Chapter 6 Result of Data Collection

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 Water Proof	"	-	129	17	146	
(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 sq m	-	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 (Back Washing)	"	-	17,750	4,239	21,989	
Flow-Meter Chamber (Raw Water)	1 set	-	21,318	9,076	30,394	
Flow-Meter Chamber (Distribution)	1 set	-	24,535	9,579	34,114	
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 "	"	50,303	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		Labor	Cost	Remarks
		F. Cost	D. Cost	D. Cost		
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

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)

6-2 Basic Principles of Water Law[1)]

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 Interior 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 Interior

(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 Government 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.

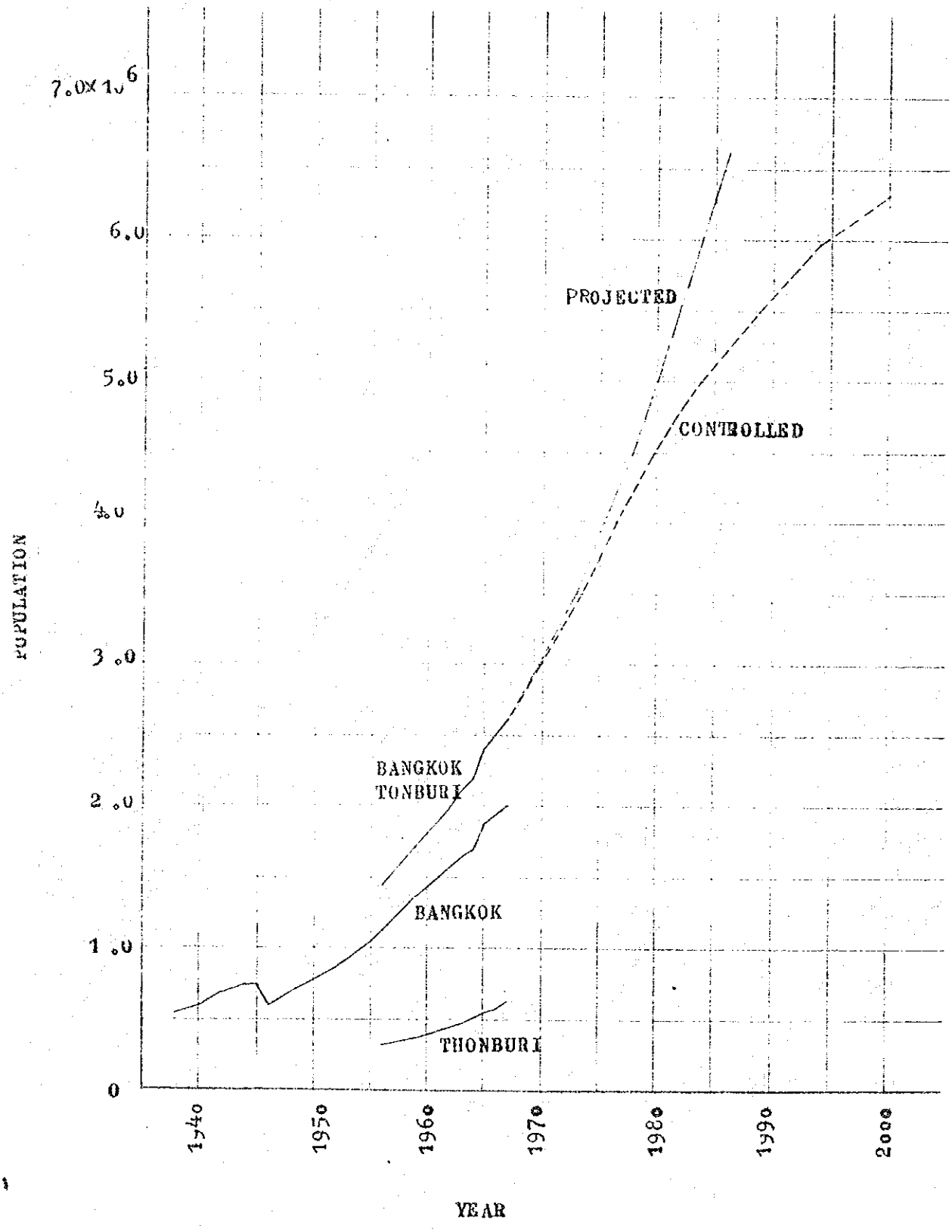
(7) Create a park system by providing green strips along the major canals existing in the metropolitan area. Expand the strips to large parks where feasible.

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		BANGKOK MUNICIPALITY Predicted Population			THONBURI MUNICIPALITY Predicted Population		
B.E.	A.D.	Minimum	Probable	Maximum	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		NONTHABURI MUNICIPALITY Predicated Population			SAMUT PRAKAN MUNICIPALITY Predicated Population		
B.E.	A.D.	Minimum	Probable	Maximum	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					Municipalities					
			Bangkok	Thonburi	Nonthaburi	Samut Prakarn	Total	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	2,141,000	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	2,675,000	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	4,095,000	1,430,000	50,000	86,000	5,661,000	10.5
2543	2000	78,000,000	6,830,000	2,330,000	1,320,000	1,340,000	11,820,000	6,345,000	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 Prakan)								
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 Population
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 Bua Thong (municipality)	Bang Bua 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 solt 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)]

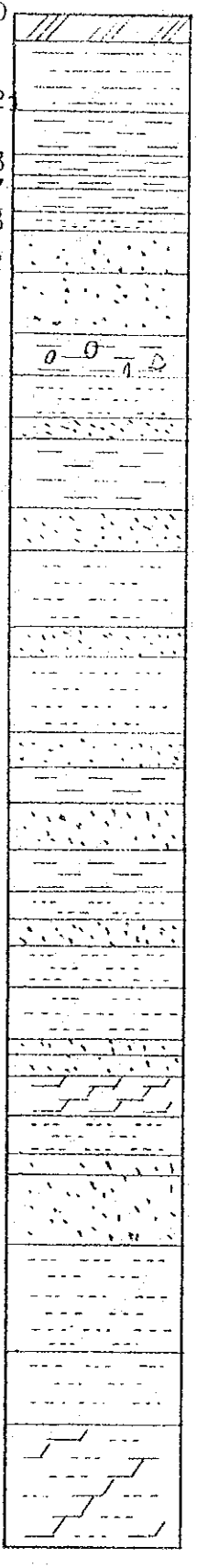
1) Water Supply and Sewerage Sector Study; World Health Organization/ World Bank Cooperative Programme, 1975.

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

WELL LOG NO 5-03

Kilometer 5o Sukumvit Rd Samutprakan

started January 1o 196o



4.00	Surface soil
14.2	Soft clay, grey
20.61	Clay, grey with shells
23.63	Clay, yellowish white
28.17	Clay, light yellow
28.94	Clay, black yellow
31.43	Coarse sand,yellow with clay
37.52	Coarse sand, black yellow
46.66	Coarse sand,white
52.75	Clay, yellow withgravel
58.84	Clay, yellow with fine sand
61.88	Fine sand, white
71.94	Clay, yellow
78.08	Fine sand, white
93.51	
104.52	Clay, yellow with fine sand
109.58	Fine sand, yellow and white
114.80	Coarse sand, yellow with clay
121.90	Fine sand, white
127.88	Clay, yellow
131.88	Coarse sand, white and yellow
135.63	Clay, yellow
	Coarse sand, yellow with clay
	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

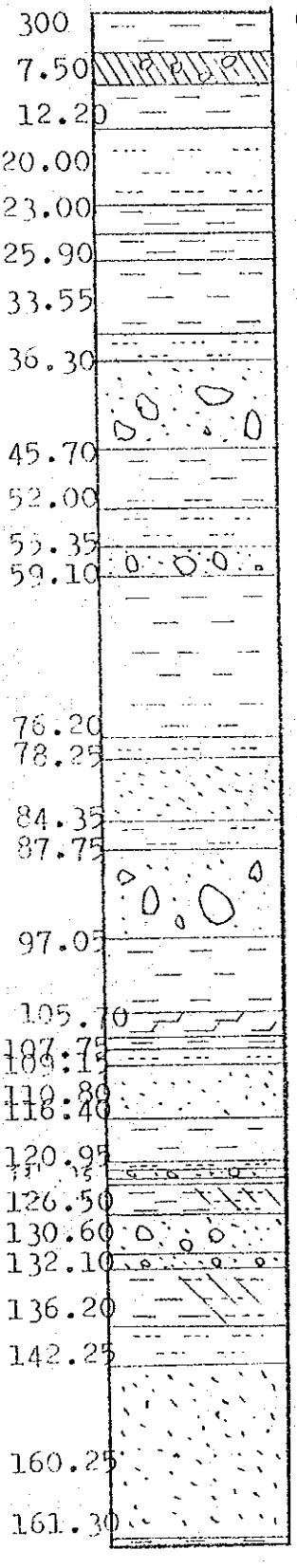
WELL LOG NO 82/39-05

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
53.35	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
116.40	
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

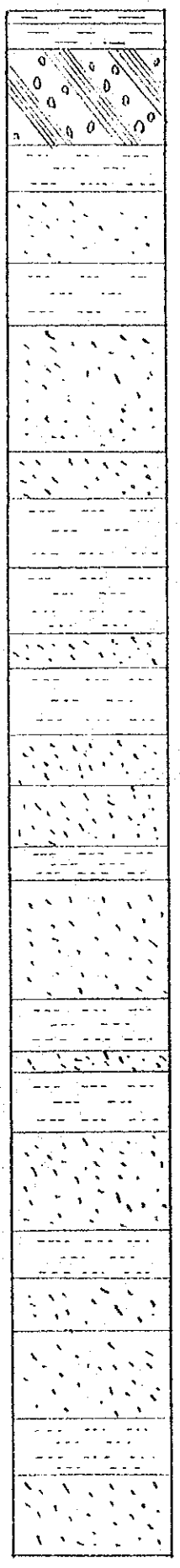
WELL LOG ที่ 106/17-06

T.Lardyoa A, Bangkhen CH.Bangkok

STATIC WATER LEVEL 8.20 m. Started 2o February 1963

Capacity 7.50 Cu.m/hr Completed 5 March 1963

Hardness 132 P.P.M. 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

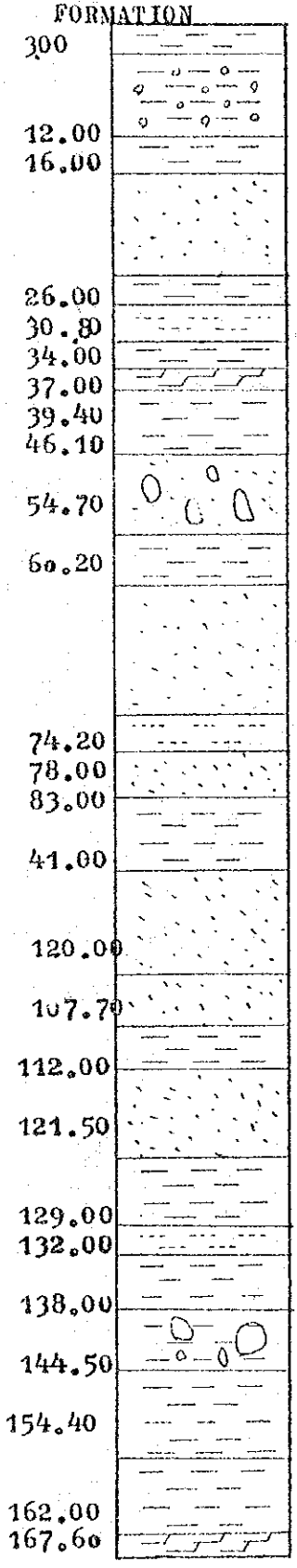
Watmai, Nong Praong, Tamble Suanluang, A Katumban

Changwad Samusakorn

Boring started: 19 August 1965

Boring Completed: 24 August 1965

Scale: 1:750



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

WELL LOG ท.386/30-11

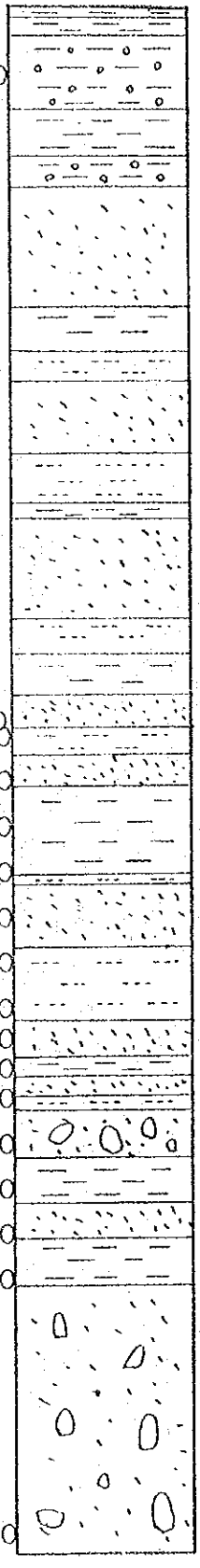
WAT BANGKUNIENNAT T.BANGMOT A. BANGKUNTIEN

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	
111.00	Clay,yellow white fine sand
123.50	Coarse sand,yellow and white
	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 white 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				Total
	Bangkok (cum)	Thonburi (cum)	Nonthaburi (cum)	Samut Prakan (cum)	(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.

Chapter 7 Appendix

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 : Riviced 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

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.

Discussion; 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.

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