

## 第 5 章 本格調査の実施方針の検討



## 第5章 本格調査の実施方針の検討

### 5.1 本格調査基本方針

バンコック市内のクローンの水質は、腐敗槽のみで処理された水洗便所からの排水、無処理の雑排水、工場排水等の流入により著しく汚濁した状況にある。また、1983年の大洪水の後にバンコック市東部郊外地域の外縁部に建設されたポルグー（輪中堤）により、平常時にクローンに流入する比較的清浄な河川流量も減少し、水質汚濁が助長されたともいわれている。

一方、抜本的対策となるべき下水道計画は、マスタープランは既に策定されているものの、主として財政的な理由から事業が実施される迄に至っておらず、また、排水規制も有効に機能する迄に至っていない。

しかし、水質改善についての社会的、行政的な意欲はかなり強く、また、国王もクローンの水質汚濁防止に強い関心を持ち、水質改善について過去二、三の指示、提言を行っている。

このため、本調査が実施されることになったものであるが、上記のような状況からして緊急的な水質改善対策として実施の可能性が高い以下の2方策について調査を行う。

(1) 洪水防御、排水のための既存又は計画中の施設を主として利用したチャオピア川からの浄化用水の導入

(2) 市内に存在する比較的大面積の池を利用したクローンの水の浄化

更に、緊急的な対策という位置づけからして、上記(1)の浄化用水の導入に関しては、

(a) 洪水防御、排水のための既存又は計画中の施設（ポンプ施設、ゲート等）を主として利用し、新規の施設は必要最少限とする案で検討する。また、新規の施設が含まれる場合、それらを洪水防御、排水のためにも利用する方策もあわせて検討する。

(b) 既存又は計画中のポンプ施設容量および導水可能量には限度があるので、調査対象区域はシティコア地区及び東部郊外地域とするものの、効果が著しいと考えられる主要クローンからなるいくつかのルートのみへの導入について主として検討する。ただし、調査対象区域およびチャオピア川西岸のクローン全般について、浄化用水導入の可能性の概括的な検討を行う。

(c) 浄化用水導入効果の検討には、クローンの流下先のチャオピア川への影響も含める。

また、(2)の池を利用したクローンの水の浄化に関しては、

(a) 主な検討はマカサン池を対象として行う。

(b) 対象処理方式はラグーンとし、曝気式ラグーンによる処理も含めて、現地で実験的な検討も行う。

(c) 下水処理への適用も含めて、設計の考え方をとりまとめる。

### 5.2 調査項目及び内容

本調査は、調査内容別には、浄化用水のクローン網内での流れを推算するための検討（水理的な検討）、ラグーン処理を評価し設計の考え方をとりまとめる検討（ラグーン処理の検討）、およびクローン水質の改善効果の検討（水質改善効果の検討）に概ね大別できる。また、調査

手順の段階別には、既存資料の収集・解析、現地観測、目標設定も含めた条件設定、計算と解析、計画案の策定、経済分析、実行プログラムの策定等の段階からなる。

調査のフローを図5-1に示す。

調査の各段階別にその概要と配慮すべき点を述べる。

#### ① 既存資料の収集・解析

水理計算、水質計算、汚濁負荷量推定等に必要な資料のうち既存の資料を収集・解析する。クローン縦横断図では、地盤沈下、ヘドロの堆積、維持しゅんせつの影響に注意しなければならない。

#### ② 現地観測

既存資料の不十分なものを補足するための現地観測で、水理計算のためのクローンの縦横断測量、流量観測、負荷量原単位および汚濁負荷流達率を求めるための4～5のモデル、小流域における流量、水質観測、ラグーン処理の現地実験等からなる。モデル小流域における流量、水質観測は、少なくとも乾季、雨季とにわけて行う必要がある。

#### ③ 目標設定も含めた条件設定

詳細な検討の対象とするルート決定、可能導水量の推定、目標水質の決定、将来汚濁負荷量の推定等からなる。

#### ④ 計算と解析

種々の条件の下での水理計算、水質計算及びそれらの結果の評価、下流のチャオピア川に対する影響の検討、ラグーン処理効果とラグーン。

### 業務担当

1 総括	既存資料解析、条件設定、計画案の策定、経済分析、実行プログラムの策定
2 水理・水文	水理・水文・洪水防御・排水施設収集解析、クローンの流量観測、モデル小流域の流量観測、流量計算の条件設定、クローン維持のための浚渫計画、施設の概略設計
3 水質調査	水質、負荷原単位、負荷量資料収集解析、モデル小流域の水質観測と流達率の調査
4 処理計画	ラグーン処理文献収集解析、ラグーン処理実験計画、ラグーン処理実験、処理効果の算定、ラグーン設計方法のまとめ、調査対象全区域についての概括的検討
5 施設設計	ラグーン処理施設の設置と運転調整、施設の概略設計、維持管理計画
6 測量	クローンの縦横断測量と結果の整理
7 負荷量予測	社会経済的統計資料及び将来推計資料の収集解析、将来フレームの予測、現況及び将来負荷量の推定
8 汚濁解析	目標水質の決定、流量計算、水質改善効果計算、チャオピア川に対する影響検討、調査対象区域全域及び西岸地区に関する概括的検討、施設の概略設計、水質改善の全体計画の中での位置づけの検討

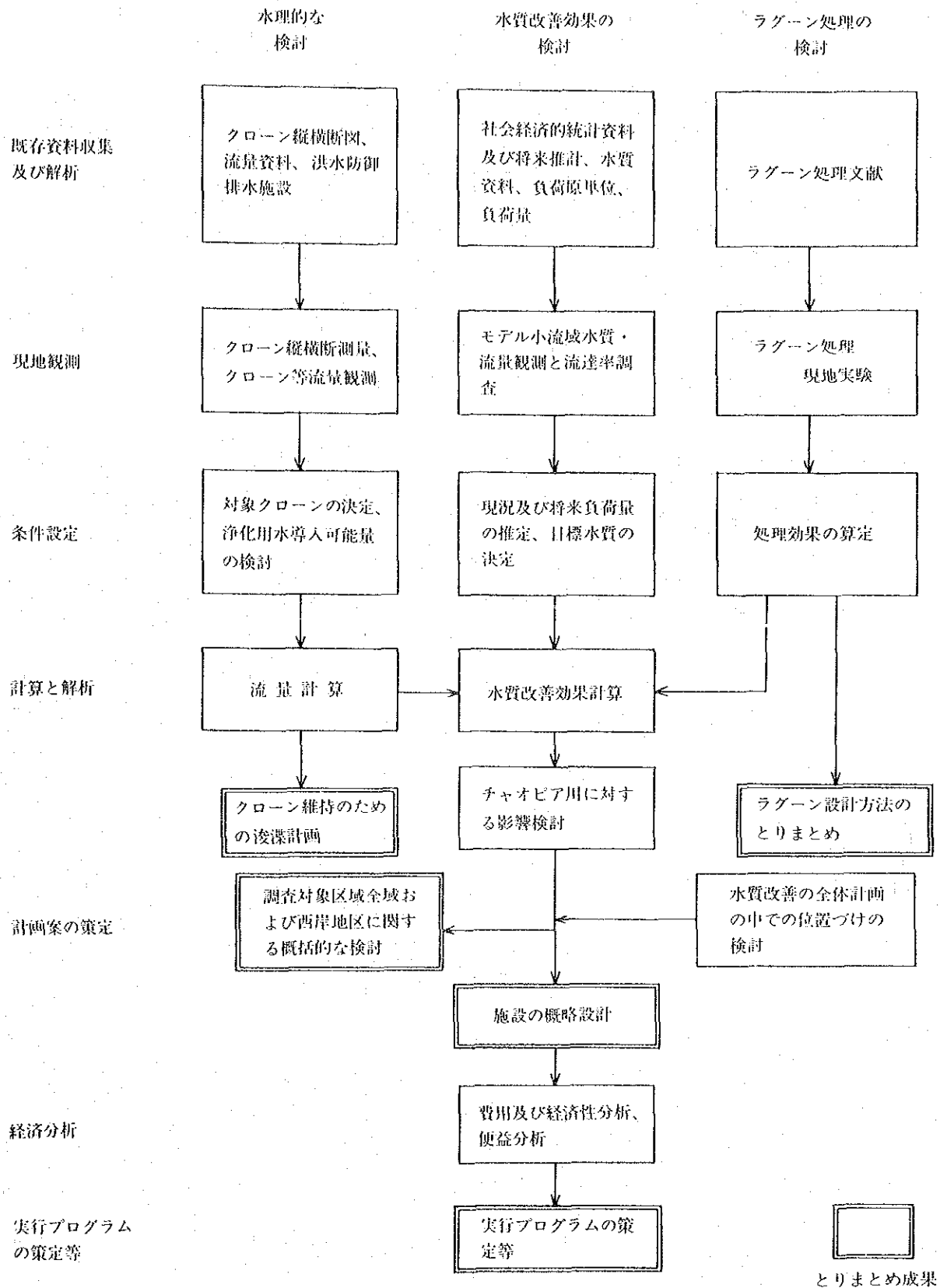


図 5 - 1 調査のフロー

- 9 財務分析 費用及び経済性分析、便益分析
- 10 組織・法制 実行プログラムの策定等

### 5.3 調査工程

本調査の計画作業期間は現地調査開始から、ドラフトファイナルレポート提出まで14ヶ月間とし、同レポート提出後1ヶ月以内にタイ側のコメントを得て、ファイナルレポート作成まで16ヶ月間である。(図5-2参照)

### 5.4 報告書作成

#### (1) インセプションレポート

英文 30部 (内タイ側提出分20部)

現地調査開始時に提出する。

同レポートには、調査のアプローチ方法、作業・要員計画、技術移転の方法、レポートシステム等について記載する。

#### (2) インテリムレポート

英文 50部 (内タイ側提出分40部)

現地調査開始後8ヶ月以内に提出。

同レポートにはクローン水質浄化計画の調査・解析経過について記載する。

#### (3) ドラフト・ファイナルレポート

英文 メイン・レポート 60部 (内タイ側提出分50部)

英文 サマリー・レポート 60部 (内 " 50部)

英文 サポートィングレポート 20部 (内 " 10部)

和文 サマリー・レポート 10部

調査開始後14ヶ月以内に提出する。

同レポートには、最終的な全ての調査結果を記載する。

#### (4) ファイナルレポート

英文 メイン・レポート 130部 (内タイ側提出分100部)

英文 サマリー・レポート 130部 (内 " 100部)

英文 サポートィングレポート 130部 (内 " 100部)

和文 主報告書 20部

和文 サマリー・レポート 20部

同レポートは、ドラフト・ファイナルレポートのタイ側コメントを得てから1ヶ月以内にコメントを吟味、検討の上、提出する。







## 第 6 章 勸告と提言



## 第6章 勧告と提言

本調査団は、バンコック市クローン水質改善計画調査について、次のとおり勧告・提言する。

- (1) 本調査を実施するに際しては、現在著しく汚濁しているクローンの緊急的な改善計画であるという位置づけを明確にする必要がある。
- (2) 下水道の整備、効果的な工場排水規制などの根本的な水質改善対策と矛盾する計画であってはならず、むしろ根本的な対策の実施を助長する方向のものでなければならない。
- (3) 緊急的な計画という観点からして、現実的な実施可能性に最大の考慮を払うべきである。
- (4) 水質改善計画が立脚すべき最も基本的なデータは対象地域から排出される汚濁負荷量であるが、本調査の対象地域に係る汚濁負荷量の信頼できる既存のデータが乏しいことから、本調査の中で汚濁負荷量の把握に相当な重点を置く必要がある。
- (5) 浄化用水の導入は、定性的には、停滞している間に沈澱等で多少とも水から除去されている汚濁物質を下流に流送する傾向になるので、下流のチャオピア川に対する影響を検討しておく必要がある。
- (6) 池を利用したラグーン処理には、上記の導水による下流への汚濁負荷量の増大を補うという観点からの検討をも含めるものとする。
- (7) 調査対象は、汚濁の最も著しいチャオピア川左岸の市域内のクローンとしているが、汚濁の程度はそれ程著しくなく、また、それ故に未だ活発な水利用のある右岸市域内のクローンについても、概括的な検討を行っておくことが望ましい。



## 付 属 資 料

1. Scope of Work
2. Minutes of Meeting
3. 要請書(T/R)
4. 面会者リスト



## 1. Scope of Work





SCOPE OF WORK  
FOR  
THE FEASIBILITY STUDY  
ON  
PURIFICATION OF KLONG WATER IN BANGKOK  
IN  
THE KINGDOM OF THAILAND

AGREED UPON BETWEEN  
JAPAN INTERNATIONAL COOPERATION AGENCY  
AND  
THE GOVERNMENT OF THE KINGDOM OF THAILAND

BANGKOK, 9TH SEPTEMBER , 1987

*Hansa Kaewbandit*

.....  
Lt. Hansa Kaewbandit  
Deputy Governor  
Bangkok Metropolitan  
Administration

*Ken Murakami*

.....  
Mr. Ken MURAKAMI  
Leader of  
Preliminary Survey Team  
Japan International  
Cooperation Agency

## I. INTRODUCTION

In response to the request of the Government of the Kingdom of Thailand, the Government of Japan decided to implement the Feasibility study on Purification of Klong Water in Bangkok (hereinafter referred to as "the Study"), within the general framework of technical cooperation between Japan and Thailand, which is set forth in the Agreement on Technical Cooperation between the Government of Japan and the Government of the Kingdom of Thailand signed on November 5, 1981.

Accordingly, the Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of the technical cooperation programme of the Government of Japan, will undertake the Study, in accordance with the relevant laws and regulations in force in Japan in close cooperation with the authorities of Thailand.

The Department of Drainage and Sewerage (hereinafter referred to as "DDS") shall act as counterpart agency to the Japanese Study Team and also as a coordinating body in relation with other relevant organizations for the smooth implementation of the study.

The present document sets forth the Scope of Work for the Study.

## II. OBJECTIVE OF THE STUDY

To conduct the feasibility study on purification of klong water project in central Bangkok.

## III. STUDY AREA

The Study covers the main Klongs in the city core and eastern suburban areas.

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H. K.

#### IV. OUTLINE OF THE STUDY

In order to achieve the objective mentioned above, the Study shall cover the following items:

##### 1. Data Collection, Review and Analysis

- (1) Existing reports (relevant previous studies, etc.)
- (2) Flow discharge, water level, water quality of the klongs
- (3) Existing klong networks, cross-sections and longitudinal profiles
- (4) Existing drainage pumps, control gates and their operation records
- (5) Waste water flow discharge and pollutant load
- (6) Economic, social and environmental conditions
- (7) Institution, administration, law and regulation

##### 2. Study and Analysis

###### (1) Field Survey

- 1) Supplementary observation of water quality and flow discharge
- 2) Survey on polluted mud and accumulated wastes
- 3) Supplementary cross sectional and longitudinal survey
- 4) Investigation on BOD run-off coefficient
- 5) Investigation on the existing drainage facilities

(2) Estimation of waste water flow discharge and pollutant load into the klongs for the present and future conditions referring to the existing sewerage development master plan

(3) Classification of the existing klongs based on the necessity and priority for the klong water purification

(4) Setting up targets of water quality improvement for the klongs

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*H.K*

(5) Analysis on purification effects of the urgent structural measures

1) Introduction of dilution water

a. Mathematical model analysis on dilution water introduction

b. Analysis on diluted water quality

2) Dredging of polluted mud and removal of accumulated wastes

3) Simple treatment in the retarding ponds or in the klongs

### 3. Project Formulation

(1) Framework for water pollution control

(2) Urgent water purification plan

(3) Preliminary design of the plan

### 4. Economic and Financial Analysis

(1) Estimation of project cost

(2) Estimation of benefits of environmental quality improvement

(3) Economic and financial analysis

### 5. Implementation program of the proposed urgent plan

### 6. Recommendations

(1) Water quality monitoring plan

(2) Institution and operation & maintenance system

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*H. K.*

## V. WORK SCHEDULE

The Study will be executed in accordance with the tentative working schedule. (See ANNEX)

## VI. REPORTS

JICA will prepare and submit the following reports in English to the Government of the Kingdom of Thailand.

### 1. Inception Report;

Twenty(20) copies at the commencement of the field survey in Thailand.

### 2. Interim Report;

Forty(40) copies within eight(8) months after commencement of the Study.

### 3. Draft Final Report;

Fifty(50) copies within eleven(11) months after commencement of the Study.

The Government of the Kingdom of Thailand will provide JICA with its comments within one(1) month after its reception of the Draft Final Report.

### 4. Final Report;

One hundred(100) copies each within one(1) month after JICA's reception of the said comments on the Draft Final Report.

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VII. UNDERTAKINGS OF THE GOVERNMENT OF THE KINGDOM OF THAILAND

1. In accordance with the Agreement on Technical Cooperation between the Government of Japan and the Government of the Kingdom of Thailand dated November 5, 1981, the Government of the Kingdom of Thailand shall accord benefits to the Japanese Study Team (hereinafter referred to as "the Team") as follows:

- (1) To permit the members of the Team to enter, leave and sojourn in Thailand for the duration of their assignment therein, and exempt them from alien registration requirements and consular fees.
- (2) To exempt the members of the Team from taxes, duties, and any other charges on equipment, machinery and other materials brought into Thailand for the conduct of the Study.
- (3) To exempt the members of the Team from income taxes and other charges of any kind imposed on or in connection with any emoluments or allowances paid to the member of the Team for their services in connection with the implementation of the Study.
- (4) To bear claims, if any arises against the member of the Team resulting from, occurring in the course of, or otherwise connected with the discharge of their duties in the implementation of the Study, except when such claims arise from gross negligence or willful misconduct on the part of the members of the Team.

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2. To facilitate smooth conduct of the Study, DDS shall take necessary measures in cooperation with other relevant organizations:

- (1) To secure permission for entry into private properties or restricted areas for the conduct of the Study.
- (2) To secure permission for the Team to take all data and documents including photograph related to the Study out of Thailand to Japan.
- (3) To provide the medical services as needed. Its expenses will be chargeable on members of the Team.
- (4) To ensure the safety of the members of the Team when and as it is required in the course of the Study.

3. DDS shall, at its own expense, provide the Team with the following, in cooperation with other relevant organizations concerned, if necessary:

- (1) Available data and information related to the Study.
- (2) Counterpart personnel and support staff necessary for the Study.
- (3) Suitable office space with necessary equipment in Bangkok.
- (4) Appropriate number of vehicles with driver.
- (5) Credentials or identification cards.

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#### VIII. UNDERTAKINGS OF JICA

For the implementation of the Study, JICA shall take the following measures:

1. To dispatch, at its own expense, the Team to Thailand.
2. To pursue technology transfer to the Thai counterpart personnel in the course of the Study.

#### IX. CONSULTATION

JICA and DDS will consult each other in respect of any matter that may arise from or in connection with the Study.

*K. M.*  
H.K.



ANNEX

TENTATIVE SCHEDULE

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
WORK IN THAILAND														
WORK IN JAPAN														
REPORTS														
	▲ IC/R								▲ IT/R			▲ DF/R	◎	▲ F/R

IC/R : INCEPTION REPORT    IT/R : INTERIM REPORT    DF/R : DRAFT FINAL REPORT

F/R : FINAL REPORT    ◎ : COMMENT

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H.K.*



## 2. Minutes of Meeting



MINUTES OF MEETING  
OF  
SCOPE OF WORK  
FOR  
THE FEASIBILITY STUDY  
ON  
PURIFICATION OF KLONG WATER IN BANGKOK  
IN  
THE KINGDOM OF THAILAND

BANGKOK, 9TH SEPTEMBER, 1987

*Hansa Kaewbandit*

.....  
Lt. Hansa Kaewbandit  
Deputy Governor  
Bangkok Metropolitan  
Administration

*Ken Murakami*

.....  
Dr. Ken MURAKAMI  
Leader  
Preliminary Survey Team  
Japan International  
Cooperation Agency

1. In response to the request of the Government of Thailand, the Government of Japan has dispatched a Preliminary Survey Team for the Feasibility Study on Purification of Klong Water in Bangkok, from 1st to 10th September 1987, through the Japan International Cooperation Agency (JICA).

2. The Preliminary Survey Team headed by Dr. Ken MURAKAMI and Thai officials concerned headed by Mr. Anuchit Sodsathit, had a series of discussions and exchanged the views on the Scope of Work for the Feasibility Study.

As a result of the discussions, both sides basically agreed on the Scope of Work.

3. In addition to the Scope of Work, both sides agreed on the followings:

(1) Study Area


The study area mentioned in III of S/W covers the master plan area of Flood Protection/Drainage Project in Eastern Suburban-Bangkok and the study area of City Core Project (350 km<sup>2</sup>) (refer to attached map).

(2) Targets Klongs for Water Purification

The main klongs mentioned in III of S/W cover the indicated klongs in attached map including Klong Saen Saeb, Klong Sam Sean, Klong Lat Phrao and so on.

(3) Adverse Effects for Chao Phraya River

The analysis mentioned in IV, 2, (5), 1, b, of S/W includes the evaluation on the adverse effects for Chao Phraya River.

  
H. Kawbandit

(4) Simple Treatment

The simple treatment mentioned in IV, 2, (5).3) of S/W aims at purifying klong water mainly in Makkasan Pond.

(5) General views on Klong Water Purification

The general views on west bank side will also be referred to in terms of Klong Water Purification. However, the way of touching upon general views of it will be decided by the Japanese side.,

4. Through the discussion, Thai side requested the following items, and Japanese side took note of them.

(1) Experimental facilities for the Water Purification in the retarding pond.

(2) Equipment for water quality and water flow measurement and survey.

(3) A vehicle for the site survey.

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H. Kaewbendit

Attendant List

Thai Side

1. Mr. Anuchit Sodsathit - Deputy Director, DDS
2. Mr. Somchitt Kattiyavara - Director, Technical Division
3. Mr. Chanchai Vitoonpanyakij - Sanitary Engineering Specialist,  
Technical Division
4. Ms. Sa-cha W. - Civil Engineer 5, Survey & Planning  
Section
5. Mr. Apinan Jaruchaiyakul - Head, Ram Intra Treatment Plant  
Section, Wastewater Treatment Plant  
Division
6. Mr. Pailin Pairon - Official, Department of Technical  
and Economic Cooperation (DTEC)

Japanese Side

1. Dr. Ken MURAKAMI - Leader of the Team
2. Mr. Haruki TAKAHASHI - Member
3. Mr. Junzou SAGO - "
4. Mr. Ryohei UMEMOTO - "
5. Mr. Fumio KIKUCHI - "
6. Mr. Takahito HINO - JICA Thailand Office
7. Mr. Toshio MOROOKA - "
8. Mr. Shigeo KANAI - JICA Expert
9. Mr. Kiyoshi HASEGAWA - "

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H. Kaewleedit



### 3. 要請書 (T/R)



TERMS OF REFERENCE  
FOR  
FEASIBILITY STUDY  
ON  
PURIFICATION OF KLONG WATER IN BANGKOK

January 1986

DEPARTMENT OF DRAINAGE AND SEWERAGE  
BANGKOK METROPOLITAN ADMINISTRATION

## I. BACKGROUND OF THE STUDY

- (1) Urbanization and industrialization of the Bangkok Metropolitan Area has rapidly developed during the last two decades. The population has increased from 2.25 million in 1960 to 5.07 million in 1980, causing an expansion of the urban area from 96 km<sup>2</sup> in 1958 to 345 km<sup>2</sup> in 1980. Amounts of industrial products has mostly grown more than two times during the recent 10 years (1970-1980).

This rapid urbanization and industrialization has brought about a high economic growth but various kinds of public hazards on the other hand.

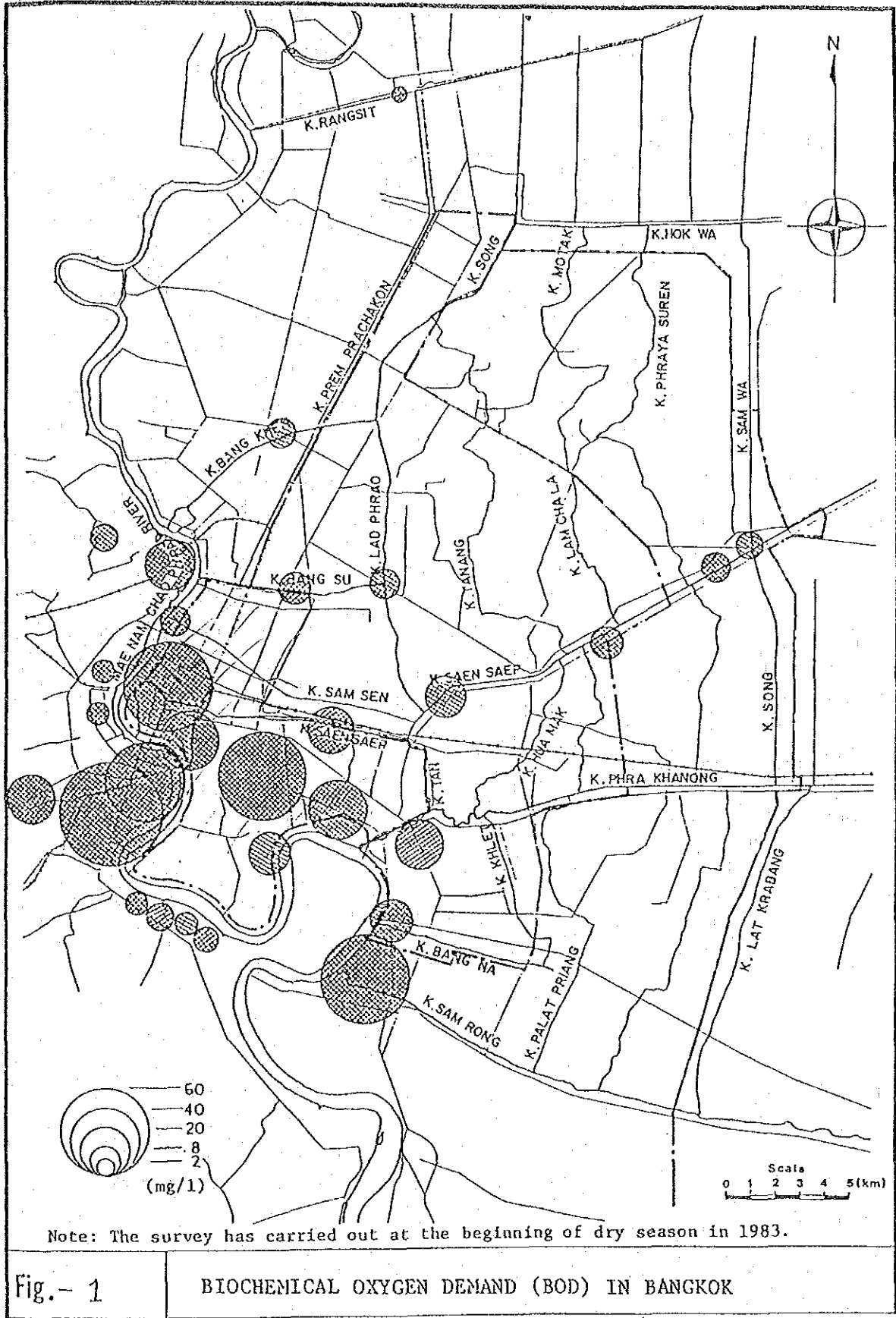
- (2) Water pollution of the klongs (canals) is one of the most serious problems as well as traffic congestion, land subsidence and flooding in Bangkok.

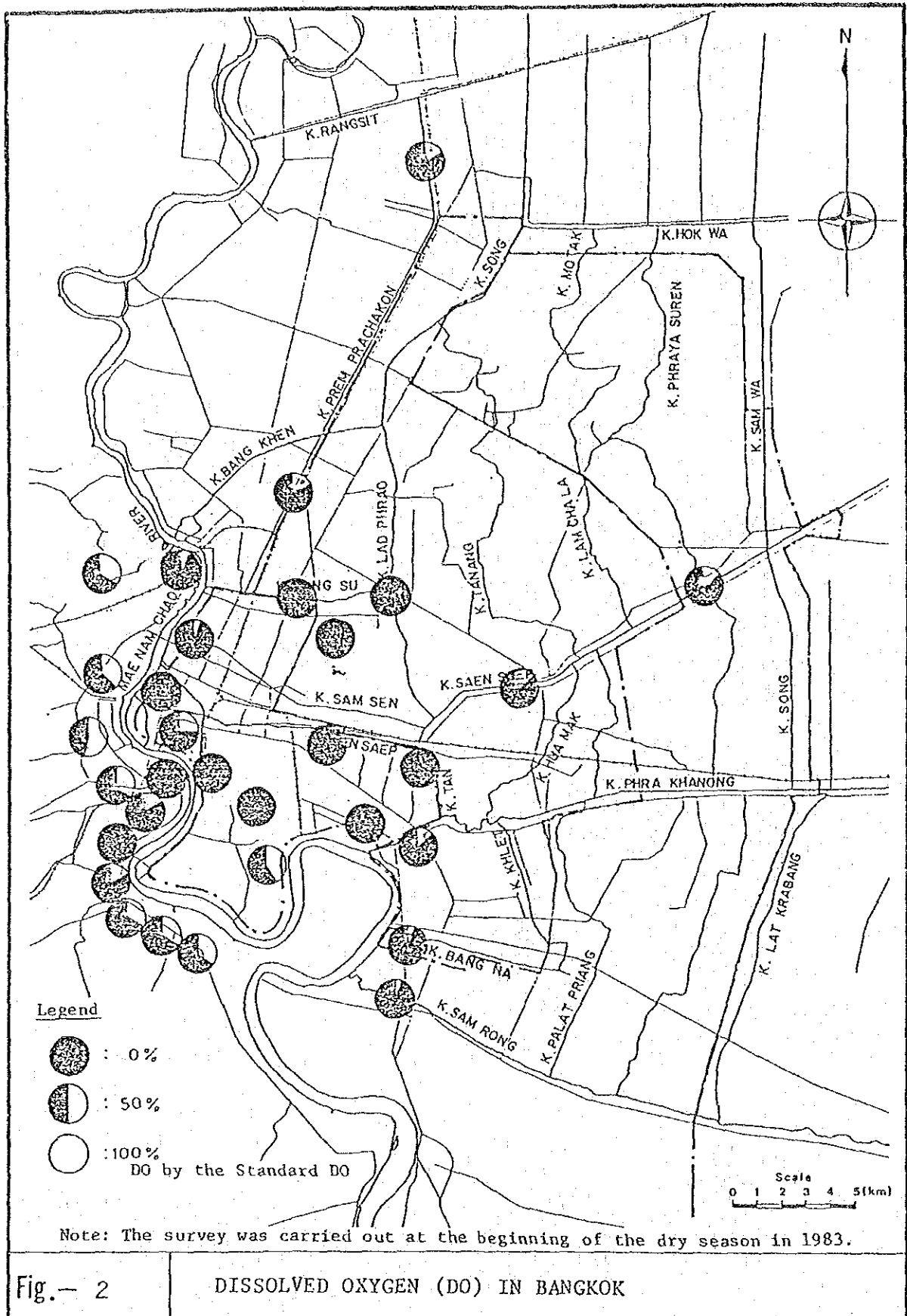
In central Bangkok, the klongs have already lost the roles for navigation, irrigation and inland fishery and are used only for draining of storm water and wastewater. The klongs run in all directions through the whole city with a high network density of one km/km<sup>2</sup> approximately and receive about one million m<sup>3</sup>/day of wastewater with almost no treatment.

Water of the klongs in central Bangkok is polluted black and emits methane with a foul odor from the bed.

Observed BOD value exceeds 60 ppm and DO content lowers down to zero percent in many places as illustrated in Fig.-1 and Fig.-2.

- (3) Water quality of the Chao Phraya River varies depending on the variation of the river discharge. It is generally tolerable except when it deteriorates as bad as to reach or exceed critical conditions for aquatic life at the time of low flow discharge in the downstream reaches from central Bangkok.





The longitudinal variation of observed BOD and DO concentration is illustrated in Fig.-3.

- (4) The flood protection barriers in the eastern suburban areas provided immediately after the 1983 flood will protect central Bangkok against flood water intrusion from the outer areas but will reduce dilution water inflow into the klongs in central Bangkok on the other hand. It will further aggravate water quality of the kongs in central Bangkok.
- (5) Sewerage development is the most fundamental measure for pollution abatement of the klong water but it generally requires a tremendous amount of cost.

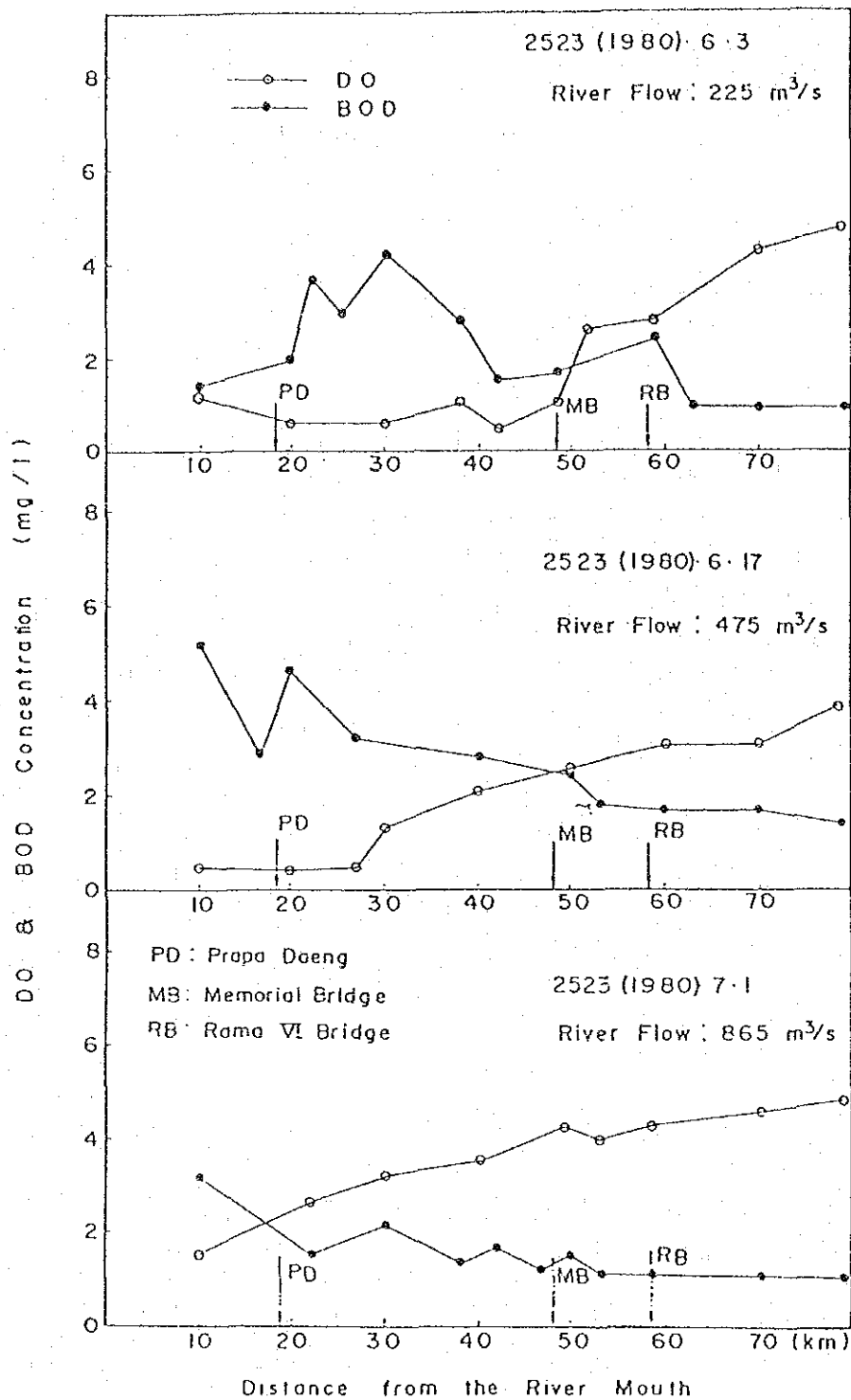
According to the sewerage development master plan prepared by JICA (Japan International Cooperation Agency) in 1981, the cost required to provide sewerage system for 360 km<sup>2</sup> of central Bangkok is estimated to be 37,000 million Bahts at 1980 price. It is expected to take a long time to achieve a full completion of the sewerage system due to budgetary constraints. By the year 2000, only 36 km<sup>2</sup> or 10% of the target area is expected to be implemented. Moreover, the economic conditions may not allow immediate implementation of the sewerage plan.

- (6) On April, 1985, His Majesty the king has made a visit to several klongs in Bangkok to inspect the water conditions. At that time, His Majesty has instructed the Bangkok Metropolitan Administration to improve water quality in Bangkok klongs so that it will not cause public hazards.

### III. NECESSITY OF THE STUDY

In view of these situations, the Bangkok Metropolitan Administration has already started a preliminary operation and study on water pollution abatement of the klongs in central Bangkok by introduction of dilution water from the Chao Phraya River to meet the urgent requirement.

Introduction of dilution water into the klongs is closely related with the flood protection and drainage plans proposed for the city core and eastern suburban areas. The drainage pumps, control gates and klong



[Source; NEB and AIT]

Fig. - 3

DO AND BOD CONTENTS IN THE CHAO PHRAYA RIVER



improvement proposed for the flood protection and drainage are expected to become available or useful for purification of the klong water if some modifications are given to their plans. For instance, if a drainage pump is designed to be of reversible type, it will be used for introduction of dilution water as well as drainage of storm run-off. Moreover, retarding ponds may be used to purify the dry-weather run-off when used as aerated lagoons.

The study of the klong water purification project shall be completed before implementation of the flood protection and drainage project of the city core and eastern suburban areas in order to integrate the both purposes and to attain an optimum development of pump stations, control gates and klong improvement.

### III. OBJECTIVE OF THE STUDY

The objective of the Study is:

- (1) To prepare a framework for water pollution control of the klongs in central Bangkok.
- (2) To prepare an urgent water purification plan of the klongs in central Bangkok and to examine the feasibility of the prepared urgent plan.

### IV. PLANNING CONCEPT OF THE PROJECT

#### (1) Framework

The framework mentioned above will include:

- 1) present and projected wastewater flow and pollutant load;
- 2) targets of water quality improvement for the klongs; and
- 3) long-term strategies for cut-down of pollutant load and dilution of wastewater.

#### (2) Urgent Water Purification Plan

The urgent water purification plan shall present some practicable measures which will produce immediate effects at a bearable cost in order to urgently abate the existing heavy water pollution of the klongs.

Sewerage development is found difficult to apply, since it will take a long time and a large amount of cost to complete as mentioned in Chapter I.

Other structural measures than sewerage system shall be developed for this urgent requirement.

The measures to be studied will include:

- 1) introduction of dilution water into the klongs from the Chao Phraya River and outer irrigation canals;
- 2) dredging of polluted mud and removal of accumulated garbages in the klongs; and
- 3) water purification by aeration in retarding ponds.

#### V. SCOPE OF WORK

The study shall be conducted for central Bangkok covering the city core area, urban areas of the eastern suburbs and urban areas of the west bank of Bangkok.

In order to achieve the objectives set out in Chapter III, the Consultants shall perform all the necessary technical studies and field investigations including the following works.

- (1) To review the relevant previous studies and reports.
- (2) To collect, collate and examine the available data and information regarding:
  - 1) flow discharge and water level of the Chao Phraya River, klongs and outer irrigation canals;
  - 2) water quality of the Chao Phraya River, klongs and outer irrigation canals;
  - 3) tide and salt water intrusion of the Chao Phraya River;
  - 4) dumped garbages in the klongs;
  - 5) existing klong networks, cross-sections and longitudinal sections;
  - 6) flow discharge capacities of the existing klong networks;
  - 7) existing drainage pumps, control gates and their operation records;

- 8) existing sewerage systems;
  - 9) present wastewater flow discharge and pollutant load;
  - 10) projected wastewater flow discharge and pollutant load;
  - 11) existing sewerage development plan; and
  - 12) existing flood protection and drainage plan.
- (3) To carry out field surveys and investigations regarding:
- 1) supplementary observation of water quality and flow discharge in the Chao Phraya River, klongs and outer irrigation canals;
  - 2) supplementary cross-sectional and longitudinal survey of the klongs;
  - 3) field investigation on BOD run-off coefficient;
- (4) To estimate wastewater flow discharge and pollutant load into the klongs for the present and future conditions referring to the existing sewerage development master plan.
- (5) To assess purification effects on the klong water by the provision of urgent structural measures:
- 1) To assess purification effects of introduction of dilution water:
    - To develop a mathematical model to distribute introduced dilution water into the klong networks
    - To assess diluted water quality of the klongs
  - 2) To assess purification effects of dredging of polluted mud and removal of accumulated garbages in the klongs.
  - 3) To assess purification effects of aeration in retarding ponds.
- (6) To classify the existing klongs based on the necessity of introducing dilution water.
- (7) To prepare targets of water quality improvement for the klongs
- (8) To prepare a framework for water pollution control of the klongs
- (9) To prepare an urgent water purification plan of the klongs

- (10) To integrate the proposed urgent water purification plan and the existing flood protection and drainage plan
- (11) To prepare a preliminary design of the proposed urgent water purification facilities and equipment such as pumps, control gates, water introduction channel, etc.
- (12) To evaluate benefits of environmental quality by the proposed urgent water purification plan
- (13) To assess adverse effects on the surrounding environments including the water quality of the Chao Phraya River by the proposed urgent water purification plan
- (14) To estimate costs required for construction and operation and maintenance of the proposed urgent water purification plan
- (15) To prepare an implementation program of the proposed urgent water purification plan
- (16) To prepare further water quality monitoring plans
- (17) To conduct studies on institutional and operation and maintenance systems

#### VI. TIME SCHEDULE AND REPORTS

All the Study will be conducted within 13 months as illustrated in tentative work schedule (Fig.-4). In the course of the Study, the following reports shall be prepared.

- (1) Inception Report (20 copies) within one (1) month after commencement of the Study
- (2) Interim Report (40 copies) within eight (8) months after commencement of the Study
- (3) Draft Final Report (40 copies) within 11 months after commencement of the Study
- (4) Final Report (100 copies) within 13 months after commencement of the Study including Executive Summary Report (200 copies)

Fig.-4 Tentative Work Schedule

Work Item	Month													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Data Collection														
Field Survey														
Analysis & Study														
Inception Report	▲													
Interim Report								▲						
Draft Final Report											▲			
Final Report														▲

VII. EXPERTISE REQUIRED

The following expertise will be required for satisfactory completion of the Study.

	<u>M/N</u>
(1) Team Leader	7
(2) Water Pollution Control Planner	11
(3) Hydrologist	5
(4) Water Quality Analyst	6
(5) Sewerage Engineer	4
(6) Drainage & Waterway Engineer	6
(7) Structural Engineer	3
(8) Surveyor	5
(9) Environment Assessment Expert	5
(10) Institutional Expert	2
Total:	54

An expert assignment schedule is tentatively prepared as illustrated in Fig.-5.

Fig.-5 Tentative Expert Assignment Schedule

	1	2	3	4	5	6	7	8	9	10	11	12	M/M
Team Leader													7
Water Pollution Control Planner													11
Hydrologist													5
Water Quality Analyst													6
Sewerage Engineer													4
Drainage & Waterway Engineer													6
Structural Engineer													3
Surveyor													5
Environmental Assessment Expert													5
Institutional Expert													2
<b>TOTAL</b>													<b>54</b>

#### 4. 面会者リスト



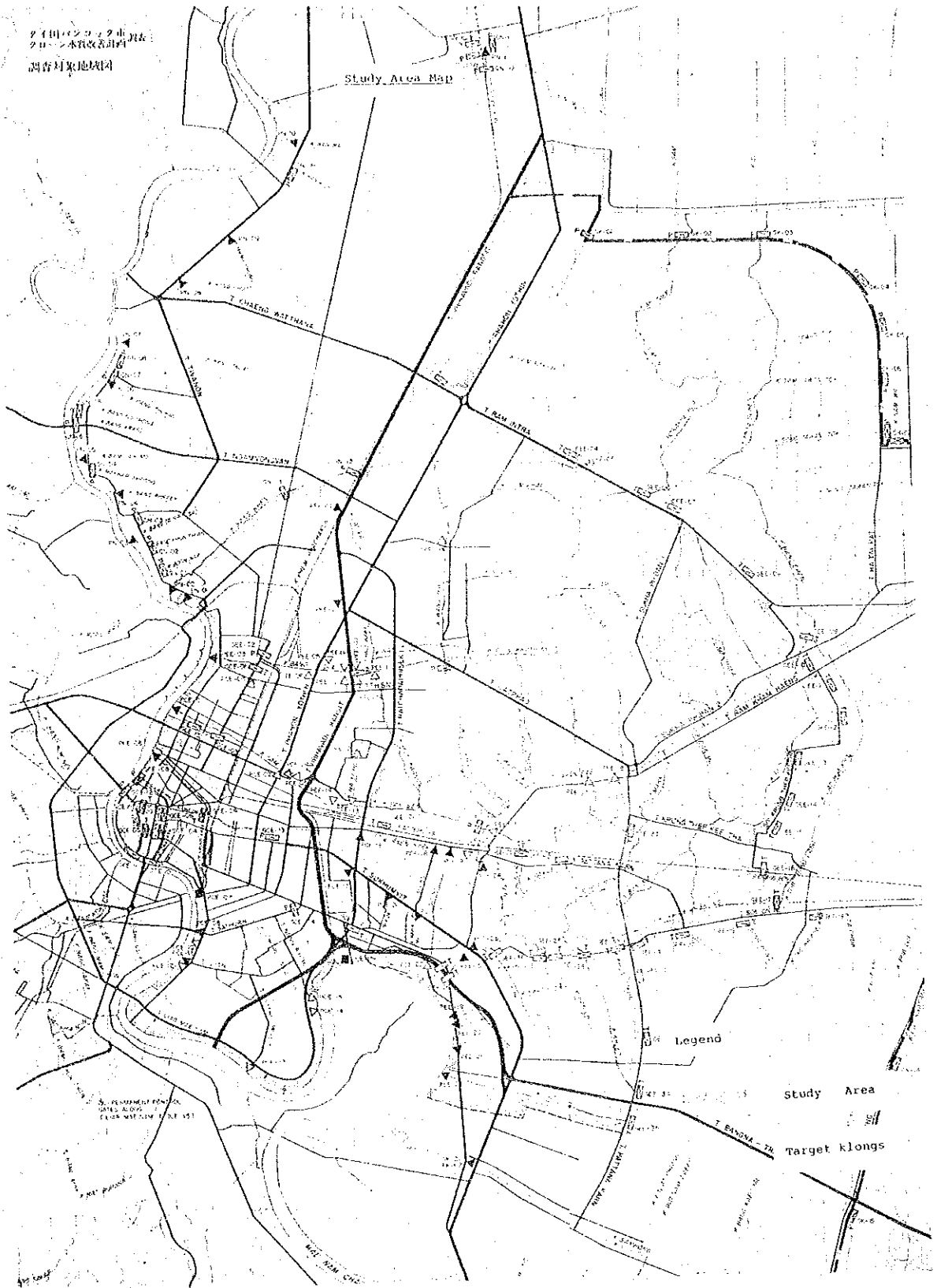


Attendant List

1. Mr. Anuchit Sodsathit - Deputy Director, DDS
2. Mr. Somchitt Kattiyavara - Director, Technical Division
3. Mr. Chanchai Vitoonpanyakij - Sanitary Engineering Specialist,  
Technical Division
4. Ms. Sa-cha W. - Civil Engineer 5, Survey & Planning  
Section
5. Mr. Apinan Jaruchaiyakul - Head, Raw Intra Treatment Plant  
Section, Wastewater Treatment Plant  
Division
6. Mr. Pailin Pairoh - Official, Department of Technical  
and Economic Cooperation (DTEC)



タイ国バンコック市  
クローン水質改善計画調査  
調査対象地域図







JICA