7. Groundwater

2-43 Groundwater in the area around Bangkok is retained in 4 aquifer stratas. There are, in decending order, the Bangkok, Phra Pradaeng, Nakhon Luang and Nonthaburi Aquifers. The DMR Groundwater Division has compiled data on the depth, thickness, salinity and piezometric surface of each aquifer, using information from existing wells (see Annex 2-20). The salinity of water in the Bangkok and Phra Pradaeng Aquifers has been increasing in recent years, and the production of wells in the area around Samut Sakhon is derived almost entirely from the Nakhon Luang Aquifer, located at a depth of around -150 m.

2-44 Because of the deterioration in the quality of water (i.e. increasing salinity), permission from DMR must be granted prior to construction of new wells. There is a general policy of not allowing new wells for the individual factories in Samut Sakhon, and a specific rule prohibits wells closer than one every 500 m.

Table 2-8 WELLS IN SAMUT SAKHON AREA

Well Number	185/16	130/16	173/16	101/20	110/20	94/21	113/21	64/21
Year	1973	1973	1973	1977	1977	1978	1978	1978
Yield (m^3/hr)	74.00	48.00	46.00	3.00	60.00	5.00	10.00	12.00
Static water level (m)	11.80	12.50	14.80	24.50	14.25	32.40	12.45	20.00
Draw down (m)	10.07	25.00	7.10	-	4.05	16.40	8.35	16.00
Hardness (ppm)	196.00	200.00	158.00	216.00	158.00	70.00	178.00	164.00
Chloride (ppm)	3.00	7.50	32.50	26.00	8.00	53.00	9.00	8.50
Iron (ppm)	0.10	0.33	0.33	0.08	0.22	0.065	0.10	0.13
Depth of well (m)	210	150	140	150	140	150	130	160

Source : PWD

F. Transportation

1. The Road Network

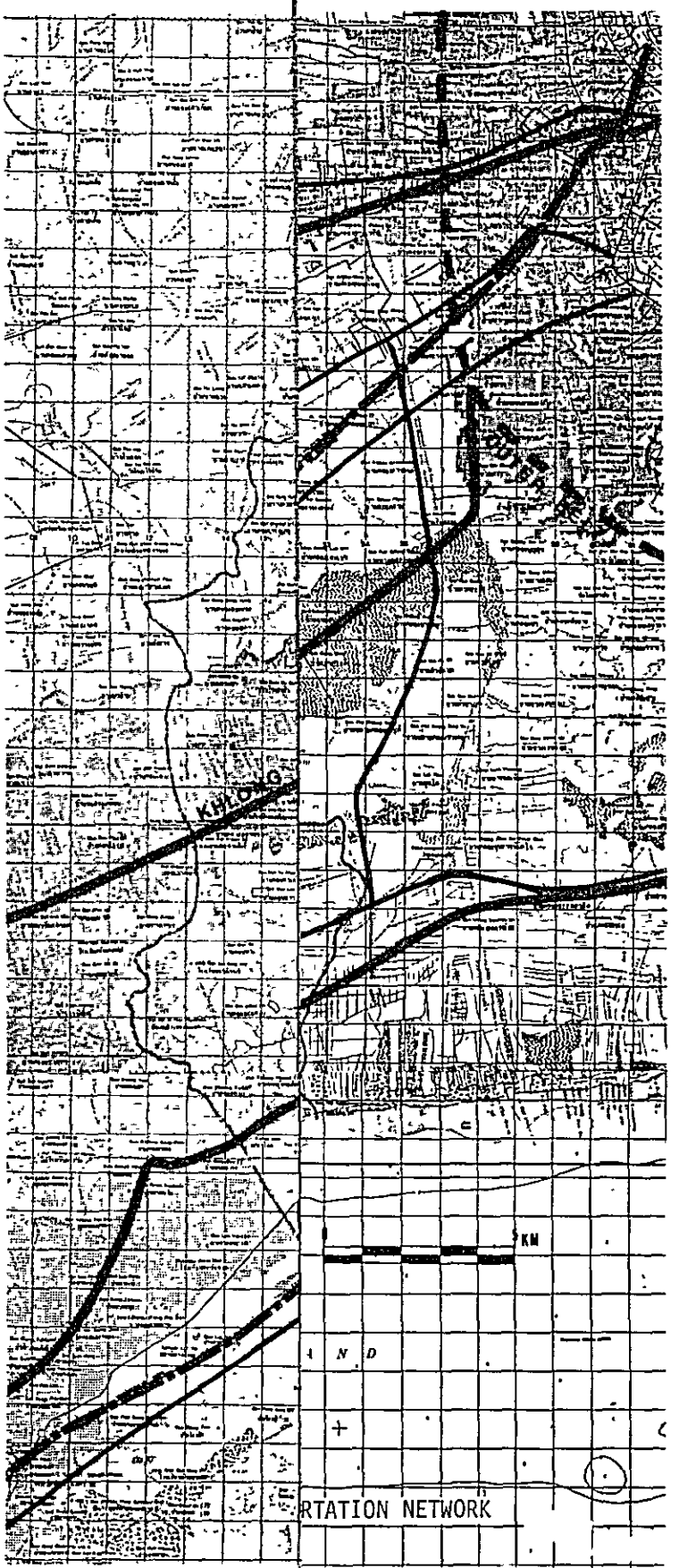
2-45 The road network around Samut Sakhon is shown in Fig. 2-11 and the daily traffic volumes for the different roads in Table 2-9. Roads linking Bangkok and Samut Sakhon are (1) R-4, a trunk road linking Bangkok with southern Thailand, (2) R-35, the Thon Buri-Pak Tho Highway shortcut from Thon Buri to Samut Songkhram, and (3) R-3242, a road approximately parallel to R-35. Linking these east-west roads are R-3043, R-3091 and R-3097 running from the Bangkok side, and R-3243 running from the city of Samut Sakhon towards the coast. The maintenance of all these roads comes under the jurisdiction of the Highway Department (H.D.); no other well maintained roads were observed.

2-46 R-4 is a divided 4-lane highway which at present carries 20.4 thousand vehicles per day, and planned to have a bypass in the north to meet the increase in traffic volume. R-35 was opened in 1972. There are about 2 km of divided four lane road starting from Thon Buri, but the rest of the road is two lane and undivided. However, the right of way is 80 m wide and traffic entering the road is controlled by service roads. The railway crossings are bridged. The H.D. has filed feasibility study applications with the relevant agencies for widening this road to 4 lanes. R-3091 is a undivided two lane road. Its shoulders are narrow and H.D. is carrying out partial improvements of the sections of the road to bring it up to standard width and quality. R-3242 and R-3043 are paved in asphalt, as is R-3091, but are narrow in width and the paving has suffered damage. Future plans call for R-3243 to follow a coastal route as far as Samut Prakan, Ban Bo and Ekachai, but at present this is a single-lane latelite road stopping at Khlong Sahakon.

Table 2-9 TRAFFIC VOLUME ON HIGHWAYS (ADT)

Route No.	Year	Type of Vehicle						
		Passenger Car	Light Bus	Heavy Bus	Light Truck	Heavy Truck	Truck over 2 axles	Total
4	1974	6,481	880	1,156	1,170	1,559	2,947	14,193
	1975	7,162	866	1,174	1,162	1,907	3,241	15,512
	1976	8,314	1,182	1,391	1,346	2,464	3,234	17,931
	1978	8,323	1,213	1,525	2,194	2,994	3,410	19,659
35	1974	3,052	289	341	598	690	492	5,462
	1975	3,717	337	493	791	886	645	9,869
	1976	3,407	461	490	856	734	638	6,602
	1977	2,731	412	602	982	997	1,929	6,753
	1978	3,150	376	697	1,088	980	1,336	7,677
3091	1974	1,557	1,098	461	460	356	132	4,064
	1975	1,869	1,166	166	615	444	343	4,603
	1976	2,098	1,061	180	759	474	397	4,924
	1977	2,660	1,122	223	1,261	960	501	6,727
	1978	2,621	1,214	199	1,656	1,156	862	7,718
3097	1974	97	150	92	103	92	106	640
	1975	119	196	66	150	114	134	779
	1976	87	180	56	190	79	58	650
	1977	145	225	55	224	105	41	795
	1978	204	225	160	315	157	707	1,768

Source : H.D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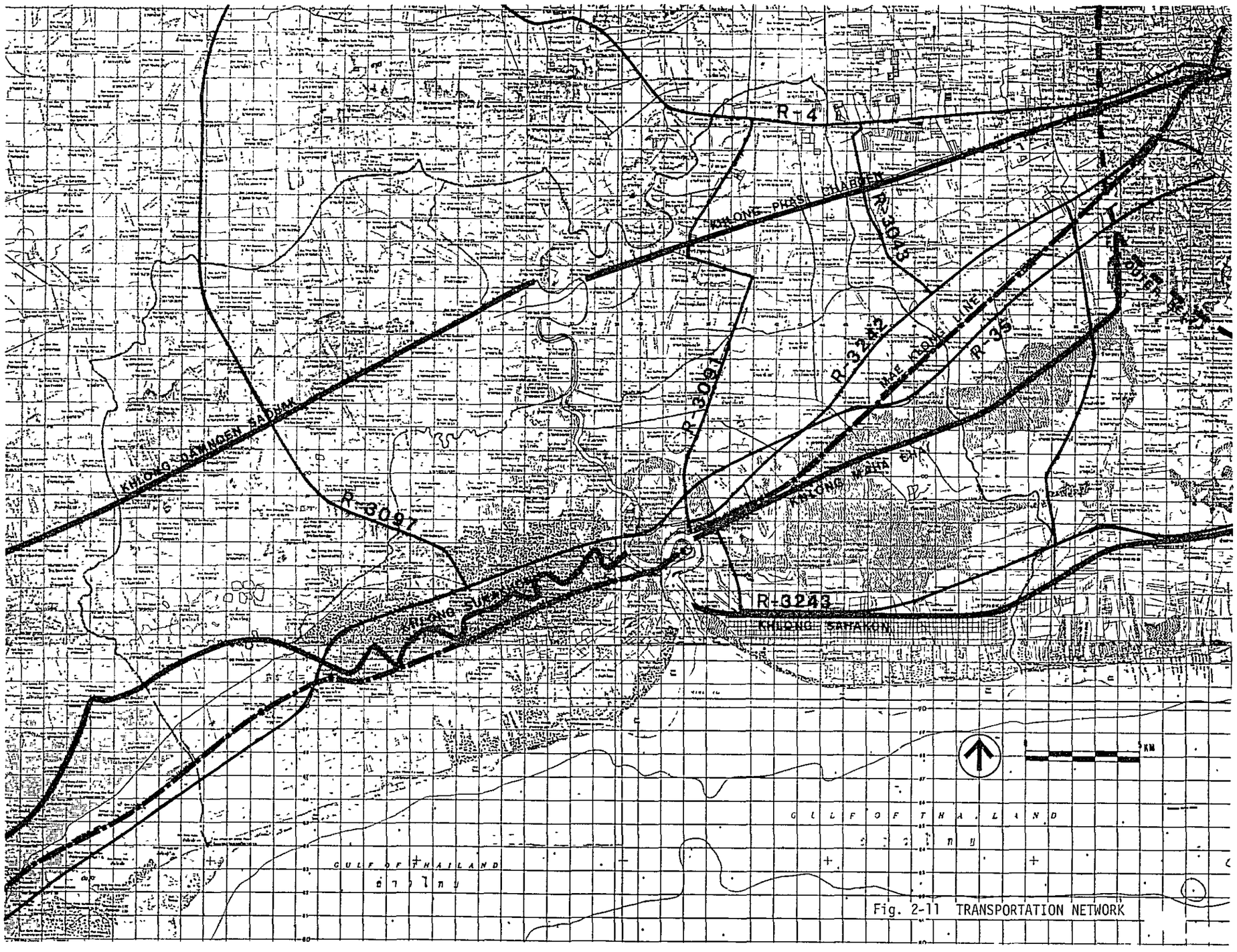


Fig. 2-11 TRANSPORTATION NETWORK

2-47 It is planned to link R-4 and R-35 with Bangkok's outer belt forming a trunk road network. The plan calls for detail design by 1981 and for commissioning in 1983 of the section of the outer belt to the north of R-35. The section to the south, however, must cross the Chao Phraya River, and no project has yet been fixed for construction. Regular bus routes out of Samut Sakhon include publicly and privately operated buses running at 15-minute intervals to Bangkok, at 20-minutes intervals to Samut Songkhram and hourly to Nakhon Pathom.

2. Railways

2-48 The Mae Klong railway runs nearly parallel with R-35 between Thon Buri and Samut Songkhram. The line is divided by the Tha Chin River, however, and a shuttle service is operating on both sides. Utilization is low between Samut Sakhon and Samut Songkhram and the RSRT is currently considering the closure of the railway. Passenger trains are running approximately hourly throughout the day on the Thon Buri-Samut Sakhon section, with 18 round trips per day, and these trains are also used by people commuting between Bangkok and Samut Sakhon. No special provision is made for freight trains, and the average share of railways of freight is about half that of the passenger trains, on a national basis.

Table 2-10 ANNUAL COMMODITY VOLUMES CARRIED BY RAILWAY (1972 and 1978)

	Annual Tonnage (1000 tons)			Ton-Kilometers (1000 KWS)		
	1972	1978	Average Annual Growth Rate (%)	1972	1978	Average Annual Growth Rate (%)
Rice Products	454	347	Δ4.3	264,309	272,924	0.5
Sugar	13	89	37.8	7,656	24,538	21.4
Other Farm Products	316	293	Δ1.3	177,891	278,519	7.8
Forestry	311	333	1.1	185,239	186,509	0.1
Fishery	37	52	5.8	25,632	34,426	5.0
Construction Materials	971	1,674	9.5	325,406	368,255	2.1
Manufactured Goods	193	226	2.7	94,038	146,194	7.6
Livestock	19	50	17.5	7,792	16,364	13.2
Minerals	808	975	3.2	179,748	215,405	3.1
Petroleum Products	1,465	1,430	Δ0.4	783,462	708,465	-1.7
Others	401	692	9.5	191,644	488,827	16.9
Total	4,988	6,161	3.6	2,242,817	2,740,926	3.4

Source : Marketing Department, RSRT

Table 2-11 ANNUAL RAILWAY TRANSPORTATION VOLUME IN THAILAND

Unit: Million passenger km
Million ton km

	1967	1968	1969	1970	1971	1972	1973	1974	1975	Av. Annual Growth Rate
Passenger	3614	3884	3962	4113	4260	4412	4694	5376	5640	5.7%
	100	107	110	114	118	122	130	149	156	
Cargo	1941	2083	1979	2209	2304	2242	2070	2296	2353	2.4%
	100	107	102	114	119	116	107	118	122	

Source : RSRT

3. Inland Water Transportation

2-49 The Tha Chin River in Samut Sakhon and Chao Phraya River in Bangkok are linked by Khlong Phasi Charoen and Khlong Sahakon. The former is controlled by double locks at Krathum Baen. The operation of these locks maintains the freshness of the Khlong, enabling it to be used for irrigation in the dry season, as well as for carrying vessels. The locks are administered by RID. An average of 62 vessels pass through these locks each day, with boats of 3 m - 4 m in width forming the majority. Traffic in the rainy season (June to September) is approximately 60% of that in the October to March period. There are no locks on the later canal, and the water in it is saline. This Khlong is administered by Harbour Department.

2-50 In the modal split of transportation, the share of goods carried by inland water transport in the central region, categorized by goods, is in the order of 80% of maize, 44% of building materials, 29% of rice and 29% of timber. Primary products yield a high proportion in the inland water transport. Construction materials consist of mainly of earth and sand. 19% of manufacturing goods are carried by inland waterway.

2-51 Large trawlers use the Tha Chin River up to Samut Sakhon fishing harbour. However, because of the small clearance below the bridge where R-35 crosses the river, only flat boats can travel any further upstream, and factories along the Tha Chin River, therefore, rely almost entirely on land transport.

2-52 Regular boat services in Samut Sakhon are as follows:

i) The Tha Chin River boat service (Samut Sakhon-Bang Yang)

ii) The Khlong Maha Chai boat service (Samut Sakhon-Bang Kun Tien)

iii) The Khlong Phasi Charoen boat service (Krathum Baen-Non Kaem)

iv) The Khlong Dam Noen Saduak boat service (Bang Yang-Dam Noen Saduak)

Table 2-12 WATERWAY TRAFFIC IN 1978 (KHLONG PHASI CHAROEN AND DAM NOEN SADUAK)

	WIDTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	TOTAL
KRATHUM BAEN	1m-1.5m	123	137	130	107	88	56	81	56		152	115	140	1,185
	-2.0	204	238	190	156	162	145	137	139		165	169	176	1,881
	-2.5	180	169	181	149	139	103	103	48		158	180	173	1,583
	-3.0	367	310	302	218	154	167	146	110		299	345	364	2,782
	-3.5	355	356	487	355	353	341	330	216	1/	456	468	417	4,134
	-4.0	747	688	590	494	483	474	473	392		575	544	588	6,048
	-5.0	546	537	587	439	471	255	272	330		565	448	291	4,741
	-6.0	20	31	43	45	30	8	7	6		44	38	42	314
	Total	2,542	2,466	2,510	1,963	1,880	1,549	1,549	1,297		2,414	2,307	2,191	22,668 2/
PHASI CHAROEN	1m-1.5m	8	14	14	15	16	18	11	12	8	39	25	25	205
	-2.0	24	18	41	28	14	12	12	21	11	19	32	25	257
	-2.5	27	28	23	19	24	22	17	12	20	19	23	22	256
	-3.0	107	87	90	57	56	78	63	40	34	142	96	124	974
	-3.5	378	345	392	367	366	363	373	274	250	433	452	446	4,439
	-4.0	679	740	812	568	626	567	570	615	617	612	614	655	7,575
	-5.0	604	589	622	501	560	349	347	369	465	617	497	637	6,157
	-6.0	11	28	48	47	33	6	7	8	9	33	28	21	279
	Total	1,838	1,849	2,042	1,602	1,695	1,415	1,400	1,351	1,314	1,914	1,767	1,955	20,142

Source : Krathum Baen Branch : RID

1/ Not observed
2/ Excluded the figures in Sept.

4. Ports

2-53 There are currently 2 passenger quays in Samut Sakhon. An average of about 9,500 passengers per day (7:00 to 18:00) cross Tha Chin River on 2 ferries (maximum loading is 100 person per vessel) using the municipal quays. Those crossing from the RSRT quay are mainly passengers of the Mae Klong Railway.

2-54 The Fishing Authority owns 2 jetties and there are also jetties operated by the Province. The Fishing Authority's jetties can accomodate 12-16 32 m class vessels per day, and their cargo landing capacity is 120 - 180 tons per day. The municipal jetties are for use by small boats of 18 m or less, and the jetties operated by the Province are also designed for small craft. The main facilities are shown in Table 2-13.

2-55 The catch landed at Samut Sakhon's fishing harbour is the highest in Thailand. In recent years, however, the estuary has become shallow, making it impossible for large vessels to navigate the river except at high tide, and there is also a lack of space on the jetties. The Harbour Dept. therefore is planning improvement, as shown in Table 2-14.

Table 2-13 EXISTING FACILITIES AT SAMUT SAKHON PORT

Reinforced concrete wharf (16.00 x 143.00 m) and reinforced retaining wall, loading capacity 15 tons
Open transit shed over the extended wharf (18.00 x 54.00 m)
Two-stories office building (10.00 x 30.00 m)
Road within the area
Commercial buildings
Road joining the main road and the port (6.00 x 746.00 m or 4,496 m^2)
Staff houses
Artesian well

Source : Harbour Dept.

Table 2-14 IMPROVEMENT PLAN OF SAMUT SAKHON PORT

Design Vessel : 500 ton
Waterway dredging : Maximum depth ..... 4 m Width .....60 m Length .....11 km Cubic Volume of dredging ... 3.5 million m^3
Installation of Safety Devices
Estimated Project Cost : Baht 18.26 million

Source : Harbour Dept.

G. Utilities

1. Water Supply

2-56 Piped water in Samut Sakhon is supplied in the following ways:

a. The Samut Sakhon municipal waterworks

The Samut Sakhon municipal area is supplied by the Municipal Waterworks. 8,000 CMD is taken from 8 wells and supplied to the 3,729 consumers (in 1977) without treatment. The system has a very high leakage factor, about 50%, because of deteriorating facilities. A redevelopment plan was established in with a target date of 1989, but presently it is not being implemented.

b. The Provincial Water Works Authority

This Authority, which was separated from the Public Works Dept. in 1979, supplies water to the rural areas. In Samut Sakhon it is supplying 1900 CMD from 6 wells to 1,496 consumers in 1977 on the right bank of Tha Chin River. A project is now under way to improve deteriorated facilities by 1981, but no other development is planned.

c. Public Works Dept., Water Supply Division

Until 1979 this Division supplied water to remote areas, but it is now supplying small communities such as Amphoe Krathum Baen. The Division has a water development plan aimed at 121 Amphoe, but presently has no system, nor plan to supply water to Samut Sakhon.

Factories in Samut Sakhon obtain their water from deep wells, and do not rely on public water services.

Table 2-15 VILLAGE WATER SUPPLY PROGRAM IN 1981-1992 IN CHANGWAT SAMUT SAKHON

Amphoe	Tambon	Village
1. Muang	Ka Long	Wat Ka Long School Group 8
2. "	Bang Ya Prake	Wat Bang Ya Prake School Group 5
3. "	Na Dee	Camp for Boy Scout Group 7
4. "	Bang Bor	Wat Bang Kould School Group 7
5. "	Bang Kor	Wat Bang Par School Group 5
6. Ban Phaeo	Luk Song	Wat Kra Jonc Tong Group 6
7. Krathum Baen	Nong Nok Kai	Bang Nong Nok Kai School Group 4
8. "	Don Kai Dee	Bang Don Kai School Group 1
9. "	Tha Mai	Wat Nang Sour Group 7

Source : PWD

2-57 In comparison the drinking water standard in Thailand with that in Japan, as shown in Table 2-16, there are only few differences on each item and values for Ca, Mg, So_4, Cd and Ba are clearly defined in Thailand. The actual quality of the drinking water of Samut Sakhon Municipal Waterworks and Provincial Waterworks Authority from deep wells are shown in Table 2-17. The figures for colour, turbidity, Mn and Fe contents slightly excess the figures of Thai standard, while the others are within the standard.

Table 2-16 DRINKING WATER STANDARDS

Unit : ppm

Item	MOPH Thailand	Japan 1966
Colour in Pt Unit	5 degrees	5 degrees
Taste	unobjectional	unobjectional
Odour	unobjectional	unobjectional
Turbidity	5	2
pH range	6.5 - 8.5	5.8 - 8.6
Total Solids	500	500
Iron (Fe)	0.5	0.3
Manganese (Mn)	0.3	0.3
Fe + Mn	0.5	-
Cupper (Cu)	1.0	1.0
Zinc (Zn)	5.0	1.0
Calcium	75	-
Magnesium (Mg)	50	-
Salfate (SO_4)	200	-
Chloride (Cl)	250	200
Fluoride (F)	0.7	0.8
Nitrate-nitrogen (NO_3-N)	45	10
Alkyl Benzyl Silfonates (ABS)	0.5	0.5
Phenolic Substances, as phenol	0.001	0.005
Mercury (Hg)	0.001	unobjectional
Lead (Pb)	0.05	0.1
Arsenic (As)	0.05	0.05
Chromium Hexavalent (Cr^{6+})	0.05	0.05
Cyanide (CN)	0.2	unobjectional
Cadmium (Cd)	0.01	-
Barium (Ba)	1.0	-
Bacterial Density	500/cm^3	100/cc
Coliform Bacteria MPN	2.5/100cm^3	unobjectional/100cc

Table 2-17 DEEP WELL WATER QUALITY OF MUANG SAMUT SAKHON IN 1974

Unit : ppm

Item	MWW 1974 JUN	MWW 1974 JUN	MWW 1974 JUN	PWWA 1974 JAN	PWWA 1974 JAN	PWWA 1974 FEB	PWWA 1974 FEB	PWWA 1974 MAR	PWWA 1974 MAR
Color in Pt Unit	-	-	-	10	7.5	-	-	2.0	2.5
Taste	unob.	unob.	unob.	obj.	obj.	unob.	unob.	unob.	unob.
Odour	unob.	unob.	unob.	obj.	obj.	unob.	unob.	unob.	unob.
Turbidity	1.0	trace	1.0	8.0	4.0	8.0	4.0	2.5	2.3
pH value	6.5	7.0	6.8	7.9	7.9	7.9	8.1	8.1	8.1
Iron (Fe)	0.065	0.050	0.050	0.040	0.17	0.25	0.34	0.065	0.075
Manganese (Mn)	nil	nil	nil	0.20	0.25	0.24	0.33	nil	nil
Zinc (Zn)	-	-	-	0.259	0.254	0.295	0.206	0.053	0.168
Magnesium (Mg)	20	20	24	31	30	32	33	18	19
Chloride (Cl)	17	18	95	182	184	149	152	27	24
Fluoride (F)	-	-	-	0.70	0.74	0.90	1.10	0.25	1.0
Nitrate-nitrogen (NO_3-N)	-	-	-	0.145	0.1714	0.0735	0.0718	0.0826	0.0866
Arsenic (As)	-	-	-	-	nil	-	-	nil	nil

Item	PWWA 1974 APR	PWWA 1974 APR	PWWA 1974 AUG	PWWA 1974 AUG	PWWA 1974 OCT	PWWA 1974 OCT	PWWA 1974 DEC	PWWA 1974 DEC
Color in Pt Unit	8.0	7.0	-	-	-	-	0.4	0.4
Taste	obj.	obj.	obj.	obj.	unob.	unob.	unob.	unob.
Odour	obj.	obj.	obj.	obj.	unob.	unob.	unob.	unob.
Turbidity	4.0	3.5	1.6	1.6	1.2	0.8	0.7	0.6
pH value	7.5	7.5	7.5	7.1	7.4	7.9	7.5	7.5
Iron (Fe)	0.065	0.065	0.27	0.35	0.11	0.15	0.08	0.04
Manganese (Mn)	nil	nil	nil	nil	0.03	0.03	nil	nil
Zinc (Zn)	0.333	0.270	0.075	0.100	0.092	0.063	0.274	0.338
Magnesium (Mg)	17	17	16	16	19	21	25	21
Chloride (Cl)	43	43	15	18	15	15	12	14
Fluoride (F)	0.70	0.58	0.69	0.75	-	0.60	0.93	0.93
Nitrate-nitrogen (NO_3-N)	0.1079	0.1541	0.0579	0.0544	0.0325	-	-	0.0244

Note : Unob: Unobjectional

Source : Municipal Water Works and Provincial Water Works Authority

2-58 All water supply facilities in Samut Sakhon rely on deep wells. With regard to surface water, the Bangkok MWWA has water-intake facilities on the Chao Phraya River, and plans to supply 40,000 CMD to Nong Khaen along R-4, and 5,300 CMD to Bang Kun Thien along R-35 by 1993. Since the present supplies in GBA are insufficient, MWWA and PWWA are now exploring for surface water resources from Nakhon Chaisi to supply for various future development projects in the west side of GBA including Samut Sakhon City, SIE, Nong Khaen and the existing Om Noi industrial area. However there is not concrete schedule for implementation of the program.

2-59 Water from fresh water canals in Samut Sakhon (the Khlong Damunoen Saduak and the Khlong Phasi Charoen) is used mainly for irrigation in the dry season, but this is now starting to fall short of requirements, and a plan exists for obtaining water from the Bangchaonen Dam on the Mae Klong River, where there is an adequate supply of water.

2. Electricity

2-60 Electricity in Samut Sakhon is supplied through PEA's 22 kV transmission network from EGAT's Samut Sakhon-1 substation, located alongside R-3091. The capacity of this substation is 2 x 25 MVA. EGAT estimates that factories which have sprung up in this area in recent years will cause demand to increase from 39.2 MW in 1980 to 65.8 MW in 1984, and that supply capacity will be exceeded by 1982. However, the SIE was not included in this estimate. To meet this demand, EGAT plans to construct the Samut Sakhon-2 substation along the 115 kV transmission line linking Samut Songkhram with Samut Sakhon-1. This project is outlined below:

i) Scope of work

The 115 kV Samut Sakhon-2 line termination and substation project consists of the following constructions:

(a) Line extension from the 115 kV Samut Sakhon-1 to Samut Songkhram line using a double-circuit steel tower and a 477 MCM ACSR conductor at a distance of approximately 3 km.

(b) The new 115 kV Samut Sakhon-2 substation with one 3-phase 115-22 kV transformer rated OA/FA/FOA 15/20/25 MVA.

(c) Additions to the communication system

(d) Total project cost : Baht 78.5 million

ii) Commissioning date

The proposed commissioning date of the 115 kV Samut Sakhon-2 substation is October 1982.

The site for Samut Sakhon-2 is not decided, but it is possible that it will be constructed within SIE.

2-61 Electricity is supplied to Samut Sakhon from the Samut Sakhon-1 substation via 7-22 kV feeder lines. The main recipients of this power are as shown in Table 2-19. PEA administers these power networks, and the number of recipients in 1977 was 5,378 houses. In special cases, power is supplied directly from EGAT, as shown in Table 2-20.

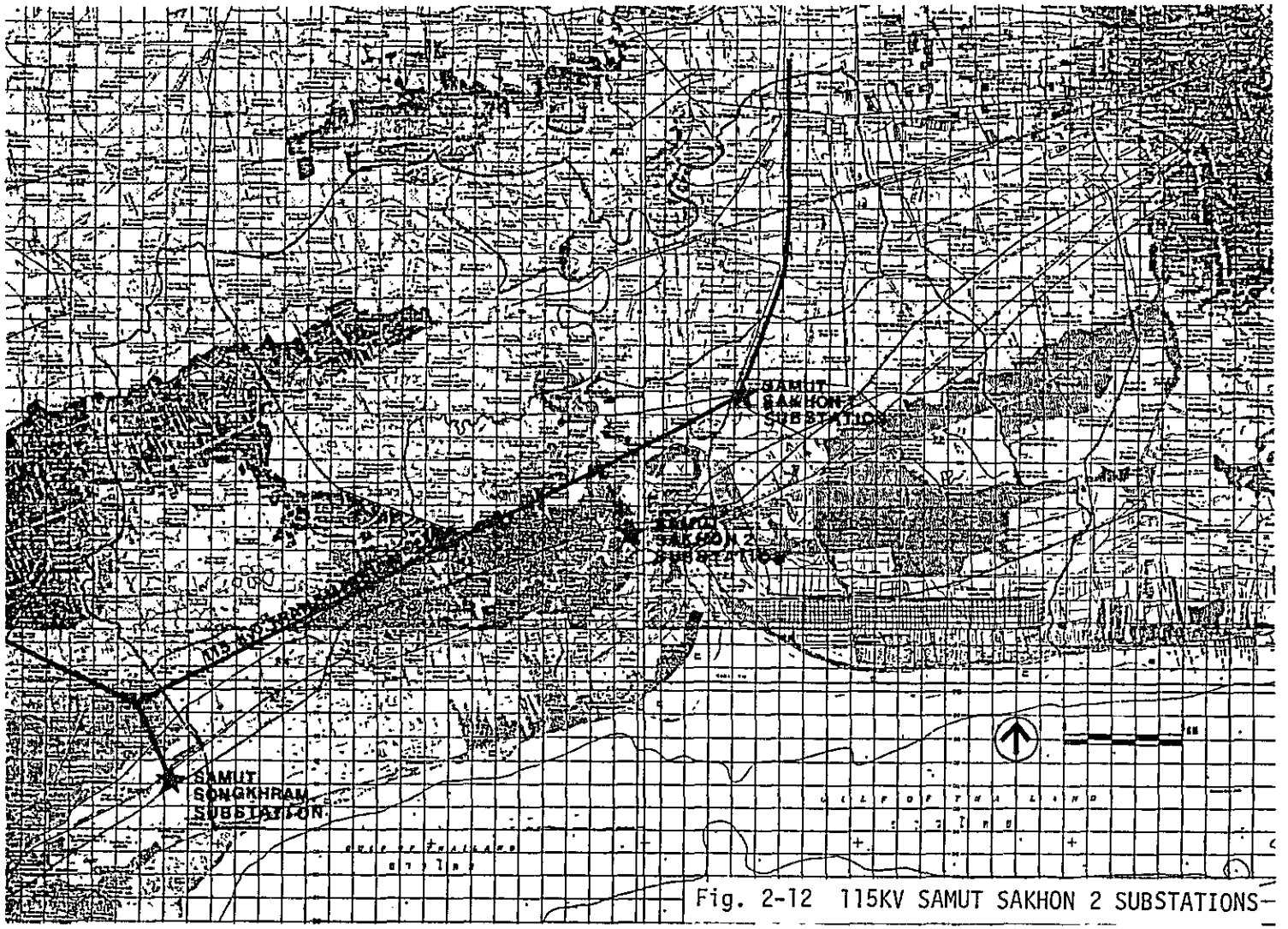


Fig. 2-12 115KV SAMUT SAKHON 2 SUBSTATIONS

Table 2-18 POWER DEMAND ESTIMATED BY PEA (SAMUT SAKHON)

1973	7.995 (MW)	
1974	9.435	
1975	22.185	
1976	26.505	
1977	30.140	
1978	33.8	
1979	37.1	
1980	39.2	
1981	46.0	Samut Sakhon 1 substation will be operating at full capacity.
1982	51.8	
1983	58.0	
1984	65.8	
1985	71.0	
1986	78.0	

Source : EGAT

Table 2-19 MAJOR ELECTRICITY CONSUMER IN SAMUT SAKHON

Name	Power Demand (KVA)
1. Pottery Factory	1250
2. Rubber Tile Factory	1000
3. Ice Mill (1)	1000
4. Ice Mill (2)	1500
5. Fish Mill	2500
6. Cold Storage	1280
7. Ice Mill (3)	2000
8. Ice Mill (4)	1000
9. Ice Mill (5)	1000
10. Ice Mill (6)	1000
11. Ice Mill (7)	1000
12. Ice Mill (8)	1600
13. Ice Mill (9)	1500
14. Dry Ice Factory	2500
15. Nakhon Luang Chemical Fiber	3750
16. Em Thai Industry	12000
17. Chemical Industry	1000
18. Rubber Factory	1000
19. Paper Industry	2000, 1500 4000, 1500
20. Carbide Factory	5000

Source : PEA

Table 2-20 EGAT'S DIRECT CUSTOMERS

Name of Direct Customers	Location/Province
1. The Siam Cement Co. Ltd. (Thaluang Plant)	Saraburi
2. The Siam Cement Co. Ltd. (Thung Song Plant)	Nakhon Si Thammarat
3. The Jalaprathan Cement Co. Ltd.	Nakhon Sawan
4. The Siam Iron and Steel Co. Ltd.	Saraburi
5. Sattahip Naval Station	Chonburi
6. VOA Broadcasting Station	Ayutthaya
7. Chemferco Plants (Chemical Fertilizer Co. Ltd.)	Lampang
8. Electricite du Laos (EDL) for distribution at Thakhek and Suvannakhet	Thakhek and Suvannakhet
9. Thai Oil Plant (Si Racha)	Chonburi

Source : EGAT

3. Telecommunication

2-62 Samut Sakhon belongs to Provincial Area 6, which is separate from BMA. Capacities at the end of the 2nd project in 1976 were as shown in Table 2-21. It is planned to increase the capacity of the Samut Sakhon exchange station to a total of 2,000 lines by 1981 and 4,000 by 1984, but this project is not being implemented smoothly.

2-63 A survey of factories in Samut Sakhon shows that most do not have telephones. Furthermore, the telphone density in Provincial Area 6 is 0.25 per 100 people, three times less than the national average.

Table 2-21 THE 3RD TELECOMMUNICATION PROJECT (1978-1982)

Name of Exchange	Capacity at End of 2nd Project	Capacity to be Added	Completion Date
Nakhon Pathom	2,400	2,400	Sept. 1980
Ratchaburi	1,600	1,400	Feb. 1981
Tha Yang	-	400	Feb. 1981
Pak Tho	-	400	Mar. 1981
Chom Bung	-	400	May 1981
Ban Phaeo	-	400	May 1981
Samut Sakhon	1,000	1,000	June 1981
Nakhon Chai Si	-	600	Aug. 1981
Kam Phaeng Saen	-	400	Sept. 1981
Krathum Baen	-	400	Feb. 1982

Source : TOT

Table 2-22 MAJOR CITIES IN AREA CODES 02 AND 034

Area Code	Exchange
02	Central Bangkok Metropolitan Area 1. Bangkok Metropolis 2. Nontha Buri 3.. Pathum Thani 4. Samut Prakan
034	Central Region 1. Kanchanaburi 2. Tha Maka 3. Tha Muang 4. Nakhon Pathom 5. Samphran 6. Samut Sakhon 7. Samut Songkhram

Source : TOT

4. Sewage

2-64 U-shaped sewers have been installed alongside major streets in the urban district, but there is no sewage treatment plant and the domestic waste is discharged directly into the Tha Chin River. While the area's elevation is low and its topography is flat, making natural downflow difficult, the city plan currently being drawn up includes a scheme for a sewage treatment plant.

5. Solid Water Disposal

2-65 Samut Sakhon City has 3 sanitary trucks. Solid waste collected from places of business and homes is dumped without incineration on leased private land in the urban area.

H. Public Facilities

1. Fire Station

2-66 Samut Sakhon City currently has 2 fire cars, 3 fire boats and 6 mobile pumps.

2. Parks

2-67 At present, there is no definite park, but it is planned to establish one in an area facing to the Tha Chin River, starting in this fiscal year.

3. Hospitals

2-68 There is a 175-bed Government Hospital in Maha Chai area. The Province Overall has 3 hospitals and 25 clinics with a total of 250 beds.

4. Educational Facilities

2-69 The total number of schools in the Province is 129 (12 national, 106 provincial and 11 private). Students number is 36,538. There is a government operated junior college in Samut Sakhon City, and one vocational school (240 students) with 4 courses in construction, engineering, industrial arts and electricity.

III. CONCEPT OF REGIONAL DEVELOPMENT

III. CONCEPT OF REGIONAL DEVELOPMENT

A. Future Population of Samut Sakhon Area [1/]

1. Future Population of Changwat Samut Sakhon

3-01 The total population of Changwat Samut Sakhon is 258,633 persons as of 1979. As the population in 1971 was 214,715 persons, this figure indicates a mean annual growth of about 5,500 persons. In recent years, however, the population growth rate has been decreasing. The increase in population in fiscal 1978 was 4,316 persons (1.7%) and that in fiscal 1979 was 4,231 persons (1.6%).

3-02 When the population of Changwat Samut Sakhon in 1990 is estimated from the present trend, it will be about 311,300 persons if the annual growth rate is 1.7%, or about 308,000 persons if the annual growth rate is 1.6%. Therefore, it is expected that the population will increase by about 50,000 persons from the current level.

Table 3-1 FUTURE POPULATION OF CHANGWAT SAMUT SAKHON BASED ON CURRENT TREND

	1979	1980	1985	1990	1995	1997	2000
Population increasing rate 1.7%	258,633	263,000	286,200	311,300	338,700	350,300	368,500
Population increasing rate 1.6%	258,633	262,800	284,500	308,000	333,400	344,200	361,000

Source : JICA Team

3-03 The annual population growth rate assumed in the preceding paragraph (1.6 - 1.7%) is considerably lower than that of Bangkok (4.3%) (see Annex 3-1). It is also lower than the recent mean annual population growth rate in the whole Kingdom (2.1 - 2.3%), but it is considered to be an almost reasonable level in a long run, because the Department of Town and County Planning (DTCP) of the Ministry of Interior (MOINT) plans to reduce the population growth rate in Thailand to 1.5% or less in the future.

3-04 If the net industrial area of SIE is assumed as 1,200 Rai, it is expected that the number of employees to work in this industrial area will be about 16,200 persons. If it is further assumed that people engaged in commerce and services as well as the staff for management and operation of the industrial estate are about two percent (300 persons) of the number of employees of factories, this industrial estate will require direct workers of about 16,500 persons in total.

1/ The area having Changwat Samut Sakhon as the nucleus, a part of Thon Buri, Samut Prakan and Samut Songkhram is tentatively called Samut Sakhon Area in this report.

3-05 In the residential area attached to this industrial estate, it is assumed that 50 percent of total number of employees come to work from Bangkok Metropolitan Area (BMA), and it is also assumed that 60 percent of workers to live in Samut Sakhon are unmarried persons and that 40 percent have families (these ratios are based on the conversations between the JICA Team and IEAT). This is an average of seven persons per household in Samut Sakhon Area, but if the average number of persons per household is assumed as four persons with the ratio of working population taken into account, it can be estimated that the number of inhabitants in the residential area is about 18,150 persons.

No. of workers living in Samut Sakhon:
16,500 x 0.5 = 8,250 (persons)

Inhabitant population in residential area:
(8,250 x 0.6) + (8,250 x 0.4 x 4) = 18,150 (persons)

3-06 Consequently, the day population of this industrial estate is 26,400 persons (number of employees including those who come from BMA + number of family members of employees living in the estate). The night population is 18,150 persons. These values for the directly increasing population. In addition to these, the population of those supporting the increasing population calculated above will increase. The relevant generated population can be estimated as about 10,300 persons if calculation is made based on the assumption that the population engaged in relevant industries in 1990 is about one half (4,125 persons) of the number of workers living in SIE and that the employment rate is 40 percent. (see IV. Section D)

4,125 ÷ 0.4 ≃ 10,300 (persons)

3-07 From the calculation described above, 28,450 persons can be expected in 1990 as the population (inhabiting population) induced and developed by SIE, and the population in Changwat Samut Sakhon in 1990 will reach a level of around 338,000 persons.

3-08 In year 2000, if it is assumed that the number of people engaged in the industries generated as related to SIE (refer to paragraph 3-06) becomes equal to the number of workers living in SIE, the population induced and developed by SIE (inhabiting population of Samut Sakhon) will become 38,750 persons, it is expected that the total population of this Changwat will reach the level of 400,000 persons.

Table 3-2 POPULATION PROJECTION OF CHANGWAT SAMUT SAKHON

	1990	2000
Population of Changwat Samut Sakhon based on present trend 1/ (A)	309,650	364,750
Population induced and developed by SIE 2/		
Inhabiting population in SIE	18,150	18,150
Indirect increased population	10,300	20,600
Sub total	28,450	38,750
Total (B)	338,100	403,500

Source : JICA Team
1/ : Average value of cases of mean annual growth rate 1.6% and 1.7%
2/ : Inhabiting population of Samut Sakhon

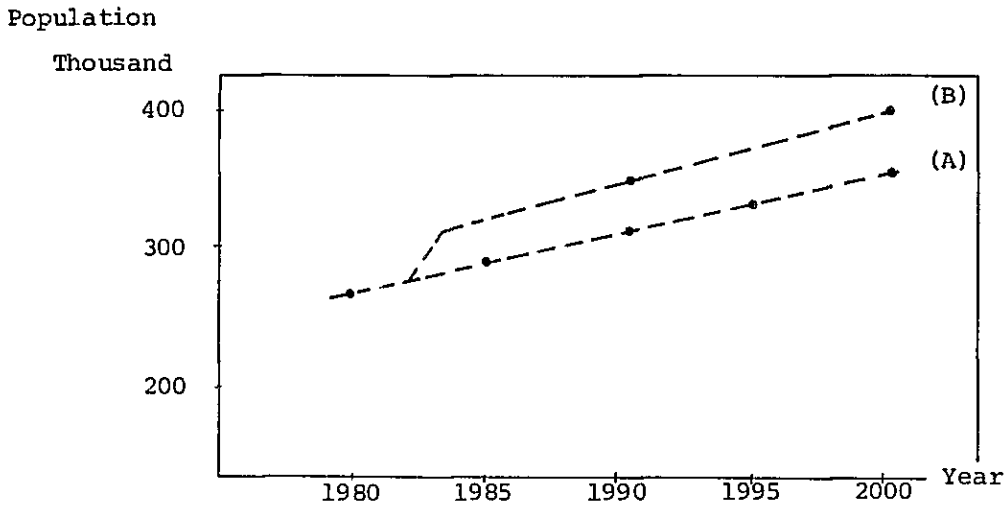


Fig. 3-1 POPULATION PROJECTION

2. Future Population of Samut Sakhon City Area

3-09 The population of Samut Sakhon City increased from 37,634 persons in 1970 to 46,380 persons in 1980, by about 9,000 persons (24.1%) in a period of ten years. DTCP of the MOINT estimates the population growth rate of Samut Sakhon City in the future as 2.34 - 3.15% per annum, and forecasts the population in 1997 as 83,800 persons in the case where growth rate of 3.15% per annum is assumed.

3-10 If the population growth rate is assumed as 3.15% per annum, the population of Samut Sakhon City will be about 67,500 persons in 1990 and about 92,000 persons in 2000. Because the increase of population in the past ten years has been almost fixed at around 1,000 persons per annum at average, the population increase described above appears to be excessive. (see Table 2-3.) DTCP, however, assumes that development of SIE will be made in an area that is close to the existing town area, and therefore, the figures indicated above can be considered as a kind of expected population based on the exceptation of increase of population induced and developed by SIE.

3-11 In this connection, if it is assumed that the increase of population of Samut Sakhon City will be 1,000 persons every year and that the population induced and developed by SIE other than the population to live in SIE (see Paragraph 3-6 and Table 3-2) will entirely become part of the increased population of Samut Sakhon City, then the population of Samut Sakhon City will be 66,680 persons in 1990 and about 87,000 persons in 2000.

Table 3-3 ESTIMATION OF FUTURE POPULATION OF SAMUT SAKHON CITY AREA

		1976	1980	1985	1990	1995	1997	2000
Annual population growth rate 2.34%	(A)	43,724	47,962	53,843	60,444	67,855	71,068	76,175
Annual population growth rate 3.15%	(B)	43,724	49,499	57,802	67,498	78,820	83,864	92,041
Annual population growth 1,000 persons	(C)		46,380	51,380	56,380	61,380	63,380	66,380
Population growth due to induction and development of SIE	(D)				10,300			20,625
Sub total (C + D)	(E)				66,680			87,005

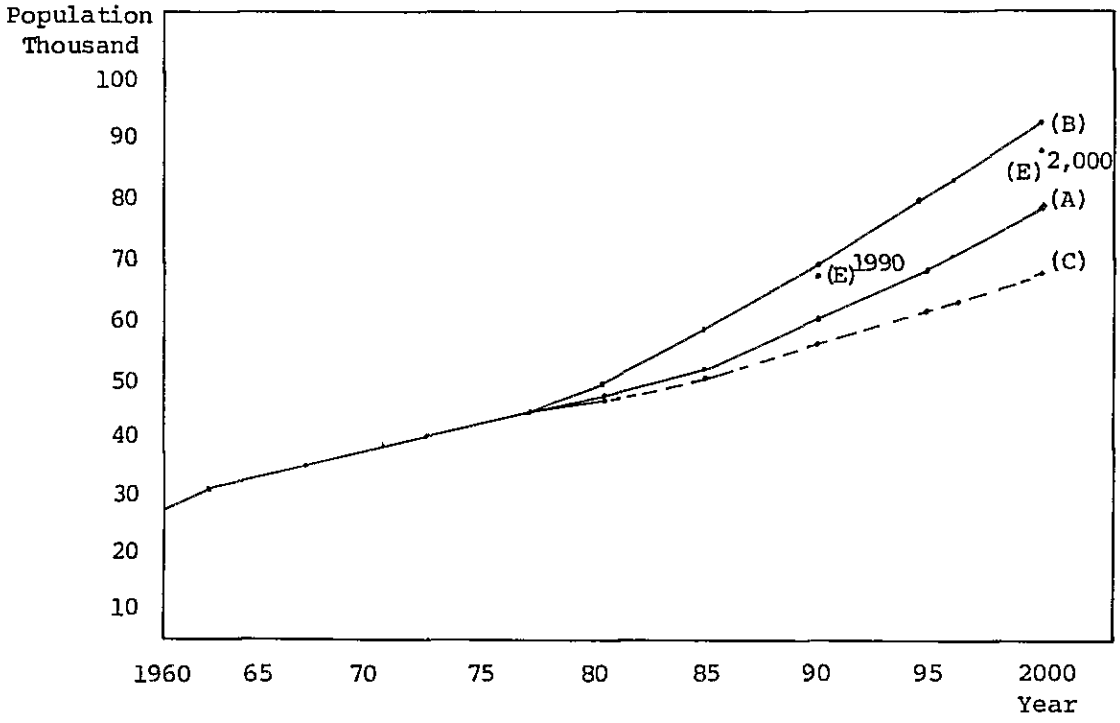


Fig. 3-2 ESTIMATED FUTURE POPULATION OF SAMUT SAKHON

B. Main Projects in Progress in Samut Sakhon Area

1. Land Use Plan of Samut Sakhon City Area

3-12 It is predicted, as discussed in the preceding paragraph, that the population of Samut Sakhon City Area will reach the level that is about twice as much as the current population in the two decades 1980-2000. Consequently, DTCP has a future plan to expand the City area of Samut Sakhon in the future to 2.7 times of the current city area. The target year of this plan is 1997, and the target of land use and direction of expansion of the town are as shown in Fig. 3-3 and Table 3-4. Physical plan including road expansion plan and waterworks channel and sewerage channel consolidation has been drawn up at the same time.

Table 3-4 LAND UTILIZATION IN 1997

Type	Land Use in 1976			Land Use 1977			Density Person /Rai
	City Area(Rai)	Rural Area(Rai)	%	City Area(Rai)	Rural Area(Rai)	%	
Residential	478	55	4.26				
-Low density	-	-	-	664.7	4,366.5	40.16	18
-High density	-	-	-	1,505.2	326.0	14.62	36
Commerce	69	6	0.60	351.6	9.2	2.88	60
Government organization	81	-	0.65	136.8	144.4	2.24	-
Industry	73	19	0.73	363.6	60.4	3.38	6
Warehouse	34	5	0.31	-	-	-	
Religious place	104	29	1.06	104	29	1.06	
Institutional	52	26	0.62	67.2	42	0.9	
Utilities	20	-	0.16	71	41.6	0.9	
Livestock	60	3	0.50	-	-	-	
Open space	-	-	-	152	194.3	2.76	
Stadium	-	26	0.21	-	86.4	0.7	
Agriculture	2,507	7,515	80.0	-	1,524.8	12.31	
River Khlong	1,084	136	9.74	1,084	136	9.73	
Road-Railway lines	96	49	1.16	157.9	890.4	8.36	
Total	4,658	7,869	100	4,658	7,869	100	
	12,527			12,527			

Source : Comprehensive Plan for Samut Sakhon: DTCP

Note : City Area = Current city area
Rural Area = Area planned to be included in city area

2. Development of Industrial Estate

3-13 This is the SIE Project, which is the subject of study of this survey. Although five industrial areas are included in the future land use conception of Samut Sakhon City, the SIE is considered to be constructed outside of the city area according to the Samut Sakhon area development program of DTCP. Furthermore, it is assumed in said program that the scale of development of SIE will be about 1,500 Rai, the number of enterprises to make entry will be 40 and the number of employees will be 12,000 persons.

3. Development of Housing Estate

3-14 SIE is a project that includes construction of a housing estate. It has been determined that the National Housing Authority (NHA) will execute development of a housing estate in cooperation with DTCP and IEAT, for the purpose of coping with increase of urban population and also with increase of population due to development of SIE.

4. Samut Sakhon Port and Fairway Improvement Project

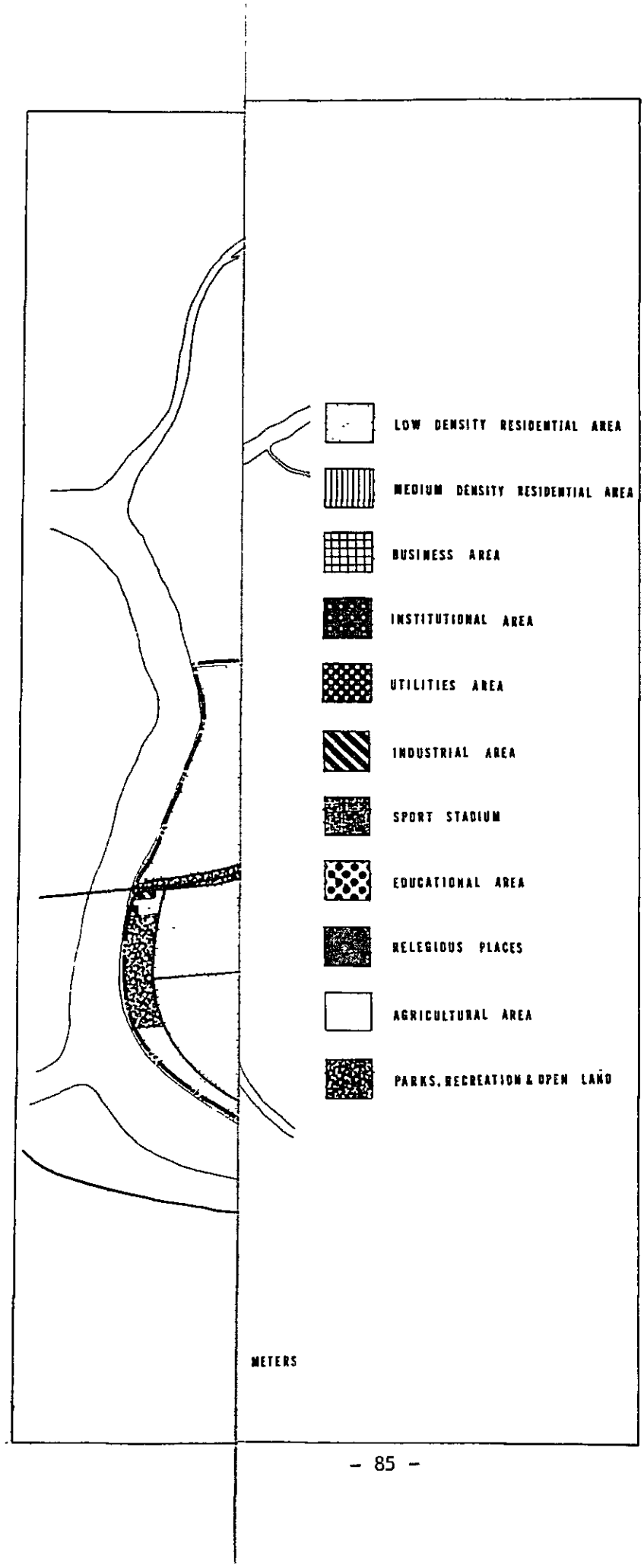
3-15 Samut Sakhon Port is located near the mouth of Tha Chin River, and the waterway for entry into the port is a natural waterway. The water depth near the port mouth is only around 1 m, and the time in which fishing boats of relatively large size can access into the port is limited to high tide period only. Therefore, the Department of Ports and Harbours of the Ministry of Communications plans to execute waterway expansion work of mean depth 4 m, width 60 m and overall length 11 km as well as provision of channel marks for enabling entry of ships of 600 - 1,000 DWT class in the whole year.

5. Samut Sakhon Fishing Port Improvement Project

3-16 The Fish Marketing Association plans to expand the Samut Sakhon Fishing Port in 1980 - 1981 period based on the 4th NESDP because of shortage of facilities for loading and docking. The facilities currently in possession of this organization enable docking of 12 - 16 boats per day and handling of fishes of 120 - 180 tons per day. When this project is completed, it will become possible for seven additional boats to make simultaneous docking and to allow ten additional trucks to work.

6. Railway Track Elevation and Tha Chin River Bridging Project

3-17 The Wong Wien Yai-Mae Klong Line which runs through Samut Sakhon has been kept disconnected by Tha Chin River, and it is also disconnected by Chao Phraya River in Bangkok and also by Mae Klong River in Samut Songkhram. The Royal State Railway of Thailand (RSRT) has a conception of completing a national network of railways by constructing bridges over rivers and with elevated tracks constructed in the areas of high population density through which railways run from the said current situation of being disconnected at many places. However, the plan to construct a bridge over Tha Chin River was withdrawn because expenses of tremendous amount will be involved in these construction works. In addition, it was informally determined to abolish the line between Ban Laen (Tha Chalon) and Mae Klong located


LOW DENSITY RESIDENTIAL AREA
MEDIUM DENSITY RESIDENTIAL AREA
BUSINESS AREA
INSTITUTIONAL AREA
UTILITIES AREA
INDUSTRIAL AREA
SPORT STADIUM
EDUCATIONAL AREA
RELEGIOUS PLACES
AGRICULTURAL AREA
PARKS, RECREATION & OPEN LAND
METERS

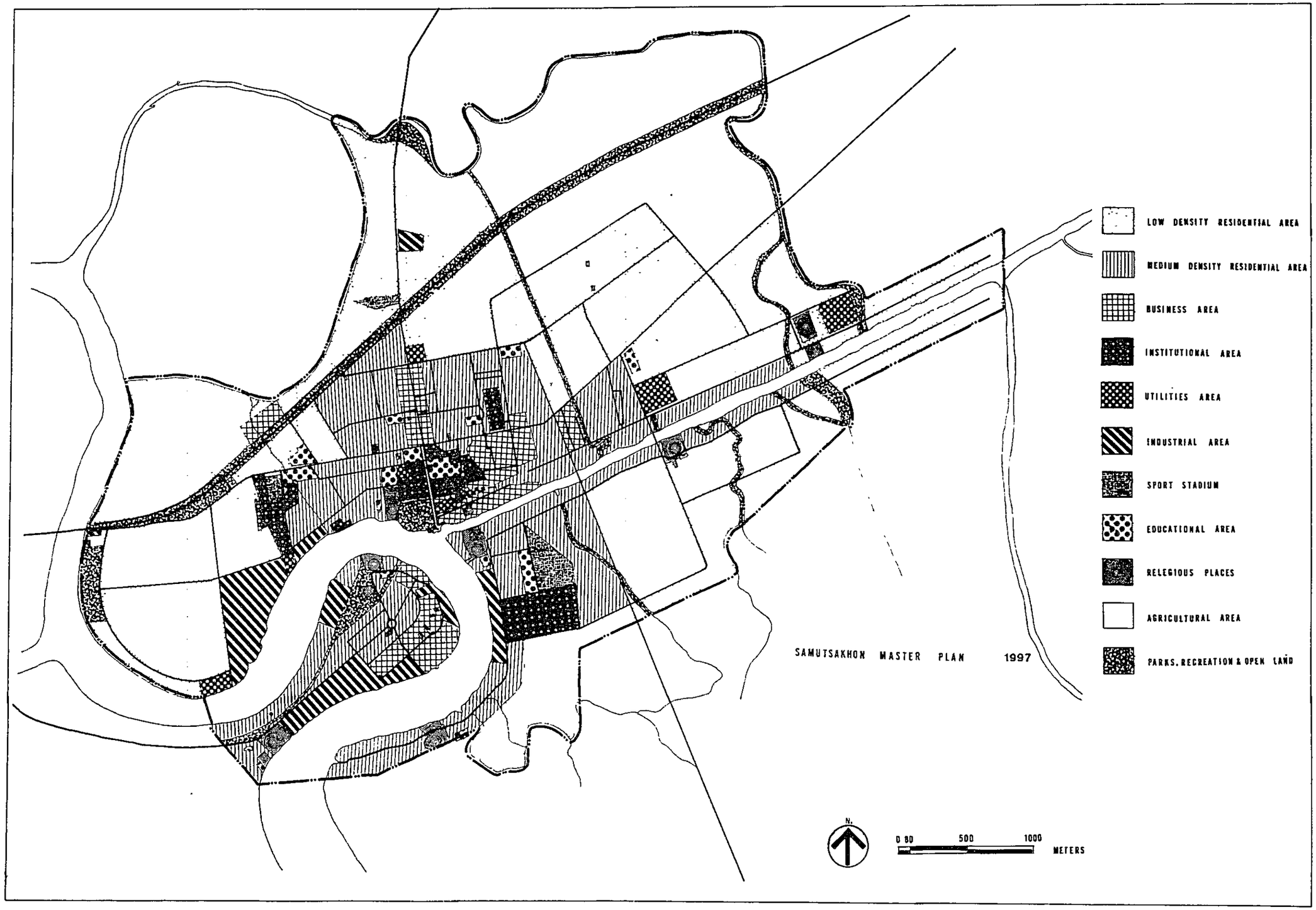


Fig. 3-3 LAND USE PLAN

on the west side of Tha Chin River. However, there is an indication that significance of existence of state railways will be reviewed due to recent increase of oil prices.

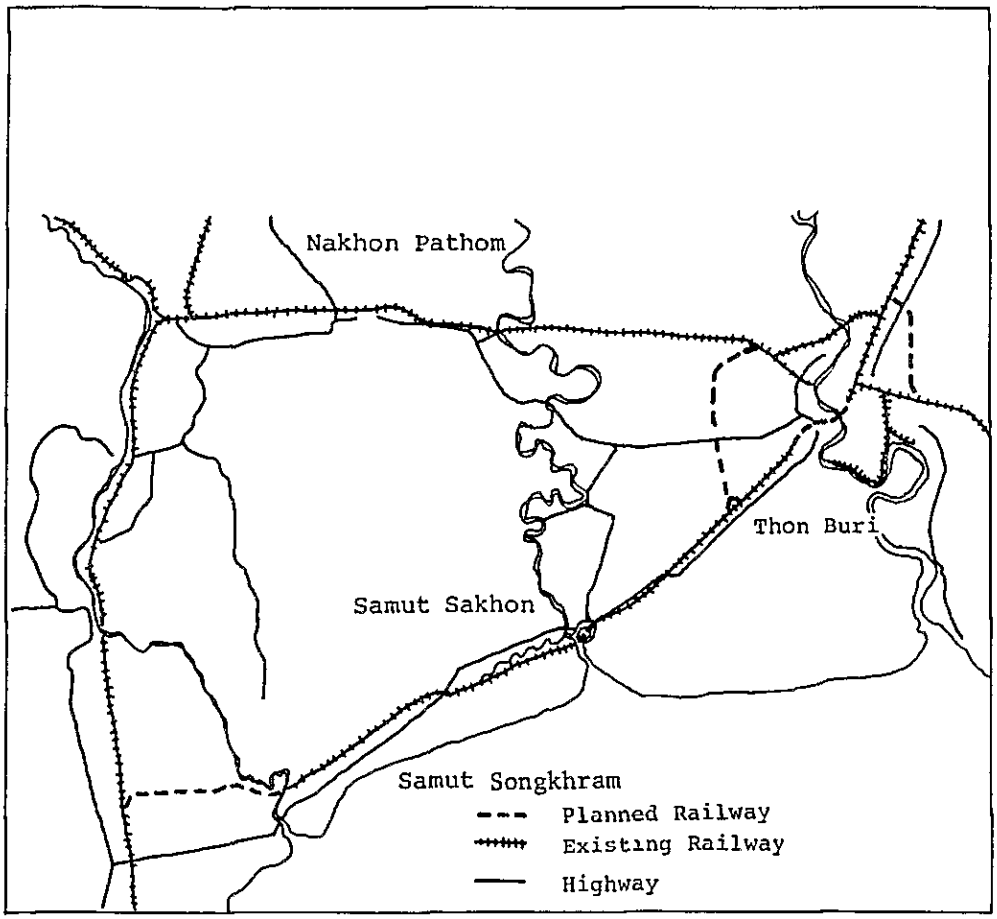


Fig. 3-4 PLAN INDICATING PROPOSED ELEVATED TRACK TO CONNECT WITH THE EXISTING MAEKLONG LINE TO FORM THE LOOPS FOR URBAN & SUBURBAN TRAFFIC

7. Project for Construction of Road Connecting Maha Chai Bridge and Samut Prakan

3-18 At the present time, an unpaved two-lane road is extended toward Kroke Krake from Maha Chai Bridge, and is further being constructed along Khlong Sahakon (Khlong Phittaya Longkorn).

8. Construction Work of Canal and Dike Connecting Tha Chin River (Samut Sakhon) and Mae Klong River (Samut Songkhram)

3-19 Wasteland of as broad as 100,000 Rai is spread between Samut Sakhon and Samut Songkhram. Two projects are currently in progress for developing this wasteland.

3-20 One is the project for construction of a canal and dike connecting Tha Chin River and Mae Klong River. It is to prevent entry of salt water from the coastline by the construction of a new canal,

to preserve farmland in the inland area, and to develop shrimp and fish farms in the areas around the canal. A part of this undertaking has already been completed.

9. Project for Construction of Fresh Water Canal Connecting Rajaburana (Bangkok) and Punthai No Ra Sin (Samut Sakhon) Area

3-21 The Khlong Bangmod located in Rajaburana is a fresh water canal. There is a plan to connect Khlong Kok Kam with Rajaburana for supplying water for farming and for drinking to Punthai No Ra Sin area.

10. Brackish Water Fisheries Development Project

3-22 There is a conception to develop a brackish water farm in the coastal area of Changwat Samut Sakhon in parallel with the projects of item 8. and 9. described earlier.

11. Construction of Park and Recreation Area

3-23 There is a fortress used during the war with Portugal during the Ayuthaya dynasty in the area that is adjacent to the government office area of Samut Sakhon and that faces a landing place of Tha Chin River. It has already been determined by the Fine Arts Development to preserve this fortress, and there is a plan to construct a park to also function as a base for induction of sightseeing and recreational guests, and execution of the undertaking has already been commenced.

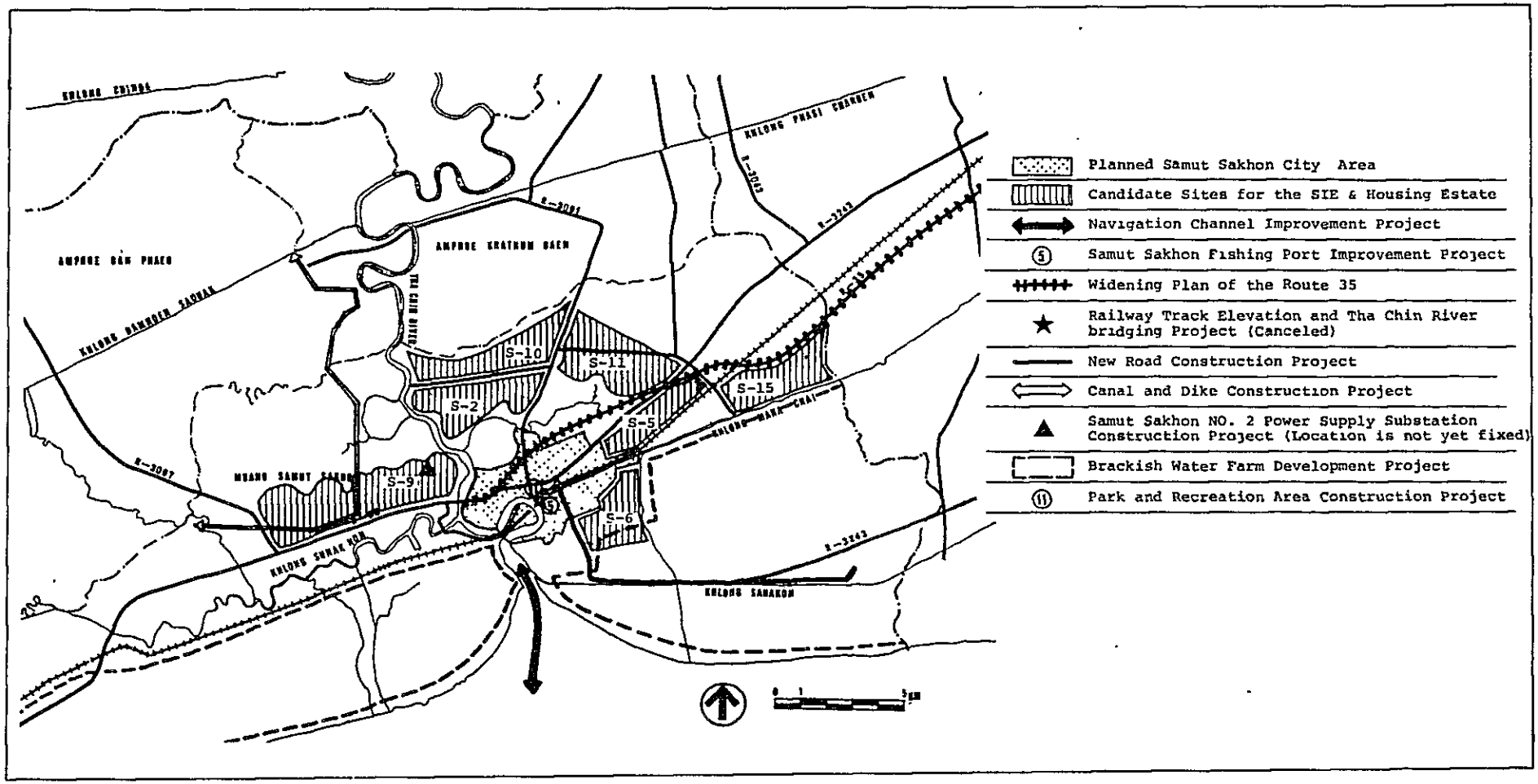


Fig. 3-5 DISTRIBUTION OF PROJECTS IN PROGRESS IN SAMUT SAKHON AREA

C. Position and Function

3-24 Positioning of the Samut Sakhon Area lies in the following three points.

i) Base for supplying fresh food to Bangkok Metropolitan Area
ii) Satellite city of capital city Bangkok
iii) Gate to western region

1. Role as the Base for Supplying Fresh Food to Bangkok Metropolitan Area

3-25 One of the functions which have been possessed by Changwat Samut Sakhon is the character as the base of fishing and aqua cultural business. The landed amount of fishes at the fishing ports in this Changwat is the biggest in Thailand (14.6% of that in the whole Kingdom in 1977), as Changwat Samut Sakhon is the base for landing fishes caught offshore and also in the coastal seas of neighboring nations. This Changwat has been positioned as the place of promotion of shrimp production, and the total area of coastal culture farms is the second in the country next to Samut Prakan. Forty percent of the income of the Changwat Samut Sakhon is obtained by fishing, and it is said that there are as many as 30,000 fishing boat crew in Samut Sakhon including those of outside of the Changwat. Thus, it can be said that the current city area of Samut Sakhon has been established with fishing as the foundation. Production of shrimp is currently level off and there is a plan for promotion of shrimp production in other Changwats. Therefore, there is a possibility where the position as the shrimp producing Changwat reduces in the future, but it is important to maintain and replete the function of having fishing ports ranked as the first in Thailand.

3-26 Approximately 60 percent of the area of Changwat Samut Sakhon is farmland. There are many areas in which the seawater reaches inland, but coconut plantation has been in progress in many of these area. In other areas, gates and walls for preventing penetration of seawater are under construction and consolidation of water supply channels is in progress, and diversified farm management including rice making, fruit tree plantation and stock farming is being developed. Income per unit area of fruit tree farming and upland field farming is larger than that of paddy field farming, and it is said that farming in Changwat Samut Sakhon is relatively rich compared to other Changwats. Farm areas near large cities are more advantageous than remoted farm areas in that it is possible to supply fresh vegetables to the markets within shorter periods of time. Therefore, efforts should be made to preserve excellent farmland while controlling the trend of sprawl due to development of housing lots, which makes expansion from BMA.

2. Role as a Satellite City of Capital City Bangkok

3-27 Changwat Samut Sakhon was positioned as a satellite city development area in the 4th NESDP. The role as a satellite city of Bangkok can be straightforwardly expressed to become a place that absorbs the population that tends to make inflow into Bangkok. For this purpose, it is designed to simultaneously transfer those functions such as industry, education, hospitals and military forces, which are unnecessary in the heart of Bangkok, to outside BMA in line

with the development of residential area. In the case of Changwat Samut Shakhon, development of an industrial estate and residential area in a set was planned in particular based on the trend of industrialization which is in progress along R-4 and R-3091, and it is requested to make formation of a town of self-contained type provided with both employment and dwelling.

3. Role as the Gate to Western Region

3-28 Changwat Samut Sakhon is the Changwat that is located at the east end of the western region adjacent to BMA. Roads, railways and canals run through this Changwat in east to west direction, and this Changwat has the position of the gate for going from Bangkok to western region and for going from western region to Bangkok. Four Changwats, i.e., Nakhon Pathom, Ratchaburi, Samut Songkhram and Samut Sakhon, which form the nucleus of western region, are in the position to form a transportation network of circulation type, and in addition, these four Changwats are connected with the circulation of BMA located on the east, with Samut Sakhon as the center. Therefore, it can be said that the Changwat is the place to become the strategic base for development of western region.

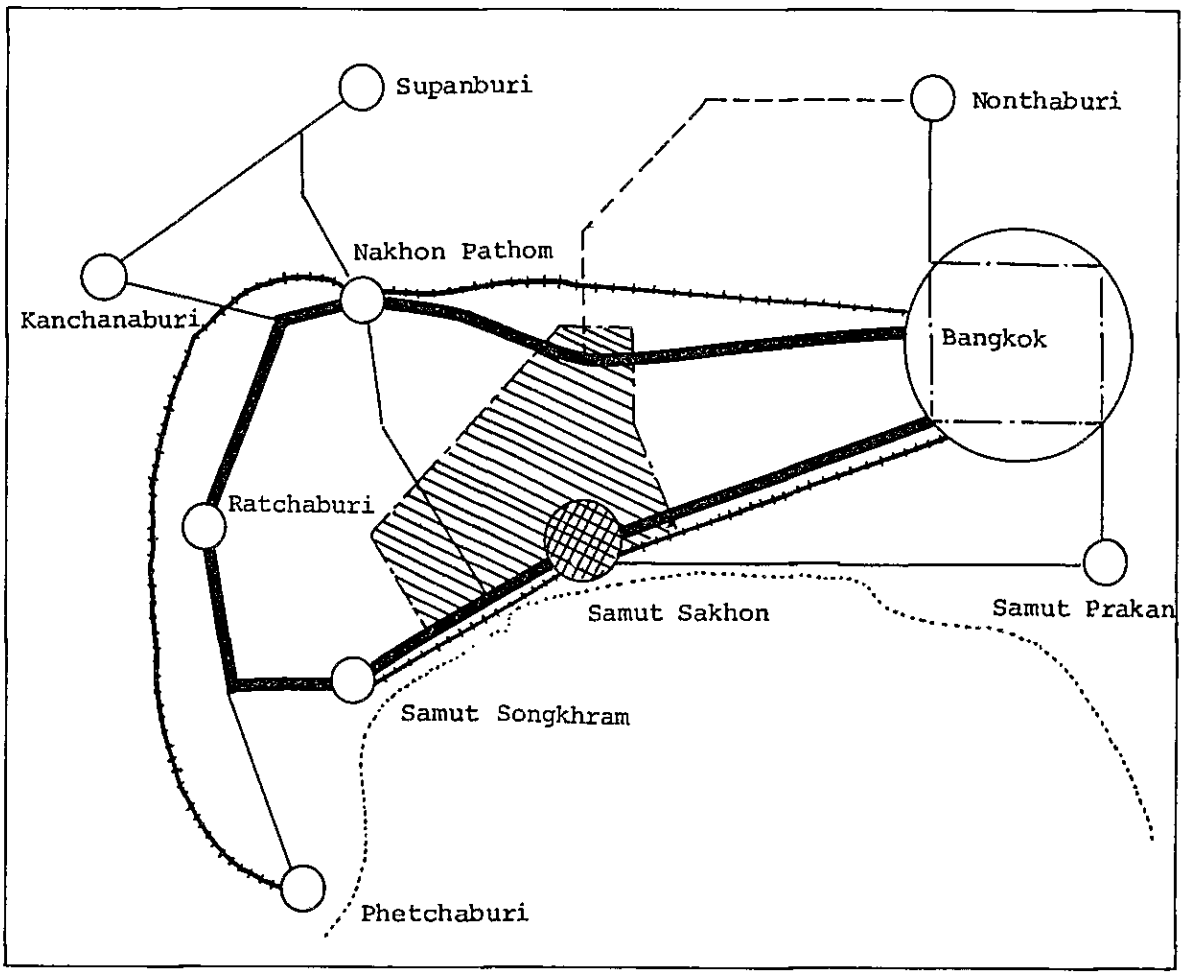


Fig. 3-6 TRANSPORTATION NETWORKS

3-29 The Samut Sakhon Area is blessed with favorable locational conditions, and it is considered to be the area which can be best spotlighted in Thailand toward the 21st century. As for Changwat Samut Sakhon alone, however, it is necessary to make consideration so that it will not be overdeveloped. If huge industrial development is made in Samut Sakhon, it may act as a negative factor for promotion of western region and of the whole undeveloped areas, even if it could satisfy the demand in the BMA. Consideration should be made so that development of the Changwat becomes a step leading to development of the region located on the west side of the Changwat, rather than making large scale development in the Changwat, and it is considered that what should be done in the future is to strengthen the function of distribution of man and goods.

a. Strengthening of distribution and processing functions with fishing as the nucleus

3-30 Although Samut Sakhon Port is the largest fishing port in Thailand today, the water depth is insufficient and port facilities are also insufficient as already described in Paragraph 3-15 and 3-16. Therefore, a large scale facility improvement plan has been established. This undertaking can be said to be one of the most important undertakings for the Changwat.

3-31 The marine products processing trade of this Changwat is not very large, despite the fact that the amount of landing of fishes at ports in the Changwat is the largest in Thailand (Annex 3-2). It is considered that the fact that the Changwat is adjacent to Bangkok and processing is not required because fresh fishes are dealt with at higher prices is the main cause for it. But it is important to strengthen the functions of refrigeration and processing and to increase the possibility of fishing boats to call at for making market prices stable and for producing high added values. Enterprises which belong to such category of business should be induced to the subject industrial estate for promoting development of Samut Sakhon Port.

3-32 Many of marine products processing businesses already in existence in the city area are of small scale, and those which operate under poor sanitary condition and are largely involved in river water pollution. It is considered to be worth examining to cause mass transfer of some of these marine products processing industries of medium and small scale to SIE.

3-33 On the other hand, relevant trades such as shipbuilding and ship's accessories manufacturing industries as well as construction of ship's crew training institute for upbringing and supplying seamen should be enhanced in the existing city area and its peripheral areas in accordance with the land use plan of DTCP.

b. Strengthening of function of distribution and processing of farm products

3-34 When production of farm products is considered, the Changwat is more suitable for cultivation of high grade crops requiring freshness (flowers, ornamental plants, vegetables, etc.), rather than making processing as the main item. It is said that many problems are involved in the process of commercial distribution in the current stage, efforts should be made to increase producer's prices and to expand the market as well by mobilizing abundant farming family labor force under cooperative works to sorting, grading, unitized packaging

and processing of farm products. Furthermore, consolidation of distribution facilities such as collection yards, classifying yards and processing plants should be made for this purpose.

3-35 On the other hand, improvement and consolidation of Samut Sakhon Port are expected to elevate the existence value of this port and to be able to exhibit the role as the port for collection and delivery of farm products to and from neighboring areas and also from upstream areas, in addition to the role as a fishing port. Fruit trees centering on citrus are in abundance in Amphoe Ban Phaeo and plantation of coconuts is also prosperous. These fruit tree crops require processing for year-round supply even in off seasons and which will allow expansion and stabilization of the market for those crops. When the location of this Changwat, which is in the gist of both land and marine transportation, is considered, it is optimum as the base for collecting, processing and shipping farm products such as fruits to be processed, and SIE should bear a part of this function.

c. Strengthening of function of distribution of industrial cargo and function of upbringing of skilled labour

3-36 The Changwat is complete with railways, roads and water-borne traffic channels, although it cannot be said that all of these means of transportation are rationally functioning. Therefore, it is a place where a intermodal transportation system can be established. It is desirable that the points which currently form bottlenecks are improved and linkage is made with other distribution base plans such as truck terminal plan in Bangkok.

3-37 Although there is a vocational training institute in Samut Sakhon, the existing facilities are insufficient compared to the scale and contents of development of SIE. The Changwat is a net gainer of social migration and it cannot be clearly stated that this Changwat is already sufficient as for supply of labor force within the Changwat, but it is at least necessary to elevate the facility level of vocational training school to such an extent that enables recruit manpower from other Changwats and provide technical training to them for making contribution for the enterprises to make entry into SIE or for making industrial development of the Changwats from where they come.

d. Strengthening of function of industrial tourism

3-38 Samut Sakhon Port is the place where the fortress for opposing to the domination by Portugal in the days of the Ayuthaya dynasty, and therefore, it is said to be a port having large historical significance. Consequently, it is currently planned to construct a park to be a base for tourism. Although Phatthaya Beach is the most famous in Thailand today as the seaside resort, beaches suitable for recreational development are also located in western region. Although the potentiality of Samut Sakhon as a tourist spot is less compared to Ayuthaya, Phattaya, Samut Songkhram and other recreational areas in the south, it is considered possible to position Samut Sakhon as the intermediate recess point for inducing recreational development in western and southern regions or as a recreational place in the outskirt of Bangkok.

3-39 Furthermore, it can be considered that the characteristic of the Changwat as a tourist spot can be found in industrial tourism.

It can be hardly said that the natural scenery of the Changwat itself is very good, but variety of sceneries such as fishing ports, broad aqua cultural farms, plantation of coconuts and fruit tree area can be good tourism resources. Promotion of a comprehensive development plan which connects undertakings necessary for community development where farm product processing plants and so forth can be visited and visitors can have experience, with a typical village designated as a tourism village, provision of meals specialized in sea food as well as typical souvenior as well as development of villages such as consolidation of farm land for formation of scenery with tourism should be examined.

D. Urban Development

1. Pattern of Development of Satellite City and Position of SIE

3-40 As typical thoughts of the pattern of development of Samut Sakhon satellite city,

i) Linear type
ii) Cluster type (independent town formation type)
iii) Loop type (inter-satellite city connection type)

can be considered.

3-41 Linear type is also called finger type. It is of such a pattern that town development is made in such a form that will extend development of a metropolis along the facilities such as roads and railways of good locational conditions from the standpoint of traffic. The pattern of development along R-35 and R-3242 corresponds to this type in Changwat Samut Sakhon.

3-42 Cluster type is such that direct linkage in urbanization with a metropolis is disconnected and an independent town is formed in the outer zone of a metropolis. The pattern of development in cluster form in the outskirt of Samut Sakhon corresponds to this type.

3-43 Loop type is of no linkage in urbanization with a metropolis like cluster type in land use. However, it does not intend growth of independent towns. It is such a pattern of development that is designed to induce development in intermediate areas for the purpose of strengthening linkage among towns located along the outer zone of a metropolis. In Changwat Samut Sakhon, the development plan at a part of Amphoe Ban Phaeo located between Samut Sakhon and Nakhon Pathom and the development plan in Punthai No Ra Sin located between Samut Sakhon and Samut Prakan correspond to this type.

3-44 Expansion of peripheral towns is most effective for solving overcrowdedness of BMA. Therefore, such a policy of development that intends formation of independent towns and to make closer connection among satellite cities so as to alleviate burden of BMA is most desirable. However, the financial capacity of local cities and the Changwat is extremely small in Thailand. Furthermore, it is difficult for a Changwat such as the Changwat, which is adjacent to Bangkok, to form independent towns.

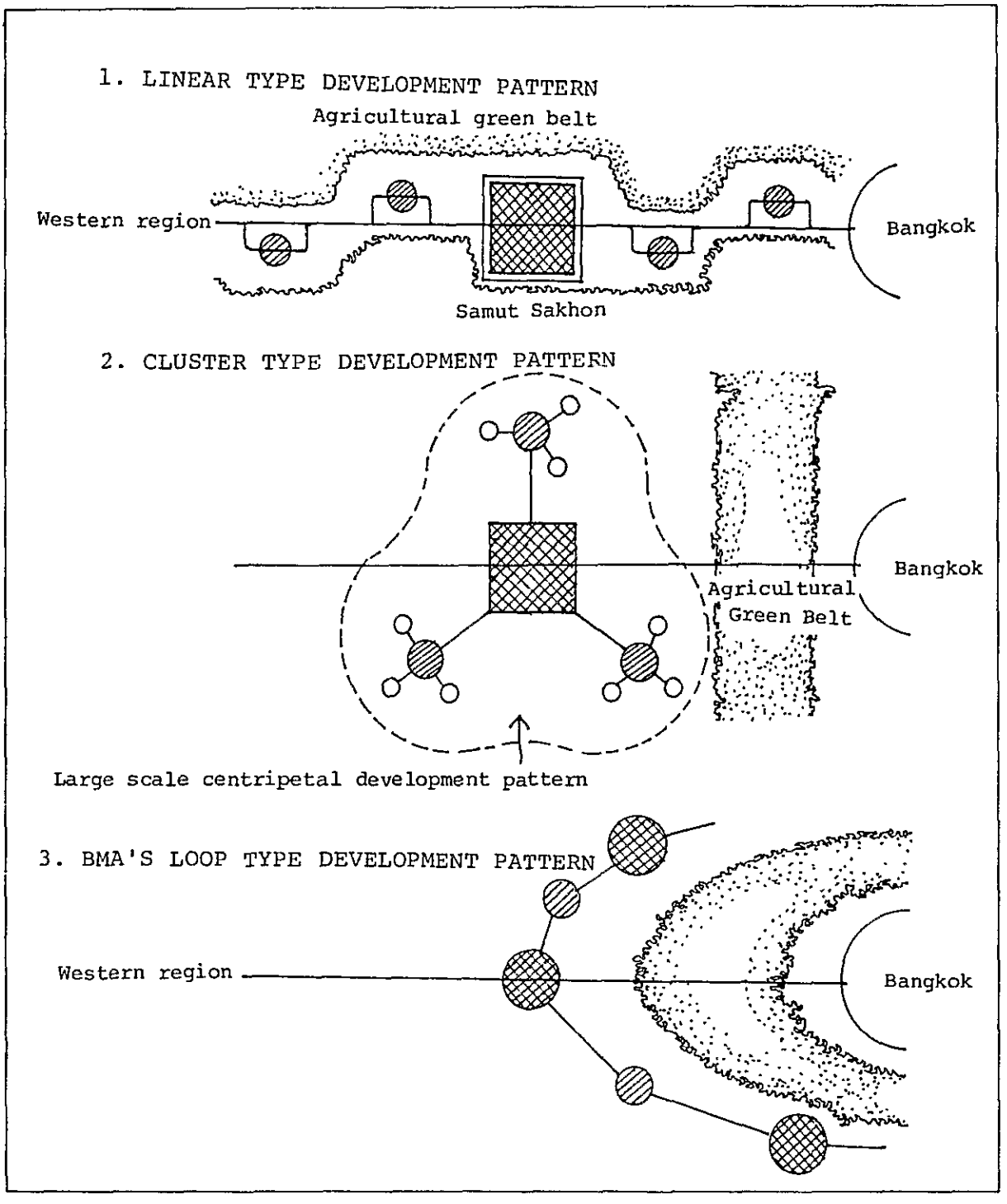


Fig. 3-7 PATTERNS OF DEVELOPMENT SATELLITE CITIES

3-45 Land use in Changwat Samut Sakhon is classified into three kinds parallel with the coastline and canal. The coastline is used for salt farms and shrimp culture basins. The area in which seawater and fresh water are mixed located on the north side of the coastline area is wasteland, where nipas and palms are planted. This wasteland is almost in correspondence to the land called Tha Chin soil. The area located on the north side of this wasteland is where paddy fields are mainly located. The form of land use described above is what was produced from the regional characteristics of mixture of seawater and fresh water. It is considered to be more desirable that town development in the Changwat is made in the area where Tha Chin soil of low productivity spreads.

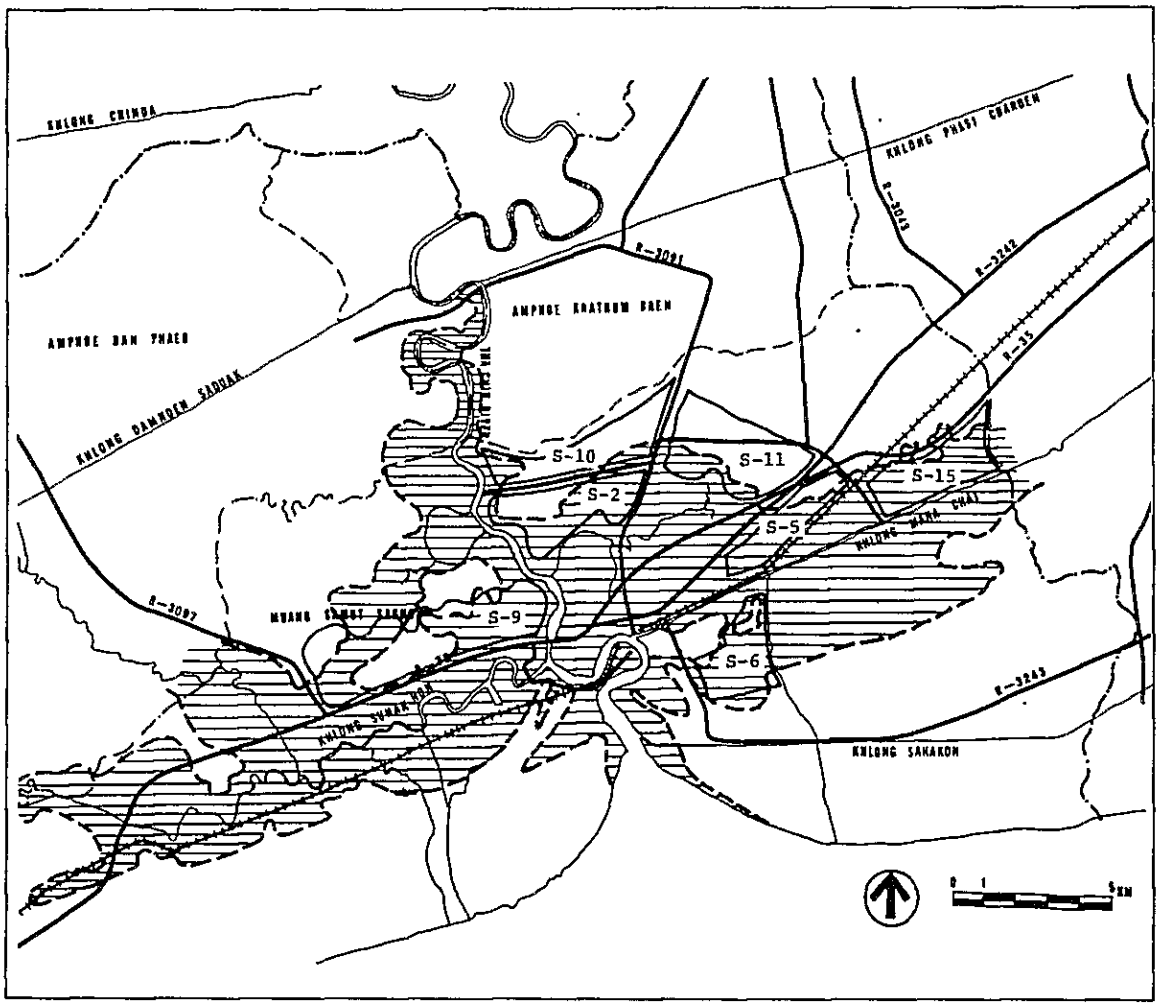


Fig. 3-8 DISTRIBUTION OF THA CHIN SOIL

3-46 All of main water-ways of the Changwat connected to Tha Chin River run in east to west direction, and city development of linear type is suitable for the Changwat also from the sense of separating water-ways for farming and fisheries from the water-ways which accept city waste water.

3-47 From the viewpoints of utilization of the influential power possessed by Bangkok metropolis, of the networks of main roads and railways and also from the viewpoints of current pattern of land use, effective use of land of low productivity and of rational use of water-ways, town development of linear type is considered to be most suitable. Consequently, urban development (corridors) in east to west direction along National Road No. 35 and National Road No. 3242 is proposed, and development of an industrial estate in a position that makes contribution to formation of said corridors is considered to be most desirable.

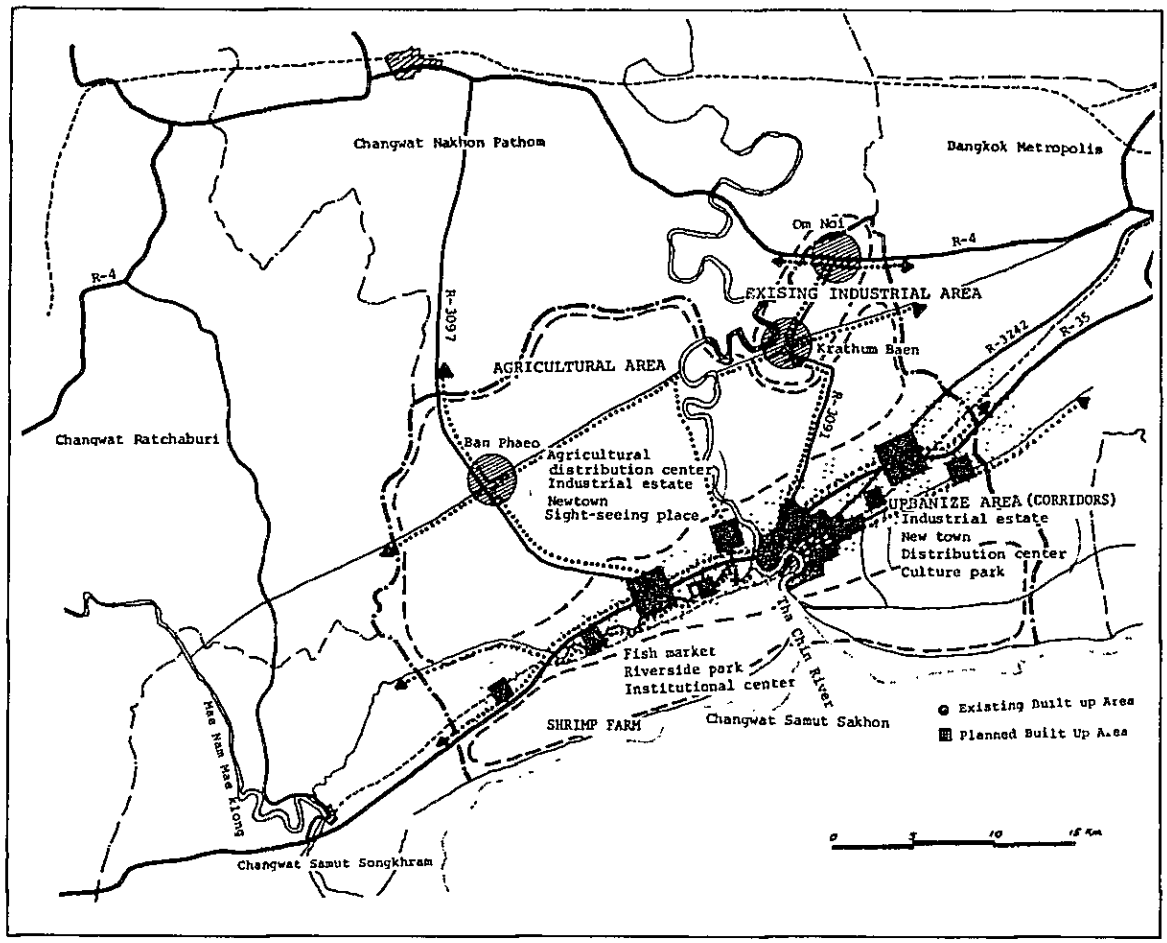


Fig. 3-9 REGIONAL DEVELOPMENT PATTERN IN CHANGWAT SAMUT SAKHON

2. Necessity of Consolidation of Cities Related to Development of SIE

3-48 The future population of Samut Sakhon City in 1997 is forecasted as 83,800 persons in the future land use plan of Samut Sakhon City, but the area of land use plan covers the range that is capable of accommodating the population of about 180,000 persons. (see Table 3-5.) Consequently, the area planned in the future land use is considered to be sufficient as the area for urban development, but the problem is whether it is possible to cause the population, which increases accompanying development of the industrial estate, to live only in the area planned to become a part of the town or not without sprawl into the peripheral area, and a powerful control over town development is probably required.

Table 3-5 AREAS OF LAND USE PLAN OF SAMUT SAKHON CITY AND INHABITABLE POPULATION

	Planned Area (Rai)	Planned Population Density(Person/Rai)	Inhabitable Population(Person)
Low density residential area	5,031.2	18	90,561
High density residential area	1,831.2	36	65,923
Commercial area	360.8	60	21,648
Industrial area	424.0	6	2,544
Total	7,647.2	120	180,676

3-49 On the other hand, what is most anxious in relation to such increase of urban population is supply of water. Water in Samut Sakhon City is currently supplied from ground water, but it is dangerous to depend on ground water only at the time when the population requiring supply of water increases by three folds and the scale of the town grows to over 100,000 persons including the people living in the industrial estate. The SIE project itself has a little anxiety in the supply of water depending on ground water. Therefore, it is considered necessary to incorporate supply of water in Samut Sakhon City in the water supply network planned by the Metropolitan Water Works Authority (MWWA) as soon as possible and to switch the source of water to surface water. For this purpose, presence of the SIE project should be transmitted to the authorities concerned as early as possible, and efforts should be made to have a full cooperation and assistances from them to have earlier realization of the plan.

3-50 Both increase of population and volume of use of water bring about increase of polluting load discharged to rivers and the sea. When BOD only is observed, the BOD load discharged by the population of about 10,000 persons is almost equal to the BOD load discharge rate at the time when treatment is made down to 20 ppm at SIE. Construction of sewage and water treatment plant in Samut Sakhon City should be made hastened for coping with the increase in the load due to increased population.

3-51 Furthermore, this increased population creates the demand for many urban facilities such as schools and parks. There are many cases where construction of public facilities largely delays due to financial troubles in the areas where population rapidly increases. In the case where satellite cities are constructed as a national policy like the case of this matter, powerful backup for consolidation of public facilities such as national schools is considered necessary.

3-52 On the other hand, the urban development zone (corridors) recommended in this section involves mangrove area of high degree of naturalness. Therefore, it is considered necessary to designate the areas of particularly high degree of naturalness as natural parks and to consolidate water-ways which allow passage of small boats and boardwalks to prevent wholely turbulant development.

Ⅳ. TYPES OF INDUSTRIES AND SIZE OF INDUSTRIAL LAND

IV. TYPES OF INDUSTRIES AND SIZE OF INDUSTRIAL LAND

A. Basic Concept

4-01 Uppermost in the minds of policymakers of the Tahi government in planning industrial development has been the accomplishment of the following two objectives:

i) To contribute to the acceleration of economic development

ii) To improve the efficiency of local development and narrow the gap of economic development among regions.

Needless to say, these two objectives will serve as basic concepts guiding the development of the Samut Sakhon Industrial Estates, as well.

4-02 However, as discussed in 1-34 one should not lose the sight of another role the SIE is expected to play -- lessening the burden falling on Bangkok. Painfully aware of the grave problems bred by the excessive concentration of population and industries in Bangkok, the Thai government has actively sought under the Third NESDP to disperse industrial activities to rural areas. For all the enthusiasm of the government, however, entrepreneurs were not very keen on the idea of relocating their factories because of the advantages offered by Bangkok and its surrounding areas; greater market potential, better infrastructure, easier access to skilled labour, etc. Only those industries which process locally-produced resources were persuaded to move out of Bangkok as seen in 1-23 and 1-24. It is precisely for this reason that the relocation of industrial activities out of the Central Region has failed to catch on. In order, therefore, to alleviate the acuteness of the problems arising from excessive concentration in Bangkok, it is important to develop industrial estates around Bangkok which have sufficient potentiality to lure factories away from the concentrated areas.

4-03 Given the proximity of Samut Sakhon Industrial Estate to Bangkok and Tom Buri (about 30 km from Bangkok), lessening the social and administrative burden of Bangkok is the basic concept underlying the development of the industrial estate.

B. Screening Criteria

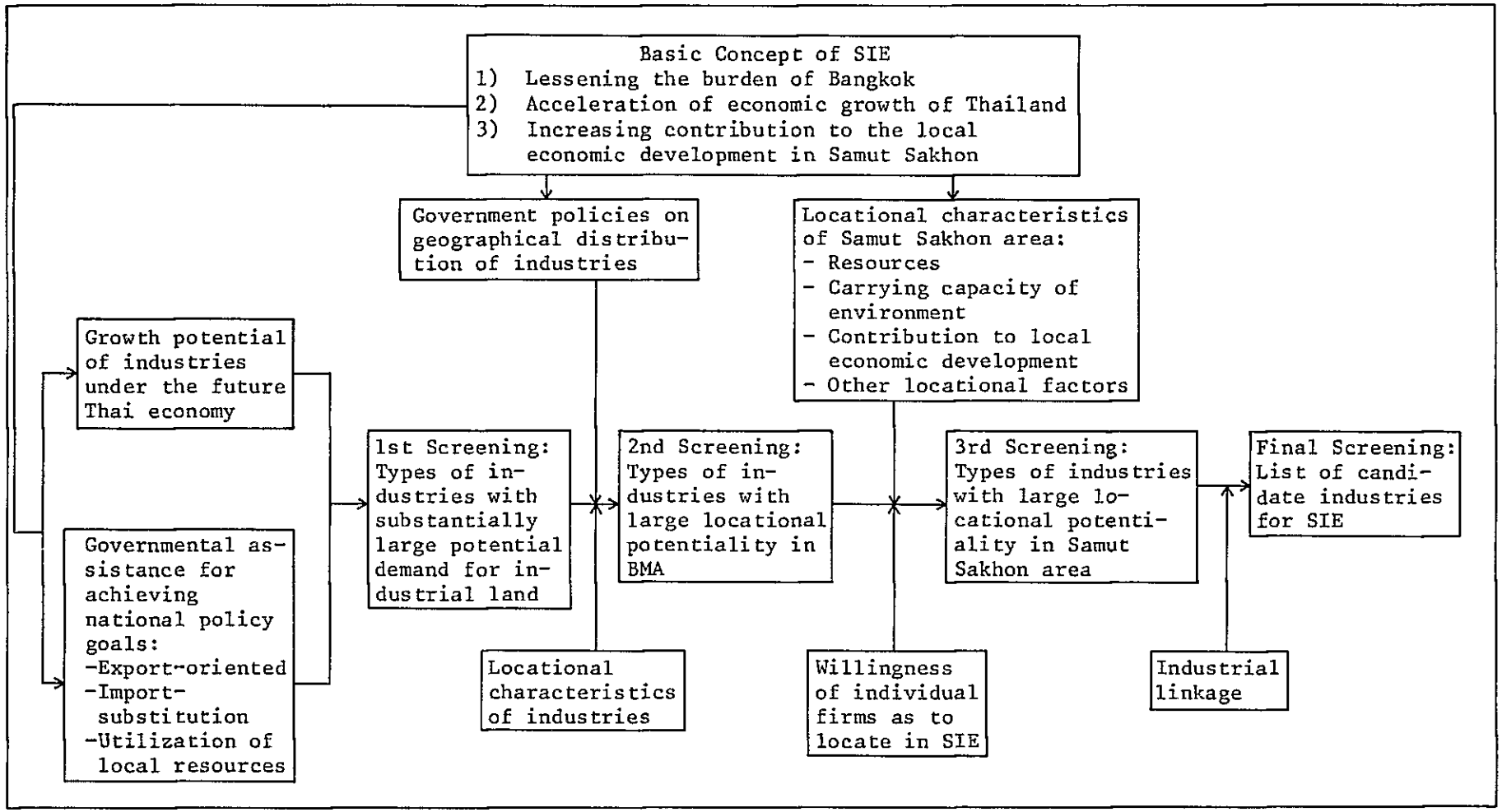
1. Procedure

4-04 The proposed procedure for screening industries is summarized in Fig. 4-1. By following the four steps described below, the types of industries for the Samut Sakhon Industrial Estate are selected.

i) Selecting the types of industries that have substantial future growth potentiality in Thailand.

ii) From this industry group, selecting those which have better potentiality in Bangkok and its surrounding areas.

iii) From such industry group, selecting those which have better potentiality in the Samut Sakhon area.



Source : JICA Team

Fig. 4-1 SCREENING PROCEDURE FOR TYPES OF INDUSTRIES IN SIE

iv) Then making the final selection of industries considering the locational characteristics of candidate sites and the relationship among tentatively selected industries.

4-05 For the purpose of the steps described above, industries are categorized into the following 20 types of industries which are widely adopted in public data released by NESDB, MOI and IEAT:

1.	Foods	11.	Chemical Products
2.	Beverages	12.	Petroleum Refining
3.	Tobacco & Snuff	13.	Rubber & Rubber Products
4.	Textiles	14.	Non-Metal Minerals
5.	Wearing Apparels	15.	Basic Metals
6.	Leather	16.	Metal Products
7.	Wood & Cork	17.	Machinery
8.	Furniture	18.	Electrical Machinery
9.	Paper & Paper Products	19.	Transportation Equipments
10.	Printing & Publishing	20.	Miscellaneous

2. Criteria on Growth Potentiality in Thailand

4-06 The criteria for selecting types of industries which have high growth potentialities includes the following two:

i) Industries which are expected to have high growth rates in the future without governmental assistance.

ii) Industries which are expected to receive strong governmental assistance and hence to have substantial potentialities for future growth.

4-07 Determination of growth potentiality requires detailed analyses of their locational characteristics and the supply/demand situation of the market they serve or propose to serve. Unfortunately, however, detailed data necessary for such analyses is not available. Therefore, we have worked out a series of indicators shown below on the basis of the growth rates during the 1970s.

Pi = Gi/Gt, wherein
P : Indicator on relative growth potentiality of industry "i"
Gi : Growth rate of industry "i"
Gt : Growth rate of the manufacturing sector as a whole

4-08 Candidates eligible for governmental assistance include the following:

i) Export-oriented industry

ii) Import-substitution industry

iii) Industry geared to the utilization of domestic resources

iv) Other industry groups which can make significant contribution to national economic development

4-09 For the purpose of weighing the fitness of the various industries to any of the eligibility mentioned above, we relied on the export and import statistics, industrial statistics and the list of industries qualified for loans provided by the Board of Investment. Specific indicators to be employed for screening include the following:

i) For export-oriented industry: Growth rate in export is comparatively high,

ii) For import-substitution industry: Decrease in import is substantially high, while their domestic production increased rapidly —.

iii) For local resource-oriented industry: Eligibility for BOI's loans aiming at rural development. Some considerations on locational characteristics based upon consultants' experiences.

iv) For other industry groups which can make significant contribution to economic development: Those which are listed by the Board of Investment as eligible for preferential loans and which the government considers as important for the nation's economic development.

3. Criteria for Selecting the Types of Industries that have a Large Potentiality in Bangkok and Its Surrounding Areas

4-10 In selecting industries which have a large potentiality in Bangkok and its surrounding areas, we were guided by the governmental policies on geographical distribution of specific types of industries. Through a series of discussions with the officials of the Ministry of Industry, NESDB and NEB, we learned that they have a strong commitment to deploying the type of industry in remoted areas, which tend to add relatively large load to the environment, e.g., industries processing basic mineral resources. The list of industries deserving preferential loans of BOI also contains a note designating areas where preferential loans will be made available. We took this to mean that such designations reflect the government's preference regarding geographical distribution of particular types of industries, and used them as an important clue.

4-11 On the other hand, locational characteristics observed in Japan and other industrial nations are utilized as a guide for selecting urban-oriented industries. They are cross checked against locational policies of the Thai government in order to form a basis for selecting final candidates for siting in Bangkok and its surrounding areas.

4. Criteria for Selecting Types of Industries that have a Large Potentiality in Samut Sakhon Area

4-12 The following two criteria were employed for selecting industries that have a large potentiality in Samut Sakhon area.

i) Types of industries which becomes concentrated in the Samut Sakhon area.

ii) Types of industries where a large number of entrepreneurs are willing to locate in the Samut Sakhon area.

4-13 As indicators for measuring the concentration in Samut Sakhon area, we computed particular indicators concerning, i) the number of employees and ii) the number of factories, on the basis of their growth rates registered in 1970-77. The indicators are computed in accordance with the following equation:

$$Pi = Gsi/Gbi$$

Where, Pi : Indicator for industry "i"
Gsi : Growth rate of industry "i" in Samut Sakhon area
Gbi : Growth rate of industry "i" in Bangkok and its surrounding areas

Also, as supplementary indicators, an analysis on scale of factories currently operating in the Samut Sakhon area was conducted.

4-14 In addition, we interviewed a number of firms currently located in Bangkok to verify whether they want to relocate from Bangkok or expand the existing facilities in Bangkok, and sought to sound out their evaluation of present location and willingness to relocate to Samut Sakhon. The findings in the interviews threw an important light on the feasibility of the SIE. Population for sampling in the survey and those responded to our questionnaire are as follows:

i) Population: 339 firms in the west area in the city of Bangkok which revealed substantial willingness for expansion and/or relocation in a survey conducted by IEAT in 1979.

ii) Samples returned: 94 firms

For further details of the questionnaire and the findings of the interviews, see Annex.

5. Criteria for Selecting Industries for the SIE

4-15 By using the criteria described in 4-06 through 4-14, a tentative list of industries appropriate for the Samut Sakhon Industrial Estate can be achieved. From this list, those which do not add excessive environmental loads are selected in such a way as to create a desirable industrial mix from the standpoint of the efficient management of the given industrial estate.

4-16 Because of the governmental policy to deploy highly pollution-prone industry groups to remoted areas, they are already eliminated from the list of candidate industry groups at the first stage of selection. Accordingly, at this stage, firms which are likely to add least pollution load to the environment by utilizing joint effluent treatment facilities will be selected.

4-17 The data relating to effluents discharged from different types of industries in Thailand are more or less scanty. Therefore, detailed quantitative analyses cannot be made satisfactorily. However, by treating the industry groups which received warnings from the Ministry of Industry (see 1-26) as those subject to this criteria, and by using the experience we have had in Japan as a guide, we worked out a list of priority for application to the selection of industry groups.

4-18 On the other hand, with a view to improving the collective performance of the firms siting in the industrial estate, we tried to use the industrial linkage as another criteria. However, since I/O table is still in the process of being compiled in Thailand, we had to content ourselves only with reviewing the qualitative aspects by drawing upon the cases reported in other countries, including Japan, and the experience we have had as consultants.

4-19 Finally, with a view to helping stabilize the financial platform of the management of the industrial estate, we sought to enlarge the variety of industries siting in the estate. The reasoning behind this is that by avoiding a heavy concentration on a limited number of specific industries, the revenues of the estate management and also influences on regional development will be better shielded from the cyclical effects of the economy.

C. Candidate Industries

4-20 The results of screening analysis with the aforementioned criteria are summarized in Table 4-1. The results summarized in Table 4-1 are then scored in the following way and the score of each industry is shown in Table 4-2.

i) As a rule, one point is assigned to each circle marked under the evaluation criteria on potentialities on national level and Samut Sakhon level, and two points to each circle marked under those of potentiality on the level of Bangkok and its surrounding areas.

ii) However, to each circle marked in the column of "Higher Growth Rate in Samut Sakhon than in Bangkok and its Surrounding Area" and "Substantial Wills of Factories to Locate in SIE", two points are assigned.

iii) Since the criteria, "Number of Large Scale Firms", is of supplementary nature, no points are assigned.

That two points are assigned to each circle marked under the evaluation criteria on potentiality on the level of Bangkok and its surrounding area is designed to equalize the total scores given at all screening stages. On Samut Sakhon level, since the criteria on industrial concentration are double scored in terms of the number of employees and of factories, other criteria such as on growth potential and willingness to locate in SIE are assigned by two points to maintain the balance of weight among criteria. Since we consider the industries receiving scores at each of the three different steps as those which have spatially wider benefits, a "+" symbol is given to them in order to distinguish from others.

4-21 Looking carefully at the distribution of total score in Table 4-2, industries are divided into the following three groups:

i) Industry group scoring 10 points or more
ii) Industry group scoring 6 to 8 points
iii) Industry group scoring 1 to 3 points

Industries which scored ten points or more and those with a score of six to eight but with a "+" mark are characterized as those having the highest potentiality, and other industries with a score of six to eight are characterized as those having a considerable high potentiality.

Industry Groups Having the Highest Locational Potentiality

Foods
Textiles
Wearing Apparels & Made-up Textile Goods
Paper and Paper Products
Chemical Products
Non-Metal Mineral Products
Machinery
Furniture

Industry Groups Having a Considerable Locational Potentiality

Beverages
Rubber and Rubber Products
Metal Products
Electrical Machinery
Transportation Equipments

Table 4-1 EVALUATION RESULTS OF CRITERIA

	Potentiality on National Level						Potentiality in Bangkok and Its Surrounding Area		Potentiality in Samut Sakhon				
	Growth Rate		Past Observation		Governmental Promotion		Current Accumulation (Based on GDP)	Growth Rate (1974-1977)	Current Accumulation			Higher Growth Rate in Samut Sakhon than in BMA	Substantial Wills to Locate in SIE
	Early '70s	Late '70s	Contribution to Export	Contribution to Imp. Sub.	Export. Orient	Imp. Sub.			Employee	No. of Factory	No. of Large Scale Factory		
1. Foods		o	o	o	o				o	o	o	o	o
2. Beverages	o	o	o	o	o			o					
3. Tobacco & snuff							o						
4. Textile	o		o	o	o			o	o	o	o	o	o
5. Wearing apparel & made-up textile	o	o	o	o	o		o	o	o			o	
6. Leather & leather products		o											
7. Wood & cork									o				
8. Furniture		o	o		o		o						
9. Paper & paper products		o				o	o						
10. Printing & publishing	o						o						
11. Chemical products		o				o	o		o	o	o	o	o
12. Petroleum refinery & coals						o							
13. Rubber & rubber products	o	o	o		o						o	o	o
14. Non-metal mineral	o	o		o	o			o					
15. Basic metal						o			o	o	o	o	o
16. Metal products						o			o	o	o	o	o
17. Machinery				o		o		o					
18. Electrical machinery	o	o	o	o	o	o	o						
19. Transportation equipment	o	o		o		o	o						
20. Miscellaneous			o	o									

Table 4-2 SCORES ON LOCATIONAL POTENTIALITY BY TYPE OF INDUSTRY

	1st Step Potential on National Level (5)	2nd Step Potential on Bangkok and its Surrounding Area Level (4)	3rd Step Potential on Samut Sakhon Level (6)	Total (15)
1. Foods	4		6	10
2. Beverages	5	2		7
3. Tobacco & Snuff		2		2
4. Textiles	4	2	6	12+
5. Wearing Apparels	5	4	5	14+
6. Leather	1			1
7. Wood & Cork				1
8. Furniture	3	2	4	6+
9. Paper & Paper Products	2	2	4	8+
10. Printing & Publishing	1	2		3
11. Chemical Products	2	2	6	10+
12. Petroleum refining	1			1
13. Rubber & Rubber products	4		4	8
14. Non-Metal Minerals	4	2	4	10+
15. Basic Metals	1			1
16. Metal Products	1		6	7
17. Machinery	2	2	2	6+
18. Electrical Machinery	6	2		8
19. Transportation Equipment	4	2		6
20. Miscellaneous	2			2

Note: Numbers given in parentheses in the above column indicate the full mark.

Source : JICA Team

D. Industrial Mix and Allocation of Land

4-22 Lastly, we will consider an optimum combination of industries based upon those selected in 4-20 and their allocation of land using the criteria for step 4. In allocating the land, not only the potentiality achieved by demand analysis but also the requirements from planning side are taken into account in order to enhance the ripple effects of the industrial estate on the local communities and strengthen the financial footing of the estate's management. From such perspectives, we allocate 80% of the land available to industries that have a large potential land demand and reserve the remaining 20% for those to be induced in line with governmental policy on both national and local level. Also, with a view to avoiding a heavy concentration of a particular type of industry that may result from an over-emphasis on inter-group linkage and to forestalling an estate-wide stagnation in times of cyclical downturns, we sought to induce a wide-spectrum of industries to maintain a year-round and long term balance of business activity.

4-23 In determining the industrial mix and the ratios of land allocation among different types of industries, the procedure described below is followed:

i) On the basis of the findings made through the interviews undertaken by JICA Team, we computed the ratios of firms belonging to specific types of industries which indicated their intention to relocate to SIE and allocated 80% of the land according to the ratios.

ii) We selected industry groups from the standpoint of planning side by examining their contribution to the nation's economic development and to the development of the local economy, and allocated the remaining 20% of the land.

iii) On the basis of the results of i) and ii) above, the final industrial mix and land allocation are determined.

4-24 The results of analysis conducted in accordance with the above procedure are summarized in Table 4-3. The findings of the interviews indicated large land demands from these industries such as textiles and apparels, metals and machinery, and chemical products. At first blush, all of these industry groups seem, even from the standpoint of the planning side, to pose no serious problem in terms of their contribution to the development of the national and local economies. Over the longer run, however, concentration to a single industry group such as textiles and apparels in excess of 30% is too large, no matter how large its immediate land demand may be, because it poses many problems arising from economic cycle and its impacts on the management of the industrial estate and the stability of the local economy concerned. Therefore, we limited the share of the industry group to a maximum of 30% of the land, with the possibility of diverting part of the "other" to textiles and apparels in the future if and when a strong additional land demand from that industry group is confirmed. The same line of thinking is applied to metals and machinery. If these two industry groups, textiles and apparels and metals & machinery, were allowed to occupy more than 50% of the land of an estate, they are likely to upset the balance of industrial mix of the estate. Accordingly, we limited the land allocation to metals and machinery to a maximum of 20%. On the other hand, we sought to

Table 4-3 COMPOSITION OF THE EXPECTED INDUSTRIES AND AREA ALLOTMENT

	Land Allocation Sought by Demand Side		Evaluation from Planning Side		Share of Land Considered Appropriate (round figures)
	(1) Share of Land Sought by Interviews	(2) Share of Land Available to Them from 80% of the Land	Contribution to local Develop-ment	to National Economic Development	
Textiles & Apparels	39.2%	31.4%	o	o	30.0%
Metals & Machinery	21.2	17.0		o	20.0
Foods	11.4	9.1	o	o	15.0
Chemical Products	13.7	11.0		o	10.0
Rubber	4.8	3.8		o	5.0
Wood & Furniture	7.3	5.8			5.0
Non-Metal Products	2.5	2.0	o	o	7.0
Paper Products			o	o	3.0
Others				o	5.0

Note: "o" in the column of "Evaluation from Planning Side" indicates substantial contribution to economic development.

Source : JICA Team

limit the presence of chemical factories from the standpoint of controlling environmental loads on the Tha Chin River.

4-25 A Considerable concentration of foods, rubber, non-metal products, paper and paper products are observed in Samut Sakhon. This suggests that Samut Sakhon is conducive to the location of these types of industries. In addition, since most of them are labor-intensive, they can make significant contribution to the development of local economy. Because of these reasons we allocated additional land to these industries. The category of "other" is designed to allow for flexibility in fashioning the industrial mix. The "other" reserved in Samut Sakhon could be effectively utilized by accommodating electrical machinery or transportation equipment which are still relatively new to the area but have large growth potentialities in Thailand as a whole.

E. Demand Estimation on Industrial Land

4-26 Land demand for SIE is estimated in two different ways:

i) Allocation model: Estimates are made from the perspective of nationwide land requirements based on a macro-economic projection, and they are regionally allocated.

ii) Accumulation model: Estimates are made on the basis of land requirements of entreprenuers achieved through our interview survey.

1. Estimation by Macro-Economic Allocation Model

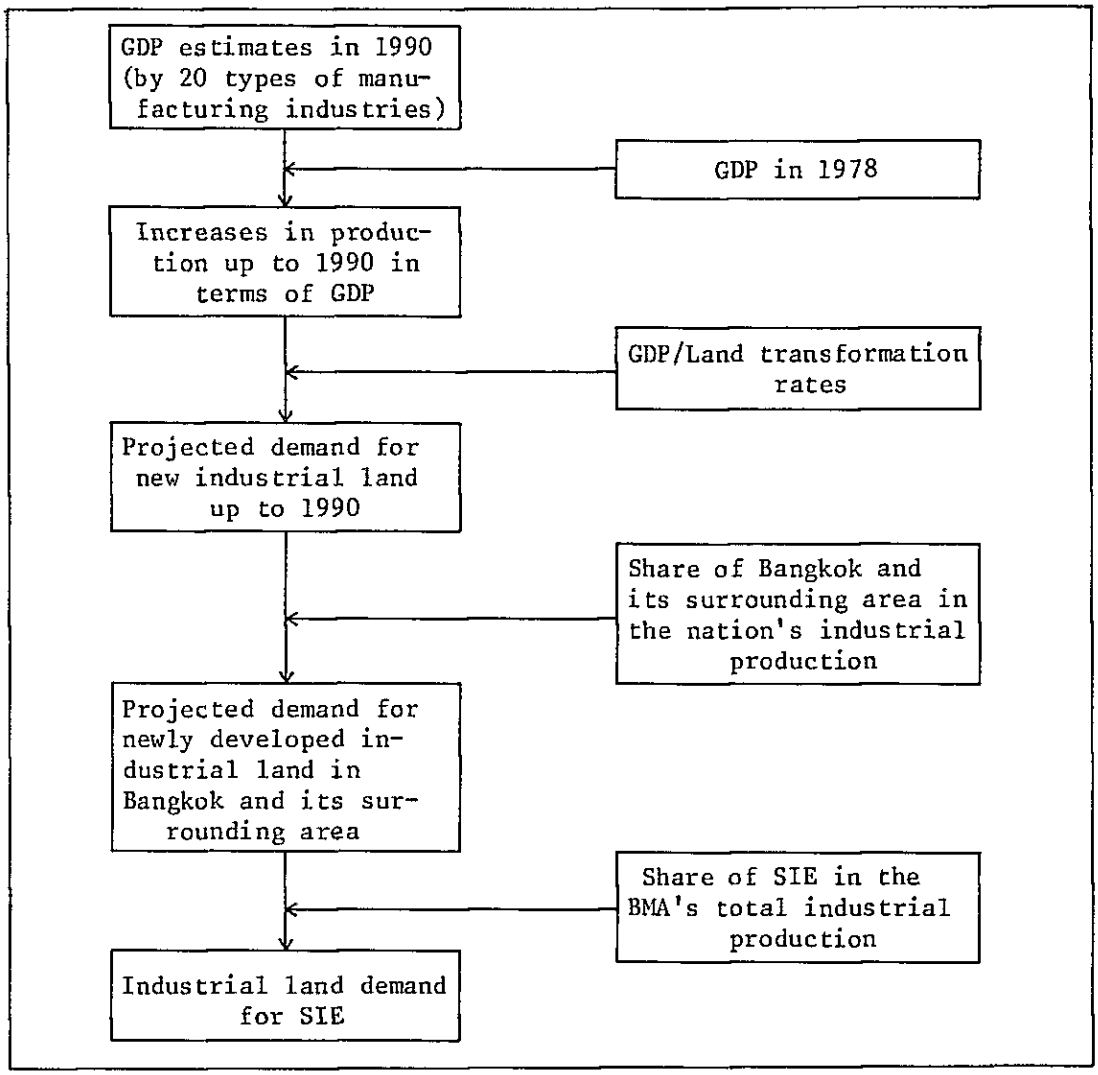
a. Procedure

4-27 Procedure for estimation is shown in Fig. 4-2. We basically followed the three steps described below:

i) An aggregate industrial production of Thailand projected for the target year is estimated, on the basic of which new requirements for industrial land were estimated.

ii) A share of Bangkok and its surrounding area in the nation's total industrial product is estimated. Based upon the share, land demand on national level is allocated to Bangkok and its surrounding area.

iii) A share of SIE in Bangkok and its surrounding area is estimated, and then potential land demand for SIE is calculated.



Source : JICA Team

Fig. 4-2 ESTIMATION PROCEDURE IN MACRO ECONOMIC APPROACH

b. Methodology

4-28 The total industrial production of Thailand in the target year (1990) is estimated by time-trend correlation analysis, using the 1970-78 GDP of manufacturing sector as a base. Formulas are given in Annex 4-1. By using the estimates thus obtained, the nation's demand for industrial land in 1980-90 is estimated in accordance with the following equation:

$$D = (P_{90} - P_{80}) \times U$$

wherein

P_{90} : GDP of the manufacturing industry in 1990
P_{80} : GDP of the manufacturing industry in 1980
U : Land/GDP ratio (land productivity)
D : Demand for newly created industrial land

Owing to the limited availability of data, we used 2.726 million Bahts/Rai as the GDP/Land transformation ratio calculated based upon the standard industrial plant operating in Thailand.

4-29 At present, the industrial production of Bangkok accounts for about 35% of the nation's total. By using this share, we worked out several alternative shares, on the basis of which several cases of land demand in Bangkok and its surrounding area are estimated. Since the 35% share we used as a base corresponds to only that of Bangkok, this is a conservative estimate when seen in light of the fact that the share of the Central Region which includes the areas adjacent to Bangkok is more than 45% (see Table 1-6).

4-30 We also assumed the share of industrial production of SIE in that of Bangkok and its surrounding area at 20%, and by varying the share up and down, the land demands in several hypothetical cases are estimated. The 20% share we used as a basis is standing the assumption that although totally nine industrial estates (including the one in Samut Sakhon) are planned for completion in Bangkok and its surrounding area by the target year of 1990, the number of those which may actually become available by 1990, in light of the fact that the development of industrial estates has fallen somewhat behind the original schedule as we saw in 1.25, may be five or six.

c. Estimates obtained

4-31 According to our estimates, the GDP of the manufacturing industry of Thailand will increase to approximately Baht 177,700 million in 1990 or an increase of approximately Baht 62,700 million from that of 1980. Computed on the basis of the Land/GDP transformation ratio mentioned earlier, newly required land for accommodating these additional industrial activities will be estimated at about 34,000 Rai.

4-32 Table 4-4 shows projected land demand for SIE by allocating the national total of land demand to Bangkok and its surrounding area and SIE with various shares. If the share of Bankgkok and its surrounding area in the national total and that of SIE in the total of Bangkok and its surrounding area are assumed at 35% and 20% respectively, the SIE will require 2,380 Rais of land for meeting the potential demand. If it is assumed that the remaining eight industrial estates of IEAT and one privately-developed industrial estate will be completed by the target year of 1990 (the share of SIE in Bangkok and its surrounding area is simply estimated at 10%), and if the share of Bangkok and its surrounding area is assumed at 30% (lower than the current share), the SIE has still 1,020 Rai of land demand in 1990.

Table 4-4 PROJECTED LAND DEMAND FOR SIE BASED ON THE ALLOCATION MODEL

Unit: Rais

SIE/Bangkok and its surrounding area (%) / Bangkok and its surrounding area/ Nationwide (%)	30	25	20	15	10
50	5,100	4,250	3,400	2,550	1,700
40	4,080	3,400	2,720	2,040	1,360
35	3,570	2,975	2,380	1,785	1,190
30	3,060	2,550	2,040	1,530	1,020

2. Estimation Based upon Interview Survey

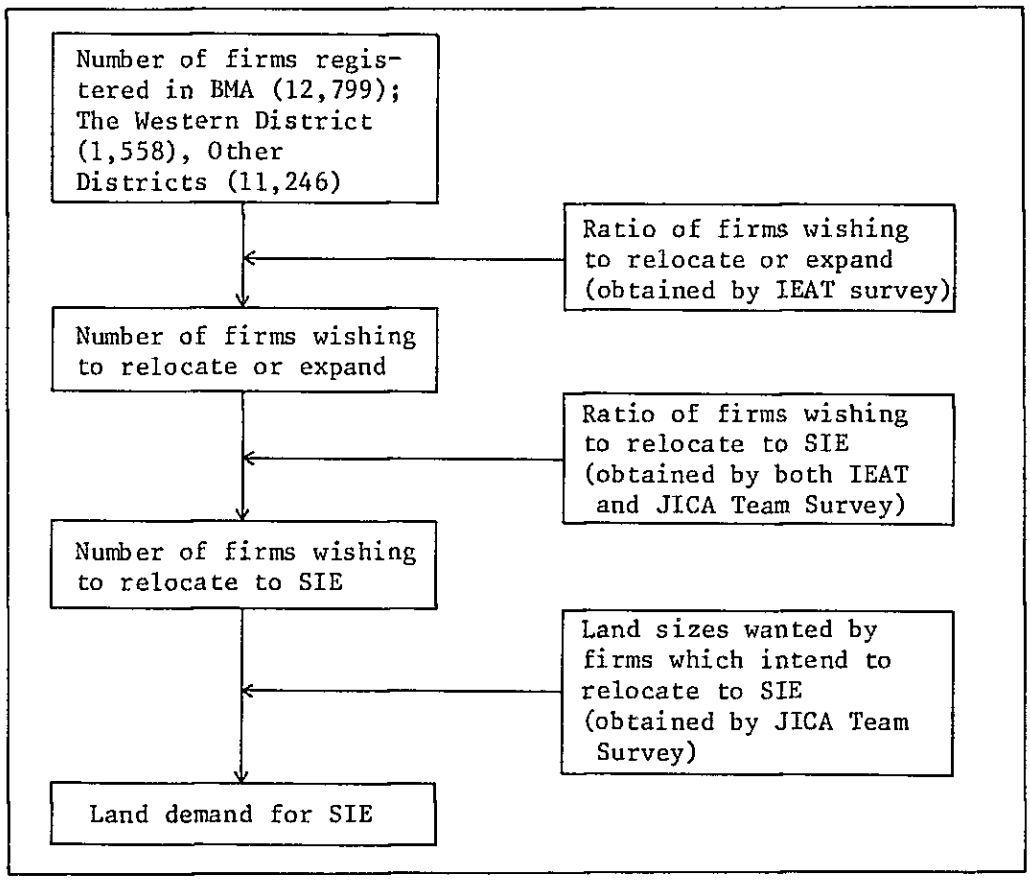
a. Procedure

4-33 As shown in Fig. 4-3, we followed the three steps described below for estimation:

i) The number of firms currently located within BMA wishing to relocate for enlarging site scale by 1990 is estimated.

ii) Of these, the number of those wishing to relocate to the Samut Sakhon Industrial Estate is projected.

iii) The total land demand for SIE is calculated by multiplying the "number of firms wishing to relocate" by an "average land requirement of such a firm".



Source : JICA Team

Fig. 4-3 PROCEDURE FOR ESTIMATING LAND DEMAND BASED ON INTERVIEW SURVEY RESULTS

b. Methodology

4-34 The findings in the IEAT survey in 1979 are fully utilized in order to estimate the number of factories which intend to relocate. Out of 1,558 firms located in the western district of Bangkok, 638 firms are covered by the IEAT's survey. Of these, 339 firms or 53.1% of the respondents indicated their intention to relocate their plants out of BMA in order to expand their production capacity.

4-35 With a view to determining the percentage of firms intending to relocate their plants to SIE, the managers of 94 firms are interviewed in our survey out of the abovementioned 339 firms and the following findings are achieved.

i) Firms positively intending to locate their plants in the Samut Sakhon Industrial Estate (Group A): 27 firms (28.7%)

ii) Firms interested in locating their plants in the Samut Sakhon Industrial Estate (Group B): 31 firms (33.0%)

iii) Firms which indicated their interest in the Samut Sakhon Industrial Estate in the IEAT survey but answered "not interested" in our survey (Group C): 35 firms (37.2%)

The total land requirements of Group A amounted to 195 Rai and those of Group B, 205.5 Rai.

4-36 Out of the 344 firms which now locate in the Samut Sakhon area, though the sample size is small, 19 firms are randumly selected and interviewed by JICA survey team. The results of the survey are summarized as follows:

i) A group: One firm wants 10 Rai of land in SIE.

ii) B group: Three firms want a total of 20 Rai in SIE

iii) C group: 14 firms

4-37 By using the foregoing data, we computed the land demand according to the following equation:

$$\sum_{i=1}^{3} D_i = P_i \cdot N_i \times S, \text{ wherein}$$

D_i : Land demand for SIE by firms in "i" area
N_i : Number of firms currently located in "i" area
P_i : Probability of firms in "i" area to locate their plants in SIE
S : Average land demand per firm
i : Western district of Bangkok ($i = 1$)
Other districts of Bangkok ($i = 2$)
Samut Sakhon area ($i = 3$)

The feature of this equation lies in the assumption that the probability of firms to relocate in SIE varies from one area to another in which the firm is currently located. In response to the questionnaire distributed by the IEAT, 93% of the respondents answering that they contemplate relocation chose the Samut Shakhon Industrial Estate as the most favorable site, while only 7% opt for other industrial estates. We suspect that the above results is strongly related to the condition that the respondents are currently located in the western district of Bangkok which is close to Samut Sakhon. Because of the chronic traffic jam in Bangkok, it takes hours to pass through the inner city and the psychological or time distance is much longer than physical distance for acrossing the city. Therefore, we assumed that the respondents in the western district have a stronger preference on an industrial estate in western outskirts of Bangkok and similarily those in the eastern district have in eastern outskirts. We accordingly assumed that the preference of firms currently located in other districts for other satellite industrial estates is also 93%, same as the preference of firms in western district on SIE. Conversely

speaking, the probability of firms in other district to locate in SIE is assumed at 7%. By varying the probability up and down, several cases are developed on land demand.

4-38 In order to finally determine the probability of P_i, we must determine the probability of actual relocation to SIE by firms which answered positively in our interview survey. This probability is highly susceptible to psychological factors. Therefore, it might be wrong to assume that the probability in Thailand is same as already known probability in Japan. We used the Japanese experience merely as a guide, and assigned 60% and 10% as basic probability to Group A and Group B respectively, and developed several cases for demand estimation by varying the probability up and down.

c. Estimate obtained

4-39 The results of the estimates thus made are shown in Table 4-5. In Case (2)-(E) which served as the basic case for the analysis, the land demand in SIE amounted to about 2,000 Rai, and even in the most conservative case, the estimated land demand amounts to 1,050 Rai; more or less the same size of land demand is estimated as estimated in the aforementioned macro-economic approach.

Table 4-5 ESTIMATED LAND DEMAND FOR SIE BASED ON INTERVIEW SURVEYS

Settlement Ratio	Case(1) Rest of BMA = 0	Case(2) Rest of BMA = 7%	Case(3) Rest of BMA = 10%	Case(4) Rest of BMA = 15%
Case(A) Group A=100 Group B= 50	2,974	4,300	4,868	5,817
Case(B) Group A= 90 Group B= 40	2,569	3,714	4,208	5,028
Case(C) Group A= 80 Group B= 30	2,163	3,132	3,547	4,239
Case(D) Group A= 70 Group B= 20	1,757	2,548	2,886	3,451
Case(E) Group A= 60 Group B= 10	1,351	1,963	2,225	2,663
Case(F) Group A= 50 Group B= 5	1,054	1,534	1,739	2,082

3. Land Requirements to Promote Development of Satellite City

4-40 The Samut Sakhon Industrial Estate is expected to contribute to the realization of the satellite city concept by playing an active role for economic development in the area. In this section, we will estimate the number of jobs which the industrial estate is required to create to support the future population of Samut Sakhon City and then estimate the size of land necessary to create the required number of jobs.

a. Expected population in Samut Sakhon

4-41 The roles to be played by a satellite city is to lure population and industry away from over-crowded BMA. The size of population which Samut Sakhon Satellite City is expected to lure away from BMA is estimated in the following two cases:

Case 1 : The satellite city absorbs the difference between the projected future population of Bangkok Metropolitan Area on the basis of the current rate of population increase and the population which the planned utility and other public facilities can accommodate.

Case 2 : The seconeary cities and the satellite cities of Bangkok absorbs the difference between the projected future population of the Greater Bangkok Area on the basis of the current rate of population increase and the population estimated on the assumption that the present share of GBA in the nation's total is maintained.

1) Estimation on population under Case 1

4-42 If it is assumed that the difference between the naturally-grown future population of BMA and a population for which utility service will be available in the year 2000 (the target year of the Greater Bangkok Plan) will be absorbed in equal proportions by the nine satellite cities, the population which Samut Sakhon, one of the nine, is expected to share 54,000 people in 1990 and 119,000 people in 2000 (see Table 4-6).

Table 4-6 POPULATION PROJECTION UNDER CASE 1

Unit: thousands of people

	a) Projected future Population of BMA	b) Planned population for which utility service will be available	c) =a-b Population expected to be absorbed by satellite cities	c) =c x 1/9 Population required to be shared by Samut Sakhon
1990	6,726	6,240	486	54.4
2000	8,568	7,500	1,068	119.0

Source : Produced by JICA Team Using data from DTCP

2) Estimation on population under Case 2

4-43 In 1975, the population of the Greater Bangkok Area including those of Samut Prakan and Nontha Buri stood at about 5.12 million or 12.5% of the nation's total population of about 41 million.

4-44 It is assumed that the population growth of the Greater Bangkok Area will be controlled to a level equivalent to its current percentage (12.5%) of the nation's population and that any growth above that level will be absorbed by the secondary cities and the satellite cities. At present, eleven cities are being considered for development into secondary cities and nine cities are into satellite cities. Since Chon Buri and Songkhla-Hat yai are classified

into both secondary and satellite cities, and other three candidate cities are located in Greater Bangkok, totally 15 cities are expected to share the excess population. As shown in Table 4-7, Samut Sakhon will be required to share 60,000 of population by 1990 and 124,000 by 2000.

Table 4-7 POPULATION PROJECTION UNDER CASE II

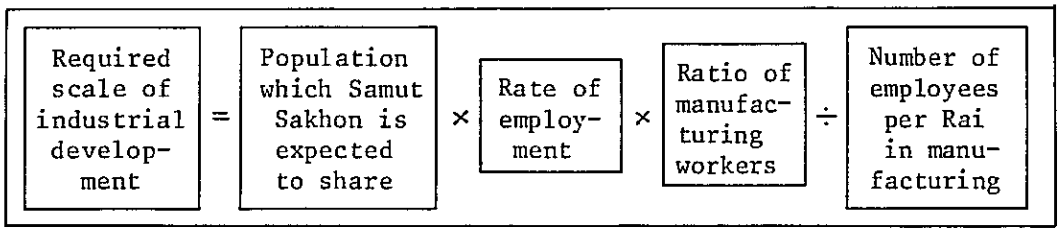
Unit: thousands of people

	a) Projected future population of BMA	b) 12.5% of the nation's population	c) = a-b Population expected to be absorbed into secondary and satellite cities	d) = c x 1/15 Population required to be shared by Samut Sakhon
1990	7,926	7,031	895	60
2000	10,106	8,250	1,856	124

Source : Compiled by JICA Team based on DTCP data

b. Scale of industrial land required for the development of a satellite city

4-45 The size of industrial land required for the development of a satellite city, more specifically for creating a sufficient volume of job opportunities, is estimated in the procedure shown in Fig. 4-4.



Source : JICA Team

Fig. 4-4 PROCEDURE FOR ESTIMATING THE REQUIRED SCALE OF INDUSTRIAL DEVELOPMENT

1) Rate of employment

4-46 The nationwide rate of employment in Thailand in July through September, 1976 was 44.1%, while that of Bangkok Metropolis in the same months was 37%. The Great Bangkok Plan 2000 assumes the rate of employment at 40%. Accordingly, the rate of employment in Samut Sakhon is assumed at 40% in this study.

2) Ratio of manufacturing workers

4-47 In order to achieve full-employment in Samut Sakhon in the target years, 21,600 and 24,000 job opportunities should be newly created by 1990 and 2000 respectively. However, although SIE is expected to create substantial part of the required job opportunities, other sectors will also contribute to create job opportunities. For example, the industrial estate needs some workers to maintain and

operate facilities commonly used, and an increasing number of inhabitants associated with the industrial development will require additional commercial and service workers. Although Samut Sakhon shall be manufacturing oriented at the first stage of development, it will have well balanced industrial structure at the end.

4-48 In 1976, the ratio of manufacturing workers in BMA stood at 24.5%, and under the Greater Bangkok Plan 2000, the ratio is expected to grow to 30% by the year 2000. This can be considered as the ratio of manufacturing workers in a matured city.

In general, a city with an industrial estate has a high ratio of manufacturing workers at its initial stage of development and as the industrial complex grows, the ratio of workers employed by non-manufacturing industries increases gradually. In Japanese cases, the number of workers employed by non-manufacturing industries increases to a level representing 30% to 70% of the manufacturing workers. In the case of Thailand, however, the rate of increase in non-manufacturing is believed higher than that of Japan. Accordingly, we considered three cases in which the ratio of non-manufacturing workers to manufacturing workers is 90%, 70% and 50% in 1990 and 70%, 50% and 30% in 2000.

3) Number of workers per Rai

4-49 As of 1976, the average number of workers per unit area for all manufacturing industries of Japan was 9.0 workers per Rai. On the other hand, the Greater Bangkok Plan 2000 visualizes 24.4 workers per Rai, while our survey of sample industrial plants of Thailand showed the average number of 13.5 workers per Rai. Since the density of worker in newly developed industrial estates has lately tended to decline, to a level of 12.0 workers per Rai among developing countries, we decided to use two ratio, one with a density of 13.5 workers per Rai and another with a density of 12.0 workers per Rai.

4) Size of net industrial land

4-50 Following the aforementioned procedure, the size of the industrial land to be developed by 1990 is estimated between 800 to 1,800 Rai and that by 2000 is estimated between 1,060 to 2,890 Rai. If the ratio of manufacturing workers to the total working population is assumed at about 70%, the appropriate size of the industrial estate for 1990 will be 1,120 to 1,400 Rai.

Table 4-8 REQUIRED SIZE OF INDUSTRIAL ESTATE BY CASE

Case	Year	Population to be shared by Samut Sakhon	Working population (Rate of employment - 40%	Manufacturing		Size of Industrial Land (Rai)	
				Ratio of workers in manufacturing sector	No. of manufacturing workers	13.5 workers/ Rai	12.0 workers/ Rai
Case I-1	2000	119,000	47,600	70%	33,320	2,468	2,777
				50%	23,800	1,763	1,983
				30%	14,280	1,058	1,190
Case I-2	1990	54,000	21,600	90%	19,440	1,440	1,620
				70%	15,120	1,120	1,260
				50%	10,800	800	900
Case II-1	2000	124,000	49,600	70%	34,720	2,572	2,893
				50%	24,800	1,837	2,067
				30%	14,880	1,102	1,240
Case II-2	1990	60,000	24,000	90%	21,600	1,600	1,800
				70%	16,800	1,244	1,400
				50%	12,000	889	1,000

Source : JICA Team

F. Optimum Size of SIE and Some Recommendation

1. Optimum Size

4-51 The analyses on demand side presented in the preceding section show that the industrial estate needs a minimum of 1,000 Rai or normally more than 2,000 Rai. It is also indicated that in order to create sufficient job opportunities and facilitate a smooth functioning of the satellite city, an industrial estate of 1,120 to 1,400 Rai must be developed.

4-52 In light of these analytical results, we considered the following points in determining the optimum size of the industrial estate.

i) Satisfying the growing demand for industrial land in the areas surrounding Bangkok, particularly in Samut Sakhon

ii) Contribution to the economic development of the Samut Sakhon area.

iii) Lessening the potential risks involved in the construction and management of the industrial estate

iv) Limitations on the use of water and other utilities

v) Protection of the natural environment

4-53 The optimum size of the industrial estate is concluded to be 1,000 to 1,500 Rai. This is smaller than 2000 Rai which the demand-side analyses suggest, but is sufficient for creating job opportunities that are necessary for facilitating efficient functioning of the satellite city. The size is also recommended by the following reasons.

4-54 First, given the demand/supply imbalance in industrial land in 1985, it is necessary to prepare available land at an earliest date even though it may fall short of a size desired. As seen in the foregoing analyses, demand for industrial land in and around Bangkok will grow steadily in 1980-1990. However, the development of industrial estates which IEAT plans to complete by 1985 is likely to fall behind schedule for various reasons, and this prospect spells a growing scarcity of land supply in 1980-85 in Bangkok and its surrounding area. In this context, the construction of SIE with a total area of 1,000 to 1,500 Rai, a size which lends itself to a quicker development, is strongly recommended for resolving the current and future urban problems in Bangkok as soon as possible.

4-55 Second, efforts must be made to lessen the potential risks involved in the management of the industrial estate. When the sale of the industrial sites does not progress as smoothly as originally hoped, such a delay would obviously add a series financial burden on the project. Although the industrial land demand for this estate is expected to exceed 2,000 Rai, it is advisable to allow for as much safety as possible and make sure that the land developed will be sold out even if the worst comes to the worst. Given the demand/supply imbalance discussed in 4-54, it is highly conceivable that a seller's market will be developed for this industrial estate. By controlling the size of the developed land below the potential demand, IEAT will be able to secure the leadership in selecting candidate industries and factories. Therefore, the size of 1,000 to 1,500 Rai is more advantageous for IEAT in implementation of the development policy.

4-56 Third, the advantage in environmental control should be noted. Since one of the basic objectives which guide the development of the industrial estate is to facilitate the control of pollution in Bangkok, many of the industrial plants in the estate will be categorized into polluted industries. Although attention will be paid to prevent pollution in the surrounding communities by installing anti-pollution facilities jointly used, the development of SIE will increase even slightly the environmental loads to the Samut Sakhon area. It is not advised to create too large an industrial estate at location near Tha Chin River which already is contaminated in some extent.

4-57 Lastly, the consideration of an efficient industrial development in the Western Region rationalizes the modelate size of the industrial estate. Past trend suggests a growing demand for industrial land in the Western Region. If a large size of industrial land becomes available in the Samut Sakhon area which is located at the gateway to the Western Region, the industrialization in hinterland might be suppressed even for a while. If it is a case, it will definitely run counter to the governmental policy encouraging dispersion of industrial plants to rural areas. The Samut Sakhon Industrial state is expected to play a role of pioneer in brightening the image

of the Western Region as a viable seat of industrial development. In this sense as well, the proposed size will be appropriate.

2. Recommendations for Development

4-58 There is a good chance that IEAT can embody its intentions into the implementation of this project because of demand/supply condition mentioned before. IEAT should make every effort to maximize this advantage.

4-59 During the interviews we conducted, we also sounded out the intention of those wishing to site in SIE as to the use of their present sites; the result of the questionnaire is shown in Table 4-9. According to the findings, one half of the respondents plan to use the current site continuously for factories, while the other half wants to sell them when they relocate to SIE. We believe that the ratio achieved through the interview is desirable also from the standpoint of socio-economic policy, since the half of the land contributes to enlarge the pie of Thai economy and another half supply sizable land for urban redevelopment in Bangkok. Therefore, when signs emerge indicating a change in the above-mentioned ratio, IEAT should use its influence in one form or another to maintain the 50-50 ratio. For this purpose, it would be necessary for IEAT to make the sale of sites conditional on certain requirements to provide against such a possibility. Again, the limited scale of the proposed estate will give the IEAT greater latitude in stipulating such conditions.

Table 4-9 UTILIZATION OF PRESENT LOCATION

	Expansion at Present Location	Keeping Present Location as Factory and Making a Branch at SIE	Selling the Land at Present Location	Total
Bangkok	21 (37.5%)	17 (30.4%)	18 (32.1%)	56
Samut Sakhon	13 (92.9%)	1 (7.1%)	0	14

Source : Interview Survey by JICA Team

4-60 Since most of the factories currently located in the Samut Sakhon area had acquired their sites in recent years, few of them are keen on relocating their plants to the industrial estate. However, it is highly conceivable that they, too, may want to relocate their plants to or establish a branch factory in SIE in five to ten years. Such a possibility will grow even stronger when the pollution control standards are strengthened, because it would be less expensive to utilize the anti-pollution facilities in SIE than installing their own at old sites. Judging from the large demand for industrial land by firms currently located in Bangkok and the necessity to accommodate local demand, future expansion of this industrial estate or development of another estate should be envisaged in the early stage of implementation.

V. SELECTION AND EVALUATION OF SITES

V. SELECTION AND EVALUATION OF SITES

A. Review of Result of Selection and Evaluation

1. Result of Selection and Evaluation made during Pre-feasibility Study

5-01 With the whole Changwat Samut Sakhon as the object, 15 candidate sites, which are located within the distance of 10 km or less from the built-up area of Samut Sakhon City and which face main roads, were selected by elimination method during the pre-feasibility study conducted by the ECFA Team in the previous year (see Annex 5-1).

5-02 Next, availability of suitable land of the area of 500 ha (3,125 Rai) as the criterion was checked at these candidate sites, and the number of candidate sites were reduced to seven as a result (see Annex 5-2). Next, a comparison of construction cost was made for these seven candidate sites, but there were not much difference among them, and final candidate site was not determined at this occasion.

2. Reexamination of Candidate Areas

5-03 Because of the fact that judgement could be hardly made during the pre-feasibility study, it was decided to eliminate the restriction of 10 km or less from the built-up area of Samut Sakhon City and to make reexamination all of them in this study including the area close to Route 4, which was recommended by IEAT (this area is called candidate sites B group), and Punthai No Ra Sin area recommended by the provincial government of Changwat Samut Sakhon (this area is called candidate sites C group) (see Fig. 5-1).

5-04 As the candidate sites belonging to B group, two sites, that is, Site 14 (B-1), which was eliminated as being of insufficient size in the stage of pre-feasibility study, and B-2 area located on the east side of Site 14 with R-3091 in between, were newly selected. These two areas belong to Amphoe Krathum Baen and are closer to the areas where the current industrialization is taking place. They are in favorable situation in terms of accessibility to the existing electric power station.

5-05 However, a policy of not to permit construction of factories in the future in Krathum Baen area for the purpose of purification of Tha Chin River was released by Factory Control Division (Mr. Manus Sooksamarn) of MOI (February 15, 1980; Bangkok Post) during the field survey in Thailand conducted by the study Team.

5-06 Furthermore, it was judged that the candidate sites in B group are inferior in locational conditions than the candidate sites located along R-3091 selected during pre-feasibility study due to the following reasons.

i) Because they are located in the paddy field area at the center of the Changwat, water ways are inter-related which makes quite difficult to select a suitable water way to be discharged with wastewater.

ii) Cost of tremendous amount will be required for constructing a drainage that is exclusive to SIE.

iii) The traffic capacity of R-3091, which is the only main road, is small.

iv) They are not matched with the intention of the provincial government to construct the SIE within the Amphoe Muang Samut Sakhon.

5-07 Punthai No Ra Sin area was originally used as salt farms, but a part of this area is now changing into shrimp farms due to a slump in salt price, and it is estimated that purchase of land is easy in this area.

5-08 The current Punthai No Ra Sin area, however, is of very inferior road traffic conditions to link with built-up area of Samut Sakhon City. There are many shrimp culture ponds in the vicinity of this area, as this area was once designated as one of promotional areas for acquaculture by Brackish Water Fisheries Division. It is a serious problem for SIE Project, which is expected to be materialized earlier, that there is no dependable road at this moment. Even though a road may be newly constructed, its use is limited to SIE, and therefore, the effect of construction of the road is not significant from the regional development point of view. Consequently, construction of an industrial estate in this area, where development of brackish water farms is in progress, should be put off for some time.

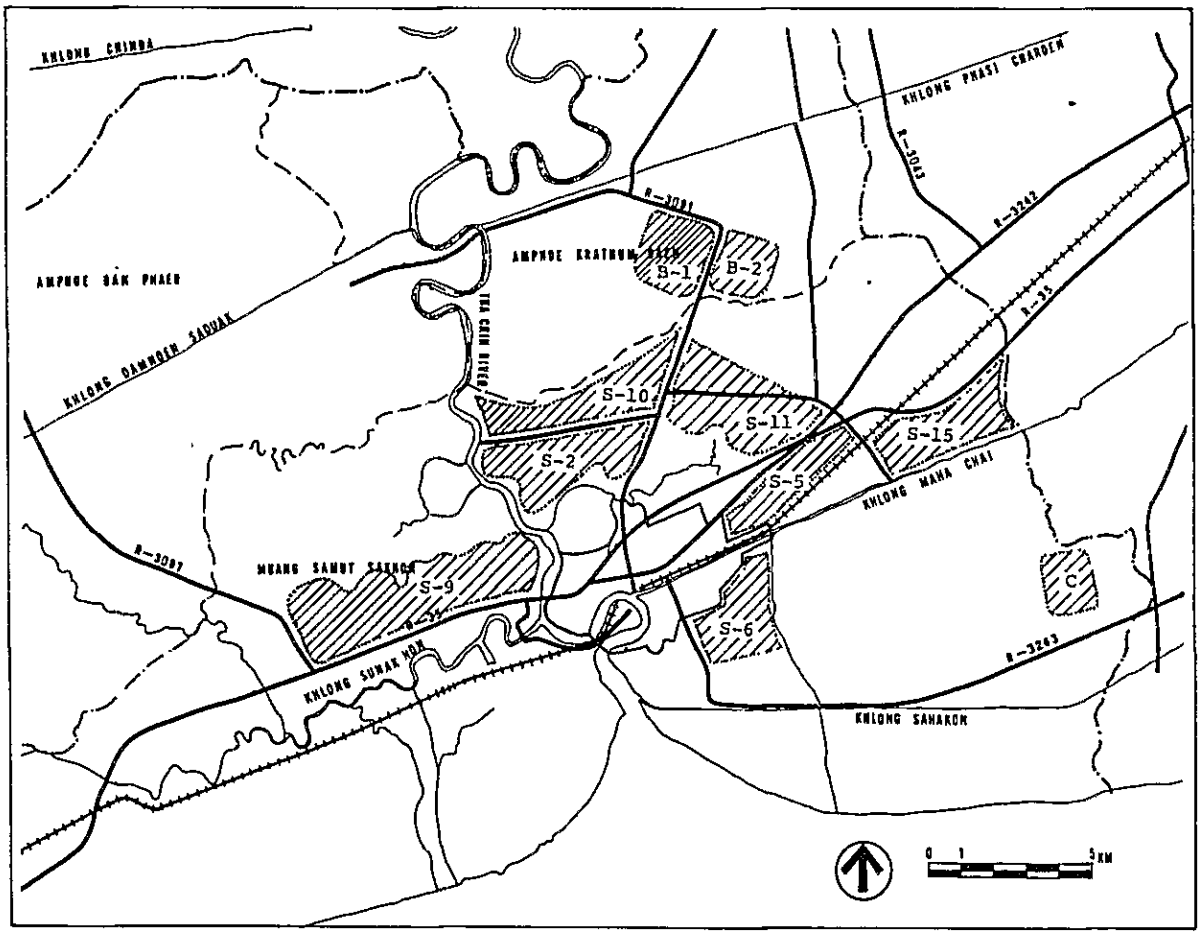


Fig. 5-1 CANDIDATE SITES

5-09 Under the circumstances stated above, it was judged that the locational conditions of the candidate sites which were newly added this time are inferior to those of the candidate sites selected during the pre-feasibility study, and accordingly, it was decided to carry out more detailed evaluation of those seven candidate sites.

B. Method of Selection and Evaluation

5-10 Each one of seven candidate sites selected during the pre-feasibility study has the size ranging from 450 ha (2,800 Rai) to 1,300 ha (8,100 Rai). However, as the land required for the SIE is approximately 2,000 Rai (320 ha), it was decided to focus the land of about 2,000 Rai out of each candidate site by exclusion of those areas where other projects are in progress, land price are higher due to proximity to roads and water-ways, farmlands which are considered to be productive and many residences are involved, and then to use the land thus focused as the object of evaluation and analysis to be described below (see Fig. 5-2).

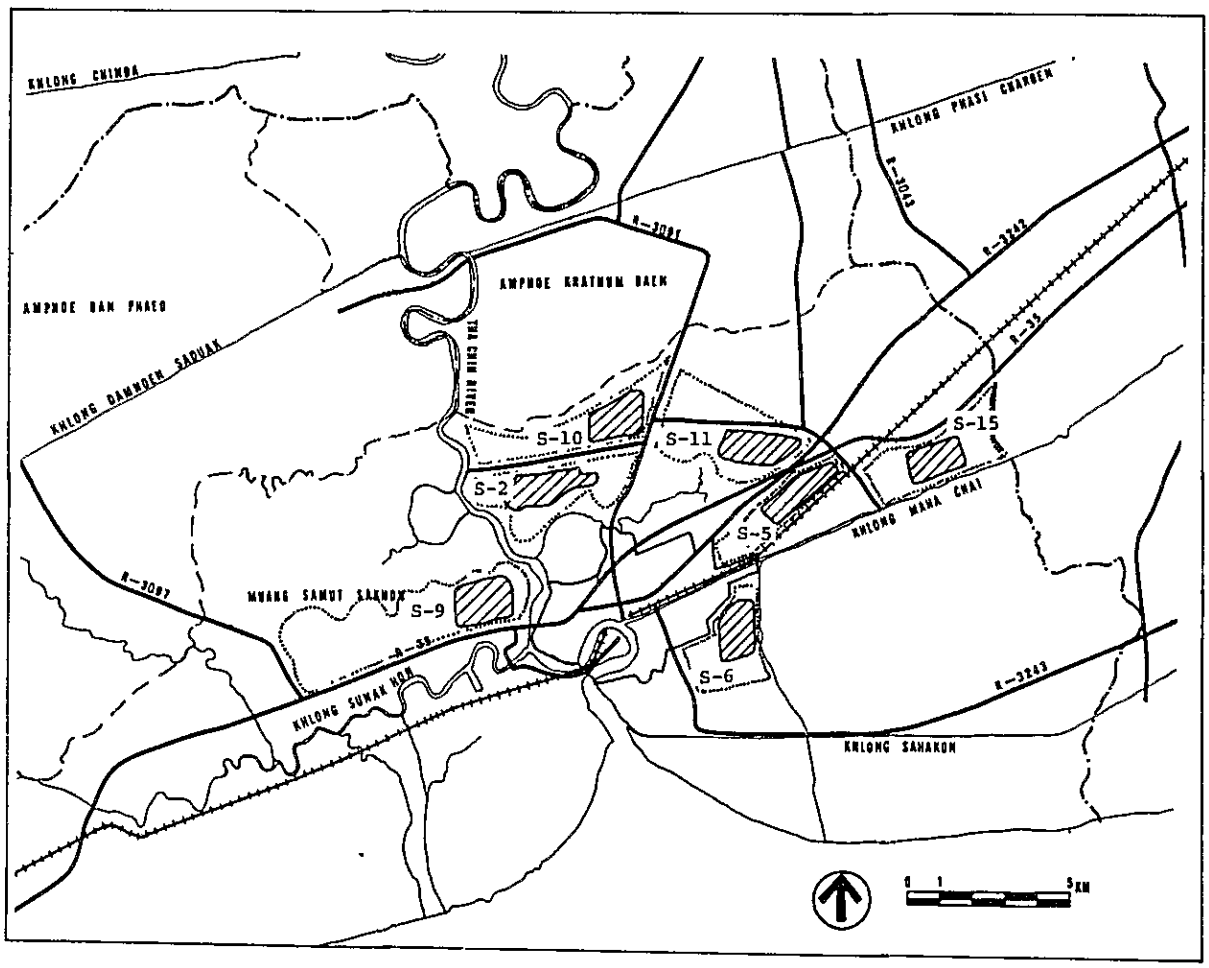


Fig. 5-2 ASSUMED AREA AT THE SIE CANDIDATE SITES

5-11 It was decided to use scoring evaluation method for detailed evaluation of the candidate sites. The main items of evaluation are as follows.

i) Environmental acceptability
ii) Infrastructure and utility services availability
iii) Land acquisition possibility and development cost
iv) Compatibility with regional development policy

5-12 As for weight distribution to these four items of evaluation, four cases shown in Table 5-1 were adopted based on deliberation with IEAT, and it was decided to make sensitively analysis in scores and order by changing weight.

Table 5-1 WEIGHT DISTRIBUTION TO MAIN ITEMS OF EVALUATION

Main Item of Evaluation	Weight Distribution for Evaluation			
	Case 1	Case 2	Case 3	Case 4
Environmental acceptability	30	25	20	15
Infrastructure & utility services availability	25	30	30	35
Land acquisition possibility & development cost	30	30	35	35
Compatibility with regional development policy	15	15	15	15
Total	100	100	100	100

5-13 The largest weight is given to environmental conditions in Case 1, and to both development cost and infrastructure in Case 4. Variation of weight distribution by sub item is shown in Annex 5-3 for each case. As for evaluation of water-way to receive wastewater discharge and of development cost, it was decided to vary the method of scoring and evaluation in addition to distribution of evaluation weight, for the purpose of causing superiority of locational conditions to be more apparently indicated.

C. Situation of Evaluated Areas

5-14 The locational conditions of each one of the areas to be evaluated are shown in Table 5-2. Sites 2 and 9 face Tha Chin River, which is the largest river in the Changwat, and Sites 5, 6 and 15 face Khlong Maha Chai, which is of the highest water transport utilization frequency among the rivers and khlongs in the Changwat, but Sites 10 and 11 are far apart from large rivers and khlong, and are linked with Tha Chin River only by means of small khlongs.

5-15 The wind direction having the highest appearance ratio in this region is southwest wind that blows in hot season, and northeast wind in the cold season follows. Because no candidate sites are located in the southwest direction of the city area of Samut Sakhon, it does not make any difference among candidate sites by wind direction.

5-16 Sites 5, 11 and 15 are linked with both Bangkok and Samut Sakhon City by two national roads, R-35 and R-3242, and Site 9 is linked with these cities by R-35 only. Site 10 faces R-3091, but sites 2 and 6 are rather apart from main roads. Bus lines linking Bangkok and Samut Sakhon City are established along R-35 and R-3091, and therefore, the sites facing these roads are convenient for commuting. The traffic volume on these two roads are almost equal at the present time. Although R-3091 has little allowance in the traffic capacity at the present time, R-35 provides sufficient capacity for expansion of width. In fact, there is a plan to improve R-35 to a 4-lane highway in the near future, and therefore, locational conditions are superior with R-35.

5-17 As for the quality of ground water, high salt concentration is indicated and it is considered that the closer to Bangkok, the poorer to water and both quality and quantity of water are better in the areas closer to Samut Sakhon, as shown in Annex 2-20. However, it will become more advantageous for the area closer to Bangkok, when supply of surface water from MWWA (Metropolitan Water Works Authority) become available in the near future.

5-18 Sites 5, 6 and 15 are close to railway tracks and railway stations. The commuting cost to Thon Buri (5 Baht) by railway has become less than that by bus (7 Baht), and number of passengers of railway has been increasing in accordance with rise of oil prices. Use of railway may not be practical for other candidate sites.

5-19 Land prices are higher in general in the areas close to city area of Samut Sakhon and Bangkok and are low in the areas between them. The zone in which the land prices are the lowest is the 8 - 10 km zone from the center of Samut Sakhon City. Land with depth of 80 m along main roads and khlongs are generally quite expensive (see Table 5-2 page 2).

5-20 When rough calculation is made as for the construction costs for such facilities as access road (from a main road to the industrial estate), electric power supply facilities (from an existing substation to the industrial estate), tele-communication facilities (from an existing telephone office to the industrial estate) and of drainage (from the industrial estate to a main canal .... with expenses for modification to a small water course allowed), which are required for operation of an industrial estate, and the cost for acquisition of land for those facilities, the total is the lowest for Site 5, and it is considered that the cost for Site 10 will be as much as nine times of that for Site 5. Although this total of construction cost and land acquisition cost is not a large amount when compared with the total development cost for the whole industrial estate. However, it is still large problem whether each authority concerned can implement the necessary work under the budgetary constraints. Therefore, the magnitude of the external infrastructure and utility services development cost is considered to be a large evaluation factor.

5-21 At Sites 10 and 11, almost the entire areas are paddy fields and dry farm land. Two crops of rice can be obtained at some places, and these sites are in the areas in which farming productivity is the highest among the candidate sites. The Changwat is plain in general, but these sites are of the highest altitude (1 - 2 m above sea level) among candidate sites, and therefore, it can be said that drainage conditions are relatively good for these sites. Other

candidate sites involve wasteland to a large extent, and therefore, it is considered that drainage conditions for other sites are inferior to those of Sites 10 and 11.

5-22 Confirmity to the development polity of satellite cities is as already described in Chapter III, and development of an area located along R-35 is considered to be effective from this standpoint. This thought is matched in general with the development policy of the Changwat Samut Sakhon.

5-23 When the candidate sites are observed from the viewpoint of development of SIE and formation of new urban area of Samut Sakhon, development at a place such as Site 15, which is apart from the built-up area by about 10 km, is almost equal to new formation of an independent city. Development of such a place provides less merits to the existing urban agglomeration at the built-up area of Samut Sakhon and will result in higher cost. Because it becomes necessary to supply sufficient town service facilities to the housing area to be included in the industrial estate and to the indirectly induced population in the vicinity of the industrial estate. As for development of areas such as Sites 2, 5, 6 and 9, which are close to the built-up area, it is possible to cause the population induced to be absorbed in the newly expanded city area where the existing urban agglomeration can be effectively utilized. Development of these areas, however, may cause rapid increase of land prices in the expanded city area, and if development is made at Site 6 or Site 9, the traffic related to the industrial estate have to pass through the built-up area, and consequently, it is most likely to have problem of traffic congestion occurs at bridges and other bottlenecks.

5-24 The SIE is a project having a possibility of future expansion. At Site 6, however, there is no room for future expansion because it is close to the area where shrimps farms are planned. At Site 9, expansion will probably made in slim form along R-35 of high land prices, because a canal and dike are being constructed close to R-35. As for Sites 2 and 10, it is unavoidable that development has to deal with the existing factories, but Sites 5, 11 and 15 have large possibility for future expansion. (At Site 5, expansion to the zone sandwiched between the railway and Khlong Maha Chai can be considered.)

Main Evaluation Item \ Candidate Site	S-15	Remarks
Environmental Acceptability		
River to which water drainage is connected	ng Maha Chai	
Distance from site to destination of drainage (km)	0.3	
Distance from destination of drainage to mouth of Tha Chin River (km): total	14.7 15.0	Total distance to river mouth
Situation of drainage route	me as S-5	It is said that productivity is low at shrimp farms located along Khlong Maha Chai because salt concentration is low.
Relation of wind direction with the built-up area of Samut Sakhon	ted on east of the t-up area.	Main wind direction is southwest in the hot season, and is northeast in the cold season.
Water pollution	in icular	
Infrastructure & Utility Services Availability		
Trunk roads to be connected	R-35	R-35 is planned to be expanded.
Distance to trunk road (km)	0.1	Distance including existing narrow streets.
Future congestion of trunk road (%)	54.9	Future magnitude of congestion was estimated by JICA Team considering the traffic volume generated by SIE.
Availability of bus service	Yes	

Table 5-2 COMPARISON OF LOCATIONAL CONDITIONS OF SITES TO BE EVALUATED

Main Evaluation Item \ Candidate Site	S-2	S-5	S-6	S-9	S-10	S-11	S-15	Remarks
Environmental Acceptability								
River to which water drainage is connected	Tha Chin River	Khlong Maha Chai	Khlong Maha Chai	Tha Chin River	Tha Chin River (through an existing waterway)	Tha Chin River (through an existing waterway)	Khlong Maha Chai	
Distance from site to destination of drainage (km)	1.0	0.6	0.6	0.7	3.5	8.0	0.3	
Distance from destination of drainage to mouth of Tha Chin River (km)	12.0	9.0	7.5	9.0	16.5	10.5	14.7	
: total	13.0	9.6	8.1	9.7	20.0	18.5	15.0	Total distance to river mouth
Situation of drainage route	The largest tidal river in the Changwat: Width: 200-300m	The river width is 50-100m, and runs through city area of Samut Sakhon in the east and west. Duck farms, nipa forest, shrimp farms and so forth are also distributed in the vicinity.	Same as S-5	Same as S-2	It is necessary to flow through an existing irrigation canal or to reconstruct the drainage for a distance of about 3.5km before inflow to Tha Chin River.	It is necessary to flow through an existing waterway for a distance of about 8km before inflow to Tha Chin River. Paddy fields, nippa forest, shrimp farms and so forth are distributed in the vicinity of this waterway.	Same as S-5	It is said that productivity is low at shrimp farms located along Khlong Maha Chai because salt concentration is low.
Relation of wind direction with the built-up area of Samut Sakhon	Located on north side of the built-up area.	Located on east side of the built-up area.	Located on south-east side of the built-up area.	Located on west side of the built-up area.	Located on north side of the built-up area.	Located on north-east side of the built-up area.	Located on east side of the built-up area.	Main wind direction is south-west in the hot season, and is northeast in the cold season.
Water pollution	None in particular	None in particular	The point of drainage is close to the built-up area, and a pollution source is in existence.	None in particular	Pollution by existing factories was observed.	None in particular	None in particular	
Infrastructure & Utility Services Availability								
Trunk roads to be connected	R-3091	R-35, R-3242	R-3242	R-35	R-3091	R-35, R-3242, R-3091	R-35	R-35 is planned to be expanded.
Distance to trunk road (km)	3.1	0.1	4.1	0.1	4.1	0.1 (2.0)	0.1	Distance including existing narrow streets.
Future congestion of trunk road (%)	331.0	54.9 54.3	54.3	54.9	331.0	54.9 54.3 331.0	54.9	Future magnitude of congestion was estimated by JICA Team considering the traffic volume generated by SIE.
Availability of bus service	Yes	Yes No	No	Yes	Yes	Yes No Yes	Yes	

Main Evaluation Item \ Candidate Site	S-15	Remarks
Distance to the built-up area of Samut Sakhon (km)	11.0	Distance along main road
Distance to Bangkok (km)	17.0	Same as above
Salt concentration of ground water (ppm)	5,000	
Depth and thickness of aquifer (m)	110 50	
Distance to area where water supply is planned by MWWA (km)	10.0	Distance along main road
Distance to electric power substation (km)	9.5	Same as above
Distance to telephone office (km)	11.0	Same as above
Distance to railway(km) (Intersection with rivers and roads)	1.5 necessary oss R-35.	Straight distance
Distance to railway station (km)	1.5	Distance along roads to closest station
Available canal	g Maha Chai	
Distance to canal (km)	0.3	
Canal utilization and linkage with site	g Maha Chai e direct- ed.	
Land Acquisition Possibility and Development Cost		
Land price: Land width depth of 80m along road (Baht/Rai)	- 100,000 - 100,000)	Assessment value for taxation. Figures in ( ) are market prices.
Area apart from roads	8,000 000 - 8,000)	
No. of houses requiring removal	houses	Approximately figure determined from aerial phtograph.

Main Evaluation Item \ Candidate Site	S-2	S-5	S-6	S-9	S-10	S-11	S-15	Remarks
Distance to the built-up area of Samut Sakhon (km)	4.5	4.5	3.5	3.5	5.5	6.0	11.0	Distance along main road
Distance to Bangkok (km)	30.0	22.0	30.0	32.0	31.0	22.0	17.0	Same as above
Salt concentration of ground water (ppm)	100 or less	500	100 or less	100 or less	100 or less	300	5,000	
Depth and thickness of aquifer (m)	110 or less 40	110 50	110 65	110 or less 40	110 or less 40	110 45	110 50	
Distance to area where water supply is planned by MWWA (km)	35.0	15.0	32.5	25.0	40.0	15.0	10.0	Distance along main road
Distance to electric power substation (km)	1.5	3.5	8.0	7.5	0.5	2.5	9.5	Same as above
Distance to telephone office (km)	4.5	4.0	3.5	3.5	5.5	6.0	11.0	Same as above
Distance to railway (km) (Intersection with rivers and roads)	4.0 It is necessary to cross R-35, R-3242 and R-3091.	0 None	0.5 It is necessary to cross Khlong Maha Chai.	2.0 It is necessary to cross R-35 and Khlong Sunak Hon.	5.0 Same as S-2.	1.5 It is necessary to cross R-35 and R-3242.	1.5 It is necessary to cross R-35.	Straight distance
Distance to railway station (km)	4.5	2.0	3.5	4.0	5.5	3.0	1.5	Distance along roads to closest station
Available canal	Tha Chin River	Khlong Maha Chai	Khlong Phra Ram or Khlong Maha Chai	Tha Chin River	To Tha Chin River through Khlong Si Wa Pha Sawa	To Tha Chin River through Khlong Khru	Khlong Maha Chai	
Distance to canal (km)	1.0	0.6	0 - 0.6	0.7	3.5	0.5 + 7.5 = 8.0	0.3	
Canal utilization and linkage with site	The largest and navigable river in the Changwat.	Maha Chai is the canal of busiest waterborne traffic. But it is disconnected by railway.	Maha Chai is the canal of busiest waterborne traffic and is linked also with Khlong Sahakon	Same as S-2	Width of existing waterway is narrow.	Same as S-10	Khlong Maha Chai can be directly used.	
Land Acquisition Possibility and Development Cost								
Land price: Land width depth of 80m along road (Baht/Rai)	120,000 - 50,000 (150,000-100,000)	80,000 - 60,000 (200,000-150,000)	200,000 - 40,000	150,000 - 80,000 (150,000-100,000)	120,000 - 50,000 (150,000-100,000)	100,000 - 50,000 (150,000-100,000)	- 100,000 (- 100,000)	Assessment value for taxation. Figures in ( ) are market prices.
Area apart from roads	-100,000 (25,000-120,000)	7,000 - 6,000 (10,000 - 8,000)	- 6,000	10,000 - 8,000 (10,000 - 8,000)	- 10,000 (20,000 - 15,000)	10,000 - 7,000 (20,000 - 15,000)	8,000 (10,000 - 8,000)	
No. of houses requiring removal	100 houses	70 houses	20 houses	100 houses	100 houses	150 house	40 houses	Approximately figure determined from aerial phtograph.

Main Evaluation Item \ Candidate Site	S-15	Remarks
Development cost: External infrastructure (Baht million)	26.6	Calculation was made based on the uniform assumption that unit price of land acquisition for road and waterway work is 200,000 Baht for land with depth of 80m along road and 20,000 Baht for other land.
In industrial estate	560.0	
Total Cost	586.0	
Land use: Ratio to paddy field and dry farmland (%)	20%	
Ground height, soil and subgrade conditions	me as S-2	Industrial estate construction cost was provisionally calculated as a model with the total area assumed at 2,000 Rai.
Regional Development Policy		
Conformity with policy of development of satellite cities	me as S-5	Linear type linking Bangkok and Samut Sakhon was considered to be the best.
Conformity to development policy of Changwat Samut Sakhon	me as S-2	
Influence over surrounding villages, town area and land use	from ing -up area.	
Conformity to trend of location of factories	me as S-5	
Possibility of expansion	me as S-11	

Candidate Site / Main Evaluation Item	S-2	S-5	S-6	S-9	S-10	S-11	S-15	Remarks
Development cost: External infrastructure (Baht million)	53.5	9.1	70.2	12.8	82.2	65.0 (42.6) (excluding improvement of waterway)	26.6	Calculation was made based on the uniform assumption that unit price of land acquisition for road and waterway work is 200,000 Baht for land with depth of 80m along road and 20,000 Baht for other land.
In industrial estate	560.0	560.0	560.0	560.0	560.0	560.0	560.0	
Total Cost	613.5	569.1	630.2	572.8	642.2	625.0	586.0	
Land use: Ratio to paddy field and dry farmland (%)	70%	40%	20%	50%	100%	100%	20%	
Ground height, soil and subgrade conditions	Area where seawater and fresh water are mixed. Tha Chin soil area of low productivity. Altitude is considered as 1-2m above sea level.	Same as S-2	It is considered that altitude is the lowest among candidate sites.	Same as S-2	Bangkok soil area. located at the elevation which is the highest among candidate sites, and drainage in dry season is relatively good.	Same as S-10	Same as S-2	Industrial estate construction cost was provisionally calculated as a model with the total area assumed at 2,000 Rai.
Regional Development Policy								
Conformity with policy of development of satellite cities	Rather non-conforming	Good and atrractive being close to Bangkok.	Same as S-2	Condition of commutation from Bangkok is inferior.	Same as S-2	Conforming	Same as S-5	Linear type linking Bangkok and Samut Sakhon was considered to be the best.
Conformity to development policy of Changwat Samut Sakhon	Conforming	Same as S-2	Partly non-conforming	Same as S-2	Generally conforming	Same as S-10	Same as S-2	
Influence over surrounding villages, town area and land use	Urbanization is in progress in the vicinity of the site.	Close to area of city planning	Close to acquacultural farms and existing built-up area, and traffic capacity of bridges is questioned.	A temple is being built. Traffic capacity of the bridge over Tha Chin River is questioned.	Adjustment of water utilization of paddy field area is required.	Same as S-10	Far from existing built-up area.	
Conformity to trend of location of factories	Conforming. Entry of factories is observed.	Non-conforming. No entry of factories is observed.	Small businesses are located along the river.	Entry of businesses is partly observed.	Conforming. Entry of businesses is observed.	Same as S-5	Same as S-5	
Possibility of expansion	There is to a certain extent.	There is on south side of railway track.	Difficult due to acquacultural farm plan.	There is a restriction by newly built waterway.	Same as S-2	Large possibility for expansion.	Same as S-11	

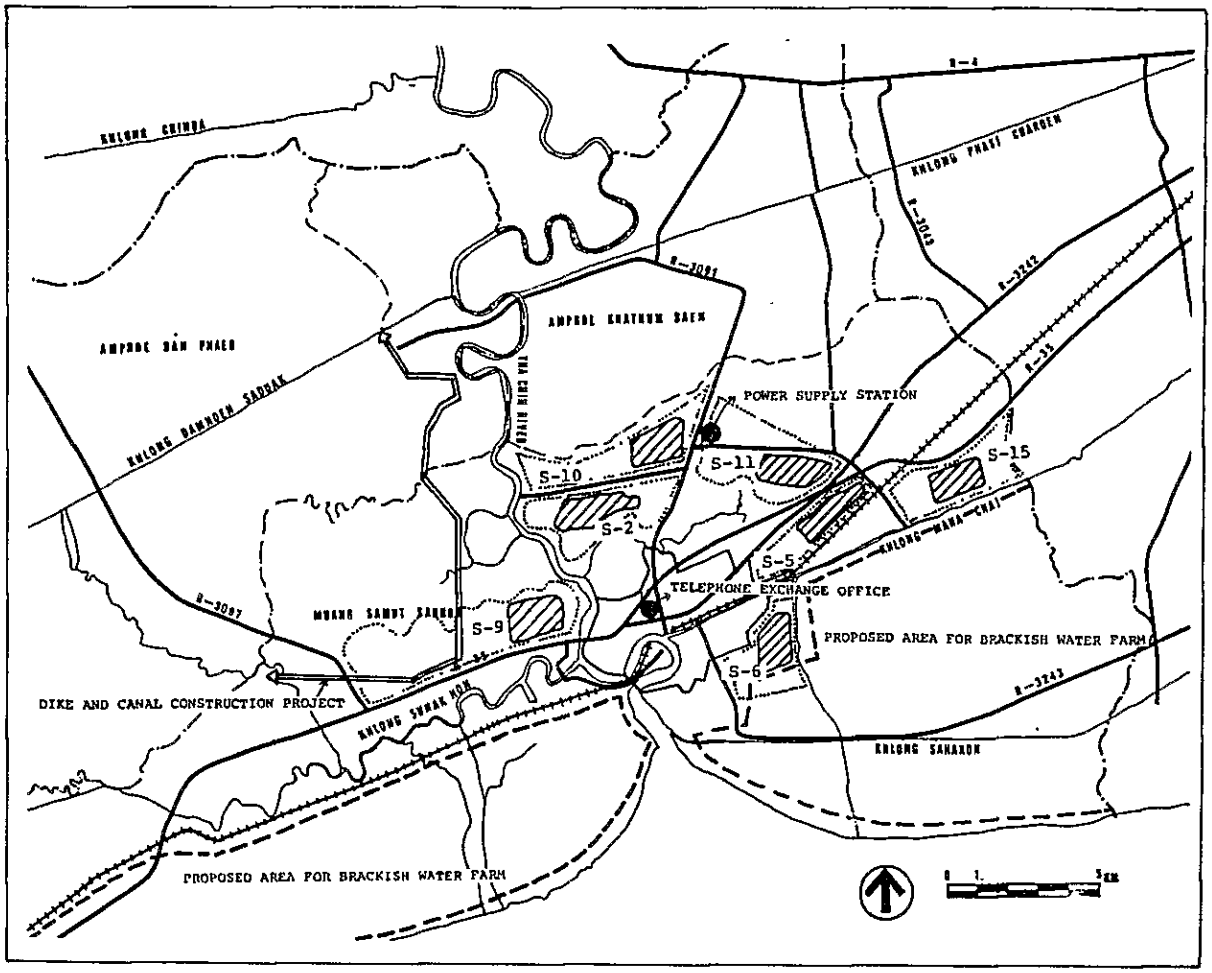


Fig. 5-3 LOCATIONAL CONDITIONS OF CANDIDATE SITES

D. Result

1. Result of Evaluation

5-25 The result of evaluation of the candidate sites is as shown in Table 5-3 (see Annex 5-3). Site 9 is of the first place and Sites 5 is of the second place in Case 1. In Cases 2 through 4, however, Site 5 is of the first place and Site 9 is of the second or third place.

5-26 Site 11 is close to Site 5. However, its score is always less than that of Site 5 by 15 - 20 marks. The reason for it is considered that establishment of a drainage is difficult and large expenses are required for expansion of the existing waterway for Site 11 and that it is inferior to Site 5 with respect to accessibility to navigable waterway and railway.

5-27 The situation of land use is similar between Site 5 and Site 9. There is not much difference, either between them as for the cost of consolidation of external infrastructure, and it is considered that this cost is the lowest for these sites among candidate sizes. As a result, it is possible to reduce the candidate sites for SIE to Site 5 and Site 9.

Table 5-3 RESULT OF EVALUATION OF CANDIDATE SITES

	Site 2		Site 5		Site 6		Site 9		Site 10		Site 11		Site 15	
	Score	Order	Score	Order	Score	Order	Score	Order	Score	Order	Score	Order	Score	Order
Case 1	69.1	3	71.8	2	69.1	3	76.8	1	50.9	7	57.4	6	67.3	5
Case 2	66.7	5	78.4	1	74.7	2	73.9	3	53.5	7	60.5	6	71.9	4
Case 3	62.9	5	79.4	1	67.8	4	71.1	2	52.4	7	58.6	6	69.9	3
Case 4	55.1	6	79.7	1	61.5	4	66.5	2	48.2	7	56.1	5	65.6	3

5-28 The main points which caused the judgement that Site 9 is superior to Site 5 are the following two points.

i) Being close to the largest river in the Changwat, it is advantageous as for discharging of the treated wastewater for further dilution.

ii) It is necessary for the SIE to be dependent on ground water for some time for supply of water. It is estimated that an area close to Tha Chin River is more advantageous as for both of quality and quantity of ground water. (This is a qualitative judgement based on existing data.)

5-29 On the other hand, the main points which caused the judgement that Site 5 is more advantageous than Site 9 are the following three points.

i) Site 5 faces two main roads, that is, R-35 and R-3242. Frequent bus service linking Samut Sakhon and Thon Buri is operated along R-35 and a plan to be widened to a 4-lane highway has also been made. Site 9 also faces R-35, but it is considered that a long period of time is required to upgrade R-35 in the area beyond Tha Chin River, and in addition, there are no bus services linked with Thon Buri (Bangkok). These are large problems.

ii) It is planned that about one half of employees of the SIE is dependent on those who commute from Bangkok. As the commuting time band is limited, burden is applied to road traffic. Site 5, however, is close to a railway and is close to an existing railway station. Therefore, it is possible to make use of this railway for both commutation and for transportation of goods. Site 5 provides such an advantage that the railway track can be used as it is as a part of the dike and therefore the flood control cost can be saved although assumption was made for comparison of candidate sites that the cost of land preparation in the industrial estate is identical.

iii) It is considered that proximity of Site 5 to Bangkok is attractive for the entrepreneurs who want to relocate their factories from Bangkok to SIE.

5-30 Two points were raised as the advantages of Site 9. However, pollution load allowance of Tha Chin River and Khlong Maha Chai is not clear. Furthermore, it is considered unavoidable to treat waste water to a high degree as a target for the SIE project, and therefore, it cannot be determined that Site 9 is more advantageous than Site 5. As for ground water, it is considered possible to use ground water at Site 5 as long as judgement is made from available data, and the area located closer to Bangkok is more advantageous for receiving water supply by MWWA in the future.

5-31 The result of examination stated above, Site 5 is proposed as the best candidate site of SIE among others, and the basic plan for the SIE is designed accordingly.

2. Recommendation

5-32 For evaluation of candidate sites, relative ease of acquisition of land was judged by the number of houses required to be removed. As for this matter, it is recommended that an immediate action to conduct a survey related to the number and will of those land holders and start preparation for purchase.

5-33 The anxiety for Site 5 is quality and quantity of ground water on which supply of water should be dependent for some time. It is necessary to immediately execute ground water boring survey in Site 5 and its vicinity.

5-34 For the purpose of materializing utilization of railway, which is the advantage of Site 5, it is recommended that deliberation should be started with RSRT (The Royal State Railway of Thailand) as for the possibility of construction of a spur line of railway in the site of SIE.

Ⅵ. LAND USE PLAN

VI. LAND USE PLAN

A. General

The land use plan of SIE shall be planned with the following basic thoughts.

1. To Create Pleasant Working Environment

6-01 It is natural that good productive environment is essential for formation of an industrial estate. In addition, attractive living environment and scenic beauty should be created in the estate itself, and pleasant working environment shall be provided by suitable land subdivision and factory arrangement by type of industry, establishment of suitable road network, provision of welfare facilities, parks and greens, provisions of greens along roads and in factory sites in addition to consideration for prevention of pollution and industrial disasters.

2. To Consider Influence to Peripheral Existing Villages and Farming

6-02 Farmlands such as paddy fields, dry farms and fish farms are located together with existing villages in the vicinity of the industrial estate. Besides, khlongs are located in the vicinity and the life of the people is dependent on these khlongs. When planning the industrial estate, therefore, full consideration should be made to the influence over the peripheral areas, and particular care should be exercised as for waste water discharged out of the factories.

3. To Make Double Assurance as for Countermeasures against Disasters

6-03 Because of the fact that the topography is generally flat, it is necessary to make double assurance as for the countermeasures against floods with the precipitation during the rainy season (1,500 mm per year at average) taken into consideration. Therefore, such a system that a dike and ditch shall be provided along the boundary of the industrial estate and water discharge is made by pumping shall be adopted, as described in Chapter VII, Section A.

4. To Provide Residences Close to the Place of Work

6-04 It is necessary to prepare land for residences for those who work in the industrial estate, and the land for residences shall be provided adjacent to the factory area with a view to minimize time and energy consumed in commuting. Buffer greens shall be provided between the working space and dwelling space for preservation of the latter.

5. Unitization of Waste Water Treatment System

6-05 Cost reduction will be accomplished through unitization (joint treatment) of waste water discharged out of factories and sewage discharged out of residences. The location of the waste water treatment plant shall be determined with the configuration and topographical conditions of the industrial estate as well as arrangement of factory

by type of industry in the estate and destination of discharge taken into consideration.

6. To Enable Entry of Relevant Minor Businesses

6-06 Multi-purpose standard factories shall be provided for enabling entry of relevant minor businesses, with the fact that those who want to make entry into the industrial estate are not limited to big businesses but those which are closely related such as parent factory-child factory (master contractor - sub contractor) may also want to make entry taken into account.

7. To Make Subdivision Capable of Coping with the Changes in Economic Environment

6-07 It is unavoidable that the economy of Thailand is largely affected by the trend of the international economy like that of neighboring nations. With this project, which requires a period of at least five years from the stage of planning to completion of construction and commencement of operation, it can be considered that the type and size of industry to make entry may change by the time before commencement of operation of the estate. Therefore, flexibility, adaptability and expansibility shall be considered when making subdivision of the land.

8. To Reduce Development Cost and to Eliminate Restricting Conditions for Sales of Land

6-08 Consideration will be made so that sales prices will be sufficiently competitive compared to the cost of lands individually developed by an occupant and that lots of irregular shapes shall be eliminated as much as possible so that these lots are both economically and physically attractive to businesses and the marketing period required shall be shortened.

B. Preconditions for Land Use Planning

The preconditions for SIE land use planning can be rearranged as follows.

1. Land Scale

6-09 The total area of this industrial estate is 1,820 Rai (291 ha). The land for factories is of the area of 1,254 Rai (200 ha) out of this total area, and the remaining is the land for relevant facilities. The total development area is 2,085 Rai (333.5 ha) including 265 Rai (42.4 ha) for the housing area.

2. Composition by Type of Industry

6-10 The factories to make entry into this industrial estate are generally composed of nine types of industry, and total area of lots assigned to factories of textile occupies about 30% (360 Rai) of the whole area. Metal and machinery occupying the space of 20% (240 Rai), foods, occupying the space of 15% (180 Rai) and chemical occupying

the space of 10% (120 Rai) of the whole area respectively are other major types of industry. Other types of industry are rubber, wood & furniture, ceramics, paper and others.

(See Chapter IV, Section B for the details of selection of type of industry.)

3. Number of Employees

6-11 The figure of 16,212 persons is obtained as the total number of employees of the factories in this industrial estate when calculation is made with the unit manpower rate (persons/Rai) of each type of industry is assumed based on the expected composition of the types of industry. Furthermore, when it is assumed that the number of employees of relevant facilities is equivalent to 2% of the total number of employees of the factories (16,212 persons x 0.02 = 324 persons), it is expected that the total number of employees to work in SIE will be 16,536 persons.

4. Water Supply and Discharge

6-12 The planned water intake volume is 18,000 m^3/day for factories and 3,700 m^3/day for residences, thus the total of 21,700 m^3/day is required. (Refer to Chapter VII, Section C for the method of calculation.) The waste water discharge volume can be considered as 16,000 m^3/day from factories and 3,000 m^3/day from residences, that is, 19,000 m^3/day in total (see Chapter VII, Section D for the method of calculation).

5. Electric Power

6-13 The planned electric power capacity is 64 MW in total for both factories and residences (see Chapter VII, Section E for the method of calculation).

6. Residences

6-14 The demand for residences was determined as follows based on the results of hearing from IEAT and NHA.

i) The object is one half of the expected employment population of SIE.

ii) The composition of the planned population is 60% unmarried and 40% married (four persons per family as average).

iii) The density in the housing area is 70 persons per Rai. (For example, it is 83.5 persons per Rai at Bang-phli Bang-Bo; but was 76.4 persons per Rai in Phase I area.)

With the above calculation and assumptions the total number of persons to live in the housing area is expected as about 18,000 persons, and land of about 260 Rai (41.6 ha) is required.

7. Traffic

6-15 The traffic in the industrial estate will be about 4,000 vehicles per day with the volume of cargoes to be generated as classified by the type of industry and traffic to be generated for commuting

taken into consideration (see Chapter VII, Section B for the method of calculation).

C. General Features of the Site

1. Relations with the Region

6-16 The proposed site (Site 5) of the industrial estate is located in the position of about 5 km in northeast direction from the existing town area of Samut Sakhon. It is located along R-35 and R-3242, which are trunk roads linked with Bangkok, and the distance to Bangkok is as short as about 25 km. R-35 is the Gulf of Thailand trunk roads which links Thon Buri located on the west side of Bangkok and Pak Tho located at the root of Malay Peninsula, and it exerts major influence over the socio economic conditions of Changwat Samut Sakhon. The right of way of 80 m width are secured for this road in preparation for future expansion. A railway was constructed in parallel with R-35. This railway links Samut Sakhon with Thon Buri area (16 round trips per day; passenger cars only), and therefore, this site is blessed with favorable traffic conditions.

2. Current Conditions of the Site

a. Topography

6-17 The site is the land surrounded by R-35, R-3242 and the railway stated above. It is of the width of about 1.0 km (at average) and of the length of about 5.2 km, and is almost plain. The maximum difference in height is around 1.0 m and the mean altitude is estimated as +1.1 m. The soil is classified into Tha Chin clay and Bangkok clay (see Fig. 6-1).

b. Land use

6-18 The land use that is related to the soil is currently observed. That is, trees such as mangrove and nipa are planted in Tha Chin clay area, and Bangkok clay area is mainly used as paddy fields. Land use of this site is generally divided into these two applications (see Fig. 6-1).

c. Water system

6-19 Khlong Maha Chai flows on the south side of the site, and its five branches are flowing through the site. Another water channel is located in parallel with R-3242. It is considered that the majority of these small channels are used as agricultural water-ways (see Fig. 6-2).

d. Distribution of village

6-20 Approximately 70 houses are located in the site when the structures appearing in an aerial photograph are observed. Many of them are located particularly in the area of R-3242 through the paddy field area. In the vicinity of the site, on the other hand, large villages are located along Khlong Maha Chai on the south side of the site and also along R-3242 on the north side of the site. Besides, land development (for housing) is observed in the section between R-35 and R-3242 (see Fig. 6-3).

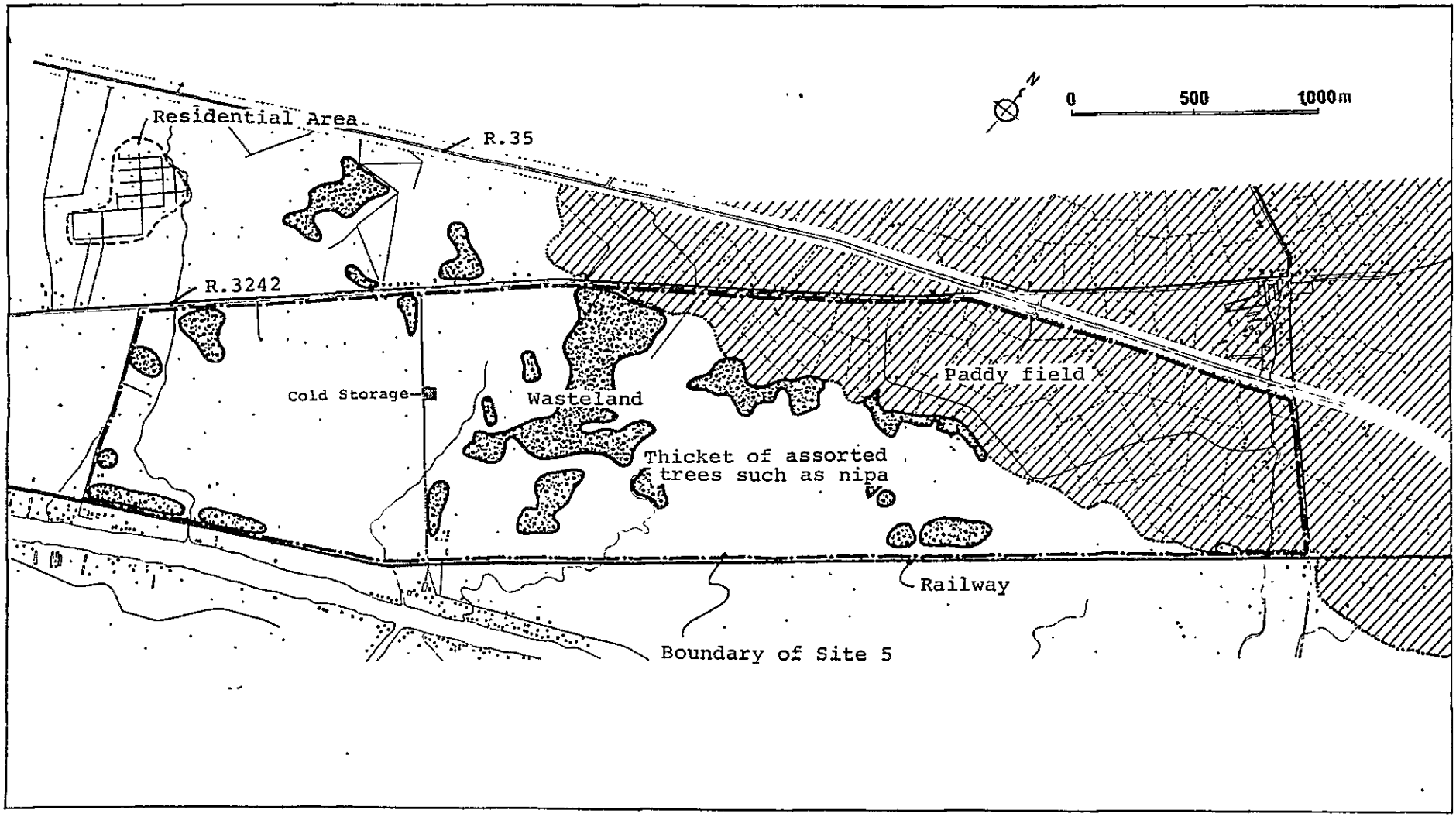


Fig. 6-1 CURRENT SITUATION OF LAND USE

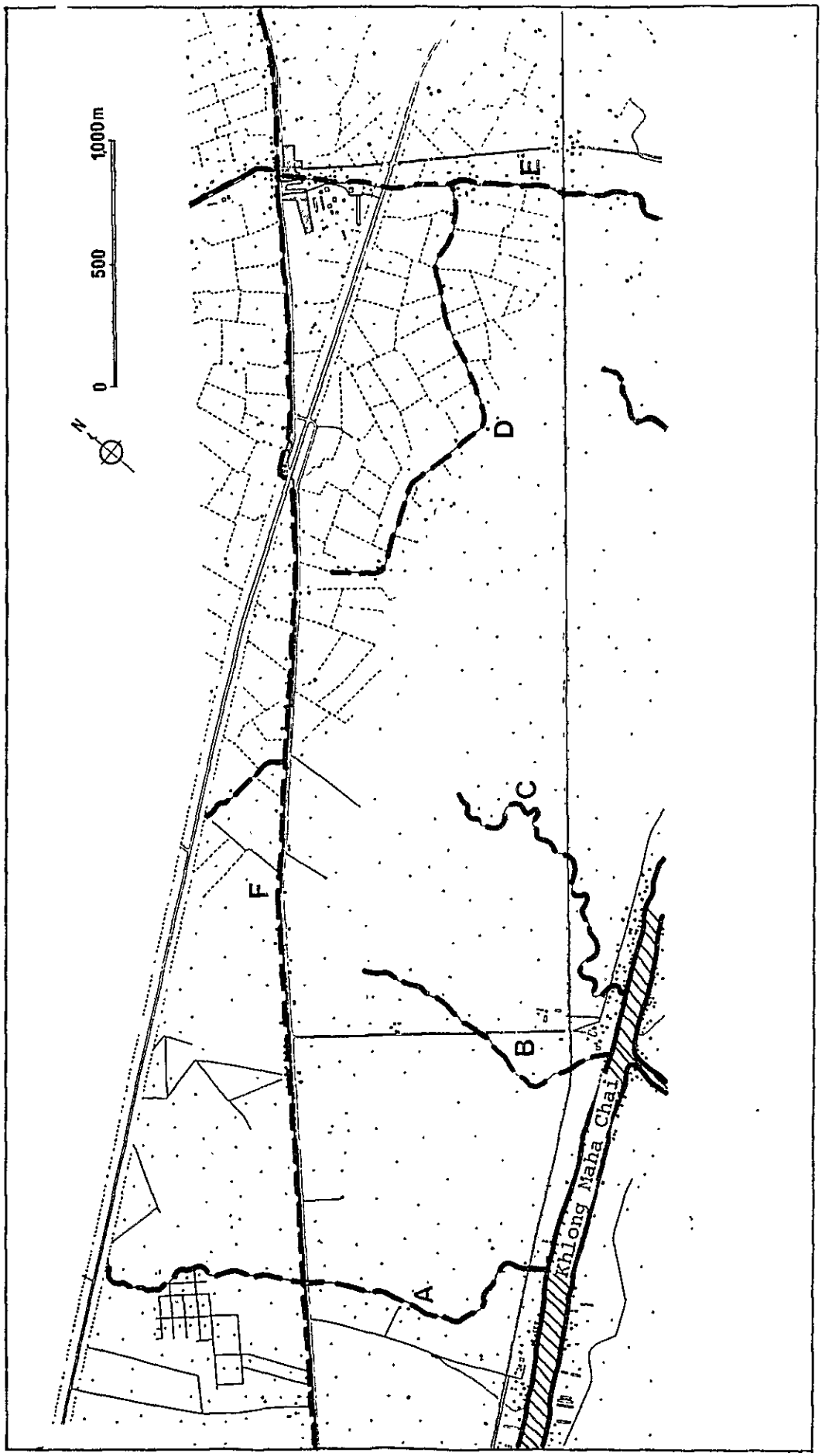


Fig. 6-2 CURRENT SITUATION OF WATER WAYS

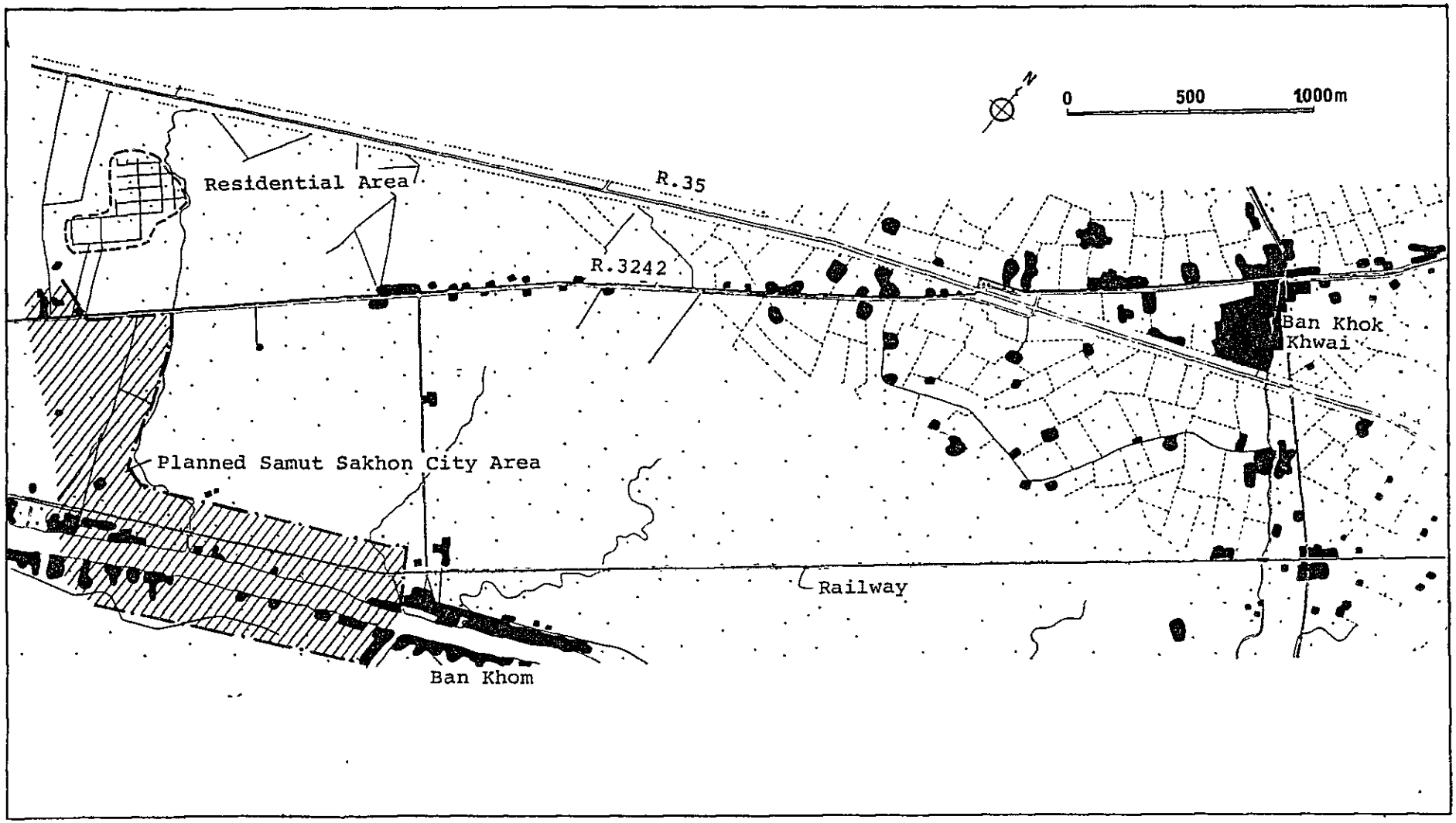


Fig. 6-3 VILLAGE DISTRIBUTION

e. City planning

6-21 Trend of development is observed in the vicinity of the site, particularly in the area located on the side of Samut Sakhon City, and a part of this site is designated as city plan area of Samut Sakhon City (see Fig. 6-3).

f. Others

6-22 According to the second site survey conducted on July 4, 1980, the following additional information was obtained.

i) Land development for housing was planned at the south western tip of the area towards Samut Sakhon City where trees were already burnt off.

ii) A shoe making factory is planned at the center of the area but there is no physical development yet.

iii) New housing estate was developed at the area sandwiched with R-35 and R-3242 at a point close to the proposed access road.

iv) There is a cold storage in the middle of the village road connecting R-3242 with Khlong Maha Chai.

D. Examination of Ideas of Land Use Plan

1. Examination of Coarse Ideas

6-23 This SIE will be the first industrial estate to be constructed in the western region of Thailand. It will have a large significance in the promotion of industry, and in addition, it will play the role of a model for construction of industrial estates in the future and also the role of the nucleus of regional development. For the land use planning of this SIE, the following two ideas were examined with the level of consolidation of Lat Krabang Industrial Estate, the construction of which has already been started, used as the reference, for the purpose of seizing the level of consolidation of the industrial estate. One is an idea (A type) of land use plan as viewed from the layout conditions of infrastructure and its relevant facilities, and another is its modification (B type). These two ideas are described below.

a. A type

6-24 The project area was established as follows. That is, the area located on the west side of the proposed site (area on west side of the road leading from R-3242 to Ban Khom village) was excluded because trend of development is observed in the area located toward Samut Sakhon City (a part of this area is designated as city plan area) and also because land price is high in this area. As for the areas along trunk roads, the portion with the depth of 100 m on road side was further excluded because land price is high. Establishment of the area was made along water way (D) based on the policy of leaving the paddy field area on east side intact as much as possible.

1) Policies on land use

i) To locate housing area in a place toward Samut Sakhon City, and to provide buffer greens (width 100 m) at the boundary to factory area.

ii) To connect the access roads (Road A) to the intersection of R-35 and R-3242.

iii) To construct the trunk road in the estate (Road B) along the railway and along the buffer greens on the west side, and to cause the block on the west side of the estate to be linked with the trunk road.

iv) To construct a dike and ditch as countermeasures against flooding in the vicinity of the estate. (It will become a buffer zone to the peripheral area.)

v) To make joint treatment of both industrial and domestic waste water, and to construct a treatment plant in a block on west side close to the (Khlong Maha Chai). A drainage of the length of about 400 m is required.

vi) To discharge rain water by pumping out of the ditch made inside of the dike described earlier, to the existing small water ways.

vii) To construct an electric power substation and a telephone exchange station along the buffer greens on the west side, with the location of the power station in Samut Sakhon and layout of the estate taken into account.

viii) To construct a water supply station adjacent to the main center which is almost located at the center of the estate, and to also construct another one in the buffer greens on the west side to supply to the residential area.

ix) To locate the main center combined with a park at the center of the estate along the access road. To provide a sub center in the buffer greens on the west side in view of the walking distance sphere (see Fig. 6-4).

2) Features in land use

• Advantages

i) Cheaper in land acquisition cost.

ii) Significance of leaving paddy field area intact as much as possible.

iii) Cost reduction for construction of waste water treatment plant can be made because of joint treatment.

iv) Shorter drainage to Khlong Maha Chai keeping away from villages.

• Disadvantages

i) Sprawling in the portion of 100 m on road side by residences and small scale factories may occur, and there is a fear that the image of the industrial estate is spoiled by it.

ii) A triangle space is located on the east side of the estate, and it is not effective from the standpoint of land use.

iii) As the access road is connected to the intersection of R-35 and R-3242, the flow of traffic at this intersection will become complicated.

iv) Location of the waste water treatment plant is close to the housing area and neighboring villages.

v) There is no allowance in space. (Land for factories is insufficient.)

b. B type

6-25 This is a modification of A type, and the project area is expanded to the road side area. Furthermore, the triangle space on the east side is minimized by diversion of water way (D).

1) Policies on land use

i) The policies of land use have basically remained unchanged from that of A type. But consideration was made to connection of access road in the estate.

ii) The waste water treatment plant is located outside of the project area (location beyond railroad) for the purpose of securing broader space for factories (see Fig. 6-5).

2) Features in land use

• Advantages

i) It is possible to secure broader space than that of A type.

ii) The triangle space, which is a problem for land use, has been solved.

iii) Occurrence of sprawl in the peripheral area can be solved.

iv) As the waste water treatment plant is located in a place that is closer to Khlong Maha Chai, drainage becomes more convenient.

• Disadvantages

i) Cost of land acquisition becomes higher (because road side 80 m area of high land prices is included).

ii) The problem of access remains unsolved.

iii) There are problems in the location of waste water treatment plant. (Problem from the standpoint of management and control; probability of negative reaction by villagers to the waste water treatment plant for an industrial area in a place located outside of project area).

iv) Diversion of river (water course D) requires additional cost.

2. Basic Policies on Land Use Planning

6-26 The land use plan was designed fundamentally based on the idea of land use, that is, A type and B type described earlier, and with further modification made so that it may become possible to satisfy the demand of 1,200 Rai (192 ha) for factory lots.

a. Delineation of the area

6-27 The project area was delineated as follows. That is, the majority of the project site is the existing forested area, and area on the west side toward Samut Sakhon City is excluded because a part of this area is designated as city plan development area. Furthermore, it was decided to leave the paddy field area on the east side intact as much as possible, and the area about 3.6 km in linear

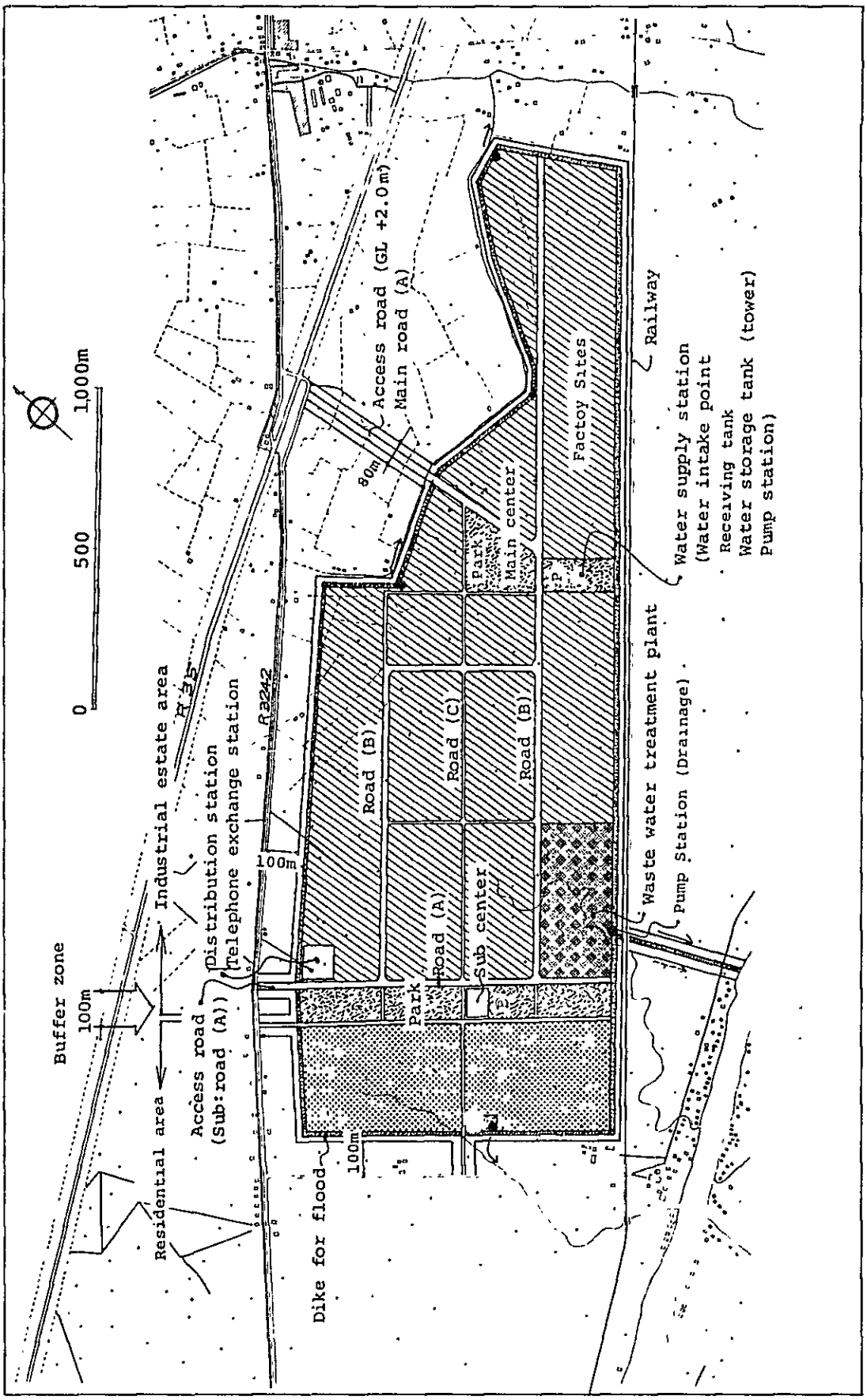


Fig. 6-4 A TYPE (Land use plan)

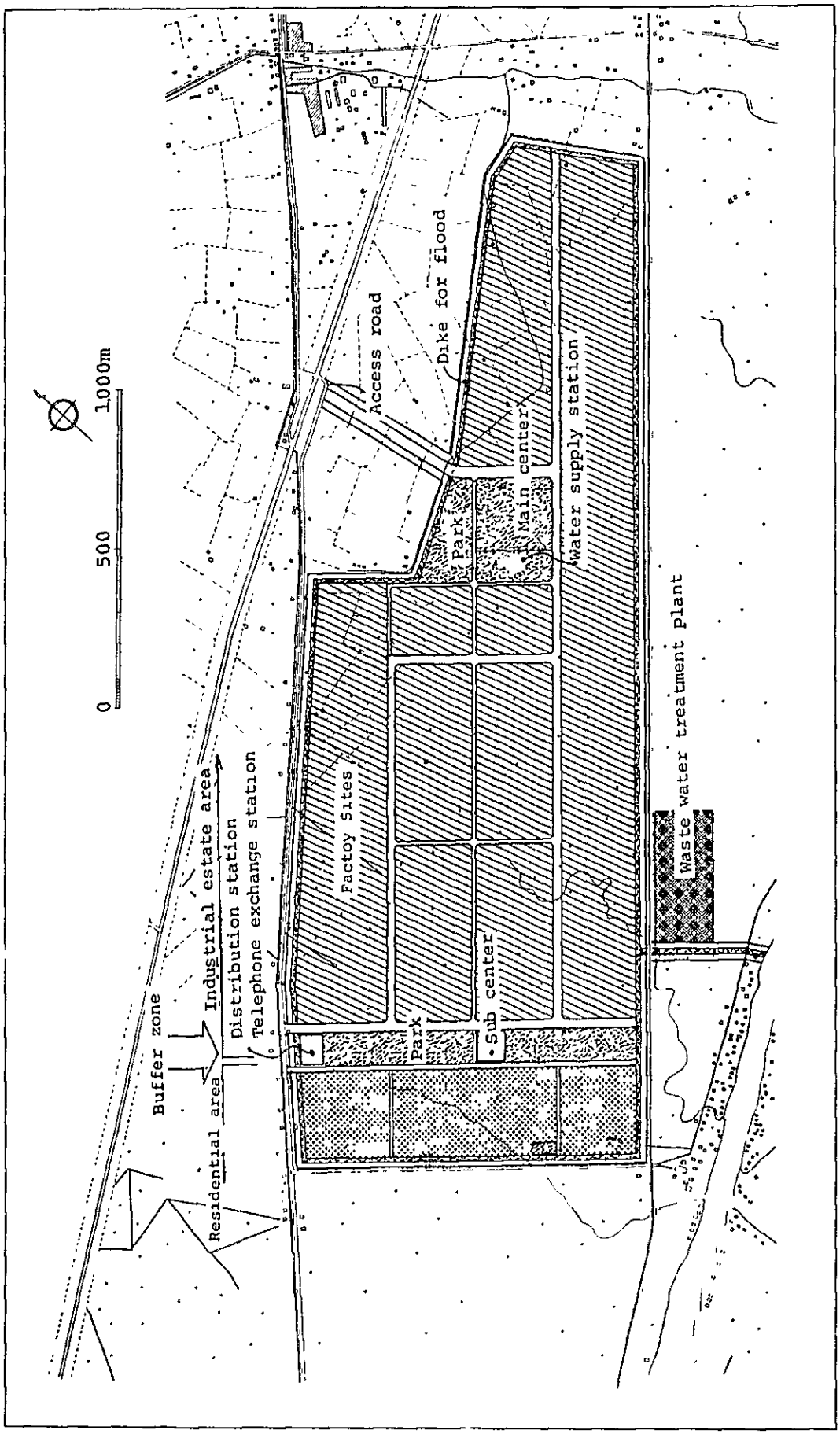


Fig. 6-5 B TYPE (Land use plan)

distance between R-3242 and railway was delineated as the project area.

6-28 According to the recent survey on land ownership conducted by IEAT, there are 159 parcels excluding small portions located in the central part where ownership information is not available. The size of less than 9 Rai per parcel occupys majority (89 parcels) of the total. The maximum size of the parcle is 52 Rai (see Annex 6-1, 6-2).

b. Policies on land use

6-29 1) Summary of planning conditions

i) Non-productive space is required besides the demand of 1,200 Rai for factory lots. Therefore, the total area required for the industrial estate becomes 1,714 - 1,846 Rai when the space for roads, parks, greens, main center, water supply and drainage facilities, public facilities and so forth is taken into consideration under the general standard of an industrial estate that the factory lots correspond to 65% - 70% of the whole area.

ii) The housing area to be constructed adjacent to the factory area requires the space of 200 - 300 Rai. The area located toward Samut Sakhon City (with the road connecting existing villages with R-3242 as the boundary) is selected as the housing area in view of the relationship with the city plan area located on the west side of the project area.

iii) To provide buffer greens between the housing area and the factory area for maintaining good living environment.

iv) To construct a dike and ditch, which surrounds the entire area of both industrial estate area and housing area, to prevent the area from disasters (countermeasures against flooding in rainy season). On the railway side, the railway track is considered to play the role of the dike.

v) To cause the access road to come down south toward the center of the estate from the point of about 800 m to the west from the intersection of R-35 and R-3242. To provide a sub access road at another location.

vi) To locate the waste water treatment plant at the center of the estate from the relationship with the shape of the estate, land use and layout by type of industry, as it is necessary to keep it apart from the housing area and existing villages as much as possible. Discharge waterway connected with the treatment plant shall be made on the part extended straight downwards from the primary road to Khlong Maha Chai to allow future expansion.

vii) To make layout of the industrial estate in such a manner that factories of large scale are located along R-3242 and also along the railway and enclose those factories of small scale, which are of diversified scale and appearance of buildings are generally not attractive, to keep good image and appearance of the industrial estate to outsiders.

viii) To provide a railway station for convenience of railway commuter at a place close to the main center.

ix) When expansion is required in future, it is proposed to use the area between the railway and Khlong Maha Chai where has easy access to both railway and waterway transports and can be best met with the future needs of distribution related industries such as truck terminal and warehouse.

x) Following method can be thought in dealing with the existing cold storage.

- To keep it as it is and enclose it with buffer green.
- To encourage the owner to move out to the factory area in the estate.

2) Facilities layout plan

- Main center

6-30 The main center will be provided at the central part of the industrial estate facing the main road linked with the access road. It was decided as a result of deliberation with IEAT to arrange the following facilities in the main center.

i) Administration center

. IEAT office
. Office of businesses in the industrial estate
. Conference hall
. Exhibition room
. Training center
. Library
. Parking area
. Security office
. Store
. Workshop

ii) Public facilities

. Post office
. Bus stops
. Fire station

iii) Commercial facilities

. Bank
. Restaurant
. Gas filling station

iv) Medical care

. Clinic

Two sub centers will be provided. One is at the boundary between housing area and industrial estate area (combination with greens) and another at greens located in the east side of the factory area with walking distances taken into account. Facilities such as shops, restaurant and small meeting rooms will be arranged in the sub center.

- Utility facilities

6-31

i) To adopt the system of joint treatment of both industrial and domestic waste waters for the waste water treatment plant. To locate the waste water treatment plant at about the center of the industrial estate located toward the railway.

ii) The extension of the drainage to Khlong Maha Chai which is the destination of discharge of waste water, is about 650 m.

iii) To locate the electric power substation in the buffer greens toward R-3242 where is closer to the substation in Samut Sakhon. To locate a high voltage transformer in the housing area.

iv) To locate the telephone exchange station in the main center building as it is required to be maintained by IEAT.

v) To locate a water supply station in a place adjacent to the main center at the central part of the industrial estate keeping in mind harmony with the park. To locate another water supply station for supply of water to the housing area; therefore, two water supply stations in total. To excavate deep wells at eight places at minimum with locations suitably selected with quality of water taken in account, for supply of water, because water should be dependent on the ground water for some time.

vi) To provide an open ditch along the dike as countermeasures against flooding, for temporarily accumulating rain water and for discharging water thereof with pumps to be located at four places.

vii) To locate the place for disposal of solid refuse in the place of irregular shape at the east end of the industrial estate.

• Parks and greens

6-32

i) To provide a large park (2 ha) adjacent to the main center and to provide two small parks (0.5 ha each) adjacent to the sub center. To provide a sport field for soccer and so forth in addition.

ii) To provide buffer greens between the industrial estate area and the housing area (width: 150 m). Facilities such as sub center, power substation, water supply station, small parks, sport field, pond and so forth are incorporated in buffer greens.

iii) The dike for flood protection described earlier is planned with the width of 40 m, and it also plays the role of buffer greens to the peripheral area of the industrial estate.

iv) Besides, the waste water treatment plant can be used as greens depending on the method of layout, out of the facilities provided in the industrial area. Furthermore, facilities arrangement providing the function similar to that of a belt will be considered at the area near the entrance/exit of the access road.

v) To plant trees all along the roads in the estate.

• Commercial facilities

6-33 To provide a shopping center in the housing area, and rather auxiliary shops will be provided in the main center as well as in the sub centers.

3) Road composition

6-34 Roads in the estate will be composed as follows.

i) The access road will be the extension of the primary road runs through the central part of the estate in north to south direction, with the broad area road network taken into account, and it will be directly linked with R-35. Its width will be 40 m.

ii) The primary road in the industrial estate will be as stated above, and its structure will be same as that of the access road.

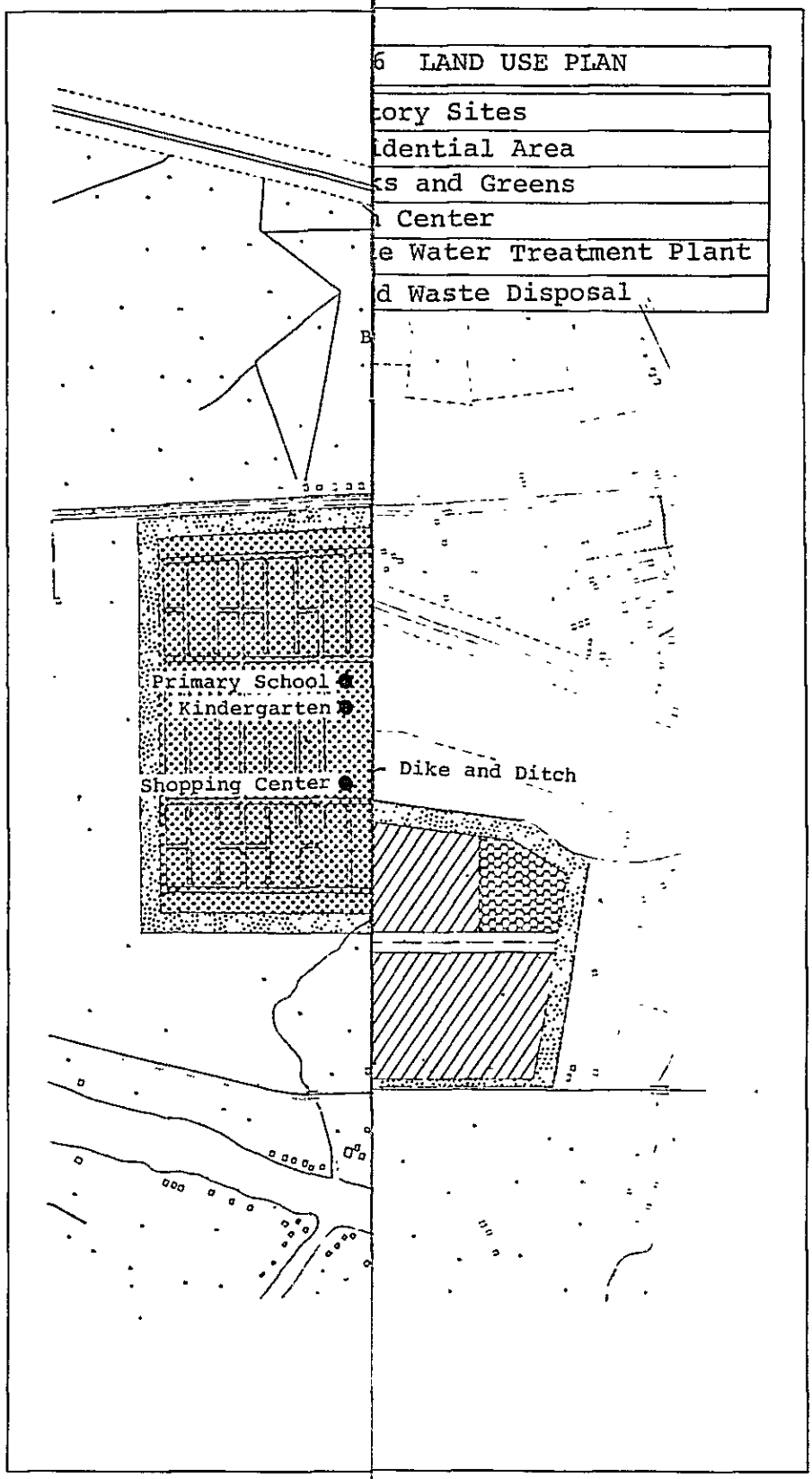
iii) A secondary road is provided in parallel with the railway with 250 m apart from open ditch, to become the axis of the industrial estate in east to west direction. Furthermore, another secondary road running in east to west direction will be provided on the side toward R-3242 and the third one is on the west side running in vertical direction from north to south along the buffer greens will be provided. The width of the secondary roads will be 40 m. The secondary road on the west side running in vertical direction will be linked with R-3242 and will be used as the sub entrance to the industrial estate. But it will be usually closed, and will be used only at an emergency.

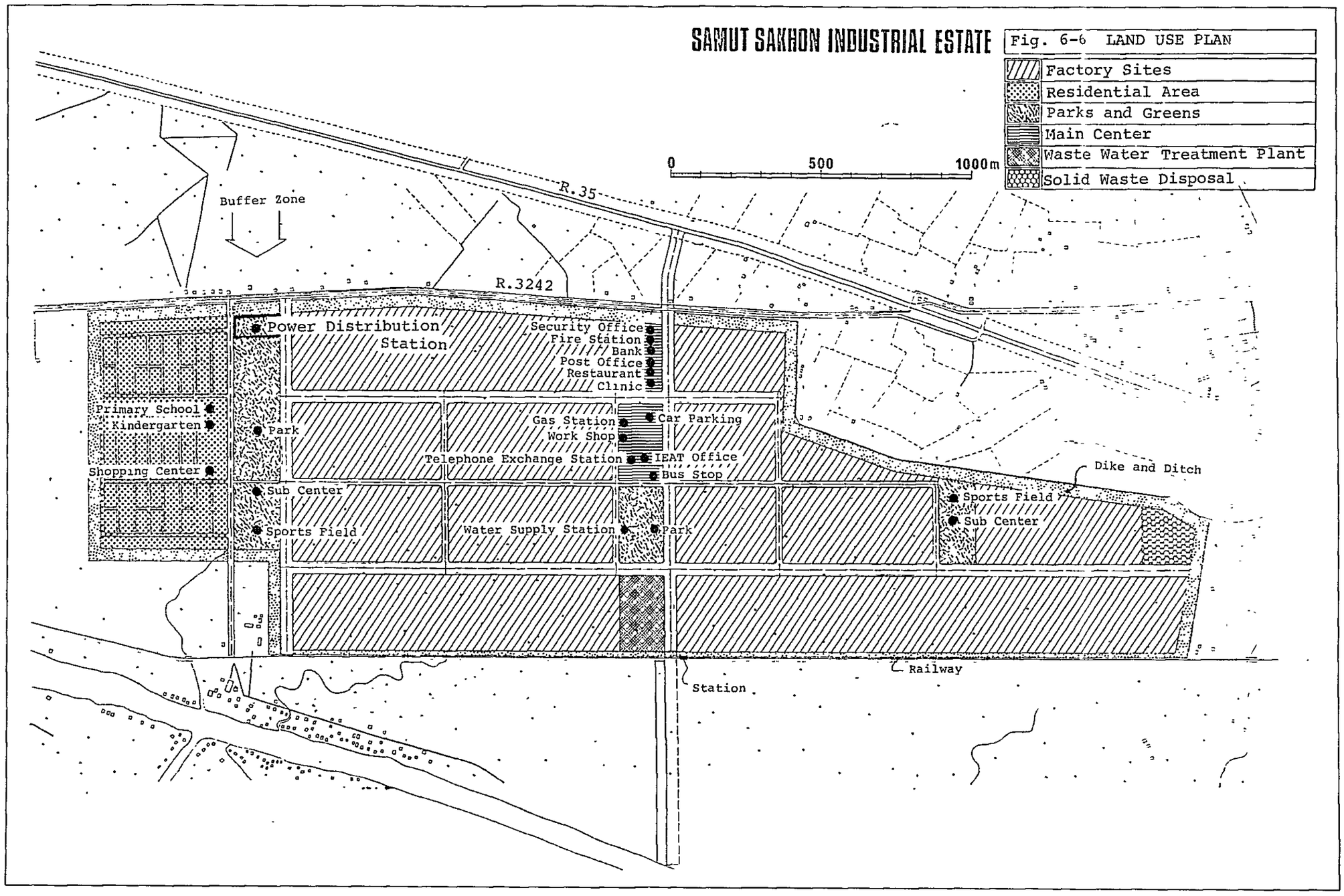
iv) Tertiary roads are connected to primary and secondary roads as service roads for the businesses (factories of medium and small scales) located at the central part of the estate. One road will be provided in east to west direction, and four roads will be provided in north to south direction. The width of the tertiary roads will be 20 m.

v) Service roads will have the function for providing convenience to factories of small scales and to standard factories, and they will be provided depending on the scales of business making entry to the industrial estate (width 10 m).

vi) Secondary roads and tertiary roads will be provided with sidewalks for safety of pedestrians.

vii) The access road to the residential area from R-3242 will be constructed by expanding the width of the existing road (width 20 m). Main road of 10 m width and service road of 6 m width will be provided within the residential area (see Chapter VII, Section B-2, for the road composition.)


6 LAND USE PLAN
tory Sites
idential Area
ks and Greens
n Center
e Water Treatment Plant
d Waste Disposal
Primary School
Kindergarten
Shopping Center
Dike and Ditch


SAMUT SAKHON INDUSTRIAL ESTATE
Fig. 6-6 LAND USE PLAN
Factory Sites
Residential Area
Parks and Greens
Main Center
Waste Water Treatment Plant
Solid Waste Disposal
0
500
1000m
R.35
R.3242
Buffer Zone
Power Distribution Station
Security Office
Fire Station
Bank
Post Office
Restaurant
Clinic
Primary School
Kindergarten
Park
Gas Station
Work Shop
Car Parking
Telephone Exchange Station
IEAT Office
Bus Stop
Shopping Center
Sub Center
Sports Field
Water Supply Station
Park
Dike and Ditch
Sports Field
Sub Center
Railway
Station