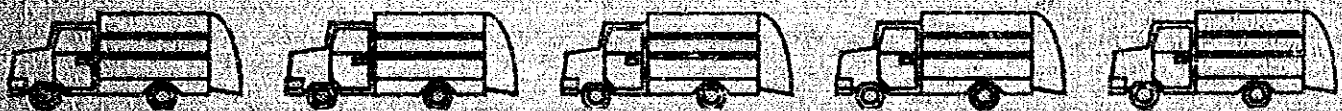


THE ROYAL THAI GOVERNMENT
THE BANGKOK METROPOLITAN ADMINISTRATION

THE STUDY ON BANGKOK

SOLID WASTE MANAGEMENT

FINAL REPORT



VOL.2

MASTER PLAN

MARCH 1991



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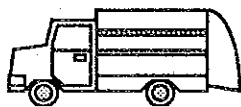
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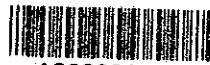
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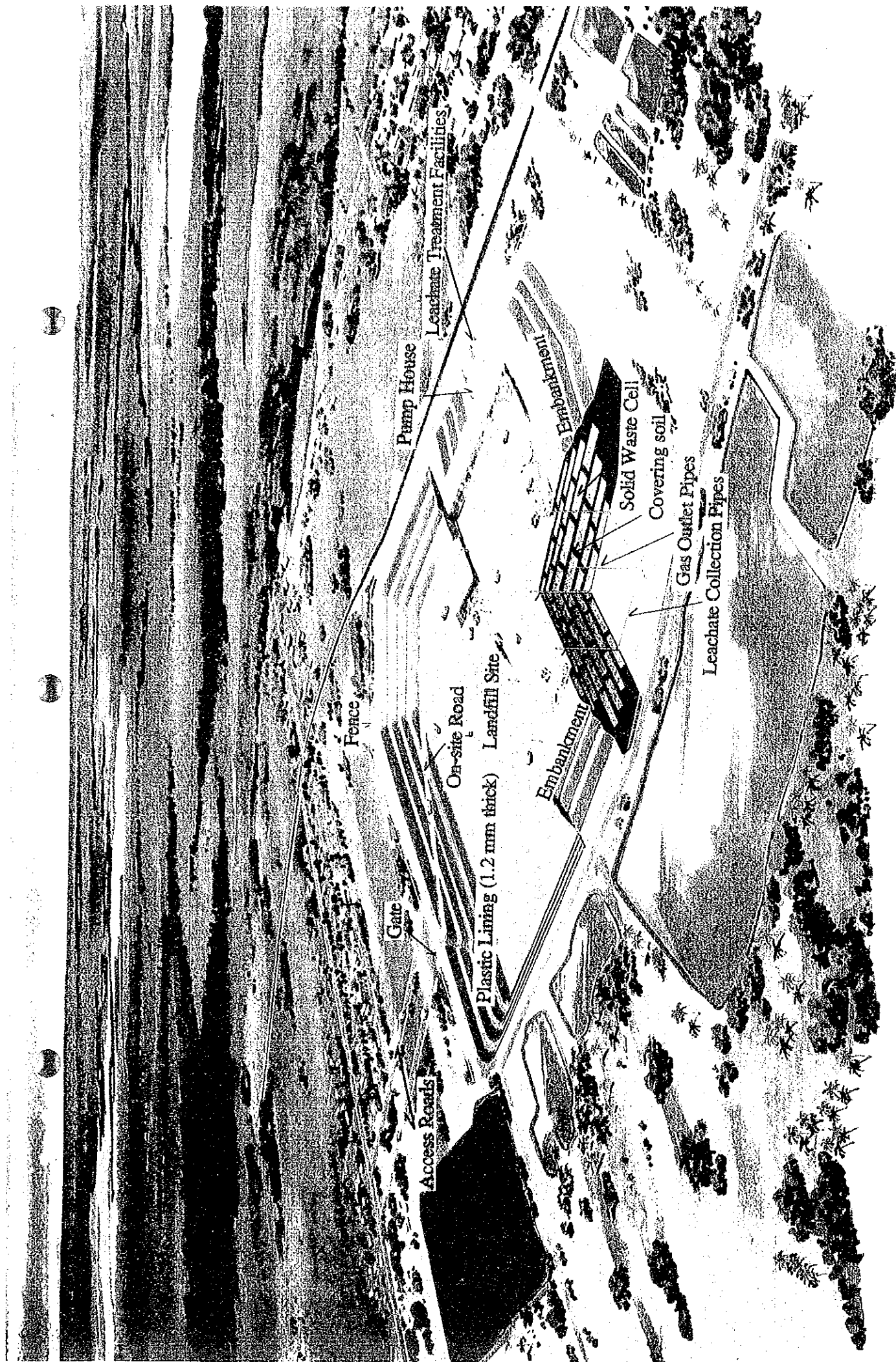
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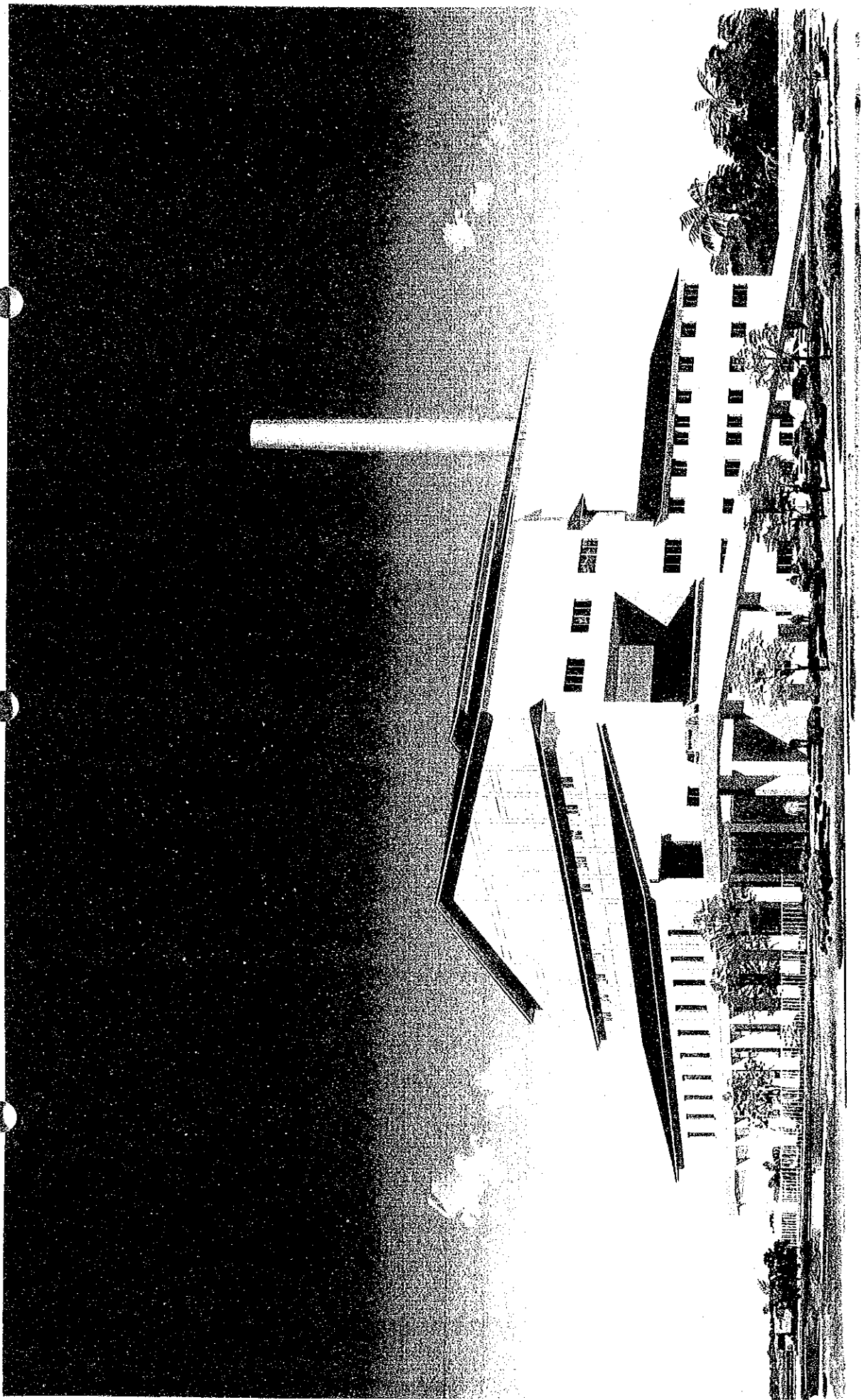
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Planned Sanitary Landfill Site (Complete Type) in Ram Intra



Planned Incineration Plant in On Nut

PREFACE

In response to a request from the Government of the Kingdom of Thailand, the Japanese Government decided to conduct a study on the Bangkok Solid Waste Management and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Thailand a study team headed by Mr. Kyoichi Miyazaki, and composed of members from the EX Corporation and Pacific Consultants International, three times between January 1990 and January 1991.

The team held discussions with the officials concerned of the Government of Thailand, and conducted field surveys. After the team returned to Japan, further studies were made and the present report was prepared.

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

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

March 1991



Kensuke Yanagiya

President

Japan International Cooperation Agency

Photo 1
Nong Khaem dumping
site.



Photo 2
Nong Khaem dumping
site.
(Enclosed area is a
Transfer Station)

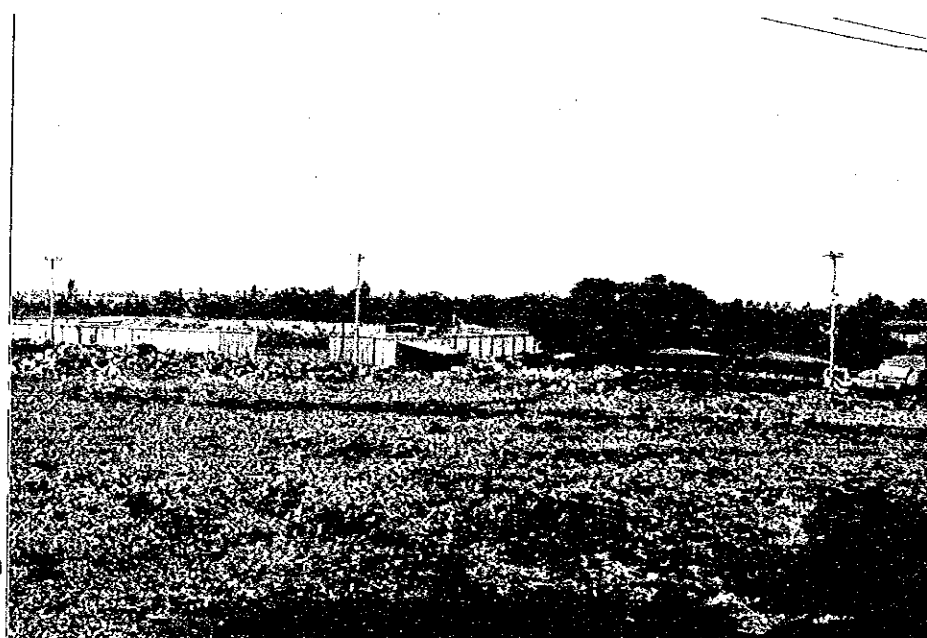


Photo 3
Hospital Waste
Collection.

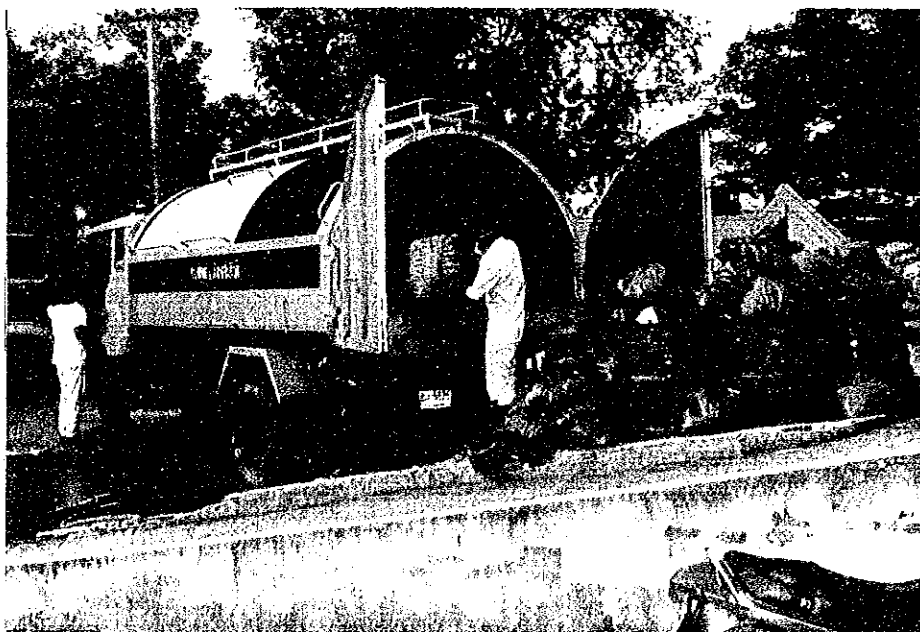


Photo 4
Sanitary landfill
by the contractor
employed by BMA
at Nakhon Pathom
Province.

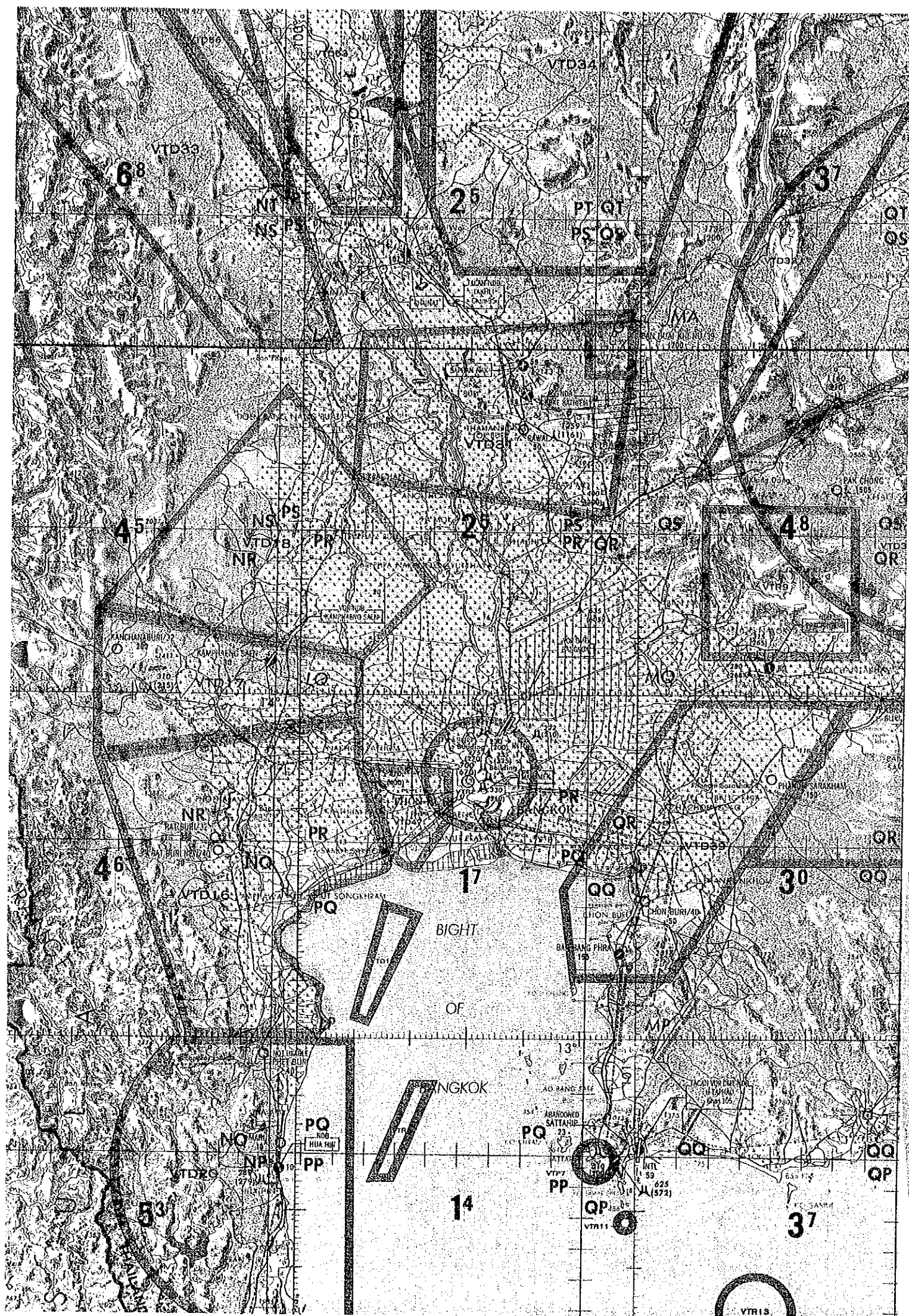


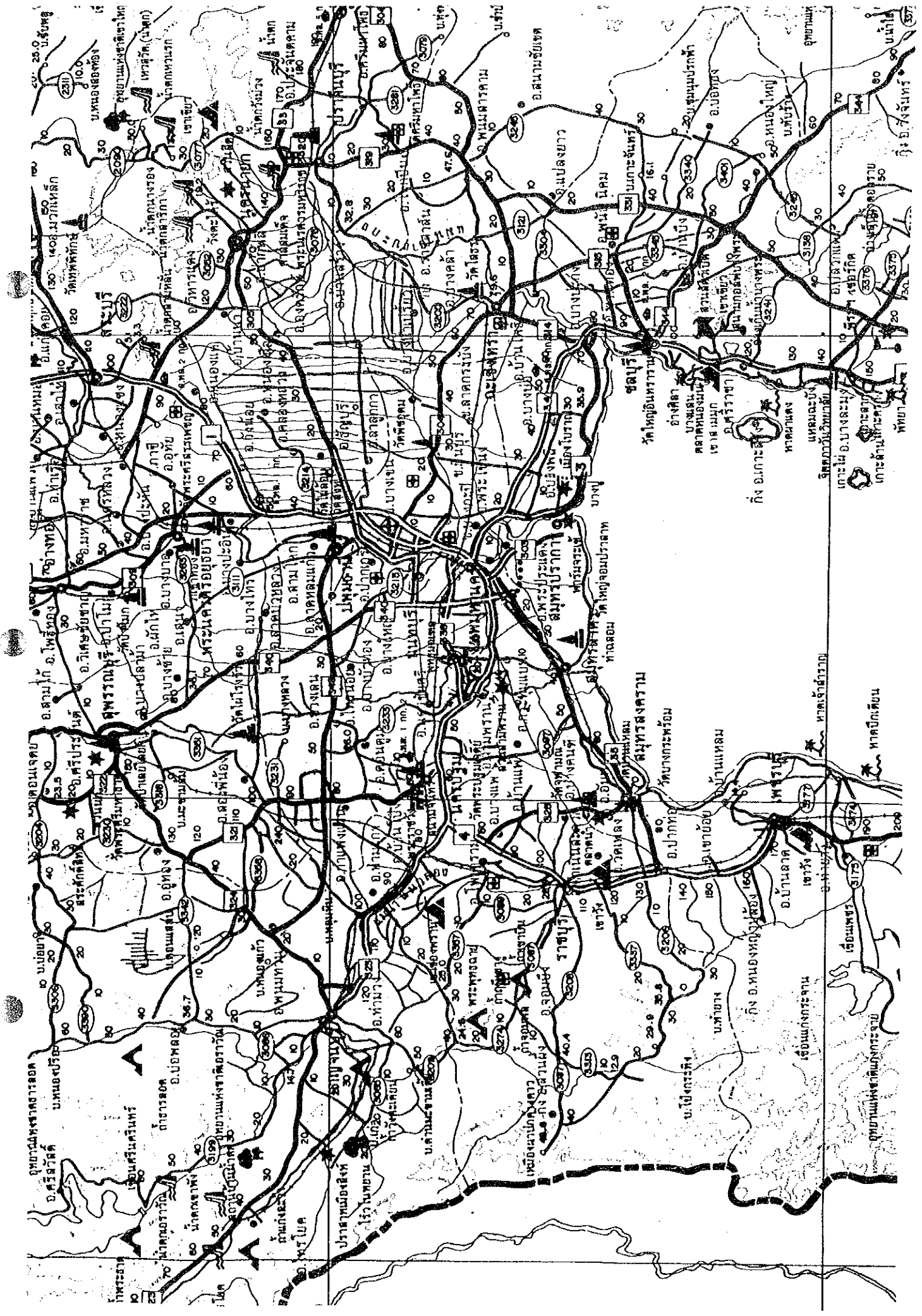
Photo 5
Ram Intra closed
compost facility
and the excavated
hole near by.

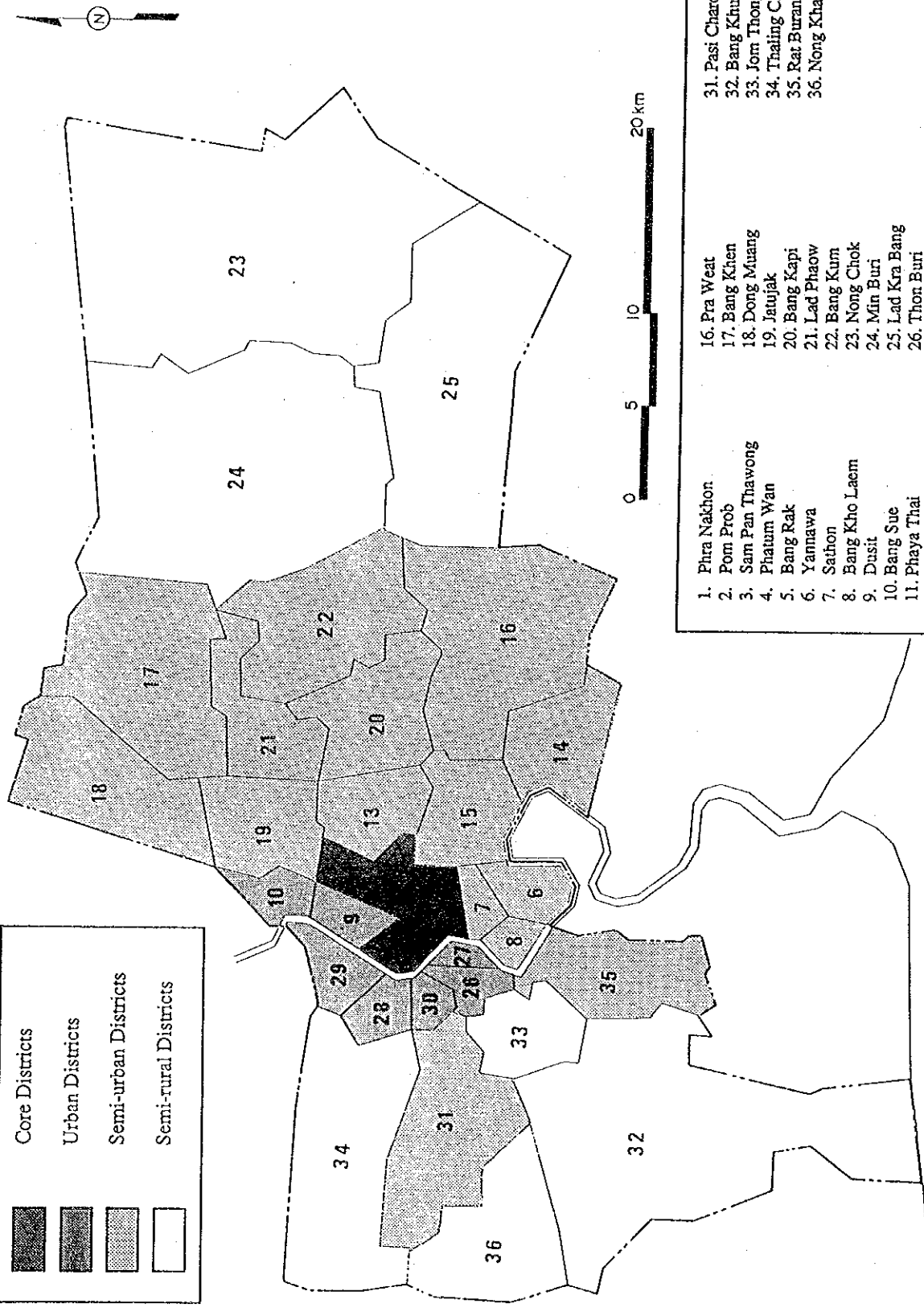
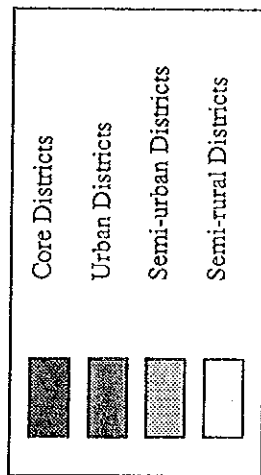


Photo 6
Planned site for
an incinerator at
On Nut.

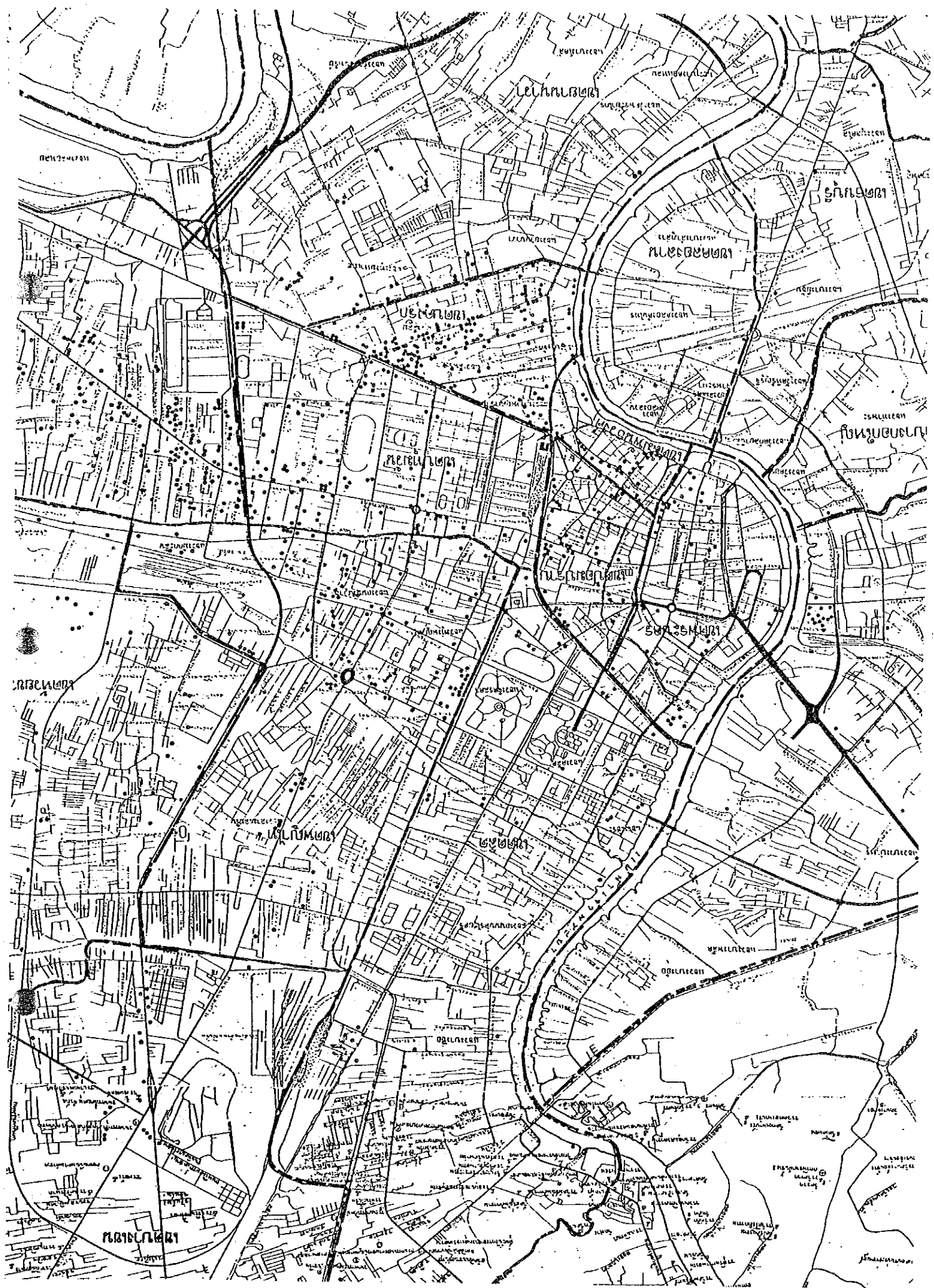








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|--------------------|------------------|---------------------|
| 1. Phra Nakhon | 16. Pra Weat | 31. Pasi Charoen |
| 2. Pom Prob | 17. Bang Khien | 32. Bang Khun Thian |
| 3. Sam Pan Thawong | 18. Dong Muang | 33. Jom Thong |
| 4. Phatum Wan | 19. Jatujak | 34. Thaling Chan |
| 5. Bang Rak | 20. Bang Kapi | 35. Rat Burana |
| 6. Yannawa | 21. Lad Phaow | 36. Nong Khaem |
| 7. Sathon | 22. Bang Kum | |
| 8. Bang Kho Laem | 23. Nong Chok | |
| 9. Dusit | 24. Min Buri | |
| 10. Bang Sue | 25. Lad Kra Bang | |
| 11. Phaya Thai | 26. Thon Buri | |
| 12. Rat Thewee | 27. Klong San | |
| 13. Huai Khwang | 28. Bangkok Noi | |
| 14. Phra Khanong | 29. Bang Plai | |
| 15. Klong Toi | 30. Bangkok Yai | |



Abbreviations (Listed in alphabetical order)

B	Baht
BMA	Bangkok Metropolitan Administration
BOD	Biochemical Oxygen Demand
BPP	Beneficiary Pay Principle
Ca(OH) ₂	Calcium Hydroxide
COD	Chemical Oxygen Demand
DDS	Department of Drainage and Sewage
DPC	Department of Public Cleansing
DTEC	Department of Technical and Economic Cooperation
F/S	Feasibility Study
GDP	Gross Domestic Product
GPP	Gross Provincial Product
HCl	Hydrogen Chloride
JICA	Japan International Cooperation Agency
LHV	Low Heat Value
MB	Million Baht
MMD	Mechanical and Maintenance Division (Central Workshop) of Finance Department, BMA
m ³ N/h	Cubic meter Normal / hour
M/P	Master Plan
N.D.	Not Detective
NESDB	National Economic Social Development Board
ONEB	Office of National Environmental Board
PPP	Polluter Pay Principle
Pt-Co unit	unit of Platinum-Cobalt method
PVC	Poly Vinyl Chloride
SWM	Solid Waste Management
SS	Suspended Solid
t/d	tons/day
T-KN (T-N)	Total Nitrogen (Kjeldahl method)

Rai (Thai Unit) = 1,600 m²

Soi (Thai Words) : Narrow Street

Khlung (Thai Words) : Canal

Exchange Rate (as of January 1991)

1 \$ = 25 Baht = 130 Yen (Approximately)

Rainfall[mm] 1980 ~1989 Average

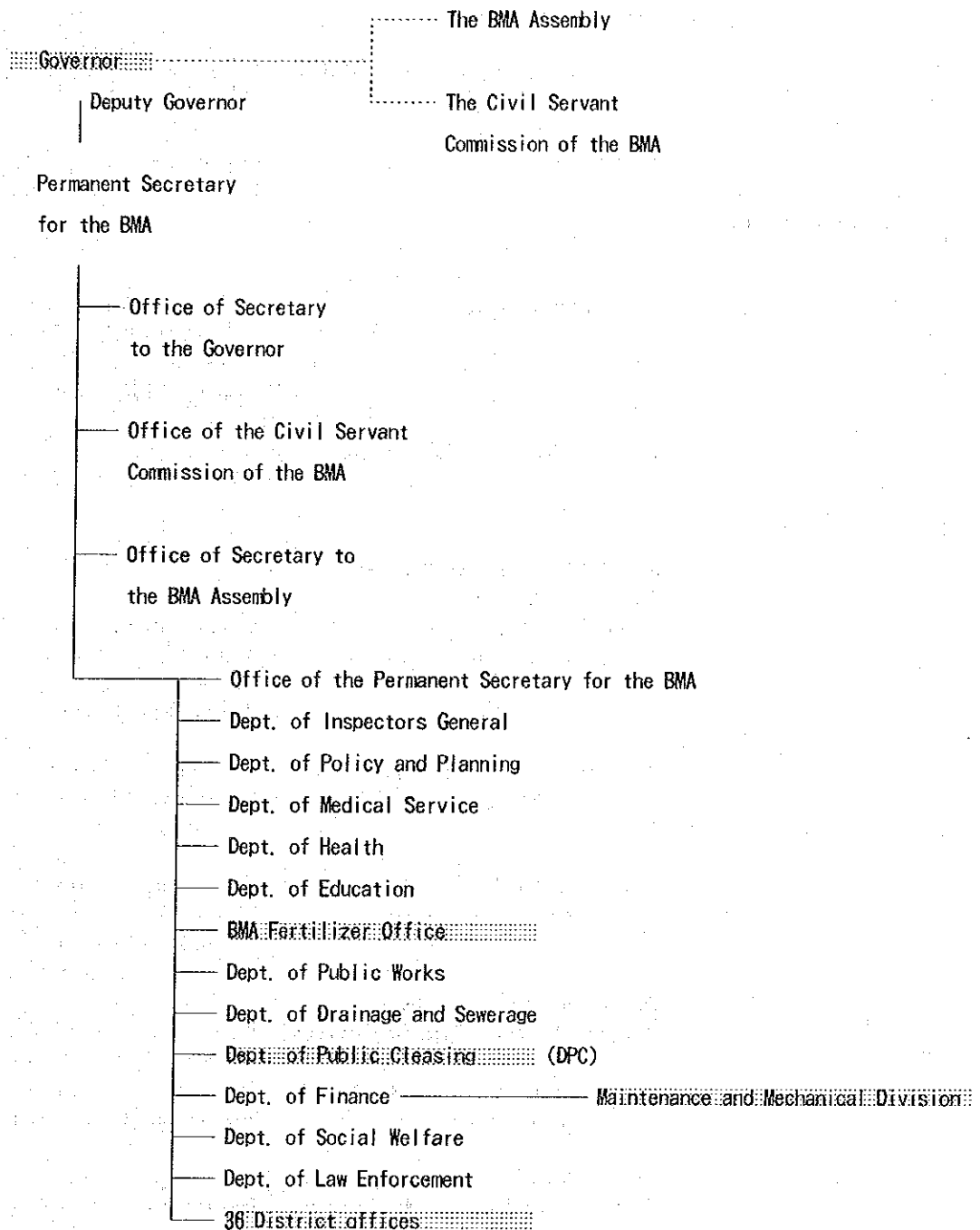
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Av	3.2	11.3	28.8	29.1	147.9	112.7	112.5	189.1	267.8	237.4	139.9	5.1	1357.1

Temperature[° C] 1980 ~1989 Average

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Av.
Av	26.8	28.5	29.7	30.8	30.2	29.4	29.1	29.0	28.7	28.2	27.6	25.8	28.6

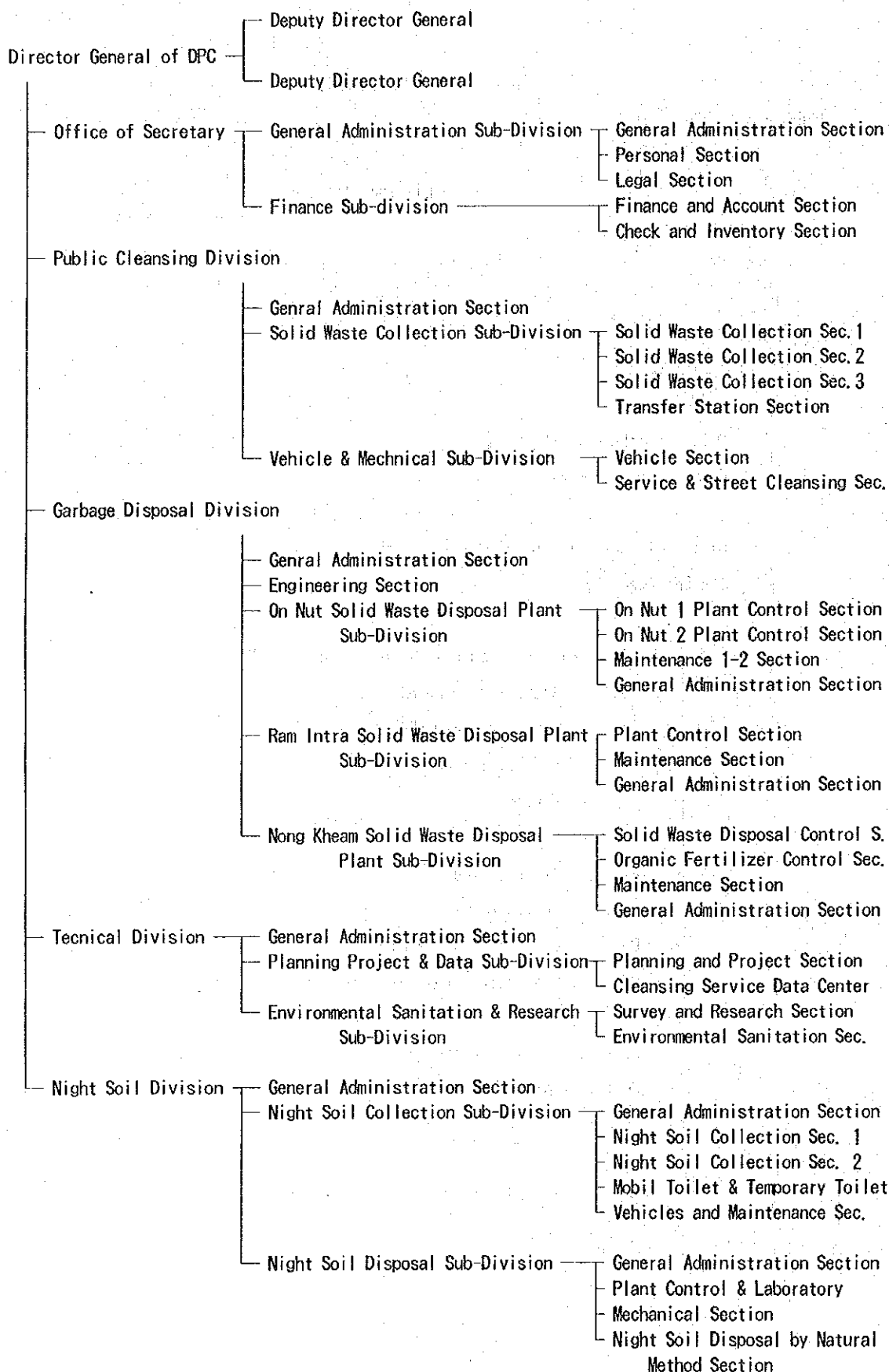
Source: Processing Sub-Division
Climatology Division
Meteorological Department

Organization of Bangkok Metropolitan Administration (BMA)



(Dept. : Department)

Organization of Department of Public Cleansing (DPC)



Study on Bangkok Solid Waste Management

VOLUME 2 MASTER PLAN

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Chapter 1. Introduction

1.1 Background of the Study

The Bangkok Metropolitan Administration (BMA) requested the Government of Japan, through the Department of Technical and Economic Cooperation (DTEC), to conduct a solid waste management study for Bangkok.

The Study consists of the two main components, i.e.

1. Preparation of a master plan based upon 1) the review of the previous study executed by the JICA during 1979 - 1982, and 2) the study of the current conditions of Bangkok. Refer to Appendix 6 for the review of the previous study.
2. Feasibility study of the projects identified in the Master Plan study.

The current study has been executed based upon the Scope of Work for the Study on Bangkok Solid Waste Management in the Kingdom of Thailand and the Meeting Minutes (hereto attached as Appendix 1) signed by the BMA and the JICA on 22nd August 1989.

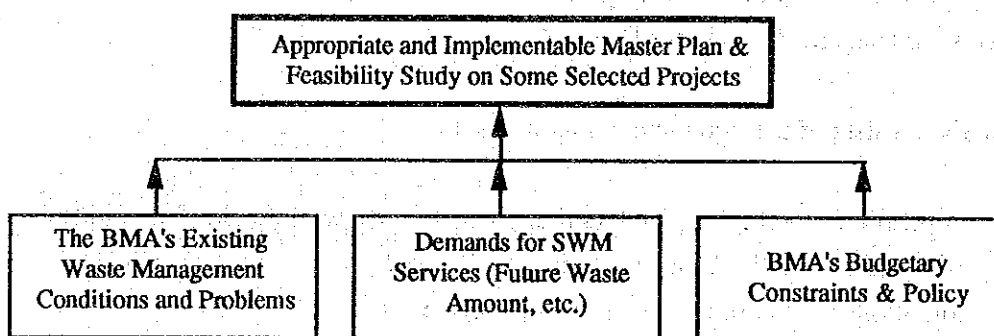
1.2 Organization of the Study

The Study has been jointly executed by both the JICA Study Team and the Thai Counterparts in close consultation with the DPC's Steering Committee and the JICA Advisory Committee. The Study organization as well as members of the Team, Counterparts and the two Committees are shown in Appendix 2.

1.3 Purpose of the Study

The purpose of the current study is to produce a master plan which presents the most appropriate solid waste management (SWM) system to be applied in Bangkok during the next ten years till the year 2000, and shows also the ways in which the plan can be implemented through the Feasibility Study.

"The most appropriate system" for the Bangkok Metropolitan Administration (BMA)'s solid waste management can be defined as "the most cost-effective and environmentally-sound system" given the BMA's existing waste management conditions as well as the BMA's budgetary constraints and the future demands for SWM services both in terms of quantity (waste amount) and quality (disposal standard, etc.).



1.4 Benefits and Costs of the Master Plan

1.4.1 Benefits

Successful implementation of the Master Plan will bring about the following benefits to the BMA:

1. Save collection and haulage cost through increases of efficiency.
2. Make streets cleaner.
3. Upgrading of disposal standard
4. Increase the level of the citizens' satisfaction and enhance an image of a clean Bangkok.
5. Promote waste volume reduction through introduction of an incineration plant

1.4.2 Costs and Requirements

The implementation of the Master Plan for the years 1991 - 2000 will require the following:

1. The BMA top officials' understanding and support
2. Department of Public Cleansing's (DPC) systematic plan for implementation and leadership (to be shown to the Districts)
3. Cash expenditure of 1,673 million Baht for the land purchase and the construction of the BMA's own two sanitary landfill sites. The construction of the proposed incineration plant with the capacity of 600 tons/day (optional) will require another 1,842 million Baht.

1.5 Reports

The study reports consist of the following four (4) volumes:

- Volume 1. Summary
- Volume 2. Master Plan
- Volume 3. Feasibility Study
- Volume 4. Supporting Report

Both volumes 1 and 2 contain major findings of the Feasibility Study in:

- Section 8.3.4 (Sanitary landfill)
- Section 8.4 (Incineration plant -600 tons/day)

Chapter 2. Outline of Bangkok

2.1 General Description of Bangkok

Bangkok is the capital city of Thailand. It has a registered population of approximately 5.7 million in 1,566 km² of area. Gross Provincial Product (GPP) of Bangkok is about 40 % of Gross Domestic Product (GDP) of the whole kingdom. GPP per capita in Bangkok is about 39,400 Baht/person in 1989. More detailed information in Table 2.1-1.

Table 2.1-1 Outline of Bangkok

Item	Description											
1) Area:	1,566 km ²											
2) Climate:	Tropical											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Temperature (C°)	26.8	28.5	29.7	30.8	30.2	29.4	29.1	29.0	28.7	28.2	27.6	25.8
Rain fall (mm)	3.2	11.3	28.8	29.1	147.9	112.7	112.5	189.1	267.8	237.4	139.9	5.1
(1980 - 1989 Average)												
3) Population												
- Population (1989):	5,716 thousand person											
- Population increase (1980 - 1989):	1.16% per year											
- Population density (1989):	3,738 person/km ²											
- Population share to the whole kingdom (1988):	11.3%											
- Household (1989):	1,100 thousand households											
4) Economic Activities												
- GPP (1989):	225 Billion Baht											
- GPP/capita (1989):	39,355 Baht/capita											
- GPP share to the whole kingdom (1987):	40.7%											
- GPP shares by industry (1987):	Primary 1.5 %, Secondary 37.5 %, Tertiary 61 %											
- Prices increase during 1984 to 1988 (Average):	2.25% per annual											
5) Governing Agency	Bangkok Metropolitan Administration (BMA) (12 departments, 36 districts)											
6) Solid Waste												
- Collected amount (1989)	4,085 Tons/day											
- Collection rate (1989)	Approximately 81% of the estimated generation amount											

2.2 Population

Bangkok has about 5.7 million people registered in 1989, a 11 % increase over the 1980 registered population. Population by districts is shown in Fig. 2.2-2. The annual population growth rate was 1.2 % on average during the past 10 years, and is estimated to be 1.5 % during the next 10 years from 1990 through 2000. Population in 2000 will be about 6.7 million, a 0.9 million increase over the 1989 population.

(Actual)		(Estimated)	
Year	Population in Thousand Persons	Year	Population in Thousand Persons
1979	5,000	1990	5,802
1980	5,154	1991	5,890
1981	5,331	1992	5,978
1982	5,468	1993	6,068
1983	5,018	1994	6,159
1984	5,175	1995	6,251
1985	5,363	1996	6,345
1986	5,469	1997	6,440
1987	5,609	1998	6,536
1988	5,717	1999	6,635
1989	5,717	2000	6,734

Data Source: The BMA for 1979-1989. The Study Team for 1990-2000.

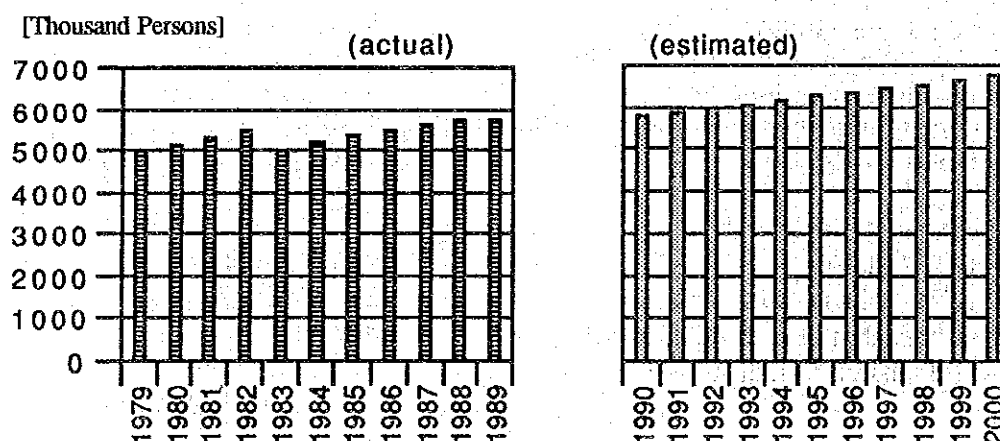


Fig. 2.2-1 Population of Bangkok

Fig. 2.2-3 illustrates the population changes by districts during the period 1979 - 1989. It can be noted that:

1. Population has been decreasing slightly in the core districts (by about 1 %), while it has been increasing in all other districts.
2. Population increases are significant particularly in semi-urban districts (located outside the urban districts).

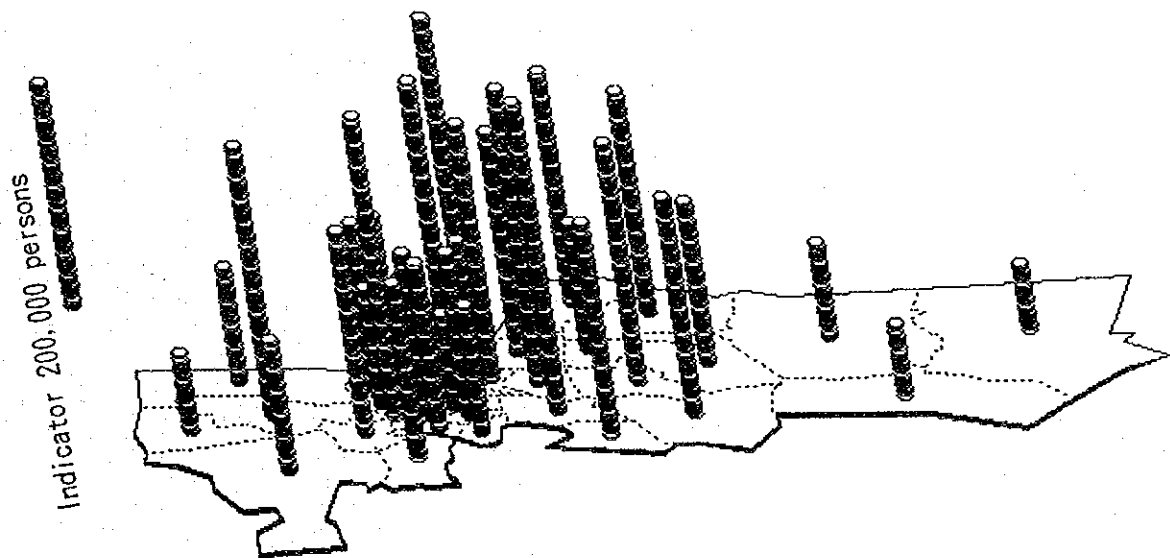
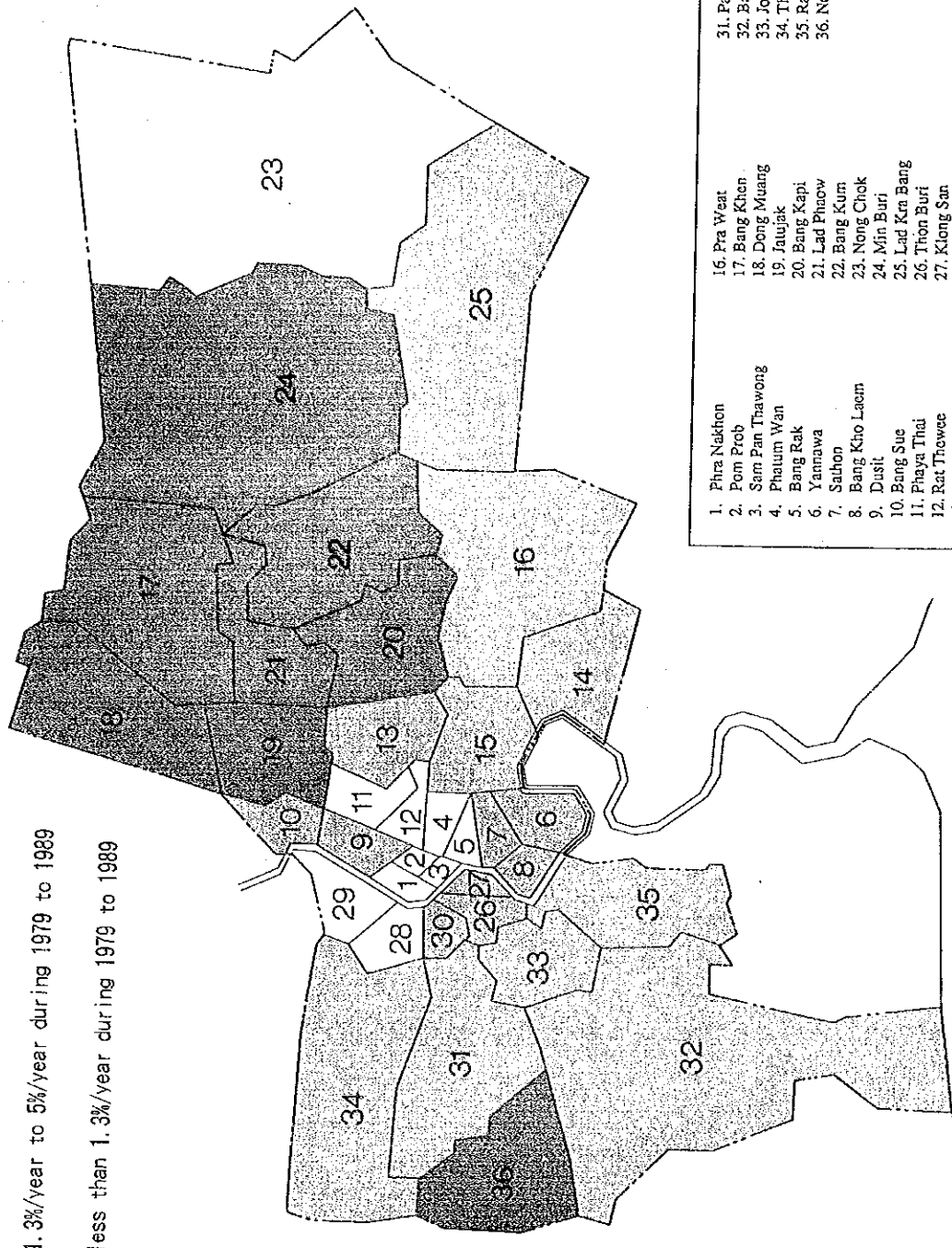
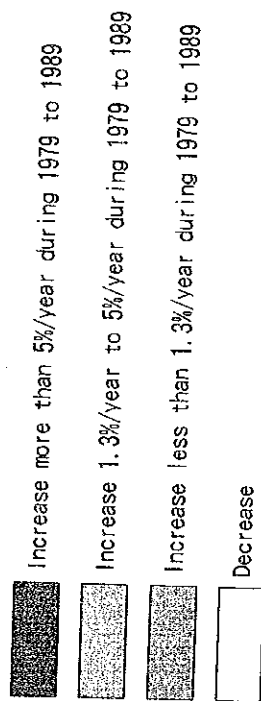


Fig. 2.2-2 Population by Districts (1989)



- | | | |
|--------------------|------------------|---------------------|
| 1. Phra Nakhon | 16. Pra West | 31. Pasi Charoen |
| 2. Pom Prob | 17. Bang Khien | 32. Bang Khun Thian |
| 3. Sam Pan Thawong | 18. Dong Muang | 33. Jom Thong |
| 4. Phatum Wan | 19. Jatujak | 34. Thaling Chan |
| 5. Bang Rak | 20. Bang Kapi | 35. Rat Burana |
| 6. Yannawa | 21. Lad Phuw | 36. Nong Khaem |
| 7. Sathon | 22. Bang Kum | |
| 8. Bang Kho Laem | 23. Nong Chok | |
| 9. Dusit | 24. Min Buri | |
| 10. Bang Sue | 25. Lad Kri Bang | |
| 11. Phaya Thai | 26. Thon Buri | |
| 12. Rat Thuee | 27. Klong San | |
| 13. Huai Khwang | 28. Bangkok Noi | |
| 14. Phra Khanong | 29. Bang Plat | |
| 15. Klong Toi | 30. Bangkok Yai | |

Fig. 2.2-3 Population Change by Districts

2.3 Economic Activities

2.3.1 Gross Provincial Product (GPP)

The GPP of Bangkok is estimated at 225 billion Baht, about 40 % of the Gross Domestic Product (GDP) of Thailand. According to the National Economic Social Development Board (NESDB), the GPP of Bangkok is estimated to grow at an average of 7.9 % per year during 1990 to 1996 and of 5.0 % per year during 1997 to 2000. The GPP growth is a major factor explaining the increase in waste generation in Bangkok.

(Actual)		(Estimated)	
Year	GPP Billion Baht	Year	GPP Billion Baht
1982	121.7	1990	246.4
1983	132.8	1991	264.6
1984	140.0	1992	284.2
1985	142.1	1993	305.2
1986	153.6	1994	327.8
1987	177.1	1995	352.1
1988	200.5	1996	378.2
1989	225.0	1997	397.1
		1998	417.0
		1999	437.9
		2000	459.8

Data Source: NESDB

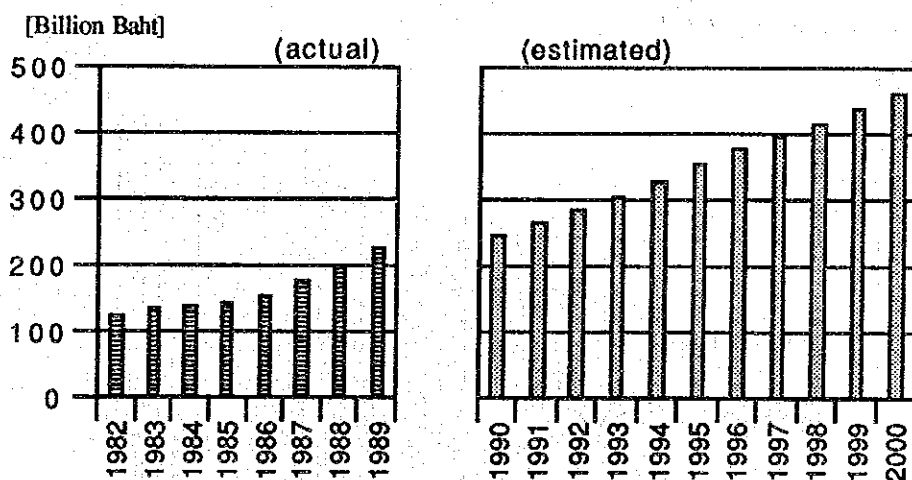


Fig. 2.3-1 GPP of Bangkok

2.3.2 Composition of the GPP

Composition of the GPP of Bangkok is shown in 2.3-2. Manufacturing industry shares about one third of the GPP. The total of wholesale and retail sales share about 20 %.

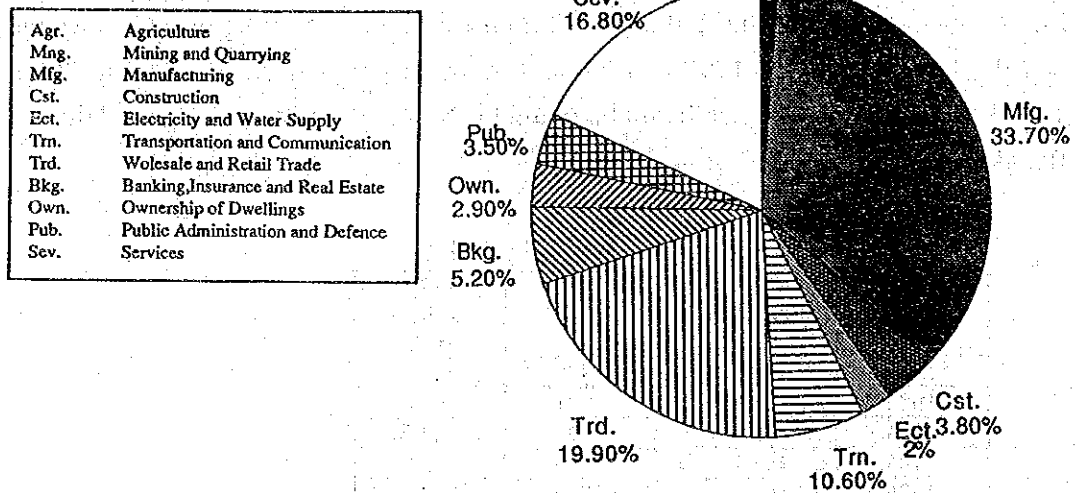


Fig. 2.3-2 Composition of GPP of Bangkok (1987)

2.3.3 GPP Per Capita

The GPP/capita of Bangkok is estimated at about 39,400 Baht in 1989 and 68,300 Baht in 2000 as shown in Fig. 2.3-3.

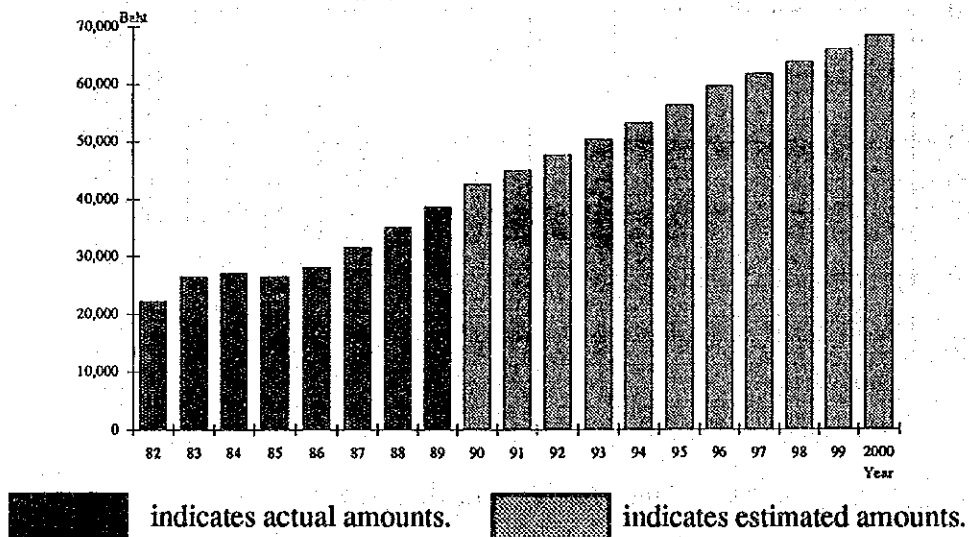
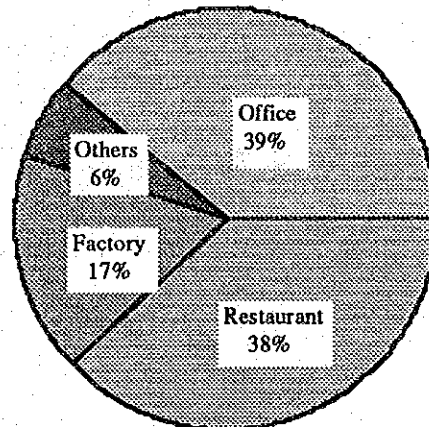


Fig. 2.3-3 GPP Per Capita of Bangkok

2.3.4 Business Establishments

According to a survey conducted by the JICA Study Team in 1990, there exist approximately 70,000 business establishments in Bangkok. As shown in Fig. 2.3-4, 39 % of them are offices, while the next 38 % are restaurants. Factories share 17 %.



Note: Others include hotel, shops, market, school, temple, and recreational places.

Fig. 2.3-4 Composition of Business Establishments in Bangkok

2.4 Land Use

The land use pattern of Bangkok is shown in Fig. 2.4-1 and Table 2.4-1. The figure shows that 40 % of Bangkok area is non-utilized space, agriculture land shares 35 % and residential area 11.5 %.

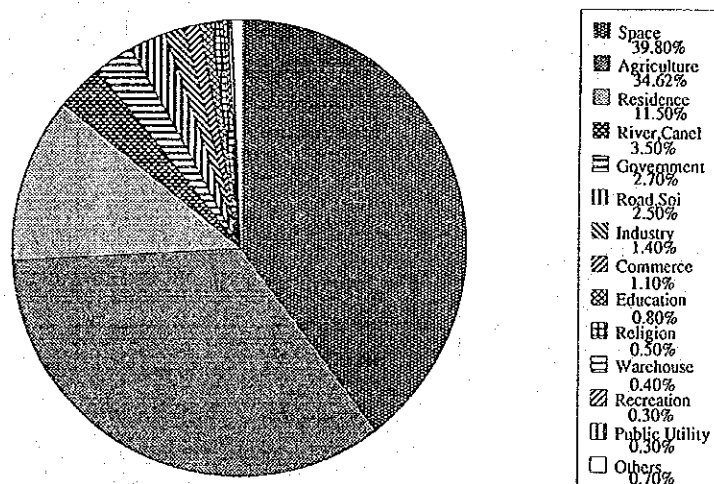


Fig. 2.4-1 Land Use Composition of Bangkok, 1987

Table 2.4-1 Landuse Composition by Districts

Type of Landuse	Unit: Rai				Unit: Rai			
	Core Districts	(%)	Urban Districts	(%)	Semi-rurban Districts	(%)	Semi-rural Districts	(%)
							Whole Bangkok	(%)
Space	390	1.6	5,186	10.4	180,182	47.7	204,158	38.7
Agriculture	0	0.0	4,665	9.3	85,421	22.6	249,370	47.3
Residence	10,138	40.3	19,119	38.2	52,261	13.8	31,601	6.0
River, Canal	823	3.3	3,906	7.8	6,674	1.8	22,569	4.3
Government	2,816	11.2	4,185	8.4	18,631	4.9	876	0.2
Road, Soi	3,149	12.5	2,697	5.4	12,619	3.3	5,565	1.1
Industry	197	0.8	1,707	3.4	5,753	1.5	6,103	1.2
Commerce	3,115	12.4	2,100	4.2	4,116	1.1	1,817	0.3
Education	1,387	5.5	1,489	3.0	3,126	0.8	2,186	0.4
Religion	704	2.8	1,038	2.1	1,231	0.3	1,454	0.3
Warehouse	184	0.7	1,434	2.9	1,486	0.4	902	0.2
Recreation	833	3.3	147	0.3	1,245	0.3	273	0.1
Public Utility	687	2.7	586	1.2	1,079	0.3	330	0.1
Others	713	2.8	1,727	3.5	4,273	1.1	38	0.0
Total	25,136	100.0	49,985	100.0	378,098	100.0	527,343	100.0
							980,461	100.0



สัญลักษณ์

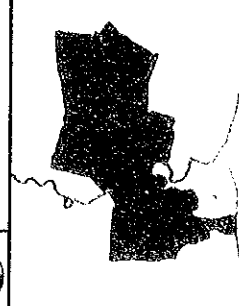
- ☐ พืชอาศัย Residential Area
- ☐ พาณิชยกรรม Commercial Area
- ☐ สถานราชการ Governmental Institutes
- ☐ สถานศึกษา Educational Institutes
- ☐ ศาสนสถาน Religious Institutes
- ☐ อุตสาหกรรม Industrial Area
- ☐ คลังสินค้า Ware
- ☐ ที่ดินว่างเปล่า Recreational Area
- ☐ สาธารณูปโภค Public Utilities
- ☐ เกษตรกรรม Agricultural Land
- ☐ ที่ดินที่ไม่ได้พัฒนา Space Not Developed

แผนที่แสดง การใช้ที่ดิน
และที่ดิน ปีพ.ศ. 2529

เขตกรุงเทพมหานคร



มาตราส่วน



กองผังเมือง
สำนักงานปลัดกรุงเทพมหานคร

Fig. 2.4-2 Land Use Map of Bangkok

