


**BASIC DESIGN STUDY REPORT**  
**ON**  
**THE PROJECT FOR IMPROVEMENT**  
**OF EXISTING PUMPING STATION**  
**FOR IRRIGATION AND DRAINAGE**  
**IN**  
**THE KINGDOM OF THAILAND**

**OCTOBER 1987**

**JAPAN INTERNATIONAL COOPERATION AGENCY**

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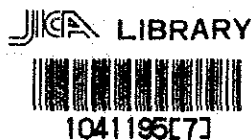
BASIC DESIGN STUDY REPORT ON THE PROJECT FOR IMPROVEMENT OF EXISTING PUMPING STATION FOR IRRIGATION AND DRAINAGE IN THE KINGDOM OF THAILAND

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## PREFACE

In response to the request of the Government of the Kingdom of Thailand, the Government of Japan has decided to conduct a Basic Design Study on the Project for Improvement of Existing Pumping Station for Irrigation and Drainage and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Thailand a study team headed by Mr. Seiichi Kanai, Deputy Head, First Basic Design Study Division, Grant Aid Planning and Survey Department, JICA, from July 5 to 24, 1987.

The team had discussions on the Project with the officials concerned of the Government of Thailand and conducted a field survey in the Project sites. After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Kingdom of Thailand for their close cooperation extended to the team.

October, 1987

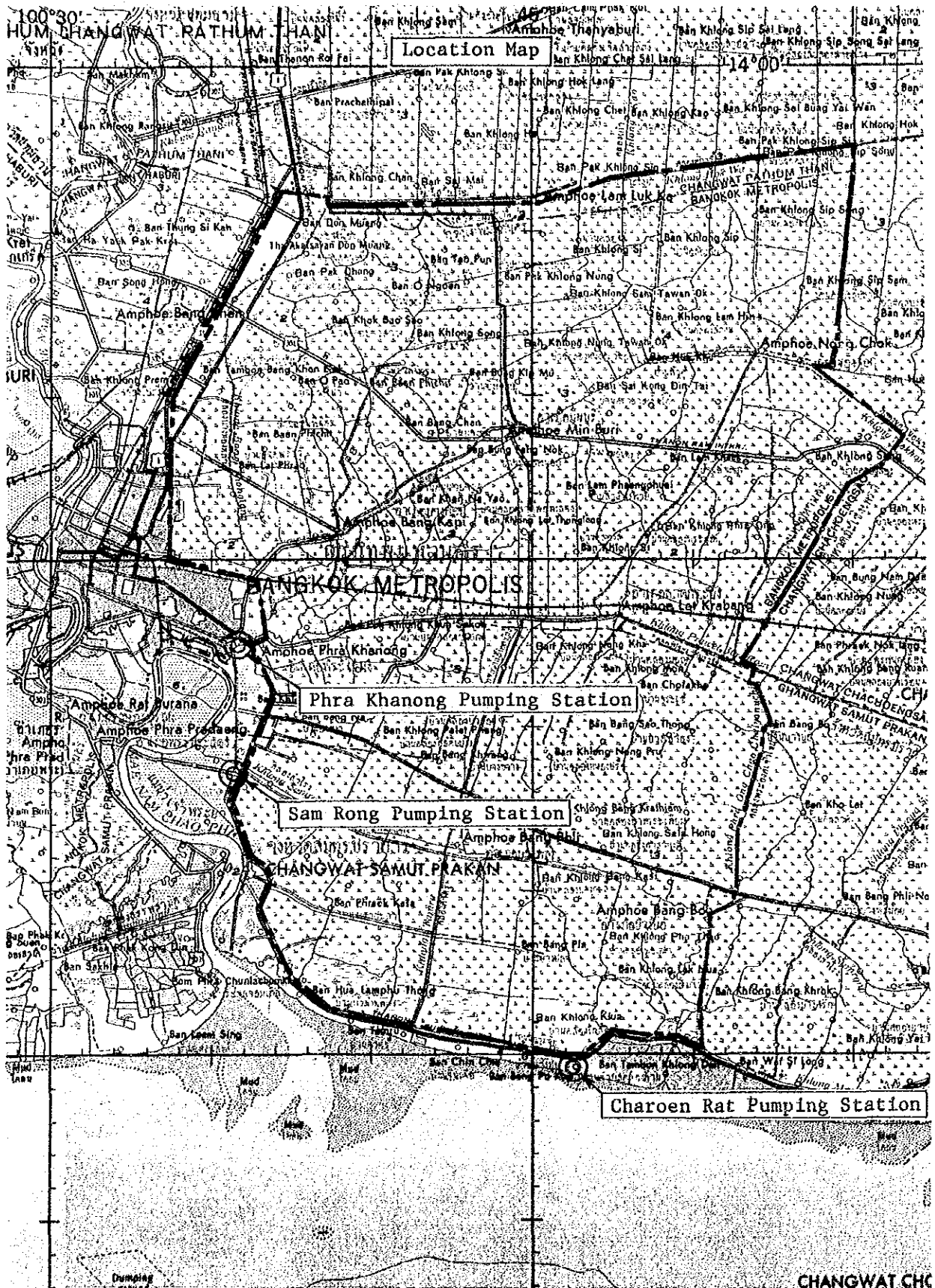


Keisuke Arita

President

Japan International Cooperation Agency





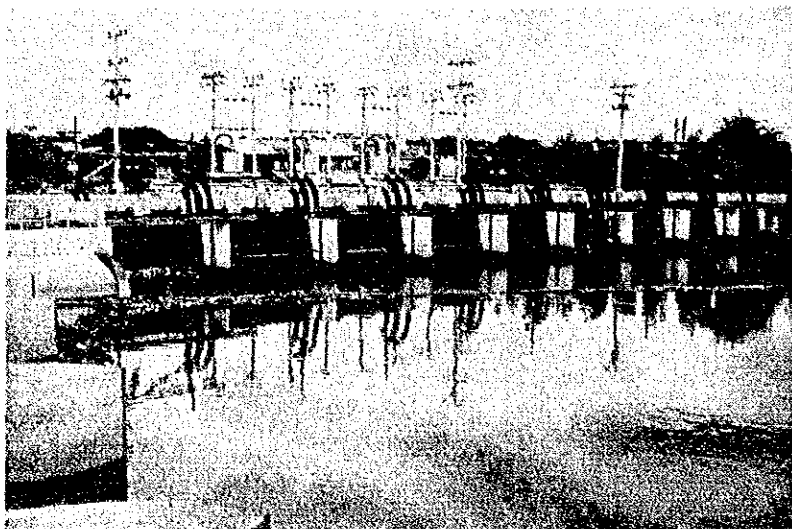
Boundary of Area

⊙ Subject Pumping Station

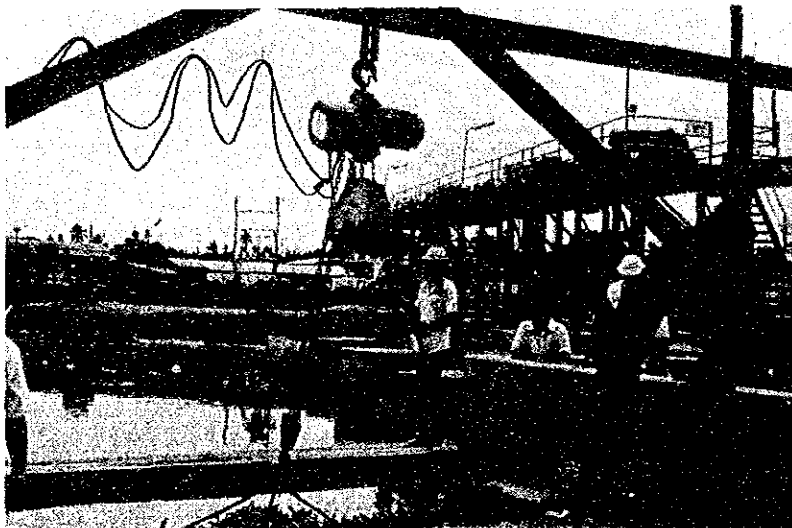




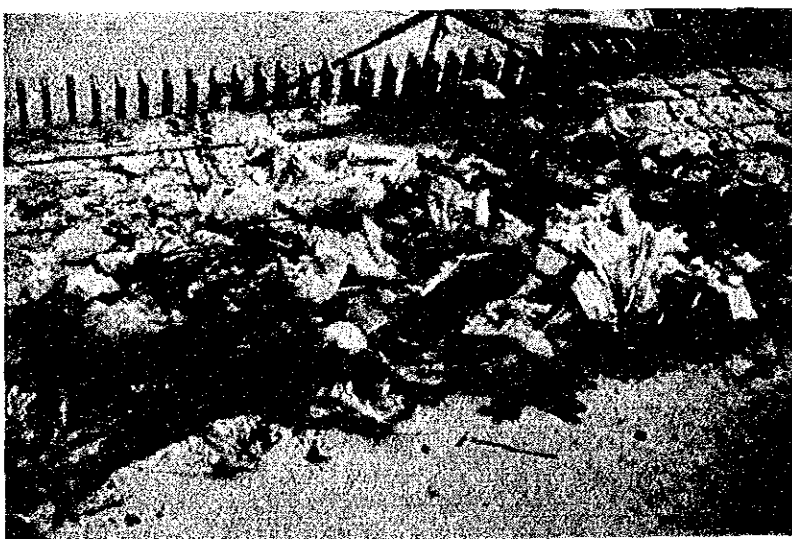
Phra Khanong Pumping Station (Right-bank)



General view

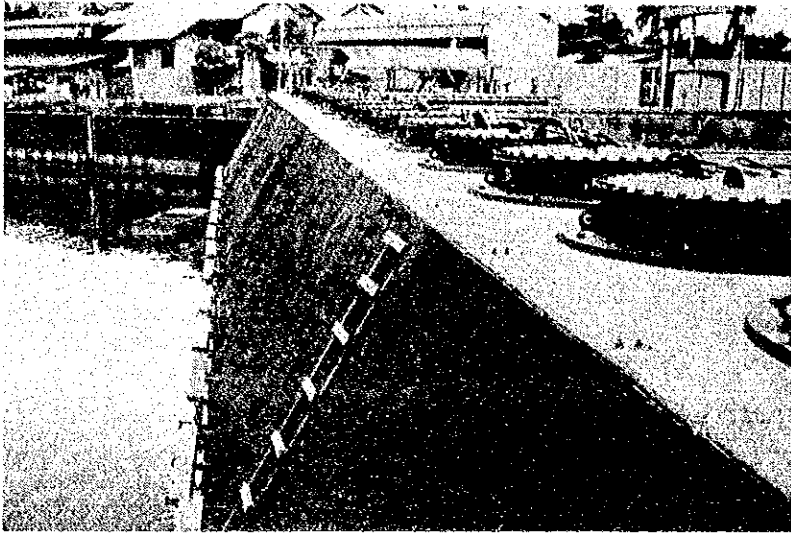


Temporary trash raking equipment

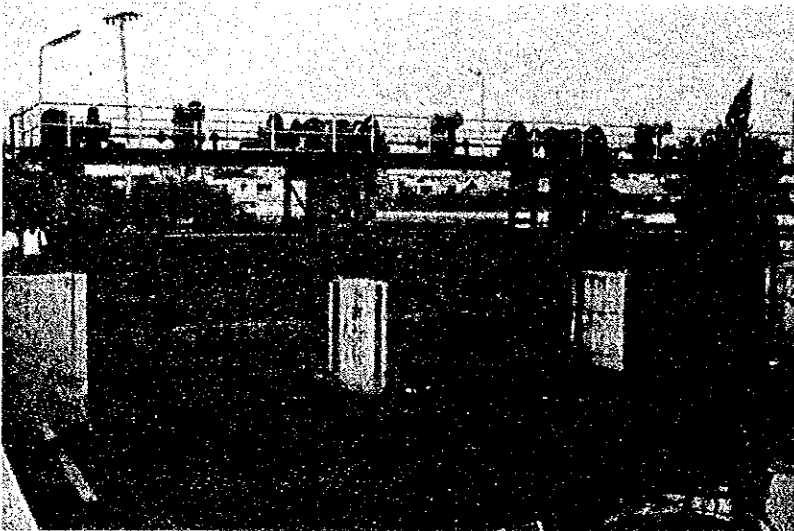


Raked-up trashes

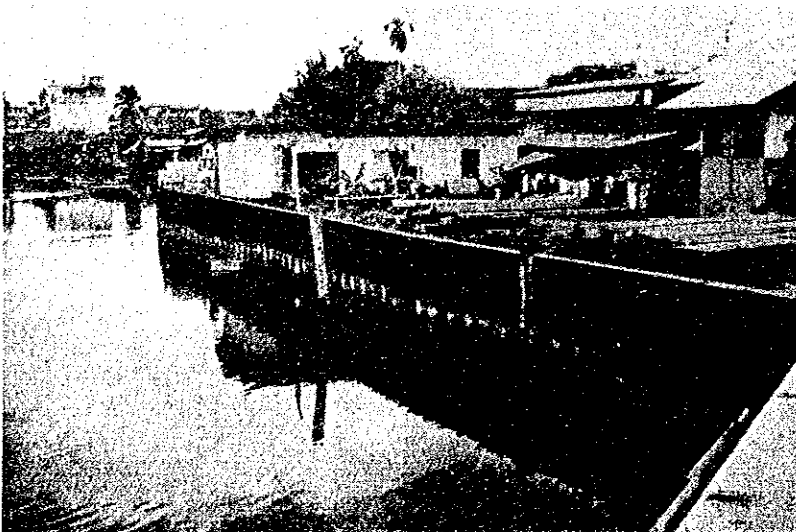
Phra Khanong Pumping Station (Left-bank)



Installation state of pumps and screens

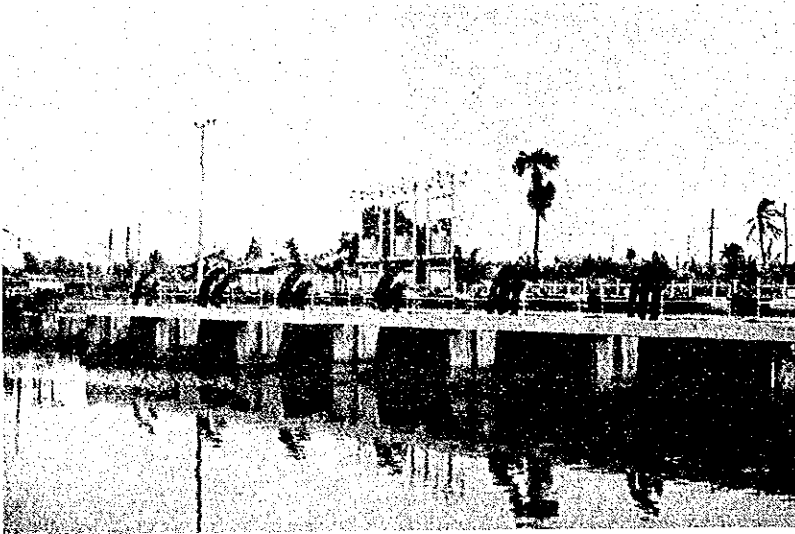


General view of the left-bank drainage gate



Construction site of new structure to be installed the automatic trash rakes

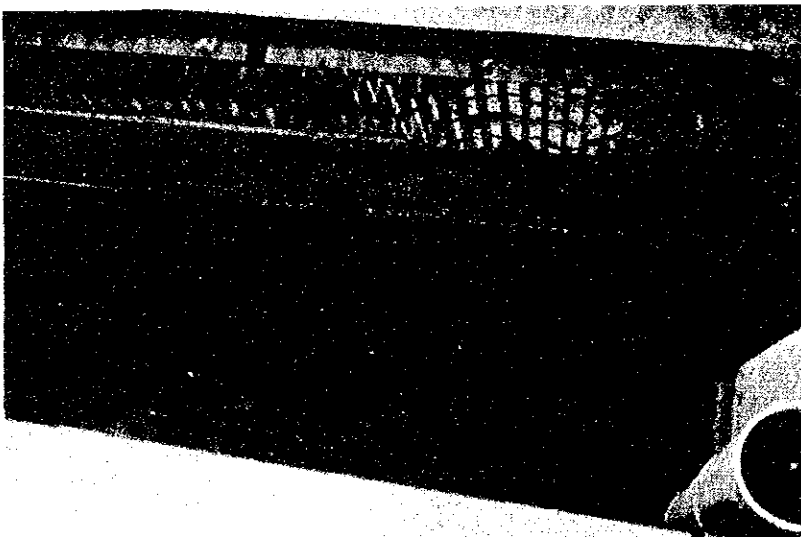
Sam Rong Pumping Station (Right-bank)



General view

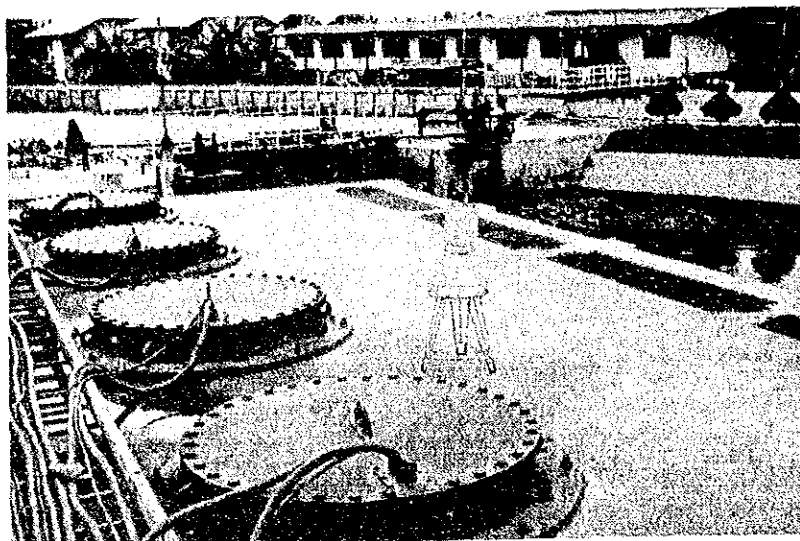


Installation state of pumps and screens

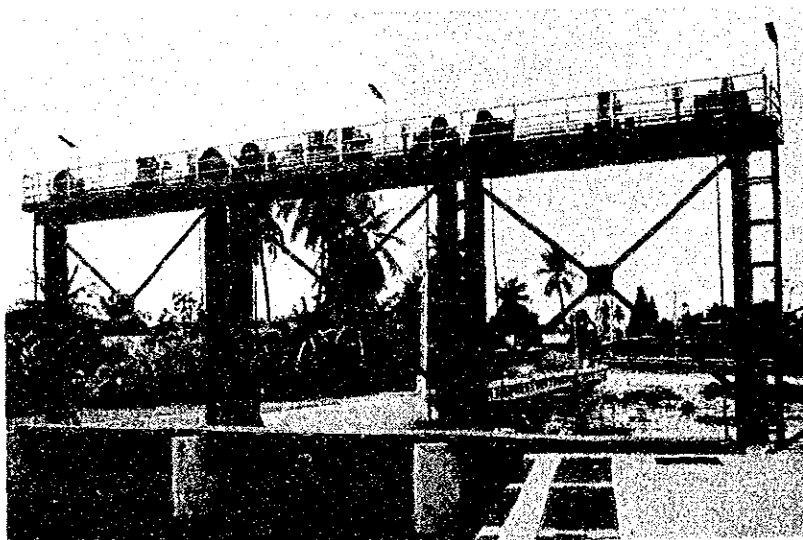


Condition of water level went down due to the trashes under water

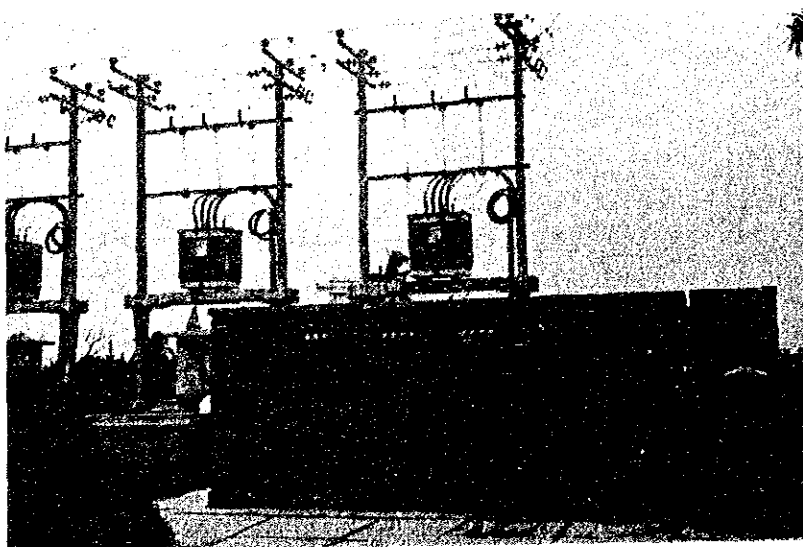
Sam Rong Pumping Station (Left-bank)



Installation state of pumps in the navigation lock

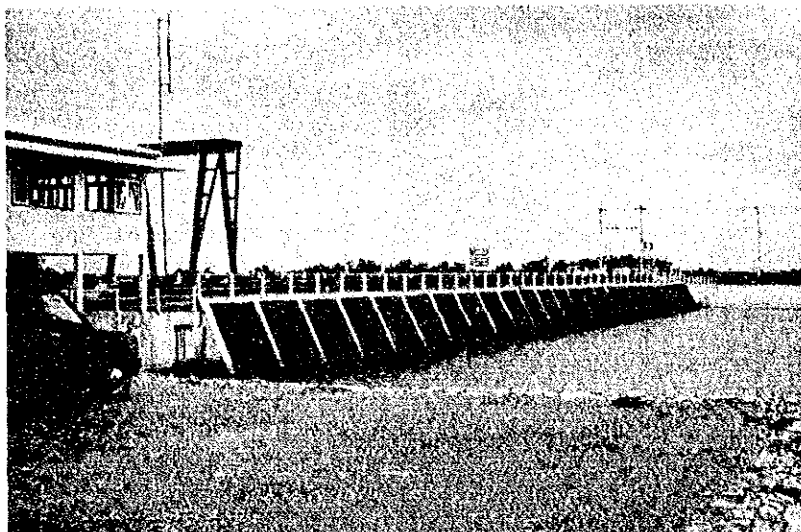


General view of drainage gate

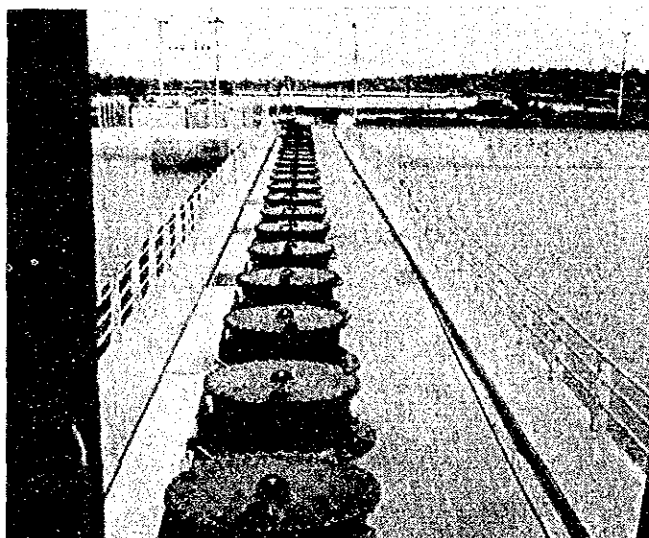


Installation state of pump control panels

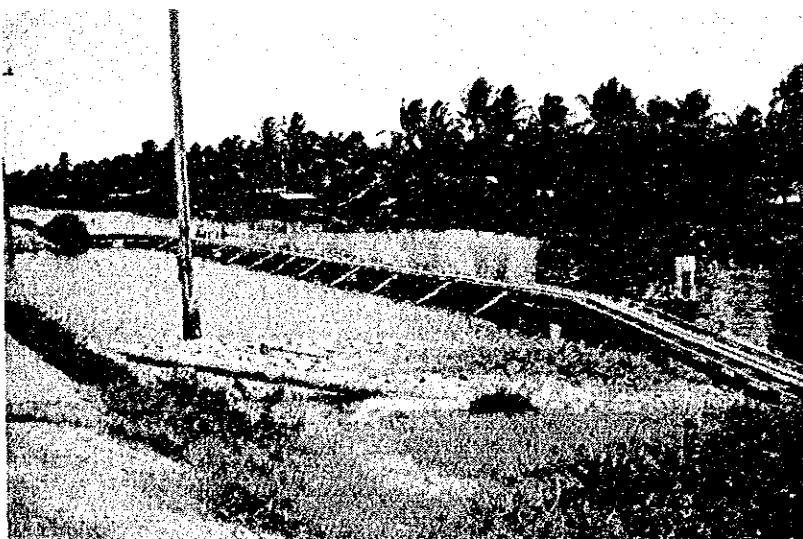
## Charoen Rat Pumping Station



General view



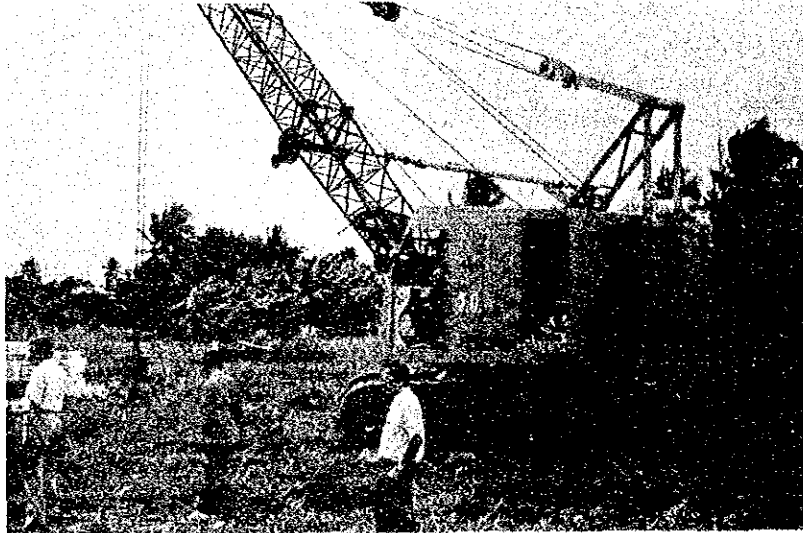
Installation state of  
pumps and crane rails



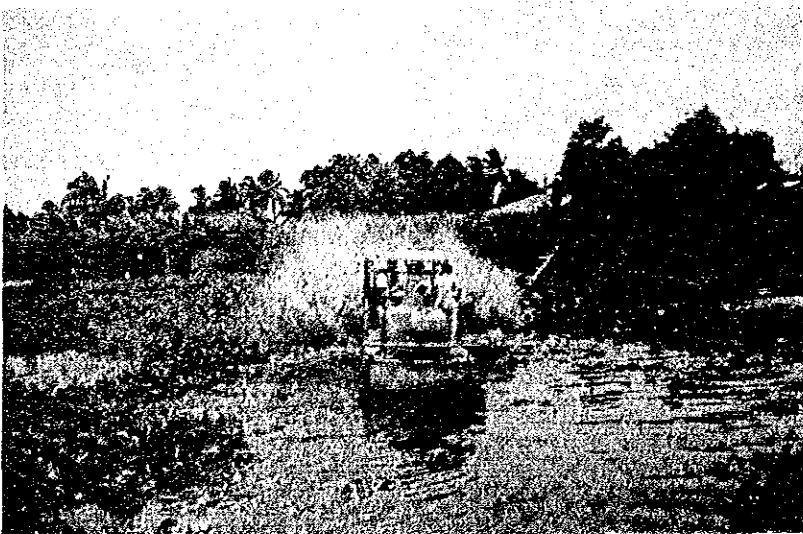
Wooden screen installed  
at the entrance of  
stilling pond



Water-surface of the drainage canal covered with water hyacinth



Removing of water hyacinths using heavy machine



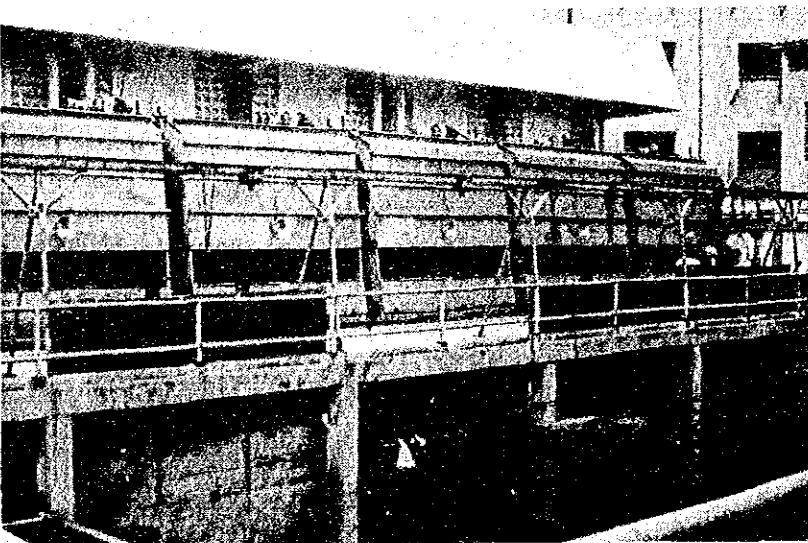
Machine to keep the course for boat



Root of grown water hyacinth



Houses on the bank of drainage canal



Automatic trash rakes at the Krung Kasem pumping station





## SUMMARY



## SUMMARY

In recent times, Bangkok has been subject to major flooding once every two to three years. The flood of 1983 was the worst in 40 years, and it caused tremendous damage in the Bangkok metropolitan area. More recently, in May 1986, the area suffered extremely heavy rains, and the entire Bangkok metropolitan area was covered with water.

Damage at this time, however, was less than that from the flooding in 1983, partly because of the increase in the emergency capacity of the drainage pumping station. This was implemented as a countermeasure against flooding to improve the drainage in the metropolitan area. It has been pointed out, however, that in 1986, the smooth running of the pumps was interrupted, because the drainage pumping stations were clogged by a combination of refuse which had been thrown into the drainage canals, and water hyacinths which grow in the drainage canals.

The Government of the Kingdom of Thailand hopes to protect the development of the metropolitan area, as well as encourage farming in the agricultural areas by solving the problem of blocked drainage caused by refuse, thus securing the smooth running of the pumps. The Bangkok metropolitan area would be protected against flooding and at the same time flood water remaining on area farmland will be removed. To achieve these objectives it is urgently necessary to install automatic trash rakes at drainage pumping station, in particular the pumping stations at Phra Khanong, Sam Rong, and Charoen Rat. These 3 stations, all located within the metropolitan area, also serve large drainage basins and broad expanses of farmland. The Government of the Kingdom of Thailand, therefore, has requested that the Government of Japan install automatic trash rakes at these drainage pumping stations under its grant aid assistance program.

After examining the contents of the said request from the Government of the Kingdom of Thailand, the Government of Japan has decided to carry out a basic design study for this project.

On the basis of this decision, the Japan International Cooperation Agency (JICA) sent a basic design study team to Thailand from July 5 to 24, 1987.

The study team discussed the contents of this request with the officials concerned of the Government of the Kingdom of Thailand, to confirm the appropriateness of the project. The team also conducted a field survey of the current situation, collecting data and information regarding the drainage pumping stations which are the objects of this project, as well as facts on refuse, etc.

The current survey on the situation has clarified that both the various kinds of refuse thrown into the drainage canals as a result of urbanization which is progressing rapidly along the shorelines of all the drainage canals upstream from the pumping stations, and the water hyacinths which proliferate in the drainage canals, etc., have increased to huge amounts. When the refuse and water hyacinths flow into the pumping stations, they clog up the screens and block the passage of running water, thus decreasing pumping efficiency. It is thus obvious that this will result in flood damage upstream during flood season. It is judged that installation of automatic trash rakes, as discussed above, in these pumping stations, is necessary to protect the Bangkok metropolitan area from flooding, and must be done swiftly for humanitarian reasons. After a thorough analysis of how refuse is decreasing pump drainage capacity, the team has determined the most appropriate system and type of automatic trash rakes.

The following summarizes the details of the grant's contents.

Pumping station Equipment	Phra Khanong						Sam Rong						Charoen Ret		
	Left-bank			Right-bank			Left-bank			Right-bank					
	m	m	kw units	m	m	kw units	m	m	kw units	m	m	kw units	m	m	kw units
Main body of automatic trash rake	5.4 x 5.0 x 5.5 x 5			5.5 x 5.0 x 5.5 x 2			2.4 x 5.2 x 3.7 x 10			5.4 x 5.3 x 5.5 x 7			5.4 x 4.8 x 5.5 x 12		
	-			5.4 x " x " x 2			-			2.4 x " x 3.7 x 1			2.6 x " x 3.74 x 1		
	-			5.3 x " x " x 2			-		-	-			-		
	-			5.0 x " x " x 1			-		-	-			-		
	-			4.9 x " x " x 2			-		-	-			-		
Belt conveyer (horizontal)	63 x 5.5 x 1		unit	67 x 5.5 x 1		unit	18 x 1.5 x 4		units	55 x 3.7 x 2		units	82 x 5.5 x 1		unit
	(Reversible-rotation type)			53 x 3.7 x 1			23 x " x 1			(1 unit is reversible-rotation type)			-		
" (inclined)	15 x 7.5 x 1			-			-			15 x 5.5 x 1			18 x 3.7 x 1		
	-			-			-			-			15 x 5.5 x 1		
	-			-			-			-			(rotary type)		
Hopper	10 x 0.75 x 2 x 1		unit	-			-			10 x 0.75 x 2 x 1		unit	10 x 0.75 x 2 x 1		unit
Trash rake control panels (Parallel panels)	1 set			1 set			2 sets			1 set			1 set		
	-			-			-			-			one unit (one set)		
Hopper operation panels	1 unit			-			-			1 unit			1 unit		
Modification of panels for existing pumps	15 units			20 units			10 units			15 units			25 units		
Water gauges	1 set			1 set			2 sets			3 sets			25 sets		
Crane (3-ton type)	1 unit			1 unit			2 units			1 unit			-		
Civil work	New structural construction • Foundation pilings (52 pilings) (φ400, L=19 m) • Concrete fill, 440 m <sup>3</sup>						Construction to extend water intake tank • Breaking up of concrete, 130 m <sup>3</sup> • Concrete fill, 270 m <sup>3</sup>						Construction to extend water intake tank • Foundation pilings (26 pilings) (φ450, L=26 m) • Breaking up of concrete: 330 m <sup>3</sup> • Concrete fill 830 m <sup>3</sup>		

The 3 pumping stations above will control drainage in paddy field by controlling the water level of the drainage canals upstream. At present, these pumping stations are administered by the Royal Irrigation Department (RID) which is in charge of irrigation and drainage projects in the Kingdom of Thailand. By this situation the executing agency for this project is RID.

The schedule for carrying out this project requires approximately 3 months for designing the facilities, and about 11.5 months for construction after the closing of an Exchange Notes between the governments of the 2 nations. It is anticipated that the total construction will be divided into 2 stages for efficiency with consideration given to the degree of modification of water intake tanks necessary, and the rainy season (flood season). The following is an outline of each stage.

	<u>Civil work</u>	<u>Manufacturing and installation of equipment</u>	<u>Term required</u>
1st stage	Improvement for the Charoen Rat pumping station	Right bank at Phra Khanong Right bank at Sam Rong Charoen Rat	Approximately 6.5 months
2nd stage	New construction for left bank at Phra Khanong  Improvement for left bank at Sam Rong	Left bank at Phra Khanong  Left bank at Sam Rong	Approximately 5.0 months

The cost to be borne by the Government of the Kingdom of Thailand will be estimated approximately 900,000 baht. This cost is considered to be bearable considering the size of the budget of RID, the executing agency in the Kingdom of Thailand.

Operation and maintenance systems shall be unified for all facilities after these facilities have been completed, considering the condition of automatic trash removing facilities and existing pumping facilities. These will be linked for operation. In other words, the operation and maintenance of each automatic trash removing facility will be done by the group which does the operation and maintenance of the existing pumping facility. The various levels of inspection and maintenance for each automatic trash removing facility are: inspection while operation is stopped, annual inspection, regular inspection, and inspection after operation. During the inspection after operation of the facility, the inspector must be given a report by the operators on actual operating conditions, and the inspector must consider an operation and control system which can prevent large-scale accidents or damage to machinery.

When this project has been carried out, the operation of the pumping stations under consideration will be smooth, and the following effects will be realized.

- (1) Decrease of flood damage in the Bangkok urban area:

Protection against floods in the urban area becomes possible by recovery of pump drainage capacity. This is an urgent matter from both a humanitarian and national standpoint.

- (2) Promotion of agriculture in the farmland in the Bangkok metropolitan area:

Floodwater remaining in the area surrounding Bangkok, can be removed in the same way as in Bangkok itself, and the control of water levels in the drainage canals will be easier. Therefore, an improvement can be expected in agricultural productivity in this area.

- (3) Savings on excess pumping costs now being caused by refuse:

A savings because of the increase in operating expenses because of the increase in pumphead which is a result of refuse accumulation; on expenses for manual removal of refuse at pumping stations; and on expenses for removal of refuse upstream with the use of heavy equipment, etc. can be expected.

- (4) Discontinuing the dangerous manual removal of refuse:

From the standpoint of worker's safety, it is urgently necessary that the dangerous manual removal of refuse at the screen sections during pump operation, to secure pump operation during the flood season, be discontinued.

- (5) Beautification of the river environment around drainage pumping stations:

When refuse is completely removed from the drainage canals by automatic trash removing facilities, the downstream drainage canal environment can be beautified. This is also connected to beautification of the areas of the city around the canals.

It is necessary to progress as planned, with the construction schedule, for the successful completion of this project. Therefore, for this purpose, the securing of space for construction at the sites involved and the

securing of access routes for these construction sites, etc., must be completed by the designated times. This is the responsibility of the Kingdom of Thailand.

The Kingdom of Thailand must also prepare the necessary hauling machinery to enable the quick transfer of the refuse collected by the automatic trash rakes to the designated locations for disposal. Facilities (pumping facilities and trash conveying facilities) must be properly operated and maintained as a single unified complex, to contribute to the continuing development of the Bangkok metropolitan area.



## Contents

	Page
PREFACE	
LOCATION MAP	
PHOTO	
SUMMARY	
CHAPTER 1. INTRODUCTION .....	1
CHAPTER 2. PROJECT BACKGROUND .....	5
2-1 National Development Plan .....	5
2-2 Flood Protection Plan for the Metropolitan Area .....	7
2-3 State of Drainage Facilities in the Bangkok Metropolitan Area .....	8
2-3-1 General situation of the Bangkok metropolitan area .....	8
2-3-2 Drainage situation in the Bangkok metropolitan area .....	10
2-3-3 Present conditions of administration relative to drainage .....	14
2-3-4 Refuse removal status of related and similar facilities .....	19
2-4 Outline of Pumping Stations Subject to This Project .....	22
2-4-1 Organization and details on project .....	22
2-4-2 Operation and maintenance budget .....	24
2-4-3 Status of activities .....	25
2-4-4 Present state of facilities and equipment .....	33
2-5 Overview of Related Projects .....	36
2-6 Present Status of International Cooperation on Irrigation and Drainage Projects in the Bangkok Metropolitan Area .....	42

	Page
2-7 Circumstances and Details of Requests .....	43
2-7-1 Circumstances of request .....	43
2-7-2 Details of request .....	44
 CHAPTER 3. DESCRIPTION OF THE PROJECT .....	 45
3-1 Objective of the Project .....	45
3-2 Study of Request .....	45
3-2-1 Review of the project .....	45
3-2-2 Examination of the requested facilities and materials .....	46
3-3 Details of the Project .....	50
3-3-1 Executing agency .....	50
3-3-2 Equipment and material .....	50
3-3-3 Overview of the project sites .....	53
3-3-4 Technical cooperation .....	57
 CHAPTER 4. BASIC DESIGN .....	 59
4-1 Principles of Basic Design .....	59
4-2 Basic Design Conditions .....	61
4-2-1 Selection of equipment and material .....	61
4-2-2 Design conditions of facilities .....	62
4-3 Basic Plan of Equipment and Material .....	64
4-3-1 Equipment and material plan .....	64
4-3-2 List of equipment .....	84
4-4 Basic Plan of Facilities .....	86
4-4-1 Distribution plan .....	86
4-4-2 Structural planning .....	89
4-4-3 Basic design drawings .....	101
 CHAPTER 5. PROJECT IMPLEMENTATION PLAN .....	 125
5-1 Project Implementation System .....	125
5-2 Construction Work Allotment .....	127

	Page
5-3 Constriction Work Schedule .....	129
5-3-1 Principles of construction work .....	129
5-3-2 Suggestions on construction work .....	130
5-3-3 Construction and supervision program .....	132
5-3-4 Equipment and material procurement plan .....	135
5-3-5 Construciton works to be taken by the Government of the Kingdom of Thailand .....	136
5-3-6 Project implementation schedule .....	137
5-4 Project Cost .....	141
 CHAPTER 6. OPERATION AND MAINTENANCE PLAN .....	 143
6-1 Operation and Maintenance System .....	143
6-2 Inspection and Maintenance Plan .....	147
6-3 Expenditures for Operation and Maintenance .....	156
 CHAPTER 7. PROJECT EVALUATION .....	 157
7-1 Effects of Project .....	157
7-2 Practicality of the Project .....	158
 CHAPTER 8. CONCLUSION AND RECOMMENDATION .....	 161
8-1 Conclusion .....	161
8-2 Recommendations .....	162
 APPENDIX	
APPENDIX 1	
1-1 Organization of Survey Team .....	A-1
1-2 Survey Schedule .....	A-1
1-3 List of Persons Interviewed .....	A-3
1-4 Conference Minutes .....	A-5
1-4-1 Minutes .....	A-5
1-4-2 Memorandum .....	A-10
1-5 Data Collected .....	A-20

	Page
APPENDIX 2-1 Bearing Capacity of Piles .....	A-23
APPENDIX 2-2 Calculation of Expenditures for Maintenance and Control .....	A-35

## CHAPTER I INTRODUCTION



## CHAPTER I INTRODUCTION

In recent times, Bangkok has suffered major flooding once every 2 to 3 years. One of these, the flood of 1983, was extremely severe, the worst in 40 years. Some areas were submerged for up to 4 months. Maximum water depth in the submerged areas was 0.8 m. An overwhelming percentage of the 6.6 billion baht worth of damage was incurred in the Bangkok metropolitan area. Damage in the eastern suburban area was especially severe, with the amount of damage reaching 3.5 billion baht. The Government of the Kingdom of Thailand constructed dikes surrounding the metropolitan area, to protect the Bangkok metropolitan area from flooding, after the 1983 flood. It also constructed pumping stations to remove flood water remaining outside the dikes, and to remove rain water within the dike areas. The drainage situation in Bangkok was considerably improved by this construction.

The value of these improvements was clearly demonstrated during the severe monsoon which occurred in May, 1986. 458 mm of precipitation was recorded in the 10-day rainfall from May 1 to 10. This rainfall alone equalled 25% of the total annual precipitation of 1,800 mm in 1986. Rainfall in the 24 hours beginning May 8 at 6 p.m., was 382 mm. This heavy a rainfall is said to be statistically likely only once every 500 or 1000 years, based on estimates from the Bangkok Central Meteorological Station. The entire Bangkok urban area was submerged by this severe rainfall, but the damage done in 1983 was greater than the damage done in 1986. The flood in 1983 involved a longer period of rainfall, and gravitational drainage by the water gates became impossible, since the water level of the Chao Phraya river which is the external water level was higher than the inner water level. Damage in 1983 was greater, since this rainfall occurred prior to reinforcement of the drainage pumping facilities by the urgent flood protection project carried out in 1984-1985.

Although total flood damage in 1986 was less than in 1983, the entire area of Bangkok was covered by flood water, causing great damage to the public transportation system, public facilities, etc. Some reasons for this were refuse thrown into the drainage canals by local residents, and water hyacinths which flow into the drainage canals, etc., causing major drainage problems. These have been pointed out as problems that must be solved in future.

Under these circumstances, the Government of the Kingdom of Thailand has requested the Government of Japan the installation of automatic trash rakes, through Japanese grant aid assistance: for 3 pumping stations, in Phra Khanong, Sam Rong, and Charoen Rat. These pumping stations cover especially wide areas which benefit from their drainage compared to other pumping station located in the metropolitan area. The purpose of installing the automatic trash rakes is the protection of urban area from flooding and the improvement of agricultural production in the farm area, and stabilization of the local standard of living, by making the control of flood water easier.

As a result of examination of the content of this request from the Government of the Kingdom of Thailand, the Government of Japan decided to conduct a basic design study of this project. JICA sent a basic design study team, headed by Mr. Seiichi Kanai, deputy head of the First Basic Design Study Division of the Grant Aid Planning and Survey Department, JICA, to the Kingdom of Thailand, from July 5 to July 24, 1987, conforming to the Government of Japan's execution policy.

The study team discussed the request with officials of the Government of the Kingdom of Thailand, and, at the same time, conducted an investigation of the current state of facilities at the drainage pumping stations which are the focus of this project, and also collected data and information. The matters on which basic agreement was reached as a result of the field survey and deliberations with officials concerned of the Government of the Kingdom of Thailand, with respect to the newly-submitted request, were arranged into minutes. These minutes were then signed and confirmed by representatives of both parties, on July 13, 1987, at RID, the Thai government agency in charge of this project.

The type of automatic trash rake to be installed in this project, must be one capable of completely solving the present problems occurring because of refuse, at pumping stations in operation. Therefore, analysis was concentrated on the blockage mechanism of the passage of running water by refuse at the screen sections. And to determine the types and volume of refuse was attempted during the term of the field survey. The kind and volume of refuse in the areas around the pumping stations were examined and also examined the situation on the upstream of the drainage canals. Detailed information about the water hyacinths which are the major components of the



refuse, was also obtained at the Weed Control & Research Branch of RID, and the botanical ecology of the water hyacinth was attempted to understand.

The study team also discussed the results of the survey, and considered future operations before terminating the field survey, to prevent misunderstandings on both sides on the scope of this project. At that time, the matters agreed upon, including the results of discussions by both sides on the contents of the newly-submitted request were arranged. A memorandum was prepared, which was then signed and confirmed by both parties, on July 23, 1987.

The study team selected the type of automatic trash rake, after returning to Japan, using the results of the comprehensive study, analysis of the site situation data and other information collected during the field survey. Basic designing of civil structure was also done, based on the results of equipment selection. The drawing up of construction plans, a rough estimation of project cost, the establishment of a plan for operation and maintenance were all done after confirmation of the appropriateness of this project. And, this basic design study report was prepared.



## CHAPTER 2 PROJECT BACKGROUND



## CHAPTER 2 PROJECT BACKGROUND

### 2-1 National Development Plan

The National Economic and Social Development Plan for the Kingdom of Thailand began its First Plan in 1961, and is presently carrying out its 6th Plan. The term covered by this Plan is the 5 years from October, 1986 to September, 1991. Characteristics of the Plan for this term include the following 4 main points.

- (1) The Plan for this term consists mainly of an adjustment plan which strongly advocates a conversion from the previous policy of quantitative expansion, to a policy of qualitative achievement.
- (2) The type of approach has changed from the previous one, in which each governmental office was the center for a complete project, to an approach by area, centered around the project program, with the various areas of each project handled by different governmental offices, as needed.
- (3) Importance is now assigned to the establishing of a consensus for the promotion of projects, and for the difficult task of economic adjustment, making it easier to execute necessary adjustments and unification.
- (4) Both annual plans and 4-year plans are being introduced to provide flexibility within the Development Plan, and to increase the project functions of each governmental office.

In order to carry out the content of this Plan, the dispersion of project functions and the reinforcement of connections between the Plan and the budget must be achieved. For this purpose, the Plan for this term has 2 overall goals, 3 strategies, and 10 programs. The two types of overall goals are: the economic goal of maintaining economic growth at an annual average of over 5% during the plan term, while continuing the important improvement of the economic balance, income distribution, and expansion of employment opportunities; and the social goal of securing peace and

justice, and improving the quality of life by continuously encouraging social development. Also, for the purpose of achieving these 2 overall goals, there are 3 strategies: the improvement of development efficiency, the reorganization of production structure, and the appropriate local distribution of revenues and prosperity. 10 programs are allocated under each strategy, as procedures for carrying out these strategies. The contents of these ten programs are as shown below.

- (1) Macro-economic operation program
- (2) Human resources and social development program
- (3) Natural resources and environmental improvement program
- (4) Scientific technologies development program
- (5) Program for improvement of development administration
- (6) Program for improvement of national corporations
- (7) Program for development of production, marketing, and employment
- (8) Program for improvement of fundamental services
- (9) Program for development of urban and special areas
- (10) District development program

Of the above programs, three are new (the program for development of production, marketing, and employment; the program for improvement of national corporations; and the scientific technologies development program). The content of these programs has not been included in any previous programs.

The Ministry of Finance of the Kingdom of Thailand has been carrying out careful financial management with the goal of recovering an equilibrium in its financial balance, because economic recovery has been unexpectedly delayed ever since the second oil shock. From this vantage point, the Finance Ministry has been testing the classification of budgets according to program structure since the 1982 fiscal year.

This program structure aims at the systematic classification of political activities which have common purposes, and at the allotment of financial funding for each policy purpose. This contributes to an understanding of the characteristics of the total budget for annual expenditures by the government, and is also aimed at clarifying the mutual inter-relationships between the various activities carried out by the government.

The break down of the annual expenditure for fiscal 1986, based on their functions, is as follows:

Function	Amount (in million baht)	%
Economy	34,197.6	15.7
Education	39,822.5	18.3
Defense	41,257.3	18.9
Public order maintenance	10,820.9	5.0
Public health	10,272.6	4.7
Public utilities	13,394.2	6.1
Ordinary administrative expenses	5,789.4	2.6
Public bonds	50,935.0	23.4
Others	11,510.5	5.3
Total	218,000.0	100

As is shown in the above table, expenditures related to the economy as cost for economic development accounts for 16% of the total amount.

83% of the economy-related expenditures, i.e. approximately 28.5 billion baht, is allocated for establishment of a stable infrastructure for the national welfare, including the development of agriculture, the transportation system, and the telecommunication network.

#### 2-2 Flood Protection Plan for the Metropolitan Area

This National Development Plan has 2 goals, 3 strategies, and 10 programs, in order to achieve the goals of the 6th Five-Year Plan. The development program for urban and special areas is included in the 10 programs for development strategies.

Thailand's economic base is shifting to the industrial and service sectors, as it undergoes a transformation into a newly industrializing country. Therefore, if preventive measures are not applied to the present situation,

a variety of economic activities will become concentrated in the metropolitan area. This development program for urban and special areas has thus established a strategy for the development of new economic areas and other cities, in order to promote decentralization of the economy, as well as to ease confusion in the metropolitan area, through the above measures, and to ensure systematic prosperity.

The concrete measures indicate a direction of urban development that will end confusion and provide for the efficient utilization of land, and which will regulate investment plans for the expansion of basic services and networks under the urbanization plan, to form a systematized metropolitan area and urbanized area. Major basic services that require improvement include traffic and transportation, flood control, the water supply system, housing, and countermeasures for over-populated areas.

As stated above, for systematic development of the Bangkok metropolitan area, the development of flood protection in the urban area and also the establishment of a minimum quality of living, by the elimination of stagnating flood waters in suburban farm villages, are indispensable. These considerations make this irrigation and drainage pumping station improvement project very important for the nation.

### 2-3 State of Drainage Facilities in the Bangkok Metropolitan Area

The Bangkok metropolitan area, is suffering from serious problems including an increase in population and urban expansion. Below are some of the problems related to drainage which is a main focus of attention in this project.

#### 2-3-1 General situation of the Bangkok metropolitan area

##### (1) Topography

The City of Bangkok has developed on the estuarine delta of the Chao Phraya river, which has a basin area of 160,000 km<sup>2</sup>. Bangkok is located about 32 km upstream from the Gulf of Thailand. This area, very close to sea level, has a flat topography. Much of the area is located below the maximum high-water level of the Chao Phraya river,



so the area has very bad drainage. The northwestern area is 1 - 2 m above sea level, but other areas are less than 1 m above sea level. The lowest area has an elevation of 0 m; it is exactly at sea level. The urbanized areas in the delta have been selectively developed in those areas relatively higher above sea level in order to avoid flood damage as much as possible.

## (2) Geology

The soil here consists of alternate layers of clay and soft sand to a depth of 20 m below the present ground level. Ground condition is poor, and it lacks permeability, so drainage is very bad. The most common composition of soil is, from the surface; a surface layer of weathered clay, 2 m thick; a soft, weak clay layer between 10 and 20 m thick; a hard clay layer, 15 to 20 m thick, and finally a tightly compressed sand layer which can be expected to provide the load-bearing capacity for structural foundations. The sand layer lies beneath all the other layers mentioned above.

## (3) Meteorology

This area is part of the tropical monsoon zone, and the year can be divided into 3 seasons; the dry season (November - February), the hot season (March - May), and the rainy season (May - October). Monthly mean temperatures are between 25°C and 30°C, and annual average rainfall is about 1400 mm. About 85% of this annual rainfall occurs in the rainy season, with about 40% of this annual rainfall in the flood season during two months of September and October. Annual average humidity is 78%, and total annual evaporation is about 970 mm.

## (4) Hydrology

In the Chao Phraya river basin, the outlet for the pumps in this project, approximately 85% of annual rainfall occurs between May and October. Lop Buri, Ang Thong, Ayutthaya, and Ban Sai, etc., all located in the upstream area of the lower Chao Phraya river delta, are flooded by overflow water from the Chao Phraya river every year in September and October. This flood water reaches the area surrounding

the capital city, Bangkok, from October to December. The area surrounding Bangkok is also part of the tidal compartment of the Gulf of Thailand. The exclusion of inland water therefore becomes difficult from September to November, when high tide levels overlap the floodstream, and result in frequent inundation of the above areas. (See Fig. 2-1)

(5) Land subsidence

Subsidence of the land has been progressing at a rate of 5 - 10 cm annually, as a result of pumping out groundwater, coupled with the rapid urbanization which has occurred since 1965. This has increased the possibility of flood damage. In order to prevent land subsidence, a project is now underway to convert the source of water supply from its conventional dependence on groundwater to the use of surface water to supply of drinking water, etc. Even after this project is completed, however, a land subsidence of between 70 and 100 cm is expected to have occurred by the year 2000.

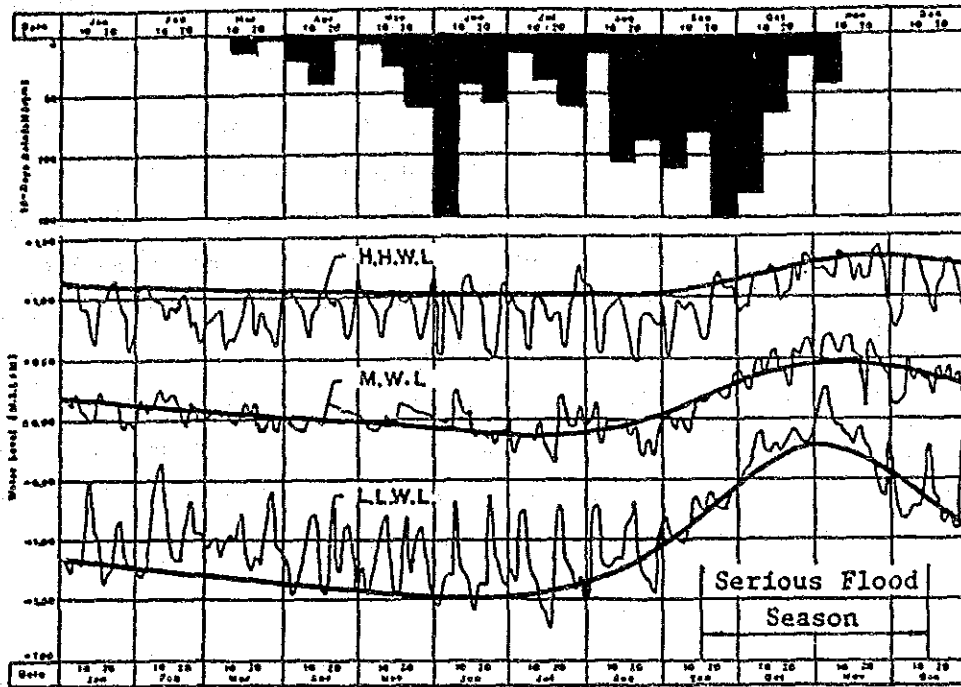
(6) Population

According to records kept by the Ministry of the Interior, the population in the Bangkok metropolitan area is approximately 5.47 million at present (April 1987). About 10% of the total population of the Kingdom of Thailand is concentrated in the Bangkok urban area. The entire Bangkok metropolitan area shows an annual average rate of increase of almost 5% for the past 10 years. The size of this urbanized area has been expanding steadily with the increase in population. Around 1960, the urbanized Bangkok area covered only about 90 km<sup>2</sup>, in what is presently the central zone, but Bangkok had swollen in size to about 300 km<sup>2</sup> by 1980.

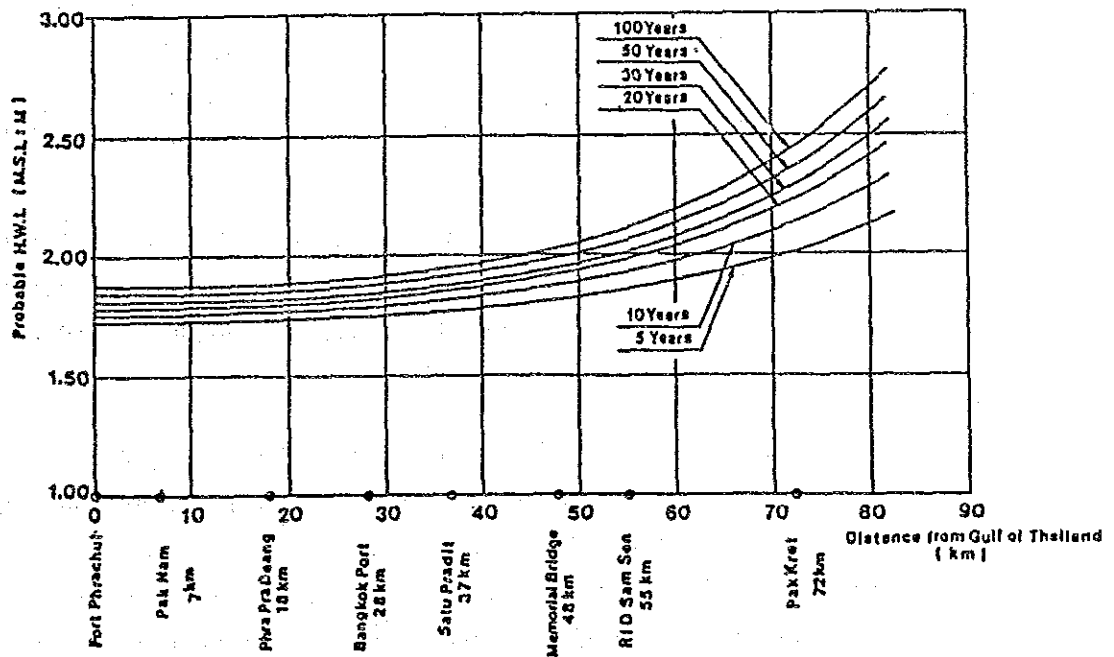
2-3-2 Drainage situation in the Bangkok metropolitan area

The delta zone of the Chao Phraya river, located downstream from the Bangkok metropolitan area, has been developed by the Great Chao Phraya Project as a paddy field region, and is equipped with a large-scale canal network. The paddy field region downstream from Ayutthaya has adopted a

Fig. 2-1 Water Level of the Chao Phraya River



Seasonal Change of Rainfall in the Subject Area and Water Level at Bangkok Port in 1980



Probable Flood Water Level of the Chao Phraya River

Source : Royal Irrigation Department and Port Authority of Thailand

submerged-type irrigation system. The water level here is constantly controlled by check weirs constructed on the canal.

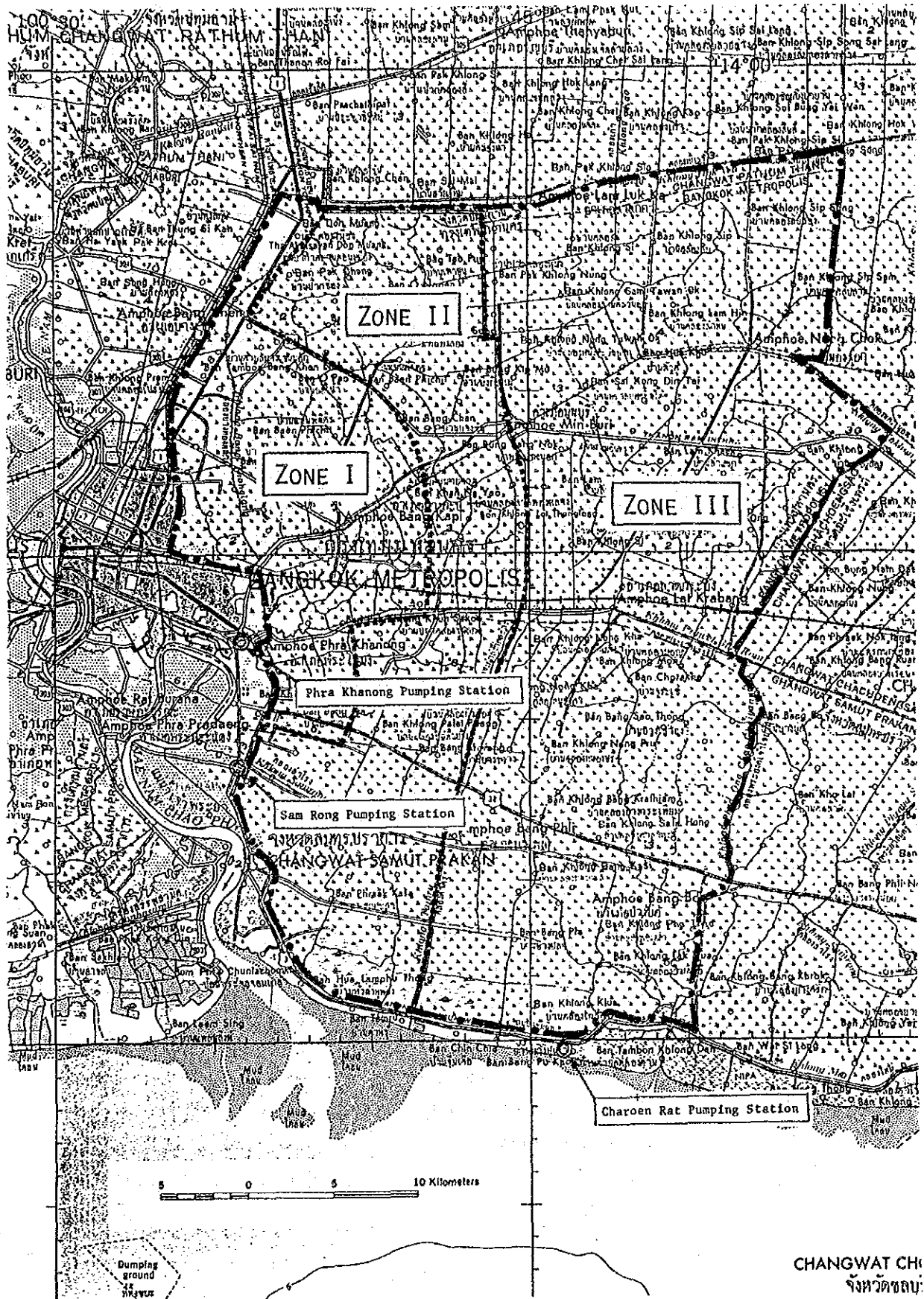
The Chao Phraya left-bank zone, including the area which is the subject of this study, is also a vast basin. This basin, however, has been divided by the construction of various flood-protection facilities constructed by projects aimed at protecting the Bangkok metropolitan area from flooding. The area of this Project is divided by a polder dike into 2 areas, one west and one east of the polder dike. The following chart shows the land utilization in each basin on the west side of the polder dike, that is, on the Bangkok urban area side of the basin, where the Phra Khanong and Sam Rong pumping stations are located; and in the basin on the east side of the polder dike, where the Charoen Rat pumping station is located.

Pumping station	Land classification	Zone I	Zone II	Zone III	Total
Phra Khanong Sam Rong	Farmland	9,000	23,000	9,000	41,000
	Other	11,000	7,000	1,000	19,000
	Total	20,000	30,000	10,000	60,000
Charoen Rat	Farmland	-	-	72,000	72,000
	Other	-	-	8,000	8,000
	Total	-	-	80,000	80,000
Total	Farmland	9,000	23,000	81,000	113,000
	Other	11,000	7,000	9,000	27,000
	Total	20,000	30,000	90,000	140,000

- Notes
- 1) Unit : ha
  - 2) Zone I - Area which includes the urban area, Zone III - East of the polder dike. Zone II - Adjustment zone, between Zone I and Zone III.
  - 3) In the land classification column, "other" means: land used for housing, commercial and industrial zones, creeks, roads, etc.

Each pumping station and the zoning of the basin where these pumping stations are located are shown in Fig. 2-2.

Fig. 2-2 Location Map of Drainage Zone



## 2-3-3 Present conditions of administration relative to drainage

### (1) Drainage

This project aims at improving and drainage situation(s) of urban area and agricultural land in the Bangkok metropolitan area. RID, the operations authority for irrigation and drainage projects in the Kingdom of Thailand, is therefore in charge of this Project.

RID belongs to the Ministry of Agriculture and Cooperatives in the central administrative organ of the Kingdom of Thailand, which consists of one representative office and 13 ministries. However, RID has a huge number of officials. It also has a budget vastly greater than the others among the 10 departments of the Ministry of Agriculture and Cooperatives, reflecting the importance of agriculture and irrigation in the Kingdom of Thailand. RID had a 1986 budget of 10 billion baht, or 60% of the total budget of the Ministry of Agriculture and Cooperatives (total: 16 billion baht). RID also has 80,000 officials, over half of the Ministry total. The reasons for such an enormous staff and budget are not only that RID handles major projects, but also that most of these projects are carried out under direct management. The administrative structure is centralized, and major irrigation facilities are controlled by direct administration.

The following duties handled by RID have been regulated on the basis of the Royal Order of 1975.

- Establishment of a Master Plan for the development of water resources
- Surveys of topography, hydrological surveys, surveys of waterways, research on soil and ground quality, and economic surveys
- Execution of studies on development feasibility
- Design and construction of irrigation and drainage systems, diversion weirs, dams, and pumping systems
- Maintenance of (construction) machinery, including vehicles, ships, and communication equipment
- Operation and maintenance of irrigation and drainage facilities

The Royal Order, mentioned above, established 22 divisions and 12 regional irrigation offices to carry out the above duties. This organization is shown in Fig 2-3.

(2) Flood protection system

Other than RID, the organization in charge of the drainage of the Bangkok metropolitan area is the Bangkok Metropolitan Administration (BMA). BMA is a self-governing body for the Bangkok metropolitan area (1,589 km<sup>2</sup>), which consists of 24 districts, organized as shown in Fig. 2-4. BMA provides public services such as the maintenance of law and order, public welfare, education, hygiene, social welfare, roads, and drainage facilities, through its 11 departments and through district offices in all 24 districts. Among its organization is the Department of Drainage and Sewerage (DDS), which is in charge of flood problems, drainage, and sewage disposal, and which carries out the management and administration of facilities such as the drainage pumping stations, drainage canals, and sewerage, etc., within the City of Bangkok. Fig. 2-5 shows its organization. At present, there are about 450 regular government employees plus about 1,400 other workers, distributed among the DDS offices and its 4 field work divisions.

(3) Regulatory organization

The Committee on Flood Protection in Bangkok and its Vicinity, established in October, 1983, regulates flood control plans nationwide. Under this committee, 2 sub-committees have been organized, and are now carrying out facilities construction projects and the evaluation of these projects, as well as public relations activities. Fig. 2-6 shows this organization.

Fig. 2-3 Organization of Royal Irrigation Department

AS of November 15, 1986

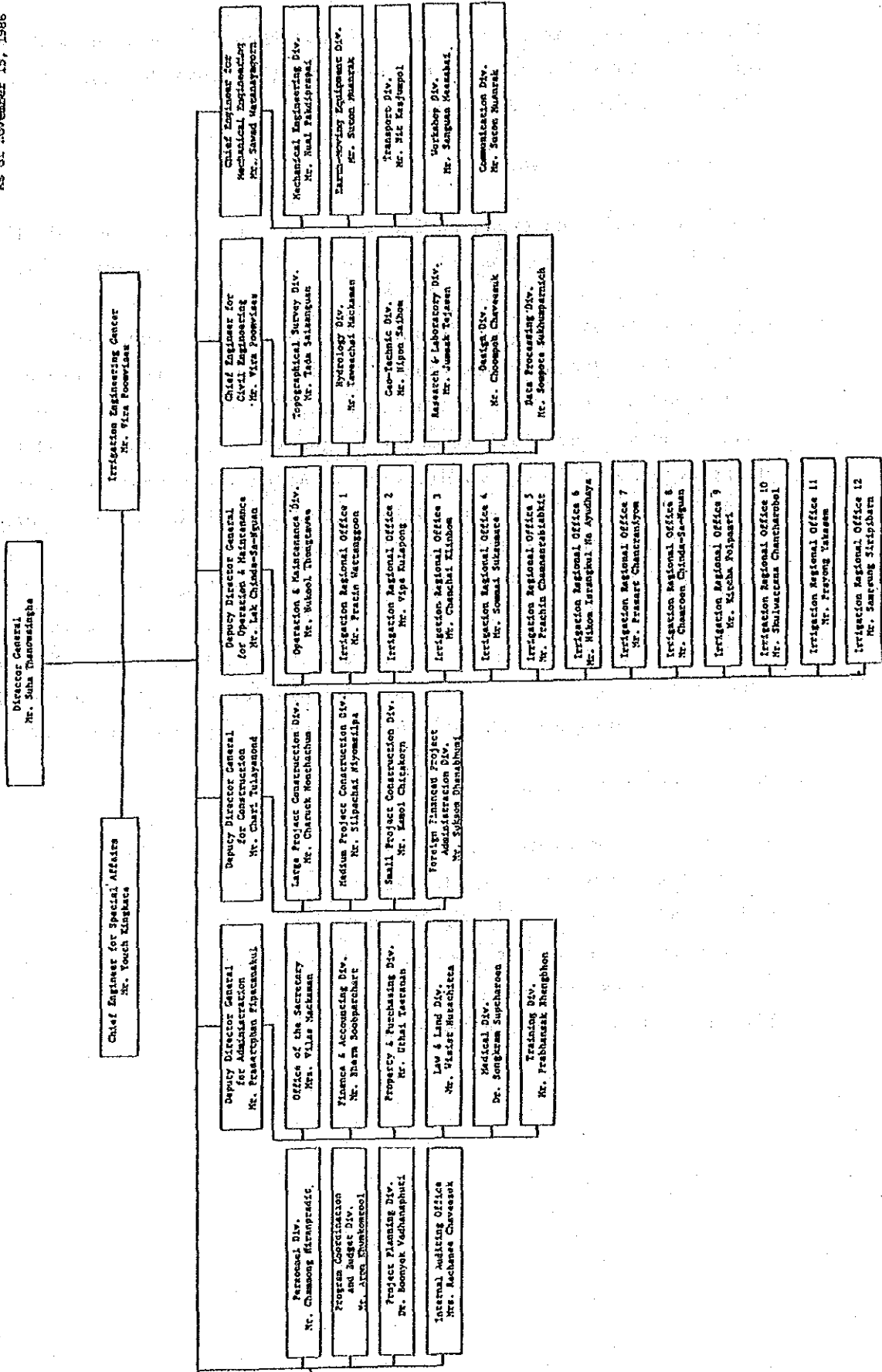




Fig. 2-4 Organization of Bangkok Metropolitan Administration

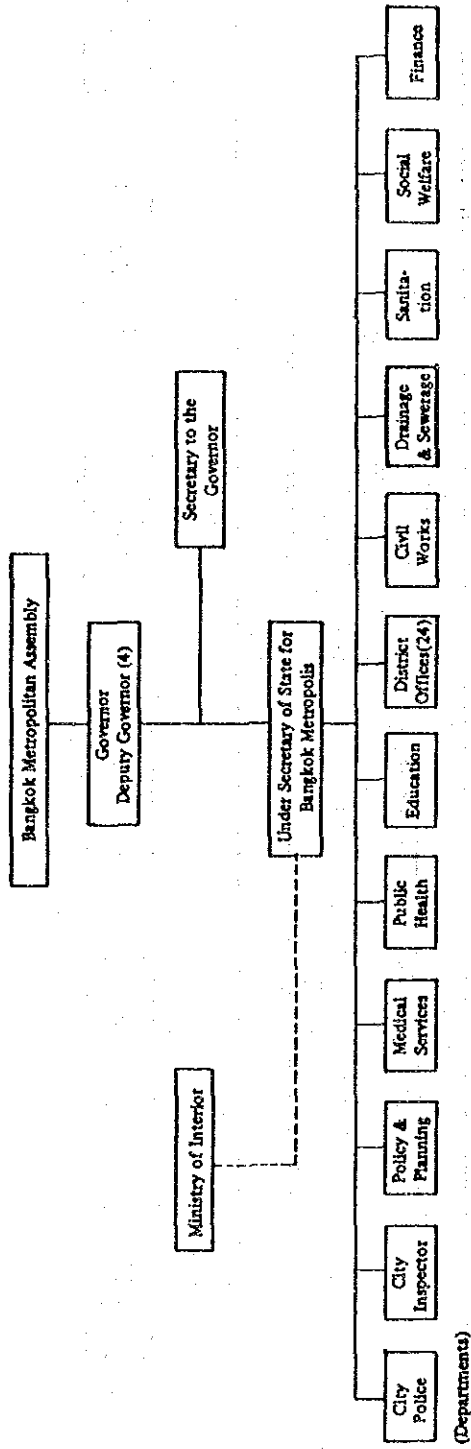


Fig. 2-5 Organization of Department of Drainage and Sewerage

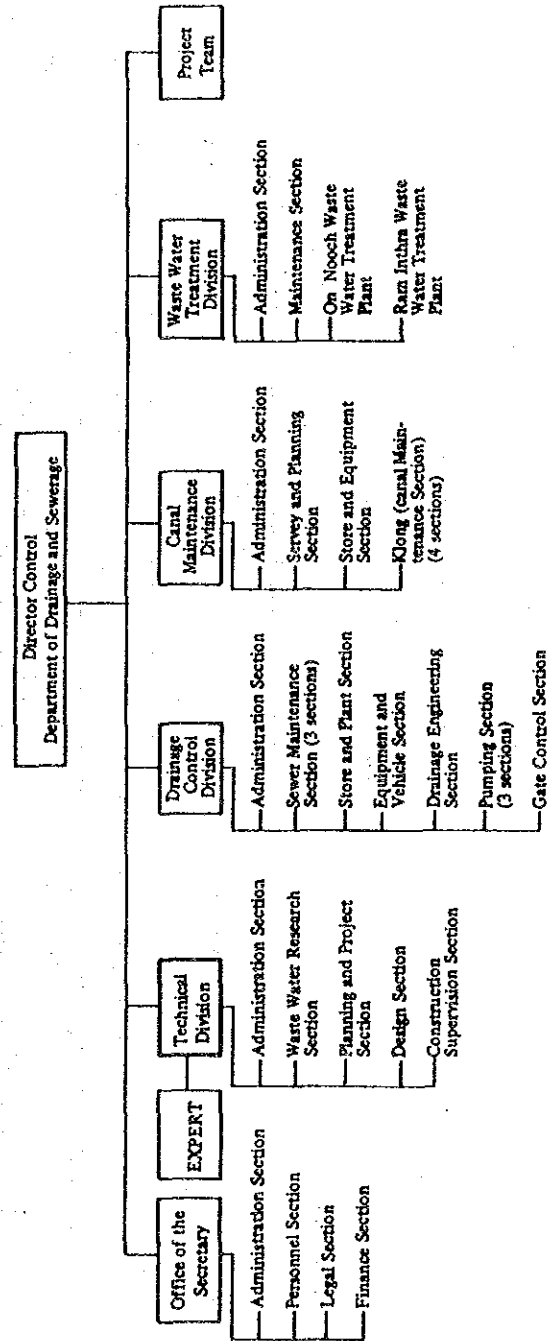
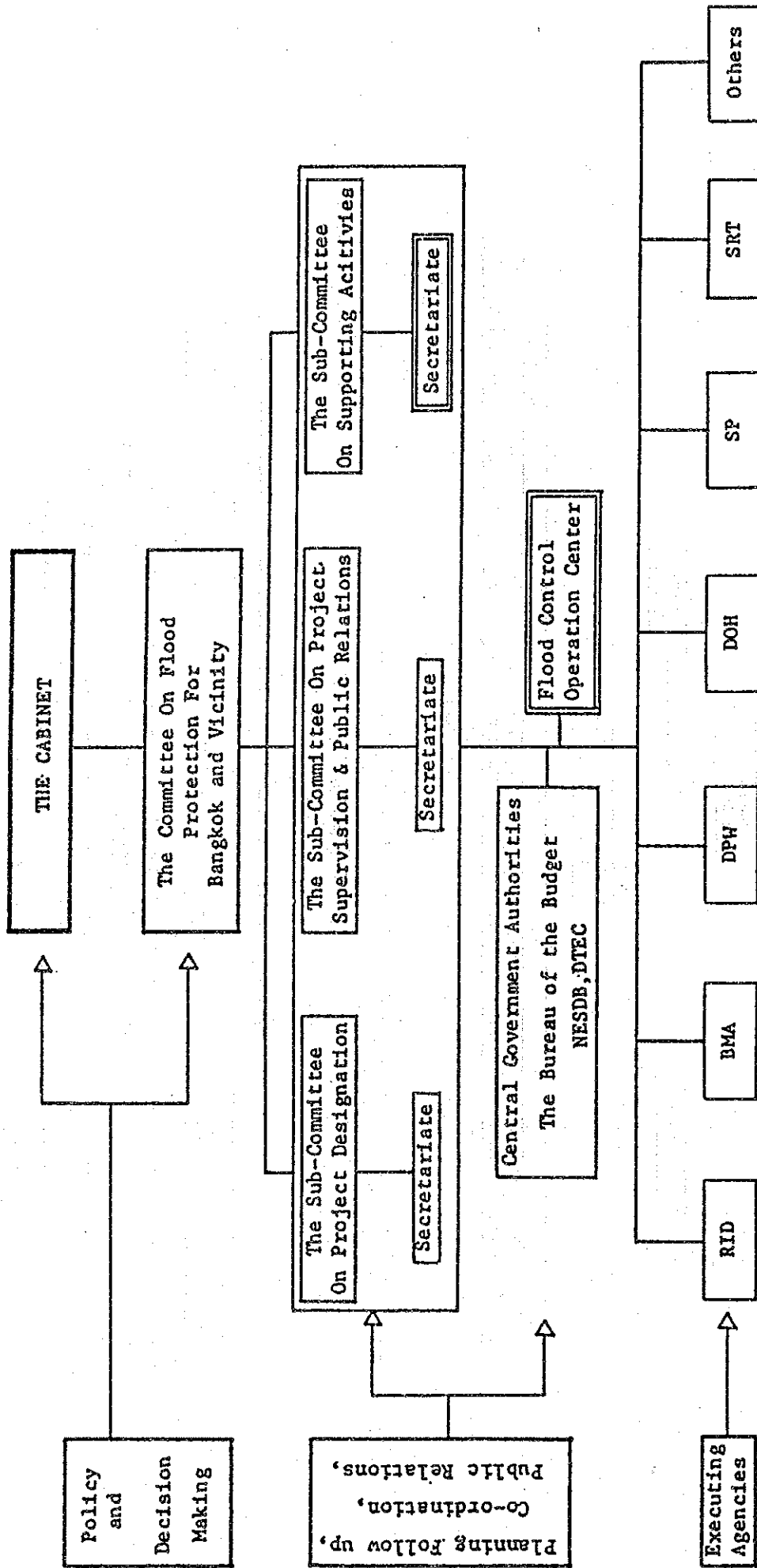


Fig. 2-6 Organization of the Committee on Flood Protection in Bangkok and Its Vicinity



#### 2-3-4 Refuse removal status of related and similar facilities

One of the related and similar facilities to the automatic trash removing facilities which will be installed in this project is the automatic trash rake to be installed at the Krung Kasem drainage pumping station. The purpose of this automatic trash rake is to remove urban-type refuse, particularly vinyl bags, plastic, resins, and pieces of cloth, etc., which block the flow of water at the screen in front of the pump. For this purpose, the trash rake used is narrow, and has no teeth at the front. But it is impossible to stir up water hyacinths with this type of rake. This may be the reason why coarse-mesh screen has been installed just upstream of the automatic trash rake. Large-sized refuse is also stopped by this screen. However, when many items of refuse, both large and small, become entangled on this coarse screen, it interfaces with the flow of water, and thus the removal of this refuse by man power is considered necessary. Therefore, the selection of an appropriate rake width is important in cases such as this, where various sizes of refuse are carried along by the water.

There are a number of drainage pumping stations which are used to pump out drainage from Bangkok metropolitan area on the east side of the Chao Phraya river. Figure 2-7 shows the location of major pumping stations constructed to be used permanently. Table 2-1 shows the major specifications of these facilities.

Subsequent to the flood of 1983, these pumping stations have gradually been upgraded, and the installed facilities have been shown to be quite effective. However, the water in the drainage canals, which flow through the city, contains urban refuse and/or waterweeds which proliferate here, and greatly decrease the efficiency of the pumps. In particular, where the capacity of a pump is greater, the pumps suck up greater amounts of the refuse and waterweeds, resulting in a substantial decrease in pumping efficiency. These pumping stations have larger drainage capacities. Therefore, when the functioning of these pumping station with larger capacities is fully restored, drainage is greatly improved.



Table 2-1 Specifications of the Major Drainage Pumping Stations in Target Areas

Names of pumping station	Pump specifications			Water gate specification		Remarks
	Capacity	Number of unit	Type of pump	Width	Number of unit	
K. Bang Khen (New)	m <sup>3</sup> /s 3.0	4	Submersible motor pumps	3.5 <sup>m</sup>	1	All pumps were acquired through Japanese grant aid
K. Bang Khen (Old)	3.0	3	Submersible motor pumps	6.0	1	All pumps were acquired through Japanese grant aid
Bang Sue	3.0	12	Submersible motor pumps	6.0	2	8 pump units acquired through Japanese grant aid
K. Sam Sen	3.0	10	Submersible motor pumps	4.0	2	6 pump units acquired through Japanese grant aid
Krung Kasem	5.0	5	Horizontal axial pump	-	-	Installed of automatic trash rake
K. Sathorn	1.25	8	Horizontal axial pump	2.3	1	
Rama IV	5.0	4	Horizontal axial pump	-	-	
Phara Khanong (Right-bank)	3.0	20	Submersible motor pumps	7.0 5.0	1 2	
Phara Khanong (Left-bank)	3.0	15	Submersible motor pumps	6.0	3	All pumps were acquired through Japanese grant aid
K. Chak	3.0	2	Submersible motor pumps	4.0	2	All pumps were acquired through Japanese grant aid
Bang O	3.0	6	Submersible motor pumps	4.0	2	All pumps were acquired through Japanese grant aid
K. Bang Na	3.0	15	Submersible motor pumps	4.0	2	5 pump units acquired through Japanese grant aid
Sam Rong (Right-bank)	3.0	15	Submersible motor pumps	-	-	
Sam Rong (Left-bank)	3.0	10	Submersible motor pumps	6.0	3	All pumps were acquired through Japanese grant aid
Charoen Rat	3.0	25	Submersible motor pumps	-	-	

## 2-4 Outline of Pumping Stations Subject to This Project

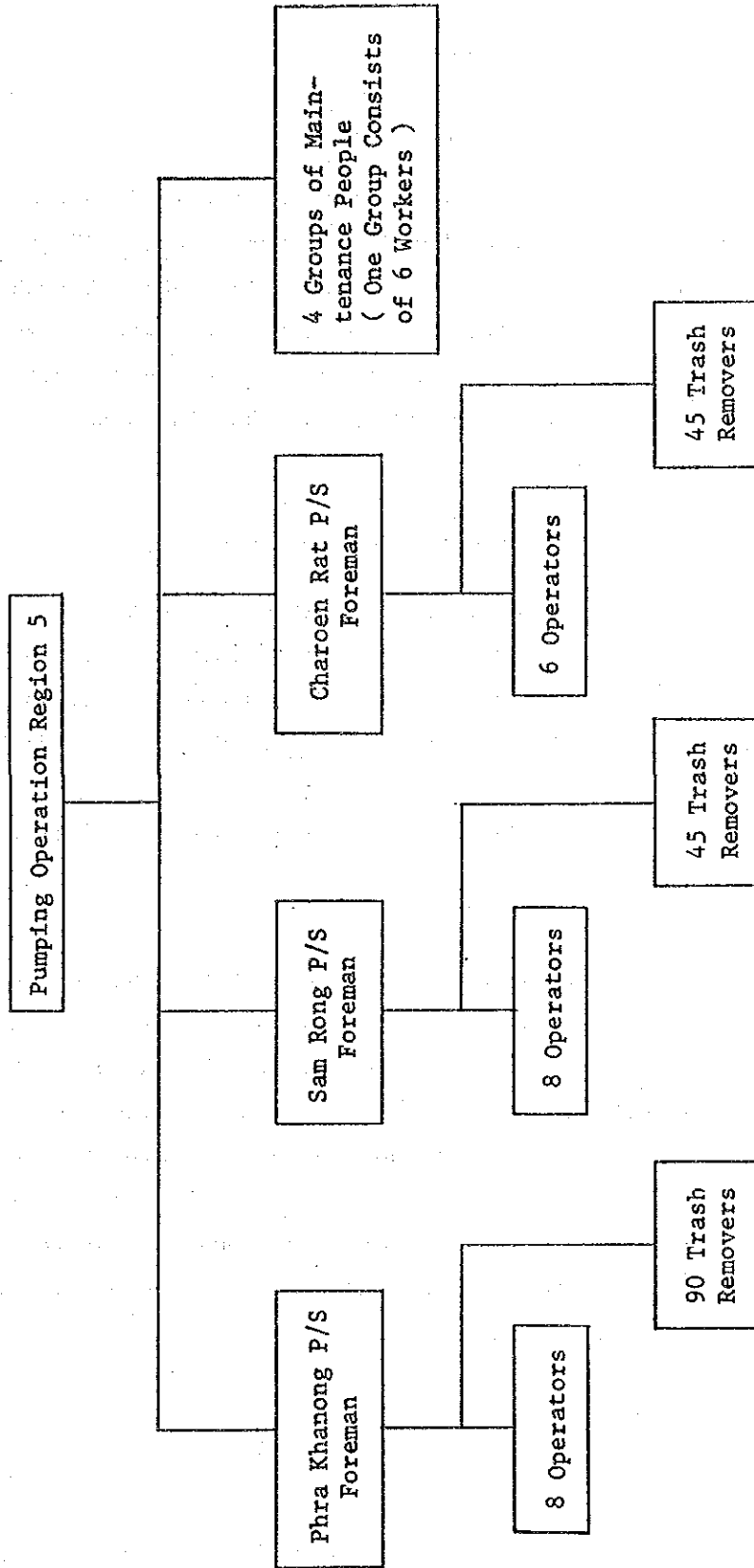
### 2-4-1 Organization and details on project

The 140,000 ha which benefit from the 3 drainage pumping stations in Phra Khanong, Sam Rong, and Charoen Rat, which come under this project, include farm area of 113,000 ha (80% of this area) with extremely flat topography. As in the drainage of Phra Khanong, the drainage canals connected with the drainage pumping station were originally canals with the dual purposes of supplying and draining water. Operation of the pumping system has a direct effect on the irrigation and drainage water for the benefit of agricultural land. Therefore, all operation and maintenance of these facilities is handled by RID. The project, for control of the supply and drainage of water, is based in the irrigation Engineering Center (IEC) of RID, with the aim of centralizing water control.

Each pumping station is operated and administered by Operation and Maintenance Division of RID. This division also carry out the operation, maintenance, and control of drainage gate and navigation locks which are linked with the pumping facilities. The Mechanical and Engineering Division of RID are in charge of the inspection and repair of the pumping facilities, drainage gate facilities, etc.

Figure 2-8 shows the organization for operation and maintenance of each pumping station. Pumping Operation Region 5 is organized into 4 groups, controlling 3 pumping stations, and also includes the pumping station operators and temporary laborers who remove refuse when the pumping stations are being operated.

Fig. 2-8 Organization for O/M and Number of the Staff



Total Number of Operators = 22

Total Number of Maintenance People = 24

Total Number of Trash Removers = 180

## 2-4-2 Operation and maintenance budget

### (1) O/M Expenditures

O/M expenditures for the 3 pumping stations involved in the project for the 1988 fiscal year (October 1987 - September, 1988) were still in the budget request stage at the time (July, 1987) that the field survey was being carried out. The following, however, is an estimate of annual operation costs, plus maintenance and control costs (costs of parts and labor), under the assumption that the pumps are operated for 4 months out of the year.

#### O/M Expenditures (Unit: baht)

	Operation Cost	Maintenance cost	Total
Phra Khanong	221,500	1,155,000	1,376,500
Sam Rong	221,500	825,000	1,046,500
Charoen Rat	172,850	825,000	997,850
Total	615,850	2,805,000	3,420,850

### (2) Cost of the Removal of Refuse

Most expenses incurred for the removal of refuse involve the removal of the water hyacinths that flow into the pumping station and are caught by the screens, protecting the pump. This happens when the pumps are in operation during the annual 4-month flood season. These expenses have been estimated as shown below, assuming the employment of laborers for 90 persons per day (30 persons x 3 shifts) for the Phra Khanong pumping station and for 45 persons per day each (15 persons x 3 shifts) for the Sam Rong and Charoen Rat pumping stations, with some cost going for materials.



Expenses for Refuse Removal (Unit: baht)

	Cost of Labor	Cost of Materials	Total
Phra Khanong	766,000	58,000	824,000
Sam Rong	383,000	39,000	422,000
Charoen Rat	383,000	39,000	422,000
Total	1,532,000	136,000	1,668,000

Approximately 1,750,000 baht more has been estimated as the cost of removing the water hyacinths upstream of the pumping stations. This amount includes fuel costs, the cost of maintenance of heavy equipment, and the cost of labor hired for the operation period of 5 months out of the year.

2-4-3 Status of activities

(1) Status of Pump Operations

The 3 pumping stations that come under this project regulate water levels, for water control for farmland, and for flood control in the Bangkok metropolitan area and in the surrounding farm land, with drainage gates and drainage pumps. The following chart shows the hours of operation for the pumps in these pumping stations for 1986.

	Number of Pumps	Annual Operation (Hours)	Annual Operation per Unit (Hours)	Number of Months Operated
Phra Khanong (left-bank)	15	31,000	2,100	12
Phra Khanong (right-bank)	20	68,000	3,400	12
Subtotal	35	99,000		
Sam Rong (left-bank)	10	7,000	700	6
Sam Rong (right-bank)	15	12,800	850	6
Subtotal	25	19,800		
Charoen Rat	25	16,900	680	5

Pump operation for each pumping station, for each season, is shown in Figs. 2-9 to 2-11. The following chart shows the maximum operating hours per day.

	Maximum Hours Per Day	Average Hours Per Unit	Rate of Operation
Phra Khanong (left-bank)	300	20	83%
Phra Khanong (right-bank)	480	24	100%
Sam Rong (left-bank)	240	24	100%
Sam Rong (right-bank)	360	24	100%
Charoen Rat	312	12	52%

Figs. 2-12 to 2-14 show the relationship between the hours of operation of the pumps for each season, and the precipitation and external water levels.

Fig. 2-9 Pump Operation Hour

Phra Khanong P/S

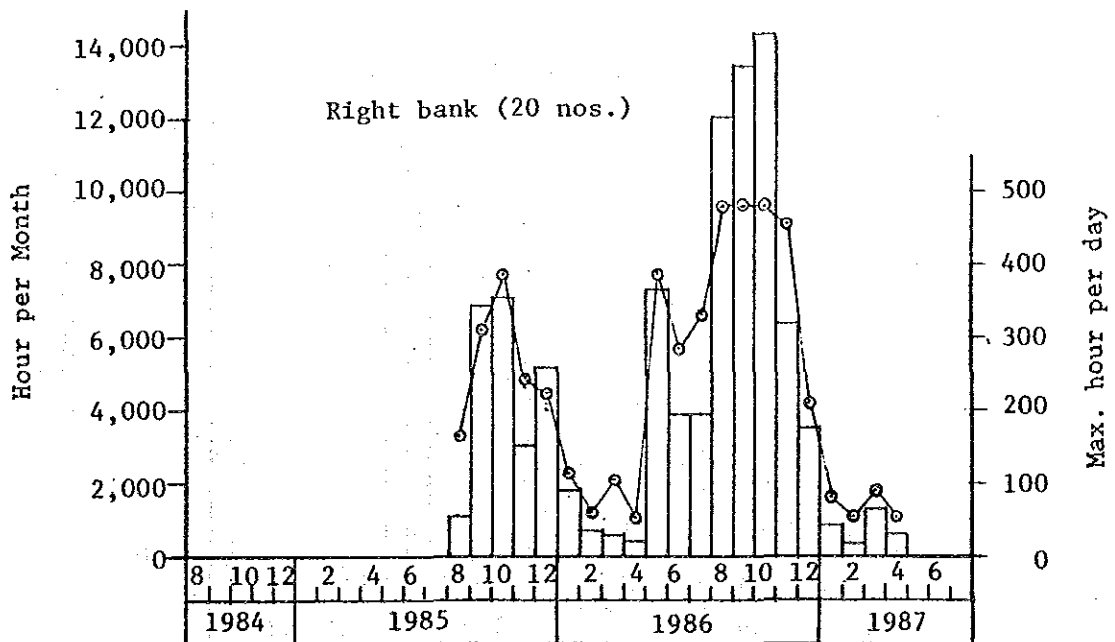
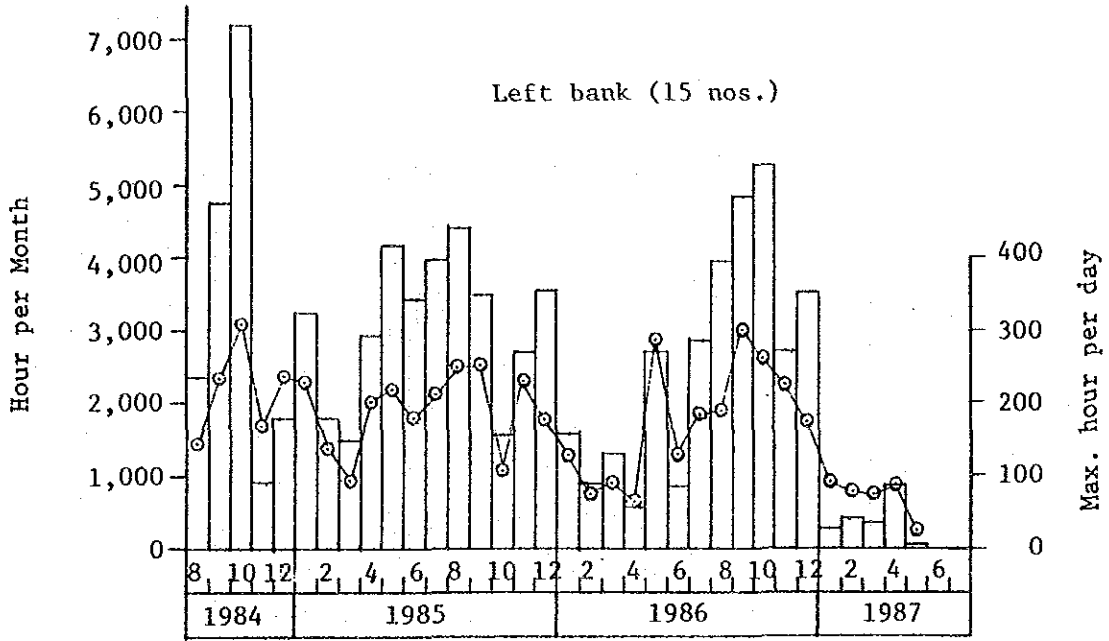
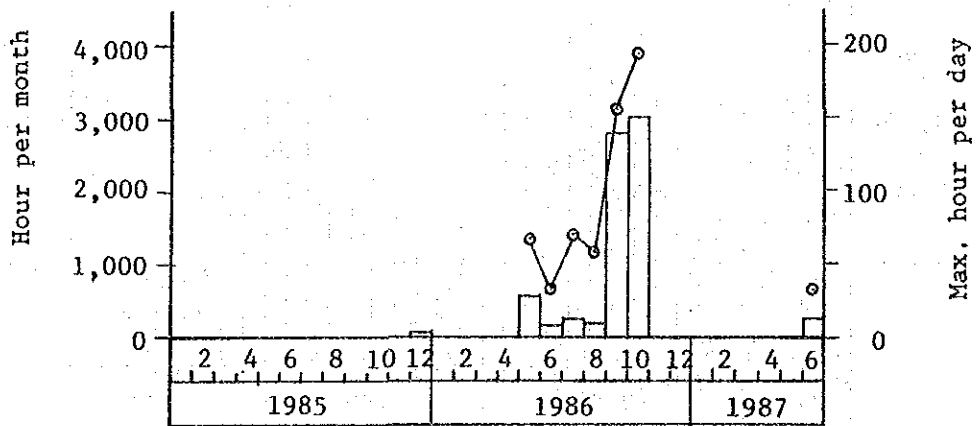


Fig. 2-10 Pump Operation Hour

Sam Rong P/S

Left bank (10 nos.)



Right bank (15 nos.)

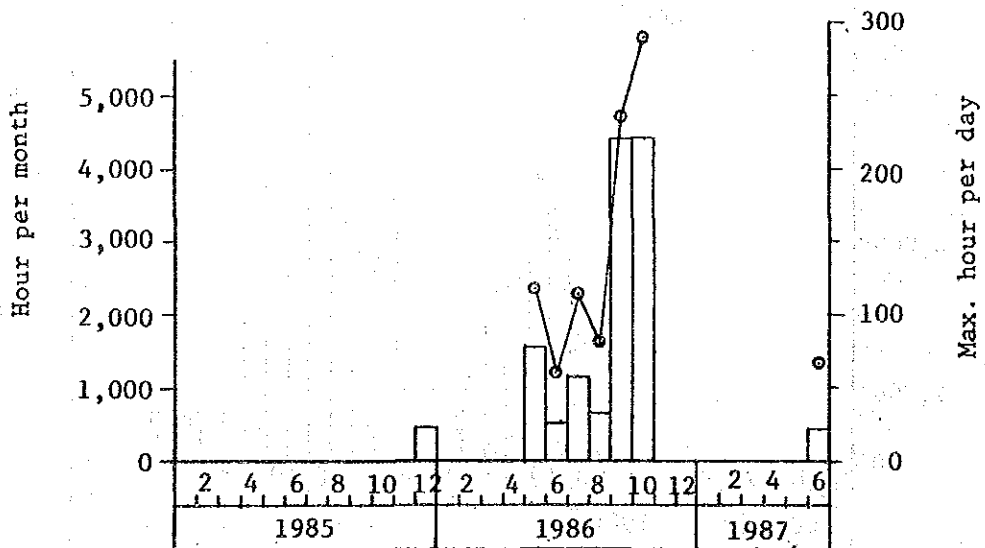


Fig. 2-11 Pump Operation Hour

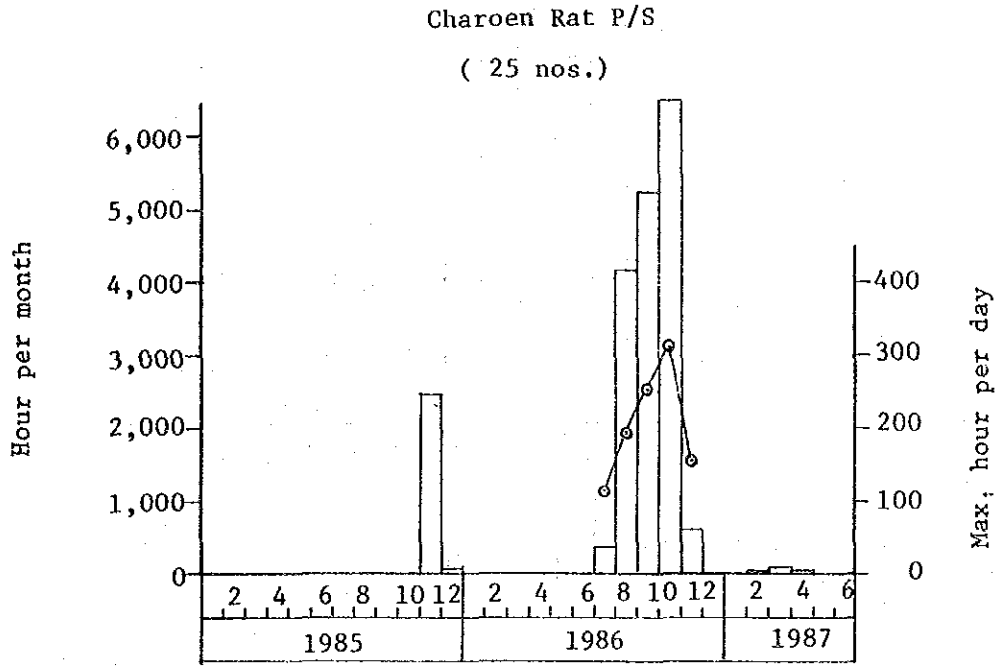
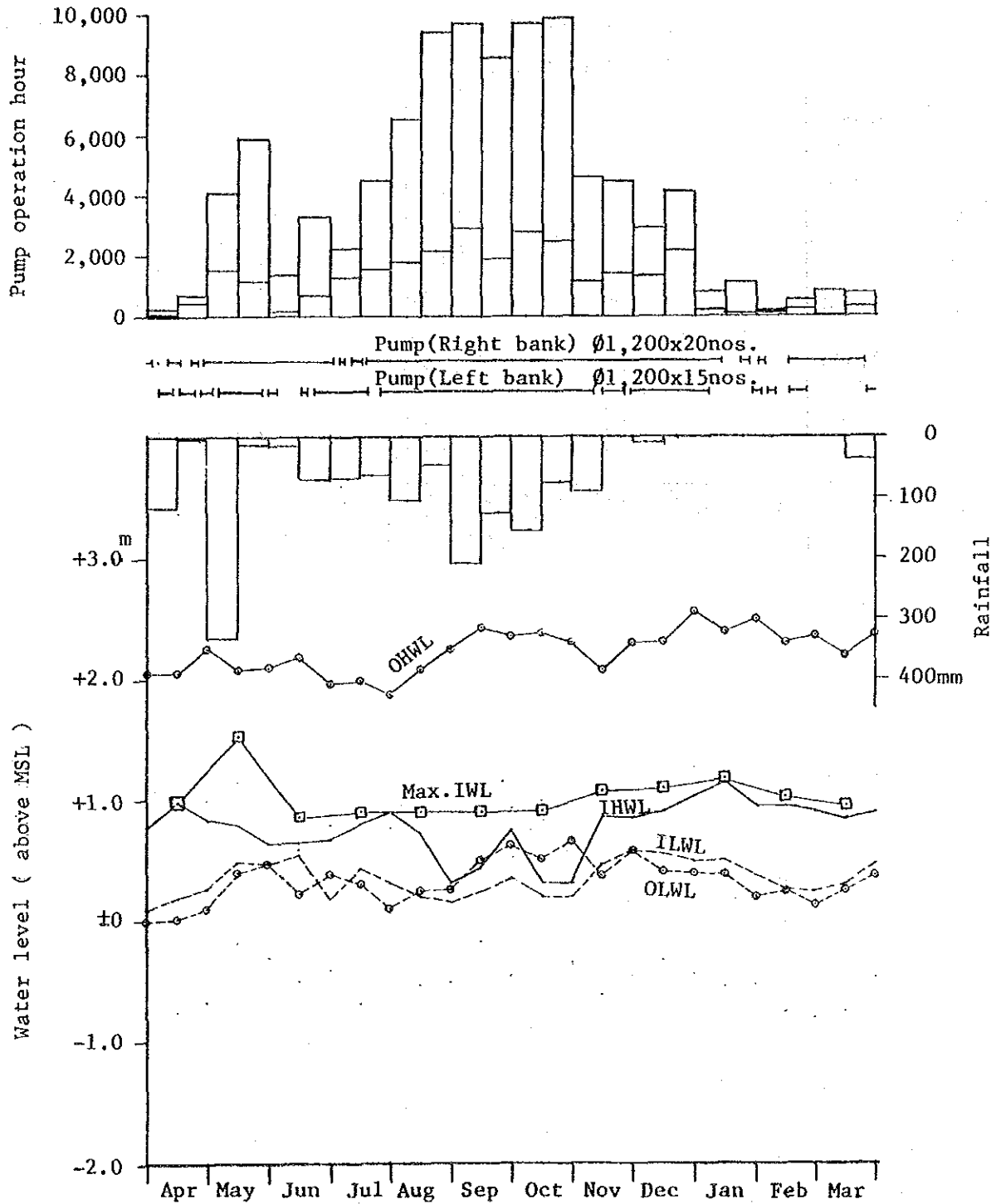


Fig. 2-12 Relations among Pump Operation Hour, Rainfall, and Water Level

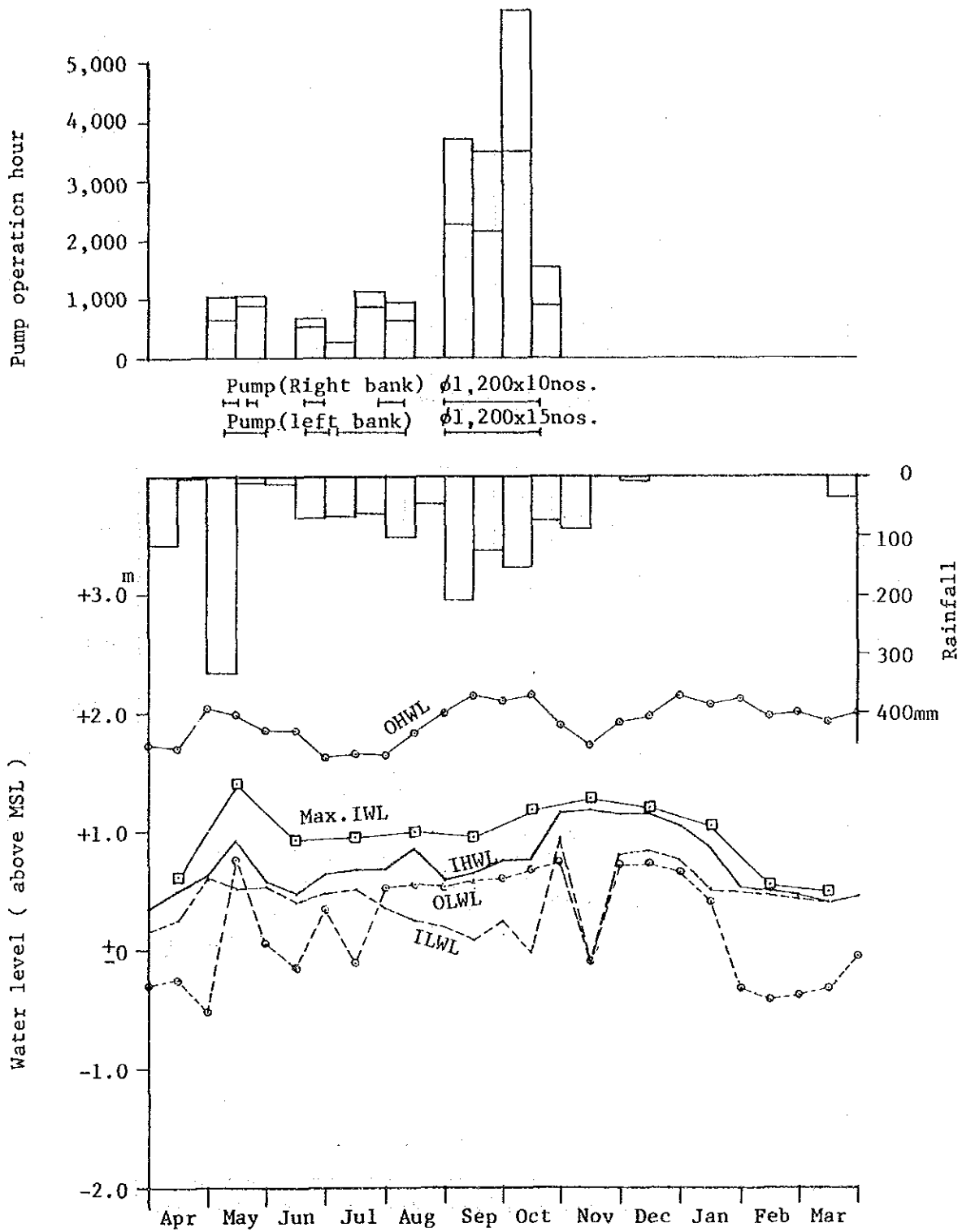
Phra Khanong P/S



1986

Fig. 2-13 Relations among Pump Operation Hour, Rainfall, and Water Level

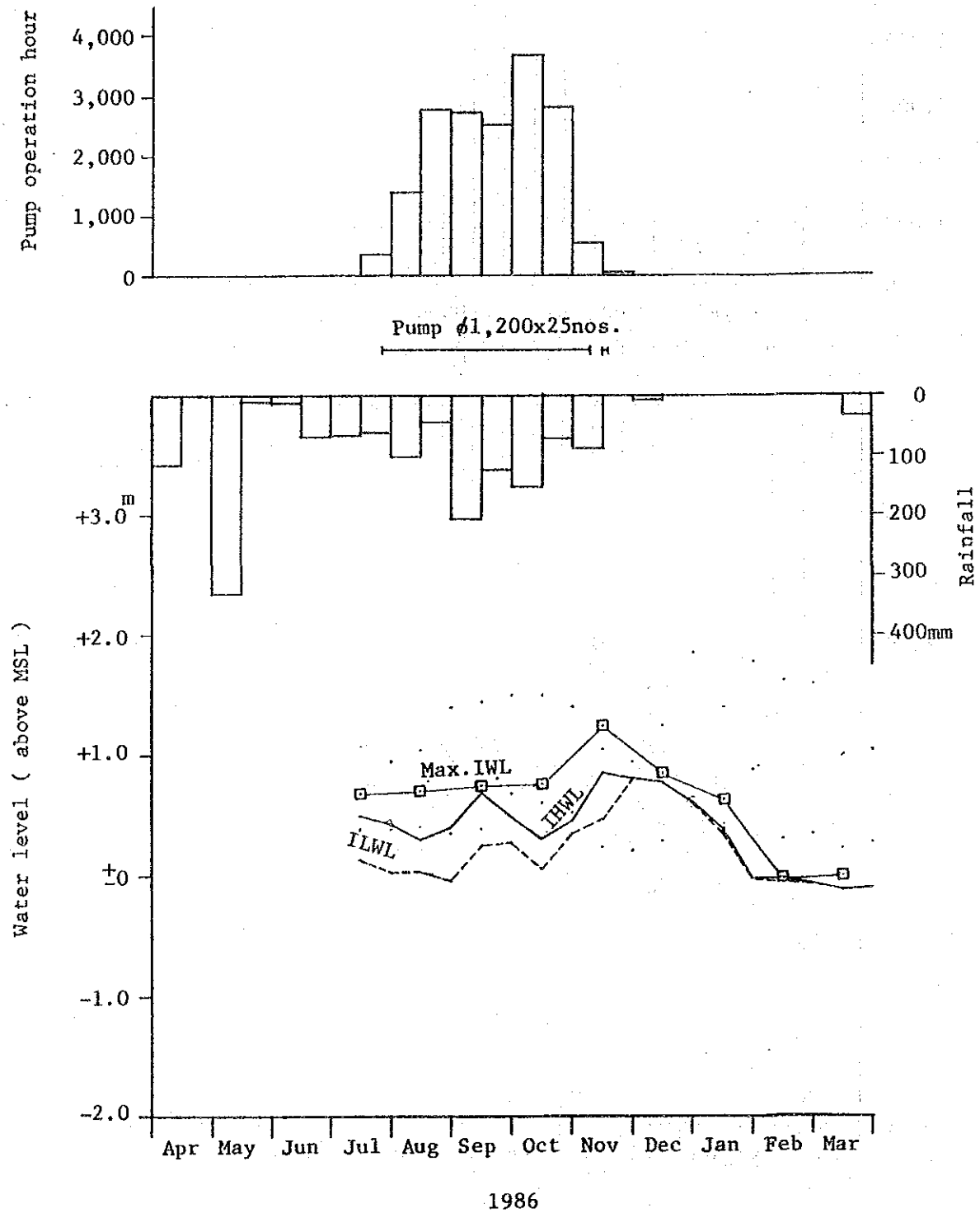
Sam Rong P/S



1986

Fig. 2-14 Relations among Pump Operation Hour, Rainfall and Water Level

Charoen Rat P/S





## (2) Refuse Removal

Water hyacinths, which proliferate in the drainage canals, and everyday refuse dumped by people into the drainage system, such as pieces of vinyl and cloth, flow into the pumping stations while they are operating during the floods. These objects accumulate in front of the screen attached to the pump intake tank. For the 3 pumping stations, 180 temporary laborers are hired for the 4 months of the flood season, to remove these items of refuse. These laborers work 3 shifts per day, but the amount of refuse which flows in and accumulates is far greater than the workers are capable of handling, so it is impossible for them to keep up. As a result, pumping capacity falls because of the lowering of water levels caused by the refuse which has accumulated on the screens, and because of the entanglement of refuse which has passed through the screens and becomes attached to the pumpshafts, etc., rendering normal pumping operations impossible. Extreme overloading of the pumps, due to refuse accumulation, has an adverse effect on pump operation, and damages the pumping equipment, rendering the pumps useless.

The drop in the water level caused by refuse adhering to the screens has exceeded 1 m, and the down time for the pumps, and the time lost to the removal of the refuse, has reached an annual total of 2,000 hours.

### 2-4-4 Present state of facilities and equipment

#### (1) Phra Khanong Pumping Station

The Phra Khanong pumping stations include a right-bank pumping station, a left-bank pumping station, and 2 drainage gates. The major specifications of these facilities are as follows.

Left-bank pumping station;	φ1,200 mm submersible motor pumps, 15 units
Right-bank pumping station;	φ1,200 mm submersible motor pumps, 20 units
Main drainage gate;	( 1 sluice gate, 7.0 m wide 2 sluice gates, 5.0 m wide
Left-bank drainage gate;	3 sluice gates, 6.0 m wide

The left-bank pumping station was completed as part of the urgent flood protection project of 1984, which was initiated as a result of the severe flooding of 1983. Fifteen pumping equipment units were provided by Japanese grant aid assistance. The Government of the Kingdom of Thailand felt that the left-bank pumping station alone was not sufficient, in light of the earlier flooding and so continued the 1984 project into 1985, completing the right-bank pumping station. The right-bank pumping station was financed entirely by the Kingdom of Thailand.

(2) Sam Rong Pumping Station

The Sam Rong pumping station comprise a total of 3 pumping stations, 2 pumping stations on the left-bank, and one pumping station on the right-bank, plus one drainage gate. The major specifications of the facilities are listed below.

Left-bank No. 1 pumping station:	φ1,200 mm submersible motor pumps, 5 units
Left-bank No. 2 pumping station:	φ1,200 mm submersible motor pumps, 5 units
Right-bank pumping station:	φ1,200 mm submersible motor pumps, 15 units
Drainage gate:	3 sluice gates, 6.0 m wide

The pumping stations in the 2 left-bank locations were begun to construct after the severe flooding of 1983, and were completed in 1984. Ten pumping equipment units were provided by Japanese grant aid assistance. The Government of Thailand felt that it was not sufficient to have a pumping station only on the left-bank, so it paid from its own budget for the pumping station on the right-bank, which was completed in 1985, in an effect to reinforce drainage capacity.

(3) Charoen Rat Pumping Station

There are drainage gates in 5 locations near this pumping station, from the Chai Thale drainage canal to the Gulf of Thailand. The following are the major specifications of the facilities here, including the pumping station.

Charoen Rat pumping station:        $\phi$ 1,200 mm submersible motor pumps,  
25 units

Drainage gate (9 km west of the pumping station):  
1 sluice gate, 6.0 m wide

Drainage gate (7 km west of the pumping station):  
4 sluice gates, 6.0 m wide

Drainage gate (4 km west of the pumping station):  
4 sluice gates, 6.0 m wide

Drainage gate (2 km east of the pumping station):  
1 sluice gate, 6.0 m wide

Drainage gate (7 km east of the pumping station):  
1 sluice gate, 6.0 m wide

This pumping station was built in 1985 by the Kingdom of Thailand, out of its own funds, budgeted as part of the urgent flood protection project.

## 2-5 Overview of Related Projects

One of the various flood protection plans of the 1960s was the CDM Plan prepared by the American consultants Camp Dresser & McKee (CDM), which suggested countermeasures based on the polder dike method for the 370 km<sup>2</sup> area of the city of Bangkok at that time. For financial reasons, however, only some of the internal water drainage facilities, in the central section, were constructed.

Later, since the damage done by standing flood waters in the 1970s, the following plans and projects have undergone continuous surveying and planning since the beginning of the 1980s.

- . Bangkok flood control and drainage project
- . Flood protection and drainage project in eastern suburban Bangkok
- . Samut Prakan project
- . Greenbelt project
- . Integrated flood relief plan for the Chao Phraya river

Plans for various projects have been drawn up and built around these basic plans. The following are the projects related to the main plans. Some of these projects, which were quite urgent, have already been started, and some have even been completed.

### (1) Bangkok Flood Control and Drainage Project (City Core Project)

This project involves the 92 km<sup>2</sup> area of the core of the city of Bangkok, and corresponds to the first stage of BMA/DDS long-term flood control plan.

This plan is based on the CDM master plan. The following countermeasures were devised to prevent the intrusion of flood waters from the Chao Phraya river into the Bangkok city core, to prevent the inflow of runoff water from the eastern suburban Bangkok into the city core, and also to improve drainage in the Bangkok city core.

- o Construction of dikes along the Chao Phraya river. This includes an increase of the height of 24 km of existing road by banking, as well as the construction of 18.5 km of new dikes, using banking or concrete walls.
- o The city of Bangkok is divided into 6 areas and polder dikes will be constructed.
- o Drainage canals (Khlongs) will be improved, and will be extend by about 100 km. For this purpose, the removal of about 1000 families of squatters from the banks of the drainage canals will be carried out.
- o 10 additional drainage pumping stations will be constructed in various locations, to increase drainage in the area.

The above plan were completed by NEDECO, under the administration of BMA/DDS, in 1985. The drainage capacity of the Sam Sen pumping station, located in the same area, was increased as part of the urgent flood protection project in 1984. The 6 reinforcement pump units ( $\phi 1,200$  mm submersible motor pumps) were provided through Japanese grant aid assistance. This plan, however, has essentially not been carried out as project, because of budget problems. The introduction of a flood tax, recommended by NESDB, is being studied as a countermeasure.

(2) Flood Protection and Drainage Project in Eastern Suburban Bangkok

BMA is the organization in charge of carrying out this plan. JICA conducted a preliminary study of about 501 km<sup>2</sup> of the subject area, with the technical cooperation of the Government of Japan. The master plan study of 260 km<sup>2</sup> in the western area was completed in 1984, and the feasibility study was completed in 1985. The purpose of this plan is to discharge waste water from the area by pumping it through the existing drainage canals into the Chao Phraya river, while

preventing the inflow of flood water from outside the area, with the creation of polder dikes. This plan will also use the greenbelt outside the King's Dike, to function as a flood retarding area.

- o The master plan area is divided into 3 areas by the polder dike.
- o 6.2 km of dikes and 55 water gates will be constructed.
- o The construction of drainage pumping stations is planned in 7 locations along the Chao Phraya river, and in 3 inland locations.
- o A total of 133 km of canals will be constructed or improved out of the 172 km of related drainage canals.
- o An area of 80 km<sup>2</sup> needs to have its main drainage pipelines improved.
- o Flood retarding area must be controlled.

The severe flooding of 1983 became the turning point for this plan. With consideration of the results of JICA's preliminary study, some part of the above-stated plans became the urgent flood protection project of 1984. The following is an outline of this.

- o The total planned drainage capacity was achieved by the construction of additional pumping stations in 10 locations. This included the Phra Khanong pumping station. Forty-three of the pump units installed were provided by Japanese grant aid assistance.
- o Improvement of the Phra Khanong drainage canal, and revetment work for the Phra Khanong drainage canal and the Chack drainage canal.
- o Construction of 7 inflow interception water gates.

In addition to these projects, which have already been carried out, a plan is now underway to install automatic trash rake to restore the Phra Khanong pumping station to full capacity. Pump performance had been hampered by the accumulation of enormous amounts of refuse.

### (3) Samut Prakan Project

Samut Prakan Province is located on the south of Bangkok, along both banks of the Chao Phraya river, near the river mouth. This plan covers flood control measures for the eastern side of the Chao Phraya river, in the province of Samut Prakan. BMA became the executive organization for this project when the plan was established in 1984 by the Thailand Institute of Scientific and Technical Research (TISTR).

The purpose of this plan is to prevent the intrusion of flood water and sea water, by constructing dikes along the green belt, the Gulf of Thailand, and the Chao Phraya river, to protect the area concerned, which, like Bangkok, has suffered flooding.

The embankment along the coastline has already been constructed, but is not high enough to provide protection against waters above the high tide level. Therefore, there is concern about flooding if subsidence of the ground should occur in the future.

The Sam Rong pumping station was constructed at the west end of the Sam Rong drainage canal, which flows westward right through the center of this area. This pumping station was constructed as a part of the urgent flood protection project in 1984, for removal of flood water from the area, following the severe flooding of 1983. Of the 25 pumps installed, 10 were provided through Japanese grant aid assistance. The plan this time has scheduled the installation of automatic trash rakes at the Sam Rong pumping station.

### (4) Greenbelt Project

Subsequent to the flood of 1980, the greenbelt project was started by RID, with the goal of eliminating the inflow of flooding into the Bangkok metropolitan area from the paddy field areas in northern and eastern Bangkok, and also of promoting the smooth outlet of floodwaters into the Gulf of Thailand, as proposed by the King of Thailand.

The 76-km flood control dike, known as "the King's dike" has already been completed. This was part of the 1984 urgent flood protection project. The regulating water gates have also already been constructed at 18 locations where the drainage canals cross the dike. These protective facilities have been constructed in cooperative projects by RID, BMA, SRT, and DOH.

The drainage conditions of the paddy field area extending east of the King's dike were worsened by the construction of the King's dike and the regulating water gates. Therefore, 4 drainage gates, 6 m wide, placed in 2 locations, and the Charoen Rat pumping station, were constructed on the Chai Thale drainage canal, which flows along the coastline, to improve the drainage conditions of the above area. In this plan, automatic trash rakes are also scheduled to be installed at the Charoen Rat pumping station.

(5) Chao Phraya 2 Plan

The construction project on the integrated flood relief plan for the Chao Phraya river consists of two plans. One is the construction of a diversion channel on the east side of the river for flood prevention in Bangkok. The other is the construction of another diversion channel on the west side of the river. The purpose of this plan is to divert the floodwaters of the Chao Phraya river upstream of the urban area of Bangkok, and channel them through the greenbelt areas on the east side of the Chao Phraya river, there to be released into the Gulf of Thailand. This plan was designed by a consortium of consultants from Austria and Thailand, and was reported to BMA in June, 1986. The following is an outline of this plan.

- 1) Design flood discharge: 3,600 m<sup>3</sup>/sec (maximum probability in 100 years)
- 2) Diversion plan:
  - Capacity of diversion channel:  
2,000 m<sup>3</sup>/sec.
  - Mainstream of the Chao Phraya river:  
1,600 m<sup>3</sup>/sec.



3) Scale of diversion channel:

Length: 60 km, Width: 200 m

4) Appurtenant facilities:

- . Sea barrier shall be constructed at 2.5 km upstream of the mouth of the river.
- . A drainage pumping station shall be installed with the tidal regulator at the mouth of the diversion channel
- . Navigation locks will be set up in one location on each side of the bank.

5) Total project cost: 20 billion baht

Even if this plan were to be carried out, it is believed that the water level of the diversion channel would be higher than the flood water level in the green belt area. Therefore, this plan is considered to contribute nothing whatsoever to the improvement of the drainage situation in the area east of the greenbelt. Therefore, the various facilities now existing in the area east of the greenbelt still seem to be essential.

The purpose of the projects stated above, some of which have already been carried out and some of which are still under consideration, is to prevent flooding in the Bangkok metropolitan area on the east side of the Chao Phraya river. The flood protection strategy is two-fold; first to block the flow of water into the area; and second to drain off the rain water which will accumulate in the area. The former covers projects from (1) through (5) as stated before, and the latter, (1), (2) and (3). The purpose of current project is to restore the discharging capacity of drainage facilities established for the latter purpose, and will have a great effect on flood protection in the Bangkok metropolitan area. Therefore, it is desirable to carry out this project at an early date.

## 2-6 Present Status of International Cooperation on Irrigation and Drainage Projects in the Bangkok Metropolitan Area

### (1) Movement of Aid from International Organizations

#### ADB

ADB has been carrying out an aid program in accordance with the principles of the Government of Thailand. In particular, ADB has listed the improvement of the infrastructure for local area development as one of its 3 major principles.

The concrete aid project carried out by this program was the Bangkok Flood Control Management Project, in 1984 - 1985. The amount of aid was US\$250,000.

### (2) Aid and Cooperation by Japan

The following shows the actual records of aid and cooperation classified by type for the Kingdom of Thailand from Japan.

#### Project-type technical cooperation

- o Irrigation Engineering Center Project (April 1985 - )
  - A hydraulic simulation study of the area subject to this project is being carried out, with a view to improvement of rice production and improvement of irrigation facilities, etc.

#### Development Study

- o Flood Protection/Drainage Project in Eastern Suburban Bangkok (preliminary study) (1983)
- o Flood Protection/Drainage Project in Eastern Suburban Bangkok (master plan study (1984 - 1985)
- o Flood Protection/Drainage Project in Eastern Suburban Bangkok (Feasibility study) (1985 - 1986)
- o Chao Phraya River Flood Forecasting System Plan (1986 - )
- o Reinforcement Plan for Water Management System for the Chao Phraya River Basin (1987 - )

## Grant Aid Assistance

- o Bangkok Drainage Facilities Improvement  
Project (1982) ----- ¥ 230 million
- o Irrigation Engineering Center Construction  
Project (1983) ----- ¥1,770 million
- o The Urgent Project of Flood Protection and  
Drainage in Bangkok and Vicinity (1984) ----- ¥ 300 million

### 2-7 Circumstances and Details of Requests

#### 2-7-1 Circumstances of request

##### (1) Circumstances of Request

After suffering severe flooding in 1983, the Kingdom of Thailand constructed a dike surrounding the metropolitan area to protect the Bangkok metropolitan area from flooding. Drainage pumping stations were also built at 2 locations inside the area surrounded by the dike, and in one location outside the dike, in order to eliminate standing flood waters in the area surrounded by the dike, and in the area crossed by the dike.

However, water hyacinths and urban refuse are contained in the water that flows through the pump operation. These accumulate on the screens of the pumping station. This results in erratic drops in the suction water levels of the pumps, and hinders pump operation. Pumps must be stopped from time to time to remove the refuse and waterweeds.

The Government of the Kingdom of Thailand has requested that Japan provide grant aid assistance, for the installation of automatic trash rakes for the pumping stations, to cope with this situation. When pump operation becomes normal and the water management of the drainage canals is accordingly improved as a result of this aid, the project will have contributed to the improvement of agricultural production in the area involved.

## 2-7-2 Details of request

The following are the final details of the request, which have been mutually confirmed with the Government of the Kingdom of Thailand during the field study.

### Purpose of Proposed Project

The installation of automatic trash rakes and belt conveyors, for the smooth operation of pumps in the Phra Khanong, Sam Rong, and Charoen Rat pumping stations.

### Organization Carrying Out the Project

RID will carry out the project.

### Facilities and Machinery Requested

The initial requests were related to the following 1) through 5). The other requests, from 6) through 9), were presented at the time of field survey. Requests number 6), 7) and 8) were confirmed in the minutes, and request 9) was confirmed in a memorandum.

- 1) Automatic trash rakes
- 2) Screens
- 3) Belt conveyors
- 4) Operation control panels
- 5) The necessary civil structures
- 6) Installation of linked operation systems for pumps and automatic trash rakes
- 7) Improvement of water level gauges for pump operation control
- 8) Installation of electric cranes in the Phra Khanong and Sam Rong pumping stations
- 9) Installation of a refuse conveying system which can make use of both transportation over water by barges, and overland haulage using trucks.

## CHAPTER 3 DESCRIPTION OF THE PROJECT



## CHAPTER 3 DESCRIPTION OF THE PROJECT

### 3-1 Objective of the Project

This project is designed to eliminate the problems caused by the waste produced in the pump sites at Phra Khanong, Sam Rong and Charoen Rat, located in the Bangkok metropolitan area and to facilitate operation of the pumps. Thereby preventing flooding in the Bangkok urban area, stabilizing the local standard of living, as well as ensuring proper administration of water in the farmlands along the drainage canals of Phra Khanong, Sam Rong and Chai Thale located upstream of these pump sites. Automatic trash rakes and trash conveying facilities will be installed at these pump sites through grant aid assistance rendered by the Government of Japan.

### 3-2 Study of Request

#### 3-2-1 Review of the project

In October 1983, a disastrous flood (the biggest in 40 years) struck the Bangkok metropolitan area of Thailand. With this accident as a turning point, the pumping power at the pump sites was increased in order to improve drainage conditions in that area. Another big flood, or rather a localized torrential downpour, which was reportedly of a size to be expected only once in 500 or 1,000 years, struck in May 1986.

However, the damage in 1986 was markedly less than in 1983 thanks to the increase in pump drainage capacity built in 1984 and 1985, through an urgent flood protection project, although it must be admitted that the water level of the Chao Phraya river was relatively low. Yet the damage caused by the flood of 1986 was still great in that area because the pumps did not perform at peak efficiency.

This was attributable to the trash, especially the water hyacinths, which flowed in to the pump sites. The damage to public facilities like roads, power supply and telephones was great particularly in the Bangkok urban area. The transport facilities were paralyzed by the flood, plunging the population into confusion. In the lowland paddy fields, the flood water

did not subside for a long time. As a preventive measure against this type of disaster, the authorities found it necessary to install automatic trash rakes as a move to improve the capability of the pumps at the existing pump sites.

The three pump sites proposed under the current project have a larger basin area than similar pump sites located in the Bangkok metropolitan area. Recovery and improvement of the drainage capacity of these pump sites will therefore have a great effect on this area. For this purpose, the installation of an automatic trash rake on the front side of the pumps is essential.

In the Kingdom of Thailand at present, there are only two pump sites where an automatic trash rake is installed: one in the Krung Kasem pump site under the jurisdiction of the BMA and one owned by a private corporation in Bangkok. The trash rakes installed at these two pump sites are small and have a small refuse disposal capacity. Therefore, the current project, which proposes to install a large number of large-capacity trash rakes, is the first of its kind of Thailand. The automatic trash rakes to be adopted in the current program are to be mechanically simple with easy operation, maintenance and management. Therefore, considering the technical ability of RID, which has been satisfactorily maintaining and managing the existing pumps, it is safe to say that there will be no problem in the operation and maintenance of the automatic trash rakes to be installed in this project. It is considered that the project is appropriate.

### 3-2-2 Examination of the requested facilities and materials

#### (1) Automatic trash rake

The objective of this project is the installation of automatic trash rakes in order to eliminate the problem caused by the waste produced at the three pump sites. This project is essential to protect the Bangkok metropolitan area from a flood. The most reliable method to prevent this pump from sucking in waste, which results in malfunctioning, is to install the automatic trash rake immediately in front of the pump. Therefore, in principle, the automatic trash rake should be installed where a screen is set at present. However, if this is



not possible because of the structure or location, a suitable position must be selected upstream of the pump. The required facilities are examined from this viewpoint.

#### Right-bank pump system, Phra Khanong pumping station

Since the Phra Khanong drainage canal runs upstream through a paddy area and downstream through an urban area, water hyacinths are found abundantly in the canal and a large amount of domestic waste flows into the canal from houses along the canal. When a pump is operating, these wastes flow into the pump site, clogging the screen and disrupting pump operation. Therefore, automatic trash rakes must be installed as quickly as possible to protect the Bangkok urban area from a flood. Also, a belt conveyor system to carry out the waste collected must be installed along with the automatic trash rake.

The screen section of the right-bank pump system was constructed taking into consideration possible future installation of an automatic trash rake. Therefore, the current equipment will present no problem as far installation of the type of automatic trash rake being planned. It is also not necessary to modify any related structures to install the automatic trash rake.

#### Left-bank pump system, Phra Khanong pumping station

Since a lot of waste accumulates in the pump system, as can be seen in the right-bank pump system, the automatic trash rake and trash conveying facility must be installed as quickly as possible.

The screen section of existing pump site has no space to install a new automatic trash rake. Also, extending the front section is also inappropriate because of the relationship with the drainage gate downstream. Therefore, an appropriate plan would be to construct a structure to installing the automatic trash rake in the vicinity of the division point of the diversion canal that runs from the Phra Khanong drainage canal to the pump site. This construction would present no problem.

#### Right-bank pump system, Sam Rong pumping station

The Sam Rong drainage canal, like the Phra Khanong drainage canal also has a thick growth of water hyacinths and a concentration of domestic waste which greatly disrupts pump operation. Therefore, the automatic trash rake and trash conveying facility must be installed as quickly as possible in order to protect the urban area from flooding.

The screen section was constructed allowing for later installation of the automatic trash rake and the current equipment will present no problem as far installation of the type of automatic trash rake being planned. It is also not necessary to modify any related structures to install the automatic trash rake.

#### Left-bank pump system, Sam Rong pumping station

Since a lot of waste accumulates in the pump system, as can be seen in the right-bank pump system, the automatic trash rake and trash conveying facility must be installed as quickly as possible.

There is not enough space in the screen section of the existing pump site to install the planned automatic trash rake, so the structure must be modified. Since the extension of the pump site structure located in the navigation lock is slight, the modification will not interfere with the navigation lock. Also, at the pump site located upstream of the drainage gate, the extension of the structure is slight, causing no drainage disturbance. Therefore, the existing structure will be extended forward to install the automatic trash rake.

#### Charoen Rat pumping station

The Chai Thale drainage canal connected to the Charoen Rat pumping station was constructed for the purpose of draining off the eastern paddy area in the project area separated by the King's dike. Flood water in this area, which used to flow into the Chao Phraya river,

must be discharged southward into the Gulf of Thailand after the construction of the King's dike. In other words, the Charoen Rat pumping station was constructed to discharge the flood water in the paddy area east of the King's dike where the flood water increased as a result of the construction of flood control facilities in the Bangkok urban area. Therefore, the majority of the waste in this pump site is the water hyacinth that grows in the drainage canal. The water hyacinth flows into the pump site, blocks the screen and greatly disrupts pump operation. Since the pump does not then function properly, flood water cannot be discharged and the life of farmers in this area is adversely affected. Accordingly, the automatic trash rake and trash conveying facilities must be installed as quickly as possible.

Since there is not enough space in screen section of the existing pump site to install the automatic trash rake, the structure must be extended. Since this pump site looks over a broad stilling pond, extending the structure in the front presents no problem.

## (2) Related facilities

New requests were made during the field survey period, and these requests are included in this project for the following reasons.

- 1) Development of an interlocking operation system between the pump and automatic trash rake:

This is essential for maintenance of the pump.

- 2) Improvement of the pump-controlling water gauge:

This is essential for protecting the pump in case of an excessive decrease in the pump water level.

- 3) Installation of a motor crane at the Phra Khanong and Sam Rong pumping stations:

Quick maintenance and checking the pump are essential and a motor crane is necessary for a pump site.

- 4) Installation of a facility which can carry trash off in two ways, by water (using a barge) and by land (using a truck):

In order to effectively use the water hyacinth, a plan will be made to meet with this request as much as possible. However, a plan will be stay in the method of carrying off the trash using a barge only, as requested initially, if the facility contents pose a problem in the future maintenance and management.

### 3-3 Details of the Project

#### 3-3-1 Executing agency

This project has been requested by RID, which is under the Ministry of Agriculture and Cooperative of the Government of the Kingdom of Thailand. The pump sites proposed in this project are facilities designed for water control upstream of the farmland, and the RID's Operation and Maintenance Division is responsible for water control at present.

Since the automatic trash rake will be operated interlocking with the pump when this project is completed, the pump operator must be able to operate and control the automatic trash rake as well. Accordingly, the Operation and Maintenance Division of the RID shall be responsible for the operation and maintenance of all facilities of the pump sites. The specific details are described in the Operation and Maintenance Plan, Chapter 6.

#### 3-3-2 Equipment and material

The equipment and materials that are to be installed in this project are: the automatic trash rakes which quickly rakes up the waste caught on the screen, thereby improving the flow of the water and ensuring smooth operation of the pump; an interlocking operation system between the installed automatic trash rake and existing pump; an improved pump-controlling water

gauge for pump protection; and machinery to carry off the raked waste to a predetermined place.

The following outlines the equipment and materials to be installed at each pump site.

(1) Phra Khanong pumping station

1) Left-bank pump system

Location:

Point at which the diversion canal to the left-bank pump system divides off from the Phra Khanong drainage canal

Equipment to be installed:

Automatic trash rake

Width 5.4 m, height 5.0 m, 5 units

Belt conveyor

Horizontal 63 m, 1 unit (can be operated in the reverse direction)

Inclined 15 m, 1 unit

Hopper

10 m<sup>3</sup>, 1 unit

Crane

Electric, suspension, 3-ton type, 1 unit

Civil structure:

New construction 52 foundation piles ( $\phi 400$ ,  $l = 19$  m)

Concrete placement 440 m<sup>3</sup>

2) Right-bank pump system

Location:

Screen section of the existing pump site

Equipment to be installed:

Automatic trash rake

Width 5.5 m - 4.9 m, height 5.0 m, 7 units

Belt conveyor

Horizontal 67 m, 1 unit

Horizontal 53 m, 1 unit

Crane

Electric, suspension, 3-ton type, 1 unit

(2) Sam Rong pumping station

1) Left-bank pump system (2 systems)

Location:

Screen section of each existing pump system

Equipment to be installed:

Automatic trash rake

Width 2.4 m, height 5.2 m, 10 units

Belt conveyor

Horizontal 18 m, 4 units

Horizontal 23 m, 1 unit

Crane

Electric, suspension, 3-ton type, 2 units

Civil structure:

Modification of existing structure

Concrete destruction 130 m<sup>3</sup>

Concrete placement 270 m<sup>3</sup>

2) Right-bank pump system

Location:

Screen section of existing pump system

Equipment to be installed:

Automatic trash rake

Width 5.4 m, height 5.3 m, 7 units

Width 2.4 m, height 5.3 m, 1 unit

Belt conveyor

Horizontal 55 m, 2 units (1 unit is operable in the reverse direction)

Inclined 15 m, 1 unit

Hopper

10 m<sup>3</sup>, 1 unit

Crane

Electric, suspension, 3-ton type, 1 unit

(3) Charoen Rat pumping station

Location:

Screen section of existing pump site

Equipment to be installed:

Automatic trash rake

Width 5.4 m, height 4.8 m, 12 units

Width 2.6 m, height 4.8 m, 1 unit

Belt conveyor

Horizontal 82 m, 1 unit

Inclined 18 m, 1 unit

15 m, 1 unit (rotary type)

Hopper

10 m<sup>3</sup>, 1 unit

Civil structure:

Modification of existing structure

26 foundation piles ( $\phi$ 450,  $l = 26$  m)

Concrete destruction 300 m<sup>3</sup>

Concrete placement 830 m<sup>3</sup>

3-3-3 Overview of the project sites

(1) Phra Khanong pumping station

The Phra Khanong pumping station is located about 2 km upstream from the point where the Phra Khanong drainage canal joins the Chao Phraya river. This confluence is approximately 30 km upstream of the mouth of the Chao Phraya river.

In the right-bank pump system, some metal fixtures were embedded and a necessary space was reserved around the pumps, in the course of construction work, anticipating the installation of an automatic trash rake in the future. During the current project, the automatic trash rake and the belt conveyor used for carrying off the trash can be installed in this reserved space, and therefore it is not necessary to modify the water suction tank.

In the left-bank pump system, on the other hand, there is no space for an automatic trash rake to be installed in the vicinity of pumps. This necessitates modification of the water suction tank, but its forward extension is not recommendable because, immediately downstream from the left-bank pump system, there is a drainage gate which may block the passage of water.

It is advisable, therefore, to shift the installation point of an automatic trash rake to the division point of the diversion canal that extends from the Phra Khanong drainage canal to the left-bank pump site. It is necessary, in addition, to build a new concrete structure for the automatic trash rake.

The right-bank pump system is supported by piles 19.0 m long. The bearing capacity of these piles is strong enough to bear the upper load created after installation of the automatic trash rake. This has been verified by the calculation of bearing capacity based on a pile-driving test conducted during construction work. These data suggest that it is possible to set up an automatic trash rake on the existing structure.

In the left-bank pump system, a new structure will be built to accommodate the installation of an automatic trash rake. For safety's sake, it is necessary to establish a deep pile foundation similar to that for the right-bank pump system.

The power source of the automatic trash rake is electricity. This electricity will be supplied from the existing pump site. The electric power needed for operating an automatic trash rake is about 1% (1/100) of the electric power needed for pumping. So the power supply used for pumps, supplied from the existing power source, is enough to cover the electricity used for automatic trash rakes.

At the present time, there is a road (4.0 m wide) being used for the maintenance and management of the pump site. This road is well paved and can be utilized as a passage approaching the pump site. A trunk road runs across the Phra Khanong drainage canal at a point about 500 m upstream from the pump site. This also gives access by water.



(2) Sam Rong pumping station

The Sam Rong pumping station is located about 3 km upstream of the junction of Sam Rong drainage canal and the Chao Phraya river. The point where the Sam Rong drainage canal joins the Chao Phraya river is located approximately 25 km upstream of the mouth of the Chao Phraya river.

The space reserved in the two left-bank pump systems is not large enough to set up an automatic trash rake. This necessitates modification of the water suction tank. Since the modification work involved only a slight forward extension job, it will have little effect on the drainage gate, navigation lock and other objects adjacent to these pump systems.

As in the case of the Phra Khanong right-bank pump system, the Sam Rong right-bank system was originally built in anticipation of the installation of an automatic trash rake in the future. It will not be necessary in the current project, therefore, to modify the water suction tank in preparation for the installation of an automatic trash rake, belt conveyor, and other equipment.

In the Sam Rong pumping station, all three pump systems are supported by piles 8.0 m long. The bearing capacity of these piles is great enough to bear the upper load created after installation of the automatic trash rake. This has been verified by calculation of pile's bearing capacity performed in conformity with the customary formula used by RID. It is possible, therefore, to set up an automatic trash rake on the existing structure.

The power source of an automatic trash rake is electricity. As in the case of Phra Khanong, this electricity can be supplied from the existing pump site, where the power supply is enough to cover the electricity that the new equipment requires.

Speaking of access to the pumping station, a trunk road runs across the Sam Rong drainage canal at a point about 300 m upstream of the pumping station. The route extending from this road can be utilized as a passage approaching the site. However, a considerable number of tent shops are doing business on the route from the trunk road to the pump site. It will be necessary to remove some of these shops when construction work gets under way.

(3) Charoen Rat pumping station

The Charoen Rat pumping station is located on a spot about 20 km east of the mouth of the Chao Phraya river along the coastline. The spot lies between the coastline and Route 3 of the national highway which runs parallel to the coastline. Confronting this pumping station on the other side of the highway, there is the Chai Thale drainage canal flowing parallel to Route 3.

The Chai Thale drainage canal is designed to drain off the rainwater from farmland into the Gulf of Thailand. The farmland is situated outside (on the east) of the polder dike which was constructed for the purpose of protecting Bangkok City from floods.

The Charoen Rat pumping station was constructed as part of the urgent flood protection project of 1985, being financed independently out of the Thai national budget. This site is not large enough to accommodate an automatic trash rake, and therefore it is necessary to modify the water suction tank.

At the Charoen Rat pumping station, the pump system is supported by piles 26.0 m long. Modification of the water suction tank is necessary, as mentioned above, and so additional piles shall be fixed over the modified area, considering the stability of the entire structure. The bearing capacity of these piles altogether is stable enough, as proved by this study of the upper load created after installation of the automatic trash rake.

The electricity used for operating automatic trash rakes can be supplied from the existing pumps as in the case of the Phra Khanong pumping station.

The Charoen Rat pumping station is adjacent to a national highway (Route 3), which can provide access to the site.

#### 3-3-4 Technical cooperation

The automatic trash rake proposed in the current project has shown almost no achievements in the Kingdom of Thailand in the past. But the mechanism is not very complicated and the operator needs no special technical skill to operate it. The model to be chosen for the project will be the type that requires rather simplified operation and maintenance. In addition, operators will be able to get adequate on-the-job training because the machine will be installed in the actual location for quite a long time. Therefore, no technical cooperation will be necessary during the project.

