タ イ 国

首都圏周辺市街地区
水道拡張計画調査

METROPOLITAN
WATER WORKS
AUTHORITY

プログレス レポート

1977年3月

国 際 協 力 事 業 団

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1－1　まえがき

バンコク首都圏周辺水道についての多角的な考察は，１９７３年３月に日本の調査団によって行なわれていた。これは Separate System と称せられる地区，９ Amphoes のうち５ Amphoes（Nong Khaem，Bang Bua Thong，Sai Noi および Lat Krabang）を対象とした Feasibility Study であった。

今回の調査は，前回の調査に引続いて行なわれたもので，前回と同様，国際協力事業団によって行なわれた。

本調査は，１９７７年１月２３日にバンコク入りしてより，１９７７年３月２６日に至る現地滞在期間６３日間，１２名の調査員がこれにあたった。

今回の調査の目的および内容はつぎのとおりである。

１）前回調査の５ Amphoes の見直しを含めて，首都圏周辺地区全域の９ Amphoes に拡げて Feasibility 調査をすること。

即ち，９ Amphoes とは

(1)　Chao Phraya River 右岸地域

北３地区：Sai Noi，Bang Bua Thong，Bang Yai，
Nong Khaem 地区
の４ Amphoes

(2)　Chao Phraya River 左岸地域

東３地区：Nong Chok，Min Buri，Lat Krabang

南２地区：Bang Phli，Bang Bo
の５ Amphoes

である。

2）前回調査以後にタイ国において計画されつゝある，関連地区の開発を考慮した調査

3）水源調査として地下水及びKhlong並びに河川よりの利用可能調査

即ち，9 Amphoesの水道計画に当って，Separate Systemとしての最大の問題点は水源対策であった。

現在，首都圏における地下水の汲み上げは，既存のもので水道用約350,000m^3／日，民間用約400,000m^3／日といわれ，またCentral Systemにおいても更に新設の深井戸が予定されている。

一方，無規制な地下水の汲み上げによる地盤沈下，塩害化は益々拡大するであろうし，このまゝ放置すれば首都圏全域に何らかの障害が起るであろう。既に一部にはそれが散見せられている所である。

またSeparate Systemの水源としては，表流水を考慮したとき，まずChao Phraya RiverとNakorn Chai Si River等の大河川がその対象となるわけであるが，Separate Systemの規模，位置からして，今直ちにこの大河川にすべての水源を求めることは経済的に成り立たず，実施可能な案とは考えられない。

しかし，Central Systemの将来計画との関連においてSeparate Systemを論ずるならば，Chao Phraya Riverのみに水源を依存する現有のCentral System計画は見直されて，Chao Phraya River以外の大河川も含めた複水源とすべきことも大切である。

即ち，Separate Systemを含めた広域水道としてBangkokの上水道全体を考えた更に長期的な構想も必要となるであろう。

しかし今回のSeparate Systemの取水方法については，地下水を出来るだけ求めたいものであるが，その水量には限界があるので，これと表流水

との複合的な組合せも考えられた。特に今回は作業途中において，工業団地計画と大規模住宅団地および新空港計画案などが提言せられてからは，経済的観点も含めてFeasibleな案の決定は相当な配慮を要することとなった。

現在時点で計画される２０００年の９Amphoesのみの上水道需要量は総計７７,７５０m³／日で，これ以外の工業団地，住宅団地，新空港のそれは１７１,７５０m³／日と大きく見込まれたのである。

よって地下水の利用は，基本的には各Amphoesの住民用飲料水のみに当てることは大方可能であろうが，たゞし既にBangkok市内およびその周辺で地盤沈下が生じているなかで，本計画のために更に地下水を揚水するということは，中心部への地下水の補給を減少せしめることとなろう。そこで今後は，Bangkok中心部における無制限な井戸の掘削は問題になろうし，また本計画に見込まれる井戸は適正な配置と管理が望まれるものである。

1－2　Central System と Separate System との関連について

さきに述べた如く，各団地計画の給水が本計画の中へ入れられるように提言されてから以，特に Separate System を独立して考えるよりは，Central System との関連により位置づけすることも得策であろうと考えられた。

それでこれの検討も加えることとし，Central System の近接配水池より，直接 Separate System の需要区域へ送水することも考えた。

今，この場合 Central System にもし設計上の余裕が認められたなら以，この案以 Feasible なものとして当然浮び上るであろう。しかし，現在以 Central System の First Stage 工事の First Phase が着工済であり，Second Phase の実施設計も完了しているので，First Stage の設計内容にまで立入って Central System の見直しをすることは困難である。

したがって，Separate System の Feasibility Study を行うにあたっての Central System の見直しは，Second Stage 以降の内容に限定される。

これらの作業の中で Second Stage の内容に相当の影響がでる時以，これらの問題も含めて別途の対タイ技術協力にゆだねなければならない。

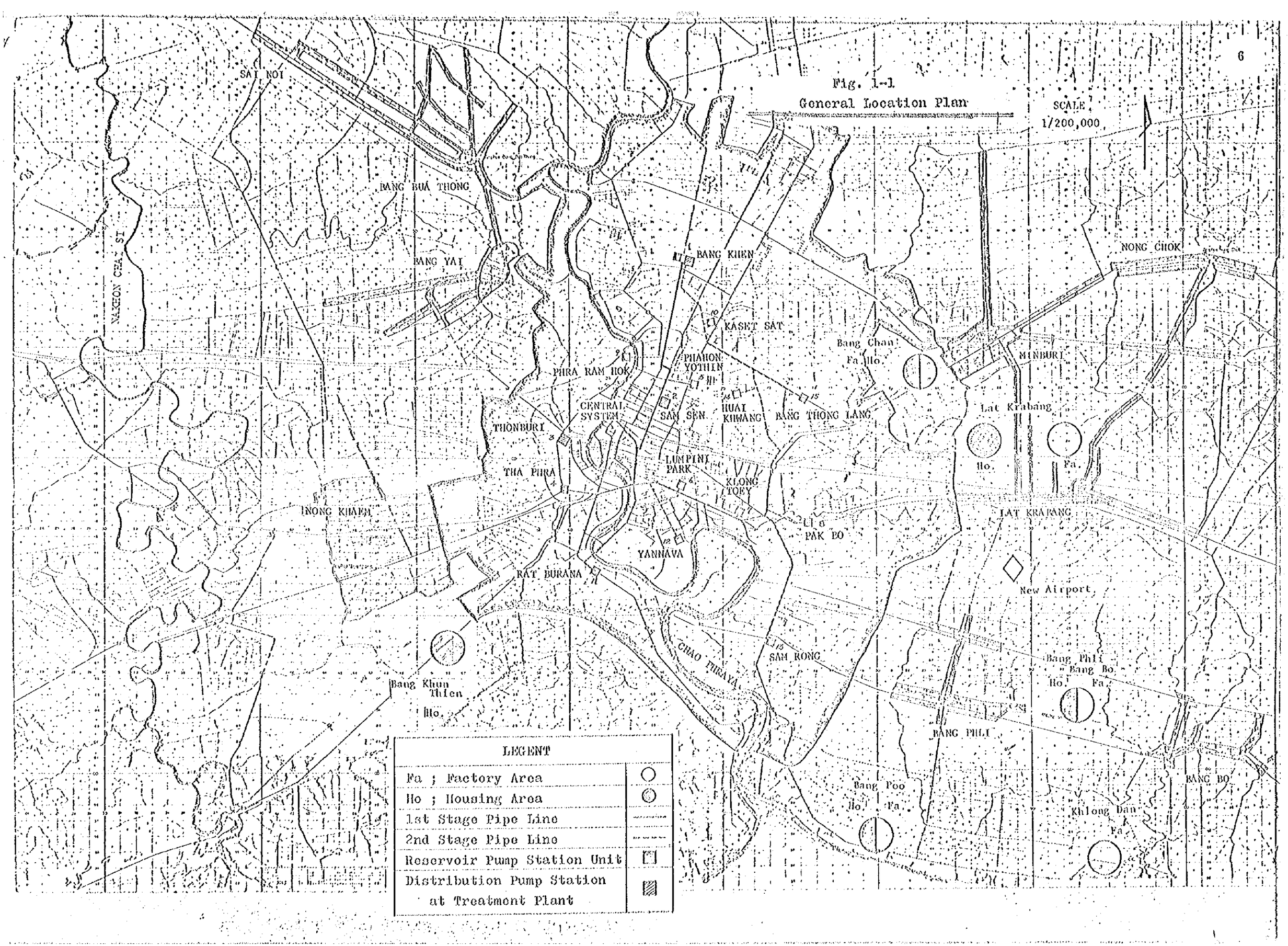
現在の時点で，Second Stage の送水管をそのまゝ利用するとした時以一部送水管に不適当と思われる部分が生じこの部分以送水管の口径を変更するか，又以 Separate System の区域への単独送水管を別個に設けなければならない。

各給水地区の位置以図１－１に示すとおりである。

Fig. 1-1

General Location Plan

SCALE 1/200,000



LEGENT	
Fa ; Factory Area	○
Ho ; Housing Area	◎
1st Stage Pipe Line	———
2nd Stage Pipe Line	- - - -
Reservoir Pump Station Unit	□
Distribution Pump Station at Treatment Plant	▨

1－3　緊急工事の考え方

各 Amphoe の計画を樹立するに当って は，基本的にまず２０００年の水需要を予測し，これに対応する水道計画を作成した。工事は需要に合わせて２期から４期に分けて施工するように考慮したが，とりあえず現状を回復するに必要なものを緊急工事として第１期工事とみなした。

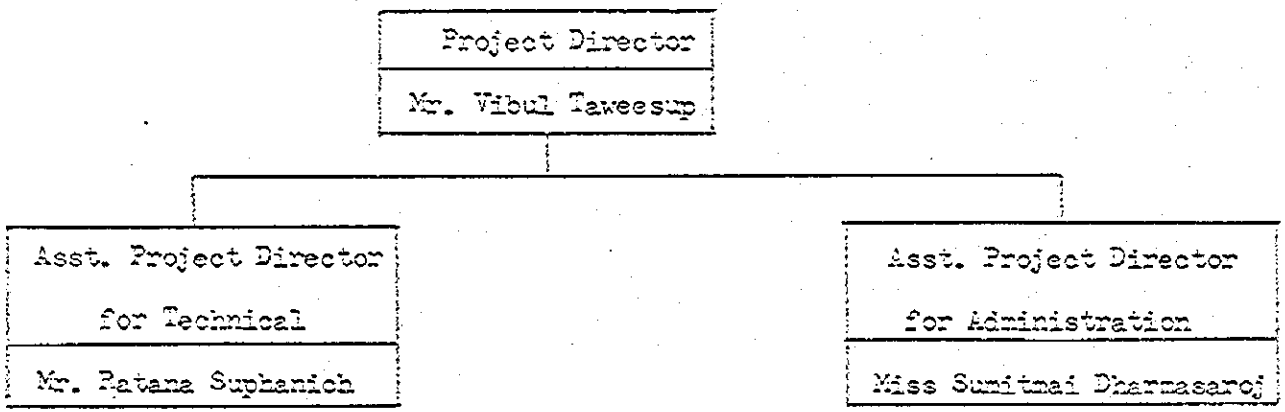
第１期工事としては Amphoe Town を中心とした人口稠密な区域にのみ限定し，順次配水管の延長を図りつゝ，他の施設の拡張を段階的に行うよう配慮した。

1-4 本業務を遂行したTeamについて

JAPANESE SURVEY TEAM FOR THE SEPARATE SYSTEM OF METROPOLITAN WATER SUPPLY WORKS

Dr. S. Naito	Technical Adviser	Japan Water Works Association (Chairman of the Mission)
Mr. K. Okazawa	Technical Adviser	Ministry of Health & Welfare (Vice-chairman of the Mission)
Mr. K. Shiozawa	Director	Nakanihon Engineering Consultants Co., Ltd. (General Planning)
Mr. K. Kawamura	Head	Nakanihon Engineering Consultants Co., Ltd. (Water Supply Planning Economics)
Mr. N. Muto	Staff	Pacific Consultants International (Ground Water)
Mr. T. Ogawa	Staff	Pacific Consultants International (Ground Water)
Mr. S. Komatsu	Staff	Pacific Consultants International (Intake & Treatment)
Mr. E. Kawabata	Staff	Pacific Consultants International (City Planning)
Mr. Y. Nakamura	Staff	Nakanihon Engineering Co., Ltd. (Intake & Treatment)
Mr. K. Miyakura	Staff	Pacific Consultants International (Water Supply Planning)
Mr. Y. Hashizi	Staff	Nakanihon Engineering Co., Ltd. (Distribution System)
Mr. H. Takemoto	Staff	Pacific Consultants International (Distribution System)

ORGANIZATION CHART OF SEPARATE WATER SUPPLY SYSTEM IN MWA



Mr. Borirak Tasanon	:	Engineer
Mr. Prasart Silphiphat	:	Engineer
Mr. Warawuth Wongwisej	:	Engineer
Miss Thidachan Chaiyapruk	:	Economist

Mrs. Boonruang Khwanboon	:	Clerk
Mr. Damrong Hase	:	Driver
Mr. Sanong Poothong	:	Driver
Mr. Pratheep Songphsook	:	Driver
Mr. Nate Sheiwka	:	Driver

1－5　現地調査における行程の経過

調査開始に当り本Teamをつぎのような Party に組み，作業の進行に合わせて適宜組合せを流動させつゝ行った。

Party 1. Electrical Prospecting

Party 2. Data Collection on Water Resources

Party 3. Planning of Water Supply Systems

Party 4. Economic Analysis & Financial Program

これらのTeamの行程経過をまとめて整理したものがつぎの表である。

月 日	曜日	行　　程	調　査　内　容
1. 23	日	羽田→バンコクL日便	内藤，岡沢，他2名渡タイ
1. 24	月		大便館JICA. MWWAを表敬訪問
1. 25	火		MWWAと打合せ（S.Wについても）
1. 26	水	羽田→バンコク JAL717便	調査団員8名渡タイ S.Wについての打合せ
1. 27	木		作業の下準備と全体会議
1. 28	金		MWWAと打合せ 左岸地区Bang Phli, Bang Bo地区 視察（既設水道施設及び水源）
1. 29	土		資料の整理，地図の複製
1. 30	日		同　　上
1. 31	月		左岸地区Min. Buri, Nong Chok, Lat Krabang地区視察 （既設水道施設及び水源）
2. 1	火		右岸地区Nong Khaem, 地区視察 （既設水道施設及び水源）
2. 2	水		右岸地区Bang Yai, Bang Bva Thong, Sai Noi地区視察 （既設水道施設及び水源）
2. 3	木		作業計画書の作成 全体会議（作業進行計画について）

月日	曜日	行程	調査内容
2. 4	金		MWWAと打合せ （作業進行計画と日程について）
2. 5	土		現場調査の資料整理
2. 6	日	内藤，岡沢，塩沢，帰国	同上
2. 7	月		追加5地区について協議 Sai Noi地区現場調査 電探現場作業準備
2. 8	火		MWWAと追加5地区について協議 Lat Krabang地区電探調査
2. 9	水		水質調査の準備 Bang Bua Thong地区現場調査 電探調査及び地下水資料収集
2. 10	木		Industrial Estate Authority & National Housing Authority と打合せ Bang Khun Thian 地区現場調査 右岸地区の内業 電探調査及び地下水資料収集
2. 11	金		Khlong Thawi Watthana の採水 Bang Khun Thian 地区現場調査 右岸地区の内業 電探調査及び地下水資料収集
2. 12	土		作業日程打合せ及び資料の整理
2. 13	日		資料整理

月日	曜日	行程	調査内容
2. 14	月		Air Port Office を訪問，打合せ Bang Phli, Bang Bo 地区現場調査 右岸地区の内業 電探調査及び地下水解析
2. 15	火		Bang Phli, Bang Bo 地区水源調査 右岸地区の内業 電探調査及び地下水解析
2. 16	水		National Housing Authority と打合せ Industrial Estate Authority よりのデータ整理 電探調査及び地下水解析 （左岸地区電探調査完了）
2. 17	木		水質調査工程表作成 Min Buri Nong Chok 地区水源調査 左岸地区の内業 電探調査の資料整理及び地下水解析
2. 18	金		Lat Krabang 地区水源調査 左岸地区の内業 電探調査の資料整理及び地下水解析
2. 19	土		下図の作成及び単価表の作成
2. 20	日		同　上
2. 21	月		9 地区及び追加 5 地区の内業 電探調査結果の整理及び地下水解析

月日	曜日	行程	調査内容
2. 22	火		地下水について協議 MWWAと打合せ 資料解析及び計画概略案の検討
2. 23	水		資料の整理，解析，水理計画 北3地区の電探調査準備
2. 24	木		資料整理 北3地区の電探調査及び地下水資料収集
2. 25	金		MWWAと打合せ 北3地区の電探調査 （右岸地区電探調査完了）
2. 26	土		資料の分析，計画案下図の作成，単価表作成
2. 27	日	地下水調査員2名帰国	同上
2. 28	月		計画案の検討，採水業務の準備
3. 1	火		計画案の検討 採水，分析についてサムセン浄水場担当者と打合せ
3. 2	水		計画案作成 Nakhon Chai Si Riverの採水
3. 3	木		計画案作成 Khlong Mae Nam Om及び井戸の採水
3. 4	金		計画案作成

月日	曜日	行程	調査内容
3. 5	土		水質試料，その他資料整理及び打合せ
3. 6	日		同上
3. 7	月		計画案の作成
3. 8	火		計画案の作成 ChaoPhraya Riverの採水
3. 9	水		Nakhon Chai Si Riverの採水 Progress Reportの作成
3. 10	木		現況道路調査 東3地区のKhlong及び井戸の採水 Progress Reportの作成
3. 11	金		現況道路調査 南2地区のKhlong及び井戸の採水 Progress Reportの作成
3. 12	土		図面作成及び資料整理
3. 13	日	羽田→バンコク 内藤，岡沢，塩沢，渡タイ	同上
3. 14	月		JICA及びMWWA訪問 Progress Reportの作成
3. 15	火		P.W.D.及びDTEC訪問 Progress Reportの作成
3. 16	水		Progress Reportのまとめ 英文翻訳

月日	曜日	行程	調査内容
3. 17	木		Rrogress Reportのまとめ 英文翻訳
3. 18	金		英文タイプ作業 挿入図，同表の作図
3. 19	土		同上
3. 20	日		図面作成
3. 21	月		英文タイプ作業 Progress Reportのまとめと照査
3. 22	火		MWWAと概略説明会議 Progress Reportの原稿整理と照査
3. 23	水		Progress Reportのコピー，製本 MWWAに対する説明図面作成
3. 24	木		MWWAと最終討議及び説明会議 （総裁以下関係者全員出席）
3. 25	金		帰国挨拶（大使館．JICA．MWWA）
3. 26	土	バンコク→東京 JAL466便にて帰国	

第 2 章　水需要の調査と解析

第 2 章　水需要の調査と解析

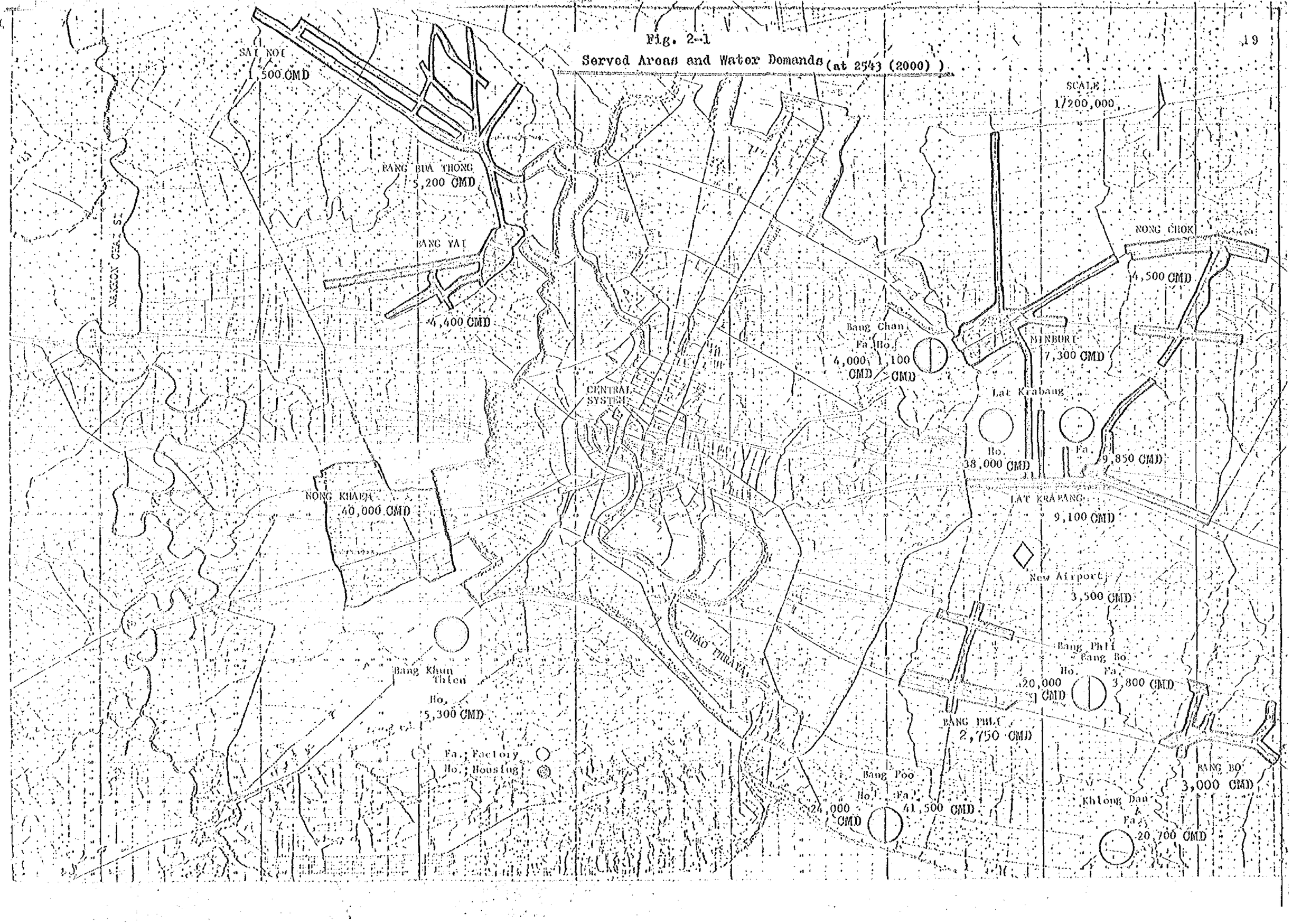
本調査の目的であるSeparate Systemを構成する首都圏周辺地区全域の9 Amphoesの水需要と，今回新たに首都圏水道公社より提言せられた工業団地，住宅団地および新空港等の追加地区の水需要の調査を行ったものである。

各地区の水需要量は，現地調査および資料収集を行ってSeparate System全体の２０００年における需要量を想定し，水源を含めた広域的水道計画立案の方策となる資料の作成を行った。

各給水地区の位置は図２－１に示すとおりである。

Fig. 2-1

Served Areas and Water Demands (at 2543 (2000))



2－1　各 Amphoe の水需要量

各 Amphoe の需要量は，前回調査（１９７３年）で 9 Amphoes について算出されていたが，今回再度，全地区の現地踏査を行い，前回の資料を基本として給水区域，給水人口，給水量の見直しを行って，各 Amphoe の基本数値を立てた。

1）給水区域の設定

給水区域の設定に当り，まず考えられることは，各 Amphoe の中に大小，縦横に走る Khlong があり，この Khlong を中心として人家が集中しているが，その範囲の決定はなかなか難しい。

給水区域の規模は，可能な限り広い地域を対象とするのであるが経済的な限界もあるので，前回の設定範囲を基として，現地踏査による現在の民家のはりつき状態と，各 Amphoe Town を通過している既設主要道路網の整備状況等による社会経済発展の可能性を想定して，将来の人口集中範囲を選定し給水区域を決定した。

各地区の給水区域は，図２－１に示してあるが，その面積は表２－１のように定める。

Table 2-3

Water Surved Area of 9 Amphoes

	Amphoe	Water Surved Area (Km^2)	Remarks
Right Bank	Sai Noi	6	
	Bang Bua Thong	18	
	Bang Yai	16	
	Nong Khaem	55.2	
Left Bank	Nong Chok	18	
	Min Buri	22	
	Lat Krabang	22	Adjacent of New Air Port
	Bang Phli	11	
	Bang Bo	7	

2）人口密度

前回の調査（１９７３年）より今回の調査までに４ヶ年間を経過しており，資料収集によるその間の各 Amphoe における総人口の推移と，前回の将来人口推定値と対比すると，Bang Phli 以外は大差がない。

又，現地踏査より各 Amphoe Town に集中している人口も前回調査時とほとんど変りがないものと見うけられた。

人口が増加したと思われるところは，多分 Amphoe Town の外側に広く散在している khlong 際であると想像せられる。

従って各 Amphoe Town の２０００年における人口密度は，前回の数値を変更することなく使用するのが適当と考えられた。よってこの値を採用して２０００年における予想人口を算定した。

人口密度および2,０００年の人口は，表２－２に示す。

Table 2-2

The Density of Population and Population in the Area
(at 2,000 AD)

	Amphoe	Water Served Area (Km^2)	Density of Population (per/km^2)	Population in the Area (person)
Right Bank	Sai Noi	6	1,500	9,000
	Bang Bua Thong	18	1,750	31,500
	Bang Yai	16	1,650	26,500
	Nong Khaem	55.2	2,500	138,000
Left Bank	Nong Chok	18	1,500	27,000
	Min Buri	22	2,000	44,000
	Lat Krabang	22	2,500	55,000
	Bang Phli	11	1,500	16,500
	Bang Bo	17	1,500	10,500

3） 9 Amphoes.の給水区域内人口推移

2.000年に至るまでの年次毎の人口推移は，前回のReportと同じく，2000年における予想人口より1980年の人口を対比し逆算して推定することとした。

その人口は表2－3に示す。

4） 水道普及率および1日最大使用水量

普及率の推定値および1日最大使用水量は，前回の採用値が妥当な値と考えられるので，同じ値を使用することとし，各年次の普及率および1日最大使用水量を表2－4，2－5のように定めた。

Table 2-3 Presumption of Population around Water Supply Area for nine (9) Amphos

	Amphoe	1975	1980	1985	1990	1995	2000	Remarks
Right Bank	Sai Noi	2,018	3,414	4,811	6,207	7,604	9,000	
	Bang Bua Thong	11,773	15,719	19,664	23,609	27,554	31,500	
	Bang Yai	5,935	10,048	14,161	18,274	22,387	26,500	
	Nong Khaem	32,000	44,000	59,000	79,000	105,000	138,000	
Left Bank	Nong Chok	7,000	11,000	15,000	19,000	23,000	27,000	
	Min Buri	17,800	23,000	28,200	33,400	38,700	44,000	
	Lat Krabang	18,242	25,592	32,944	40,296	47,648	55,000	
	Bang Phli	7,000	8,900	10,800	12,700	14,600	16,500	
	Bang Bo	5,500	6,500	7,500	8,500	9,500	10,500	

(person)

Table 2-4 Presumption of House Connection (percent)

Year	1975	1980	1985	1990	1995	2000
House Connection (per cent)	62.5 %	65.0	67.5	70.0	72.5	75.0

Table 2-5 Daily Maximum Quantity Consumed (l/c.d.)

Year	Less than 50,000 Persons	50,000-100,000 Persons	More than 100,000 Persons
1975	182.5	190	225
1980	190	210	240
1990	205	230	270
2000	220	250	300

5）各 Amphoe Town の年次別給水量

以上今までに算定したところの数値より，各 Amphoe Town の年次別給水量を算出したが，Nong Khaem 地区では，その東北部に位置する一部に区域外給水が含まれていることと，Bang Bo 地区では，南へ約 7 km 離れたところの Khlong Dan 地区への区域外給水が現在行なわれていることを考慮して給水量を決定した。

以下各 Amphoe Town の水道基本数値をまとめたものが表 2－6～2－15 である。

Table 2-6 Summary of Population to be Served and Daily Maximum Water Demand

	Amphoe		1980	1985	1990	1995	2000	Remarks
Right Bank	Sai Noi	Po	2,219	3,247	4,345	5,513	6,750	
		Da	500	700	900	1,200	1,500	
	Bang Bua Thong	"	10,217	13,273	16,526	19,977	23,625	
			2,000	2,700	3,400	4,300	5,200	
	Bang Yai	"	6,531	9,559	12,792	16,231	19,875	
			1,300	1,900	2,700	3,500	4,400	
	Nong Khaem	"	28,600	39,825	55,300	76,125	103,500	
			8,000	14,000	20,000	28,000	40,000	
	Sub-Total	"	47,567	65,904	88,963	117,846	153,750	
			11,800	19,300	27,000	37,000	51,100	
Left Bank	Nong Chok	"	7,150	10,125	13,300	16,675	20,250	
			1,400	2,000	2,800	3,600	4,500	
	Min Buri	"	14,950	19,035	23,380	28,058	33,000	
			2,900	3,800	4,800	6,000	7,300	
	Lat Krabang	"	16,635	22,237	28,207	34,545	41,250	
			3,200	4,400	5,800	7,400	9,100	
	Bang Phli	"	5,785	7,290	8,890	10,585	12,375	
			1,100	1,450	1,850	2,250	2,750	
	Bang Bo	"	4,225	5,063	5,950	6,888	7,875	
			1,500	1,700	2,100	2,550	3,000	
	Sub-Total	"	48,745	63,750	79,727	96,751	114,750	
			10,100	13,350	17,350	21,800	26,650	
TOTAL		Po	96,312	129,654	168,690	214,597	268,500	
		Da	21,900	32,650	44,350	58,800	77,750	

Note: Po, Population to be Served (person)

Da, Daily Maximum Water Demand (CMD)

Table 2-7

Basic Plan -SAI NOI-

	1975	1980	1985	1990	1995	2000
Population in Water Supply Area(person)	2,018	3,414	4,811	6,207	7,604	9,000
House Connection (%)	62.5	65.0	67.5	70.0	72.5	75.0
Population to be Served (person)	1,261	2,219	3,247	4,345	5,513	6,750
Daily Maximum (ℓ/c.d.)	182.5	190.0	197.5	205.0	212.5	220.0
Daily Maximum (CMD)	300	500	700	900	1,200	1,500

Table 2-8

Basic Plan -BANG BUA THONG-

	1975	1980	1985	1990	1995	2000
Population in Water Supply Area(person)	11,773	15,719	19,664	23,609	27,554	31,500
House Connection (%)	62.5	65.0	67.5	70.0	72.5	75.0
Population to be Served (person)	7,358	10,217	13,273	16,526	19,977	23,625
Daily Maximum (ℓ/c.d.)	182.5	190.0	197.5	205.0	212.5	220.0
Daily Maximum (CMD)	1,400	2,000	2,700	3,400	4,300	5,200

Table 2-9

Basic Plan -BANG YAI-

	1975	1980	1985	1990	1995	2000
Population in Water Supply Area(person)	5,935	10,048	14,161	18,274	22,387	26,500
House Connection (%)	62.5	65.0	67.5	70.0	72.5	75.0
Population to be Served (person)	3,709	6,531	9,559	12,792	16,231	19,875
Daily Maximum (ℓ/c.d.)	182.5	190.0	197.5	205.0	212.5	220.0
Daily Maximum (CMD)	700	1,300	1,900	2,700	3,500	4,400

Table 2-10

Basic Plan -NONG KHAEM-

	1975	1980	1985	1990	1995	2000
Population in Water Supply Area(person)	32,000	44,000	59,000	79,000	105,000	138,000
House Connection (%)	62.5	65.0	67.5	70.0	72.5	75.0
Population to be Served (person)	20,000	28,600	39,825	55,300	76,125	103,500
Daily Maximum (l/c.d)	225.0	240.0	255.0	270.0	285.0	300.0
Daily Maximum (CMD)	4,500	6,864	10,155	14,931	21,695	31,050
Out of Nong Khaem Area (CMD)	500	1,136	3,845	5,069	6,305	8,950
Total	5,000	8,000	14,000	20,000	28,000	40,000

Table 2-11

Basic Plan -NONG CHOK-

	1975	1980	1985	1990	1995	2000
Population in Water Supply Area(person)	7,000	11,000	15,000	19,000	23,000	27,000
House Connection (%)	62.5	65.0	67.5	70.0	72.5	75.0
Population to be Served (person)	4,375	7,150	10,125	13,300	16,675	20,250
Daily Maximum (l/c.d.)	182.5	190.0	197.5	205.0	212.5	220.0
Daily Maximum (CMD)	800	1,400	2,000	2,800	3,600	4,500

Table 2-12

Basic Plan -MIN BURI-

	1975	1980	1985	1990	1995	2000
Population in Water Supply Area(person)	17,800	23,000	28,200	33,400	38,700	44,000
House Connection (%)	62.5	65.0	67.5	70.0	72.5	75.0
Population to be Served (person)	11,125	14,950	19,035	23,380	28,058	33,000
Daily Maximum (ℓ/c.d.)	182.5	190.0	197.5	205.0	212.5	220.0
Daily Maximum (CMD)	2,100	2,900	3,800	4,800	6,000	7,300

Table 2-13

Basic Plan -LAT KRABANG-

	1975	1980	1985	1990	1995	2000
Population in Water Supply Area(person)	18,242	25,592	32,944	40,296	47,648	55,000
House Connection (%)	62.5	65.0	67.5	70.0	72.5	75.0
Population to be Served (person)	11,401	16,635	22,237	28,207	34,545	41,250
Daily Maximum (ℓ/c.d.)	182.5	190.0	197.5	205.0	212.5	220.0
Daily Maximum (CMD)	2,100	3,200	4,400	5,800	7,400	9,100

Table 2-14

Basic Plan -BANG PELI-

	1975	1980	1985	1990	1995	2000
Population in Water Supply Area(person)	7,000	8,900	10,800	12,700	14,600	16,500
House Connection (%)	62.5	65.0	67.5	70.0	72.5	75.0
Population to be Served (person)	4,375	5,785	7,290	8,890	10,585	12,375
Daily Maximum (ℓ/c.d.)	182.5	190.0	197.5	205.0	212.5	220.0
Daily Maximum (CMD)	800	1,100	1,450	1,850	2,250	2,750

Table 2-15

Basic Plan -BANG BO-

	1975	1980	1985	1990	1995	2000
Population in Water Supply Area(person)	5,500	6,500	7,500	8,500	9,500	10,500
House Connection (%)	62.5	65.0	67.5	70.0	72.5	75.0
Population to be Served (person)	3,438	4,225	5,063	5,950	6,888	7,875
Daily Maximum (ℓ/c.d)	182.5	190.0	197.5	205.0	212.5	220.0
Daily Maximum (CMD)	700	850	1,000	1,250	1,500	1,750
Out of Bang Bo Area (CMD)	500	650	700	850	1,050	1,250
Total	1,200	1,500	1,700	2,100	2,550	3,000

2－2　首都圏周辺開発地区の水需要量

Separate System に関する開発計画としては５ヶ所の工場団地と，５ヶ所の住宅公団ならびに新空港が１ケ所計画されている。

これらの計画需要量は，Industrial Estate Authority と National Housing Authority よりの年次別計画資料によった。

各開発ケ所の水需要量は表２－１６に示すとおりである。

Table 2-16 Water Demand for Additional Area (CMD)

	Location		1980	1985	1990	1995	2000
Right Bank	Bang Khun Thien	Fa	"	"	"	"	"
		Ho	5,300	5,300	5,300	5,300	5,300
	Total		5,300	5,300	5,300	5,300	5,300
Left Bank	Bang Chan	Fa	4,000	4,000	4,000	4,000	4,000
		Ho	1,100	1,100	1,100	1,100	1,100
	Lat Krabang	Fa	5,200	5,200	9,850	9,850	9,850
		Ho	2,700	13,300	26,000	38,000	38,000
	New Airport		1,500	2,000	2,500	3,000	3,500
	Bang Phli Bang Bo	Fa	1,100	3,800	3,800	3,800	3,800
		Ho	4,000	12,000	20,000	20,000	20,000
	Bang Poo	Fa	10,400	10,400	20,700	31,200	41,500
		Ho	5,040	17,760	24,000	24,000	24,000
	Khlong Dan	Fa	5,200	12,450	20,700	20,700	20,700
		Ho	"	"	"	"	"
	Total		40,240	82,010	132,650	155,650	166,450

Fa: Factory Area

Ho: Housing Area

2－3　水需要量総括表

1）水需要量

以上今まで算出したSeparate System全体の水需要量は，2000年で249,500m³／日となった。

この内Chao Phraya Riverの右岸で56,400m³／日，左岸で193,100m³／日である。

この水量に対してSeparate System は，水源の確保および送配水計画を，Central Systemよりの送水の可能性も含めて立案する。

全体の需要量は，表2－17～2－19に示す。

Table 2-17
Summary of Water Demand (2000 AD)

		Right Bank	Left Bank	Total
Population to be served(person)		153,750	114,750	268,500 (9 Amphoes)
Water Demand	Amphoe (CMD)	51,100	26,650	77,750
	Additional Area (CMD)	5,300	166,450	171,750
	Total (CMD)	56,400	193,100	249,500

Table 2-18 Water Demand of the right bank of Chao Phraya River (ONE)

Location		Year	1980	1985	1990	1995	2000	Remarks
North 3 Districts	Amphoe	Sai Noi	500	700	900	1,200	1,500	
		Bang Bua Thong	2,000	2,700	3,400	4,300	5,200	
		Bang Yai	1,300	1,900	2,700	3,500	4,400	
	Sub Total		3,800	5,300	7,000	9,000	11,100	
Nong Khaem District	Amphoe	Nong Khaem	8,000	14,000	20,000	28,000	40,000	
	Development Program	Bang Khun Thien Ho	5,300	5,300	5,300	5,300	5,300	
	Sub Total		13,300	19,300	25,300	33,300	45,300	
Right Bank Total			17,100	24,600	32,300	42,300	56,400	

Table 2-19 Water Demand of the left bank of Chao Phraya River (CRO)

	Location			1989	1995	1990	1995	2000	Remarks
East 3 Districts	Amphoe	Nong Chok		1,400	2,000	2,800	3,600	4,500	
		Min Buri		2,900	3,800	4,800	6,000	7,300	
		Lat Krabang		3,200	4,400	5,800	7,400	9,100	
	Sub Total			7,500	10,200	13,400	17,000	20,900	
	Development Program	Bang Chan	Fa	4,000	4,000	4,000	4,000	4,000	
			Ho	1,100	1,100	1,100	1,100	1,100	
		Lat Krabang	Fa	5,200	5,200	9,850	9,850	9,850	
			Ho	2,700	13,300	26,000	38,000	38,000	
		New Air Port		1,500	2,000	2,500	3,000	3,500	
	Sub Total			16,500	25,600	43,450	55,950	56,450	
South 4 Districts	Amphoe	Bang Phli		1,100	1,450	1,850	2,250	2,750	
		Bang Bo		1,500	1,700	2,100	2,550	3,000	
	Sub Total			2,600	3,150	3,950	4,800	5,750	
	Development Program	Bang Phli -Bang Bo	Fa	1,100	3,800	3,800	3,800	3,800	
			Ho	4,000	12,000	20,000	20,000	20,000	
		Bang Poo	Fa	10,400	10,400	20,700	31,200	41,500	
			Ho	5,040	17,700	24,000	24,000	24,000	
		Khlong Dan	Fa	5,200	12,450	20,700	20,700	20,700	
	Sub Total			25,740	56,410	89,200	99,700	110,000	
	Left Bank Total			50,340	95,360	150,000	177,450	193,100	

Fa : Factory Area

Ho : Housing Area

第 3 章　既存給水施設の検討と将来計画に対する提案

第 3 章　既存給水施設の検討と将来計画に対する提案

バンコク首都圏周辺水道計画に包含されている 9 Amphoes の 水道計画を行うに際し，既存施設の有効な利用を はかるために約 1 ヶ月にわたり現場調査を行なった。

以下，その現況を述べるとともに，既存施設の検討と提案を行なう。

3－1　既存施設の能力

1）The Right Bank of Chao Phraya River

(1)　Sai Noi　……　約１０年前に井戸を廃止した。その原因は塩害とも，又鉄分が多くなったとも言われているが真相は不明である。

現在，飲料水は雨水，他の生活用水はKhlong 水を利用していて，水道施設は皆無である。

(2)　Bang Bua Thong　……　１９６３年に浄水場を建設し現在にいたっているが，Khlong Phra Phimonの水質が年々悪化の傾向にあるので将来地下水に関する再調査を行なう計画がある。

(i)　浄水場の能力　　浄水方式；薬品沈でん＋急速ろ過

浄水能力；2,０００m^3／日

平均原水濁度；約1,０００度

薬注率（平均）

パン土；１３２ppm

消石灰；２５０Kg／月

cl　；２ppm

ろ過速度；１００m／日

洗　　浄；逆洗のみ（１日１回）

(ii)　高架水槽　　５０m^3×１槽，　有効高　約２０m

(iii)　配水管　　主配管　A.C.P. φ１００㎜

(iv)　問題点　　逆洗圧が一定でないため，沪床の砂利が露出し，ブレークスルーがはなはだしいため，浄水も濁度が認められる。

(3) Bang Yai …… 当初使用していた井戸は砂の混入が著しいため，1976年，約500m離れた地点に新しい井戸を設け，現在にいたっている。

(i) 井戸の能力　1,200m³/日（水中タービンポンプ）

(ii) 高架水槽　60m³×1槽，　有効高　約20m

(iii) 配水管　主配管　A.C.P. φ100mm

(4) Nong Khaem …… 1973年にFeasibility Planが提案されたが，以後計画は着手されず，現在にいたっている。

現在，井戸が1ヶ所あるがその水質は悪く，塩素イオン濃度は200 ppmをはるかに超えているので，将来の水源として利用するのは不可能である。

2) The Left Bank of Chao Phraya River

(1) Nong Chok …… 現在，井戸は2ヶ所あるがその揚水量は極めて少なく，雑用水として使用するためにKhlong水を大型タンク車で運んで着水井に井戸水と混合して投入しており，完全な水道施設としての目的を果していない。

(i) 井戸の能力　不明

(ii) 高架水槽　60m³×1槽，　有効高　約20m

(iii) 配水管　主配管　A.C.P. φ100mm

(2) Min Buri …… 現在，2ヶ所の井戸より揚水し給水を行っている。建設年次は比較的古く2井共約15年前であり，設備の老朽化が目立つ。

(i) 井戸の能力　2,800m³/日

1,900m³/日

(iii) 高架水槽　　50m^3×1槽，　有効高　約20m

70m^3×1槽，　　〃

(iii) 配水管　　主配水管　A.C.P. φ200㎜

(3) Lat Krabang …… 地下水の汲上げにより地盤沈下が激しく，8年間に約10㎝の沈下が生じている。原因は既存の井戸が近くに集中しているためと思われる。揚水不能になる前に対策をたてる必要がある。

(i) 井戸の能力　　1,000m^3／日×3井

(ii) 高架水槽　　50m^3×1槽

60m^3×1槽

(iii) 配水管　　主配管　A.C.P. φ100㎜

(4) Bang Phli …… 井戸揚水量は非常に少なく，殆んどの雑用水をKhlong水に依存している。

(i) 井戸の能力　　720m^3／日

(ii) 高架水槽　　100m^3×1槽，　有効高　約23m

(iii) 配水管　　主配管　A.C.P. φ100㎜

(5) Bang Bo …… 現在，Khlong Danへ区域外給水が行なわれており，将来も行なう予定で計画を作成する必要がある。

(i) 井戸の能力　　1,200m^3／日

500　〃

(ii) 高架水槽　　100m^3×1槽，　有効高　約18m

120m^3×1槽，　〃　約23m

(iii) 配水管　　Bang Bo　　A.C.P. φ150㎜

Khlong Dan　A.C.P. φ200㎜

(V) そ の 他　MWWAにて２００m^3／日の井戸を掘削中

１２０m^3の高架水槽を築造中

配水管を布設中

竣工は１９７７年９月予定

3－2　検討と提案

第２章で算出した２０００年における総需要水量２４９,５００m^3／日を全部地下水でまかなうことは，地下水調査により，事実上不可能と判断された。

その結果，水源を表流水あるいはCentral Systemに求めるにせよ,将来の水道システムは広域水道システムをとらざるを得ないと思われる。

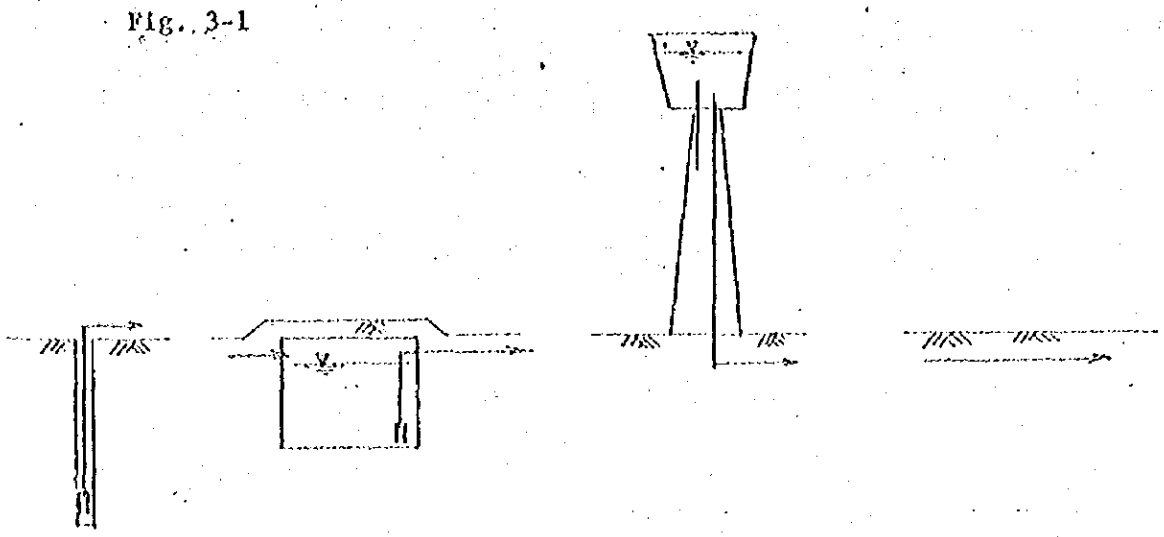
一方，緊急に水道施設の整備が望まれている各Amphoeに対して，広域水道システムがその機能を発揮する時期を早期に求めることは困難と思われる。

以上のことから，各Amphoeの現況改善に対しては地下水を利用する水道計画が暫定的にせよ必要と思われるので，この観点から以下の提案を行なう。

１）配水システムの基本フロー

各Amphoeの配水システムは図３－１を基本とする。

Fig. 3-1



2）既存施設に対する提案

(1) Well

現在使用されている井戸は５～１０年前に建設されたものであり，管理に必要な設備（流量計，水位計等）が備わっていないので，これら設備を新たに設ける。

(2) 高架水槽

各Amphoe共，Townの中心部に高架水槽が設置してあり，将来の配水システムからも望ましい位置なので，これらは将来共利用する。

(3) 配 水 管

各Amphoe共，配水主管は将来の水量に対して余裕がないので，将来水量に見合った配水管を布設する。

3）計画に対する提案

(1) 配水池の建設

現在，各Amphoe共，高架水槽の容量が小さく，揚水量と給水量の調節がなされていない。そのため，井戸の運転が不規則となり井戸の寿命を短かくしていると共に給水が非常に不安定な状態にある。

これを解決するに１日最大給水量の６hr分の配水池を建設する。

表３－１に各Amphoeの容量を示す。

(2) 観測井の設置

Amphoe Bang Phli および Bang Bo は塩水の進入が予想されるので，新規井戸を建設した段階で観測井の設置が望まれる。

(3) 機器の設置

ｉ）塩素注入設備　（配水池流入部）

ⅱ）流 量 計　　（各井戸の導水管部）

Table-3-1

Capacity of Service Reservoir in each Amphoe

Amphoe	Capacity of Service Reservoir (CM)	Daily Maximum Water Demand (CMD)
Sai Noi	400	1,500
Bang Bua Thong	1,300	5,200
Bang Yai	1,100	4,400
Nong Khaem	10,000	40,000
Min Buri	1,800	7,300
Nong Chok	1,100	4,500
Lat Krabang	2,300	9,100
Bang Phli	700	2,750
Bang Bo	450	1,750
Klong Dan	300	1,250

(4) 将来建設計画

別紙のような建設計画を提案する。

（図３－２～図３－１０）

Fig. 3-2

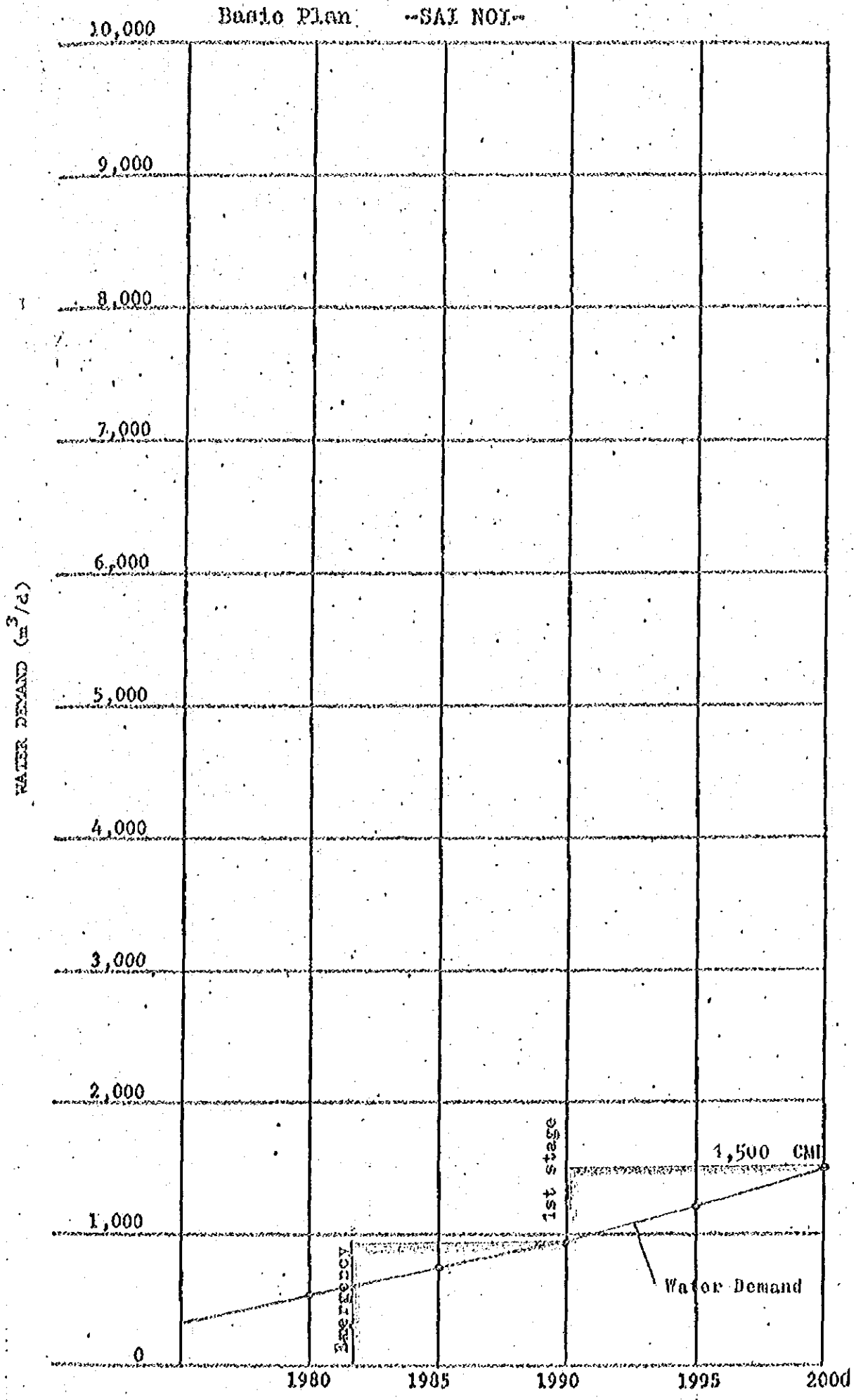

Bando Plan --SAI NOI--
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
WATER DEMAND (m³/d)
1980
1985
1990
1995
2000
Emergency
1st stage
1,500 CMD
Water Demand

Fig. 3-3

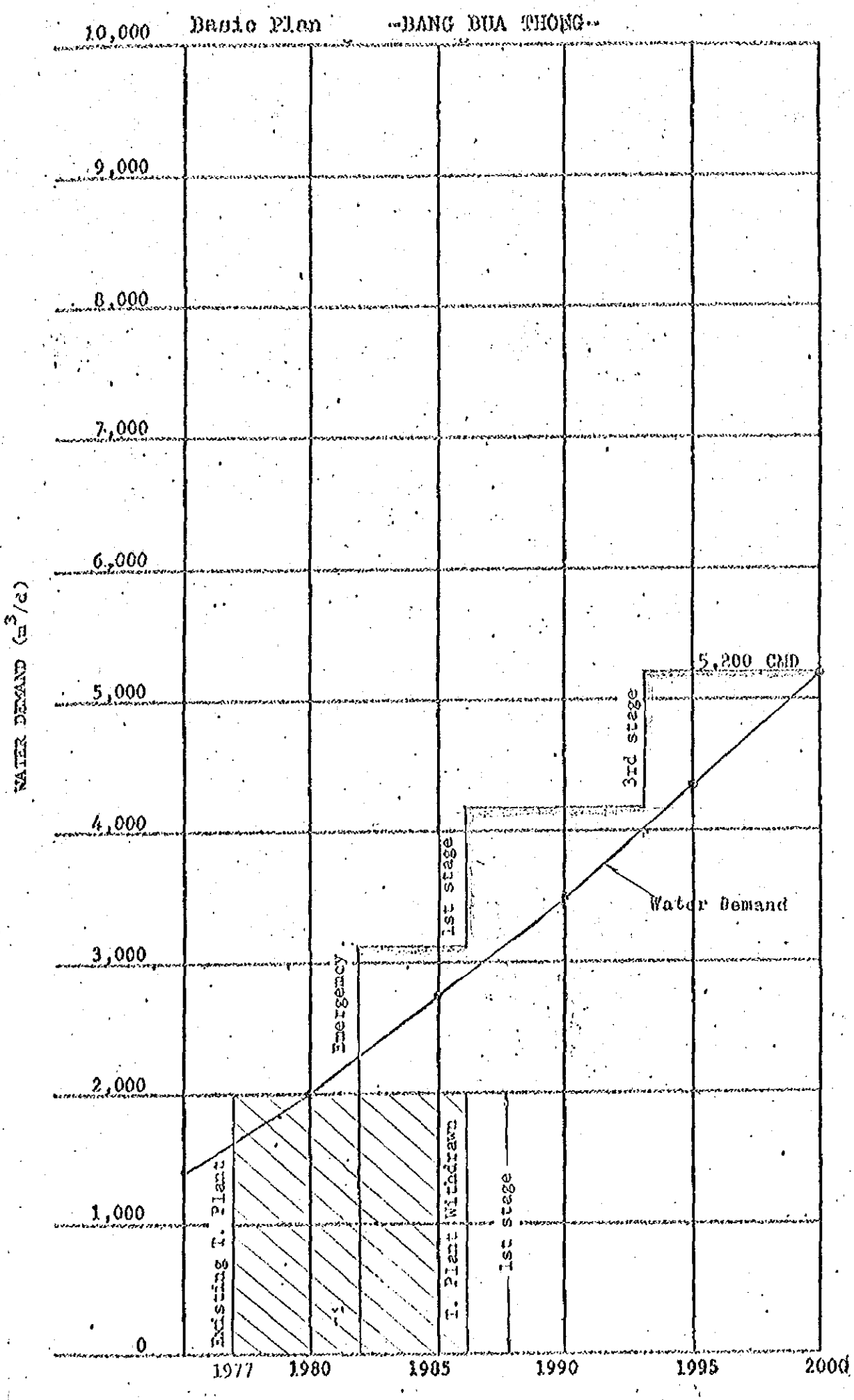

Basic Plan -BANG BUA THONG-
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
WATER DEMAND (m3/d)
1977
1980
1985
1990
1995
2000
5,200 CMD
3rd stage
1st stage
Emergency
Water Demand
Existing T. Plant
T. Plant Extension
T. Plant Withdrawn
1st stage

Fig. 3-4.

Basic Plan -BANG YAI-

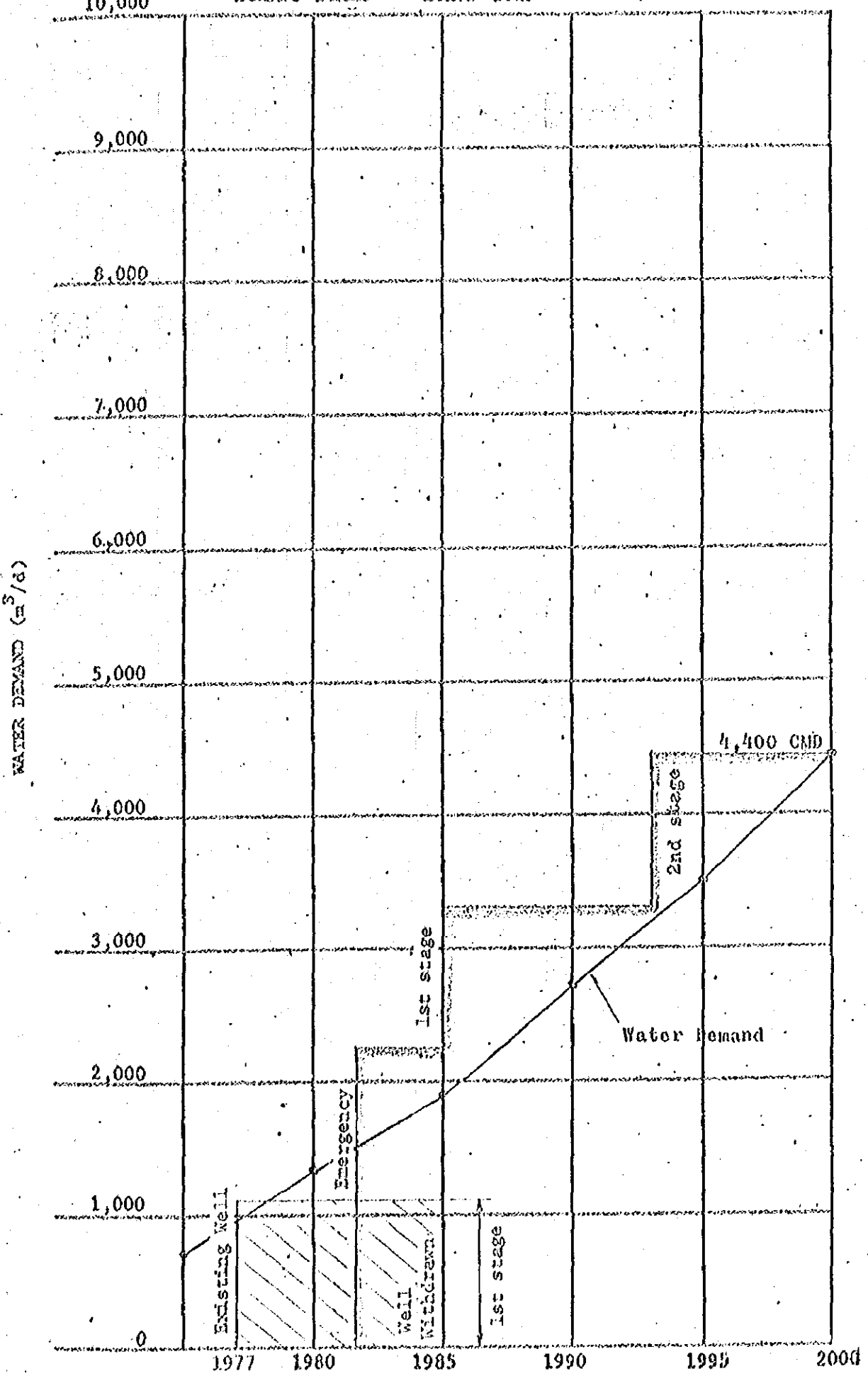


Fig. 3-15

Basic Plan -- NONG KHAEM--

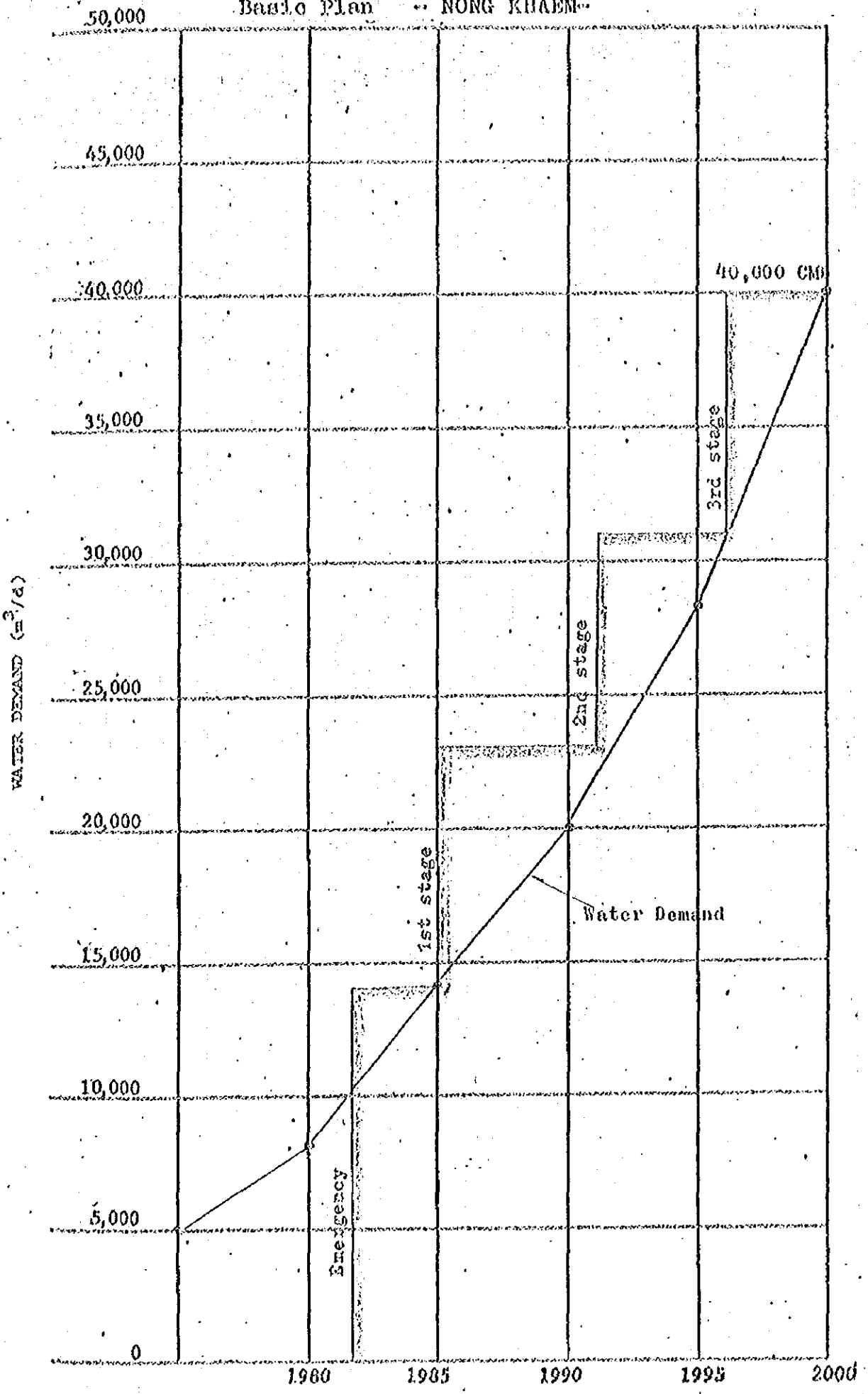


Fig. 3-6

Basic Plan -NONG CHOK-

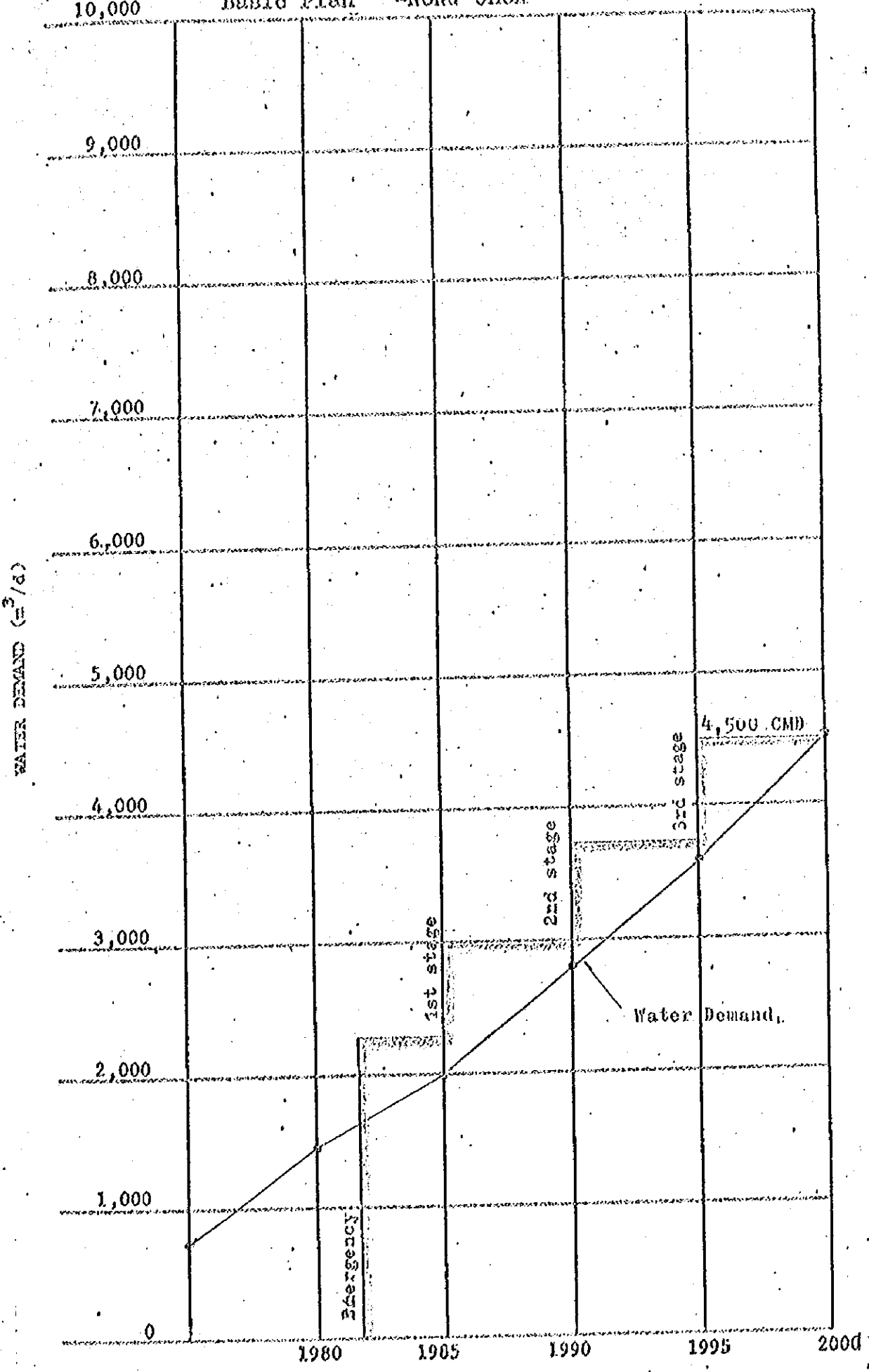


Fig. 3-7

Basic Plan -MIN BURI-

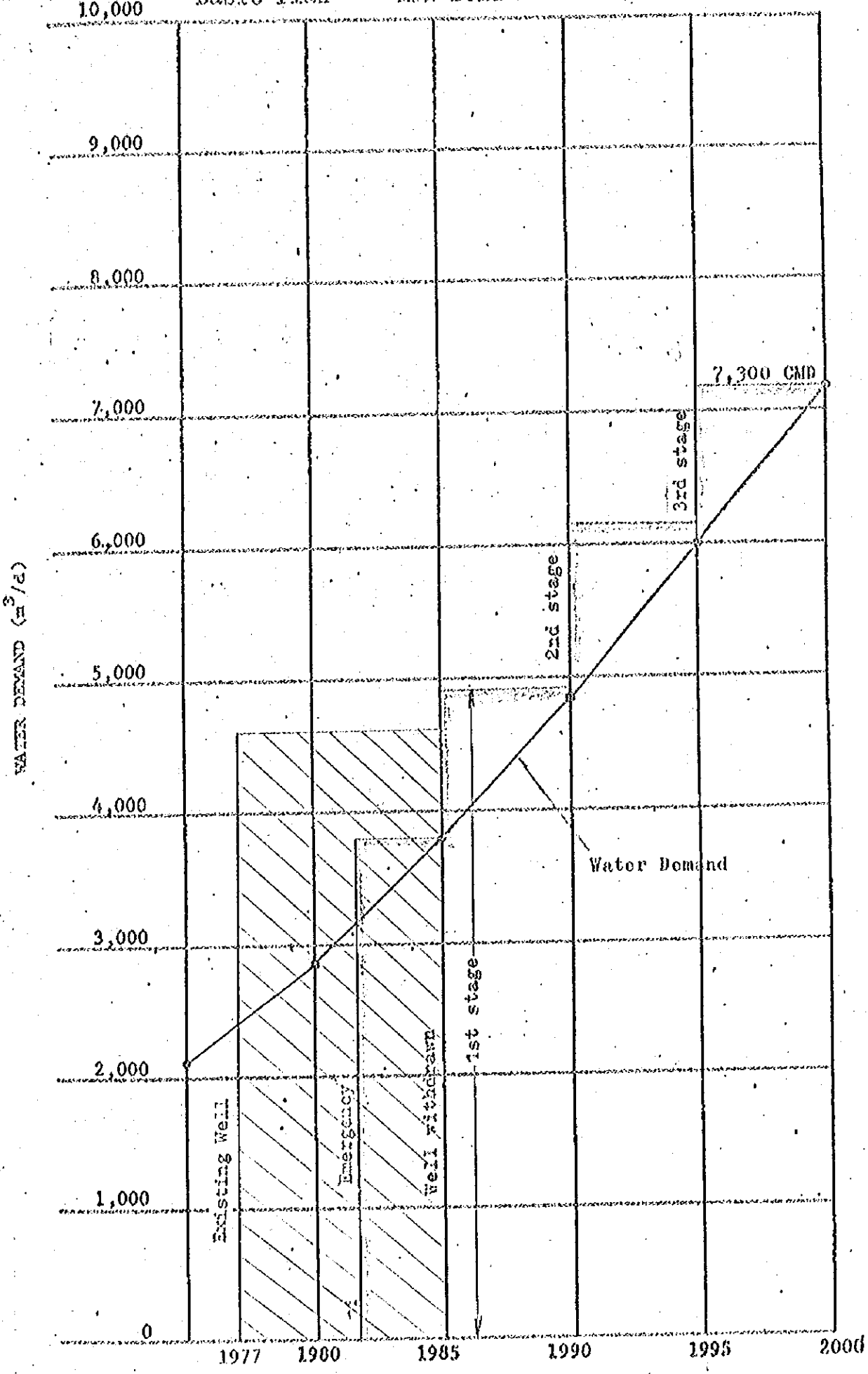


Fig. 3-8

Basic Plan -JAT KRABANG-

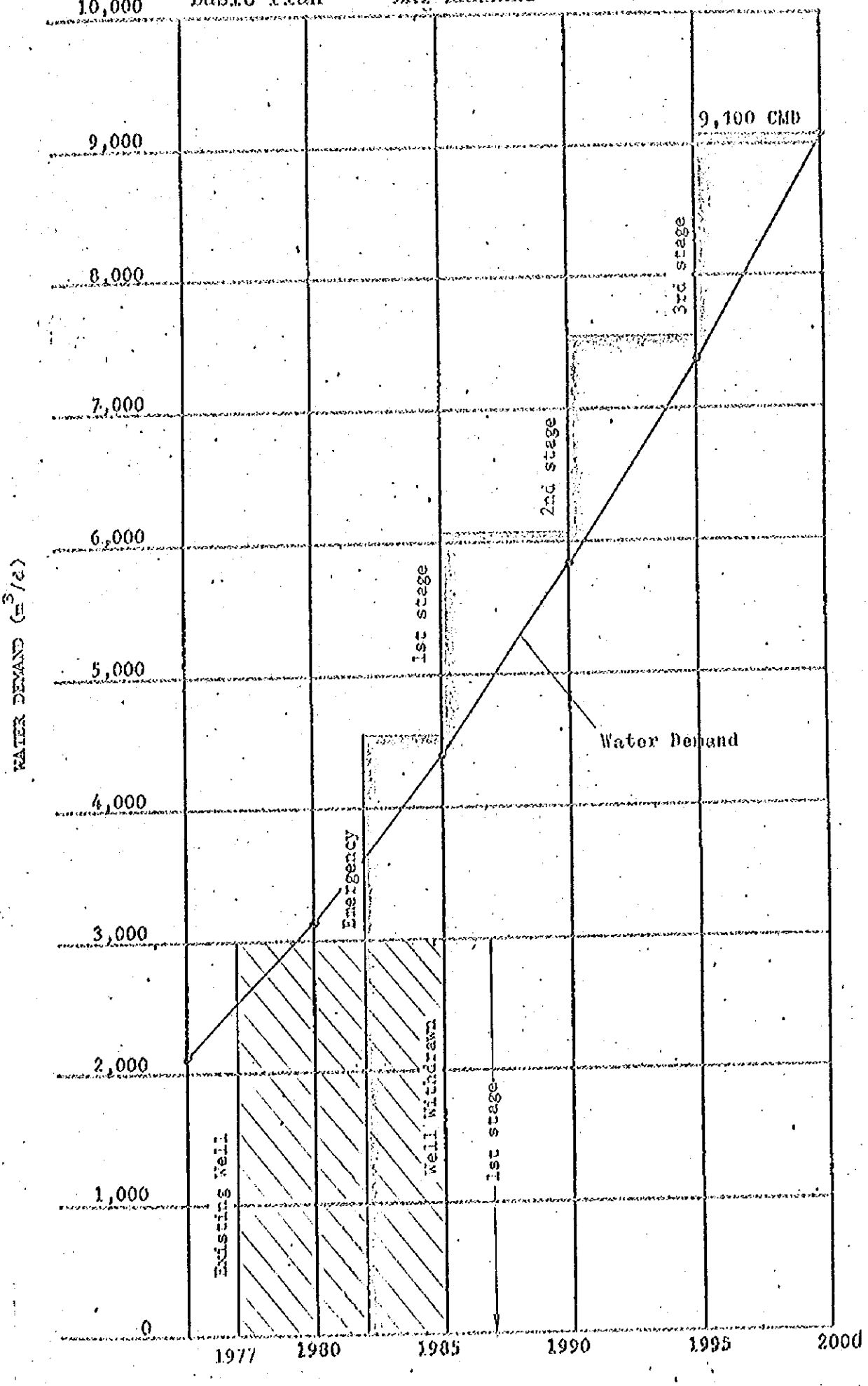


Fig. 3-9

Basic Plan -BANG PHLI-

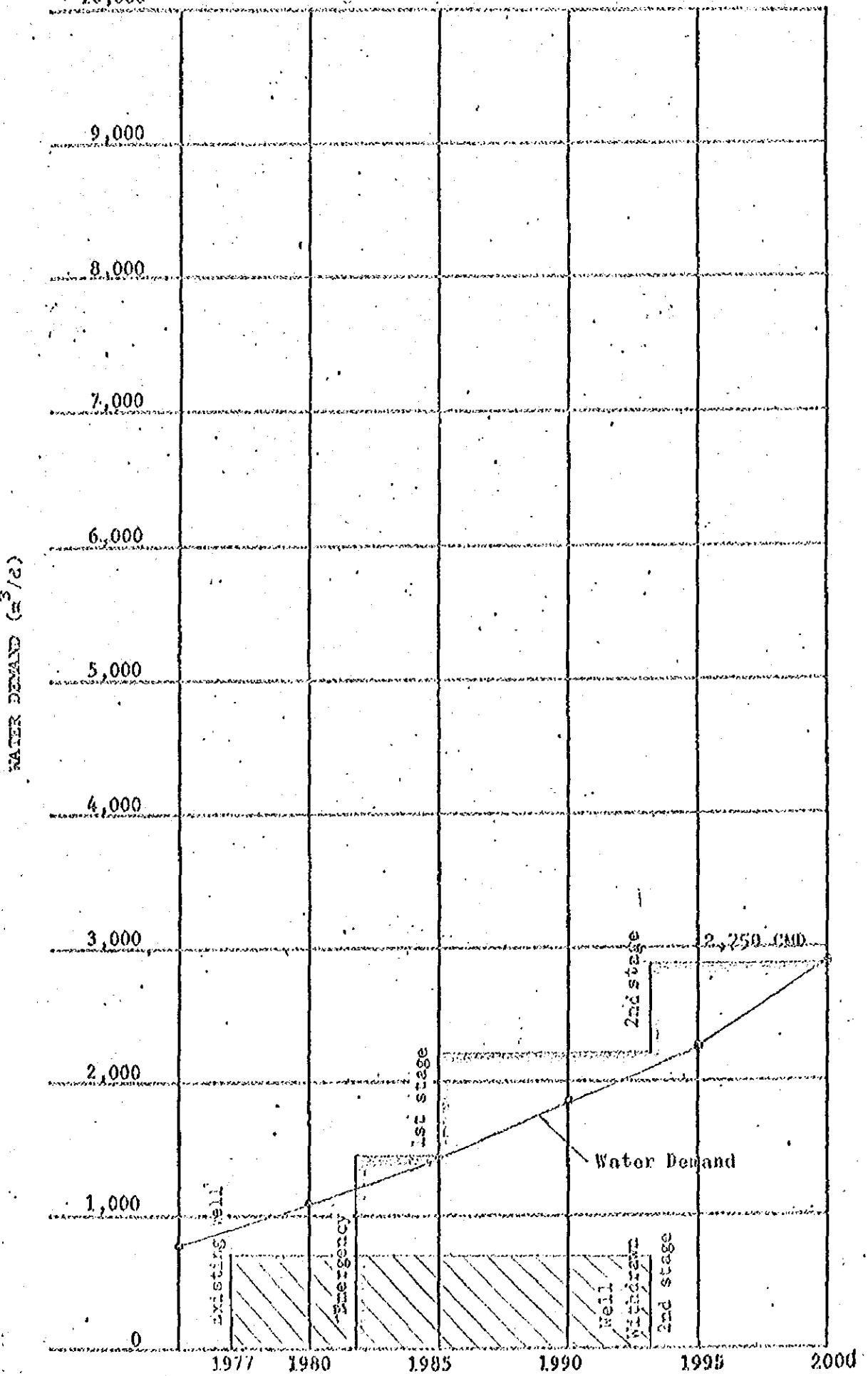
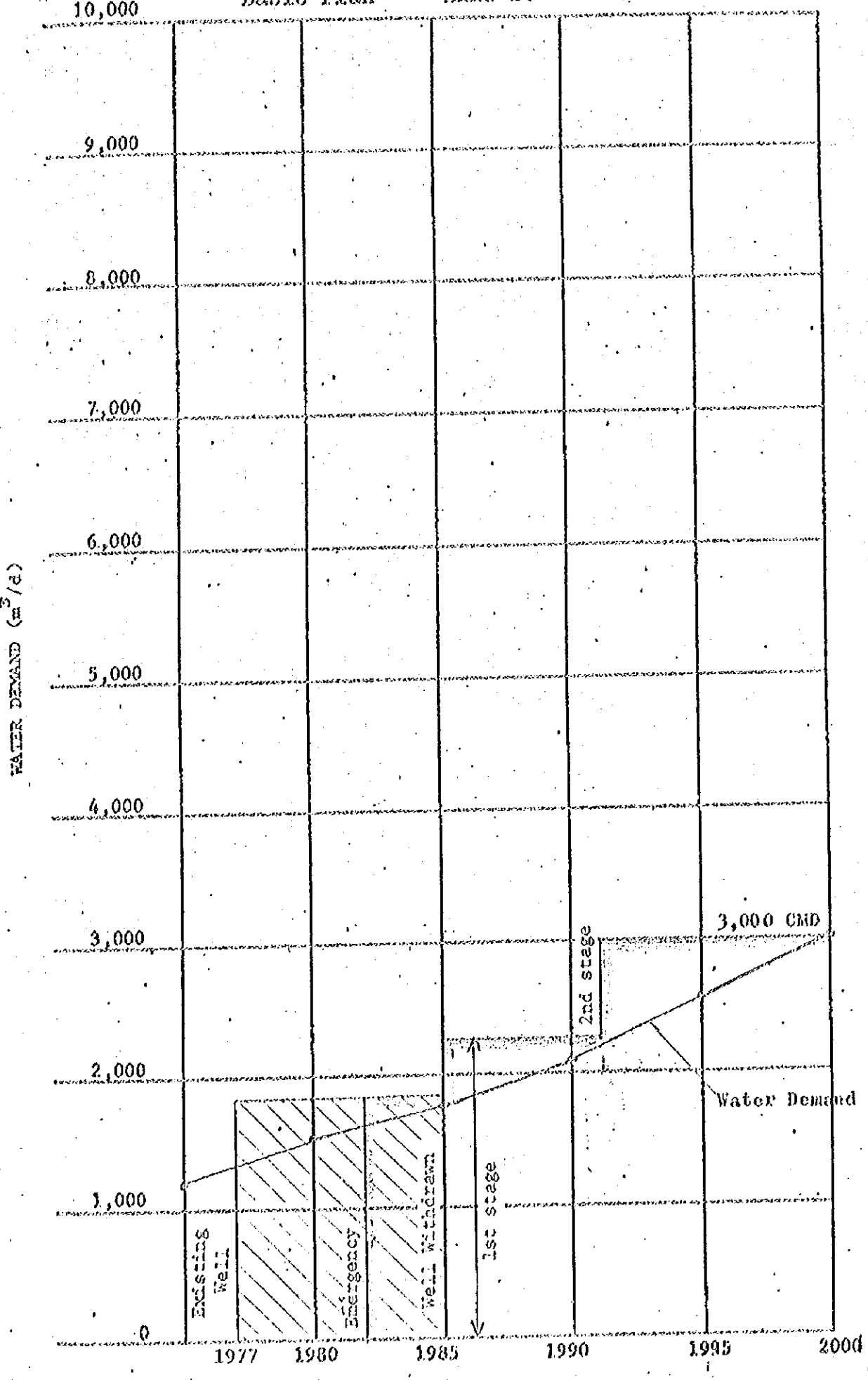


Fig. 3-10

Basic Plan -BANG BO-



第 4 章　水源調査の結果と提案

第 4 章　水源調査の結果と提案.

4－1　地　下　水

今回の調査はChao Phraya River 左岸一帯及び右岸北部 3 地区において 32 測点の電気探査と既設井戸の聞きとみ，及び既存資料の収集を中心に約 1 ヶ月行われたが，その結果 Bangkok 周辺地区における地下水理地質の概要を把握することが可能となった。かつ，本プロジェクトにおける地下水の取扱いについても，その方向性が明らかとなった。

1）電 気 探 査

電気探査を実施するため本調査団は 3 機種の測定器を持参したが，結果的に大型の農資 S 型機をすべての測点に使用することになった。電気探査は左岸にて 24 測点を実施し，右岸地区において 8 測点を実施した。測定は上部層の厚い粘土層に影響されて困難を極めたが，慎重に測定に努めた結果，予期以上の成果を収めるに至った。電気探査の測定結果は次のようなものである。測定位置は図 4－1 参照。

(1) 一般的に層比抵値は低く，粘性土を全般的に含んでいることが解る。

(2) 左岸において特に層比抵値の低い場所は Nong Chok，Min Buri 北部と Bang Phli 及び Bang Bo の南部である。

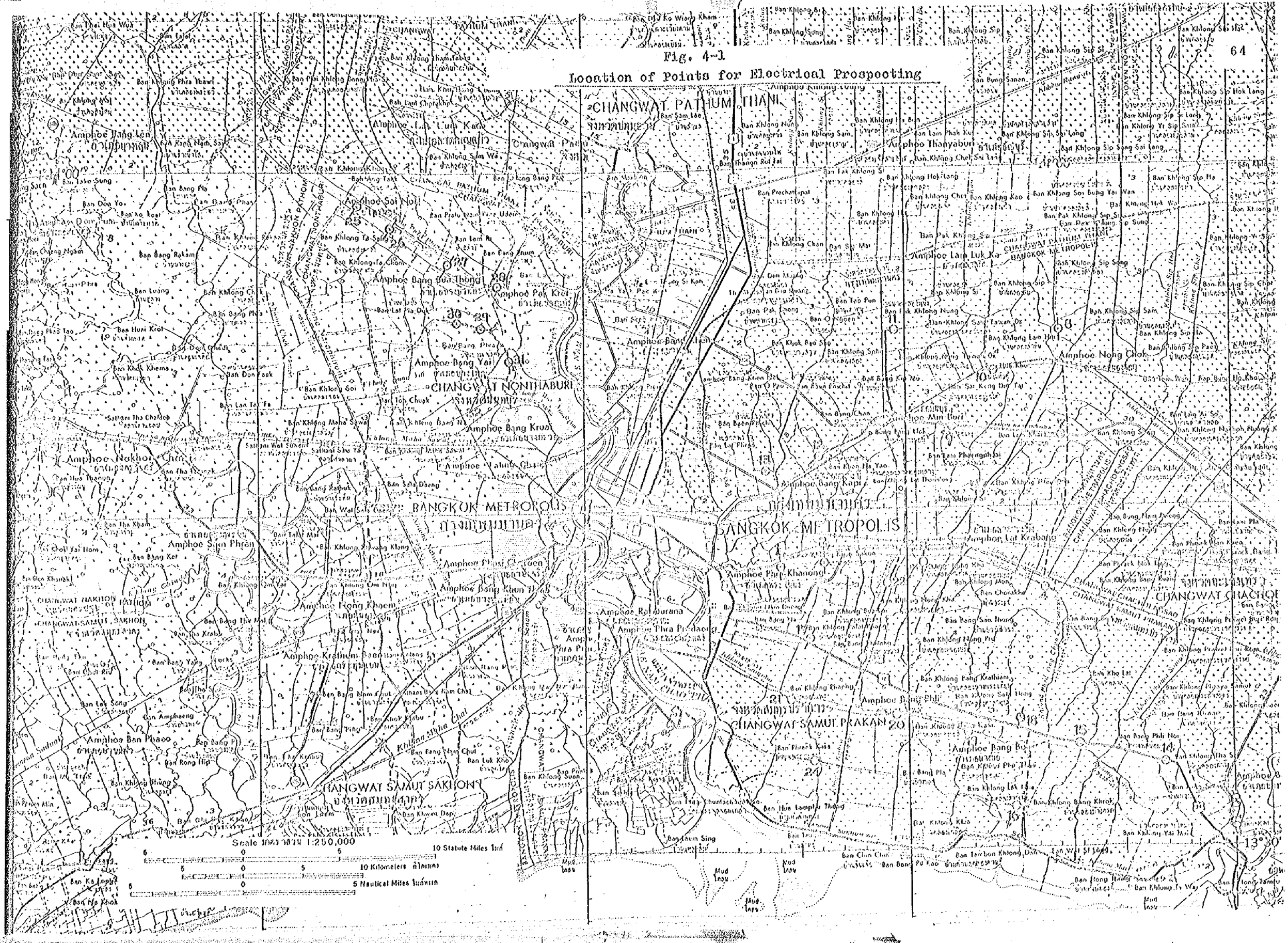
(3) 比較的帯水層の状況が良いと判断される部分は国道 34 号線沿いと Lat Krabang を通る東西方向の地域である。

(4) 右岸地区については，Bang Yai 及び Bang Bua Thong の東部が悪く，西部程ど良いという結果が得られた。

現状において標準曲線法による解析がすでに終了し，帯水層の性状については明らかになったが，既設井との地層対比によって行われる直視法解析は現在行われつつある。この解析によって帯水層の構造を検討する予定である。

Fig. 4-1

Location of Points for Electrical Prospecting



2）既調査資料の解析

(1) 帯水層について

帯水層は最上部層の Bangkok Aquifer（50m zone）から Pak Nam Aquifer（550m zone）迄8帯水層が存在するが，上部2層は水質的に問題があり，300m以下の4帯水層については充分なデータがない。しかし，EGAT で使用している深井戸は100m^3/hr の Capacity をもつにもかかわらず，その地下水は水温が49℃と高く，かつ，SO_4 イオンの Contents が高いという性質を有しており，深度的にみて Recharge が充分でないと推定される。

残る2帯水層の Nakhon Luang Aquifer（150m zone）と Nonthburi Aquifer（200m zone）は水質的に飲料に適し，かつ 経済性のの高い帯水層であり，透水量係数の値からしても充分に補給涵養のある帯水層であると推定され，本 Separate System の地下水源として，両帯水層をその対象としたい。

しかしながら，両帯水層は Bangkok 南部において塩水が侵入し塩害を生じている状況下にある。

※ 深度500m以下の帯水層を利用するに際し涵養量以上の取水を行うなら仮容易に水質を悪化せしめ，かつ本帯水層の減圧は，圧密層の範囲を拡大せしめることになり，地盤沈下は現状以上の規模となることが予測されよう。

3） Bangkok 市内における地下水事情について

Bangkok 市内における地下水揚水量及び地下水位の状況は Charoen Piancharone and Charoen Chuamthaisong（1976）によってすでに明らかにされている。

この報告によると Bangkok 中心部において１９５８年～１９５９年の調査結果ですでに３０feet～４０feet に水位が低下し，１９６８～１９６９年の調査では６０feet から７０feet に水位が低下している。又このときは Phra Pradaeg 工業地帯に新しい水位降下の中心が出現している。さらに１９７３年～１９７４年には水位降下の中心はさらに北上し，その水位は１００feet になっている。北上の原因は Private Housing Projects に起因するものと推定される。この時点において影響は Bangkok 周辺及び Min Buri において７０feet，Bang Phli において６５feet，Bang Bua Thong において６０feet と水位が変化している。この水位の降下は地下水の過剰な揚水によるものと考えられ，このため海側からの塩水の侵入が顕著になって来ている。地下水の揚水量については，１９６０年に１７５,０００m^3／日の値が得られ，１９６３年に３３0,０００m^3／日，１９７６年には６００,０００m^3／日（Piancharoen，１９７６）あるいは７００,０００m^3／日（by Ministry of Agriculture and Cooperatives １９７６）が揚水されていると言う。水位の低下状況は年々増加し１９６０年に 0.6m／年であったものが，１９６８年では 1.4m／年，１９７３年では 2.3m／年と低下し，現状では３～４m水位が低下している。地下水に対する補給は垂直涵養と水平流動による涵養力があるが annual rainfall の５％～６％が Recharge 量であるとされている。従来のデータより概略計算を行ってみると，全揚水量のわずか３０～３５％が涵養されているにすぎない。

現状の揚水をこのまま放置しておくことは地下水の枯渇のみならず，地盤沈下を生ぜしめることは明らかである。

従って早急に表流水を水源とする上水道及び工業水道を新設あるいは増設し，限度ある資源の保全をはかるべきであろう。

尚，塩水化の速度として２５０ ppmの塩水クサビの侵入速度を求めると，この結果約年間５００～５５０ mの値が得られた。

4） Separate Systemにおける地下水源について

現状において Bangkok 市内の地下水位が年々低下しつつある状況下にあって，周辺地区は重要な涵養源となっている。従って，この地域でさらに地下水を利用することは好ましくない。量の大小にかかわらず，周辺地区で地下水を揚水することはその量に近いだけの補給を停止せしめることになる。しかしながら住民の生活改善を安価な水源をもって行うとすれば地下水以外になく，地下水を Separate System において使用することは当然Central System において同量の 地下水取水を停止すると言う条件下にあってはじめて可能となるものであり，Bangkok の状況を考えるとその取水量は Recharge 量と同程度のものと考えられよう。かつ又揚水に伴うに井戸相互間の干渉を考慮すると，地下水源は１ヶ所に集中させることは避け，分散させるべきであると考える。

(1) Recharge 量について

Recharge 量は annual rain-fall の５％として考える。

又，水平方向の流動量も Recharge 量として考えるべきであるが，この場合これを無視することとする。

annual rain-fall １４００㎜／年

１４００㎜／年 × 0.05 ＝ ７０㎜／年

$$\frac{1}{1000} \times 70mm/年 \times 1,000,000m^2 = 70,000m^3/年/Km$$

$$= 191m^3/日/Km$$

$$\fallingdotseq 190m^3/日/Km$$

(2) 地層状況及び地下水理状況を考慮した条件（安全率）

(i) 左 岸

Min Buri 及び Nong Chok は北方に粘土層の厚い地層をひかえていることとよりF.S. = 2.0とする。

Bang Phli Bang Bo 塩水化の危険があるためF.S. = 2.0とする。

Lat Krabang は F.S. = 1.5として考える。

(ii) 右 岸

Sai Noi は粘土層を考慮しF.S. = 2.0とし，Bang Bua Thong 及び Bang Yai は F.S. = 1.5とする。

Nong Khaem はすでに塩水化しているので地下水源は考慮しない。

(3) 涵養面積

各地区の必要水量（前回レポートの値）に見合う涵養面積は表4－1のとおりである。

Table - 4-1

Location		Recharge Area
LEFT BANK	BANG PHLI	3,800 CMD ÷ 190 CM/day/km^2 x 2.0 = 40 km^2
	BANG BO	2,500 CMD ÷ 190 CM/day/km^2 x 2.0 = 26.3km^2
	MIN BURI	7,300 CMD ÷ 190 CM/day/km^2 x 2.0 = 76.8 km^2
	NONG CHOK	4,500 CMD ÷ 190 CM/day/km^2 x 2.0 = 47.3 km^2
	LAT KRABANG	7,500 CMD ÷ 190 CM/day/km^2 x 1.5 = 59.2 km^2
RIGHT BANK	SAI NOI	1,500 CMD ÷ 190 CM/day/km^2 x 2.0 = 15.8 km^2
	BANG BUA THONG	5,000 CMD ÷ 190 CM/day/km^2 x 1.5 = 41.1 km^2
	BANG YAI	4,400 CMD ÷ 190 CM/day/km^2 x 1.5 = 34.7 km^2
TOTAL		341.2 km^2

(4) 井戸からの可能揚水量について

Sai Noi 及び Nong Chok については T＝9 m^2／時 S＝1.0×10^{-3} として計算し，Min Buri 及び Bang Phli，Bang Bo，Lat Krabang，Bang Yai 及び Bang Bua Thong は T＝15 m^2／時 S＝1×10^{-4} として計算する。

Sai Noi 及び Nong Chok

140 m^3／日／$m\times10m\times0.7$＝980 m^3／日／well

Min Buri，Bang Phli，Bang Bo，Lat Krabang，Bang Bua Thong，Bang Yai

220 m^3／日／$m\times10m\times0.7$＝1540 m^3／日／well

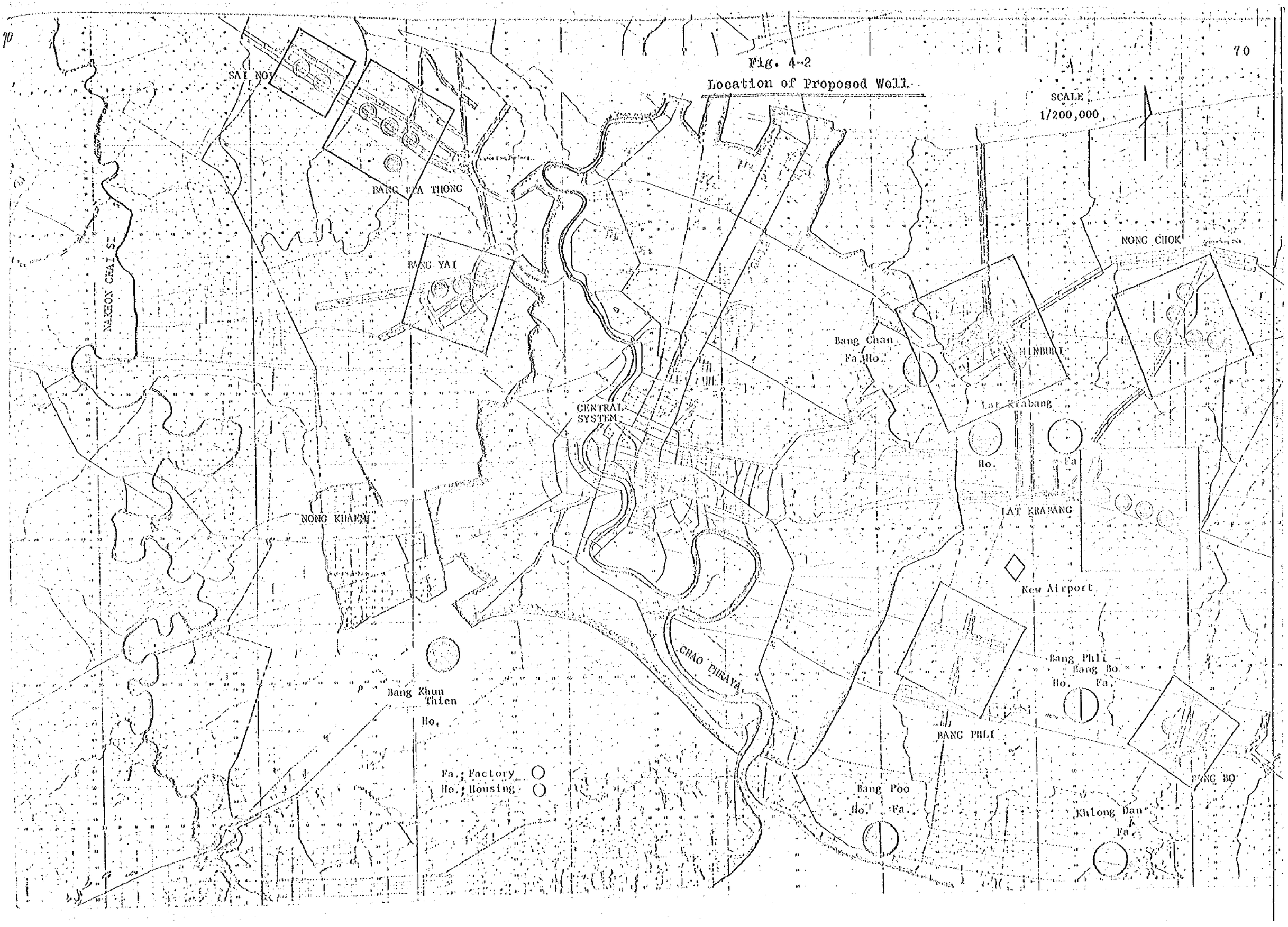
以上の結果をまとめると表4－2のとおりであり，井戸配置は図4－2に示す。

Table-4-2

Location	Daily Demand CMD	Lifting Volume, CMD/well	No. of Wells	Recharge Area km^2	-do- per each well km^2
BANG PHLI	3,800	1,540	3	40	13.3
BANG BO	2,500	1,540	2	26.3	13.1
MIN BURI	7,300	1,540	5	76.8	15.4
NONG CHOK	4,500	980	5	47.3	9.5
LAT KRABANG	7,500	1,540	5	59.2	11.8
SAI NOI	1,500	980	2	15.8	7.9
BANG BUA THONG	5,200	1,540	4	41.1	10.3
BANG YAI	4,400	1,540	3	34.7	11.6

Fig. 4-2

Location of Proposed Well



4－2　表　流　水

表流水をSeparate Systemの水源として考えた場合，Fig. 4－3に示すKhlong及びRiverが，計画給水区域との関連において，位置的に大きな可能性を占めている。

一方，水道水源として最も重要なFactorは，その水源の持つ水量と水質であることは言うまでもない。

今回の現地調査で得られたDataを基に，以下対象の表流水をKhlongとRiverに大別して，各水源毎にその可能性の大要を述べる。

1）Right Bang of Chao Phraya River

(1)　Khlong Water

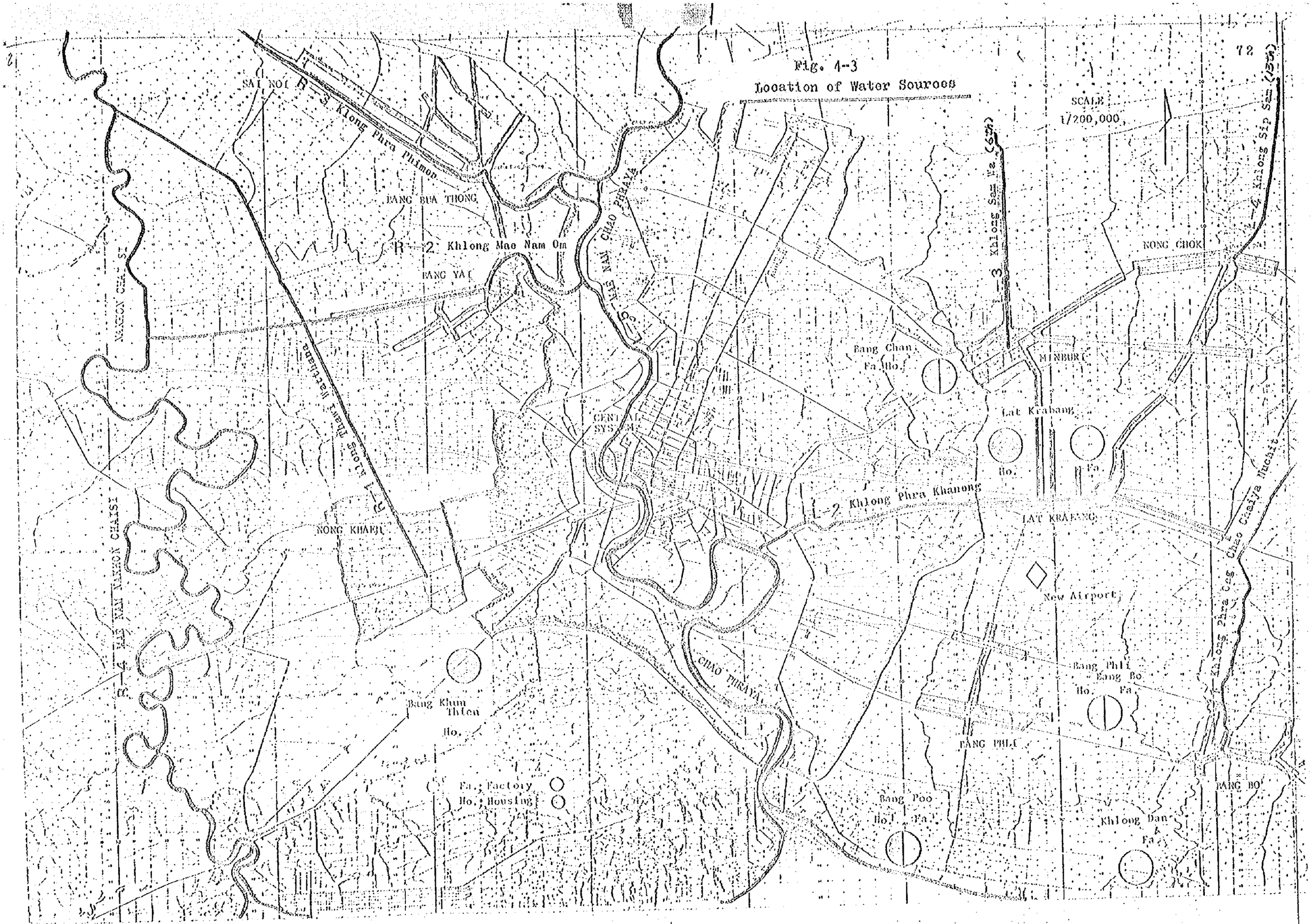
(i)　Khlong Thawi Watthana（R－1）

このKhlongは前回（1973年）のFeasibility Studyにおいて地下水の全く可能性のないNong Khaem地区の水道水源として，Recommendされた。一般的にKhlongの水を水道水源として考える場合問題となるのは，Khlongの有機的汚染の進行である。

従って，今回の踏査では，水道水源としての評価をするに当り，Khlongについては，特に有機的汚染に着眼して集中的に行なわれた。つまり，汚濁の指標としてBOD$_5$を採用して，各対象Khlongでの水質解析をした。

Khlong Thawi WatthanaについてのBOD$_5$値は，3点について行なったがその結果は以下に示す通りである。

Fig. 4-3
Location of Water Sources



Water Quality of Khlong Thawi Watthana

Item / Point	DO (ppm)	BOD-5 (ppm)	Remarks
Amphoe Taling Chan	1.5	4.3	Near Railway Bridge
Amphoe Phasi Charoen	2.8	5.2	In front of Wat Saladaeng
Amphoe Phasi Charoen	1.6	4.5	Near Petch Kasem Bridge

上表に示すように，本Khlongを水道水源として考えた場合，BOD_5は既に通常の水処理での限界値と言われる4 ppmを超えており，4年前検出されたBOD_5値1.6 ppmと比較すると約3倍の値であり，毎年約0.8 ppmづつ汚濁が進んでいることになる。

他方，本Khlongを水量的に評価した場合，第7章のRefference No 9に示すようにDry Seasonにおいては殆んど流量がないため，何らかの対策をたてなければ約50,000m^3／日にも及ぶNong Khaem地区のDemandには到底対応できないであろう。

以上，Khlong Thawi Watthanaについての検討の結果は，水道水源として重要な2つの要求である水量及び水質のどちらも不適当であると判断された。よって，本Khlongは計画水源の枠よりはずさなければならない。

(iii) Khlong Mae Nam Om (R--2)

Khlong Mae Nam Omは，Chao Phraya River本流より直接分岐しており，量的にも水道水源として充分であり，ゲート等の水制がないところから，水質的にもChao Phraya Riverと大差ないもの

と思われる。従って，もしChao Phraya River右岸全体の地域にChao Phraya Riverの水を供給するにしても，本Khlongでその役割は充分果たせるものと思われる。

前回の調査では，本Khlongの有機的汚染についての解析は，その外観より判断して不要として行なわれなかった。しかし，先に述べた如く，Khlong Thawi Watthanaが水道水源として不適当と判断されるに至った現在，右岸地区の水道水源としてKhlong Mae Nam Omは，大きなShareを占めることとなる。従って，その重要性を考えて本Khlongの水質解析を行なった。

(iii) Khlong Phra Phimon (R－3)

このKhlongは，Fig. 4－3に示す通り，位置的に他地区と大きく離れているSai Noi地区の表流水源として一応検討の対象と考えた。しかし，このKhlongの有機的汚染は非常に顕著なものであり，先に述べたKhlong Thawi Watthanaの水質と比較しても，その汚濁は，はるかに進行している。更に水量的にも非常に大きな不安が残る。

従って，一応位置的には評価できるが，水質的或いは水量的な評価をすれば，Khlong Phra Phimonは水道水源としての可能性は無い。

(2) River Water

(i) Nakhon Chai Si River (R－4)

今まで右岸地区のKhlong表流水の可能性について検討した結果，結局のところKhlong Mae Nam Omのみが，唯一のFeasibleな水道水源と考えられる。

また，右岸地区に他の表流水源の可能性を求めるならば，やゝ遠

くなるがNakhon Chai Si Riverが考えられる。Nakhon Chai Si River にSeparate Systemの右岸地区の全水量を求めた場合，そのTotal Demandは，２０００年においては５６,４００m^3／日（0.６５m^3／sec）である。

一方，Nakhon Chai Si Riverの渇水期における総水量は５0m^3／sec）であり，このうち３０m^3／secは塩水遡上防止の為の維持用水で，残りの２０m^3／sec＝1,８００,０００m^3／日が水道用水として取水可能であると伝えられている。

従って，右岸全体のSeparate SystemのDemandは，２０００年においても充分Coverできることになる。

また，C.M.D.（Camp Dresser & Mckee）のReportによれば，Central Systemにおける右岸全体のWater Demandは２０００年において1,２３０,０００m^3／日といわれ，この値にSeparate Systemの２０００年におけるWater Demandを上乗せしてもTotal Demandは1,２８６,４００m^3／日であり，今仮にChao phraya River右岸全域の水需要量を，このNakhon Chai Si Riverに依存したとしても取水可能量の2／3程度である。

従って，Chao Phraya Riverの横断Tunnelの工事の成否が問題となっている現在，もし，この横断工事が不可能となった場合は，Central Systemを右岸と左岸に分断して，Nakhon Chai Si Riverを水源とした変更計画を立案することが可能であろう。

他方，このように大きなCapacityを持つNakhon Chai Si Riverには，塩水遡上という水質的に大きな問題がある。Nakhon Chai Si Riverの塩水遡上に関する資料は比較的少ないが，前回（１９７３年）の踏査で入手したDataによると１９７０年に河口より６０～８０

kmの間に飲料水としての限度ぎりぎりのクロールイオン２００ppmを検出した実例や，６０km地点で１６,０００ppmという異常に高いクロールイオンを検出した１９６８年の実例が報告されている。

一方，前回の調査団によって行なわれた試験結果によるとSampling pointの最下流点であったKhlong Phasi Charoenとの交点（河口より２５km）においてもクロールイオン値約２０ppmに過ぎず，海水の遡上は認められなかった。

このようにクロールイオン濃度に関する資料が少ないことや，各資料の数値が大巾に違う為，これらの相関をつかむ事は非常に困難なことになっている。

従って，一応Nakhon Chai Si Riverよりの取水は，河口よりも８０km以上さかのぼるならば，水道水源として先ず問題がないものと見做される。しかし，もしNakhon Chai Si Riverを水源と定める場合には，水源の予定地点において少なくとも１ヶ年の水質試験を継続して行なう必要があろう。

2） Left Bank of Chao Phraya River

(I) Khlong Water

(i) Khlong Phra Ong Chao Chaiya Nuchit（L－1）

このKhlongは，Fig. 4－3に示す通り，Chao Phraya River左岸及び南部地区のAmphoe Bang Bo，Bang Phliの水源として位置的には非常に都合のよい所にある。また，水質的にも先に述べたKhlong Thawi Watthanaと比較するとかなり清澄であるといえる。

しかしながら，このKhlongは，現在Chacheong Sae Water Works (belonging to PWD)によって，4,800m^3／日の水が，水道原水として取水されており，新たに近い将来4,800m^3／日の水が

拡張工事として増量される予定である。

また，Amphoe Bang Bo から 2 km北に上った位置で，Bang Prakong Water Works（belonging to PWD）によって，5,000㎥／日の水が水道水源として計画されている。従って，既にTotal量で約15,000㎥／日の水が，他の水道施設の水源として配分されている事実を考えた場合，本Khlong は非常に捨て難い水源であるが，このKhlong に左岸南部地区，即ち，Bang Bo，Bang Phli，Khlong Dan，Bang Poo の総量 約120,000㎥／日もの大量の水を依存することは，量的に極めて困難であるので，このKhlong は水源として放棄せざるを得ないであろう。

(iii) Khlong Phra Khanong（L—2）

このKhlong は，前回の調査でAmphoe Lat-Krabang 地区の水源として暫定的に選定されたが，水質的には大きな問題が残っている。前回の調査で，このKhlong については，いわゆる有機的汚染の疑いが強かったので，BOD_5の試験が行なわれた。この結果は 2 ppm であり，同時期に実施されたKhlong Thawi Watthana のBOD_5値 1.6 ppm よりも大きく，水道水源としてはやゝ疑わしいものであった。しかし，前回のScope of Works の中では，Chao Phraya River 左岸地区については，対象がAmphoe Lat-Krabang地区のみに限られていたので，いたずらに遠い水源をLat-Krabang地区だけの為に求めることは経済的にFeasible なPlan だとは言えなかった。従ってKhlong Phra Khanong は，水道水源として決して最適であると言えないが，本Khlong に対する排水処理対策の早急な確立を前提として，一応Amphoe Lat-Krabang 地区に対する水源としてRecommend された。

しかし，先に述べたようにKhlong Thawi Watthana の水質汚染が毎年 BOD_5 値で約 0.8 ppmの割合で進行している事実や，Khlong 沿いに密集する人家を考えた場合，水道水源としては不適であろう。

(iii) Khlong 6 th（L—3）及びKhlong 13 th（L—4）

この2つのKhlongは，Chao Phraya River左岸のAmphoe MinBuri Nong Chokにそれぞれ流れ込んでいる。これらのKhlongは，北部に位置するKhao Yai 山脈に囲まれた広大な流域面積を持っている。従って，その流量は非常に豊富であり，特にKhlong 13 th においては，Flood Season で 20 m^3／sec，Dry Season においても 5 m^3／sec の水が直接 Nong Chok の Amphoe Town に流れ込んでいる。

この2つのKhlongに左岸全体のWater Demand を求めた場合，そのTotal量は2000年において193,000 m^3／日であるのに対し，Khlong 13 th のDry Season の流量は，先にも示した如く 5 m^3／sec = 432,000 m^3／日である。この内，Khlong 13 th の Separate System に対する取水可能量を半分と考えても充分に，左岸全体のDemand を満たすことになる。

この様にこの2つのKhlong は非常に重要なKhlong であり，Separate System内にあるKhlong の中では，水道水源として最適なものと言えよう。

又，Khlongにおいても，たびたび問題となる有機的汚染も，これらの2つのKhlong は例外であり，水質的な面からも，水道水源としてRecommendable なKhlong である。

(2) Chao Phraya River（L—5）

Separate System を考える場合のChao Phraya River の価値は，Separate System の水源として考えられている井戸，あるいはKhlong

が，水量及び水質的に将来その使用に堪えられなくなった場合に甚深い意味を持つであろう。

ＲＩＤが最近に調査したところによると，最下流の流量は８５m^3／secであり，河口における塩水遡上防止流量６０m^3／secを差引いた残りの２５m^3／sec（2,160,000m^3／日）の範囲でCentral Systemの水道水源に与えられるようである。

他方Central Systemの将来の必要原水量は表４－３の如くである。

Table-4-3: Demand Estimates of Raw Water for Water Supply in Bangkok Metropolitan Areas

Year	Raw Water Required			
	Surface Water cu.m./day	Ground Water cu.m./day,	Total cu.m./day	Ground Water as Percentage of cu.m./day
1975	1,000,000	350,000	1,350,000	25.92
1977	1,000,000	438,000	1,438,000	30.45
1978	1,800,000	580,000	2,380,000	29.36
1980	2,800,000	330,000	3,313,000	10.54
1985	3,600,000	160,000	3,760,000	4.25
1990	4,800,000	-	4,800,000	-
1995	6,000,000	-	6,000,000	-
2000	6,000,000	-	6,000,000	-

この表より判断されることは，近い将来Chao Phraya Riverおよびその他の水源開発が，Central System内の将来における水需要を満たす為に必要となってくるであろう。

4－3　Central System

さて今迄，Separate Systemの水源として，Well と Surface Water のみに限って検討を進めて来たが，ここでもう一つ，大きな可能性を占めている，Central System からの送水について検討を加える必要がある。

Table -4-4: Water Demand of Central System and Separate System

(unit: 1,000 CMD)

Year	Right Bank		Left Bank		Total		Ground Total	Separate System (% of Total Demand)
	Central System	Separate System	Central System	Separate System	Central System	Separate System		
1985	1,462	25	1,227	100	1,689	125	1,814	7.0
2000	1,064	60	3,558	190	4,622	250	4,872	5.0

* Excluding capacity of existing treatment plant & well

表4－4は，１９８５年と２０００年における Central System と Separate Systemの水需要の比較表である。

Separate Systemの２０００年における需要量は 250,000m^3/日であり，その量は Central Systemのそれに比較してわずかに５％にすぎない。

この事は，Separate Systemの水需要をすべて Central Systemでまかなう事の可能性が非常に大きい事を示している。したがって今回の Study の中に，Central Systemより，分水を受けた場合の可能性と経済性について，おおまかではあるが検討を加えた。

4－4　水 質 調 査

1）採 水 位 置

今回の水質調査は，

(1)　Chao Phraya，Nakhon Chai Si 両大河の塩水遡上の把握

(2)　水源となる可能性のあるKhlong Water の調査

(3)　既設井戸水の水質調査

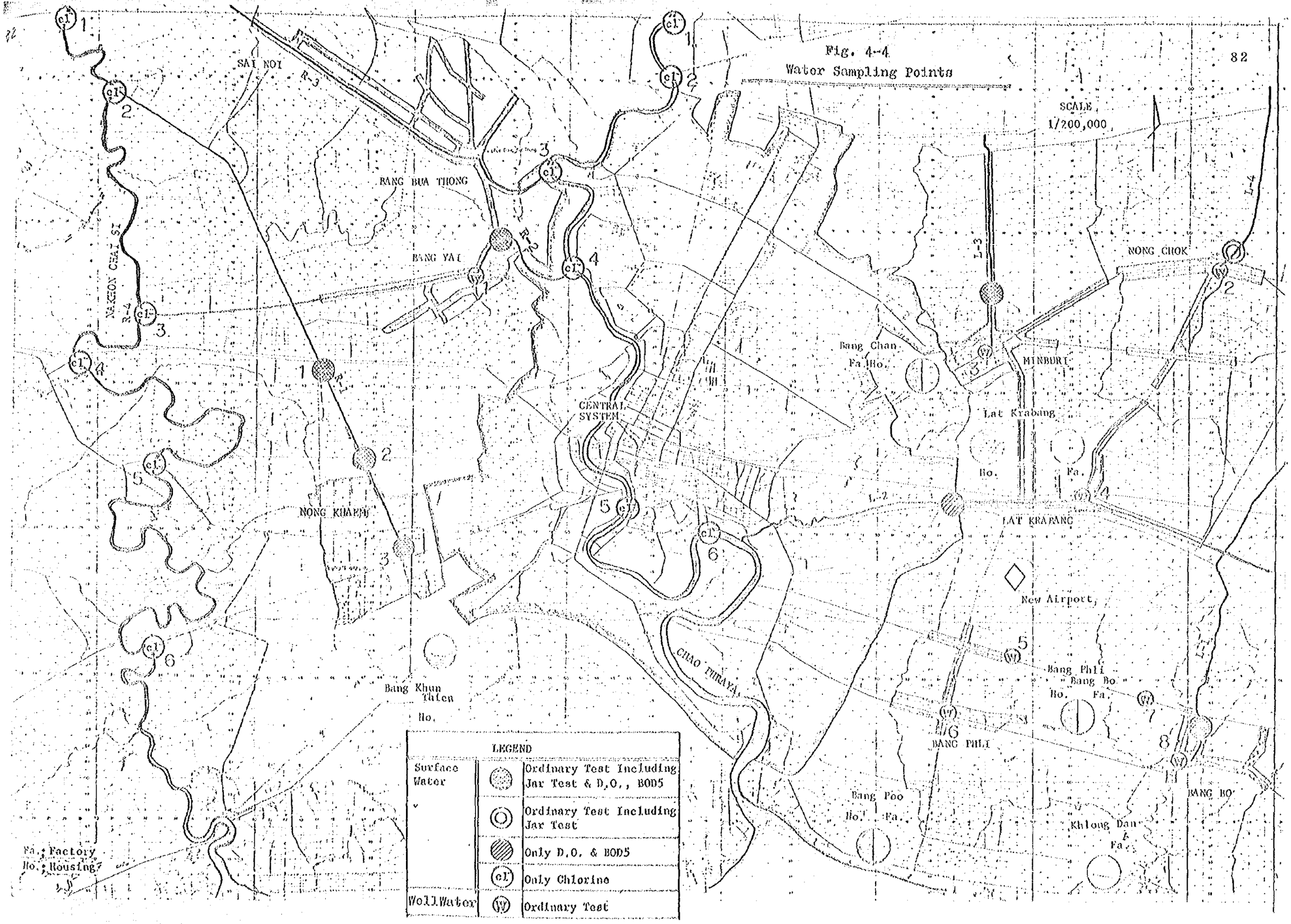
以上，3点に関して調査を行ないSeparate Systemの水源として良好な取水地点の選定がなされた。

各採水点の数は表4－5の如くであり，位置は図4－4に示す。

Table 4-5

Location	Item	Number
Khlong	Ordinary Test Including Jar Test & D.O., BOD-5	6
	Ordinary Test Including Jar Test	1
	Only D.O. & BOD-5	1
River	Only Chlorine	12
Well	Ordinary Test	8
Total		28

Fig. 4-4
Water Sampling Points



LEGEND		
Surface Water		Ordinary Test Including Jar Test & D.O., BOD5
		Ordinary Test Including Jar Test
		Only D.O. & BOD5
	cl	Only Chlorine
Well Water	W	Ordinary Test

2）考　察

(1)　Chao Phraya，Nakhon Chai Si 両河川については，Chao Phraya の水を既に Sam Sen 浄水場で多量に使用しており，両河川共，量的にみて一般的な水質調査は必要ないものと思われるため，今回は塩水遡上の現況把握とその予測に重点を置くことにした。

なお，採水点の選定については，過去の測定 Data との比較をはかる意味で，概ね同一場所からの採水となるよう考慮し，新しい地点を主に上流側に加えることで採水点が決定された。

まず，Nakhon Chai Si の採水は，海から約２０km～９０kmに亘る 6 point，各３層（上層，中層，下層，No 6 の中層，下層は除く）Total １６本の採水が行なわれた。

また，Chao Phraya 河については，中層の測定を除くものとし，採水場所は，Nakhon Chai Si と同様，海から約２０km～９０km に至る 6 point Total １２本の採水が行なわれた。

(2)　井戸水の水質調査

電気探査と聞き込み調査によって得られた現況での井戸水の利用状況と Ground Water の概況を基に，近い将来に亘っても取水可能と思われる地点についてのみ採水を行なった。

(3)　Khlong Water の水質調査

前回の調査対象であった Khlong Watthana をはじめ，その他の各 Khlong Water については，常にほとんどの Test が必要と思われるが，L－４（Khlong １３ th）の場合は，位置，人口の張り付き具合から見て L－３（Khlong ６ th）より比較的清浄と考えられること，および L－２の場合は外見的に汚濁が進行していることから，L－４と L－２ Khlong については Test 項目を減らし，作業の円滑化をはかる

ものとした。

なお，水質調査は本来継続して行なうもので，今後Studyが進むにつれ，水源として重要な位置付けがなされたものについては，より長期的な調査が必要であることを付け加えておきたい。

以下水質試験結果を表4－6～4－8に示す。

Table 4-6

Result of Water Quality Analysis

River (ppm)

	Chao Phraya River			Nakhon Chai Si River		
	Surface	Middle	Bottom	Surface	Middle	Bottom
1	11.0		10.0	10.0	9.0	8.0
2	10.0		11.0	13.0	11.0	11.0
3	11.0		10.0	13.0	15.0	14.0
4	13.0		12.0	14.0	17.0	16.0
5	30.0		45.0	19.0	18.0	17.0
6	2,750.0		3,850.0	144.0	--	--

Table 4-7

Result of Water Quality Analysis

Khlong

Chemical Analysis	R-1-1	R-1-2	R-1-3	R-2	L-1	L-2	L-3	L-4
Color	nil	nil	nil	nil	nil		nil	nil
Odor	"	"	"	"	"		"	"
Turbidity	125	170	80	22.0	88		73	75
pH	7.10	7.22	7.46	7.4	7.3		7.2	7.65
Methyl Orange Alkalinity	110	112	136	92	134		82	88
Phenolphthalein Alkalinity	nil	nil	nil	nil	nil		nil	nil
Total Solids	574	954	436	152	642		303	415
Dissolved Solids	206	230	250	100	310		120	90
Suspended Solids (by M.F.)	-	-	-	-	262		154	295
Total Hardness as Calcium Carbonate	140	152	144	94	152		106	88
Carbonate Hardness "	110	112	136	92	134		82	88
Non-Carbonate Hardness "	30	40	8	2	18		24	nil
Chloride as Chlorine	25	40	66	8	92		10	8
Sulphate as Sodium Sulphate	42.6	-	-	6.4	59.6		52.5	22.7
Oxygen Consumed 37°C. 3 hours	5.782	7.036	6.554	1.620	6.112		2.222	0.889
Ammonia free as Nitrogen	0.700	0.564	1.056	0.336	-		0.496	0.404
Ammonia-albuminoid as Nitrogen	1.092	1.348	1.124	0.408	-		0.604	0.804
Total Organic N. as Nitrogen	-	-	-	-	-		-	-
Nitrate as Nitrogen	0.625	0.385	0.025	0.250	0.175		0.115	nil
Nitrite as Nitrogen	0.0530	0.0374	0.0194	0.002	0.0218		0.0176	0.0046
Calcium	-	-	-	-	-		-	-
O-Phosphate	0.14	0.07	0.23	0.13	-		-	-
Iron	4.0	7.8	2.0	0.52	3.7		1.63	1.77
Fluoride as Fluorine	-	-	-	0.39	-		-	-
Manganese	0.207	0.450	0.070	nil	0.263		nil	nil
Magnesium	-	-	-	-	-		-	-
Free Carbon Dioxide	11	14	14	6.0	-		-	-
D.O.	1.5	2.8	1.6	4.7	0.5	0.1	2.6	-
B.O.D.	4.3	5.2	4.5	1.3	2.2	4.2	0.8	-
Bacteria 37°C-24hrs. (Number/ml)	11,000	18,000	35,000	16,500	18,000		24,000	13,000
Coliform bacteria (")	115,000	135,000	144,000	23,000	47,000		261,000	162,000
Faecal coliform (Number/100 ml)	55,000	60,000	81,000	5,000	2,000		66,000	14,000

Note: R-1-1, Khlong Thawee Wattana

R-1-2, " " "

R-1-3, " " "

R-2, Khlong Mae Nam Om

L-1, Khlong Phra Ong Chaiya Nuchit

L-2, Khlong Phra Khanong

L-3, Khlong Sam Wa

L-4, Khlong Sip Saam

Table 4-8

Well Water

Item \ Place	W-1 Bang Yai	W-2 Nong Chok	W-3 Min Buri	W-4 Lat Krabang	W-5 Bang Phli 1	W-6 Bang Phli 2	W-7 Bang Bo 1	W-8 Bang Bo 2
Color	nil	nil	nil	nil	nil	nil	nil	nil
Odor	"	"	"	"	"	"	"	"
Turbidity	3.6	0.5	2.3	1.2	14.0	2.8	1.3	3.4
pH	7.1	7.98	7.55	7.5	7.6	7.5	7.92	7.7
Methyl Orange Alkalinity	256	430	368	386	292	340	328	282
Phenolphthalein Alkalinity	nil	14	8	4	nil	nil	8	nil
Total Solids	364	926	500	534	507	654	567	740
Dissolved Solids	330	730	390	400	375	510	430	595
Suspended Solids	"	"	"	"	"	"	"	"
Total Hardness as Calcium Carbonate	166	120	96	86	136	172	76	148
Carbonate Hardness	166	120	96	86	136	172	76	148
Non-Carbonate Hardness	nil	nil	nil	nil	nil	nil	nil	nil
Chloride as Chlorine	40	126	18	13	43	118	48	166
Sulphate as Sodium Sulphate	9.7	73.8	58.2	48.2	61.1	75	12.8	110
Osygen Consumed 37°C. 3 hours	"	"	"	"	"	"	"	"
Ammonia-free as Nitrogen	"	"	"	"	"	"	"	"
Ammonia-albuminoid as Nitrogen	"	"	"	"	"	"	"	"
Total Organic N.as Nitrogen	"	"	"	"	"	"	"	"
Nitrate as Nitrogen	"	nil	nil	nil	nil	nil	nil	trace
Nitrite as Nitrogen	"	trace	trace	trace	trace	0.0026	trace	0.0036
Calcium	"	"	"	"	"	"	"	"
O-Phosphate	0.03	"	"	"	"	"	"	"
Iron	0.40	nil	nil	nil	2.4	nil	nil	nil
Fluoride as Fluorine	0.39	"	"	"	"	"	"	"
Manganese	0.31	trace	trace	trace	trace	nil	nil	nil
Magnesium	"	"	"	"	"	"	"	"
Free Carbon Dioxide	56.0	28.0	34.0	36.0	28.0	22.0	16.0	42.0
MPN per 100 ml	0	0	0	0	0	38	0	38
24hr. Total Plate Count at37°C	0				2	49	14	11

第 5 章　比較設計案の概略

第 5 章　比較設計案の概略

Separate Systemの水需要量に対し，広域的水道計画としては種々の案が考えられる。

今までの検討結果より，まず水源として可能なものは次の通りである。

1）各 Amphoe の需要量に対応できる Well

2）水量，水質共良好である Khlong

3）Chao Phraya River 及び Nakhon Chai Si River

4）Central Systemよりの送水

以上の水源を対象として，各地区への給水計画を検討した結果，Right Bank で 5 Case，Left Bank で 4 Case の比較案が考えられた。

各 Case の水源と給水地区の組合せを表 5 － 1，5 － 2 に示し，比較概略図は図 5 － 1 ～ 5 － 9 に示すとおりである。

Comparative Plans for The Right Bank of Chao Phraya River

	Water Source	Water Demand (CMD)	Surved Area
Case 1 (R)	Central System	56,400	Amphoe: Sai Noi, Bang Bua Thong, Bang Yai Nong Khaem Additional Area: Bang Khun Thien
Case 2 (R)	Well	11,100	Amphoe: Sai Noi, Bang Bua Thong, Bang Yai
	Central System	45,300	Amphoe: Nong Khaem Additional Area: Bang Khun Thien
Case 3 (R)	Well	11,100	Amphoe: Sai Noi, Bang Bua Thong, Bang Yai
	Surface (Nakhon Chai Si)	45,300	Amphoe: Nong Khaem Additional Area: Bang Khun Thien
Case 4 (R)	Khlong (Mae Nam Om)	11,100	Amphoe: Sai Noi, Bang Bua Thong, Bang Yai
	Central System	45,300	Amphoe: Nong Khaem Additional Area: Bang Khun Thien
Case 5 (R)	Khlong (Mae Nam Om)	56,400	Amphoe: Sai Noi, Bang Bua Thong, Bang Yai, Nong Khaem Additional Area: Bang Khun Thien

Table 5-2

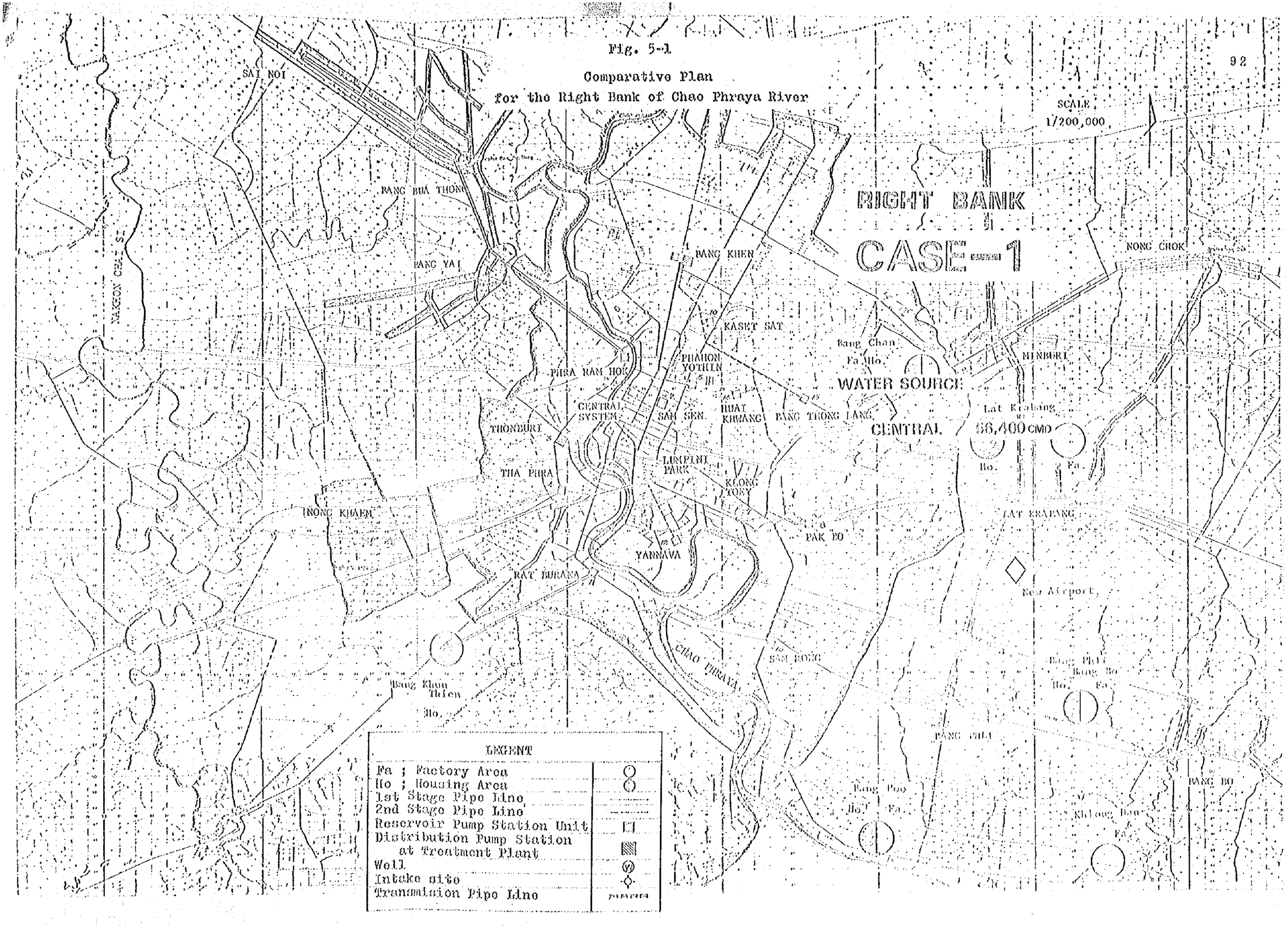
Comparative Plans for The Left Bank of Chao Phraya River

	Water Source	Water Demand (CMD)	Served Area
Case 1 (L)	Well	26,650	Amphoe: Min Buri, Nong Chok, Lat Krabang, Bang Phli, Bang Bo
	Central System	166,450	Additional Area: Bang Chan, Lat Krabang, New Airport, Bang Phli, Bang Bo, Khlong Dan, Bang Poo
Case 2 (L)	Well	26,650	Amphoe: same Case 1 (L)
	Khlong (Khlong 6th, 13th)	166,450	Additional Area: same Case 1 (L)
Case 3 (L)	Central System	193,100	Amphoe: Min Buri, Nong Chok, Lat Krabang, Bang Phli, Bang Bo Additional Area: Bang Chan, Lat Krabang, New Airport, Bang Phli, Bang Bo, Khlong Dan, Bang Poo
Case 4 (L)	Khlong (Khlong 6th, 13th)	193,100	Amphoe: same Case 3 (L) Additional Area: same Case 3 (L)

Fig. 5-1

Comparative Plan

for the Right Bank of Chao Phraya River



LEGENT	
Fa ; Factory Area	
Ho ; Housing Area	
1st Stage Pipe Line	
2nd Stage Pipe Line	
Reservoir Pump Station Unit	
Distribution Pump Station at Treatment Plant	
Well	
Intake site	
Transmission Pipe Line	

Fig. 5-2
Comparative Plan
for the Right Bank of Chao Phraya River

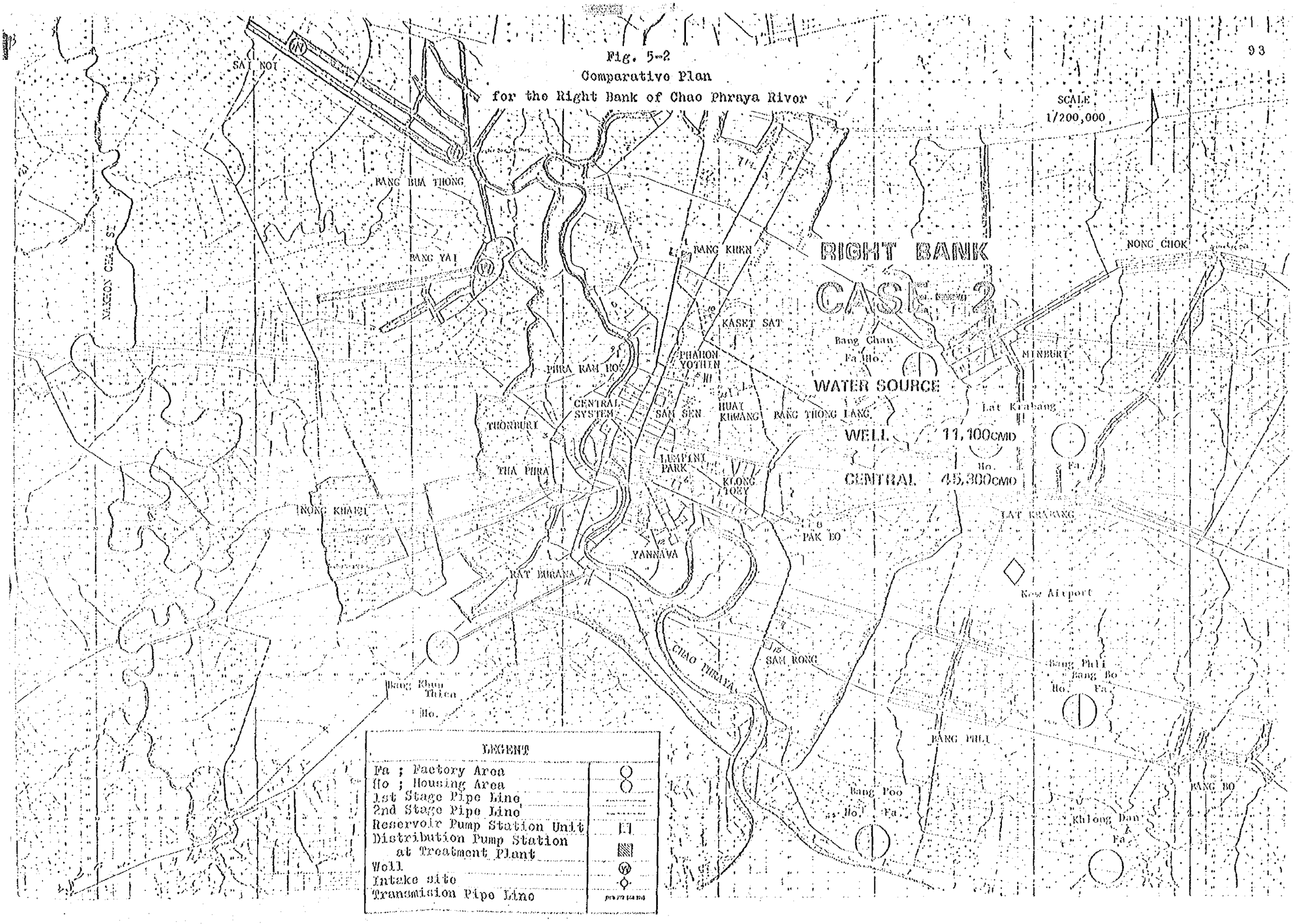


Fig. 5-3

Comparative Plan
for the Right Bank of Chao Phraya River

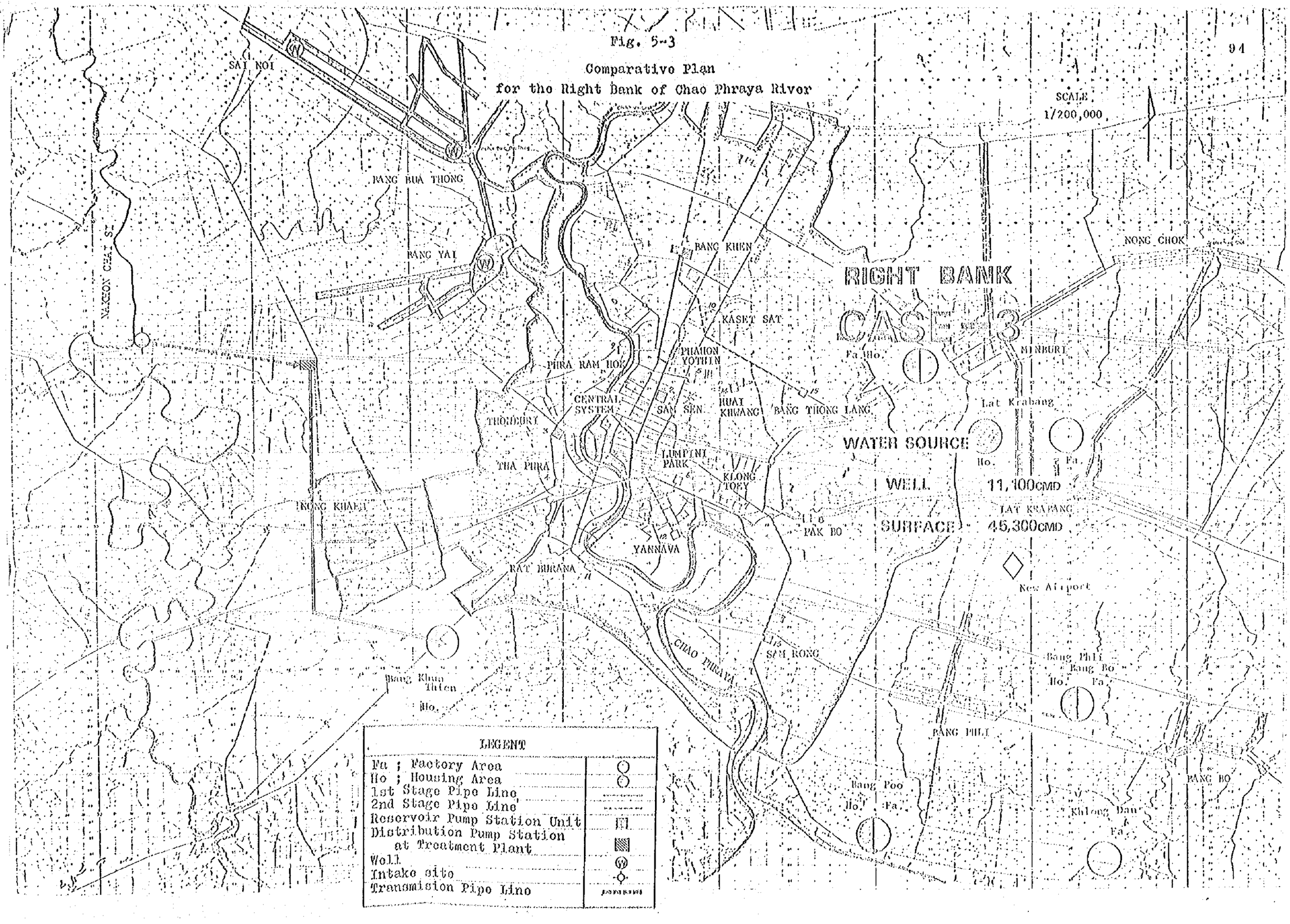
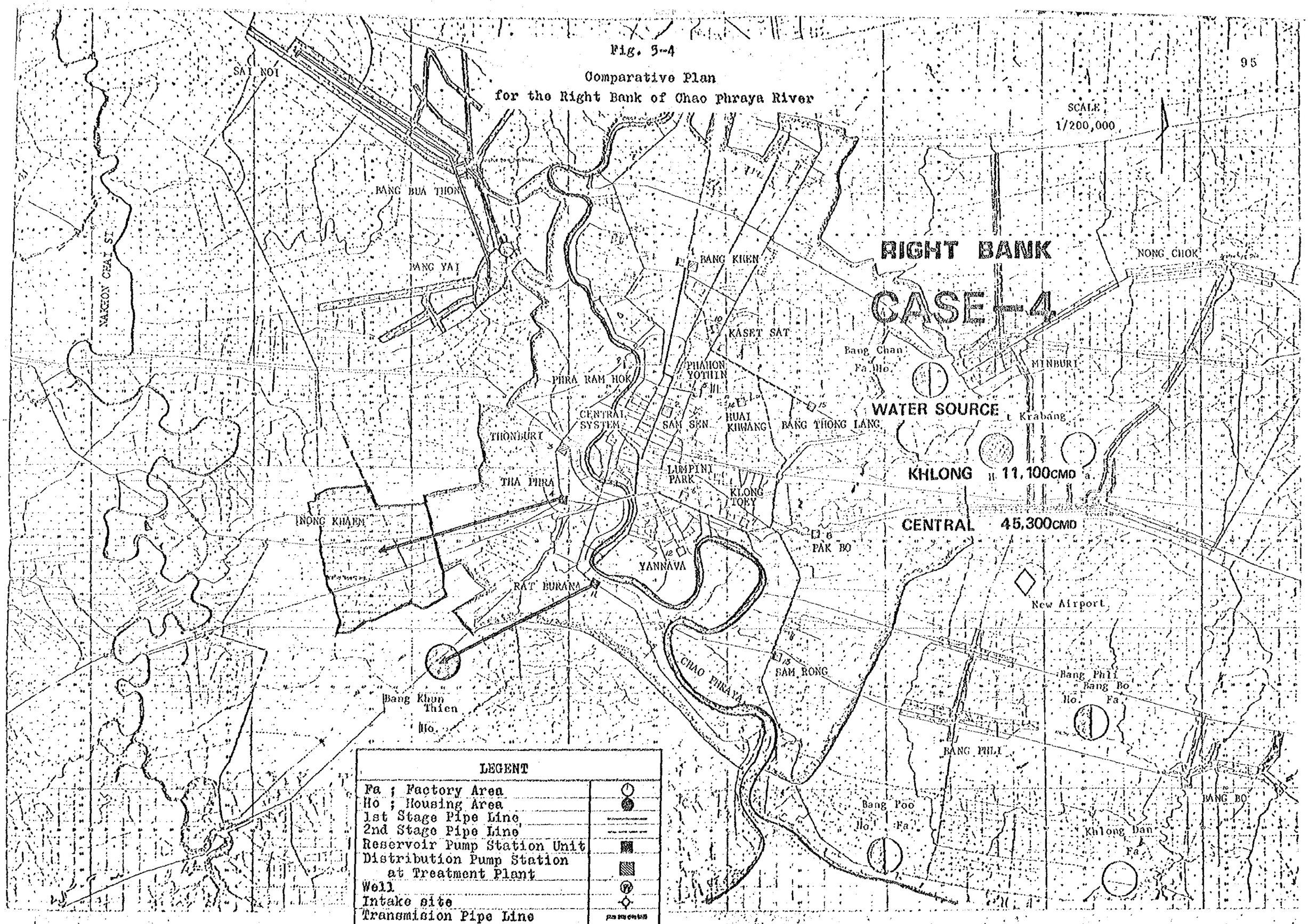


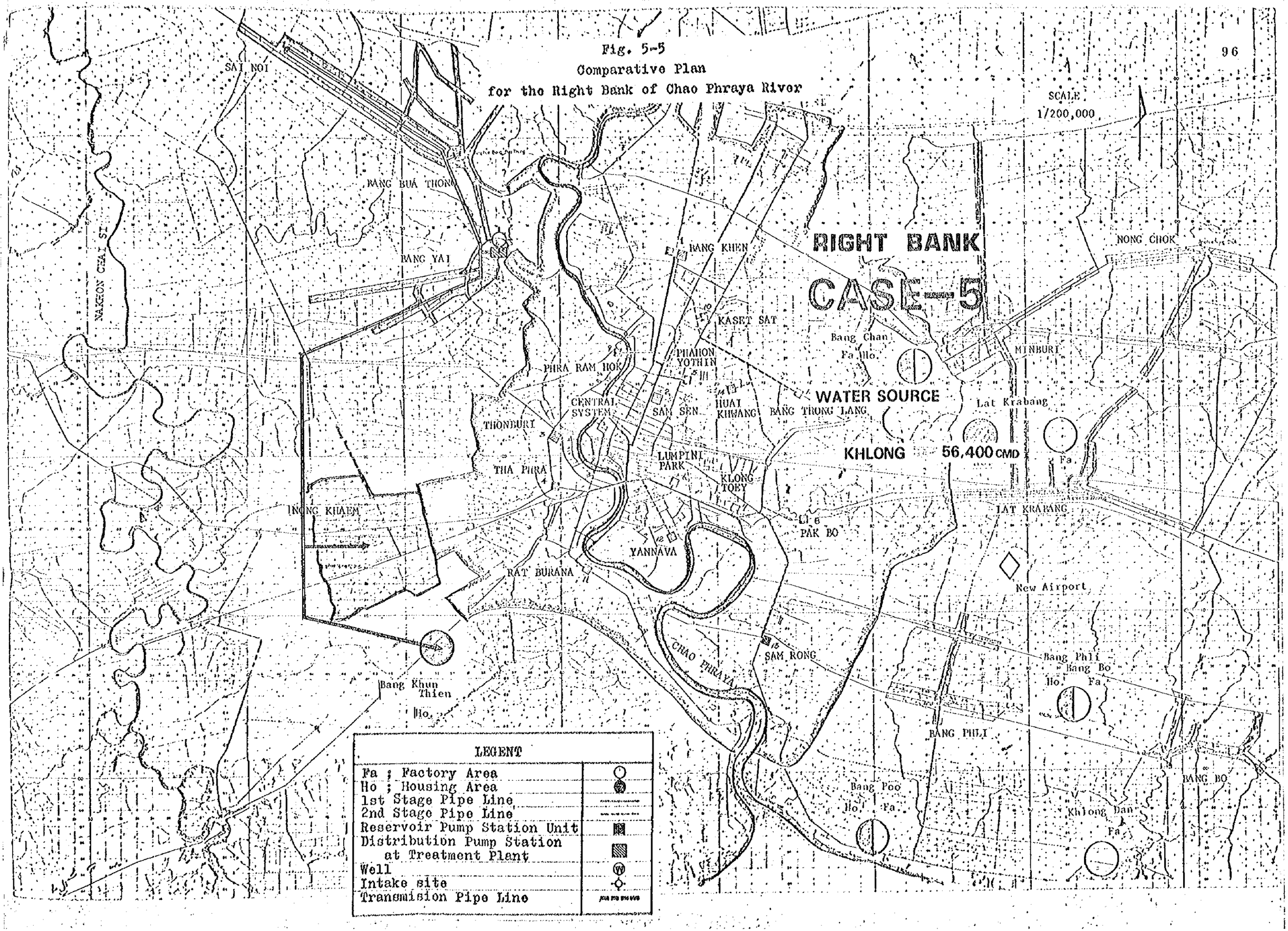
Fig. 5-4

Comparative Plan
for the Right Bank of Chao Phraya River



LEGENT	
Fa ; Factory Area	
Ho ; Housing Area	
1st Stage Pipe Line	
2nd Stage Pipe Line	
Reservoir Pump Station Unit	
Distribution Pump Station at Treatment Plant	
Well	
Intake site	
Transmision Pipe Line	

Fig. 5-5
Comparative Plan
for the Right Bank of Chao Phraya River



LEGENT	
Fa ; Factory Area	
Ho ; Housing Area	
1st Stage Pipe Line	
2nd Stage Pipe Line	
Reservoir Pump Station Unit	
Distribution Pump Station at Treatment Plant	
Well	
Intake site	
Transmision Pipe Line	

Fig. 5-6

Comparative Plan
for the Left Bank of Chao Phraya River

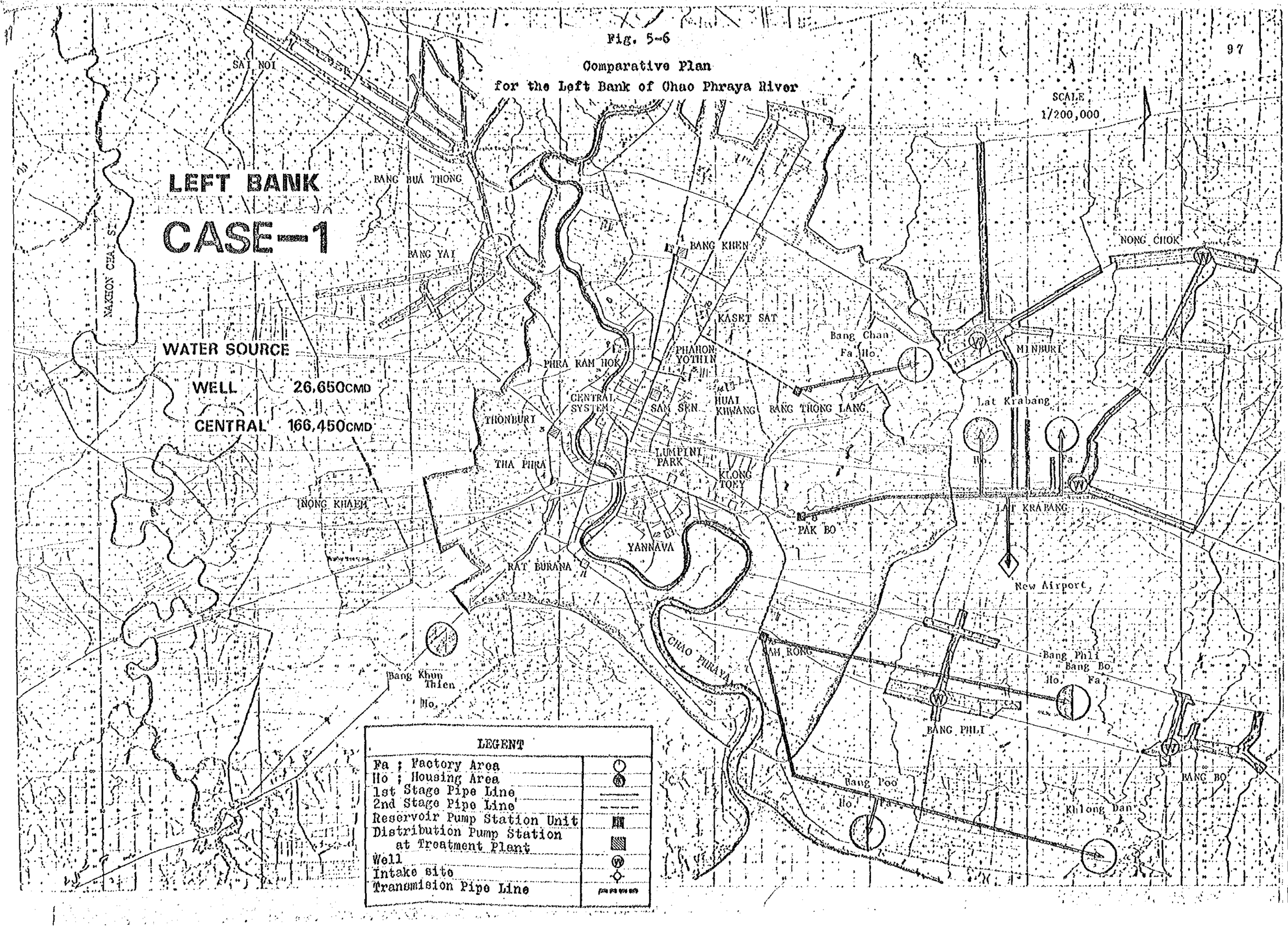


Fig. 5-7

Comparative Plan

for the Left Bank of Chao Phraya River

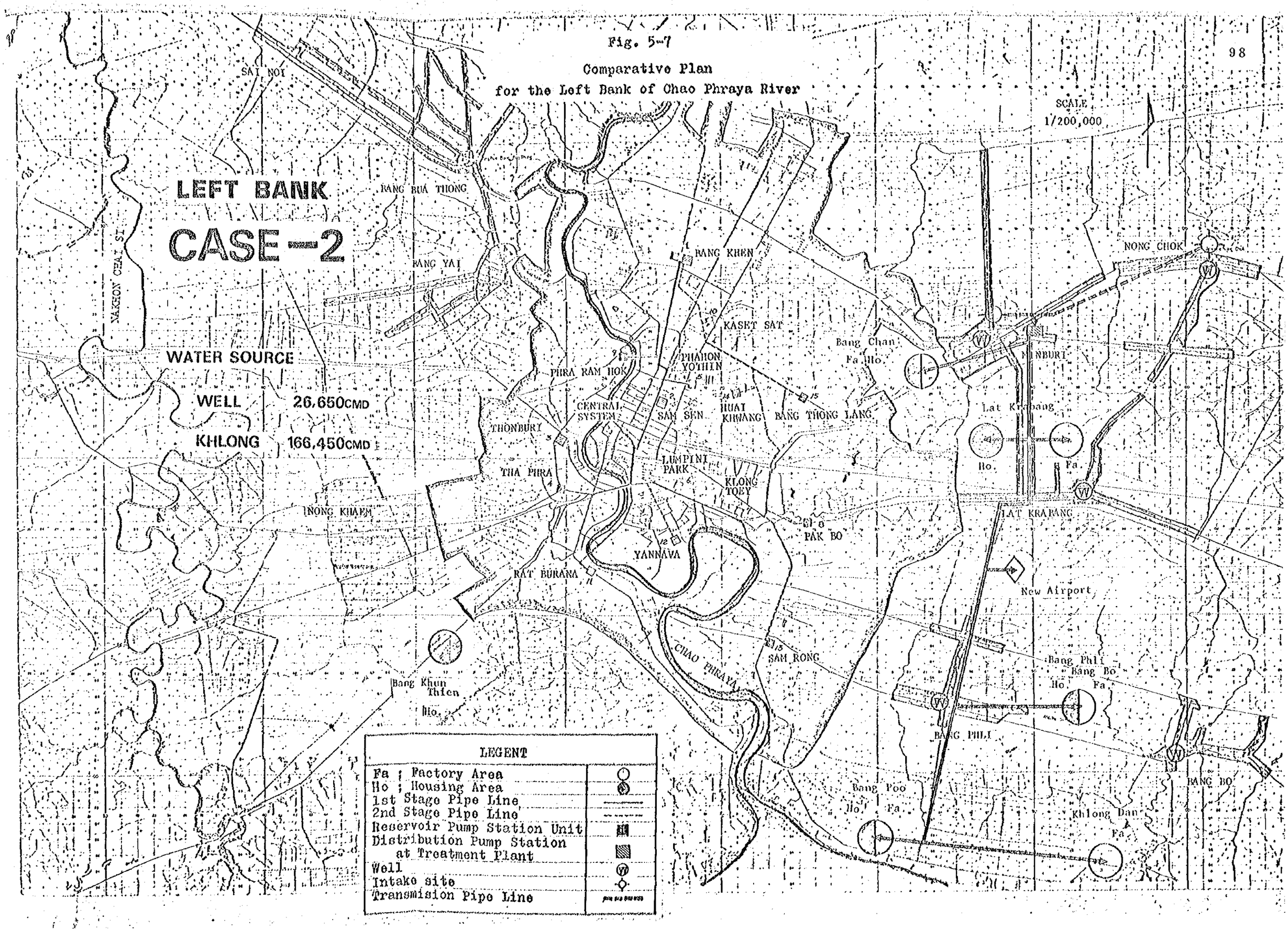


Fig. 5-8

Comparative Plan
for the Left Bank of Chao Phraya River

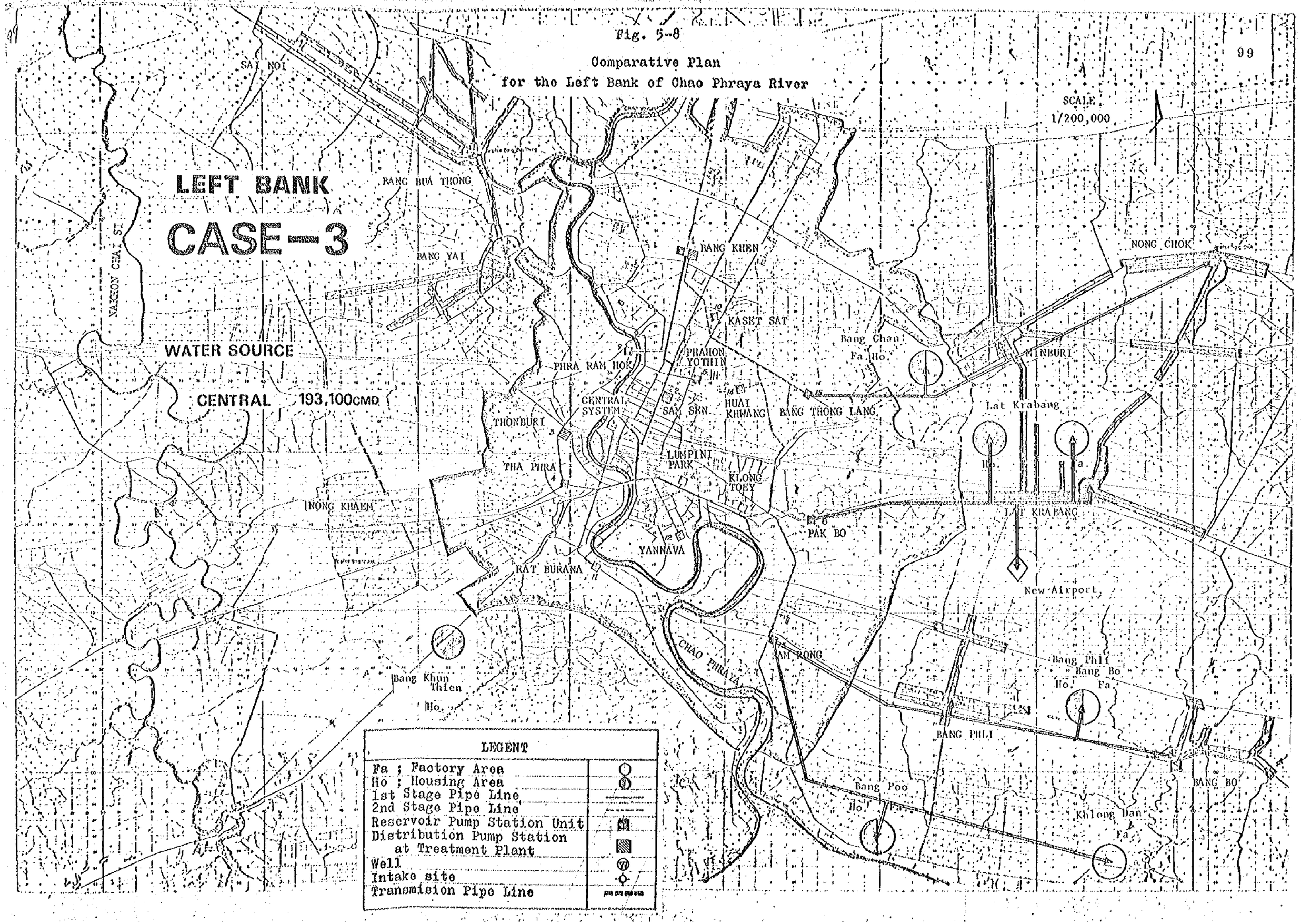
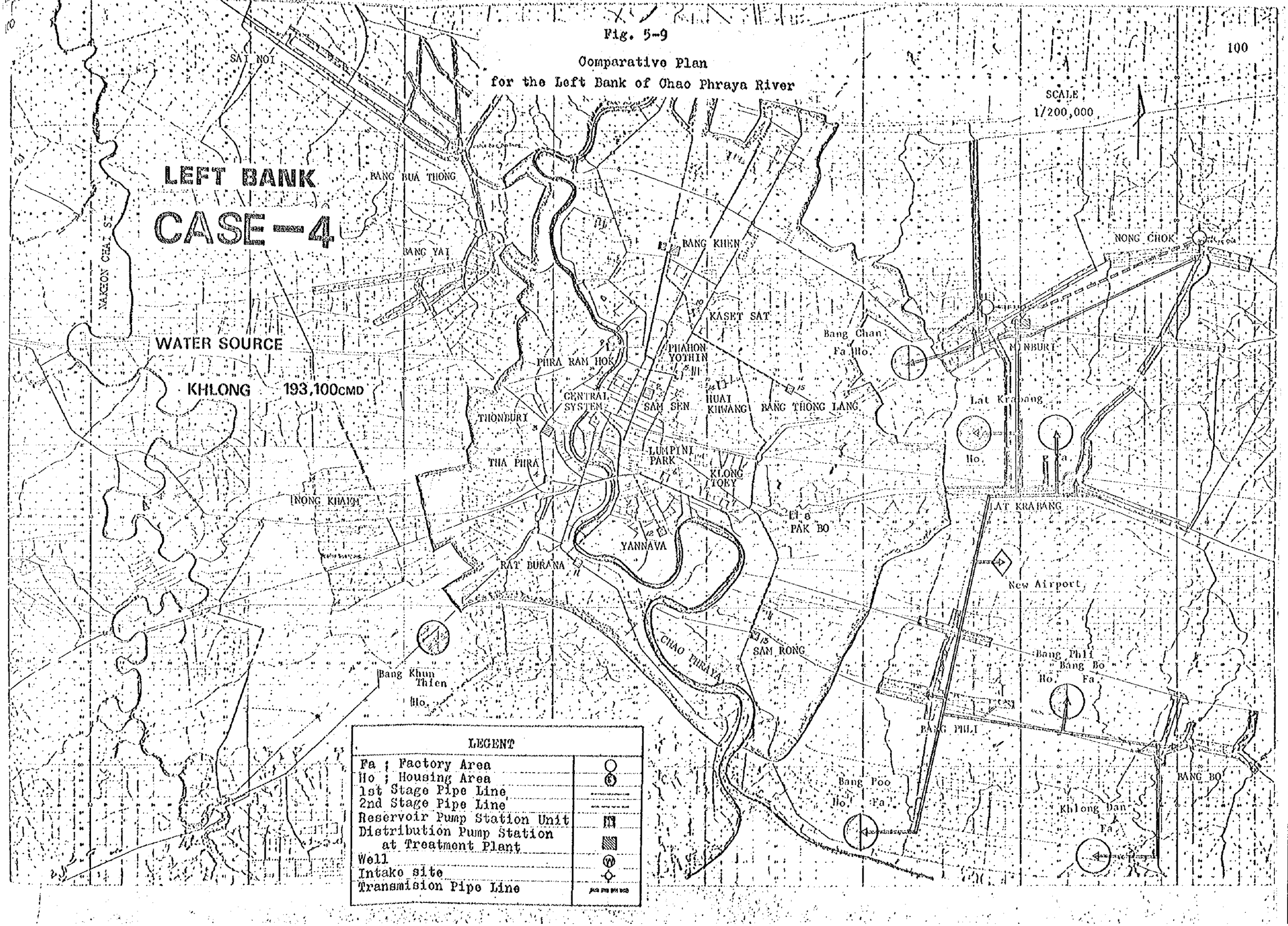


Fig. 5-9

Comparative Plan

for the Left Bank of Chao Phraya River



第 6 章　収　集　資　料

6-1 Labour and Material Cost

(1) Wages by Occupation at Bangkok Separated System Area

Occupation	Unit (per day)	Cost (Baht)	Remarks
Carpenter	person	100	
Electrician	person	120	
Plasterer	person	150	
Welder	person	150	
Mason	person	150	
Steel Bending Worker	person	120	
Plumber	person	40	
Machine Operator	person	80	
Assistant	person	40	
Worker	person	30	

(2) Cost of Materials

(Including Customs Tariff) Unit: Baht

Item	Unit	Foreign Currency	Domestic Currency	Remarks
DCIP Ø100	1 m	250	135	Include Joint
" 150	"	358	193	"
" 200				"
" 250				"
" 300	1 m	740	399	"
" 350	"	851	459	"
" 400	"	1,096	579	"
" 450	"	1,280	689	"
" 500	"	1,490	805	"
" 600	"	1,963	1,057	"
" 700	"	2,590	1,394	"
" 800	"	3,203	1,725	"
DCIP Ø100				
150				
200				
250				
300				

Item	Unit	Foreign Currency	Domestic Currency	Remarks
DCIP Ø350	1 kg	14.7	7.9	Include Joint
400	"	15.1	8.3	"
450	"	15.0	8.1	"
500	"	14.8	7.9	"
600	"	14.4	7.8	"
700	"	14.8	8.0	"
800	"	14.6	7.8	"
DCIP Fitting Ø100				
150				
200				
250				
300				
350	1 kg	32.2	14.5	
400	"	32.2	14.5	
450	"	32.2	14.5	
500	"	32.3	14.6	
600	"	32.3	14.6	
700	"	32.3	14.6	
800	"	32.3	14.6	
DCIP Gland Ø100	1 set	130	56	
150	"	140	60	
200	"	236	101	
250	"	319	137	
300	"	335	143	
350	"	437	187	
400	"	715	307	
450	"	788	338	
500	"	883	378	
600	"	1,016	436	
700	"	1,577	676	
800	"	1,890	811	
SP Ø350 x 6m	1 pc	6,413	3,454	Flange, Tar-Epoxy Coating
400 x 6m	"	7,216	3,885	"
450 x 6m	"	8,067	4,345	"
500 x 6m	"	8,854	4,768	"
600 x 6m	"	10,832	5,833	"
800 x 6m	"	14,977	8,065	"
SP Ø350	1 kg	17.4	9.3	"
400	"	17.0	9.1	"
450	"	16.3	8.8	"
500	"	15.7	8.5	"
600	"	15.5	8.4	"
800	"	13.3	7.2	"
SP Ø 12	1 m	-	17	GSP
20	"	-	22	"
25	"	-	32	"
32	"	-	42	"

Item	Unit	Foreign Currency	Domestic Currency	Remarks
SP Ø 35	1 m	-	48	Flange, Tar-Epo xy Coating
50	"	-	68	"
60	"	-	88	"
80	"	-	114	"
100	"	-	146	"
150	"	-	306	"
200	"	-	808	"
250	"	-	1,261	GSP
300	"	-	1,612	"
350	"	1,068	576	Tar-Epo xy Coating
400	"	1,203	647	"
450	"	1,344	724	"
500	"	1,475	795	"
600	"	1,805	972	"
800	"	2,496	1,344	"
SP Fitting	1 kg	-	40	
"	"	44.2	19.8	
ACP (20) Ø100	1 m	-	71	Include Fitting
" 125	"	-		"
" 150	"	-	93	"
" 200	"	-	140	"
" 250	"	-	185	"
" 300	"	-	239	"
" 400	"	-		"
" 500	"	-	685	"
" 600	"	-		"
ACP (A) Ø 80	1 m	-	15	"
" 100	"	-	17	"
" 150	"	-	26	"
Gibault Ø 75	1 set	-	65	
" 100	"	-	71	
" 150	"	-	124	
" 200	"	-	187	
" 250	"	-	237	
" 300	"	-	304	
" 400	"	-	595	
" 500	"	-	730	
" 600	"	-	1,041	
ACP Fitting	1 kg	-	15	
"	"	44,2	19.8	
SV Ø 75	1 set	4,084	1,086	Screw-Type
100	"	4,748	1,262	"
125	"			"
150	"	6,701	1,773	"
200	"	8,823	2,436	"
250	"	11,750	3,124	"

Item	Unit	Foreign Currency	Domestic Currency	Remarks
SV Ø300	1 set	14,940	3,971	Screw-Type
350	"	17,347	4,611	"
400	"	23,987	6,376	"
450	"	29,327	7,796	"
500	"	50,503	13,425	"
BV Ø350	"	32,271	8,578	"
400	"	38,556	10,249	"
450	"	42,555	11,312	"
500	"	45,222	12,019	"
600	"	53,256	14,156	"
700	"	76,586	20,358	"
800	"	86,968	23,916	"
Air Valve	1 set	8,518	1,964	
Angle Valve Ø 13	1 set	-	395	
" 19	"	-	479	
" 35	"	-	1,032	
" 100	"	-	4,000	
PVCP Ø 15	1 m	-	3	
18	"	-	4	
20	"	-	5	
25	"	-	7	
35	"	-	9	
40	"	-	12	
55	"	-	18	
65	"	-	29	
80	"	-	40	
100	"	-	64	
125	"	-	99	
Concrete Pipe Ø100	1 m	-	30	
150	"	-	48	
200	"	-	58	
250	"	-	81	
300	"	-	100	
500	"	-	172	
600	"	-	230	
R.C.P. Ø500	1 m	-	263	Reinforced
Bolt & Packing Ø 75	1 set	-		
100	"	-	10	
150	"	-	14	
200	"	-	20	
250	"	-	32	
300	"	-	42	
350	"	-	58	
400	"	-	68	
450	"	-		

Item	Unit	Foreign Currency	Domestic Currency	Remarks
Bolt & Packing Ø500	1 set	-	106	
" 600	"	-	140	
" 700	"	-	190	
" 800	"	-	250	
Steel Plate	1 kg	4.3	1.0	
L - Steel	"	6.1	1.2	
I - Steel	"	9.6	2.4	
C. H. Plate	"	5.8	1.0	
Steel Sheet Pile	"	6.5	1.5	
Trench Sheet Pile	"	6.1	1.9	

(3) Unit Cost Estimations for the Various Categories
(Including Customs Tarriff) (unit: Baht)

Item	Unit	Materials		Labor	Cost	Remarks
		F. Cost	D. Cost	D. Cost		
Excavation						
(a) By Hand	1 cum	-	-	27	27	
(b) By Bulldozer	"	-	10	1	11	10 ton
(c) Cost of Operating	1 hr	-	37	19	56	
(d) By Shovel	1 cum	-	20	1	21	Cap: 0.6cum
(e) By Dragline	"	-	57	1	58	"
(f) Cost of Operating	1 hr	-	49	19	68	
Surplus Soil						
(a) By Hand	1 cum	-	-	21	21	
(b) By Dump Trucks	"	-	32	3	35	
(c) Cost of Operating	1 hr	-	46	19	65	
Concrete Pile						
(a) 300mm L=6m	1 pc	-	975	62	1,037	
(b) Cost of Operating	1 day	-	13	32	45	
(c) 300m L=8m	1 pc	-	1,289	106	1,395	
(d) Cost of Operat-	1 day	-	19	46	65	
Rubble Stone	1 cum	-	174	21	195	
Forms						
(a) Class-A	1 sqm	-	68	28	96	
(b) Class-B	1 sqm	-	56	15	71	
(c) Class-C	1 sqm	-	34	15	49	
Timbering	1 cum	-	7	3	10	
Staging	"	-	10	4	14	
Reinforcing						
(a) Round Bar less than Ø9mm	1 ton	-	6,953	900	7,853	
(b) Round Bar Ø12mm -- Ø22mm	"	-	6,953	900	7,853	
(c) Deformed Bar Ø12mm-Ø23mm	"	-	6,926	750	7,676	
Concrete						
(a) 1:4:8	1 cum	-	350	147	497	

Item	Unit	Materials		Labor	Cost	Remarks
		F. Cost	D. Cost	D. Cost		
(b) 1:3:6	1 cum	-	407	174	581	
(c) 1:2:4	"	-	522	222	744	
Mortar						
(a) 1:2	1 cum	-	849	27	876	
(b) 1:2 t=20m/m	1 sqm	-	17	17	34	
(c) 1:2 t=20m/m	"	-	129	17	146	
Water Proof						
(d) Expansion Joint	1 m	340	60	14	494	Rubber
Pump Drainage						
(a) Engine 10ps	1 day	-	62	95	157	
(b) Engine 5ps	"	-	27	80	107	
(c) By Hand Pump	"	-	-	60	60	
Walling						
(a) 1.6 x 2.2m both side	1 m	-	98	47	145	Wood
(b) 1.3 x 1.5m "	"	-	66	44	110	"
(c) Trench Sheet Pile	"	173	234	272	679	
(d) Cost of Operating	1 day	-	80	304	384	
Revetment	1 m	-	4,640	214	4,854	
Concrete Slab Pitching	1 sqm	-	121	41	162	
Solding	1 sqm	-	13	2	15	
Paving						
(a) Concrete Pavement	1 sqm	-	73	52	125	
(b) Asphalt Pavement	1 sqm	-	126	30	156	
(c) Brick Pavement	1 sqm	-	65	5	70	
Planting	1 tree	-	305	60	365	
Fence						
(a) Silaraeng Fence	1 m	-	313	155	468	
(b) Barbed Wire Fence	"	-	74	38	112	
(c) Net Wire Fence	1 m	-	189	15	204	
Gutter & Open Channel						
(a) 500 x 735mm	1 m	-	287	162	449	
(b) 800 x 1,220mm	"	-	353	195	548	
(c) 450 x 450mm	"	-	70	7	77	
(d) 200 x 200mm	"	-	35	2	37	
(e) Brick Gutter	"	-	4	15	19	
(f) Concrete Gutter	"	-	23	10	33	
(g) Drain Pit	1 set	-	119	64	183	
Coffering						
(a) Closing Dyke	1 m	-	262	62	324	
(b) Driving Sheet Pile	"	778	1,322	482	2,582	
(c) Removing Sheet Pile	"	-	19	257	276	
Stone Masonry	1 m	-	193	68	261	
Steel Bar Screen	1 set	6,385	812	6,437	13,634	

Item	Unit	Materials		Labor	Cost	Remarks
		F. Cost	D. Cost	D. Cost		
Sluice Gate	1 set	96,380	25,620	1,404	123,404	
Drain Pit (A)	"	-	2,470	2,435	4,905	
Drain Pit (B)	"	-	4,430	3,174	7,604	
Flow-Meter Chamber	"	-	17,750	4,239	21,989	
(Back Washing)						
Flow-Meter Chamber	1 set	-	21,318	9,076	30,394	
(Raw Water)						
Flow-Meter Chamber	1 set	-	24,535	9,579	34,114	
(Distribution)						
Laying Pipes						
75 Coupling	1 m	-	-	1.5	1.5	
100 "	"	-	-	2.0	2.0	
150 "	"	-	-	2.5	2.5	
200 "	"	-	-	3.9	3.9	
250 "	"	-	-	4.8	4.8	
300 "	"	-	-	6.1	6.1	
350 Mechanical	"	-	-	10	10	
400 "	"	-	-	12	12	
450 "	"	-	-	13	13	
500 "	"	-	-	17	17	
600 "	"	-	-	21	21	
700 "	"	-	-	26	26	
Angle Valve Box						
(a) Less than Ø75mm	1 set	-	58	14	72	
(b) More than Ø100mm	"	-	88	15	103	
Cost of Jointing						
75 Gibault	1 set	-	65	6.2	71.2	
100 "	"	-	71	8.2	79.2	
150 "	"	-	124	10	134	
200 "	"	-	187	15	202	
250 "	"	-	237	19	256	
300 "	"	-	304	24	328	
350 Mechanical	"	437	187	60	684	
400 "	"	715	307	72	1,094	
450 "	"	788	338	83	1,209	
500 "	"	883	378	104	1,365	
600 "	"	1,016	436	131	1,583	
700 "	"	1,577	676	157	2,410	
Sluice Valve						
75 Screw	1 set	4,084	1,086	59	5,229	
100 "	"	4,748	1,262	62	6,072	
150 "	"	6,701	1,773	69	8,552	
200 "	"	8,823	2,436	93	11,262	
250 "	"	11,750	3,124	120	14,994	
300 "	"	14,940	3,971	150	19,061	
350 Hat	"	17,347	4,611	167	22,125	
400 "	"	23,987	6,376	222	30,585	
450 "	"	29,327	7,796	288	37,411	
500 "	"	50,503	13,425	387	64,315	
600 "	"	80,447	21,385	468	102,300	
700 "	"	108,428	28,822	549	137,799	
Butterfly Valve						
350 Screw	1 set	32,271	8,578	167	41,016	

Item	Unit	Materials		Labor	Cost	Remarks
		F. Cost	D. Cost	D. Cost		
400 Screw	1 set	38,556	10,249	222	49,027	
450 "	"	42,555	11,312	288	54,155	
500 "	"	45,222	12,019	387	57,630	
600 "	"	53,256	14,157	468	67,881	
700 "	"	76,586	20,358	549	97,493	
800 "	"	89,968	23,916	588	114,472	
Welding						
350	1 pc	-	319	129	448	
400	"	-	346	151	497	
450	"	-	372	173	545	
500	"	-	398	191	589	
Anchor Block (T)						
100 x 100	1 set	-	89	34	123	
200 x 100	"	-	141	55	196	
200 x 150	"	-	150	58	208	
200 x 200	"	-	162	63	225	
250 x 200	"	-	220	86	306	
300 x 200	"	-	286	112	398	
300 x 300	"	-	335	130	465	
350 x 250	"	-	367	143	510	
350 x 300	"	-	421	164	585	
450 x 450	"	-	768	304	1,072	
500 x 500	"	-	898	356	1,254	
600 x 600	"	-	967	381	1,348	
Anchor Block (H 90°)						
200	1 set	-	216	89	305	
250	"	-	338	139	477	
300	"	-	441	182	623	
350	"	-	720	296	1,016	
400	"	-	980	404	1,384	
450	"	-	1,296	532	1,828	
500	"	-	1,648	688	2,336	
Anchor Block (H 45°)						
100	1 set	-	85	34	119	
150	"	-	158	64	222	
200	"	-	269	109	378	
250	"	-	387	158	545	
300	"	-	570	232	802	
350	"	-	705	288	993	
400	"	-	980	401	1,381	
450	"	-	1,401	577	1,978	
500	"	-	1,762	726	2,488	
600	"	-	1,762	726	2,488	
Anchor Block (V,U, 45°)						
200	1 set	-	230	93	323	
250	"	-	443	182	625	
300	"	-	686	285	971	
350	"	-	726	303	1,028	
400	"	-	1,532	643	2,175	
450	"	-	1,791	753	2,544	
500	"	-	2,212	930	3,142	
Anchor Block (V,L, 45°)						
200	1 set	-	228	91	319	

Item	Unit	Materials F. Cost	Materials D. Cost	Labor D. Cost	Cost	Remarks
250	1 set	-	313	126	439	
300	"	-	438	177	615	
350	"	-	489	197	686	
400	"	-	504	203	707	
450	"	-	617	249	866	
500	"	-	751	304	1,055	
Laying Plain Concrete Pile						
300 Socket	1 m	-	106	33	139	
500 "	"	-	184	63	247	
600 "	"	-	244	80	324	
800 "	"	-	383	124	507	
1000 "	"	-	629	173	802	
Laying Polyvinyl Chloride Pipe						
20	1 m	-	6.4	8.6	15	
25	"	-	8.6	9.4	18	
30	"	-	11.6	17.4	29	
40	"	-	15.0	18.0	33	
50	"	-	21.6	18.4	39	
75	"	-	46.8	27.2	74	
100	"	-	73.3	27.7	101	
Cutting of Asphalt Pavement						
(a) Cost of Operating	1 hr	-	48	32	80	
Cost of Operating	1 hr	-	4	2.6	6.6	
Hand Rail	1 m	-	178	82	260	
Air Valve	1 set	8,281	2,855	391	11,527	
Fire Hydrant		-	1,379	51	1,430	
Gate						
(a) Proposed Plant	1 set	-	7,017	1,275	8,292	
(b) Intake Site	"	-	2,507	910	3,417	
Name Plate of W.T.P	"	-	4,665	1,905	6,570	
Flag Pole of W.T.P.	"	-	9,614	3,684	13,298	
Brick Masonry	1 sqm	-	83	9	92	
Finishing Mortar	"	-	9	41	50	
Coping Finishing Mortar	"	-	51	54	105	
Window Frame Mortar	1 m	-	3	26	29	
Finishing Mortar Floor	1 sqm	-	11	21	32	
Finishing Mortar Wall	1 sqm	-	11	41	52	
I-Steel Beam 250mm	1 m	368	92	45	505	
Checkered Steel Plate	1 m	107	38	36	181	
Tile	1 sqm	-	291	66	357	
Antificial Stone Ground Finish	"	-	159	71	230	
Artificial Stone Wet Brush Texturing	1 sqm	-	159	71	230	
Wood Brackets for Ceiling	1 sqm	-	32	10	42	

Item	Unit	Materials		Labor	Cost	Remarks
		F. Cost	D. Cost	D. Cost		
Textile Finishing	1 sqm	-	170	3	173	
Leveling Mortar	"	-	14	21	35	
Silaraeng Masonry	"	-	22	57	79	
Folding Door	1 set	-	5,394	4,900	10,294	
I-Steel Beam 350mm	1 m	533	133	51	717	
Sub-Station Foundation	1 set	-	37,872	19,950	57,822	
Retaining Wall	1 m	-	257	130	387	

(4) Running Cost for Thonburi - Treatment

a. Power Cost [1]

Demand of Electrical Energy	Cost
First 1000 kw	39 ฿/kwh
Over 1000 kw	36 ฿/kwh

According to the rate using by Metropolitan Electricity Authority

b. Chemical Cost

Alum	1,700 ฿/ton	$Al_2(SO_4)_3 \cdot 18\ H_2O$ $Al_2(SO_4)_3$ must not less than 50% Al_2O_3 must not less than 7.6% Density at 20°C must not less than 1.31 (Fiscal Year 1976-1977)
Lime	600 ฿/ton	(Fiscal Year 1976-1977)
Chorine	11,690 ฿/ton	Liquid Chlorine (Fiscal Year 1977)

1. Text Concerning Water Law

There is no overall water law in Thailand. All water resources are deemed to be state property. The State of Thailand holds and has reserved the full right to regulate water distribution and allocation for any kind of utilization. The right to use water is not covered completely by any statute. The Civil and Commercial Code of Thailand which was put into operation on 1 April 1932 contains some sections which give right to the ownership of land to extend above and below the surface but this land ownership does not automatically entail ownership of the water located above or under this land. The ownership of land which waterway passes has merely right to use these waters but is not entitled to draw more water than is necessary for his reasonable needs. While the right to use water for various purposes may be exercised freely, a number of limitation have been provided in various laws and regulations with respect to major utilization for which a permit has to be secured.

2. Main Principles of These Laws

The legal provisions concerning water resources conservation and development are derived directly or indirectly either from legal texis or from customary laws or else from special laws regulating one or more water utilization.

The main principles of these laws concerning the use of water may be summarized as follows:

(a) For Agricultural Uses

The Agricultural uses of water are governed by the following laws:

(1) Act on Conservation of Canal, B.E. 2444(1901).

(2) The People Irrigation Act, B.E. 2482(1939).

(3) The State Irrigation Act, B.E. 2485(1942) and its amendment.

(4) The Dykes and Ditches Act, B.E. 2505(1962).

The main principles of these acts concern the use of water for Irrigation purpose which may be carried out under 4 different systems: Private Irrigation, Contractual Irrigation, People Irrigation and State Irrigation.

The Private Irrigation means an irrigation system constructed by one or more persons for his own cultivation. Any person desirous of constructing private irrigation work must apply for permission to do

so. The granting of the permission shall be referred to didderent authorities, according to sizes of the areas to be irrigated.

The Contractual Irrigation means an irrigation work constructed by any person for remuneration to be obtained from those who are desirous of making use of water from such irrigation for their cultivation. This type of undertaking prescribes for construction of such work, a concession from the Ministry of Agriculture and Co-operatives. The concession establishes the conditions concerning the extent of the works, the remuneration, the reports to be submitted, and other obligations of the person holding such concession.

The People Irrigation is any irrigation system jointly constructed by the people for the benefit of cultivation by people within that locality. While such People Irrigation is put under government control, the work to be constructed either by individual or by the Government or jointly have to be approved by the majority of the users benefiting from them.

These above mentioned three systems are governed by the People Irrigation Act, B.E. 2482(1939).

State Irrigation is defined as any work constructed by the Government to supply water from any waterways or reservoirs for cultivation including the prevention of damage to cultivation with regards to water as well as navigation within the irrigation area. This type of water utilization is governed by the State Irrigation Act B.E. 2485(1942). However, this law also provides for control, on the part of the Royal Irrigation Department, of the water uses or activities such as conservation or storage of water, irrigation, drainage, reclamation, flood control, hydro-power, water communication and transportation.

The State Irrigation Act divides the Waterways into 4 categories as follows:

1st category: for supplying, drawing, conserving or retaining water for irrigation purposes.

2nd category: for navigation and irrigation within the area benefited from irrigation works.

3rd category: reserved only for irrigation purposes; and

4th category: accessory to irrigation.

(b) For Domestic Uses

The Laws relating to domestic uses of water are the following:

(1) Act on Conservation of Canals, B.E. 2444(1901) and its amendments.

(2) Royal Proclamation an Establishment of Public Water Supply, B.E. 2451(1908).

(3) Act on Conservation of Public Water Supply Canals, B.E. 2456(1913).

(4) Municipality Act, B.E. 2496(1953).

According to the Act on Conservation of Canals, general rules are established in order to maintain and conserve the water and structures of the canals. The Act also lays down general rules for protection, maintenance and conservation of canals for public uses.

The first public water supply system to provide water for domestic uses was established for the city of Bangkok by the Royal Proclamation of B.E. 2451(1908). The works was put under the control of the Sanitation Department of the Ministry of Metropolitan Affairs (now the Ministry of Interior). The Department was responsible for digging canals, supplying water to the town, establishing a pumping station and supplying equipment to ensure potability of water. Subsequently, by the Municipality Act, B.E. 2496(1953), the responsibility for providing domestic water for cities and people living in municipal areas was given to the Municipalities under the control of the Ministry of Interior.

In the Act on Conservation of Public Water Supply Canals, the control over water supply was established for keeping the water clean and potable.

(c) For Industrial Uses

The industrial uses of water especially concerning hydropower production, are governed by the following laws:

(1) National Energy Authority Act, B.E. 2496(1953).

(2) The Yanhee Electricity Authority Act, B.E. 2500(1957).

(3) The Metropolitan Electricity Authority Act, B.E. 2501(1958).

(4) The Provincial Electricity Authority Act, B.E. 2503(1960).

(5) The Northeastern Electricity Authority Act, B.E. 2505(1962).

(6) The Electricity Generating Authority of Thailand Act, B.E. 2511(1968).

The National Energy Administration was established by the legislation in 1953, with a view to unifying power production, standardization, transmission, and distribution in the whole Thailand. The

National Energy Administration has the power to set up sub-committee, request information or enter the premises of any ministry, to declare any locality as a National Energy Area for conservation of energy and sources of energy, and to grant permits for the production of energy.

Special energy organization may be set up by Royal Decree. The first one of autonomous authorities to be set up was the Yanhee Electricity Authority established by the Yanhee Electricity Authority Act, B.E. 2500(1957), as an autonomous body with statutory powers and fundtions to generate, acquire, transmit and supply electrical energy within the geographical area specified by the Royal Decree. The Authority authorized and delegated its responsibilities for the construction of the Bhumibol Dam to the Royal Irrigation Department, completed in 1964.

The similar autonomous authorities have been created by subsequent legislation for the purpose of producting and/or distributing electricity in specified areas and regions. They are the following: the Provincial Electricity Authority in 1960; and the Metropolitan Electricity Authority in 1958.

In 1969, the Government established, under the Electricity Generating Authority of Thailand Act, B.E. 2511(1968), the new autonomous authority, the Electricity Generating Authority of Thailand, to take over the works on electric power generation of the recent three authorities, viz, the Yanhee Electricity Authority, the Northeastern Electricity Authority and the Lignite Authority.

(d) For Transportation Uses

The laws relating to transportation uses of water are the following:

(1) The Navigation in Thai Waters Act, B.E. 2456(1913) and its amendment.

(2) The Act on Control of Mooring of Vessels in Rivers and Canals, B.E. 2479(1936).

(3) The State Irrigation Act, B.E. 2485(1942) and its amendment.

(4) Ministerial Regulation, B.E. 2497(1954) issued under State Irrigation Act, B.E. 2485(1942) concerning irrigation waterways maintenance fees.

(5) The Act on Prevention of Collision of Vessels, B.E. 2497(1954).

On the basis of the above legislation, no clear distinc-

tion is made between inland waters and sea territorial waters, although different Government Agencies are responsible for such Thai Waters.

The State Irrigation Act, B.E. 2485(1942) empowers the Royal Irrigation Department to collect irrigation waterway maintenance from persons using irrigation waterways of the first and second categories for transportation purposes.

The Navigation in Thai Waters Act, B.E. 2456(1913), with amendments defines Thai waters and provides the granting of any permission to use Thai waters with charging of fees for such permits. The Act and its amendments regulate in detail all navigation requirements, formalities, and rules concerning Thai waters, including inland canals, as well as general regulations concerning the licensing and registration of vessels and boats, pilots and other provisions on navigation requirements and different types of fees and rates to be collected.

(e) For Waste Water, Quality and Pollution Control

The legislation concerning water wastage, quality and pollution control is the following:

(1) Public Health Act, B.E. 2484(1941).

(2) The State Irrigation Act, B.E. 2485(1942) and its amendment

(3) Sanitation Act, B.E. 2495(1952).

No special enactment has been promulgated concerning waste and misuses of water. There is one section of the State Irrigation Act, B.E. 2485(1942), referring to retaining of flood water from flowing to waste so as to allow the neighbouring land to be reasonably inundated. Many sections of this Act refer to various kinds of misuse of water which are prohibited.

The Factories Act of B.E. 2485(1942) establishes a prohibition against the factories discharging wastes into waterways and canals without having treated such wastes so as not to cause water pollution endangering human life, water quality or cultivations.

(f) Use of Underground Waters

No specific provisions exist concerning the use of underground water in Thailand. However, a ground water committee has been established to study all aspects of ground water resources. The Ground Water Act is being drafted and accepted on principle by the Cabinet. The Act is hopefully to be enacted within 1978.

The principle of the draft Act is to make provision for the control of the drilling for ground water, the use of ground water

and the disposal of water or liquid into the aquifers through wells; and for the protection of the ground water resources. The Act shall be applied only in specific areas where ground water resources are critical with respect to quantity, quality and environment. No person shall engage in activities relating to ground water in the legally proclaimed "ground water area", no matter whether such activities are being undertaken in places which are within the rights of a person unless he has received the permits. Provision is made that the legal "ground water" in the "ground water area" shall mean underground water occurring in layers of earth or rocks at depth from the surface greater than the depth stipulated in the ministerial regulations. Under such principles, a person can still enjoy the privilege in his ground water activities outside the ground water area or in the ground water area so far as his activities are limited to an uncontrolled depth. However, the Minister may proclaim as many ground water areas as he deems appropriate.

The Act is entirely legal in format and no detailed description and technical comment are offered. At any rate, provisions are made for the Minister to issue the ministerial regulations for properly executing the Act. The following are set out as the ministerial regulations under the draft Act.

1. Prescription of the ground water area for the purpose of the Act. The depth from ground surface of the prescribed area which is exempted from the provisions of the Act shall be specified.

2. Description of a permit application procedure and information required in the permit application.

3. The condition or stipulation under which a permit may be approved and issued or revoked.

4. Application for Well Driller's Licence and information required in the application.

5. Prescription of procedures in drilling for ground water, well completion and development, well abandonment, testing well for yield, and submission of geologic and hydrologic data including drilling report and well records.

6. Guidelines and technical standards for withdrawal of ground water from well with respect to water requirement, water allotment, conservation of ground water, and protection of public health and environment. The requirement for permit holder to install and maintain the flow meter and water level indicator shall be also specified.

7. Prescription of quantity and quality of water or li-

quids to be disposed of into the aquifer by means of a well, including the methods and thechniques of disposal. The establishment of a system of monitoring the disposed aquifer and the reighbouring aquifers shall be also specified so that the sanitation and environment can be safeguarded.

8. Procedure and information required for registration of existing ground water activities prior to the enactment of the Act, including a permit application description.

9. Assignment of the Department of Mineral Resources to carry out a study and research on the simulation of the aquifers in the ground water area so that ground water resource can be properly managed.

10. Regulations on the fees which shall not exceed the rates shown in the list attached to the Act.

3. Strength and Weakness of These Laws

As it has been described, the water resources utilization in Thailand are controlled by different acts by which the full provision for various beneficial uses are not covered completely in any statute. The weakness of these laws is that the right of water users is not clearly defined. Hence, when water becomes more heavily utilized and scarce, it creates conflicts among various users. Many acts that have been enacted since more than 20 years ago are now considered inadequate. Another point is that the offences and punishments that have been provided in such laws are not fully enforced. The punishments are not strong enough compared to present conditions that has been changed radically. Considering that water is a valuable commodity there should be clear legal little to its uses. Many things which are now problems could be covered in a new Act. The comprehensive use and management of both surface water and ground water resources should also be considered for inclusion.

1) Thailand Country Report; United Nations Water Conference, Escap Regional Preparatory Meeting, Ministry of Agriculture and Cooperatives, 14 May 1976

6-3 Organizations

1. Section Relationships [1)]

Apart from Bangkok which receives its water from a parastatal organization, the Metropolitan Water Works Authority, three ministreis have central roles in providing improved water supplies to the population the Ministry of Health, the Ministry of Interior and the Ministry of Industry. All three are involved in supplying water to the rural

sector but only the Ministry of Interior is concerned with providing urban water supplies. Draft legislation which would estiblish an Urban Water Authority encompassing the activities of the Ministry of Intetior dealing with water supplies in Municipalities and Sanitary Districts, is under consideration. If the Authority is properly structured providing adequate administrative flexibility with respect to rates, financing of connexion charges, and borrowing and sets reasonable standards for financial performance, the urban sector should be enabled to improve its effectiveness.

In contrast to the situation in the urban areas where one agency in the Ministry of Interior is responsible for water supplies, seven agencies in three ministries have responsibilities for water supplies in the rural area. Each agency has its own programme and seemingly are not duplicating each others work. There is, however, no overall planning for the sector - no overall data base, strategy or common criteria. Evaluation of progress is therefore virtually impossible with any degree of accuracy and the validity of future programmes difficult to assess. This has been a long standing problem which the Government has previously tried to solve by establishing various committees. There is now recognition that a more permanent organization is required and a proposal has been made to establish a "Rural Water Supply Center", which would, at least in the initial stage, be attached to the NESDB. The mission strongly supports this proposal and recommends that a small group of about 5 - 6 professional staff members be detached from the various agencies presently concerned with rural water to form the nucleus of the "Center".

Both the Ministry of Health and Ministry of Interior have responsibilities for sanitation in rural and urban areas respectively. In the reral sector, financial and technical assistance is couple with the individual effort of villagers; in urban areas assistance is limited to technical advice.

2. Urban Water [1]

(a) Organization, Responsibilities and Administration

Urban water systems as used in this report refer to systems which serve populations in Metropolitan Bangkok, Municipalities and the larger Sanitary Districts throughout Thailand. Generally the communities have more than 5,000 inhabitants and total about 9,000,000 people, about 21% of the entire population. Closs to 40% of the urban dwellers are concentrated in the Metropolitan Bangkok area. The remain 60% are distributed among 118 municipalities and about 290 Sanitary Districts. Two organizations are responsible for the urban water sec-

tor; the Metropolitan Water Works Authority and the Provincial Water Supply Division (PWSD) of the Public Works Department in the Ministry of Interior. About 41% of the urban population is served by these agencies.

(b) Metropolitan Water Works Authority (MWWA)

MWWA is an autonomous parastatal organization which supplies Bangkok and Thonburi and a few small communities extending over 3 130 km2. Approximately 63% of the population is served and capacity needs to be increased to provide water to the population which is growing at 6% per year. A large expansion project financed by the Government , the World Bank, the Asian Development Bank and MWWA's own funds, is being constructed which is expected to meet the areas needs until 1982 and possibly until 1985. Compared to other urban and the rural communities with piped water systems, consumers in Bangkok pay far less for water even though in general they are more affluent. From an equity standpoint, this situation deserves greater attention and if adjusted would free more resources for less favoured urban areas.

(c) Provincial Water Supply Division (PWSD)

PWSD, which is responsible for all urban water supplies outside Metropolitan Bangkok, either owns the systems or grants concessions to Municipalities and Sanitary Districts. For those it owns, PWSD plans, designs, constructs, manages, operates and maintains the systems. Concessions are owned, operated and maintained either by private enterprises or communities but in all cases PWSD must approve plant design and construction. There are 226 communities served by these systems.

Six regional offices of PWSD provide technical support to its own systems, conduct surveys of new projects, and are the principal channels for administrative supervision. Monthly data on sales, water produced and expenses are submitted to Bangkok by each system manager. All capital expenditures must be approved by PWSD and each manager has only a small (3,000 baht) petty cash fund for minor day to day expenses. New plants and expansions of PWSD owned systems are financed by the Central Budget but concession systems must finance their own construction. A loan fund operated by the Ministry of Interior provides limited funds at 5% to municipal and Sanitary District concessions.

During 1969 - 1971, three bi-lateral agencies, in collaboration with national staff prepared master plans for the expansion of 15 municipal water supply systems. Most of these studies related to concession operated systems and to the extent that they were considered suitable have been used by PWSD in preparing expansion plans which were financed internally. Chiang Mai, the largest of the cities studied, is likely to

be the beneficiary of an externally financed project. Before it is approved, however, there should be a through investigation to ensure that an expensive expansion using surface water is not neglecting the possibility of using low cost ground water sources.

3. Rural Water[1)]

(a) Organization Responsibilities

Responsibility for providing or assisting approximately 31 million rural inhabitants to have improved water supplies can be roughly divided into two groups: (1) Piped water supplies systems and (2) other types of water supplies. About 6 million people or 19% of the rural population falls in the first group and 25 million or 81% in the second.

Communities with population from about 1,000 to 5,000 are being provided with piped water supplies by the Rural Water Supply Division (RWS), of the Ministry of Health. RWS designs and constructs these systems using either ground or surface sources. When deep wells are required, RWS may be assisted by the Department of Mineral Resources (MR) or Provincial Water Supply Division (PWSD) of the Public Works Department or the Accelerated Rural Development (ARD) Organization.

Communities with less than 1,000 population are assisted in obtaining improved water supplies by a number of Governmental agencies. These are not piped systems but improved dug or drilled wells with hand pumps, storage tanks for rain water, and construction of small surface ponds or storage reservoirs. These agencies are:-

(a) The Ground Water Division of MRD- Ministry of Industry

(b) The Sanitation Division (SD) of the Ministry of Health

(c) The PWSD Well Drilling Section - Ministry of Interior

(d) ARD (Accelerated Rural Development) - Ministry of Intetior

(e) The Department of Local Administration (DOLA) - Ministry of Interi or

(f) The Department of Community Development (CD) - Ministry of Interior

The activities of the six agencies are coordinated at the Provincial level by a committee headed by the provincial planning officer, and also at the National level by a "Clean Water Committee" whose chairman is the Under Secretary of the Ministry of Interior. There is sample work for all agencies and there does not seem to be any serious duplication of effort in implementing the vaiours programmes. There are, however, questions whether some agencies should be operating as they now are, if potable water is to be provided at the least cost.

4. Function [2)]

There is a number of Goverument Agencies, Organizations, and Authorities whose functions involve in the management, administration and control of national water resources. Their names and functions may be described as follows:

1) The Royal Irrigation Department of the Ministry of Agriculture and Cooperatives has jurisdiction and control over the following water uses, utilization and related activities: (1) Irrigation, (2) Drainage, (3) Reclamation, (4) Flood Control, (5) Hydroelectric power production, (6) Water Communication in Irrigation Waterways, (7) Conservation or storage of waters. Its function covers the works involving in investigation, survey planning, design, construction and operation of such water resources projects.

2) The Department of Fisheries, Ministry of Agriculture and Cooperatives, has jurisdiction and control over the use of water for fishing purposes in all Thai waters including inland and sea waters.

3) The National Energy Administration, Office of Prime Minister, has jurisdiction to control and coordinate over the use of all energy potentials of the country including hydro-power production. The Administration also has control over special autonomous power production and/or distribution authorities.

4) The Electricity Generating Authority of Thailand has come into existence with the merger of the Yanhee Electricity, the Lignite, and the Northeastern Electricity Authorities since May 1969. The Authority is an autonomous body with power and function to generate, acquire, transmit and supply electric energy, and to undertake all types of activities related to electric energy.

5) The Metropolitan Water Works Authority, Ministry of Interior is the agency that is responsible for provision of domestic water supply for Bangkok Metropolitan Area and surroundings which at present activity does not involve in water resources development as its present raw water requirement of about 1 million m^3 per day can be met by the surplus flow of the Chao Phraya River throughout the year. Its future enlargement of activities requires a definite plan for a reservoir project built particularly for the purpose.

6) The Public Works Department, Ministry of Interior, through its Provincial Water Supply Division is responsible for providing piped water supplies in provincial municipalities, sanitary districts and towns with population above 5,000. Its main activities include design construction, management and operation of urban water supply systems, and shares responsibility with the Ground Water Division of the Department of Mineral

Resources in a well drilling programme for rural water supplies.

7) The Department of Health, Ministry of Public Health, exercises juridiction over water quality, pollution control and health preservation together with the local authorities and municipalities under the overall control of the Ministry of Interior.

The Department if also responsible for providing potable water supply in rural communities with population between 1,000 to 5,000.

8) The Harbour Department is responsible for control and has jurisdiction over the use of water for transportation and navigation purposes; this competence is shared with similar one on water communication in the irrigation canal controlled by the Royal Irrigation Department.

9) The Department of Mineral Resources through its Ground Water Division is responsible for the investigation, development and control of ground water resources.

10) The National Economic and Social Development Board is responsible for social and economic developments. Its involvement in water resources is to establish policy, make decision and set up priority of projects proposed by various Govenment Agencies in order to conform with well-co-ordinated plan of the country.

11) National Environment Board with authorities to develop national plan for pollution abatement and resources conservation, is coordinating the activities of various implementing agencies in water resources management with emphasis on water pollution control.

12) Other Govenment Agencies. There are other Government Agencies that are engaged in the construction and development of small reservoirs and water wells for purposes which fall within their particular responsibilities. They are: (1) Land Co-operative Department, Ministry of Agriculture and Cooperatives, carries out very limited activity on well drilling; (2) Public Welfare Department, Ministry of Interior, carries out a limited programme of well construction; (3) Office of Accelerated Rural Development, Ministry of Interior, carries out small reservoir constructions and well drilling programme located primarily in politically sensitive areas of the country; (4) Mobile Development Unit of the Supreme Command Office, Ministry of Defence carries out similar activity as that of the Office of Accelerated Rural Development in the areas located primarily in politically sensitive areas of the country.

5. Agencies of Ground Water [2)]

Ground Water has played a less important role in solution of Thailand's water problems although its utilization could be dated back to the last six or seven decades. Ground water where feasible, is now being increasingly preferred as a source for urban and rural domestic supply, even

where surface water is available. The development of the ground water for such purposes is under the responsibility of four government agencies: the Department of Mineral Resources, the Public Works Department, the Department of Health and the Office of Accelerated Rural Development. The Metropolitan Water Works Authority which is responsible for municipal water supply in Bangkok Metropolitan Areas also utilizes ground water for about one-third of its public water supply. An attempt to provide ground water for agricultural use is undertaken by the Royal Irrigation Department, Among these government agencies, only the Department of Mineral Resources has been assigned the ground water resource investigation and evaluation as well as the development.

1) Water Supply and Sewage Sector Study. World Health Organization/World Bank Cooperative Programme, 1976.

2) Thailand Country Report; United Nations Water Conference, Escap Regional Preparatory Meeting, Ministry of Agriculture and Cooperatives. 14 May 1976.

6-4 City Planning (Future Population)

1. Population in Bangkok [1)]

It is proposed to plan Bangkok Metropolitan District, its public utilities, services and facilities for a population of 6.5 millions by the year 2000. This design population is very much lower than the projected population would be in three decades at the present annual increase rate of 5.1%. In order to limit the population to 6.5 millions in the year 2000, the following measures are recommended:

(1) Encourage the growth and economic development of other cities throughout the country.

(2) Improve the urban and regional transportation facilities.

(3) Establish Regional Planning as a national policy.

(4) Encourage family planning by establishing clinics in the Metropolitan area.

2. Land Use in Bangkok [1)]

In order to accommodate an urban population of 6.5 millions, the following steps are recommended on land use and zoning.

(1) Expand the limits of the municipalities of Bangkok and Thonburi to a Metropolitan District three times-their present size.

(2) Encourage the "finger type" land development along main traffic routes.

(3) Group the industrial areas into three specific districts,

chosen for the availability of adequate transport and other facilities.

(4) Develop "industrial park" units where workers can live in close proximity to their jobs.

(5) Disperse sub-commercial and government offices to avoid congestion in the center of the city.

(6) Encourage high and medium density residential development.

(7) Create a park system by providing green strips along the major canals existing in the metropolitan area. Expand the strips to large parks where feasible.

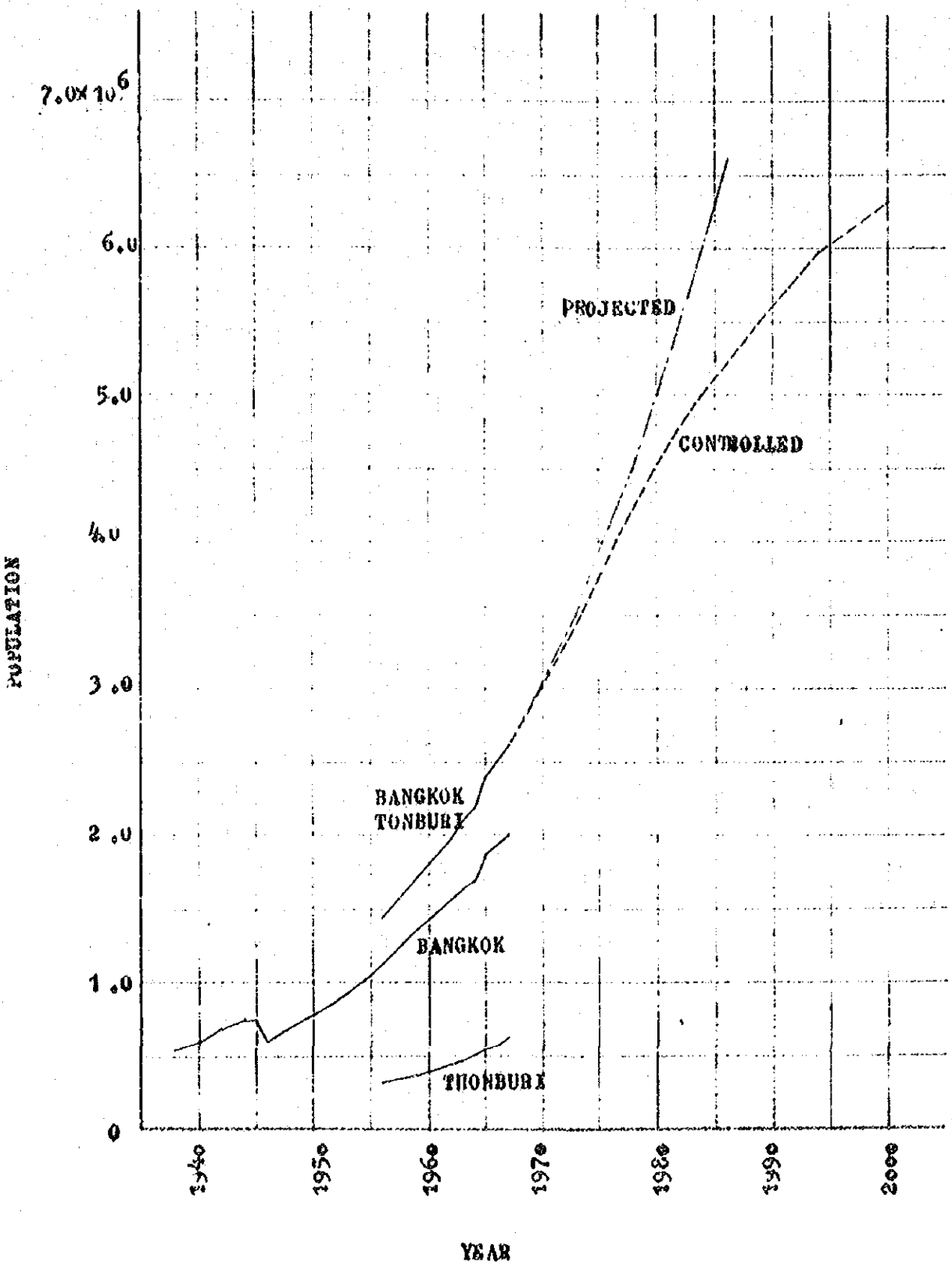
PROPOSED LAND USE 2000 [1]

(For a Population Of 6.5 Millions)

Land Use			sq. kilometers
Residential			293
N 130-264 G(126-216)	High Density (30%)	24	
N 42-96 G (39-75)	Medium Density (55%)	143	
N 14-24 G (12-16)	Low Density (15%)	112	
	For flexible change 5%		
Commercial			30
Industrial			70
Government			60
Utilities & Services			37
Recreation			30
	Total		520
Agriculture			300
	Total Planning Area		820 km^2

(514,000 rai)

BANGKOK-TONBURI POPULATION GROWTH [1]



PAST AND PRESENT POPULATION OF THAILAND [2]

Census Date	Census Year B.E.	Census Year A.D.	A	B	C	D
April 1	2462	1919	9,207,355	-	10,110,000	-
July 15	2472	1929	11,506,207	2.19	12,130,000	1.8
May 23	2480	1937	14,464,105	2.96	14,410,000	2.2
May 23	2490	1947	17,442,689	1.89	18,450,000	2.5
April 25	2503	1960	26,257,916	3.22	26,860,000	3.0
					35,000,000 [2]	3.0
April 1	2454	1911	8,266,408 [3]			
Feb. 23	2499	1956	20,095,139 [4]			

Note: A Enumerated Total Population
B Annual Percentage Rate of Growth
C Adjusted [1] Total Population
D Adjusted Annual Percentage Rate of Growth

(1) Adjusted by UN. Population Division
(2) See text for explanation
(3) Too incomplete to be of value
(4) Under-estimated to the point of being unadjustable

FUTURE POPULATION OF THAILAND [2]

Year B.E.	Year A.D.	PREDICTED POPULATION Minimum	Probable	Maximum
2512	1969	35,000,000	35,000,000	35,000,000
6 years		(2.3) [1]	(2.7)	(3.0)
2518	1975	40,000,000	41,000,000	42,000,000
10 years		(2.3)	(2.7)	(3.0)
2528	1985	50,000,000	54,000,000	57,000,000
15 years		(2.3)	(2.5)	(3.0)
2543	2000	70,000,000	78,000,000	90,000,000

Note:

(1) (2.3) = Annual percentage rate of growth

FUTURE POPULATION OF FOUR MUNICIPALITIES [2]

Year B.E.	Year A.D.	BANGKOK MUNICIPALITY Predicted Population Minimum	Probable	Maximum	THONBURI MUNICIPALITY Predicted Population Minimum	Probable	Maximum
2512	1969	2,141,000	2,141,000	2,141,000	670,000	670,000	670,000
6 years		(2.3)[1]	(4.0)	(5.2)	(2.3)	(5.6)	(6.0)
2518	1975	2,450,000	2,675,000	2,900,000[2]	770,000	930,000	940,000
10 years		(2.3)	(4.3)	(4.7)	(2.3)	(4.4)	(6.0)
2528	1985	3,100,000	4,095,000	4,600,000[2]	960,000	1,430,000	1,700,000
15 years		(2.3)	(3.0)	(4.7)	(2.3)	(3.0)	(6.0)
2543	2000	4,300,000	6,345,000	9,000,000	1,320,000	2,300,000	3,900,000

Year B.E.	Year A.D.	NONTHABURI MUNICIPALITY Predicated Population Minimum	Probable	Maximum	SAMUT PRAKAN MUNICIPALITY Predicated Population Minimum	Probable	Maximum
2512	1969	22,500	22,500	22,500	41,500	41,500	41,500
6 years		(2.3)	(5.5)	(7.0)	(2.3)	(4.8)	(7.0)
2518	1975	26,000	31,000	35,000	47,000	55,000	60,000
10 years		(2.3)	(4.9)	(7.0)	(2.3)	(4.6)	(7.0)
2528	1985	32,000	50,000	70,000	59,000	86,000	120,000
15 years		Large Boundary Increase			Large Boundary Increase		
2543	2000	300,000	530,000	800,000	500,000	745,000	900,000

(1) (2.3) = Annual percentage rate of growth

(2) 90 percent of the maximum changwat population was assumed as the controlling limit.

SUMMARY OF PROJECTED MUNICIPAL POPULATIONS AND POPULATION DENSITY [2]

Municipality	Year 2512 (1969) Population	Area[1] sq.km	Persons Per sq.km	Year 2518 (1975) Population[2]	Area sq.km	Persons Per sq.km	Year 2528 (1985) Population	Area sq.km	Persons Per sq.km	Year 2543 (2000) Population	Area sq.km	Persons Per sq.km
Bangkok	2,121,000	238.6	9,000	2,675,000	238.6	11,200	4,095,000	293	14,000	6,345,000	387	16,400
Thonburi	670,000	52.0	12,900	930,000	52.0	17,700	1,430,000	92	15,400	2,300,000	156	14,700
Nonthaburi	22,500	2.5	9,000	31,000	2.5	12,400	50,000	10	5,000	530,000	58	9,200
Samut Prakan	41,500	7.3	5,700	55,000	7.3	7,500	86,000	15	5,800	745,000	62	12,000
Total (Density)	2,875,000	300.4	(9,600)	3,691,000	300.4	(12,300)	5,661,000	410	(13,800)	9,920,000	663	(15,000)

(1) Area from Table 4.6

(2) Probable future population from other Table

SUMMARY OF PAST, PRESENT AND PROJECTED FUTURE POPULATION OF
THAILAND FOUR CHANGWATS AND FOUR MUNICIPALITIES [2]

Year B.E.	Year A.D.	Thailand	Changwats: Bangkok	Thonburi	Nonthaburi	Samut Prakarn	Total	Municipalities: Bangkok	Thonburi	Nonthaburi	Samut Prakarn	Total	As a Percentage of Thailand
PAST													
2462	1919	10,110,000	391,000	156,000	95,000	110,000	752,000						
2472	1929	12,130,000	558,000	193,000	108,000	112,000	971,000						
2480	1937	14,410,000	683,000	205,000	115,000	132,000	1,135,000						
2490	1947	18,460,000	941,000	306,000	141,000	172,000	1,560,000	604,000	177,000	10,000	10,000	801,000	4.3%
2503	1960	26,860,000	1,650,000	568,000	201,000	255,000	2,674,000	1,300,000	404,000	18,000	22,000	1,744,000	6.5
PRESENT													
2512	1969	35,000,000	2,400,000	960,000	266,000	318,000	3,944,000	2141,000	670,000	22,500	41,500	2,875,000	8.2
FUTURE													
2518	1975	41,000,000	2,960,000	1,240,000	325,000	395,000	4,920,000	2675,000	930,000	31,000	55,000	2,691,000	9.0
2528	1985	54,000,000	4,475,000	1,750,000	500,000	580,000	7,305,000	4095,000	1,430,000	50,000	86,000	5,661,000	10.5
2543	2000	78,000,000	6,830,000	2330,000	1,320,000	1,340,000	11,820,000	6345,000	2,300,000	530,000[1]	745,000[1]	9,920,000	12 6

(1) Large boundary increase

PRESENT AND FUTURE POPULATION OF AMPHOE TOWNS OUTSIDE THE CENTRAL SYSTEM [2)]

Amphoe	Present Area, Square Kilometers		Estimated Population					
			Year 2512 (1969)		Year 2528 (1985)		Year 2543 (2000)	
	Total Amphoe	Amphoe Town	Total Amphoe	Amphoe Town	Total Amphoe	Amphoe Town	Total Amphoe	Amphoe Town
(Bangkok)								
Minburi	161	2.0	39,000	6,500	54,400	20,000	97,000	50,000
Nong Chok	238	0.8	43,000	4,500	52,400	15,000	77,000	30,000
Lat Krabang	149	1.0	30,000	5,500	41,200	20,000	65,000	35,000
(Thonburi)								
Nong Khaem	48	0.6	20,600	3,400	41,000	20,000	62,000	35,000
(Nonthaburi)								
Bang Bua Thong	112	1.0	32,800	8,500	53,000	20,000	88,000	40,000
Bang Yai	92	1.7	30,800	3,300	43,000	20,000	63,000	40,000
Sai Noi	194	1.0	27,200	1,000	39,000	10,000	55,000	15,000
(Samut Prekan)								
Bang Phli	308	1.0	59,800	7,000	82,000	20,000	129,000	35,000
Bang Bo	211	3.0	56,100	4,100	70,000	16,000	103,000	25,000
TOTAL	1,513	12.1	339,300	43,800	476,000	156,000	739,000	305,000

(1) Sanitary District or Consultant's estimate The Amphoe Town area estimates are somewhat arbitrary.. In the future, the area of each Amphoe Town is expected to increase considerably.

SUMMARY OF PRESENT AND FUTURE POPULATION SERVED BY SEPARATE SYSTEMS [2)]

Changwat and Amphoe	Year 2512 (1969)			Year 2518 (1975)			Year 2528 (1985)			Year 2543 (2000)		
	Total Population	Percent Served	Served Population	Total Population	Percent Served	Served Population	Total Population	Percent Served	Served Population	Total Population	Percent Served	Served Populatio
Bangkok												
Min Buri	6,500	42	2,700	10,000	65	6,500	20,000	75	15,000	50,000	80	40,000
Nong Chok	4,500	20	900	8,000	50	4,000	15,000	67	10,000	30,000	67	20,000
Lat Krabang	5,500	22	1,200	10,000	60	6,000	20,000	70	14,000	35,000	72	25,000
Thonburi												
Nong Khaem	3,400	0	0	5,000	50	2,500	20,000	70	14,000	35,000	85	30,000
Nonthaburi												
Bang Bua Thong	8,500	39	3,300	12,000	50	6,000	20,000	60	12,000	40,000	75	30,000
Bang Yai	3,300	15	500	8,000	50	4,000	20,000	60	12,000	40,000	75	30,000
Sai Noi	1,000	20	200	5,000	40	2,000	10,000	50	5,000	15,000	67	10,000
Samut Prakan												
Bang Phli	7,000	26	1,800	10,000	40	4,000	20,000	50	10,000	35,000	72	25,000
Bang Bo	4,100	20	800	8,000	38	3,000	16,000	50	8,000	25,000	60	15,000
TOTAL	43,800	26	11,400	76,000	50	38,000	161,000	62	100,000	305,000	74	225,000

Other Separate Systems in 2512 (1969) which are expected to become part of the MWWA System:

System	Served Population	Remarks
Phra Pradaeng	7,000	Part of Thonburi by 2518 (1975)
Phasi Charoen	25,000	Part of Thonburi by 2518 (1975)
Bang Khen	3,600	Part of Bangkok by 2518 (1975)
Bang Kapi	2,500	Part of Bangkok by 2518 (1975)

Population

(1973-1976)

Years	Nong Chok	Minburi	Lat Krabang	Nong Khaem	Bang Sua Thong (municipality)	Bang Sua Thong out of (municipality)	Sai Noi	Bang Yai	Bang Phli	Bang Bo
1973	44,344	44,608	33,185	28,679	9,505	25,247	26,305	32,628	66,466	58,346
1974	46,197	45,309	22,959	30,519	9,646	28,584	26,568	30,649	67,056	59,354
1975	46,939	46,342	34,951	32,308	7,806	29,011	26,786	30,814	68,352	60,046
1976	47,666	47,115	36,065	34,015	7,959	29,492	28,463	31,385	69,977	61,051

Resources of Data 1973 - 1975: Statistical Report Division: Office of National Statistics

1976: Registration Division : Department of Administration, Ministry of Interior

1) THE GREATER BANGKOK PLAN FOR YEAR 2000,
CITY PLANNING DIVISION OFFICE OF THE CITY CLERK
BANGKOK MUNICIPALITY

2) MASTER PLAN; WATER SUPPLY AND DISTRIBUTION,
CDM, 1970

6-5 Geology [1)]

Geologic History. The mountains surrounding the Chao Phya Plain were formed during the late or Post Miocene orogeny. The present Chao Phya River basin was possibly the result of the development of structural basins in the late Tertiary epoch followed by heavy alluvial depositions during the Quarternary epoch. These first deposits, consisting of layers of fine gravel sand and sandy clay, are now located at a depth of 300 meters or more below the surface A thick layer of grey, relatively homogeneous clay was later deposited after the major movement of the earth's crust had stopped.

The delta steadily advanced into the Gulf waters to the south About 500 years ago the present site of Bangkok was at the shore of the Gulf of Thailand Recent flood control and irrigation projects have caused most of the silt to precipitate before it reaches the Gulf but the southward growth of the delta, although slowed, is continuing.

Type of Soil. The central valley is a geologic depression, which has been filled with sediment. The upper formations underlying the Bangkok metropolitan area consist of alternating beds of sand, gravel, clay, and silt. However, a few thin cemented layers on the order of 3 to 6 meters thick have been encountered at depths as shallow as approximately 100 meters. Although no test wells have been drilled through the entire sequence of unconsolidated deposits in the Bangkok metropolitan area, it is reported that the rock was encountered at a depth of 365 meters at Ayudhya, 70 kilometers north of Bangkok. A test well drilled in Samut Prakan in December 2511 (1968) during this investigation penetrated 457 meters of unconsolidated deposits without encountering bedrock.

Subsurface conditions in the area are relatively uniform. Borings to a depth of 20 meters recently made during the preparation of the master plan for sewerage, drainage and flood protection, indicate that there are basically two types of clay, one soft and one stiff The soft clay is on the upper level. The change from soft to stiff occurs at an average depth of 13.5 meters and varies from 11 to 17 meters During the dry season, however, the top one or two meters of the natural ground surface dries and becomes a relatively stiff brown clay An evaluation of the load carrying capacity

of these soils is presented in other Chapter, Construction Methods and Materials.

1) Master Plan; Water Supply and Distribution, CDM, 1970.

6-6 Climate

Thailand has a tropical climate which is influenced by monsoons blowing from the northeast from November to February and from the southwest from May to September.. Most of the rainfall occurs during this latter period and ranges from 1,000mm to 3,000mm per year..[1)]

Thailand has three generally recognized seasons: the "Cold Season", which includes November, December and January; the "Hot Season", extending from February through May, and the "Wet Season", covering the other five months of June through October. The relatively dry period extends from November through April with practically no rainfall in December and January.

The mountains around Bangkok dissipate the forces of the typhoons or cyclones that create such havoc in the South China Sea and the Bay of Bengal. While gentle breezes of more than 15 kilometers per hous prevail about two thirds of the time these breezes seldom exceed 12 kilometers per hour. Maximum winds up to 122 kilometers per hour have been recorded, however. The prevailing winds are either from the north or the south.[2)]

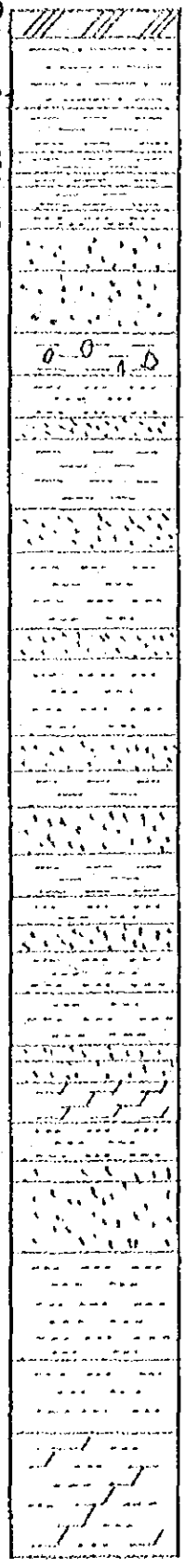
1) Water Supply and Sewerage Sector Study; World Health Organization/ World Bank Cooperative Programme, 1975.

2) Master Plan; Water Supply and Distribution, CDM, 1970.

WELL LOG NO 5-63

Kilometer 5o Sukumvit Rd Samutprakan

started January 1o 196o



4.00	Surface soil	4.00
14.2	Soft clay, grey	10.2
20.61	Clay, grey with shells	6.41
23.63	Clay, yellowish white	3.02
25.17	Clay, light yellow	1.54
28.96	Clay, black yellow	3.79
31.43	Coarse sand, yellow with clay	2.47
37.52	Coarse sand, black yellow	6.09
46.66	Coarse sand, white	9.14
52.75	Clay, yellow withgravel	6.09
58.84	Clay, yellow with fine sand	6.09
61.88	Fine sand, white	3.04
71.94	Clay, yellow	10.06
78.08	Fine sand, white	6.14
93.51		
104.52	Clay, yellow with fine sand	11.01
109.58	Fine sand, yellow and white	5.06
114.80	Coarse sand, yellow with clay	11.22
121.90	Fine sand, white	7.10
127.88	Clay, yellow	5.98
131.88	Coarse sand, white and yellow	4.00
135.63	Clay, yellow	3.75
	Coarse sand, yellow with clay	4.00
	Fine sand, yellow	
141.85	Clay, yellow with coarse sand and limestone	
149.10	Clay, yellow with coarse sand	
151.25	Fine sand, yellow	
154.50	Coarse sand, white and yellow	
160.20	Clay, yellow whit hard shale	
165.70	Clay, yellow with coarse sand	
168.80	Coarse sand, yellow and white	
179.00	Coarse sand, white	
194.30	Coarse sand with yellow clay	
205.10		
	Clay, yellowish white and green with sand	
226.65	Clay, yellow white with coarse sand, hard shale	

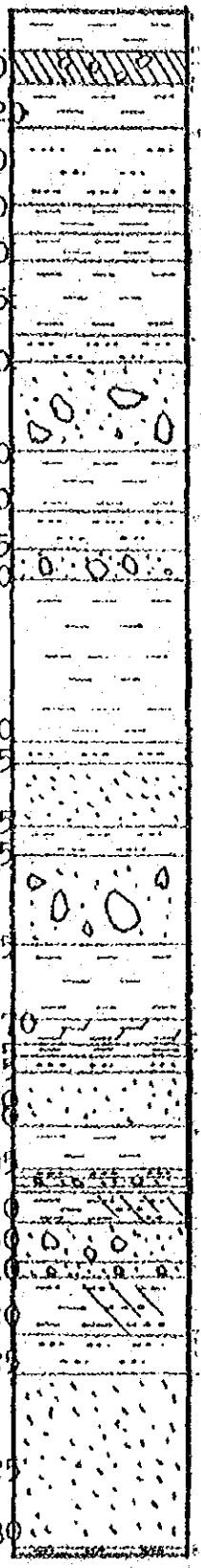
WELL LOG NO 82/39-05

A.PARKLET CH. NONTHABURI

started 11 June 1962

Completed 20 July 1962

Scale 1:750



	Formation	Description
300		Clay, brownish
7.50		Clay, black with sells
12.20		Clay, grey
20.00		Clay, brown with coarse sand
23.00		Clay, black
25.90		Clay, light brown and yellow
33.55		Clay, grey
36.30		Coarse sand with clay
		Coarse sand, with gravel
45.70		
52.00		Clay, brown
55.35		Clay, brown, with sand
59.10		Coarse sand, white with gravel
		Clay, brown
76.20		
78.25		Clay, grey with sand
		Sand, dark brown
84.35		
87.75		Fine sand with Clay, brownish
		Coarse sand, white with gravel
97.05		
		Clay, brown
105.70		Clay, brown with shale
107.75		Clay, brown
109.15		Clay, brownish with coarse sand
110.80		Coarse sand, dark brown
116.45		
120.95		
126.50		Clay, brown, with limestone
130.60		Coarse sand, with Soil with gravel
132.10		Coarse sand with gravel
136.20		Clay, brown with limestone
142.25		Clay, brown with coarse sand
		Coarse sand, light brown
160.25		
161.30		Clay brown

WELL LOG ที่ 106/17-06

T.Lardyoa A, Bangkhen CH.Bangkok

STATIC WATER LEVEL 8.20 m.

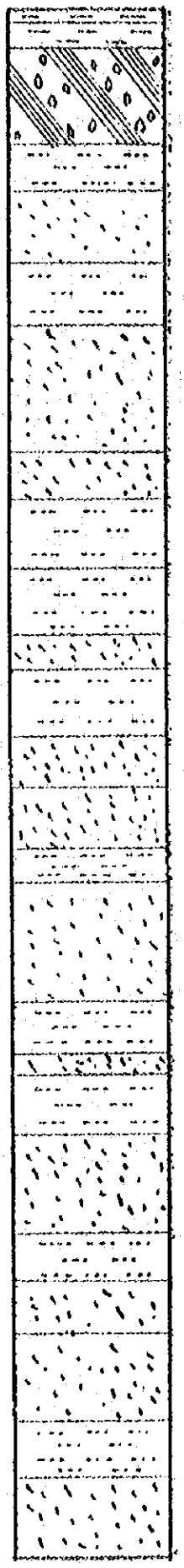
Capacity 7.50 Cu.m/hr

Hardness 132 P.P.M.

Started 20 February 1963

Completed 5 March 1963

Scale 1:750



1.50	Clay,black
4.50	Clay, yellowish white and yellow
15.75	Muddy clay, black with shells
21.35	Clay, yellow with fine sand
29.75	Small grain sand,red and yellow with fine sand
37.05	Clay, yellowish white with yellow fine sand
52.30	Coarse sand, red
57.80	Fine sand, white
66.00	Clay, yellow with coarse white sand
73.65	Coarse sand, white and yellow with yellow clay
77.80	Small grain sand with fine white sand
85.85	Coarse sand, red with yellow clay
91.95	Small grain sand, red and yellow
99.10	Coarse sand, white and yellow
102.75	Clay, yellowish white with white and yellow coarse sand
116.35	Coarse sand, white and yellow
123.00	Clay, grey with white coarse sand
125.50	Fine sand, white
132.65	Clay, yellow with red small grain sand
144.25	Coarse sand, red and white
149.90	Clay, yellow with red sand
156.00	Small grain coarse sand, red and white
166.50	Coarse sand,white and yellow
173.10	Clay,white with white and yellow coarse sand
183.45	Sand, yellow and white

Static water level 8.20 m.

Capacity 7.50 cu.m/Hr

DEEP WELL NO 215/39-08

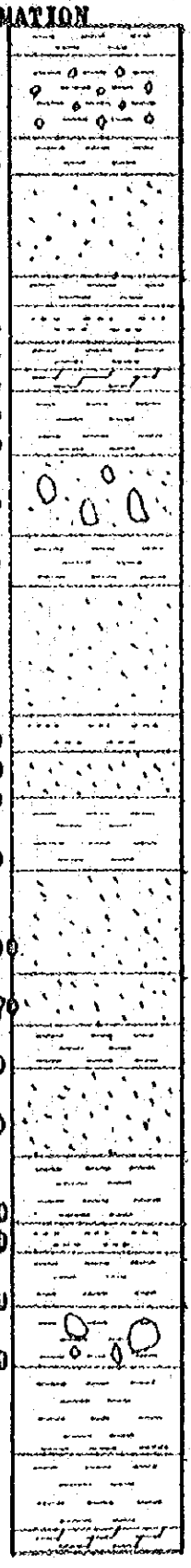
Watmai, Nong Praong, Tamble Suanluang, A Katumban

Changwad Samusakorn

Boring started: 19 August 1965

Boring Completed: 24 August 1965

Scale: 1:750



	FORMATION
300	Clay, black
	Muddy clay, black
12.00	Clay, yellow
16.00	
	Fine sand, yellow
26.00	Clay, yellow
30.80	Fine sand, yellow with clay
34.00	Clay, yellow
37.00	Clay, yellow with shale
39.40	Clay, yellow
46.10	
	Coarse sand with gravel
54.70	
60.20	Clay, yellow
	Small grained sand, white
74.20	Small grained sand with yellow clay
78.00	Coarse sand, white and yellow
83.00	
	Clay, yellow
41.00	
	Coarse sand, yellow
120.00	
107.70	Coars sand, white
	Clay, yellow
112.00	
121.50	Coars sand, yellow
	Clay, yellow
129.00	
132.00	Coarse yellow sand with clay
	Clay, yellow
138.00	
	Gravel with yellow clay
144.50	
154.40	Clay, yellowish white
	Clay, yellow
162.00	
167.60	Clay, yellow with shale

WELL LOG N.386/30-11

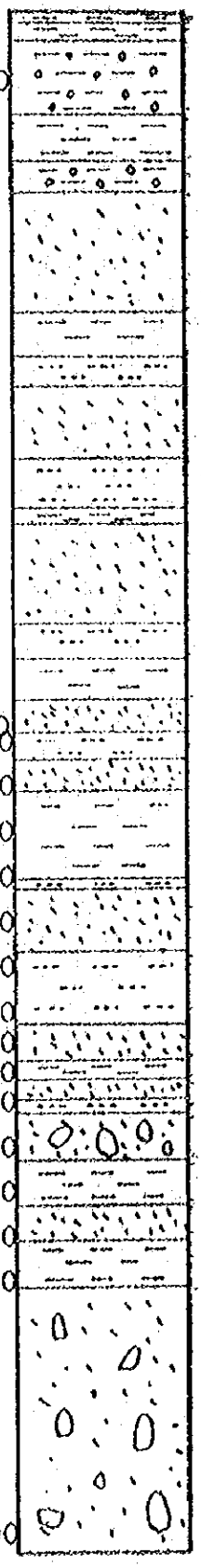
WAT BANGKUNIENNAT T.BANGMOT A. BANGKUNTIEN

CH. THONBURI

Started 1 Feb. 1968

Completed II Feb. 1968

Scale I:I000



4.00	Clay,black
14.50	Clay,yellow
21.00	Clay,grey with shells
25.50	Clay,yellow
42.50	Clay,yellowish white,with shells
	Coarse sand,yellow and white
49.00	Clay,yellow
53.00	Clay,yellow with coarse sand
63.50	Coarse sand, yellow and white
70.50	Clay,yellow with coarse sand
72.50	Clay,yellowish white
	Coarse sand,yellow and white
87.00	
92.00	Coarse sand,yellow with Clay
94.00	Clay,yellow white and yellow
102.30	Coarse sand,yellow and white
106.20	Clay,yellow white fine sand
111.00	Coarse sand,yellow and white
123.50	Clay,yellow
124.00	Clay,yellow white coarse sand
134.00	Coarse sand,yellow and white
144.20	Clay,yellowish white with sand
150.00	
152.30	Coarse sand,yellow and white,with gravel
155.10	Clay,yellow
157.00	Coarse sand,yellow and white Clay,yellow whit coarse sand
164.50	Coarse sand,yellow and white,with gravel
170.50	Clay,yellow
175.20	Coarse sand,yellow and white
182.00	Clay,yellow
220.00	

TABLE CLIMATOLOGICAL DATA FOR METROPOLITAN BANGKOK(1)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Temperature, °C													
High	36	36	40	39	39	37	38	35	35	34	34	35	40
Low	10	16	17	20	21	22	22	21	21	20	16	13	10
Mean	26	28	29	30	30	29	28	28	28	28	27	26	28
Relative Humidity													
Percent (Mean)	73	76	77	77	80	80	82	83	85	85	81	75	79
Evaporation													
Millimeters (Piche)	109	96	118	120	101	89	82	77	60	63	74	98	1087
Days of Rainfall													
Per Month	2	3	4	6	15	16	18	21	23	18	6	1	133
Rainfall, Millimeters													
Mean	9	35	31	66	182	149	193	218	364	254	46	3	1549
Greatest in 24 hours	40	73	40	134	87	83	109	90	115	123	45	15	134
Wind Velocities													
Max: km/hr	57	69	89	104	78	80	80	84	82	72	84	57	
Mean: km/hr	83	11	12	12	10	11	9	10	9	8	8	8	

(1) Station: Phra Nakhon
Latitude: 13° 44'N.
Longitude: 100° 30'E.
Period: 2494 - 2508 (1951 - 1965)
Master Plan: Water Supply and Distribution, CDM, 1970.

6-7 Statistic of Ground Water

(1) Statistic of Ground Water Distribution in Central System (MWWA) from 1960 - 1976

Year	Amount of Water Distribution				
	Bangkok (cum)	Thonburi (cum)	Nonthaburi (cum)	Samut Prakan (cum)	Total (cum)
1960	25,696,000	12,775,000	175,200	876,000	39,522,000
1961	50,516,000	12,775,000	182,500	1,051,200	64,524,700
1962	49,056,000	12,775,000	335,800	1,226,400	63,393,200
1963	51,100,000	12,775,000	1,058,500	1,810,400	66,743,900
1964	50,990,500	12,775,000	1,095,000	2,102,400	66,962,900
1965	14,495,650	12,775,000	1,401,600	2,102,400	30,774,650
1966	50,709,600	18,250,000	1,635,200	2,102,400	72,697,200
1967	87,619,392	24,090,000	1,879,750	2,102,400	115,691,542
1968	91,453,596	28,843,880	2,482,000	2,102,400	124,881,876
1969	81,438,800	21,931,025	5,743,275	4,036,900	113,150,000
1970	75,649,900	27,542,900	5,190,300	3,869,000	112,252,100
1971	83,979,200	27,459,100	6,299,900	3,429,300	121,167,500
1972	79,080,160	23,987,890	7,869,220	5,233,360	116,170,630
1973	95,597,386	23,595,187	7,927,941	5,295,185	132,415,699
1974	97,849,551	22,274,291	9,593,755	5,344,105	135,061,702
1975	95,406,968	17,657,125	9,487,383	5,467,548	128,019,024
1976	89,740,099	13,353,048	10,196,824	6,668,977	119,958,948

(2) Statistic of Ground Water Distribution in Central System (MWWA)

Year	Bangkok (cum/day)	Thonburi (cum/day)	Nonthaburi (cum/day)	Samut Prakan (cum/day)	Total (cum/day)
1960	70,400	35,000	480	2,400	270,480
1961	138,400	35,000	500	2,880	345,780
1962	134,400	35,000	920	3,360	367,880
1963	140,000	35,000	2,900	4,960	423,270
1964	142,800	35,000	3,000	5,760	573,685
1965	26,080	35,000	3,840	5,760	636,480
1966	93,000	50,000	4,480	5,760	725,740
1967	157,200	66,000	5,150	5,760	820,410
1968	213,500	80,000	6,800	7,760	887,560
1969	223,120	60,085	15,735	11,060	895,800
1970	207,300	75,500	14,200	10,600	917,500
1971	230,100	76,600	17,300	9,700	959,000
1972	216,700	65,720	21,600	14,500	1,061,020
1973	261,910	64,640	21,720	14,510	1,208,500
1974	268,080	61,025	26,285	14,640	1,222,645
1975	261,390	48,375	25,990	14,980	1,208,175
1976	245,190	36,485	27,860	18,220	1,178,825

(3) Statistic of Ground Water Production in Fiscal Year 1976

Date	Capacity of Water Distribution				Total
	Bangkok (cum)	Thonburi (cum)	Nonthaburi (cum)	Samut Prakan (cum)	(cum)
Oct '75	7,581,412	1,091,332	838,250	504,247	10,015,241
Nov '75	7,115,819	1,024,230	766,860	529,897	9,436,806
Dec '75	7,704,680	1,170,470	837,560	559,592	10,272,302
Jan '76	7,716,131	1,190,110	896,520	560,904	10,363,665
Feb '76	7,226,335	1,023,003	822,230	510,968	9,582,536
Mar '76	7,414,615	1,093,566	893,460	628,561	10,030,202
Apr '76	7,368,040	1,162,925	948,960	577,122	10,057,047
May '76	7,703,843	1,139,739	965,580	558,363	10,367,525
June'76	7,314,777	1,112,300	848,160	553,701	9,828,938
July'76	7,707,675	1,111,806	847,530	593,180	10,260,191
Aug '76	7,539,729	1,110,687	805,394	556,095	10,012,715
Sept'76	7,347,043	1,122,880	726,320	535,537	9,731,780
Total	89,740,099	13,353,048	10,196,824	6,668,977	119,958,948

Ref: Deep Well Div. Dept. of Production Research: Development Div.

第 7 章　添　付　資　料

FEASIBILITY STUDY FOR THE SEPARATE SYSTEM OF METROPOLITAN WATER WORKS SUPPLY IN BANGKOK, THAILAND

Reference No. ; 1
Date : Feb. 4, 1977
Subject : Field Study of Separate System
Reference : Rivised Schedule - Feb. 7 - Mar. 25, 1977
Prepared : K. Miyakura, T. Ogawa

Sect.	Date	Party 1 Electrical Prospecting Team	Party 2 Data Collection Team	Party 3 Water Supply Survey Team (Including Water Analysis)	Remarks
1	Feb. 7(Mon)	Office Work	Office Work	Sai Noi Field survey (Mr. Kawamura & Mr. Miyakura) Discussion about Additional Area	
	8(Tue)	Field Survey Using L-10 & N-S	Same as left	Same as left	
	9(Wed)	Ditto Using L-10	Industrial Area of Bang Bo and Bang Phli	Bang Yai & bang Bua Thong Field Survey	
2	10(Thu)	Ditto Using L-10	Industrial Area of Min Buri	Nong Kheam & Additional Area Field Survey	
	11(Fri)	Ditto	Industrial Area of Nong Chok	Ditto and Water Analysis at Samsen T. Plant	
	12(Sat)	Analysis	Office Work	Office Work	
3	14(Mon)	Field Survey Using N-S		Bang Bo, Bang Phli & additional Area Field Survey	
	15(Tue)	Ditto Using N-S	Analysis	Ditto	
	16(Wed)	Ditto Using N-S	Analysis	Office Work	

Sect.	Date	Party 1 Electrical Prospecting Team	Party 2 Data Collection Team	Party 3 Water Supply Survey Team (Including Water Analysis)	Remarks
4	17(Thu)	Analysis	Analysis	Nong Chok Field Survey	
	18(Fri)	Analysis	Preparation of Summary Ground Water Report	Lat Krabang & Min Buri Field Survey	
	19(Sat)	Analisis	Ditto	Office Work	
5	21(Mon)	Discussion & Coordination between Party 1,2 & 3			
	22(Tue)	Ditto			
	23(Wed)	Ditto			
6	24(Thu)	Conclision of Alternative Summary in every nine (9) Amphoe including five (5) Additional Districts.			A part of Svev. Team Leave for Japan.
	25(Fri)	Ditto			
	26(Sat)	Ditto			
7	Feb.28 - Mar.12	Comparative Study (1) Preparation of Alternative Plans (2) Construction Cost Estimation (3) Selection of Feasible Plans (4) Preparation of Draft Report (in Japanese)			
8	14 - 19	Preparation of Progress Report (in English) Supplementary Works and Data Collection			Mar. 12, Dr. Naito Mr Okazawa Mr. Shiozawa in Bangkok
9	21 - 25	Discussion with MWWAand DTEC if necessary about Progress Report			
	Mar.26				Leave for Japan

FEASIBILITY STUDY FOR THE SEPARATE SYSTEM OF
METROPOLITAN WATER SUPPLY IN BANGKOK, THAILAND

Reference No.; 2
Date ; Feb. 4, 1977
Subject ; Field Study of Separate System
Reference ; Request to MWWA
Prepared ; K. Miyakura

(1) Data of 5 Test Wells which were already carried out at Lat Krabang, Min Buri and Nong Chok, mentioned as page 3 of Inception Report.

(2) The latest population data of every 9 Amphur and Amphur Town.

(3) The latest Survey Map (prepared in 1969) of 10 sets of each Amphur and 2 sets of central area.

(4) To dispatch us 1 counterpart, who can test Dissolved Oxygen (DO.) at site on 11th Feb., at Klong Tawi Watthana.

And to arrange meeting with the Water Analysis Engineer in the afternoon on 9th Feb.

(5) Car Arrangement

	Microbus	Car	Wagon
Party 1	7th-12th 14th-16th	---	7th-12th 14th-16th
Party 2	---	9th-11th	---
Party 3	7th-18th 1 Vehicle	---	---
Party 4	---	---	---

FEASIBILITY STUDY FOR THE SEPARATE SYSTEM OF METROPOLITAN WATER SUPPLY IN BANGKOK, THAILAND

Reference No.; 3
Date ; Feb. 4, 1977
Subject ; Field Study of Separate System
Reference ; Organization of Survey Team
Prepared ; Dr. Naito, Mr. Okazawa

		Combination A	Combination B
Manager (Mr. Kawamura)	Party 1 Electrical Prospecting	Mr. Muto (Chief) Mr. Varavut (Counterpart) 1 Geologist 4 Assistants	Mr. Muto (Chief) Mr. Varavut (Counterpart) 1 Geologist 4 Assistants
	Party 2 Data Collection on Water Resources	Dr. Ogawa (Chief) Mr. Borrirak (Counterpart)	Dr. Ogawa (Chief) Mr. Miyakura Mr. Takemoto Mr. Borrirak (Counterpart)
	Party 3 Planning of Water Supply Systems	Mr. Miyakura (Chief) Mr. Nakamura Mr. Takemoto Mr. Komatsu Mr. Prasat	Mr. Miyakura (Chief) Mr. Nakamura Mr. Kawabata Mr. Hashizi Mr. Komatsu Mr. Prasat (Counterpart)
	Party 4 Economic Analysis & Financial Program	Mr. Kawamura (Chief) Mr. Kawabata Mr. Hashizi Miss Tidachan (Counterpart)	

FEASIBILITY STUDY FOR THE SEPARATE SYSTEM OF
METROPOLITAN WATER SUPPLY IN BANGKOK, THAILAND

Reference No.; 4
Date ; Feb. 8, 1977
Subject ; Field Study of Separate System
Reference ; Request to Industrial Estate Office & Housing Project Office
Prepared ; Mr. Kawamura & Mr. Miyakura

1. Location shown on the map
   (1) Existing
   (2) Future.....

2. Water Supply for Factory
   (1) Existing Condition
   (2) Future Planning.....whether will include to Separate System or not

3. Water Supply for Worker
   (1) Existing Condition
   (2) Future Planning.....whether will include to Separate System or not

4. Water Supply for Surrounding Area of Industrial District
   (1) Existing Condition
   (2) Future Planning.....whether will include to Separate System of not

5. Water Demand Estimate
   (1) Existing Condition
      i) Factory
         (a) Number of Factories
         (b) Type of Factories & Each Ratio
         (c) Water Demand in Seasonaly, Daily, Hourly in detail
      ii) Worker
         (a) Working Time
         (b) Number of Workers

...../2

(c) Water Demand in Seasonaly, Daily, Hourly, in detail

iii) Persons, Surrounding Area

(a) Population

(b) Water Demand in Seasonaly, Daily, Hourly, in detail

(2) Future

i) Factory

(a) Number of Factories according to future planning year by year until 2000 AD

(b) Type of Factories & Each Ratio according to future planning year by year until 2000 AD

(c) Water Demand according to future planning year by year until 2000 AD, in Seasonaly, Daily, Hourly, in detail

ii) Worker

(a) Working Time in future

(b) Number of Workers according to future planning year by year until 2000 AD

(c) Water Demand according to future planning year by year until 2000 AD, in Seasonaly, Daily, Hourly, in detail

iii) Persons Surrounding Area

(a) Population according to future planning year by year until 2000 AD

6. Existing Deep Well

Name of Industrial District:-

Well

(1) Diameter	(mm)
(2) Depth of the Well	(m)
(3) Static Water Level	(m)
(4) Operating Water Level	(m)
(5) The Year of Construction	

Pump & Elevated Tank

(1) Type of Pump & Number	
(2) Diameter of Section Pipe	(mm)
(3) Capacity of the Pump	(cum/min)
(4) Lift Head	(m)
(5) Operating Time	(hr/day)
(6) Capacity of the Elevated Tank	(cum)
(7) Effective Water Level	(m)

FEASIBILITY STUDY FOR THE SEPARATE SYSTEM OF METROPOLITAN WATER SUPPLY IN BANGKOK, THAILAND

Reference No.; 5
Date ; Feb. 9, 1977
Subject ; Field Study of Separate System
Reference ; Water Quality Analysis
Prepared ; Mr. K. Miyakura, Mr. Takemoto

Schedule - Klong Tawi Watthana Sampling [illegible]

Feb.11(Fri)	1 Field Work (1) Water Sampling for i) usual test ii) jar test (2) Water Sampling for BOD 5 i) sample for present dissolved oxygen (DO) - 100ml incubation bottel x 2 (Necessary to fix DO at site) ii) sample for 5-day DO-100ml incubation bottle x 3 (Not necessary to fix DO at site) 2 Laboratory Work measuring fixed DO value x 2
Feb.12(Sat) – Feb.15(Tue)	1 Usual Water Quality Analysis 2 Jar Test
Feb.15(Wed)	1 Measuring 5-day DO value x 3 2 Calculation BOD_5

List of Equipment on Feb.11, 1977

(1) P.V.C. Bottle; 5^{l} capacity x 1

(2) Incubation Bottle; 100^{ml} capacity x 15

(3) Chemical: Manganese Sulfate Solution (Mn SO4)
Alkali - Iodide

(4) Others : Incubation bottle storage
Pipet

FEASIBILITY STUDY FOR THE SEPARATE SYSTEM OF
METROPOLITAN WATER SUPPLY IN BANGKOK, THAILAND

Reference No.; 6
Date ; Feb. 10. 1977
Subject ; Field Study of Separate System
Reference ; Minutes of Meeting; Additional Industrial Area
Prepared ; K. Miyakura

Attendants; Japanese Survey Team: Mr. K. Kawamura
Mr. K. Miyakura

Industrial Estate Authority: MR. JAROEN VATTASINGH

Place ; Meeting Room of Industrial Estate Authority

Discussion; Ahead of the discussion, Japanese Survey Team expressed purpose of visit to Industrial Estate Authority. The meeting carried out for one hour.

Following are summary content of meeting.

1. General Condition of Industrial Area.

There are 5 industrial area to supply water mentioned bellow as a part of Seperate System.

; Bang Chan, near Min Buri
; ~~Min Buri, near~~ Lat Krabang
; Bang Phli
; Bang Poo.
; Klong Dan, near Bang Bo

Among these only Bang Chan is existing industrial area and others are future planning.

As a past, Record of Water Consumption at Bang Chan was about 4,000 cum/day.

2. Another Informations

As for the another informations such as existing well date, number of factories according to future planning, will be given to Japanese Survey Team at the beginning of next week.

FEASIBILITY STUDY FOR THE SEPARATE SYSTEM OF METROPOLITAN WATER SUPPLY IN BANGKOK, THAILAND

Reference No.; 7
Date ; Feb. 14, 1977
Subject ; Field Study of Separate System
Reference ; Minutes of Meeting; Additional New Airport
Prepared ; K. Miyakura

Attendants; Japanese Survey Team: Mr. K. Kawamura
Mr. K. Miyakura

Department of Commercial Aviation: Dr. Boonsorn Boonsukha
(Director General)

Place ; Meeting Room of Department of Commercial Aviation

Discussion; Ahead of the discussion, Japanese Survey Team expressed purpose of visit to Department of Commercial Aviation. The meeting carried out for one hour.

Following are summary content of meeting.

1. General Condition;
Feasibility study of new airport will carry out from Feb. 1977 to Dec. 1977 with the joint-venture between T.A.M.S. (The American Consultants) and T.E.C. (Thai Engineering Consultants).

Proposed site of new airport is near Amphoe Lat Krabang and four km. away from super highway.

This airport will have two runway with the length of four km. each.

2. Number of Passengers of DON-MUANG Airport;
Number of passenger of don-muang airport is 4,200,000 person per year including transit.

FEASIBILITY STUDY FOR THE SEPARATE SYSTEM OF
METROPOLITAN WATER SUPPLY IN BANGKOK, THAILAND

Reference No.; 8
Date ; Feb. 16, 1977
Subject ; Field Study of Separate System
Reference ; Minutes of Meeting: Additional Housing Project
Prepared ; K. Miyakura

Attendants; Japanese Survey Team; Mr. K. Kawamura
Dr. T. Ogawa
Mr. S. Komatsu
Mr. Y. Nakamura
Mr. E. Kawabata
Mr. K. Miyakura
Mr. T. Hashizi
Mr. H. Takemoto

National Housing Authority; Mr. Sidhijai Tauphiphat
Mr. Thitanon Pibulnakarin

Place ; Office of Japanese Survey Team.

Discoussion; Ahead of the discussion, Japanese Survey Team expressed purpose of meeting to National Housing Authority. The meeting carried out for one and half hours.

Following are summary content of meeting.

1. General Condition;
National Housing Authority will carry out five housing projects which have relation to separate system.

Those proposed districts are follows;

(1) Left bank of Chao Phya;
Minburi, Lat-Krabang, Bang Phli - Bang Bo and Bang Poo

(2) Right bank of Chao Phya;
Bangkumtien

2. Water Consumption Ratio;
Water consumption per capita per day is 200litre/capita day.

3. Date Collected;
(1) population year by year
(2) Number of workers in combined district where housing and factory are belonging together.

FEASIBILITY STUDY FOR THE SEPARATE SYSTEM OF METROPOLITAN WATER SUPPLY IN BANGKOK, THAILAND

Reference No.; 9
Date ; Feb. 15, 1977
Subject ; Field Study of Separate System
Reference ; Information of Water Sources
Prepared ; Mr. Ratana, Mr. K. Miyakura

Source of Information:

Mr. Chatchaval; Chief of Water Resource Distribution Center, RID

1. Right Bank of Chao Phya River

R-1; Khlong Thawi Wattana
(1) Flood Season - 2cum/sec = 172,800cum/day
(2) Dry Season - 0cum/sec
(3) Necessary to negotiate with RID

R-2; Khlong Maenum Om (near Chao Phya River)
Less than 0.1cum/sec = 8,640cum/day is available for separate system.

R-3; Khlong Phra Phimol
no flow capacity

2. Left Bank of Chao Phya River

L-1; Khlong Phraongchao Chaiyanuchit
(1) no flow capacity for separate system
(2) Necessary to negotiate with RID

L-2; Khlong Phra Khanong
(1) Less than 0.1cum/sec = 8,640cum/day is available for separate system
(2) Be careful water pollution

L-3; Khlong 6th
Less than 0.1cum/sec = 8,640cum/day is available for separate system

L-4; Khlong 13rd (Transmission Canal)
(1) Flood Season - 20cum/sec = 1,728,000 cum/day
(2) Dry Season - 5cum/sec = 432,000 cum/day
(3) Less than 2.5cum/sec = 216,000 cum/day
is available for separate system

FEASIBILITY STUDY FOR THE SEPARATE SYSTEM OF
METROPOLITAN WATER SUPPLY IN BANGKOK, THAILAND

Reference No.; 10
Date ; March 4, 1977
Subject ; Field Study of Separate System
Reference ; Request to MWWA
Prepared ; Mr. K. Miyakura

(1) The latest population date of every 9 Amphoe and Amphoe Town, already requested Reference No. 2 on Feb. 4, 1977.

(2) Basic data for amortization schedule:-

i Personal expenditure (per month) of each occupations
- Super Intendant
- Senior Engineer
- Junior Engineer
- Mechanics
- Workers

ii General management expenditure such as repair expenditure etc.

iii Running cost for Treatment Plant itself
- Power Cost per KWH
- Chemical Cost per cu.m.
  . Alum
  . Lime
  . Chlorine

(3) The basic line of the land elavation shown on the map which prepared your authority.

(4) The below mentioned tidal lange of Gulf of Thailand or somewhere else with relating to the basic line mentioned item (3);

i High sea water level

ii Mean sea water level

iii Low sea water level

(5) Reports

i Ground Water Level in Bangkok prepared by Ground Water Division Department Industry.

ii Results of test boring at Bang Bo, carried out your authority.

...../2

iii Capacity of existing deep well industries & Central System area from 1960 to 1976, if any.