

FIGURES

第2章

図2.1	マスタープラン調査対象地域	1
図2.2	現況地盤高図(1984年)	2
図2.3	地盤沈下の進行	3
図2.4	将来地盤高図(2000年)	4
図2.5	バンコクの一般気象	5
図2.6	チャオブラヤ川の水位	6
図2.7	チャオブラヤ川流域の堤防及び灌漑用排水路網	7

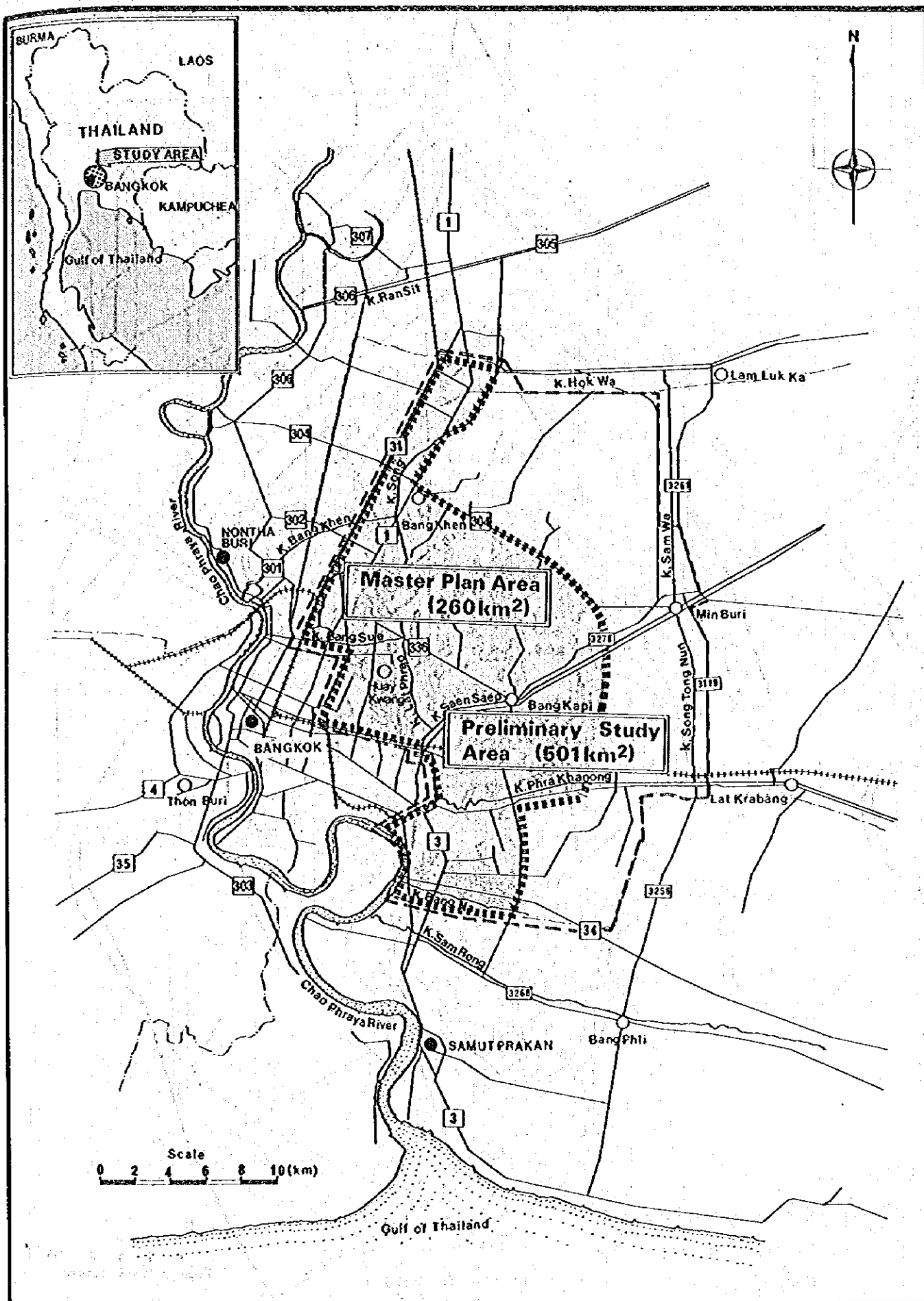
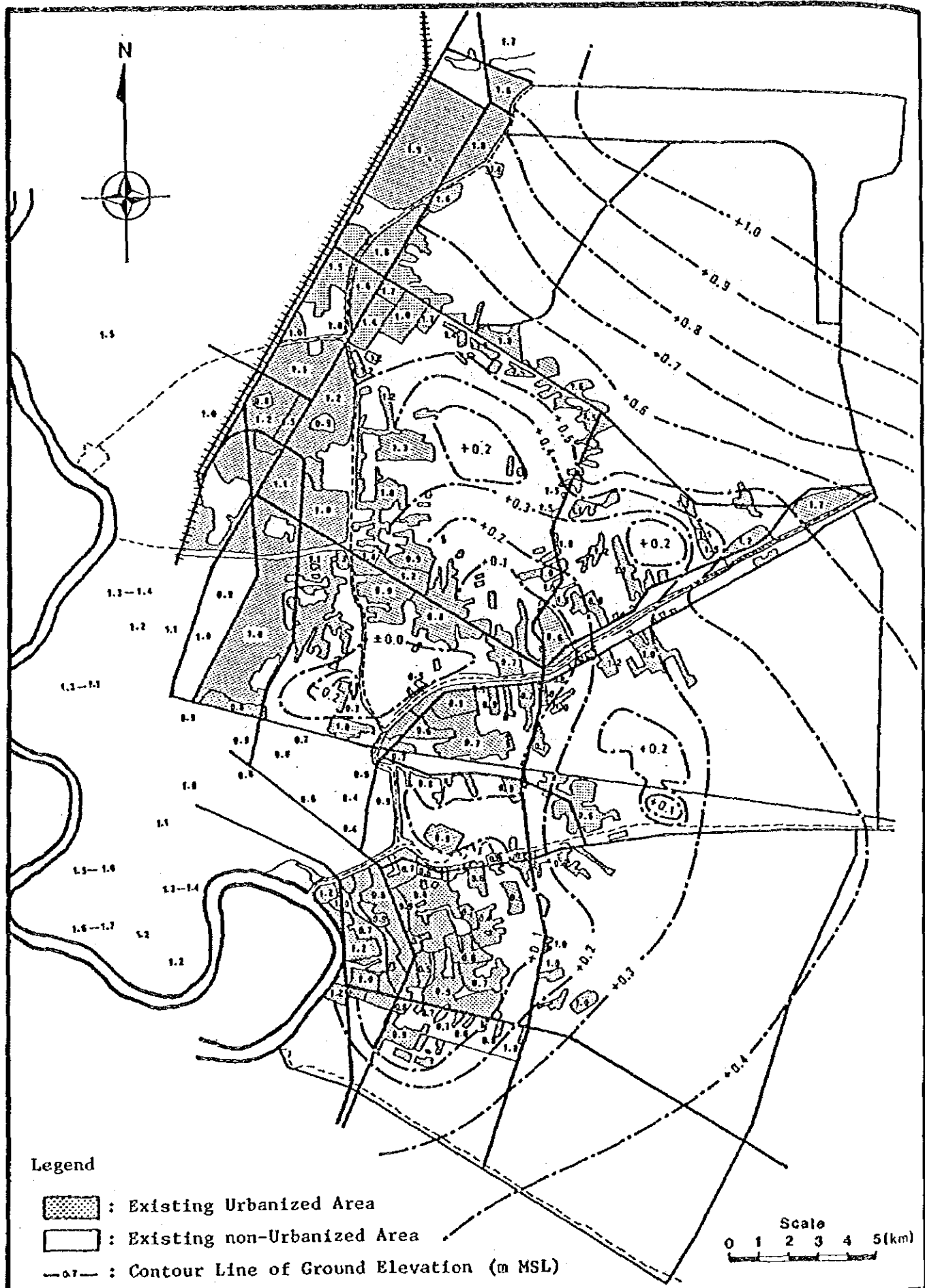





図 2.1 マスタープラン調査対象地域

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK



Legend

-  : Existing Urbanized Area
-  : Existing non-Urbanized Area
-  : Contour Line of Ground Elevation (m MSL)

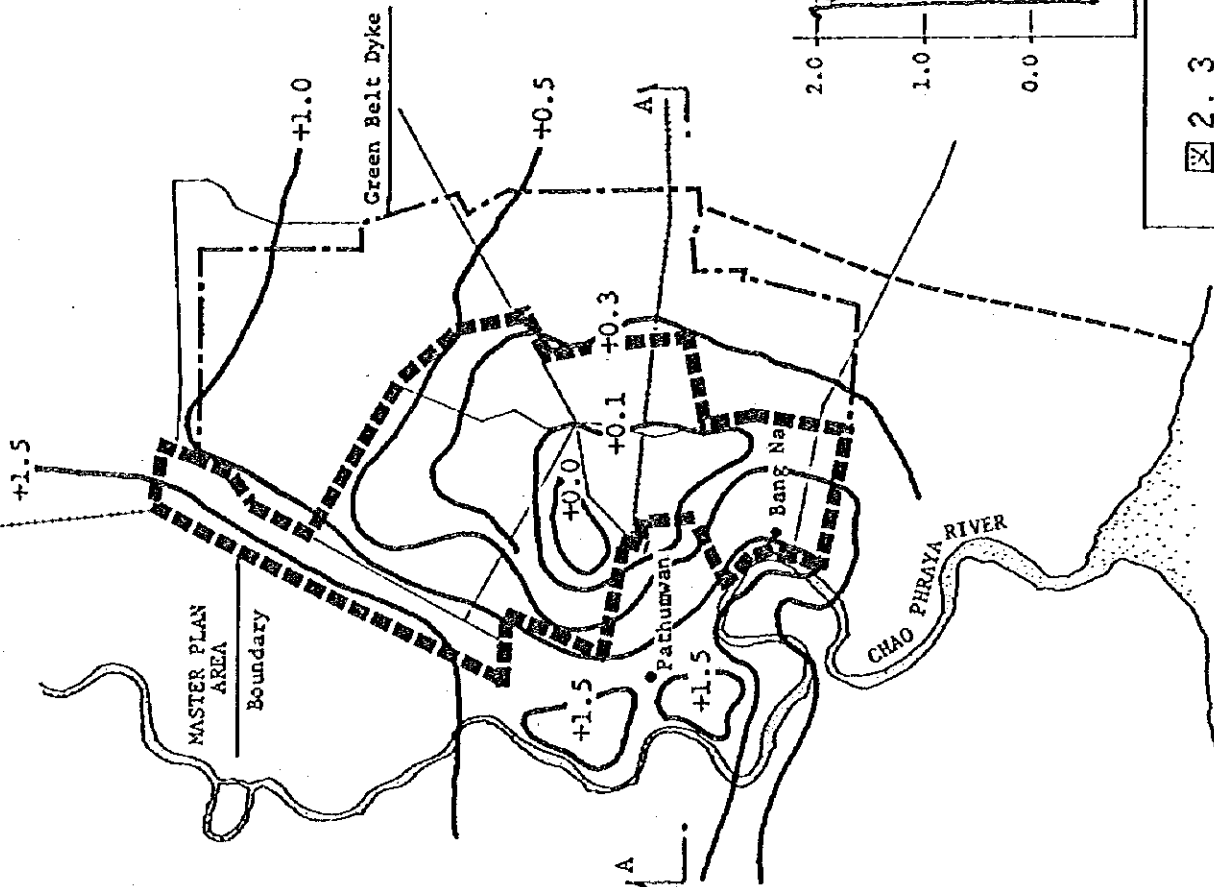
Scale
0 1 2 3 4 5 (km)

図 2. 2

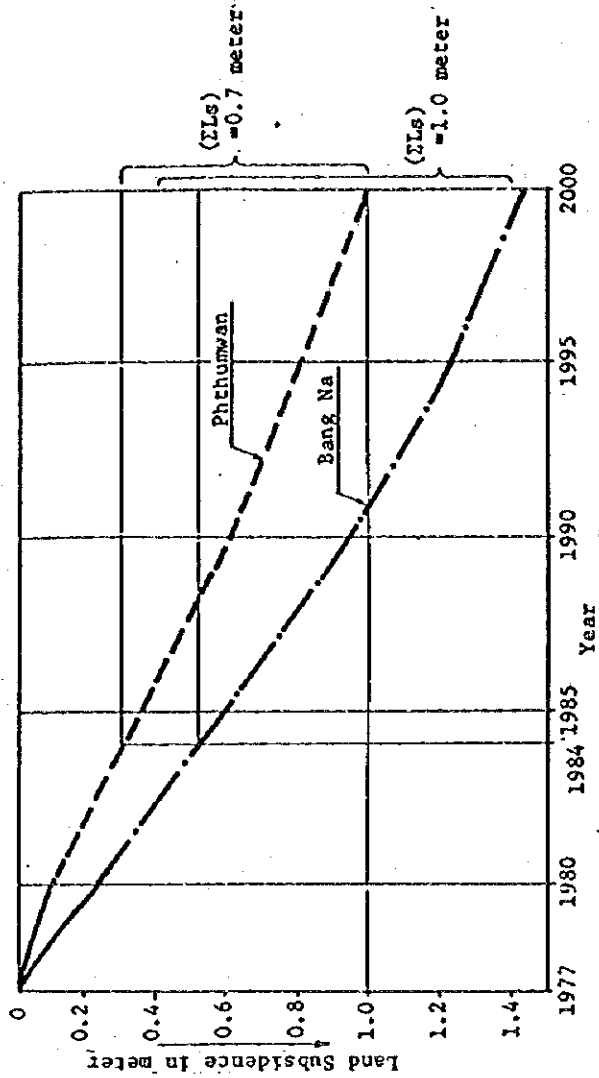
現況地盤高図 (1984年)

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

GROUND ELEVATION IN 1984



PROGRESSION OF LAND SUBSIDENCE



LAND PROFILE (A - A section)

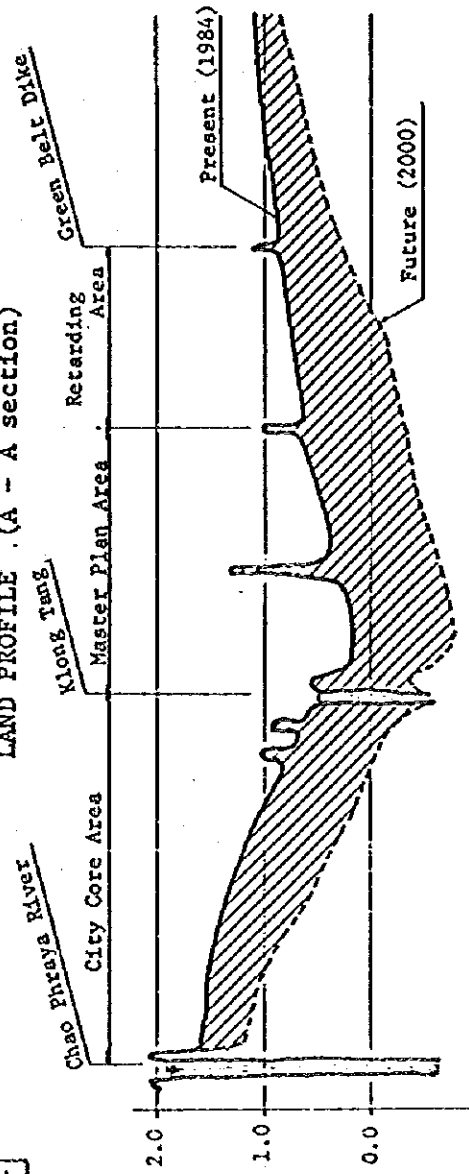
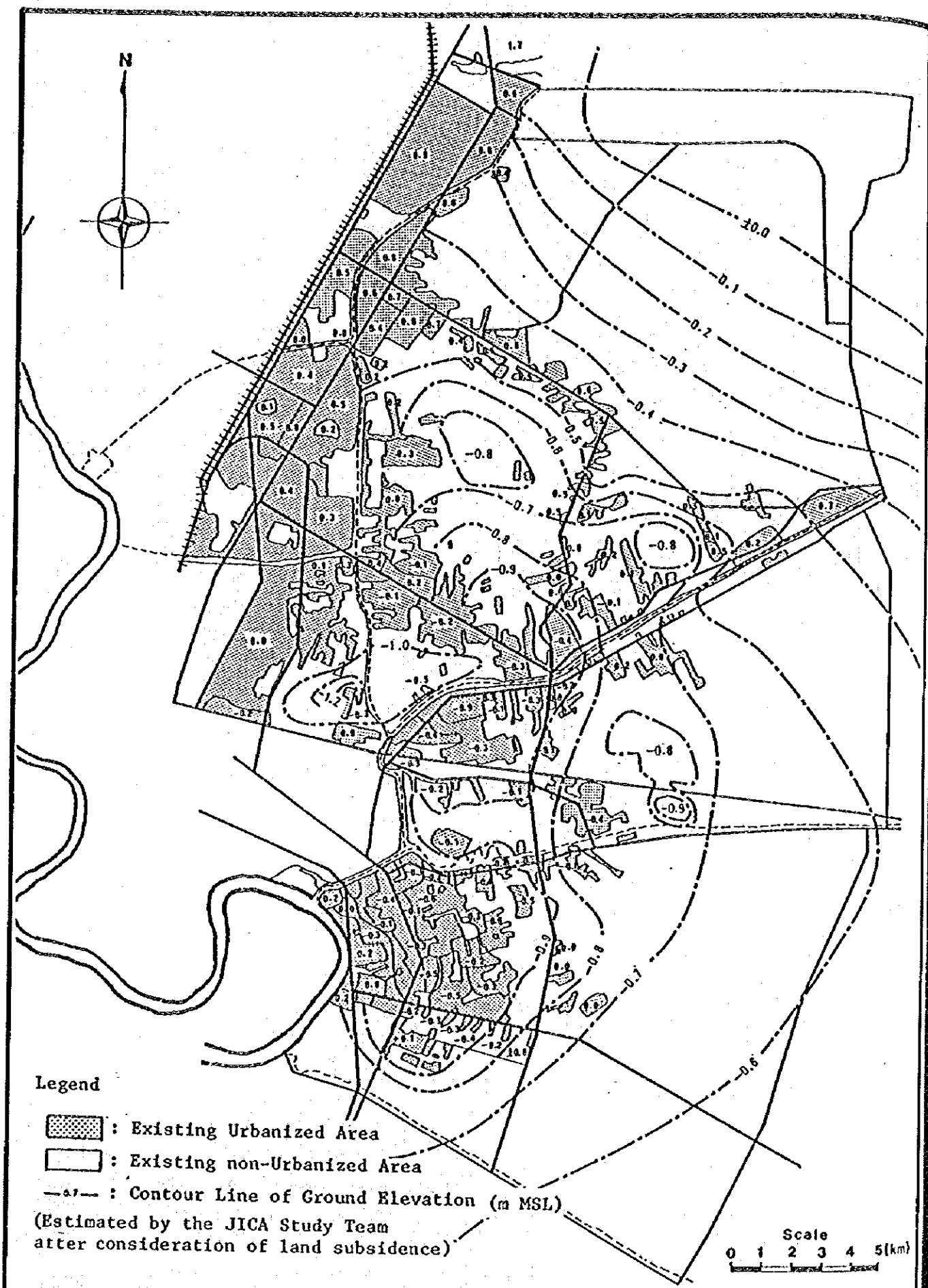


図 2. 3 地盤沈下の進行

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK



Legend

- : Existing Urbanized Area
- : Existing non-Urbanized Area

--- : Contour Line of Ground Elevation (m MSL)

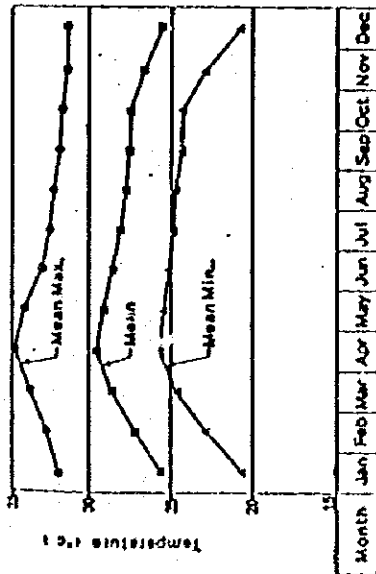
(Estimated by the JICA Study Team
after consideration of land subsidence)

Scale
0 1 2 3 4 5 (km)

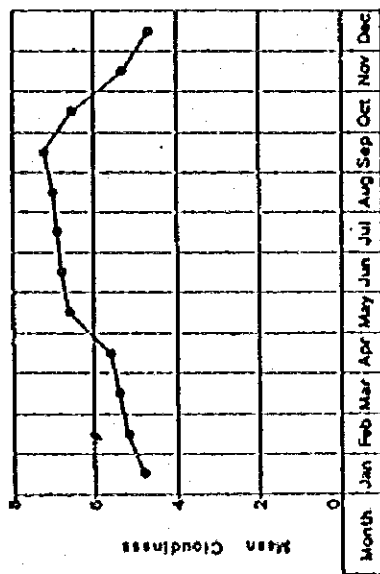
图 2.4

将来地盤高図 (2000年)

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK



Temperature



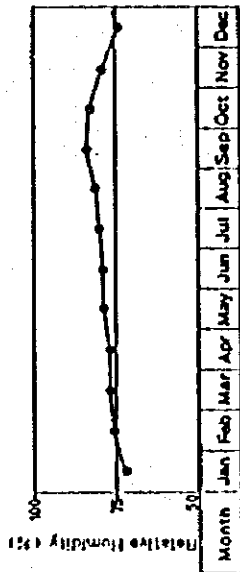
Note

1. Source

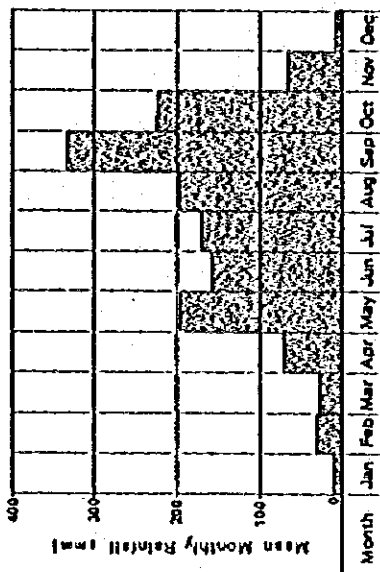
Evaporation: AIT, Rainfall and Evaporation Analysis of Thailand, 1980 12.

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

Others: Meteorological Department



Humidity



Monthly Rainfall

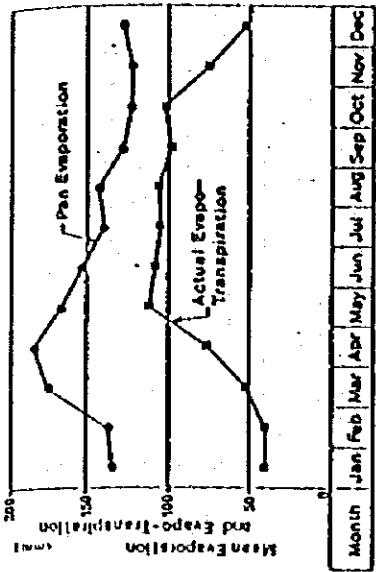
2. Period

Evaporation: 17 years

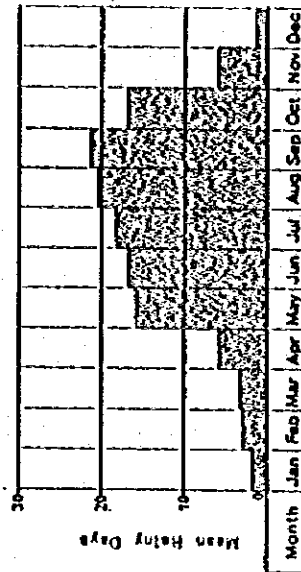
Evapotranspiration: 1956 - 1974

Rainfall and Rainy Days: 1951 - 1982

Others: 1951 - 1980



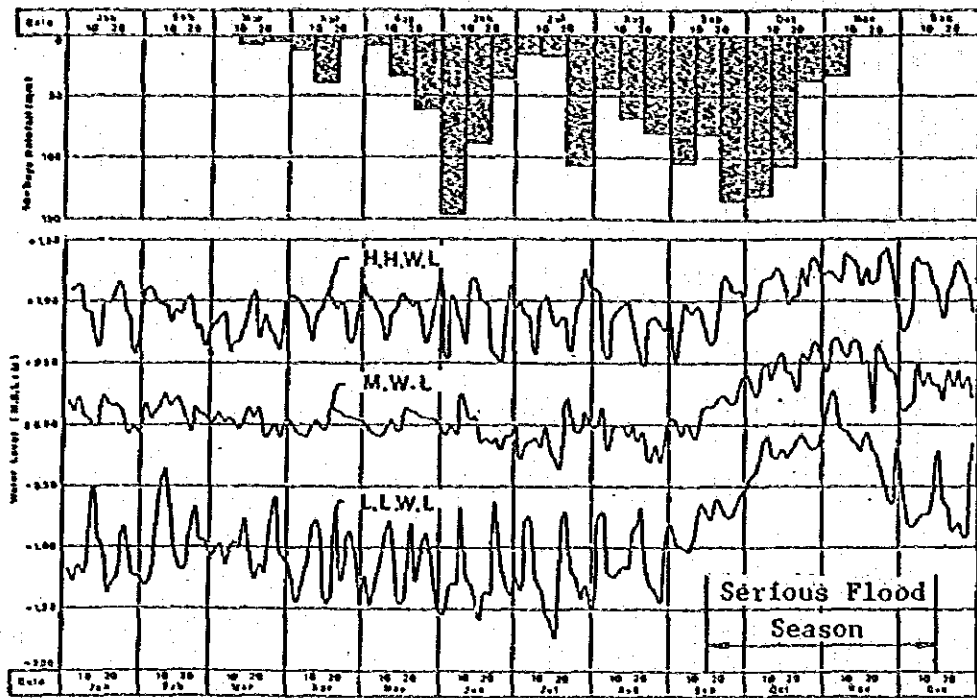
Evaporation and Evapotranspiration



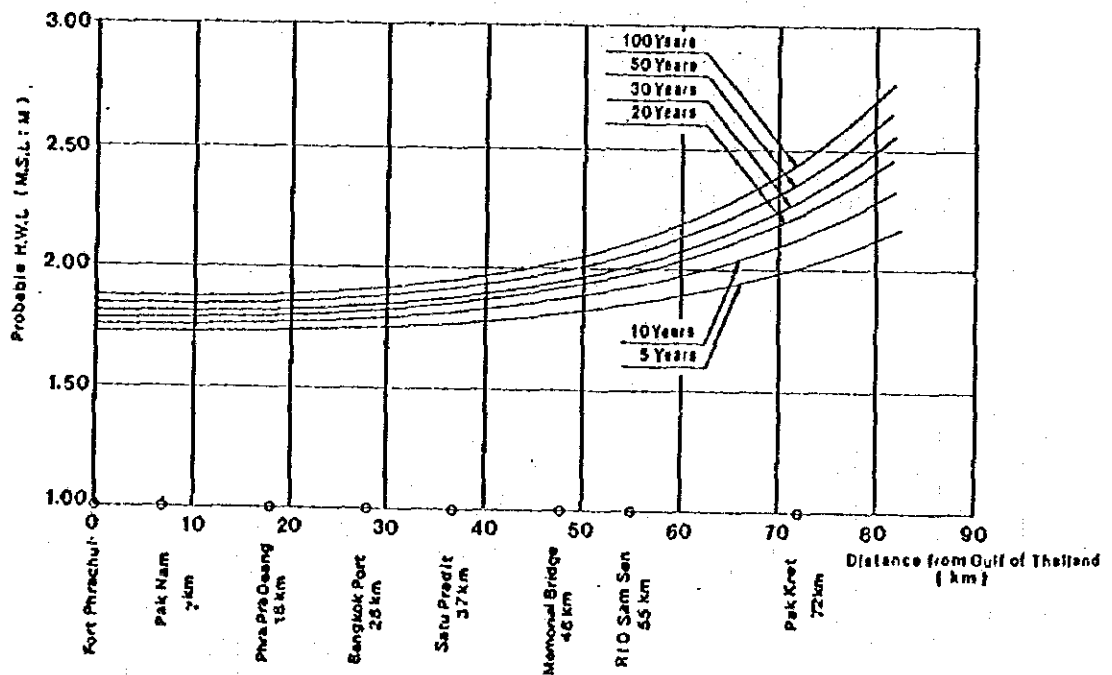
Rainy Days

図 2.5 バンコクの一般気象

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK



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



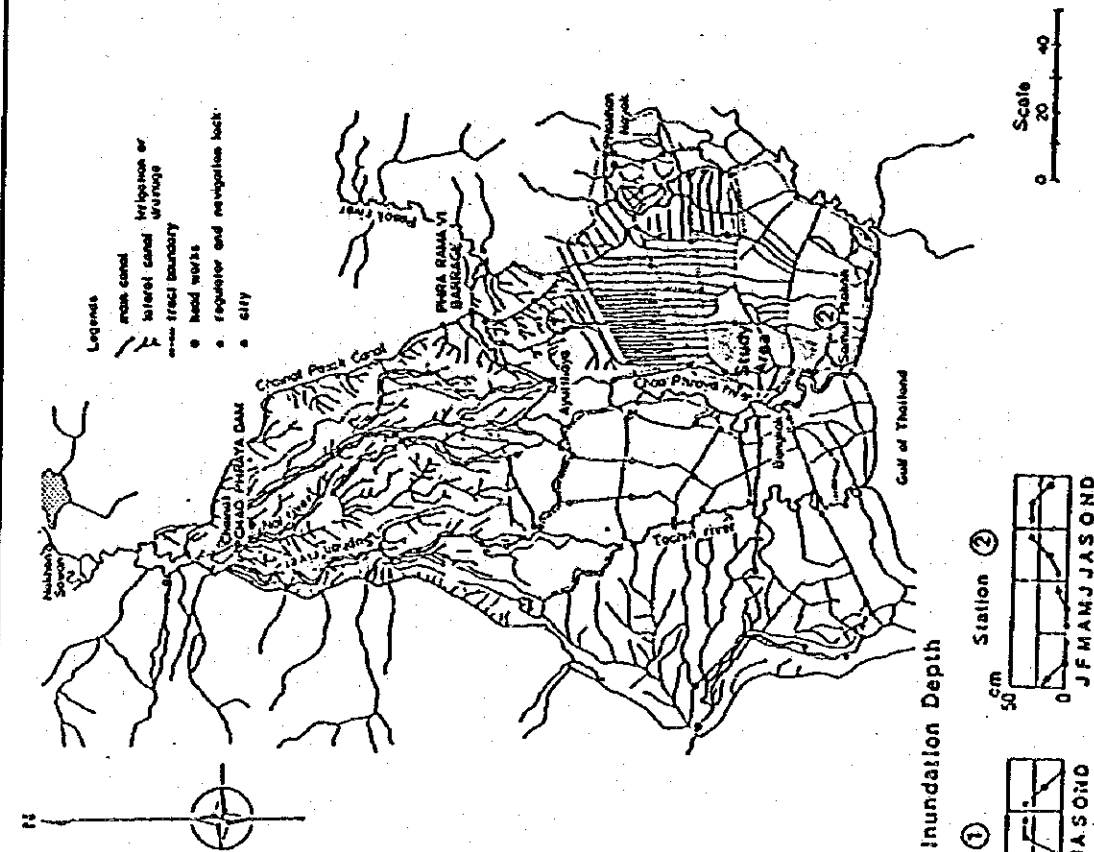
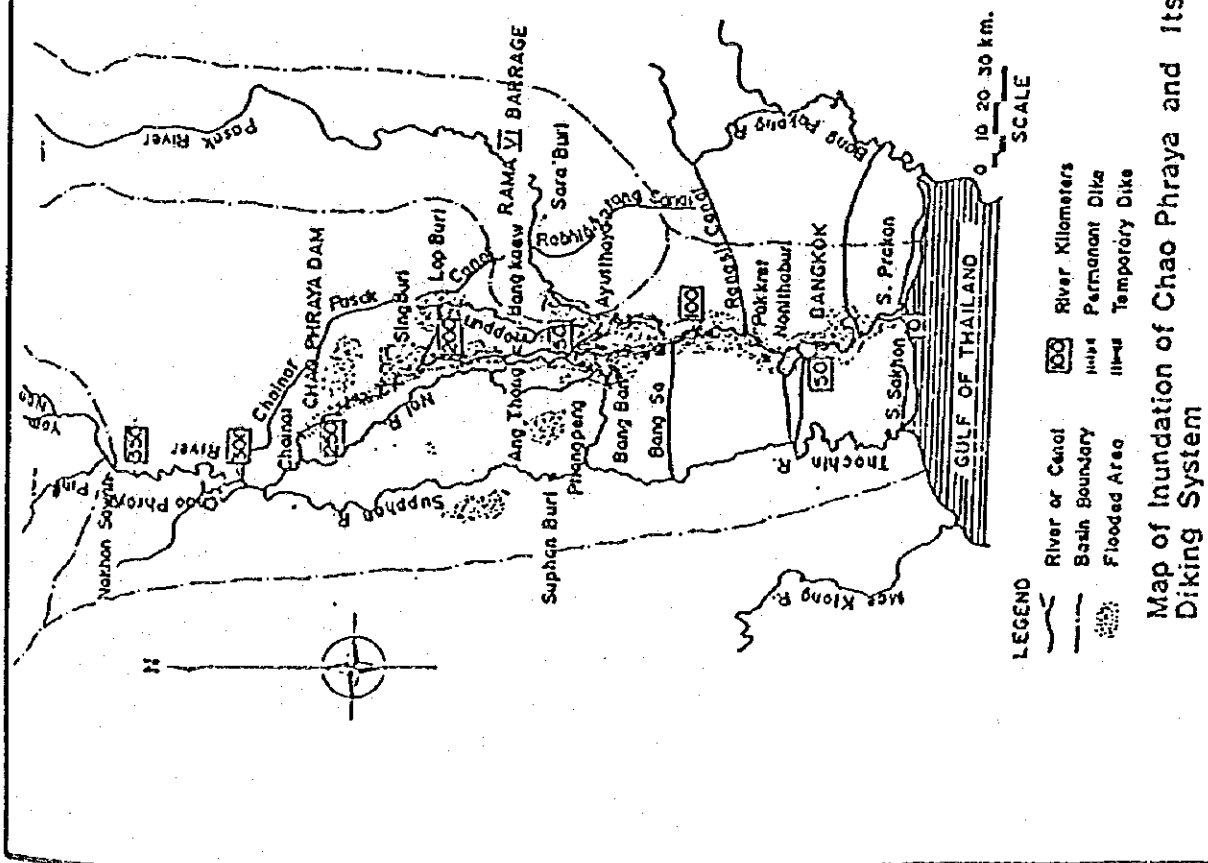
PROBABLE FLOOD WATER LEVEL OF CHAO PHRAYA RIVER

Source : Meteorological Department and Port Authority of Thailand

図 2.6

チャオプラヤ川の水位

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK



(Source: IRID) Irrigation Canal Network for the Greater Chao Phraya Project

図 2.7

チャオプラヤ川流域の堤防及び灌漑用排水路網

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

第3章

図3.1	浸水実績図（バンコク首都圏，1983年）	9
図3.2	浸水実績図（マスタープラン地域，1983年）	10
図3.3	関連計画（内水排除計画）	11
図3.4	関連計画（チャオプラヤ川放水路計画）	12
図3.5	関連計画（表流水転用広域水道整備計画）	13

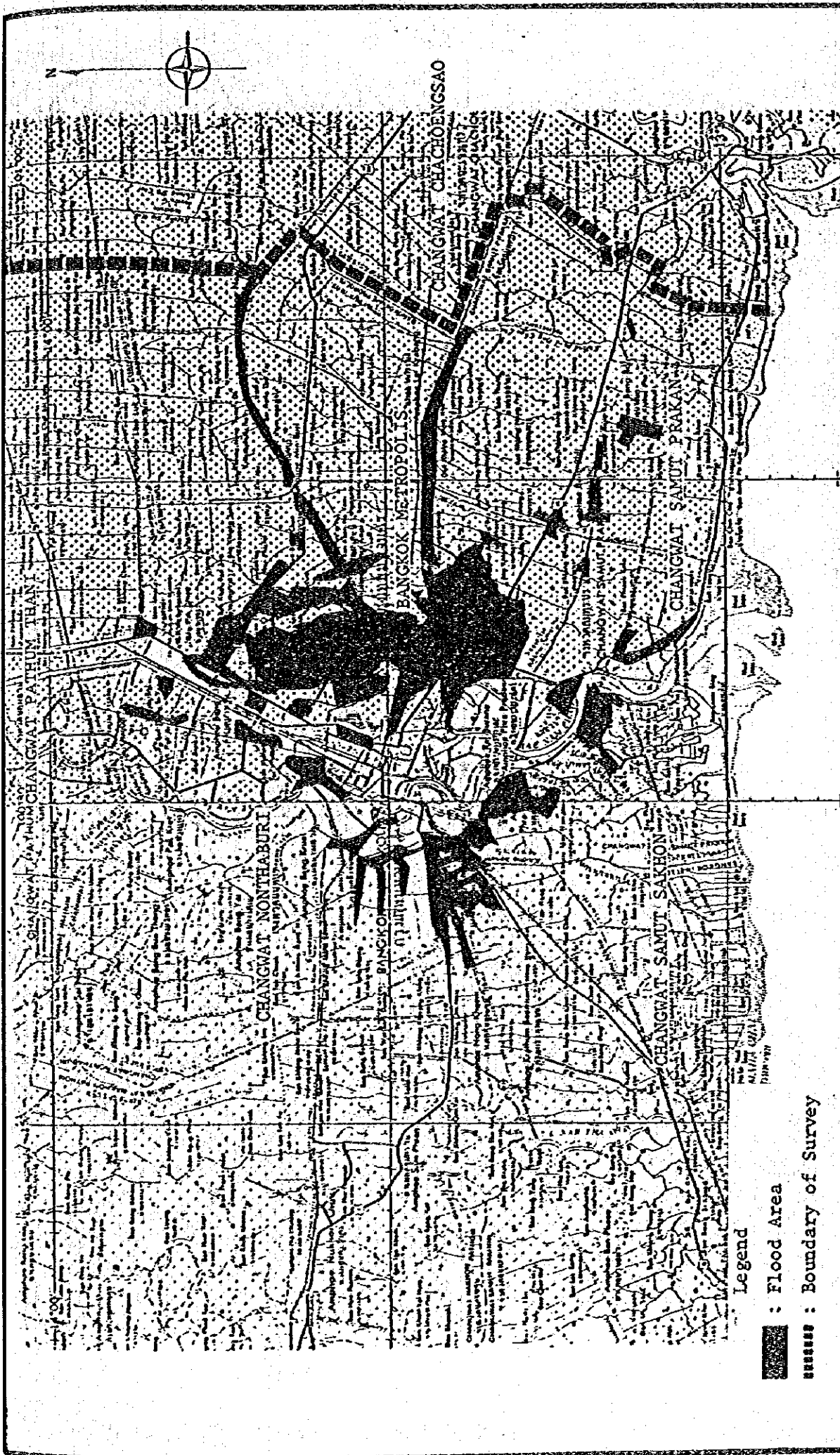


図 3. 1 浸水実績図 (バンコク首都圏, 1983年)

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

[Source: Flood Damage Survey by NSO]

Scale
0 2 4 6 8 10 20 Km

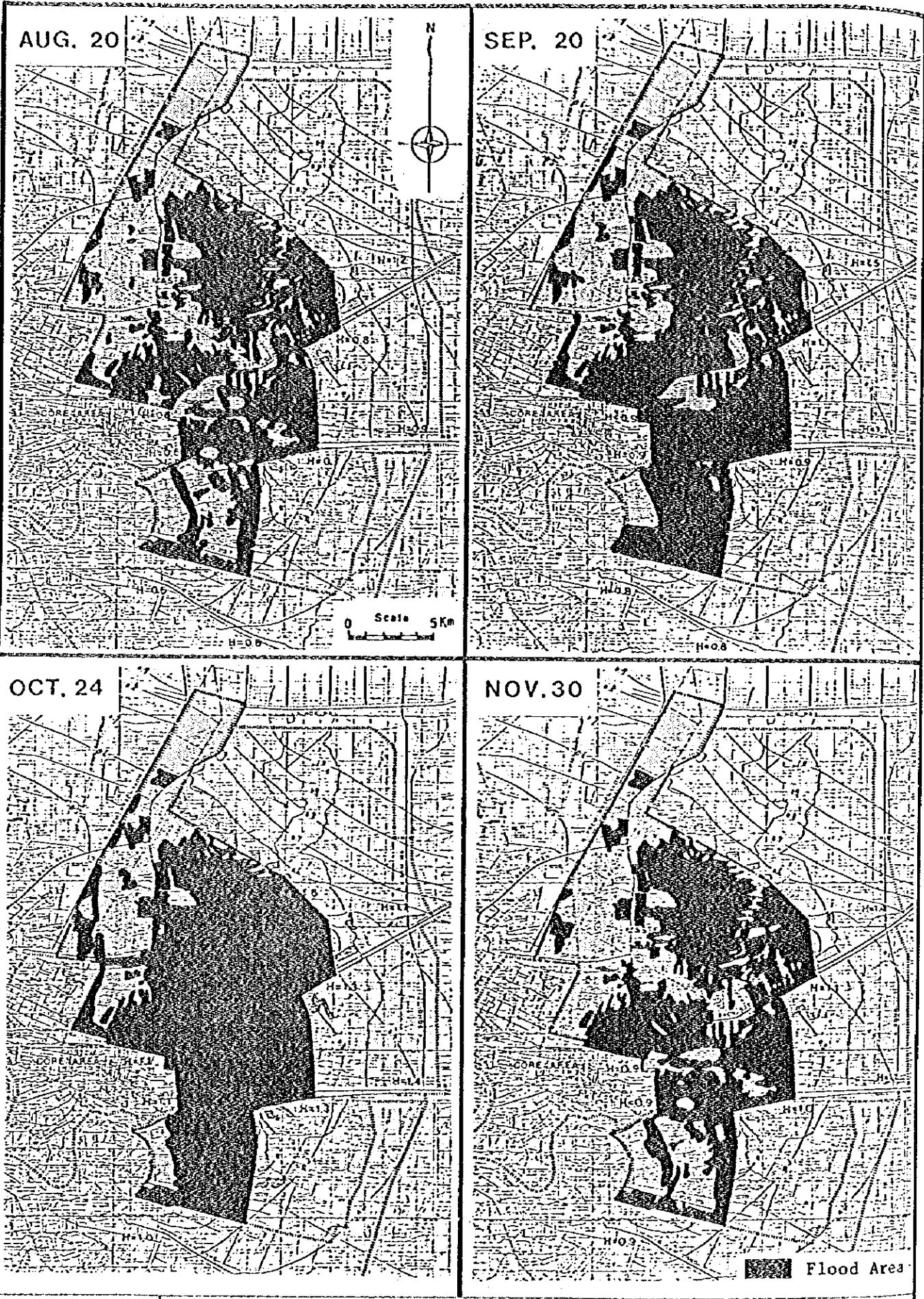
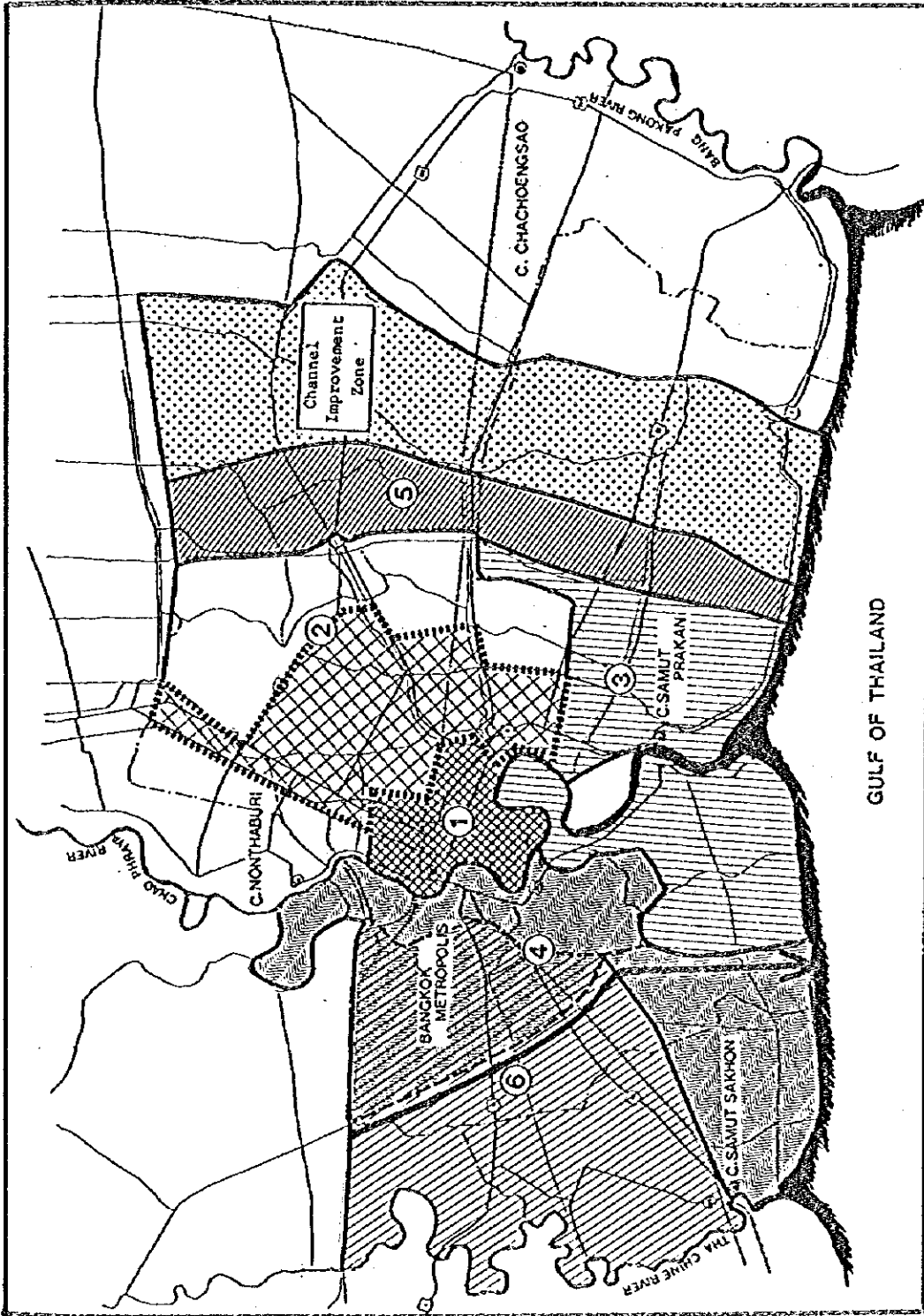


図 3. 2

浸水実績図 (マスタープラン地域, 1983年)

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

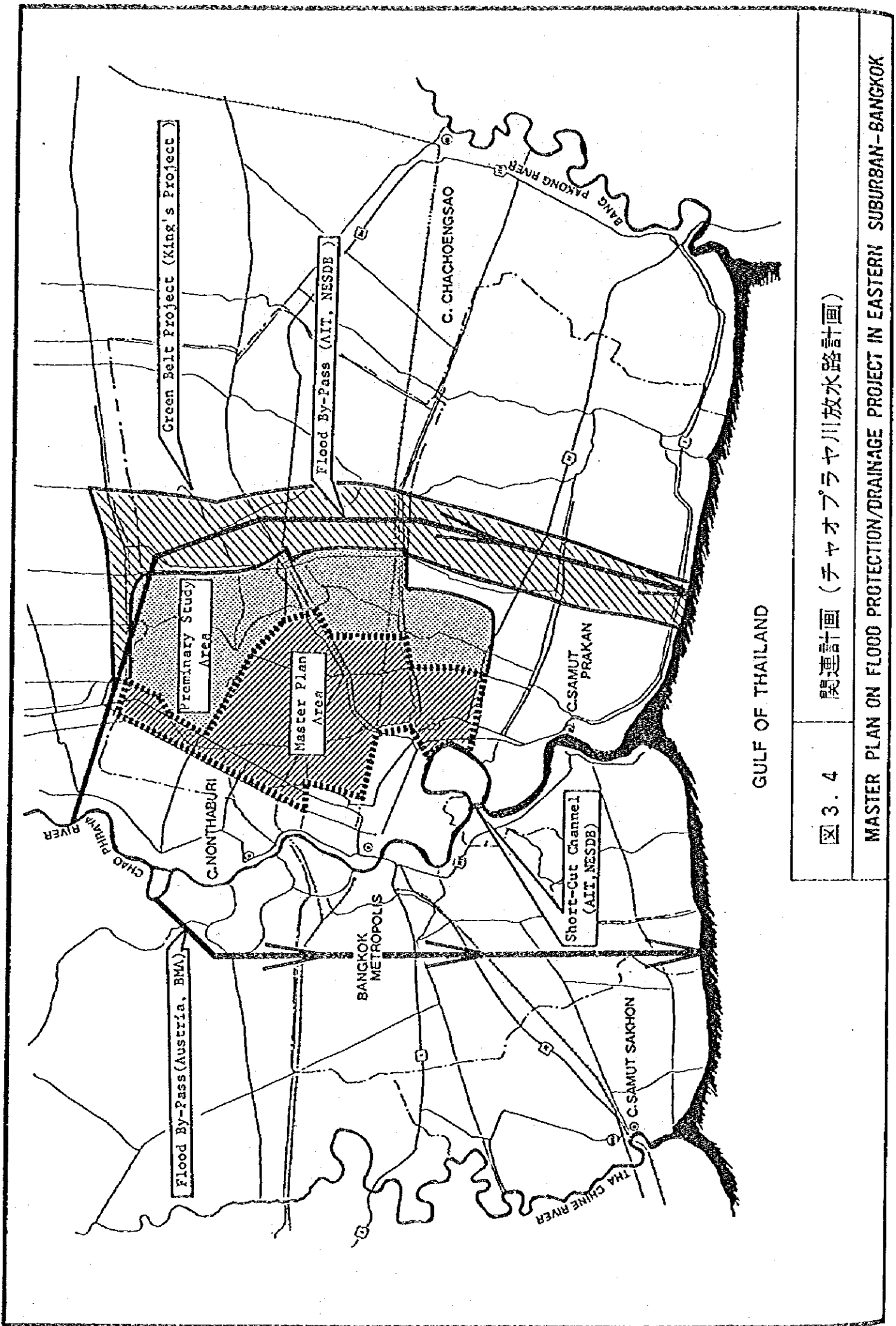


Legend

- ① City Core Project (NESDB, BMA)
- ② Eastern Suburban Project (JICA, BMA)
- ③ Surt Prakan (East-West) Project (TISTR, SP)
- ④ Thonburi Project (Netherland)
- ⑤ Green Belt Project (King's Project)
- ⑥ Thaews Wattana (West Bank) Project (AIT: BMA)

圖 3. 3 關連計畫 (內水排除計畫)

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK



GULF OF THAILAND

図 3. 4 関連計画 (チャオプラヤ川放水路計画)

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN - BANGKOK

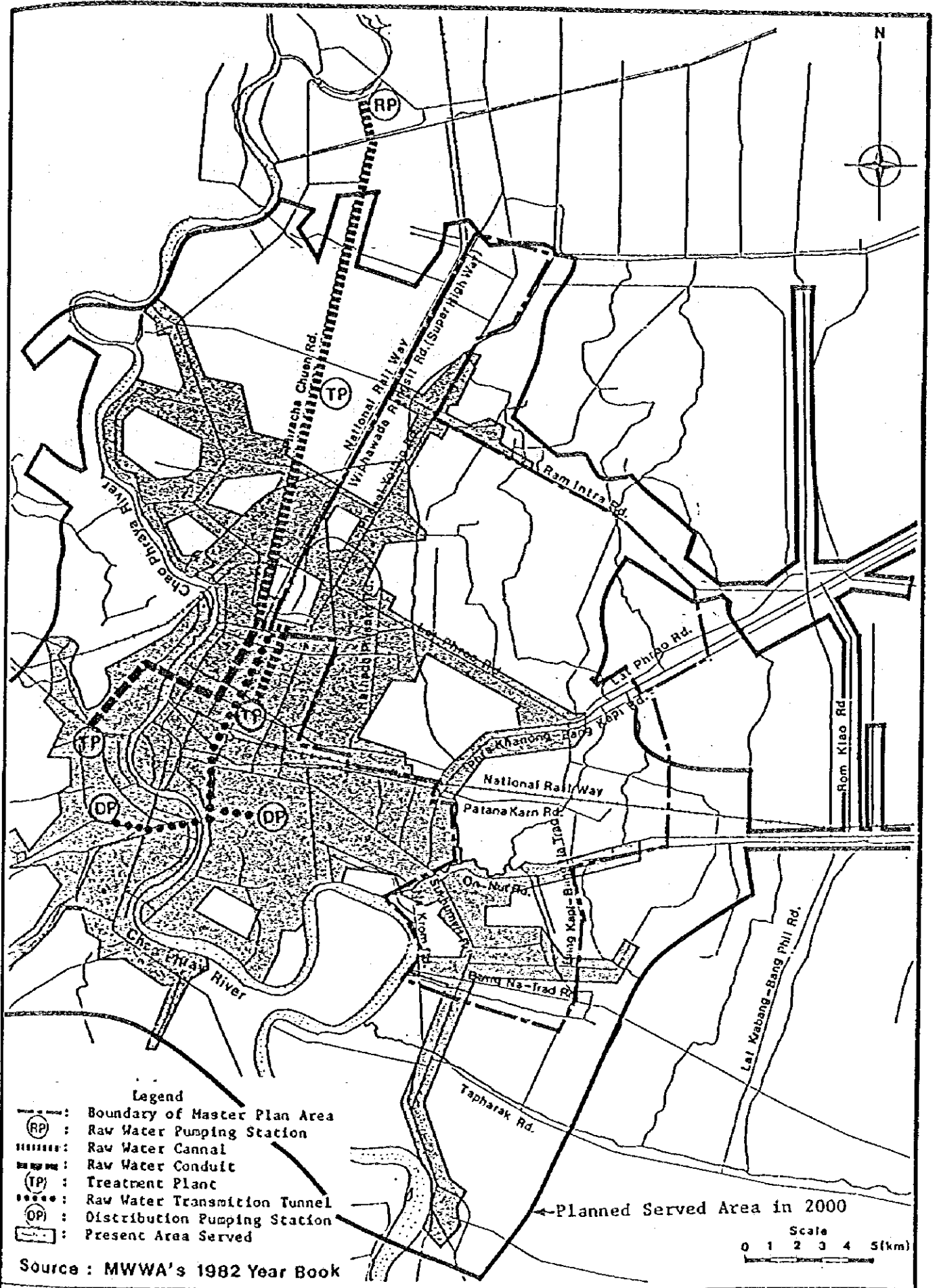


図 3. 5

関連計画 (表流水転用広域水道整備計画)

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

第4章

図4.1	洪水防御・排水対策システムの現状（1983, 緊急洪水対策以前）	15
図4.2	クローンの現況流下能力	16
図4.3	緊急洪水対策施設（1984年）の概要	17
図4.4	緊急洪水対策施設の水理的効果-（1）（Basin 3の水位）	18
図4.5	緊急洪水対策施設の水理的効果-（2）（水位, 期間, 深さ）	19
図4.6	緊急洪水対策施設の水理的効果-（3）（貯留高）	20
図4.7	主クローンの水位低下と Bang Na地区の浸水（緊急洪水対策後）	21

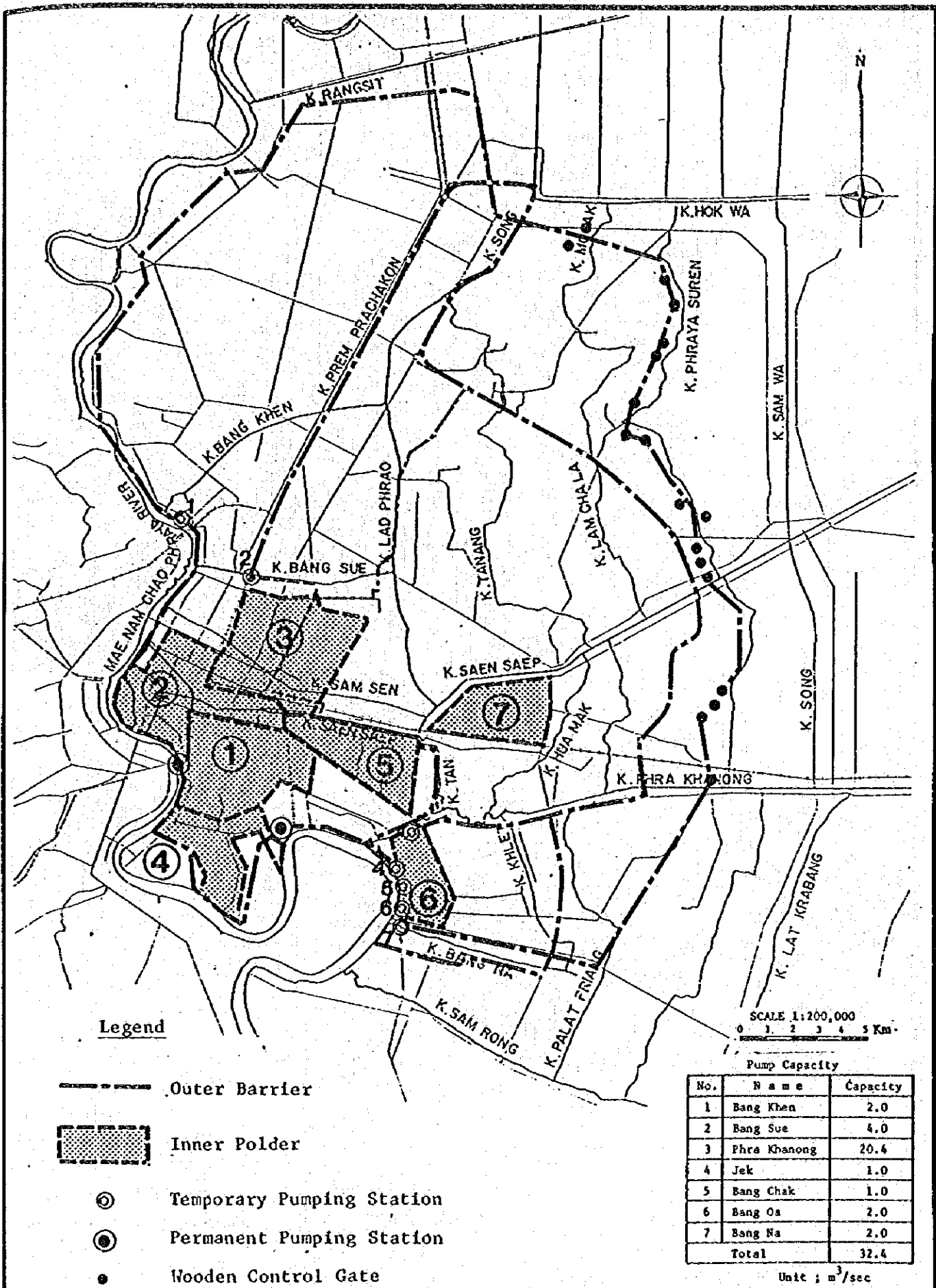


図 4. 1 洪水防御・排水対策システムの現状 (1983, 緊急洪水対策以前)

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

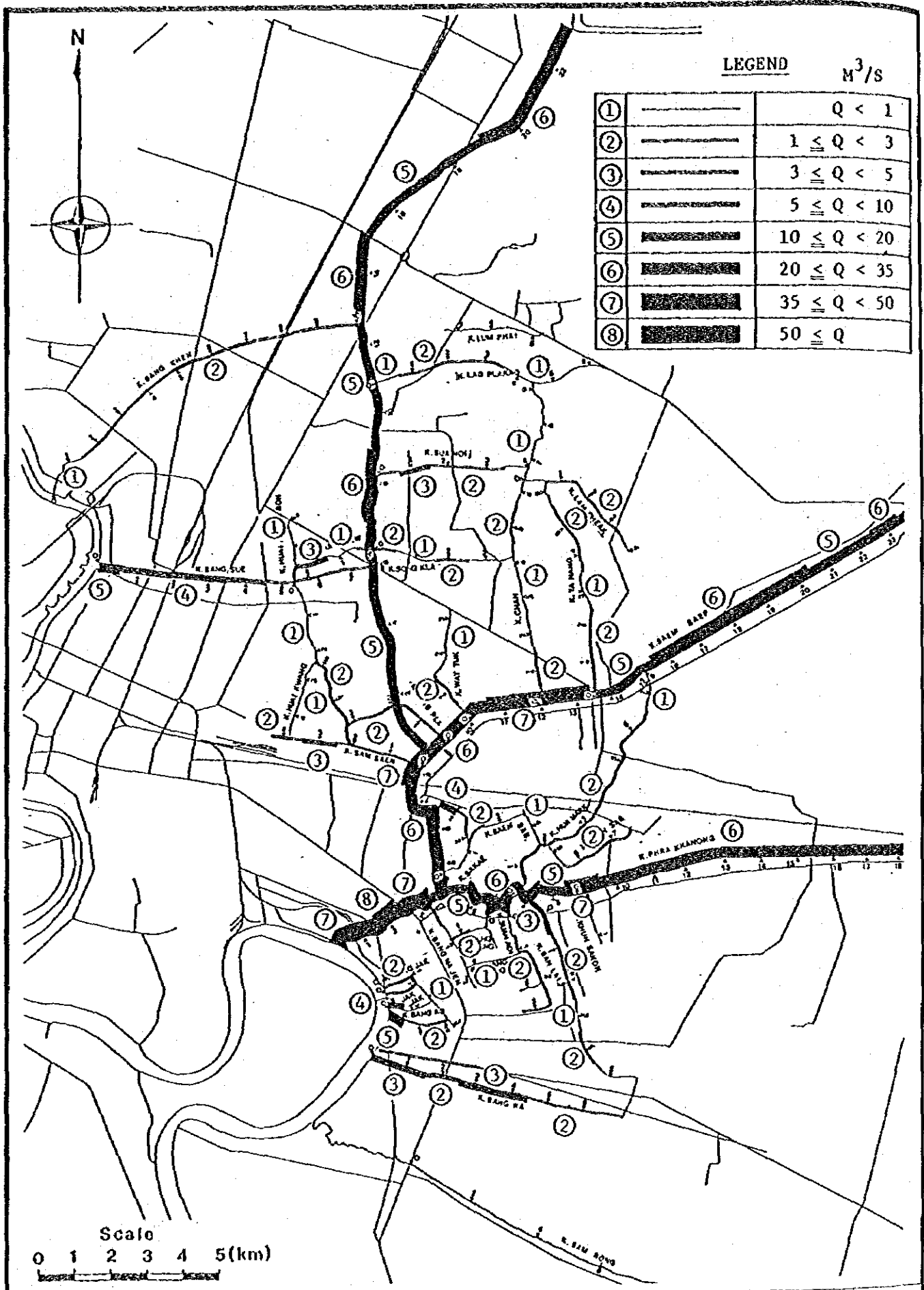


図 4. 2

クローンの現況流下能力

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

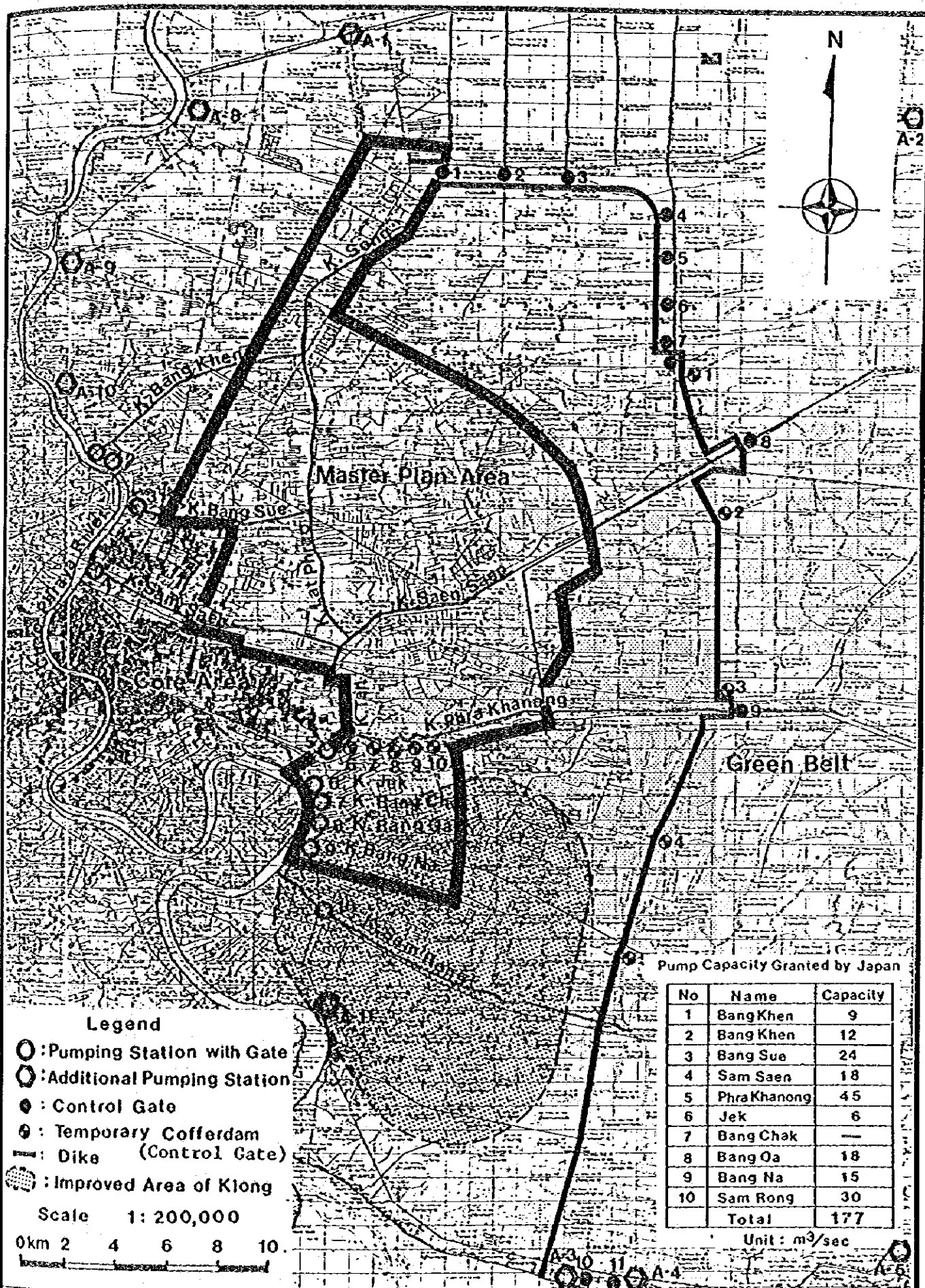
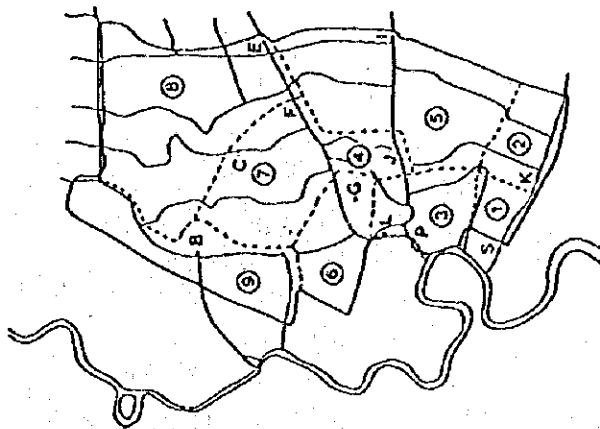


図 4. 3

緊急洪水対策施設（1984年）の概要

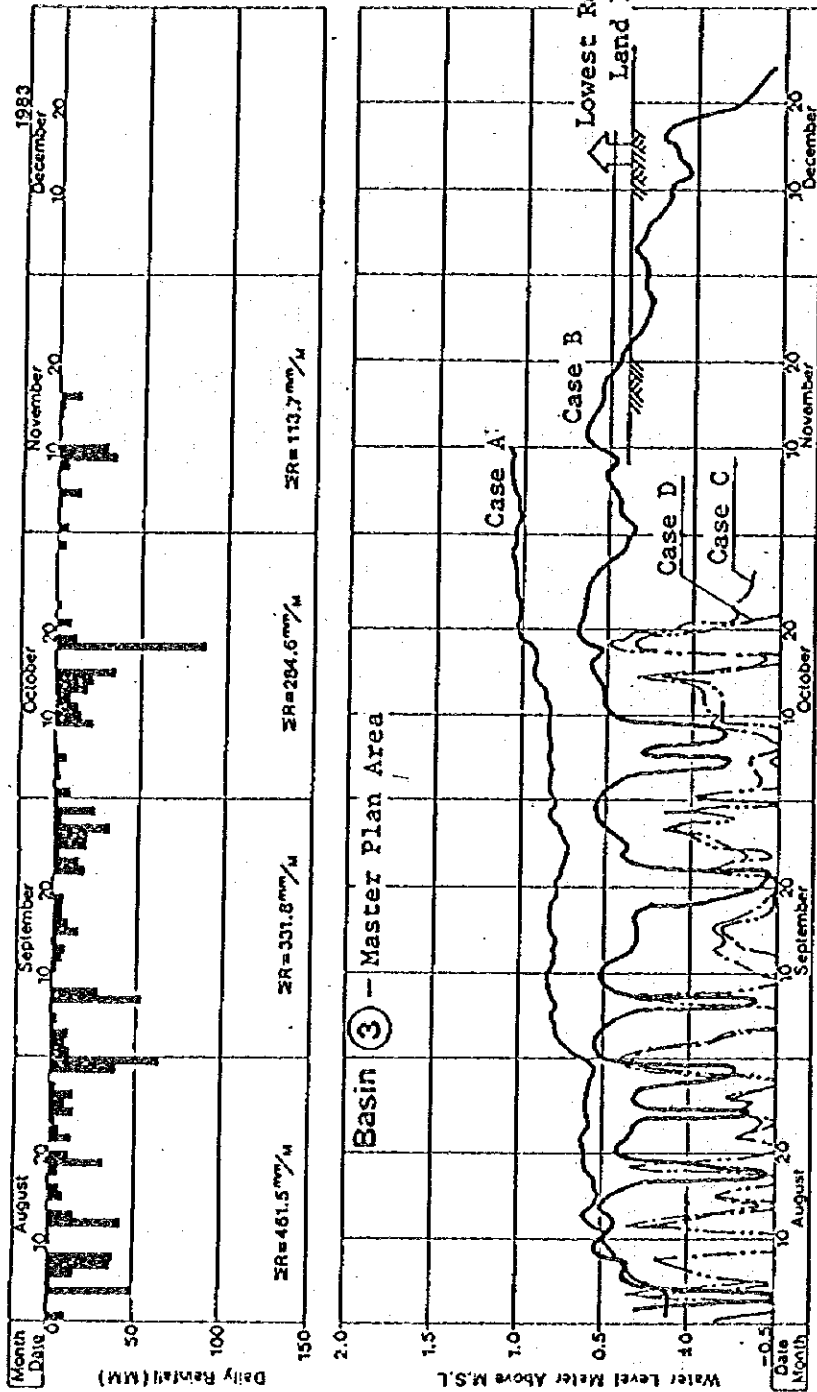
MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

Key Map



Legend

- ① : Basin Number
- B : Water Level Gauge station



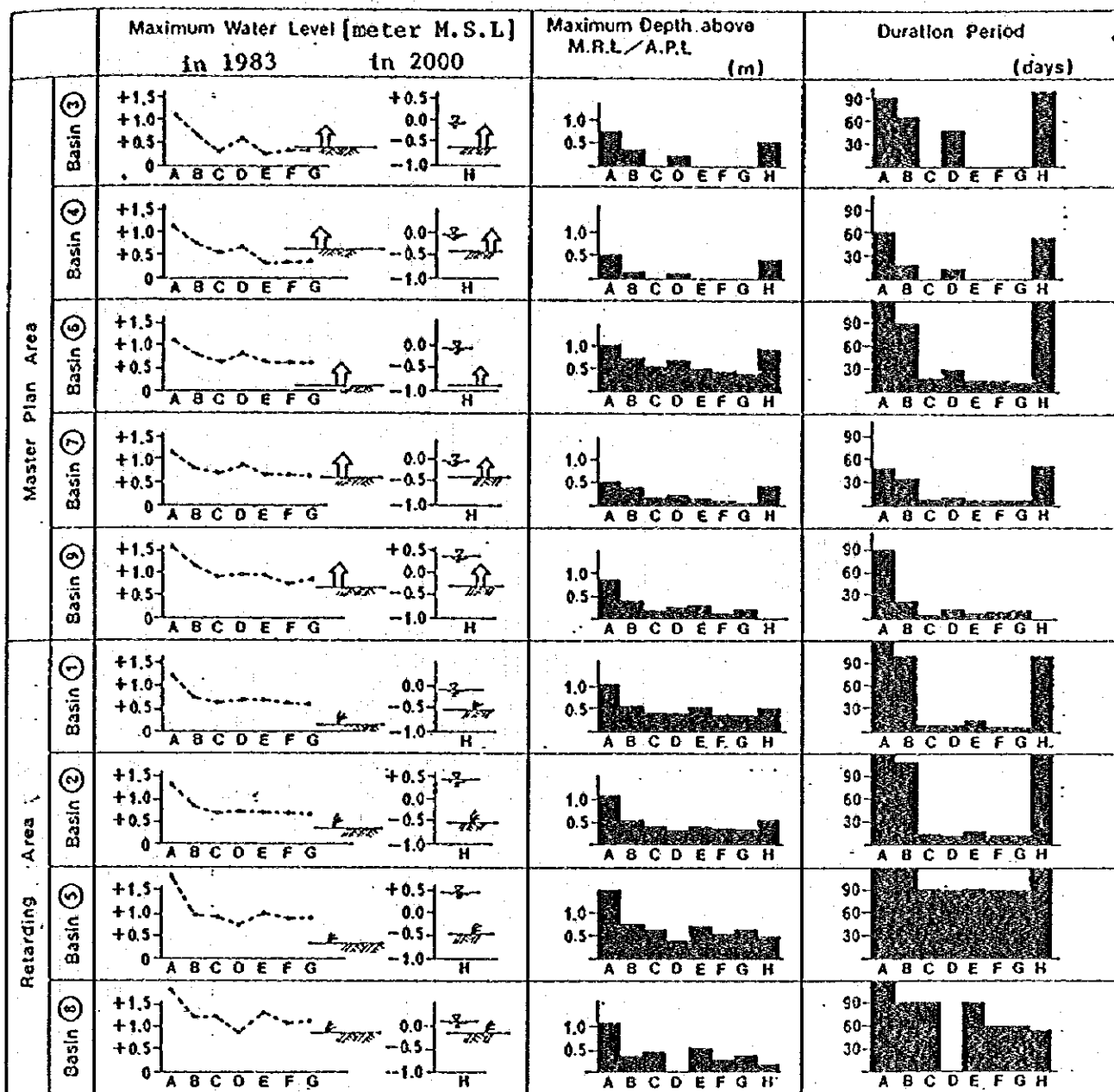
	Observed water level	Calculated water level	Main fall 1983	Topography Existing	Green Belt Pump	Urgent Inner Barrier	Pump Capacity city m ³ /s
Case A	—	—	1983	Existing	X	X	21
Case B	—	—	"	"	O	X	21
Case C	—	—	"	"	O	O	159
Case D	—	—	"	"	O	O	159

- X : not considered
- O : considered
- Δ : Existing Cofferdam in K. Saen Saep and K. Phra Khanong be considered

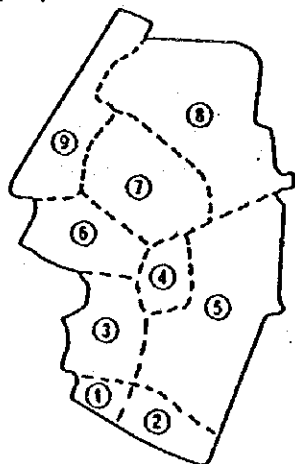
[Estimated by 9-Basin Model]

図 4. 4 緊急洪水対策施設の水利的効果一(1) (Basin 3 の水位)

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK



1. Key Map of Basins



①: Number of Basin

2. Area size of Basin

	No. of Basin	Area (km ²)	HRL/APL	
			In 1983	In 2000
Master Plan Area	③	52	+0.4	-0.6
	④	22	+0.6	-0.4
	⑥	42	+0.1	-0.9
	⑦	80	+0.6	-0.4
	⑨	64	+0.7	+0.3
Retarding Area	①	19	+0.3	-0.6
	②	35	+0.3	-0.5
	⑤	105	+0.4	-0.6
	⑧	160	+0.8	-0.2

HRL: Minimum Residential-Land Level above MSL(m)

APL: Average Paddy Field Land Level above MSL(m)

3. Condition of Calculation Case

case	A	B	C	D	E	F	G	H
Rain (all)	Areal Average Rainfall in 1983 ER=1078mm/3M					Design Rainfall 1/N=1/5 ER=872mm/3M		
Topography	Existing (1983)						Future (2000)	
Green Belt	x	o	o	o	o	o	o	o
Urgent Pump	x	x	o	o	o	o	o	o
Inner Barrier	Δ	Δ	Δ	x	o	Δ	o	o
Pump Capacity	CNS 21	CNS 21	CNS 159	CNS 159	CNS 159	CNS 159	CNS 159	CNS 159

x: not considered

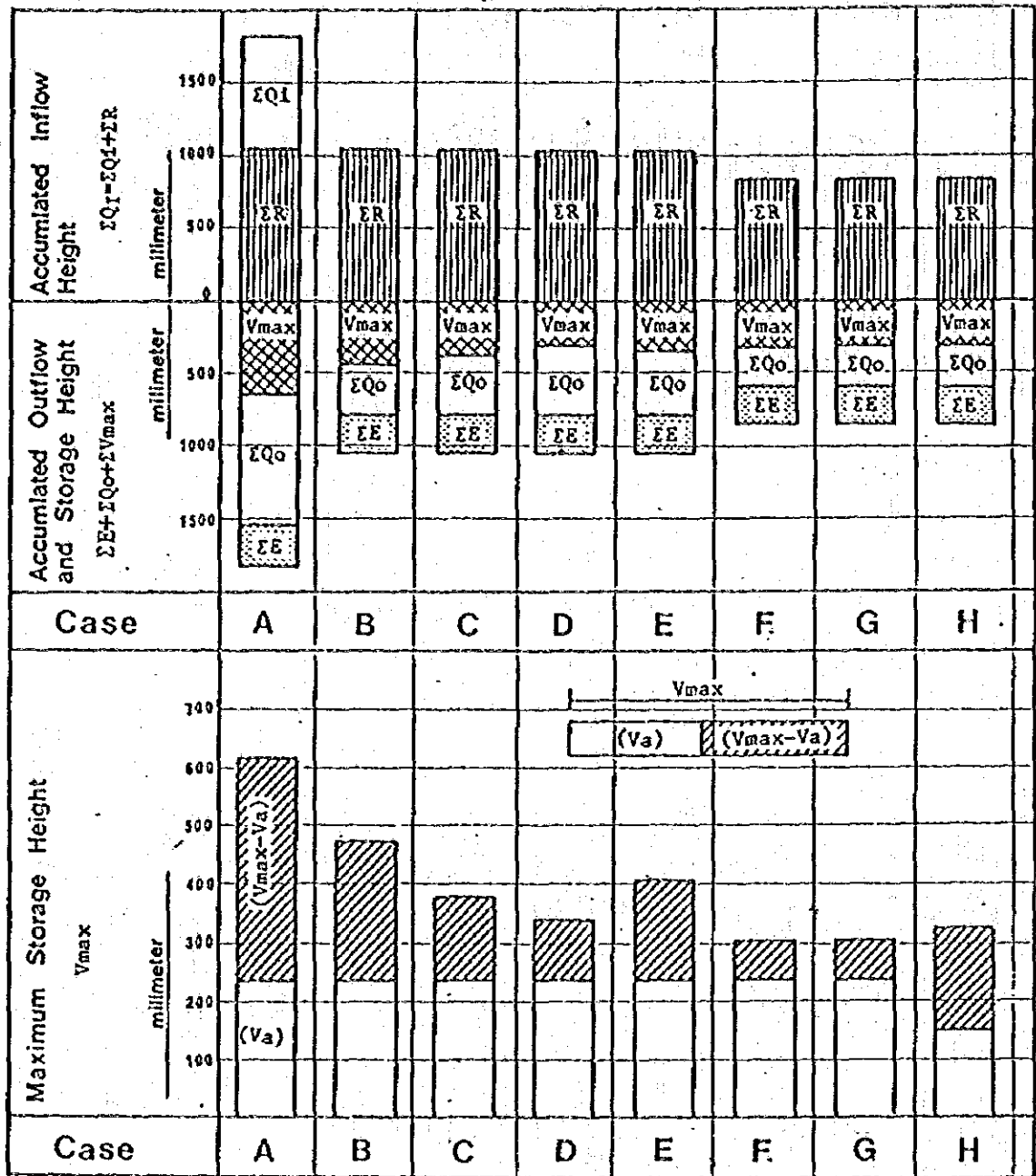
o: considered

Δ: Existing Cofferdam in K. Saen Saep and K. Phra Khanong be considered

図 4. 5

緊急洪水対策施設の水利的效果—(2) (水位, 期間, 深さ)

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK



Legend

- EQ_i : Inflow from Outer Area
- ER : Rainfall
- V_{max} : Maximum Storage Volume
- EQ_o : Discharge Volume
- ΣE : Evapotranspiration
- V_a : Allowable Storage Capacity
(under lowest residential-land level)

Study Case

case	A	B	C	D	E	F	G	H
Rain fall	Areal Average Rainfall in 1983 ER=1078mm/3month				Design Rainfall 1/N=1/5 ER=872mm/3month			
Topography	Existing (1983)							Future (2000)
Green Belt	x	o	o	o	o	o	o	o
Urgent Pump	x	x	o	o	o	o	o	o
Inner Barrier	Δ	Δ	Δ	x	o	Δ	o	o
Pump Capacity	CHS 21	CHS 21	CHS 159	CHS 159	CHS 159	CHS 159	CHS 159	CHS 159

AREA : Preliminary Study Area (501km²)
+ Surrounding Area (104km²)
= (605km²)

x : not considered
o : considered
Δ : Existing Cofferdam in K. Saen Saep and K. Phra-Khanong be considered

図 4.6

緊急洪水対策施設の水利的效果—(3) (貯留高)

第5章

図5.1	市街化区域の進展	23
図5.2	将来(2000年)の推定人口	24
図5.3	将来(2000年)の土地利用計画	25

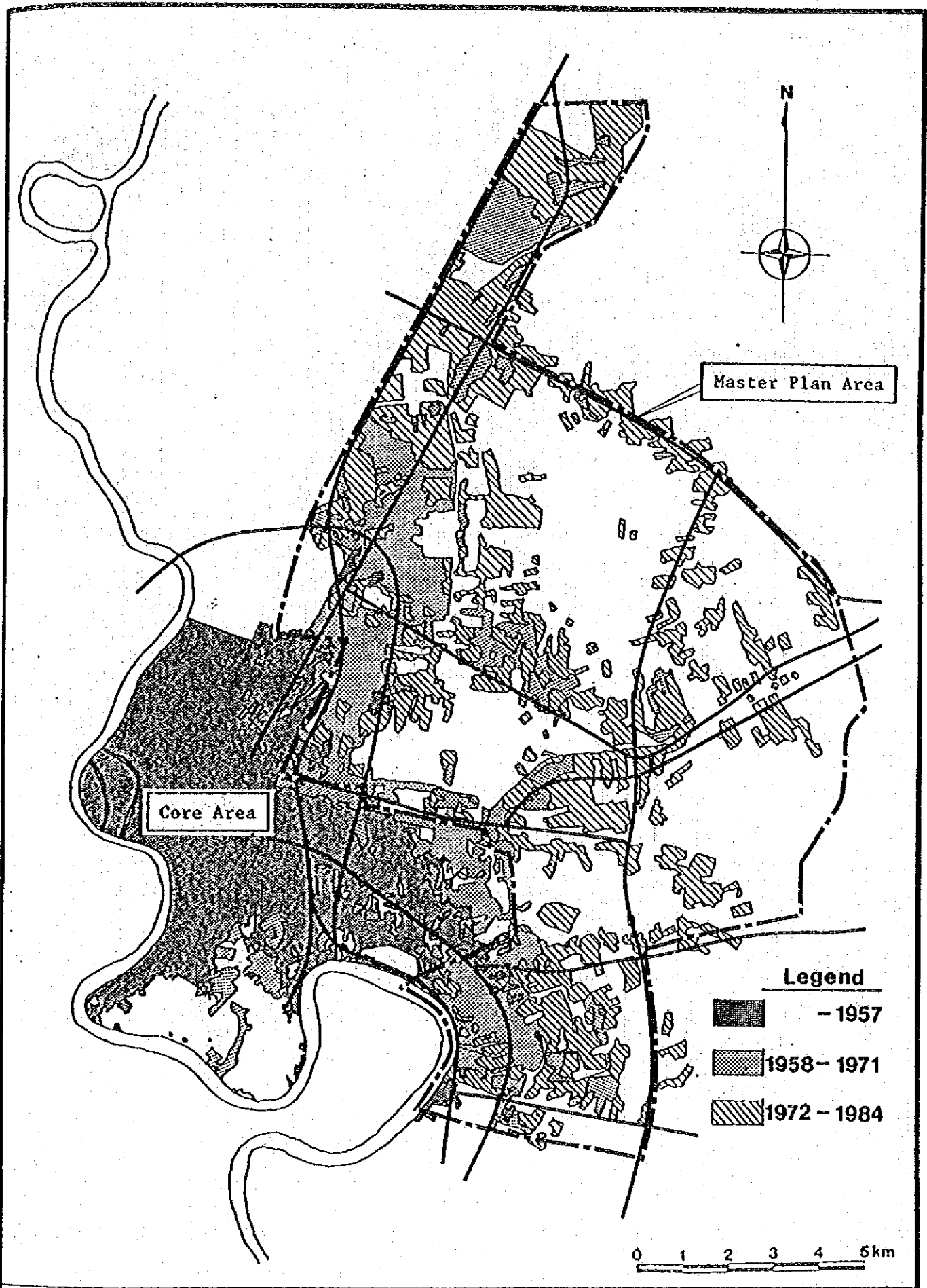


図 5. 1

市街化区域の進展

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

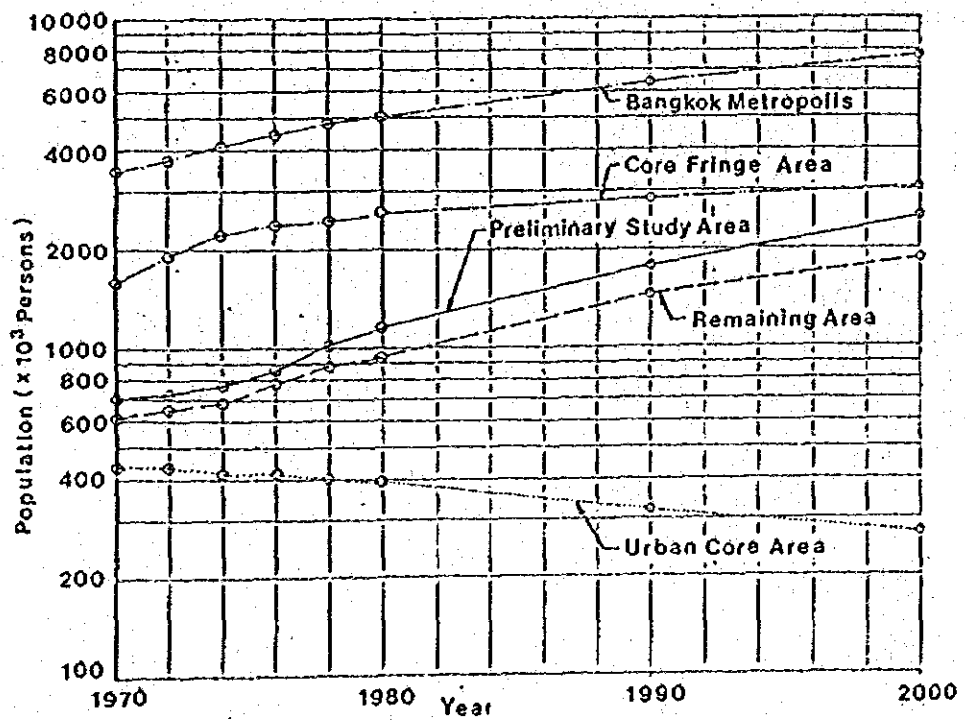
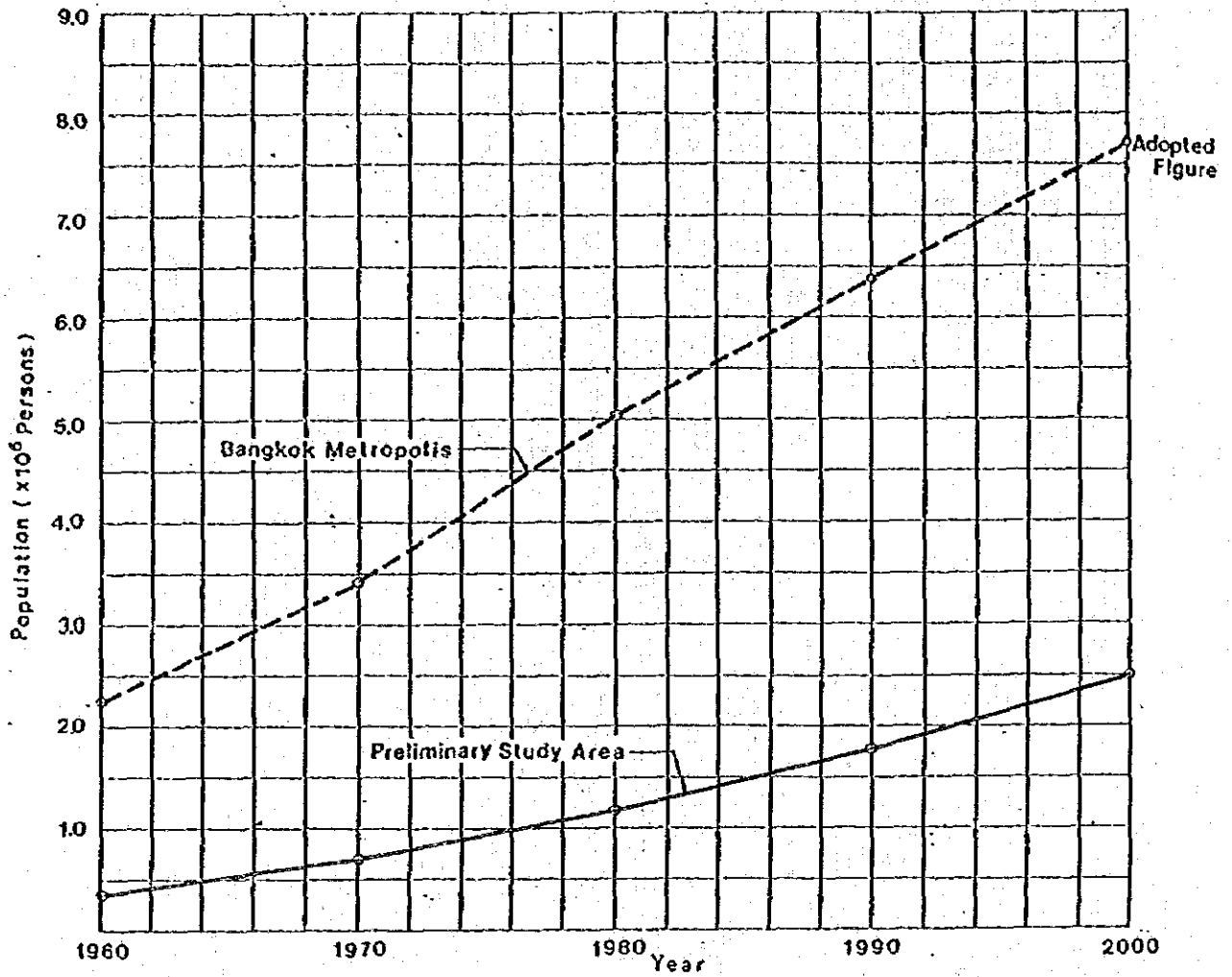


図 5. 2 将来 (2000年) の推定人口

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

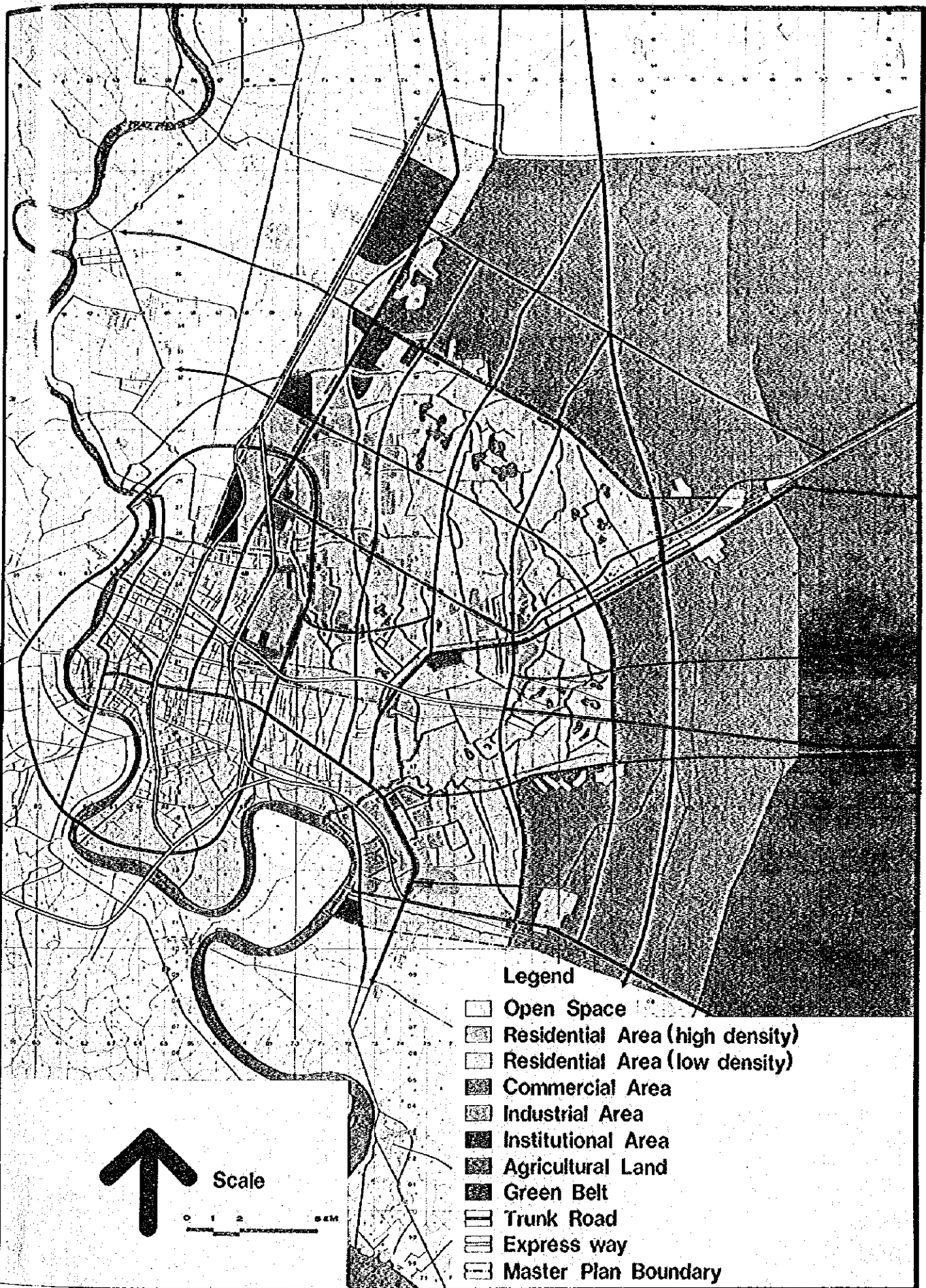


図 5-3

将来(2000年)の土地利用計画

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

第6章

図6.1	総合治水対策概念図	27
図6.2	洪水防御・排水対策	28
図6.3	輪中方式による洪水防御計画代替案	29
図6.4	洪水防御・排水計画概念図	30
図6.5	輪中内の内水排除排出に関する代替案	31
図6.6	浸水危険度を考慮した土地利用計画	32

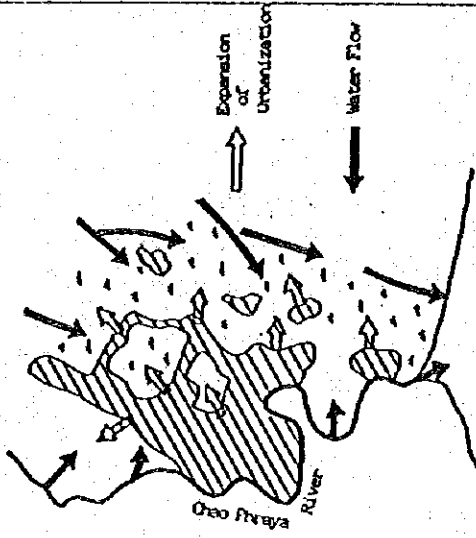
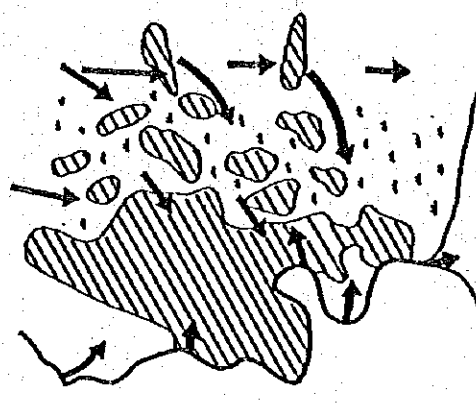
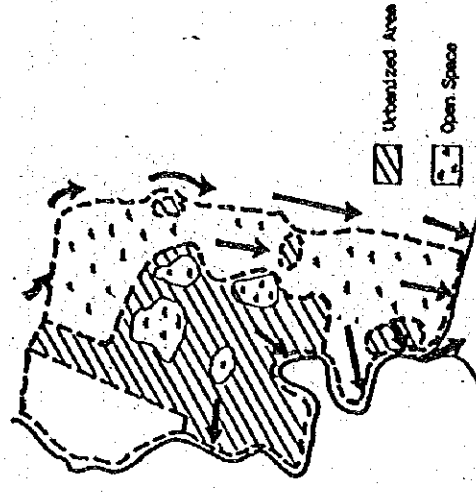
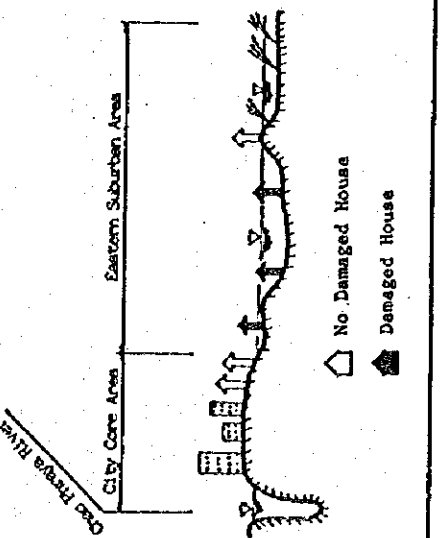
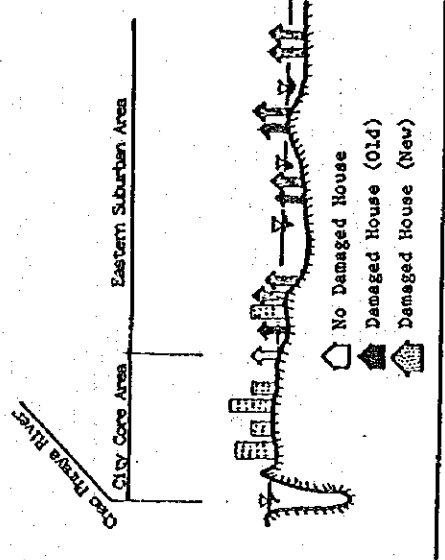
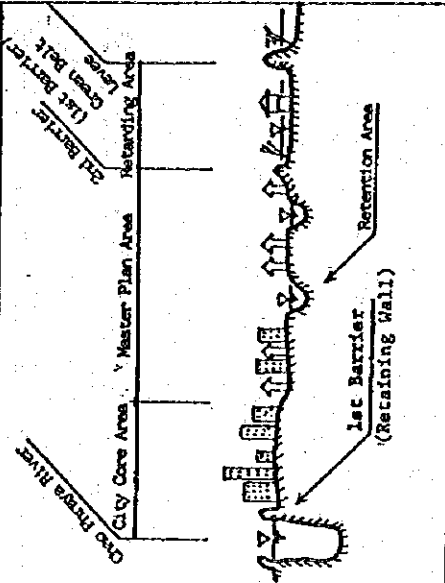
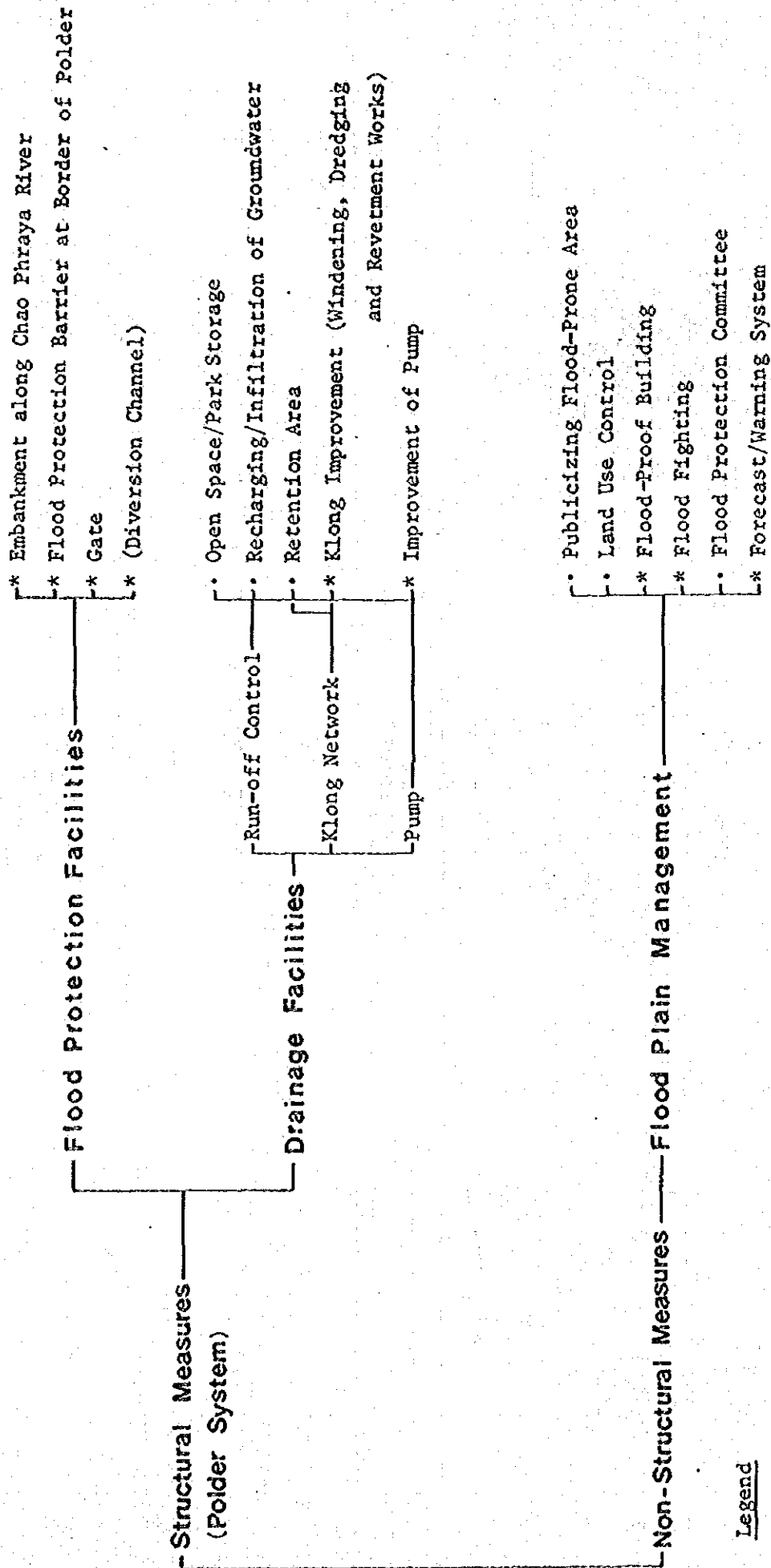
<p>KEY WORDS</p>	<p>(A) EXISTING URBANIZATION</p> 	<p>(B) PROGRESSION OF URBANIZATION WITHOUT FLOOD PLAIN MANAGEMENT</p> 	<p>(C) URBANIZATION WITH FLOOD PLAIN MANAGEMENT AND DRAINAGE FACILITY</p> 
<p>KEY WORDS</p>	<ul style="list-style-type: none"> • Saturated Capacity of Urbanization in City Core Area • Poor Flood Control Measures 	<ul style="list-style-type: none"> • Sprawling in and around Bangkok • Poor Flood Control Facility • Progression of Land Subsidence • Increase of Flood Damage Potential 	<ul style="list-style-type: none"> • Improvement of Flood Control Facility • Flood Plain Management (Land Use Control)
<p>SCHMATIC PROFILE</p>			

図 6. 1 総合治水対策概念図

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

CONCEPT OF FLOOD PROTECTION/DRAINAGE MEASURES



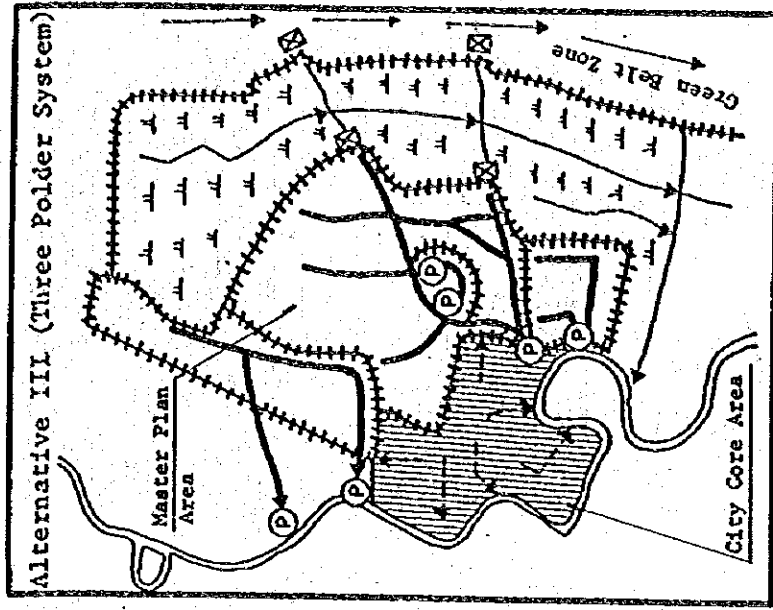
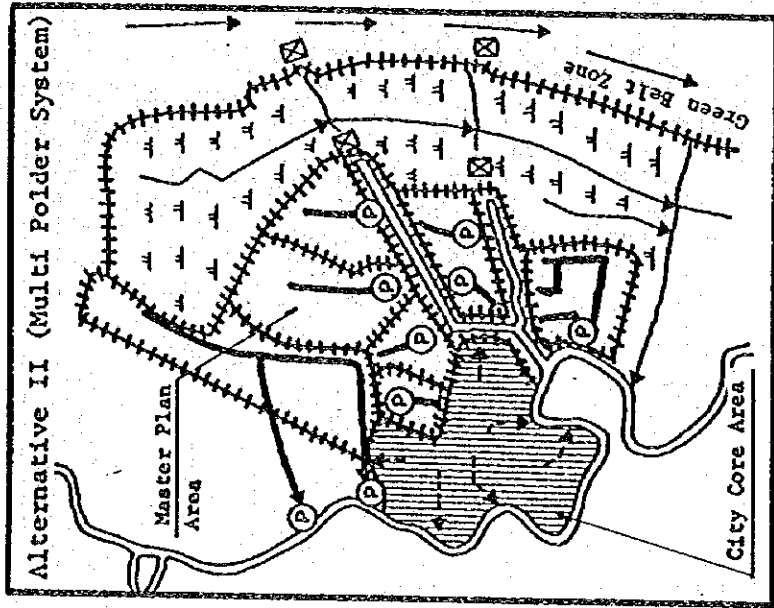
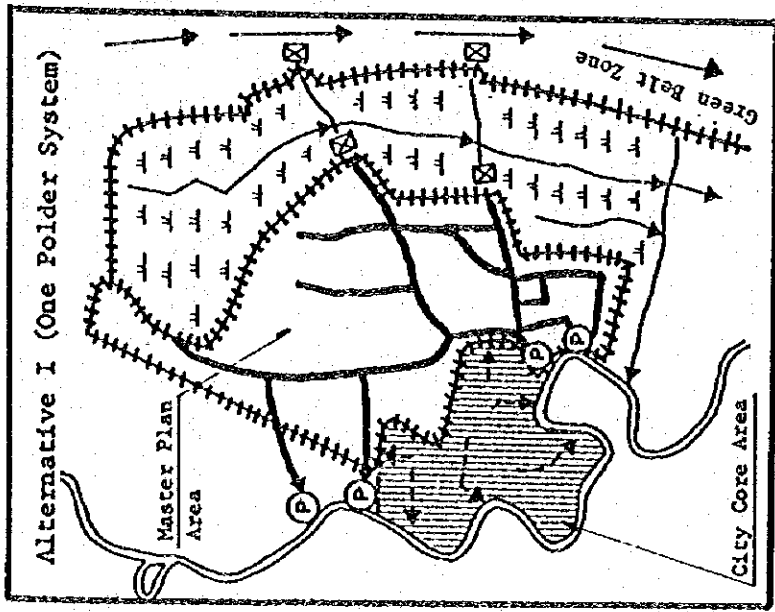
Legend

* Measures, partly executed by urgent measures.

• Measures, requiring new action from now.

图 6. 2 洪水防御・排水対策

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN - BANGKOK



- Legend
- Retarding Area
 - Master Plan Area
 - City Core Area
 - Polder Levee (Dike, Retaining Wall)
 - Gate
 - Pumping Station
 - Klong
 - Chao Phraya River and Trunk Klong

図 6.3 輪中方式による洪水防御計画代替案

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

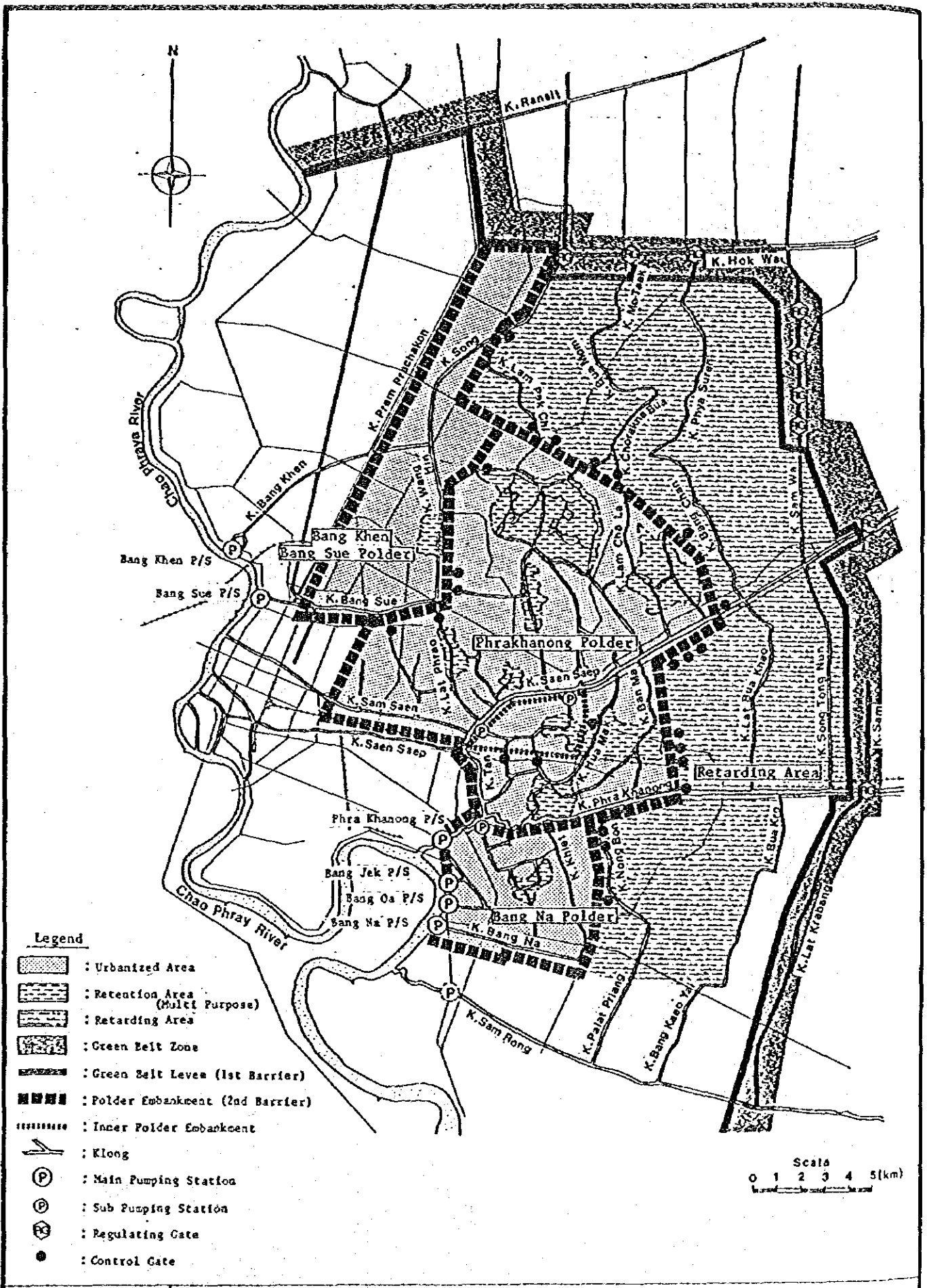
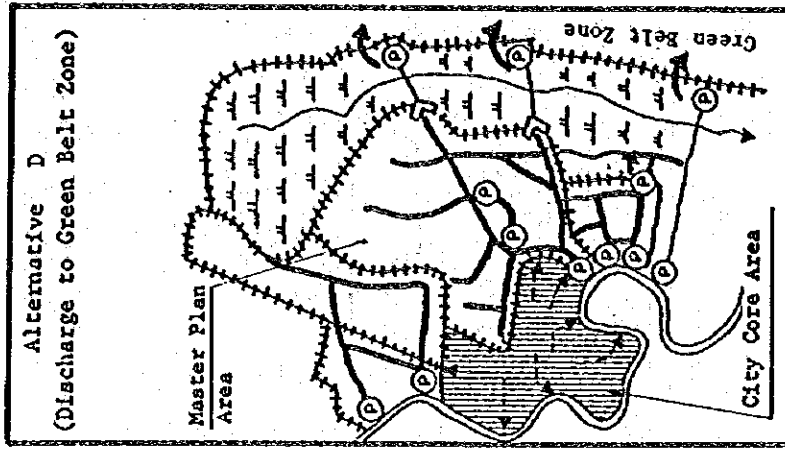
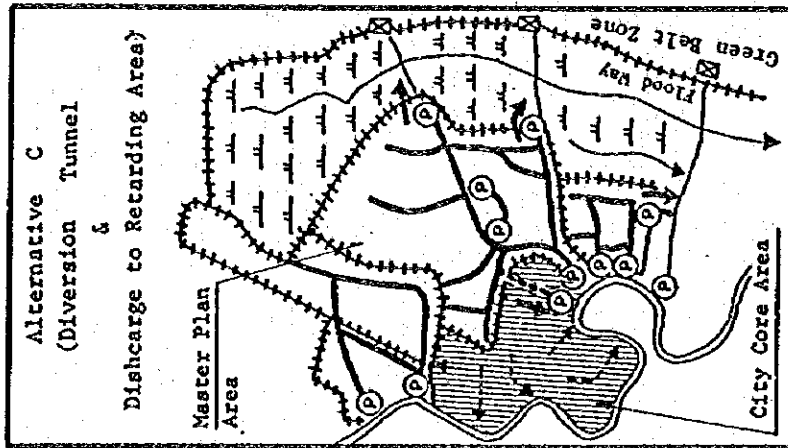
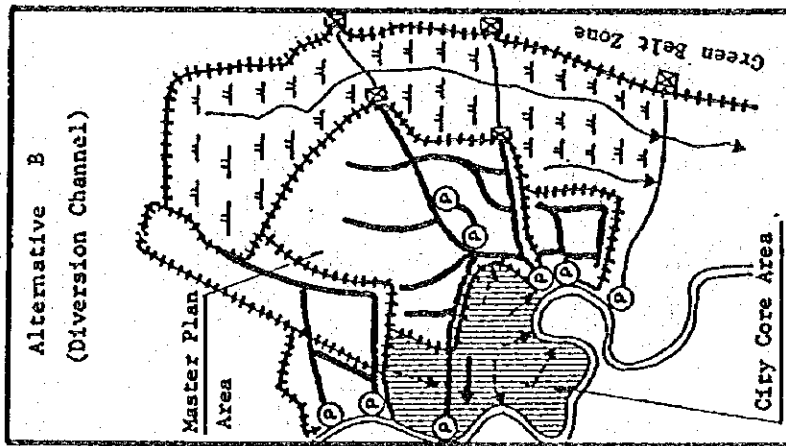
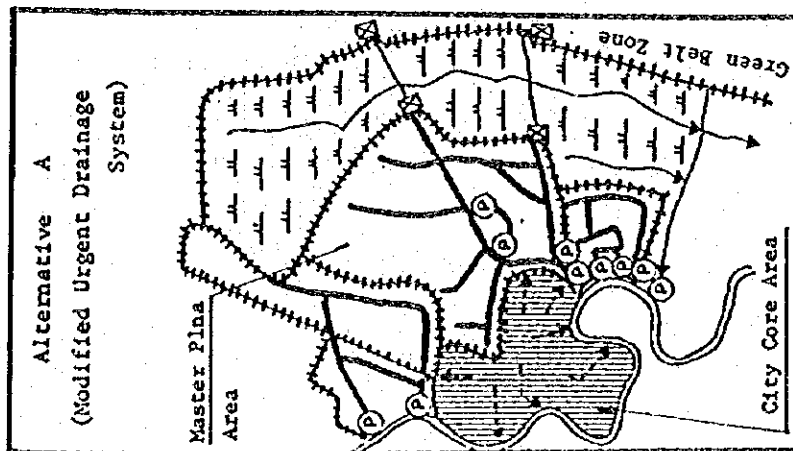


図 6.4 洪水防衛・排水計画概念図

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK



Legend

- Retarding Area
- Master Plan Area
- City Core Area

Polder Levee (Dike, Retaining Wall)

Gate

Regulating Gate

Pumping Station

Diversion Tunnel

Klong

図 6.5

輪中内の内水排除排出に関する代替案

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN - BANGKOK

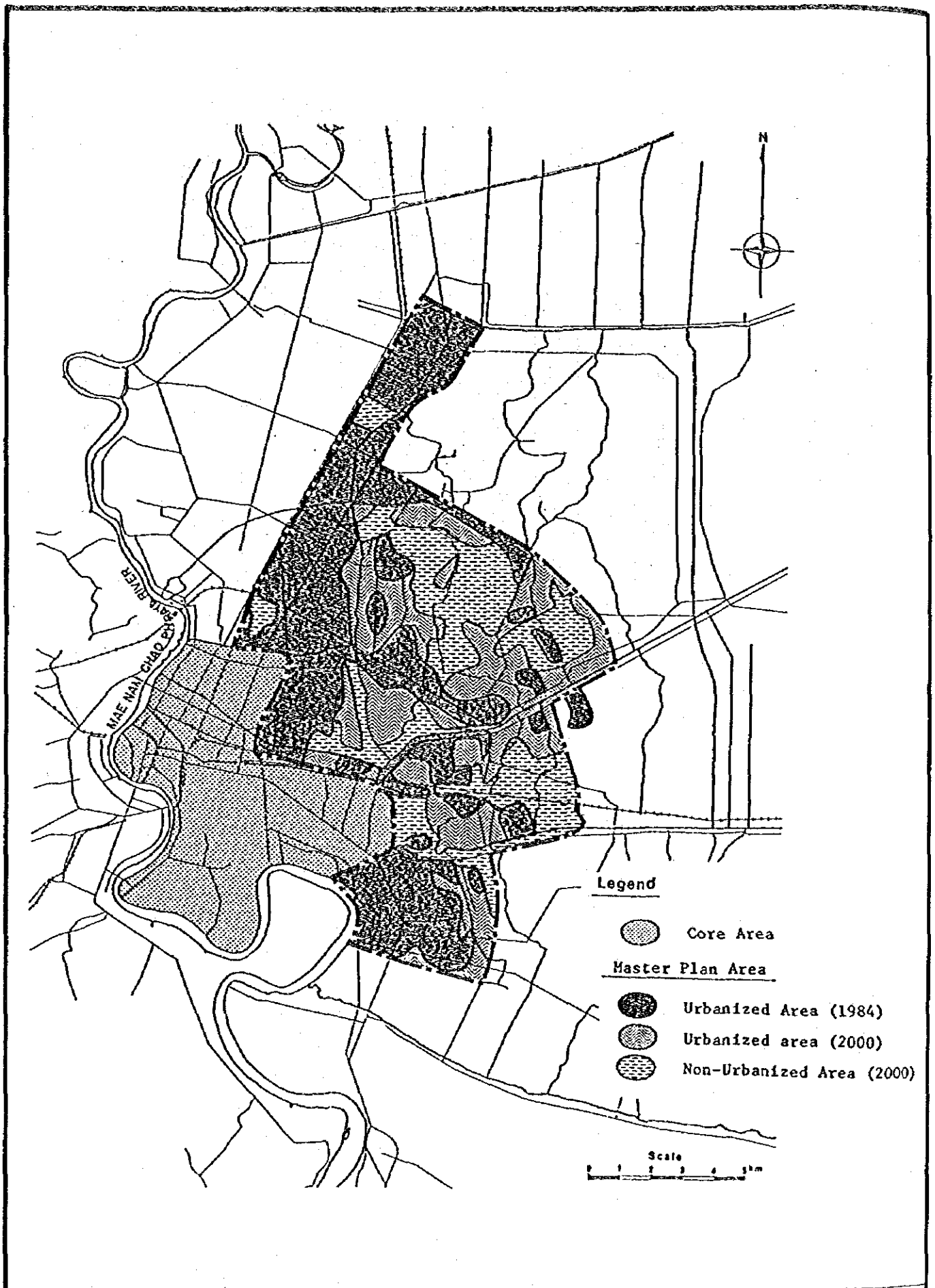


図 6. 6

浸水危険度を考慮した土地利用計画

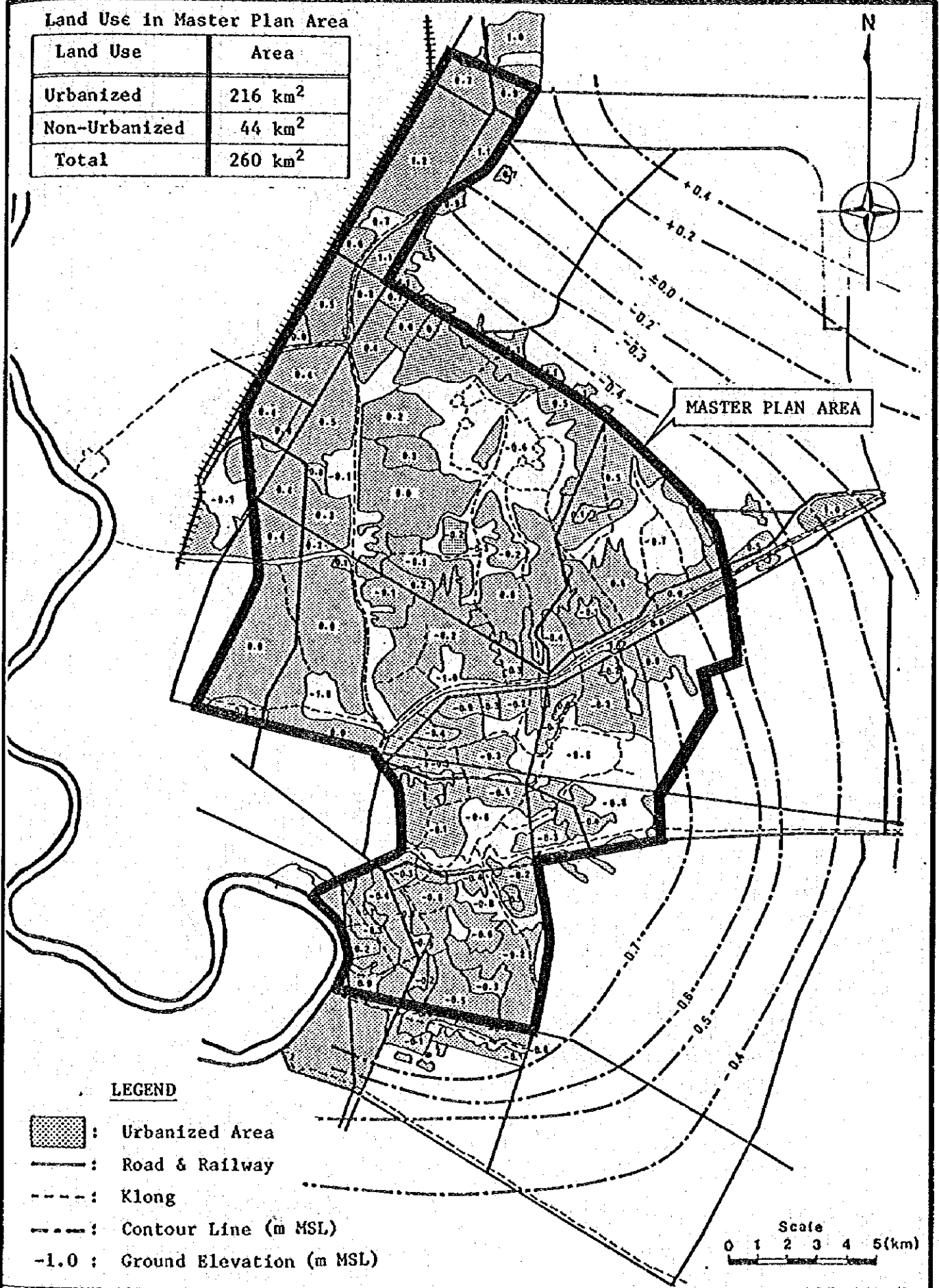
MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

第7章

図7.1	盛土を考慮した市街地推定地盤高(2000年)	33
図7.2	計画排水区	34
図7.3	計画施設(堤防及び水門)	35
図7.4	遊水地及びクローンの雨水貯留量とポンプ排水量の関係	36
図7.5	クローンの推算最大流量	37
図7.6	計画施設(ポンプ場)	38
図7.7	計画施設(クローン)	39
図7.8	主クローンの改修計画(Saen Saep, Tan クローン)	40
図7.9	主クローンの改修計画(Phra Khanong クローン)	41
図7.10	全体事業計画施設一般図	42
図7.11	計画施設による水理的効果	43

Land Use in Master Plan Area

Land Use	Area
Urbanized	216 km ²
Non-Urbanized	44 km ²
Total	260 km ²



LEGEND





-  : Urbanized Area
-  : Road & Railway
-  : Klong
-  : Contour Line (m MSL)
- 1.0 : Ground Elevation (m MSL)

図 7.1

盛土を考慮した市街地推定地盤高 (2000年)

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

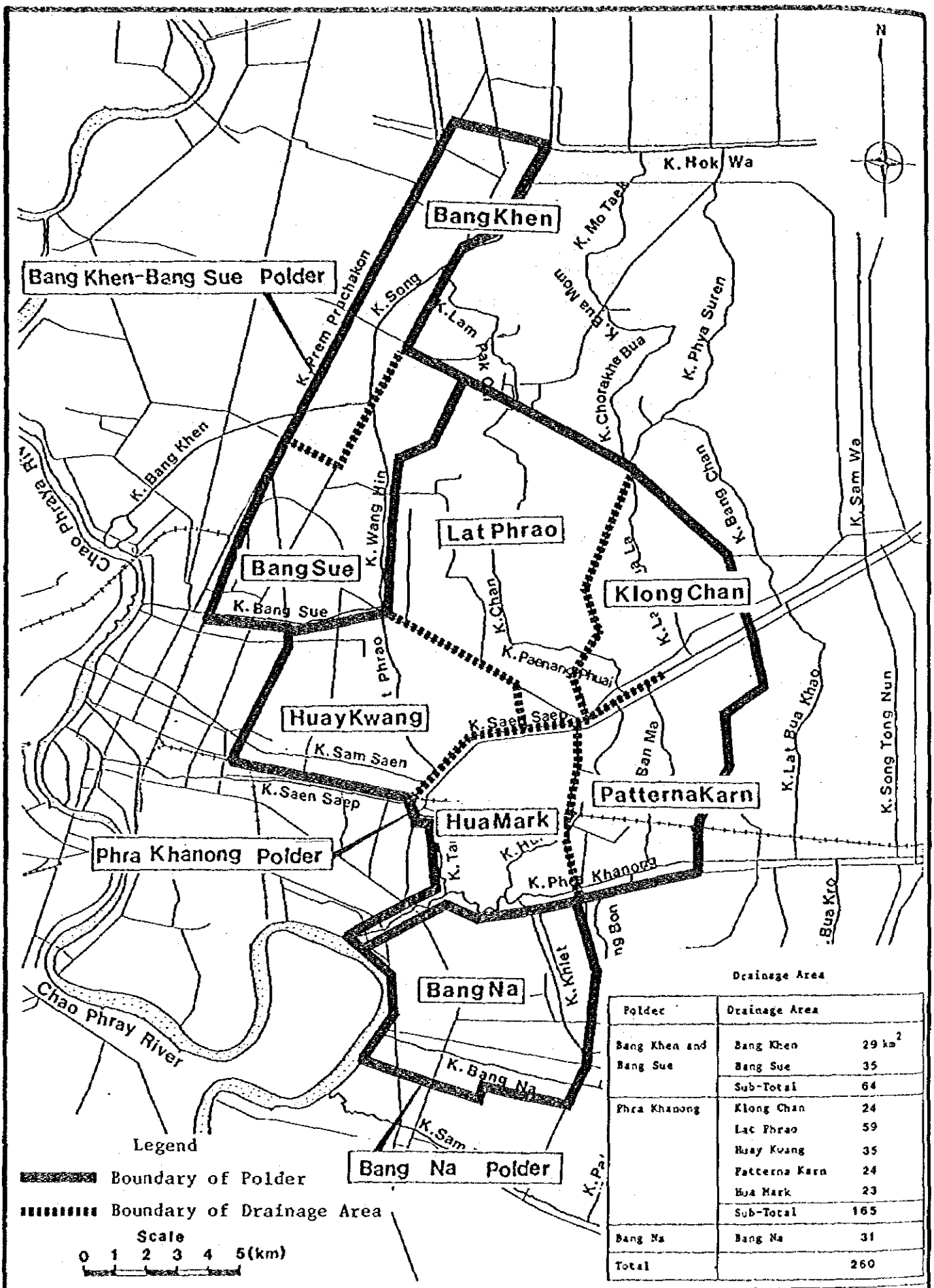
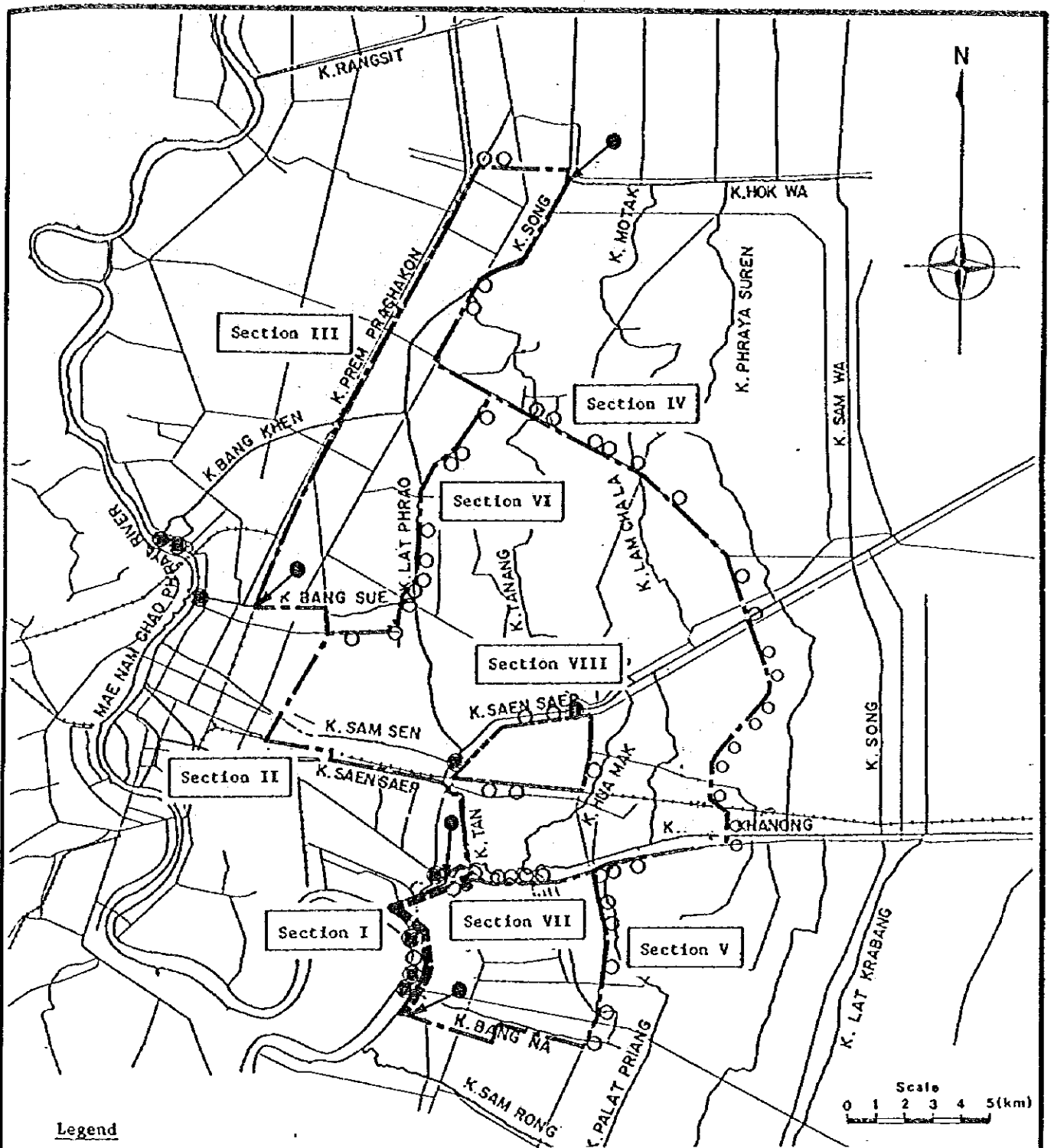


図 7. 2

計画排水区

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK



Legend

- Barrier to be newly constructed
- Barrier utilizing existing road & railway
- Gate
- Pumping Station with Gate

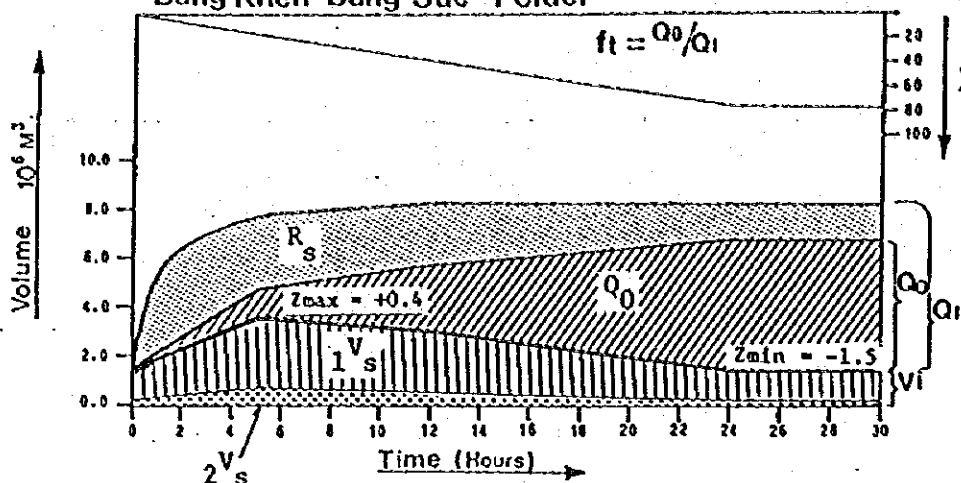
Note: The barrier alignment (---),utilizing the existing road is adopted for part of section V,instead of the originally studied alignment (---) running on the future extension of the Outer Ring Road.

Section	Barrier		Total Length
	Exist. Road/Railway	To be Constructed	
I	- km	6.2 km	6.2 km
II	19.4	-	19.4
III	20.9	-	20.9
IV	26.4	-	26.4
V	23.6	-	23.6
VI	12.1	-	12.1
VII	5.6	-	5.6
VIII	13.0	-	13.0
Total	114.5 km	6.2 km	121.0 km

図 7. 3 計画施設 (堤防及び水門)

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

Bang Khen Bang Sue Polder

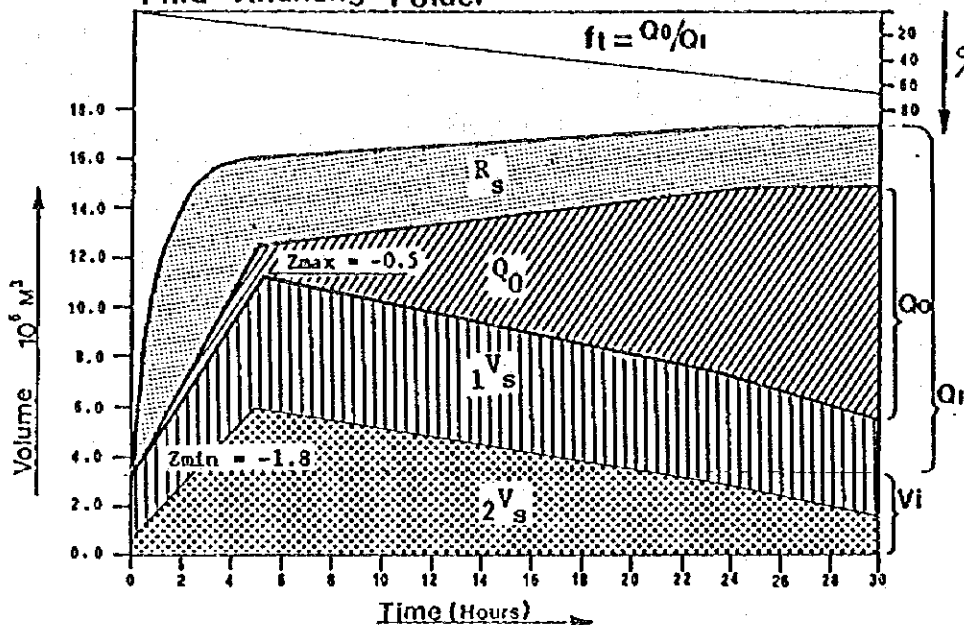


Polder Area = $64 + 29 = 93 \text{ km}^2$
 Design Rainfall
 2year Freq.
 $R_{24}^2 = 91 \text{ mm/day}$
 A.R.F = 0.78

Pump Capacity
 Bangkhen P/S = 15CMS
 Bang Sue P/S = 50CMS
 Total = 65CMS

* Additional area between Chao Phraya R. and Super Highway.

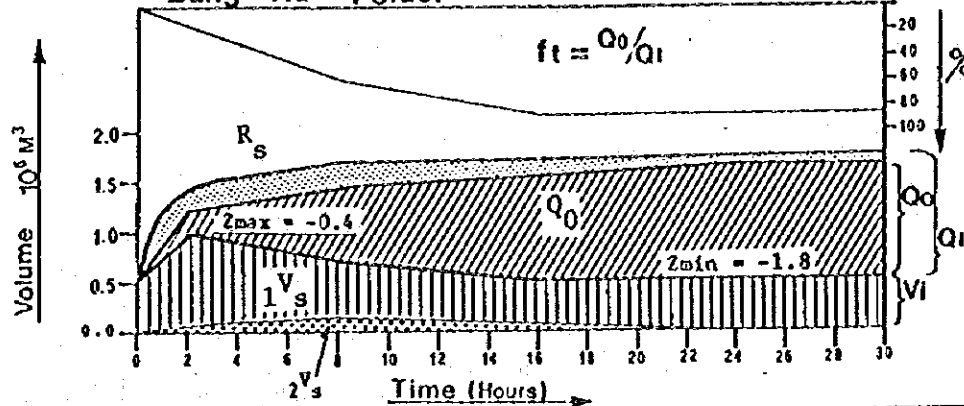
Phra Khanong Polder



Polder Area = 165 km^2
 Design Rainfall
 5year Freq.
 $R_{24}^5 = 120 \text{ mm/day}$
 A.R.F = 0.68

Pump Capacity
 Phra Khanong P/S = 90CMS
 (Inner Polder Pump Capacity)
 North Hua Mark
 K.Gig P/S = 3CMS
 K.Kacha P/S = 6CMS

Bang Na Polder



Polder Area = 31 km^2
 Design Rainfall
 2year Freq.
 $R_{24}^2 = 91 \text{ mm/day}$
 A.R.F = 0.84

Pump Capacity
 Bang Jek P/S = 6CMS
 Bang Oa P/S = 18CMS
 Bang Na P/S = 21CMS
 Bang Na Chine P/S = 9CMS
 Total = 54CMS

Legend Q_1 : Accumulated Rainfall $1V_s$: Storage in klongs
 Q_0 : Accumulated Discharge $2V_s$: Storage in Retention Area
 V_1 : Initial Storage Volume Z_{max} : Average Maximum Water Level
 R_s : Ground Surface Storage Z_{min} : Maintenance Water Level

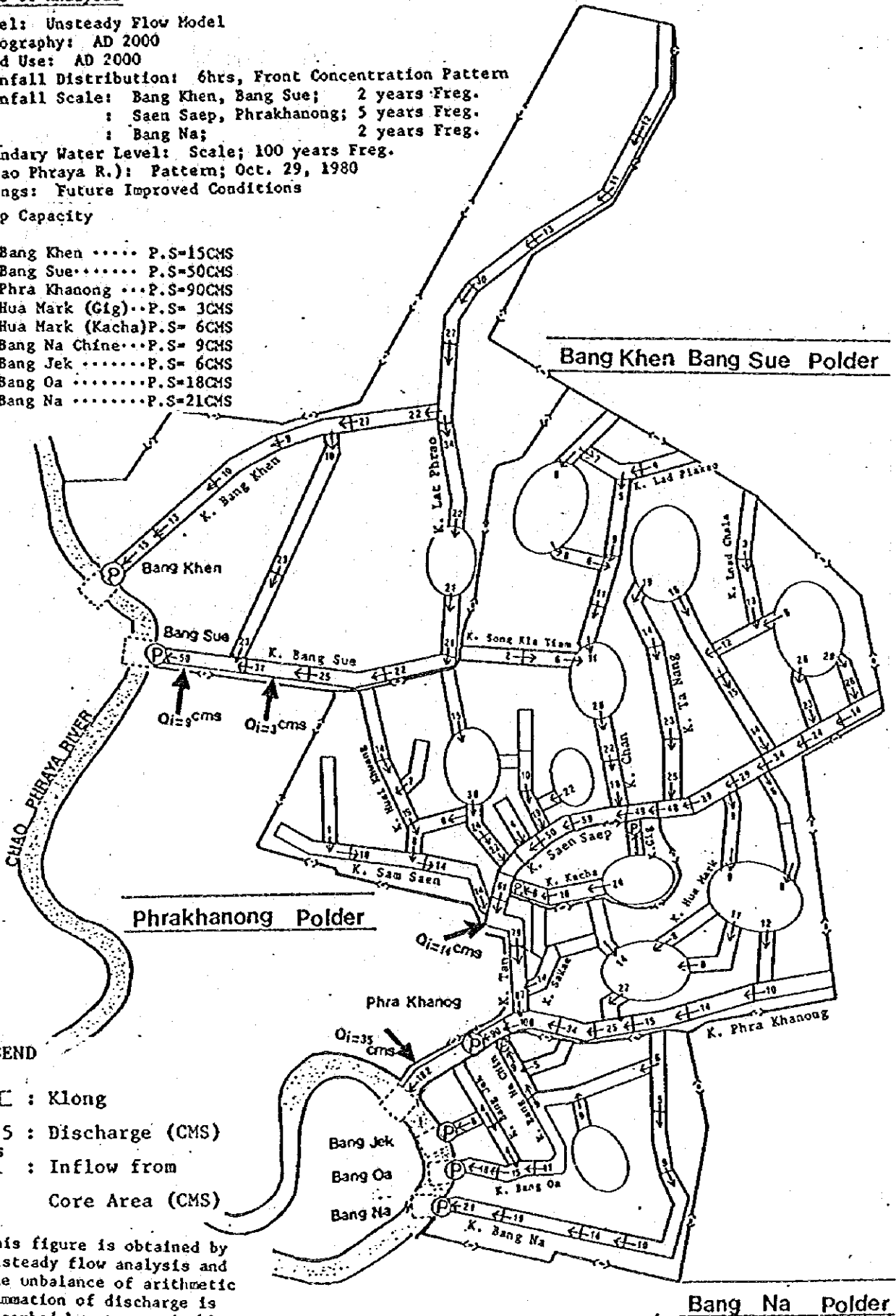
図 7. 4

遊水地及びクローンの雨水貯留量とポンプ排水量の関係

Conditions of Analysis

- 1) Model: Unsteady Flow Model
- 2) Topography: AD 2000
- 3) Land Use: AD 2000
- 4) Rainfall Distribution: 6hrs, Front Concentration Pattern
- 5) Rainfall Scale: Bang Khen, Bang Sue; 2 years Freq.
: Saen Saep, Phrakhanong; 5 years Freq.
: Bang Na; 2 years Freq.
- 6) Boundary Water Level: Scale; 100 years Freq.
(Chao Phraya R.): Pattern; Oct. 29, 1980
- 7) Klongs: Future Improved Conditions
- 8) Pump Capacity

Bang Khen P.S=15CMS
 Bang Sue..... P.S=50CMS
 Phra Khanong ...P.S=90CMS
 Hua Mark (Gig)..P.S= 3CMS
 Hua Mark (Kacha)P.S= 6CMS
 Bang Na Chine...P.S= 9CMS
 Bang JekP.S= 6CMS
 Bang OaP.S=18CMS
 Bang NaP.S=21CMS



LEGEND

- : Klong
- : Discharge (CMS)
- : Inflow from Core Area (CMS)

Note: This figure is obtained by unsteady flow analysis and the unbalance of arithmetic summation of discharge is absorbed by storage in klongs.

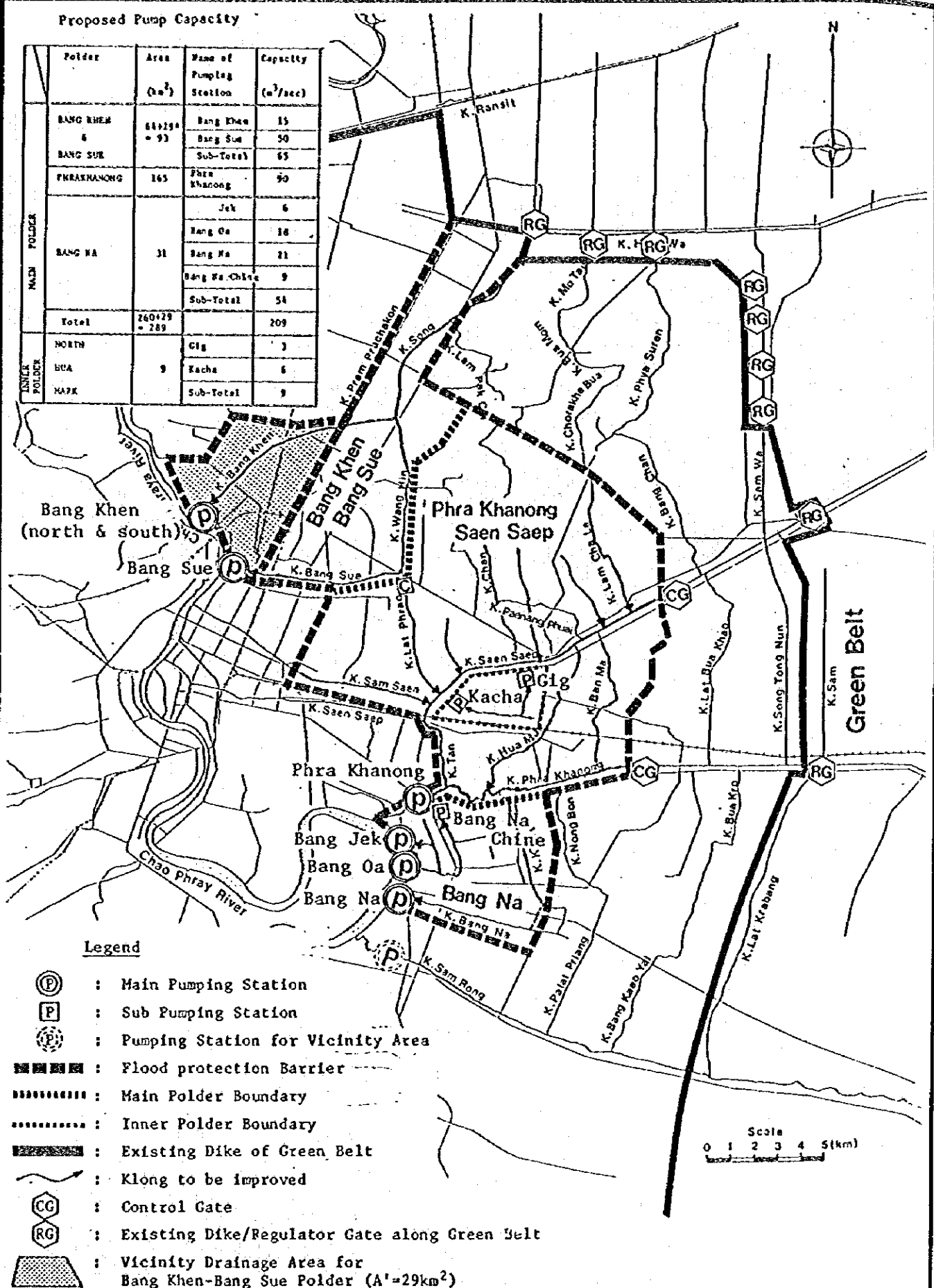
図 7. 5

クローンの推算最大流量

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

Proposed Pump Capacity

Folder	Area (km ²)	Name of Pumping Station	Capacity (m ³ /sec)
BANG KHEN & BANG SUE	64.29 = 93	Bang Khen	15
		Bang Sue	50
		Sub-Total	65
PHRA KHANONG	165	Phra Khanong	90
BANG NA	31	Jek	6
		Bang Oa	18
		Bang Na	21
		Bang Na-Chine	9
		Sub-Total	54
Total	260.29 = 289		209
NORTH BUA MAEK	9	Gig	3
		Kacha	6
		Sub-Total	9








Legend

- (P) : Main Pumping Station
- (P) : Sub Pumping Station
- (P) : Pumping Station for Vicinity Area
- ▬▬▬▬▬▬ : Flood protection Barrier
- ▬▬▬▬▬▬▬▬ : Main Polder Boundary
- ▬▬▬▬▬▬▬▬▬ : Inner Polder Boundary
- ▬▬▬▬▬▬▬▬▬ : Existing Dike of Green Belt
- ▬▬▬▬▬▬▬▬▬▬ : Klong to be improved
- CG : Control Gate
- RG : Existing Dike/Regulator Gate along Green Belt
- ▬▬▬▬▬▬▬▬▬▬ : Vicinity Drainage Area for Bang Khen-Bang Sue Polder (A'=29km²)





Scale
0 1 2 3 4 5(km)

図 7. 6 計画施設 (ポンプ場)

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

-  **Category I** = new drain (7 km)
 -  **Category II** = deepening and widening + construction of retaining walls (9 km)
 -  **Category III** = deepening + construction of retaining walls (63 km)
 -  **Category IV** = no improvement (II, 39 km) or dredging (I, 20 km)
 -  **Category V** = deepening + widening (34 km)
- Total Klong Improvement Length = 233 km

Legend

-  : Proposed Pumping Station
-  : Klong
-  : Retention Area
-  : Boundary of Drainage Area

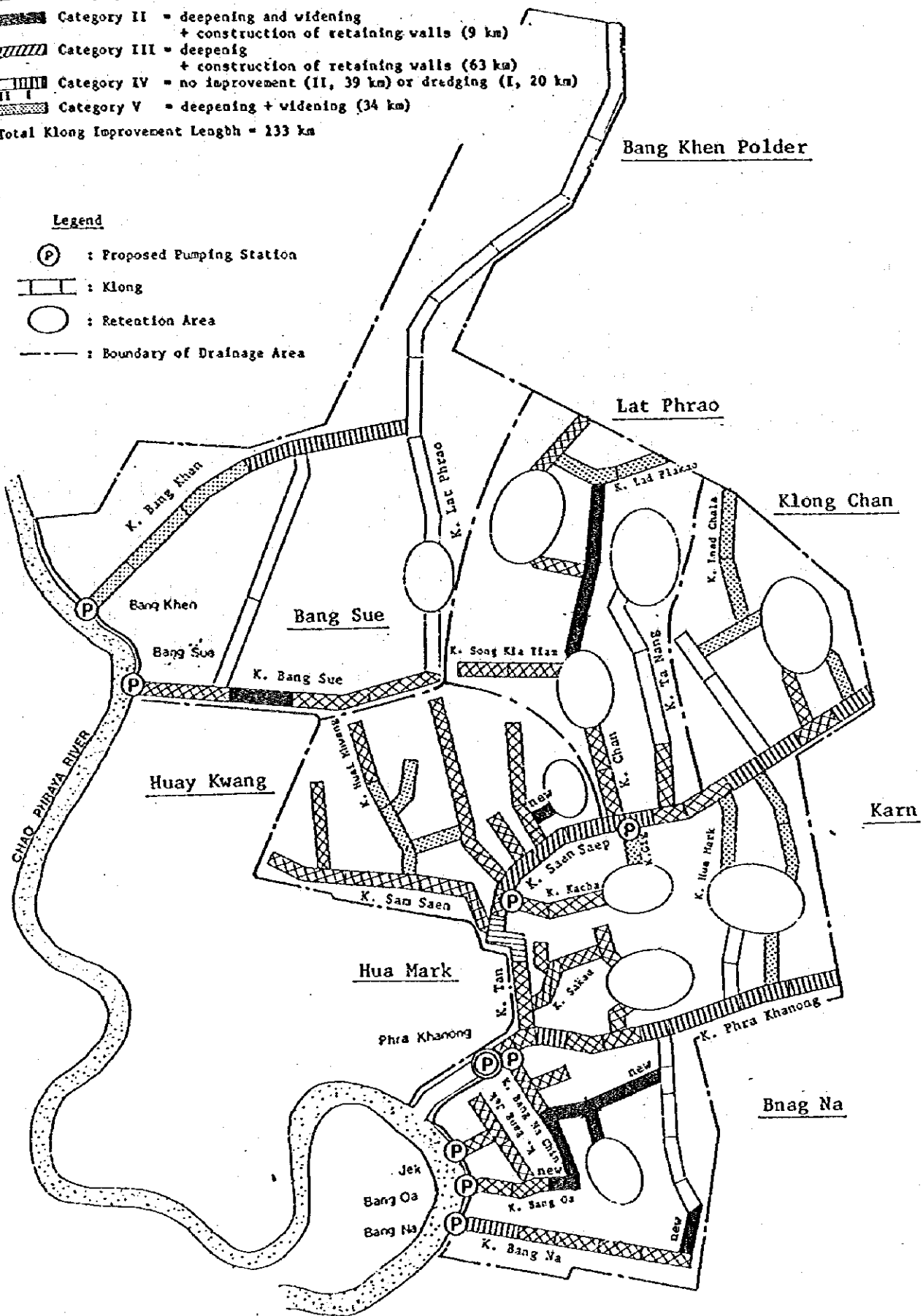


図 7. 7

計画施設 (クローン)

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

KLONG SAEN SAEF

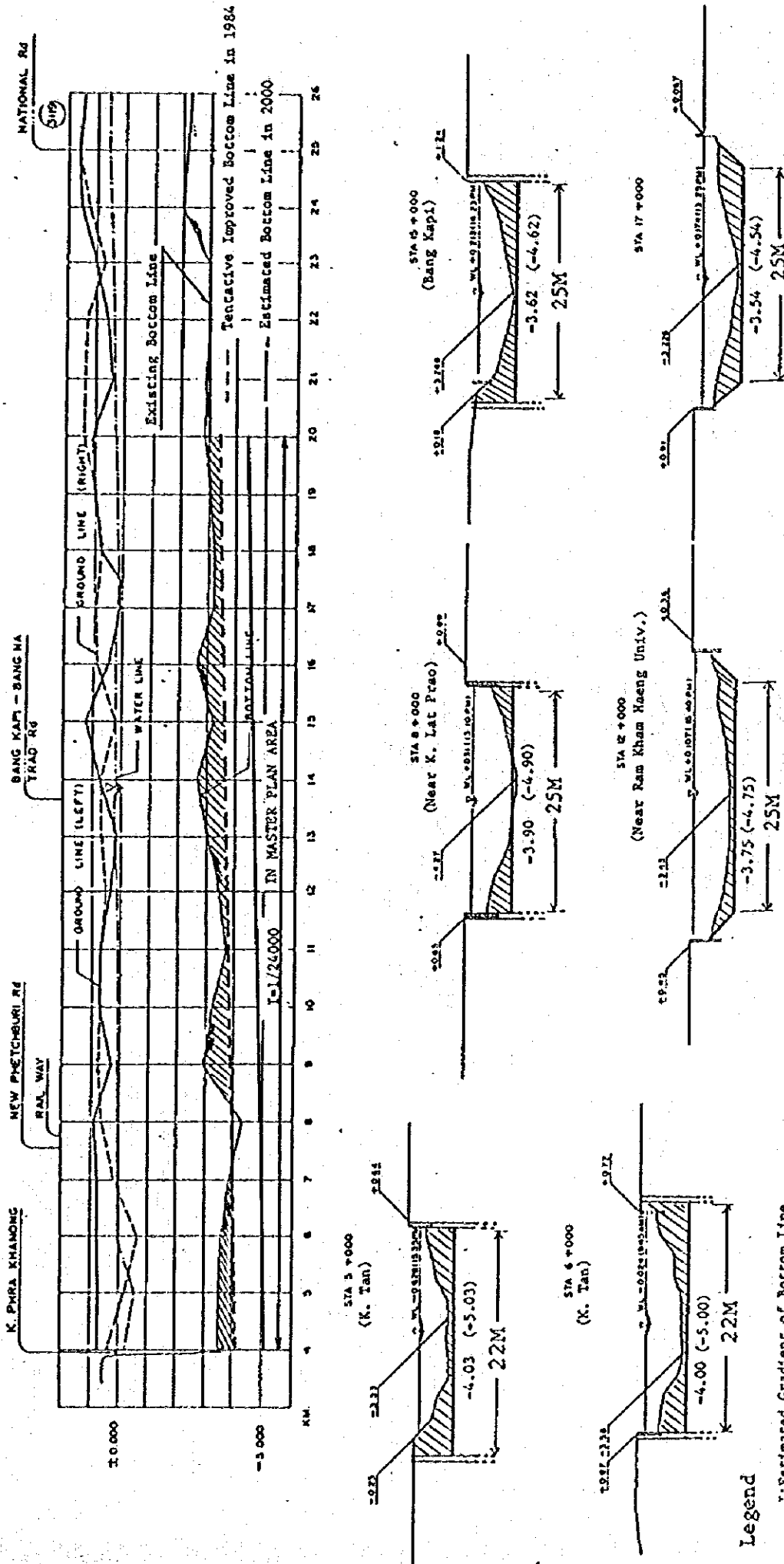


図 7.8 主クローンの改修計画 (Saen Saep, Tan クローン)

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

- Legend
- 1: Estimated Gradient of Bottom Line
 - 3.8 : Elevation of Tentative Improved Bottom in 1984
 - (-4.8) : Elevation of Estimated Bottom in 2000
 - ▨ : Proposed Dredging Area

KLONG PHRA KHANONG

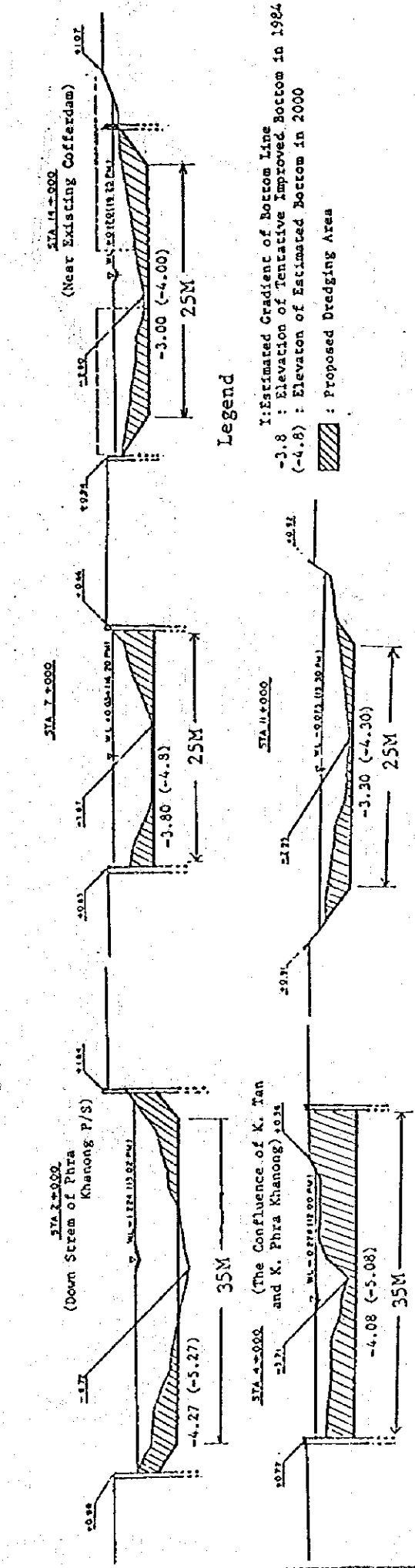
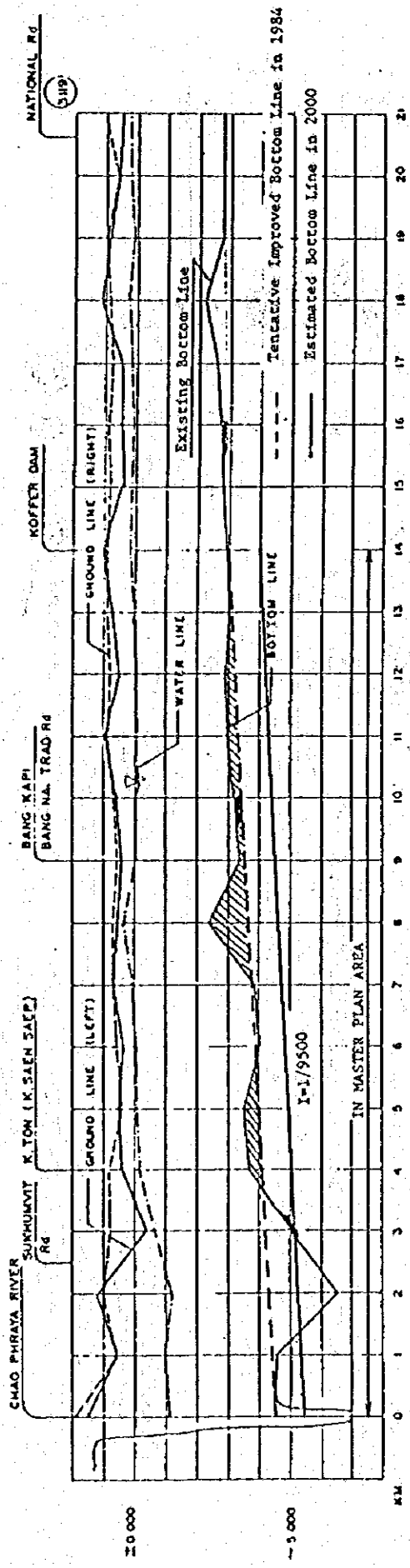


図 7.9 主クローンの改修計画 (Phra Khanong クローン)

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

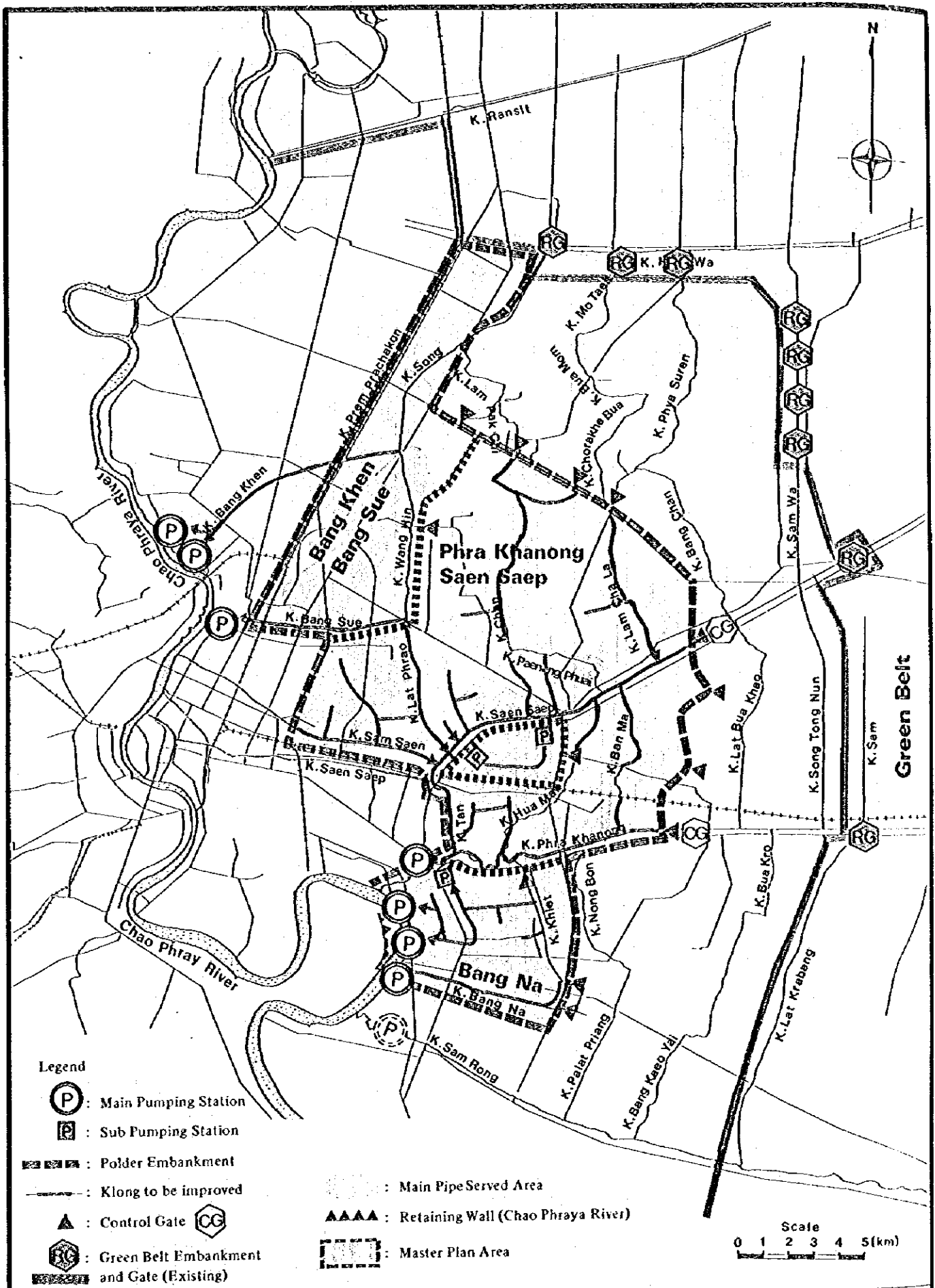
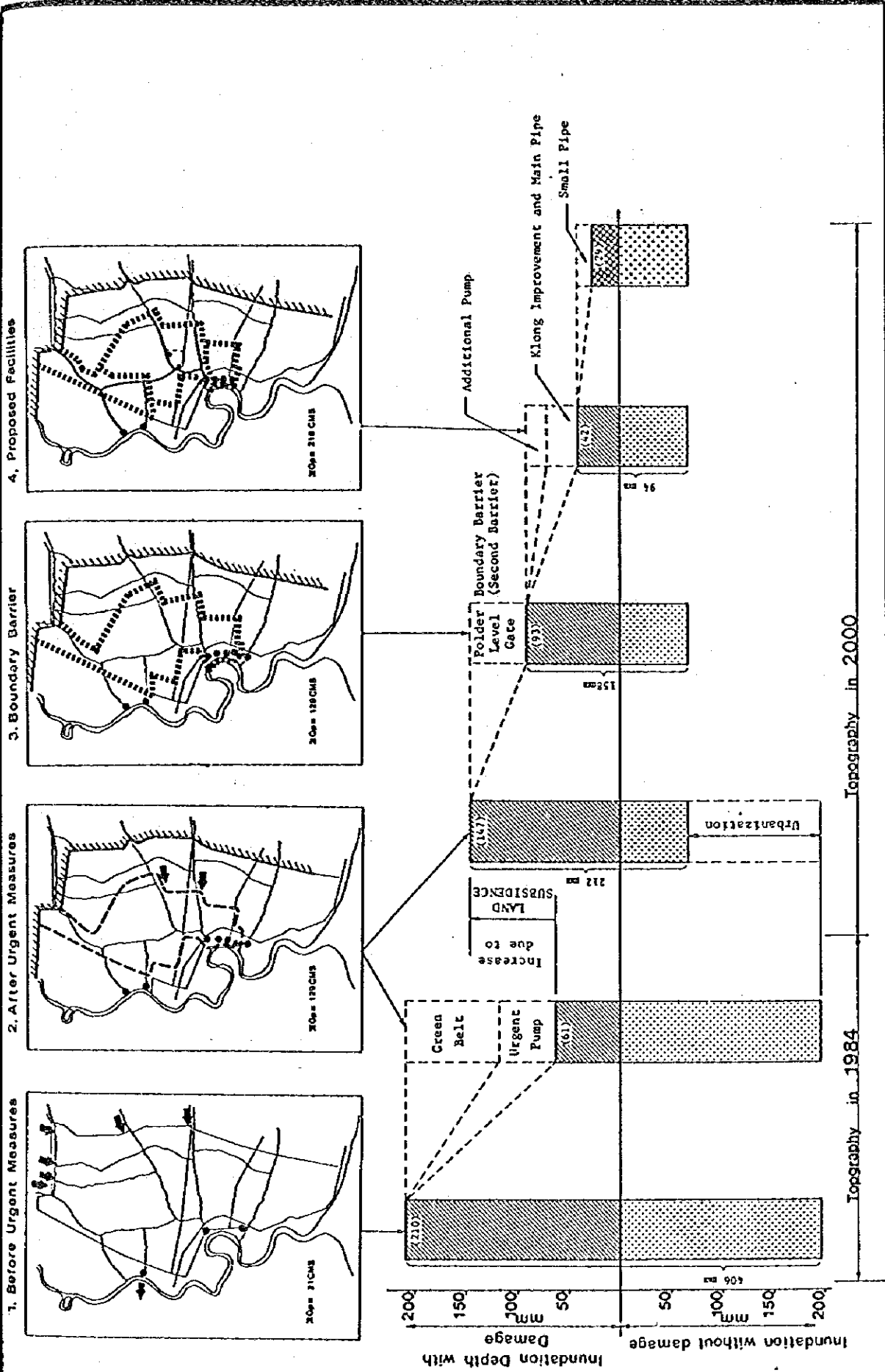


図 7.10

全体事業計画施設一般図

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK



Note: Hydraulic effect is calculated for 5-year frequency rainfall.

図 7.11 計画施設による水理的效果

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

