standard block diagram of the monitoring station is shown in Fig. 4.5.

Fig. 4.2 Outline of Rain Gauge (for reference)

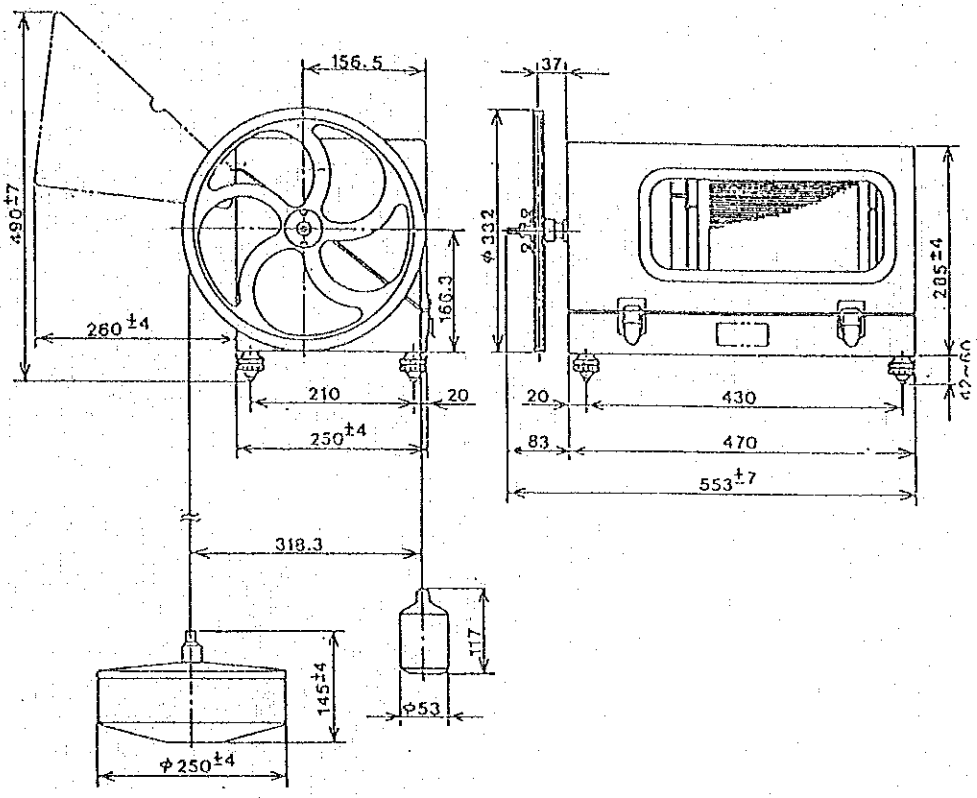


[FEATURES]
- No AC Power required.
- Simple and reliable.

[SPECIFICATIONS]

Detector:	Tipping bucket.
Recorder:	Pulse counting event recorder, Arc tracing.
Effective recording width:	100 mm.
Chart drive:	Quartz clock (chart speed; 10 mm/h).
Continuous recording period:	1 or 3 months (To be specified)
Measuring distance:	100 m or less (With 1.25 mm^2 cable).
Power supply (Pulse counter):	100 V AC ±10 %, or 12 V DC (Both modes).
(Clock):	1.5 V DC (Dry cell).
Dimensions & Weight:	Sensor; φ210×450(H) mm, Approx. 3.5 kg.
	Recorder; 330(W)×355(H)×255(D) mm, Approx. 17 kg.

Fig. 4.3 Outline of Water Level Gauge (for reference)



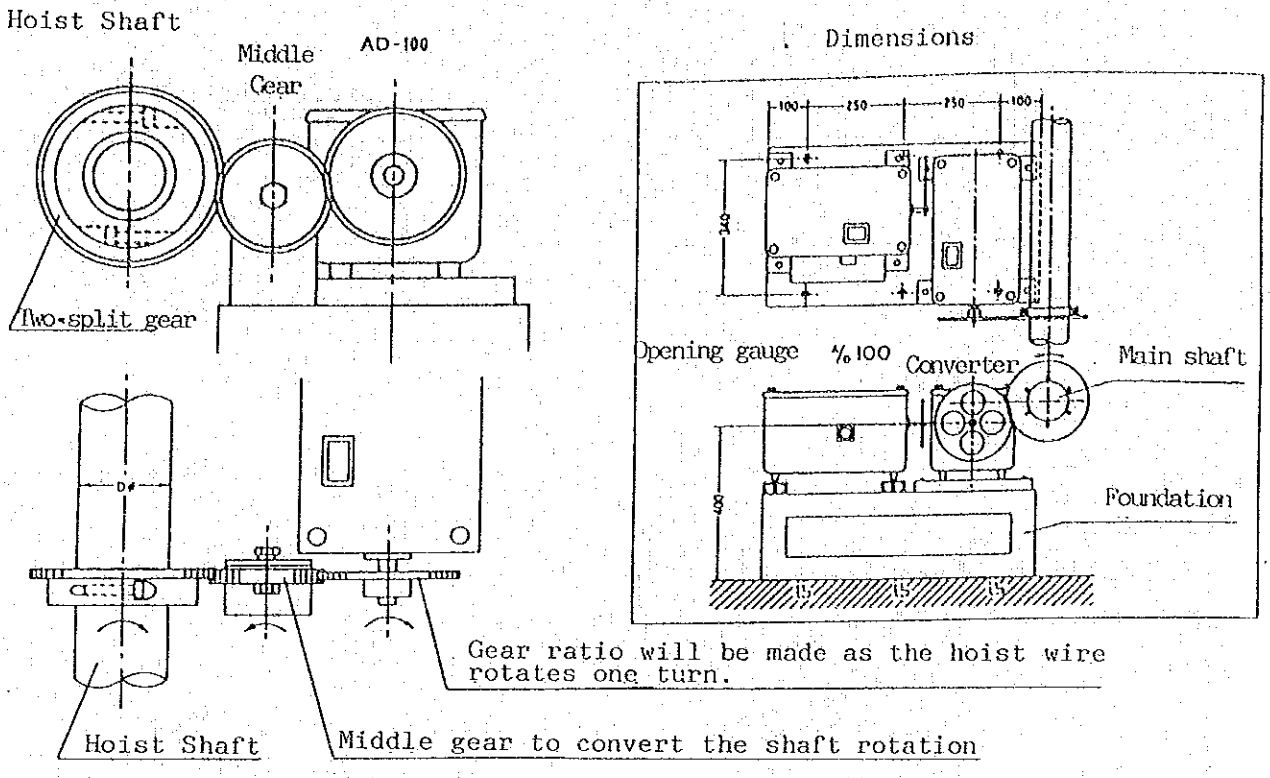
[FEATURES]
- 1 cm per division, 10 m full scale, with 2 pens.
- High accuracy, heavy duty, general purpose.
- Optional built-in telemetering transmitter.

[SPECIFICATIONS]

Detector:	Float.
Measuring range:	0 to 10, 20 or 50 m (To be specified).
Accuracy:	Within ± 1 cm.
Float diameter:	250 mm.
Recorder:	Felt-cartridge pen, 2pens, Linear Tracing.
Chart:	Roll paper.
Effective recording width:	200 mm.
Chart speed:	6 mm/h (3-months recording). 18 mm/h (1-month recording).
Chart drive:	Quartz clock.
Continuous recording period:	3 months or 1 month (To be specified).
Power supply for clock:	(To be specified from the following). ① Dry cell type; Use 4 dry cells. ② Outside power source type; 12 V DC (Any size). ③ Rechargeable battery type; Use 4 Ni-cd battery with Model N-035 charger.
Dimensions:	553(W) x 320(H) x 250(D) mm.
Weight:	Approx. 24 kg.

Fig. 4.4 Outline of Gate Opening Gauge (for reference)

. Installation Sketch

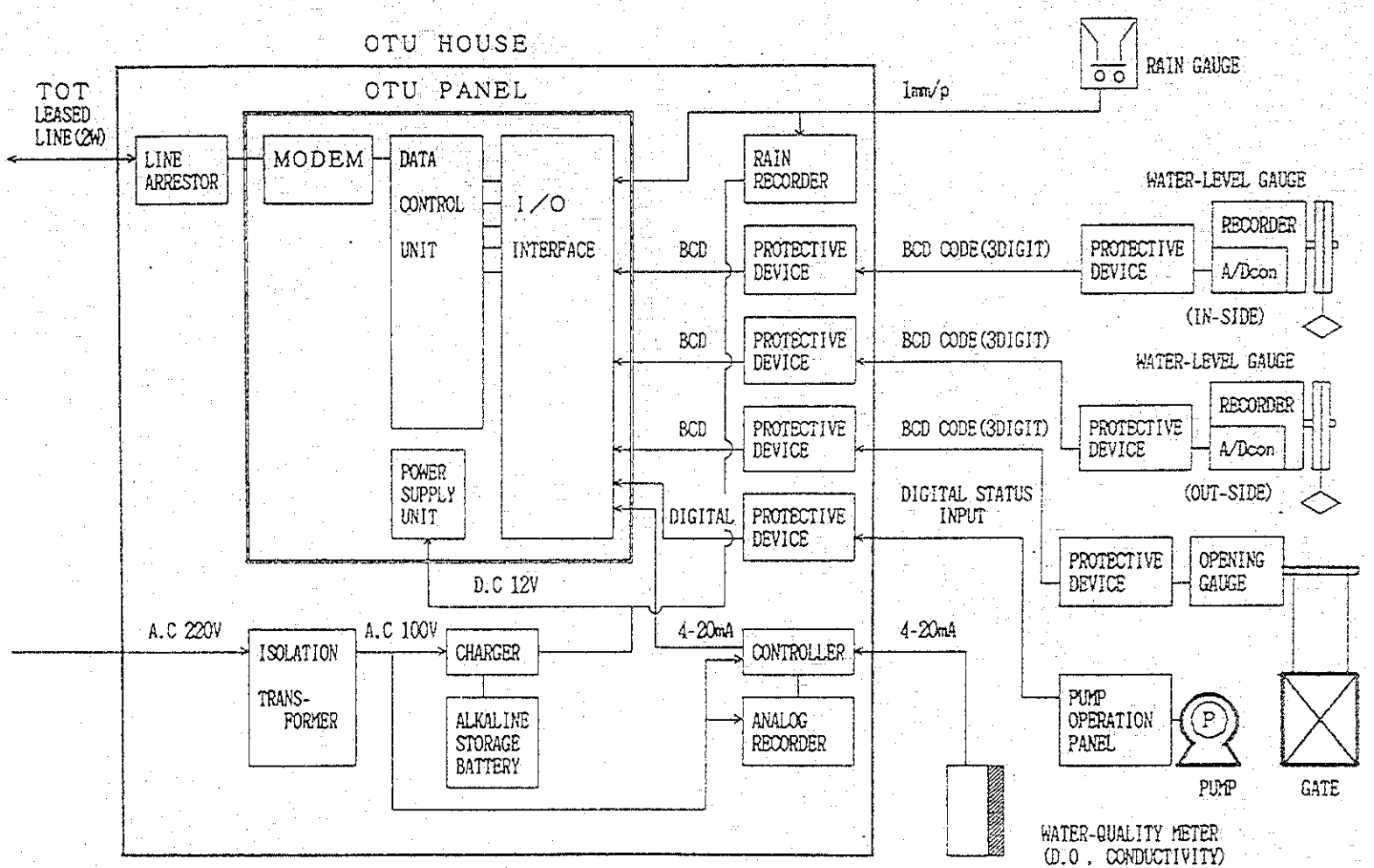


Note: For the design and manufacturing of the middle gear, it is necessary to know the hoist shaft diameter and the number of rotations to hoist the gate 1.0 m.

FEATURES:

Measuring Range:	0 to 9.99 m (3-digits), 0 to 99.99 m (4-digits)
Accuracy:	Within ± 1 cm
Input Shaft:	1 turn/1m (increase in clockwise rotation)
Output:	BCD (0 voltage "a" connector)
Output Connection Capacity:	24V DC 300 mA
Power:	DC 24V or DC 12V full time input
Power Consumption:	DC 24V less than 350 mA
Connection Cable:	18 wires for 3 digits, additional 3 wires for warning signal output 23 wires for 4 digits, additional 3 wires for warning signal output
Warning Connection:	0 votlage "a" connector, AC 100V 5A

Fig. 4.5 Standard Block Diagram of Monitorining Station



STANDARD BLOCK DIAGRAM

4-3 Design of Data Transmission System

4-3-1 Communication Method

Communication methods can be classified by direction and type:

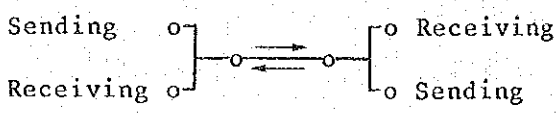
1) Communication Methods by Direction:

The following communication methods are either one-way or two-way:

a. One-way Communications: Sending o——→o Receiving

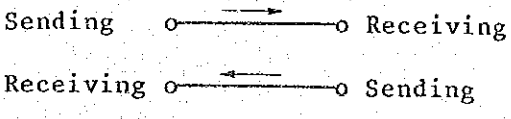
- Information flow direction is fixed.
- For data collection use, the observation station is always the sending side and the main station is always the receiving side.

b. Half Duplex Communications:



- It is possible to send information in both directions, but only one way at a time.
- Each side has a transmitter and a receiver. Communications can be performed in both directions by switching either to the transmitter or to the receiver.
- A simplex radio communications link of VHF/UHF has one or two channels through repeater stations and operates.
- This type of communications is used for general polling telemeters and portable radio equipment.

c. Full Duplex Communications:



- It is possible to send information in both directions simultaneously.
- Each station has a transmitter and a receiver, and they can communicate simultaneously.

- A simplex radio communication link of VHF/UHF has two or four channels operating through relay stations. Each cannel of a multiplex radio link can allow two-way communications simultaneously.
- This system can be utilized for telephone circuits that can send and receive information simultaneously.

2) Communication Methods by Types

The following communication methods are dependent upon what kind of information collecting and transmitting methods are used:

a. 1 : 1 Type:

This is the most basic connection type for opposite direction communication links.

b. (1 : 1) X N Type:

- This type has more than one opposite direction communication link (N-system).
- Communications of this type is the cyclic method that sends a series of information repeatedly.

c. 1 : N Type:

This type is used for general telemeter systems and warning systems that have one main station and various substations (N-stations).

d. 2 : N Type:

This is a system whereby various substations have two main stations. In general, one main station controls the substations and the other main station works as a receiving station.

e. Network:

A compound large-scale communication system consists of the above mentioned communication types and forms an information network.

4-3-2 Data Transmission (Gathering) Link:

Data transmission method can be classified as follows:

1) Cyclic (Continuous Transmission) Method:

By this method the data is transmitted only in one direction, such as from an observation station to its main station. This method is suitable for transmitting or gathering large on certain amounts of data at all times.

2) Polling (call Control) Method:

By this method the station that requries data (master station) calls data sources (observation stations) one at a time and gathers the data. This method is suitable for gathering relatively small amounts of data, or for gathering data periodically with long time intervals, or in such cases where the data transmission route has certain limitations.

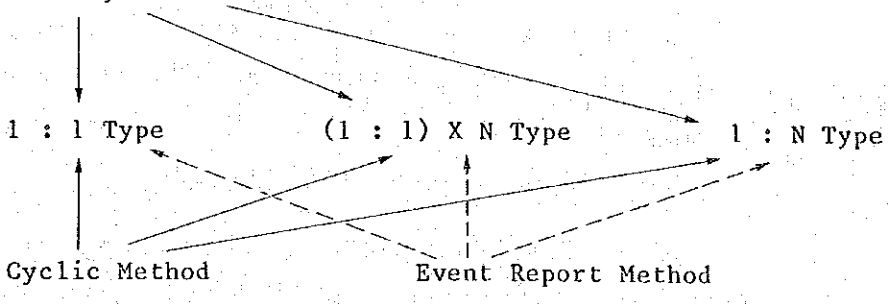
3) Event Report Method

By this method data is transmitted from the source to the master station only when such data is created at the source (such as rainfall). This method is suitable for use with a small number of data sources having a small amount of data.

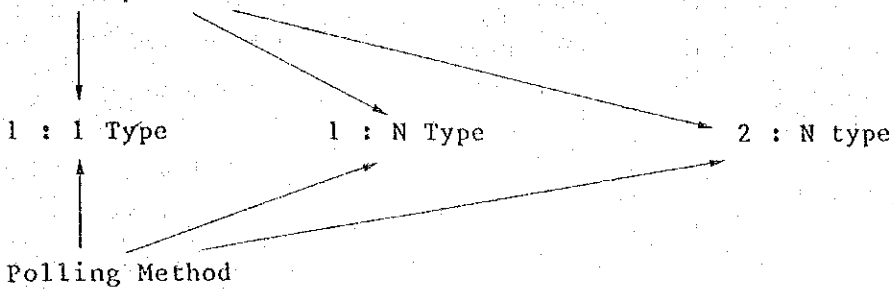
4-3-3 Combinations of Communication Methods and Data Transmission (Gathering) Methods

Combinations of the above mentioned methods are as follows:

1) One-way Communication Method



2) Half Duplex Method



3) Full Duplex Method

This combination method is applicable to all communication types and methods.

4-3-4 Applicability to the Project

Design requirements for the Project are as follows:

- o One (1) data requiring station (master station) and twenty-six (26) data sources (monitoring stations).
- o Data transmission (gathering) times are at 15 minute cycles or at any other times required, such as during flood periods.
- o Each monitoring station can transmit (gather) an average of six data.
- o Communication lines are TOT leased lines.
- o Effects from natural disasters shall be minimal.

It was decided upon to adopt the following methods to satisfy the above requirements:

- . Communication method:: One-way method
- . System type: 1 : N type
- . Data transmission (gathering) method: Cyclic method
- . Communication lines: TOT leased lines (2W/station)

The above system has the following merits:

- o Data transmission process is simple.
- o Data transmission equipment is simple.

o Monitoring of each communication line and observation station can be made at any time and it is possible to take immediate measures in the event of a system breakdown.

4-3-5 Signaling Method

It was decided upon to adopt the generally used cyclic digital telemeter method that has been standardized by the Japanese Ministry of Construction.

The outline of the cyclic digital telemeter is as follows:

. Data transmission:	Multiplex cyclic transmission method
. Modulation:	Frequency shift
. Coding:	NRZ fixed length coded
. Synchronization:	Frame synchronized
. Speed:	200 baud
. Modulating frequency:	800 + (n-1) x 400 $\pm$ 100 Hz (n=1 to 6)

4-3-6 Power Supply to Monitoring Stations

Power supply equipment for monitoring stations shall consist of lightning-proof transformers, DC power source equipment, and batteries. An outline of the equipment is as follows:

1) Lightning-proof Transformers:

. Input:	AC 200 V, Single phase
. Output:	AC 100 V, Single phase
. Discharge capacity:	10 KVA at 4 x 10 ps

2) DC Power Supply:

. Input:	AC 100 V, Single phase
. Rectifier output:	15 A
. Constant voltage accuracy:	$\pm$ 2%

3) Batteries:

. Type:	AM 100 P-10

4-4 Design of Information Receiving System from Other Agencies

4-4-1 Information Receiving System from RID

The international standards for facsimile machines were made by CCITT as group 1 (G1), group 2 (G2), group 3 (G3), and group 4 (G4) for high speed transmission. G1 and G2 were the standards for facsimile machines when they were first put into practical use. Presently, G3 standards are used, and G3 machines are widely used. G4 machines, that were made by adopting image condensing technology, can transmit data at high speeds. However, it will take a while before it can be used in generally available.

Judging from the basic design requirements, it was decided upon to adopt the following standard:

- Group 3 (G3) type of CCITT
- Sending paper size: up to A3
- Heat printing method

4-4-2 Information Receiving System from MD

There are two types of modems -- the synchronized type and the asynchronized type. The data transmission speeds specifications vary widely; there are 300 baud, 1,200 baud, 2,400 baud, 9,600 baud, etc. At any rate, the transmitting side and receiving side must satisfy the same specifications.

In order to gain access to the MD's existing information service system that are specified in the basic design requirements, the Project modem must satisfy the following specifications:

- Synchronized modem
- Transmission speed of 2,400 baud
- Transmission lines: TOT leased lines (CCITT M1020 standard), two wire.

4-5 Design of Process Indication System

4-5-1 Basic Items to be Examined

1) Intervals for telemetering data's processing by OTU shall be 15 minutes as a basis.

2) The number of telemetering data will be as follows:

		Number of Data
. Rain gauges:	21 stations	21
. Water level gauges:	24 stations	41
. Gate opening gauges:	17 stations	30
. Pump operation:	12 stations	158
. Water quality meters:	2 stations	4

3) Process Indication Methods

Collected data will be processed by the main computer in the Flood Control Center and will be indicated on the system indication board, 70-inch large screen projector, CRT display equipment, color hard copier, and printer.

4) Major Functions of the Equipment

a. Telemetering panel:

The telemetering panel will gather data from each of the 26 OTU stations and transmit to the main computer and the mimic panel.

b. Mimic panel:

The mimic panel will observe the overall conditions of the entire monitoring area of the Flood Control Center. The panel will indicate the following information:

- Real time water levels at the major stations (digital indication)
- Rainfall during the past 24 hour period at the major stations (digital indication)
- Pump operation at each station (condensed information indication)

- Gate open or close condition at each station (condensed information indication)
- Water levels at each station (macro indication with red, yellow, and green colors)
- Conditions of TOT lines between each station and the Flood Control Center (normal/abnormal indication)
- Major BMA covered area map both west and east side.

The mimic panel will also maintain the observation of the monitoring system unders the abnormal condition of the computer.

c. Visual display units (VDU):

The VDU will process and indicate rainfall, water level, pump operation, gate opening, and water quality data at real time, every hour, and daily.

VDU will indicate data with tables, line charts, bar charts, and maps. Selection of indication on the VDU screen shall be easily made by keyboard or light pen operation. Hard copy order and 70-in projector indication displayed pictures of VDU shall also be easily made by operator.

Two VDU units will be installed for independent use.

d. Color hard copier:

The color hard copier will make colored hard copies of the data indicated on the VDU.

e. Printers:

The printers will record daily, monthly, and yearly rainfall, water level, and water quality data, as well as pump operation hours. It must be carefully operated to prevent making unnecessary prints.

Three printer units will be installed for rainfall and water level data, and gate and pump operation

information, for recording water quality data, and for various other recording purposes.

Water level recording shall be selectable zero point whichever MSL or DDS through VDU.

f. 70-inch projector:

The 70-inch large screen projector will indicate the data shown on the VDU to exhibit the data not only to the operator but to the related members of the Flood Control Center. The projector, in combination with a VTR, must be able to display the contents of a videotape.

g. Hard disk:

The hard disk stores data necessary for the software and the display on VDU.

h. Floppy disk:

The floppy disk automatically loads the computer program that is necessary for activating the computer system (initial starting or restarting after abnormal operation).

i Magnetic tape drive:

The magnetic tape drive will record the accumulated data, covering approximately a six-month period, that was transmitted from each OTU station and stored as 15 minute basis data.

The recorded data will be utilized for analyses and simulation at the engineering work station.

j. System console:

Program data that functions to gain access into the main computer can be changed by operating the system console.

k. Computer and main memory:

The computer and main memory will process the software operations, such as interfacing between data collection, indication, recording, storing, and the operator.

5) Data Storing Process

The basic concept of the telemetering monitor system is as follows:

a. Data related to rainfall, water level, and water quality will be recorded on the paper of the self-recorders in the OTU stations.

b. Information indicated on the VDU can be retained as a record in the color hard copier, if required.

c. Daily, monthly, and yearly arranged data will be recorded as the printer output.

d. Data to be utilized for analyses and simulation will be recorded on magnetic tape and then offered to each exclusive system.

Each exclusive system that stores data becomes an engineering work station (EWS). Data in the magnetic tape are passed from one EWS to another.

Passing data to an IBM personal computer that uses floppy disks, shall be performed by format conversion processing in EWS without passing from the main computer as a floppy disk basis.

In general, the capacity of a floppy disk is 1 megabyte/diskette, and the capacity of a magnetic tape drive is 20 to 40 megabyte/reel.

By assuming that the amount of data to be recorded will be the six-month accumulation of 15-minute value data, the required memory will be 20 to 30 megabyte. Thus, floppy disks will not be proper for this purpose.

6) Software Composition

a. Basic software and utility software:

Because software is a main part of the computer system, it is called an "operating system" (OS). The OS conducts the run control of application software as well as data input and output management, time management, equipment's abnormal operation management, language processing, data base management, and program changes. And, as the Project system is a telemetering monitor system, basic and utility software must be a real time OS.

b. Application software:

This is the software that will realize the functions of the Project's system, such as data processing, indicated image processing, recording, data storing, etc.

c. Data base:

The data base will conduct the input process, inside process, output process, and clarify, in accordance with each function and objective, the data that will be used in the system, and will store them with preset formats.

7) Function of application software

a. System management

b. Communication functions

c. Rainfall data processing task

Real time, hourly, daily, monthly and yearly data processing.

d. Water level data processing task

Real time, hourly, daily, monthly, and yearly data processing.

e. Water quality data processing task

Real time, hourly, daily, monthly, and yearly data processing.

f. Pump operation data processing task
   Real time, monthly, yearly data processing.
g. Gate opening data processing task
   Real time, monthly, yearly data processing.
h. VDU background picture data processing task
i. Logging data processing task, printer output
j. Historical data storage task, storage in MT
k. Line and bar graph generation task
l. Accumulated data processing task
m. VDU picture editing task
n. Set point value data modification task, limit check value
o. Utilities

8) Functions of Data Base

a. Real time data
b. VDU picture data
c. Recorded data
d. Historic data

9) Data Indication

Judging from past experience and future predictions, the data indication shall be as follows:

a. Rainfall data:

. Hourly rainfall:	3 digits	mm/hr
. Daily rainfall:	3 digits	mm/day
. Monthly rainfall:	4 digits	mm/month
. Yearly rainfall:	4 digits	mm/year
b. Water level data:	3 digits	m
c. Water quality data (DO):	3 digits	ppm
d. Water quality data (EC):	3 digits	μS/cm

10) Estimated Data Volume

The memory capacities are estimated as follows:

. Basic and utility software:	10 to 20 MB
. Application software:	5 MB
. Data base (real time 15 minute basis data):	25 MB
. Historic data base:	50 MB
. Program development area (future use):	20 MB
TOTAL	110 to 120 MB

Thus, the required capacities of the hard disc and the main computer must be:

① Hard disc capacity: More than 120 MB

② Main computer's main memories: More than 3 MB

The number of telemetering data words at each monitoring station is shown in Table 4.3.

Table 4.3 Number of Telemetering Data Words at Each Monitoring Station

No.of Monitoring Station	Location Of Monitoring Station		Monitoring indexes							TOTAL
			Rainfall	Water Level		Gate Opening (0.20.40.60.80.100 %)	Pump Operation (ON /OFF)	Water Quality		
				Inside	Outside			D.O.	Conductance	
M 1	K.Song (Don Muang)	W.D.	1w	1w	1w	1w				4w
M 2	K.Prem Prachakorn	W.G.	1	1	1	1				4
M 3	K.Lat Phrao		1	1						2
M 4	K.Lam Charat		1	1						2
M 5	K.Bang Khen (South)	P.S.	1	1	1	1	4set 2w			6
M 6	K.Bang Sue	P.S.		1		2	12 4			7
M 7	K.Lat Phrao	W.G.	1	1	1	1				4
M 8	K.Saen Saep (Wat Banphen Tai)	C.D.	1	1	1					3
M 9	K.Saen Saep (Minburi)	W.G.	1	1	1	1				4
M10	K.Sam Sen	P.S.		1	1	2	10 4			8
M11	K.Krung Kasem	W.G.	1	1	1		5 2			5
M12	Flood Control Center		1							1
M13	K.Sam Sen	W.G.		1	1	2				4
M14	K.Saen Saep	P.S.	1	1	1	2	5 2	1w	1w	9
M15	K.Saen Saep (Bang Kapi)		1	1						2
M16	K.Krung Kasem	P.S.	1	1	1	1	5 2	1	1	8
M17	Rama IV	P.S.	1				4 2			3
M18	K.Phrakanong	P.S.	1	1	1	6	35 12			21
M19	K.Bang Jek	P.S.		1	1	2	2 1			5
M20	K.Phrakanong (Wat Khachon Siri)		1	1						2
M21	K.Phrakanong (Wat Krathum Sua Pra)	C.D.	1	1	1					3
M22	K.Phrakanong (Lat Krabang)	W.G.	1	1	1	1				4
M23	K.Wat Sai	C.D.	1		1					2
M24	K.Bang Oa	P.S.	1	1		2	6 2			6
M25	K.Bang Na	P.S.		1	1	2	5 2			6
M26	K.Sam Rong	P.S.	1	1	1	3	25 9			15
	M. D.									
	R. I. D.									
	T o t a l		w 21	w 23	w 18	w 30	w 44	w 2	w 2	w 140

note: 1 word = 3 digit = 12 bit
1 digit = 4 bit

※ Telemetering data format shall be compiled with 40 bit CDT Format.

1-Rainfall = 1 word
1-Water Level = 1 word
1-Gate Opening = 1 word
1-Pump Operation = 1 digit
1-Water Quality = 1 word