educational facilities. Satellite station is situated in the east of the Route 3.

2.2.2 Natural Condition

1) Topography

The Study Area is characterized by undulating hilly topography. The proposed port area is facing the Gulf of Thailand and the most of the area lies below El. 4 m. The area of the industrial estate is located adjacent to the proposed port area in the west of Route 3 as shown in Fig. 2.2.7. Its latitude ranges between El. 2 m and El. 30 m. The elevation of the urban development area proposed to be located at the opposite side of the industrial estate varies from El. 10 m to El. 55 m.

2) Climate

The climate over the Study Area is tropical and monsoonal. There are two distinct seasons in a year. Dry season with the northeast monsoon lasts from November to April, while season with the southwest monsoon extends from May to October.

Air temperature is 27.9°C on the average. Mean relative humidity ranges from 66% in December to 80% in September. Diurnal variation of relative humidity is 30-35% for the dry season and 25-31% for the wet season. The average annual rainfall is about 1,300 mm, of which more than 80% occurs during the wet season. The amount of evaporation is slightly less than annual rainfall, being 1,100 mm per year. The climatological features of the Study Area are summarized in Table 2.2.4.

3) Geology

Geological map covering the whole area planned for the Laem Chabang Complex was prepared by Land Development Department (LDD) as presented in Fig. 2.2.8 with the corresponding soil characteristics presented in Table 2.2.5. As a whole, geological characteristics of the area is considered to be good for foundation. Most of the area is characterized by loamy sand texture except the area along the boundary between the industrial

estate and port area of which soil is clayey. For this area, detailed geological survey will be required at the implementation stage of the Project.

4) Vegetation

Cassava field covers most of the Study Area with cluster of coconut and mango trees scattered over the area. Paddy is being grown only in the western half of the planned industrial estate area.

Fig. 2.2.9 shows the suitability of soil for agriculture. Most of the land in the area is suited only for coconut, pasture and nonflooded annual crops.

Table 2.2.1 POPULATION AND NUMBER OF HOUSEHOLD

Item	Population			No. of Household		
	1978	1981	Growth Rate (%/Y)	1978	1981	Growth Rate (%/Y)
Thailand	46,113,756	47,875,002	1.3	7,209,899	7,939,155 /2	3.3
Chon Buri	712,426	738,221	1.2	101,469	111,139	3.1
Amphoe Siracha	99,726	108,871	3.0	16,073	15,739	Δ 0.7
Tambon						
1. Siracha	19,518	22,315	4.6	2,685	2,797	1.4
2. Surasak	15,065	16,635	3,4	2,021	2,200	2.9
3. Tung Sukhla	13,019	13,827	2.0	1.701	2,150	8.1
4. Bung	16,270	16,839	1.2	2,200	2,399	9.0
5. Nong Kham	11,371	11,875	1.5	2,414	1,712	Δ 10.8
6. Khao Kan Song	7,061	7,363	1.4	1,271	1,265	Δ 0.2
7. Bang Phra	17,422	18,129	1.3	3,781	3,797	0.1
8. Bo Win	N.A.	N.A.	-	N.A.	N.A.	-
Amphoe Bang Lamung	72,573	81,279	3.8	10,741	16,597 /2	11.5
Tambon						
1. Na Guo	16,967	1,211	Δ 58.5 /3	2,752	1,775	Δ 13.6
2. Bang Lamung	7,602	7,921	1.4	1,039	978	2.0
3. Nong Prue	17,857	5,265	Δ 33.4 /3	2,292	870	Δ 27.6 /3
4. Nong Pla Lai	4,917	4,708	Δ 1.4	763	785	1.0
5. Pong	4,705	4,740	0.2	566	640	4.2
6. Khao Mai Kaew	2,550	2,474	Δ 1.1	420	421	0
7. Huai Yai	13,677	13,300	Δ 0.1	2,501	4,373	20.5
8. Ta Kien Teiy	4,298	4,232	Δ 0.5	408	814	25.9
9. Pattaya /1	N.A.	36,567	-	N.A.	7,430	-

/1 : Pattaya City /2 : Figure of 1982 /3 : Reason for rapid decrease is not clear.

Table 2.2.2 GDP AND GPP

Description	Y E A R					Average Annual Growth Rate (%/Yr)
	1978	1979	1980	1981	1982	
GDP/1						
Amount (฿ 10^6)/2						
Agriculture	72,513	71,408	72,784	77,701	77,784	1.8
Manufacturing	52,521	57,841	60,597	64,490	68,224	6.8
Others	136,063	147,658	159,472	169,080	178,282	7.0
Total	261,097	276,907	292,853	311,271	324,290	5.6
Per Capita GDP/1	5,873	6,092	6,304	6,554	6,688	3.3
Share (%)						
Agriculture	27.8	25.8	24.9	25.0	24.0	-
Manufacturing	20.1	20.9	20.7	20.7	21.0	-
Others	52.1	53.3	54.4	54.3	55.0	-
Total	100.0	100.0	100.0	100.0	100.0	-
GPP/3 OF CHONBURI PROVINCE						
Amount (฿ 10^6)/2						
Agriculture	2,380	1,683	2,043	1,952	2,078	43.3
Manufacturing	2,614	2,836	3,226	3,575	3,641	8.6
Others	3,844	4,303	4,514	4,993	5,273	8.2
Total	8,838	8,822	9,783	10,500	10,992	5.6
Per Capita GPP/4	13,003	12,528	13,438	13,920	14,122	2.1
Share (%)						
Agriculture	26.9	19.1	20.9	18.6	18.9	-
Manufacture	29.6	32.1	33.0	34.0	33.1	-
Others	43.5	48.8	46.1	47.4	48.0	-
Total	100.0	100.0	100.0	100.0	1-0.0	-

/1 : Gross domestic products
/2 : In 1972 constant price
/3 : Gross provincial products
/4 : in baht

Table 2.2.3 ECONOMICALLY ACTIVE POPULATION IN CHONBURI PROVINCE

Description	1970	1980	Growth Rate (%/yr)
Number			
1. Agriculture	149,947	172,035	1.4
2. Manufacturing	18,650	31,177	5.3
3. Others	82,278	131,749	4.8
4. Total	250,875	334,961	2.9
Share (%)			
1. Agriculture	59.8	51.4	-
2. Manufacturing	7.4	9.3	-
3. Others	32.8	39.3	-
4. Total	100.0	100.0	-

Table 2.2.4 SUMMARY OF CLIMATE

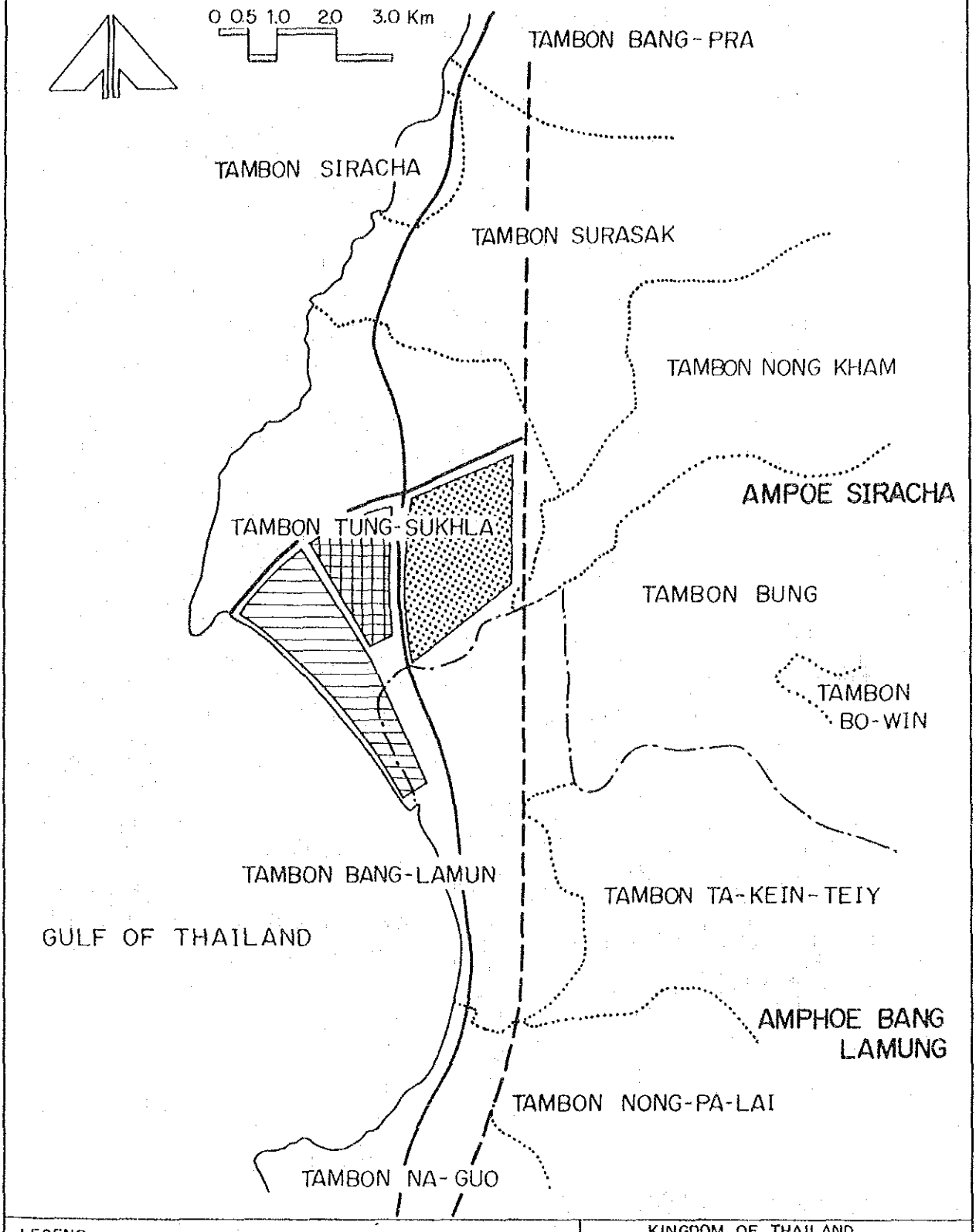
(Recorded at Chon Buri Observatory, except evaporation and rainfall)

Climatological Features	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual	Data Source
Air Temperature (°c)														(1)
Mean	25.9	27.4	28.8	29.6	29.3	28.9	28.6	28.3	27.9	27.3	26.7	25.8	27.9	
Mean Ma.	31.3	32.1	33.2	34.1	33.3	32.5	31.9	31.6	31.2	31.3	31.1	31.0	32.0	
Mean Min.	20.1	22.4	24.2	25.4	25.4	25.5	25.0	24.9	24.4	23.8	22.1	20.3	23.6	
Extreme Max.	36.2	36.6	37.0	38.0	37.8	37.1	35.5	34.7	34.4	34.8	35.2	36.1	38.0	
Extreme Min.	9.9	16.5	17.5	20.4	21.2	21.0	20.5	20.9	20.6	18.2	14.2	12.0	9.9	
Relative Humidity (%)														(1)
Mean	67.0	71.0	71.0	71.0	75.0	75.0	75.0	76.0	80.0	80.0	73.0	66.0	73.0	
Mean Max.	85.0	88.2	87.8	87.6	88.8	87.6	88.5	90.0	92.3	93.0	89.5	85.1	88.6	
Mean Min.	52.0	56.2	56.6	56.7	60.8	61.8	62.9	64.0	67.1	66.7	57.2	50.1	59.3	
Extreme Min.	20.0	25.0	23.0	29.0	32.0	42.0	43.0	45.0	46.0	42.0	29.0	22.0	20.0	
Wind Velocity (km/hr)	11.9	13.0	13.2	11.9	10.9	13.2	12.2	12.0	9.8	9.3	11.5	12.2	11.7	(1)
Cloud Cover (Oktas)	3.9	3.8	4.0	4.7	6.1	6.5	6.7	6.9	6.7	5.8	4.5	3.6	5.2	(1)
Evaporation (mm) (Bang Phra)	72.8	75.0	100.0	110.4	110.6	100.7	99.7	93.9	80.9	89.8	82.6	80.7	1,097	(2)
Rainfall (mm)														(2)
Chon Buri	13.9	23.3	34.1	77.6	158.8	119.4	152.2	162.4	295.2	210.9	53.9	6.0	1,310	
Bang Phra	15.9	38.7	53.1	125.1	149.9	122.6	117.8	137.9	269.2	202.5	51.5	14.3	1,299	
Si Racha	11.1	31.4	38.7	88.3	150.6	110.8	113.6	131.7	257.7	218.1	51.3	13.7	1,217	
Bang Lamung	10.4	36.9	48.7	102.6	158.6	89.6	94.5	113.6	220.1	252.7	61.5	9.3	1,198	

Data Source : (1) Climatological Data of Thailand, 25-Year Period (1951 - 1975), MD
(2) RID

Table 2.2.5 SOIL CHARACTERISTICS (Refer to fig. 2.2.8)

Soil Name	Texture	Color	Parent Materials
Ban Bung series (Bdg)	loamy sand or sand throughout	brown to dark brown over light gray with brownish color mottles	alluvium or low terrace
Bacho series (Bc)	loamy sand or sand throughout	brown to dark brown over yellowish brown or strong brown	beach
Bacho brown (Bc-br.)	loamy sand or sand throughout	brown to dark brown over brown throughout	beach
Bacho mottled (Bc-m)	loamy sand or sand throughout	brown to dark brown over brown with mottles of yellowish brown	beach
Ban Suan series (Bs)	loamy sand or sand more than 100 cm over sandy loam or sandy clay loam	grayish brown to brown over pinkish gray or pink or light reddish brown	granite, quartzite
Chaing Rai series (Cr)	silty clay loam or clay loam over clay with plinthite 5-50%	dark gray, gray to grayish brown with brownish or yellowish color mottles over gray to light gray, with red and strong brown mottles	alluvium
Hua Hin series (Hh)	loamy sand or sand throughout and meet shells in subsoil	brown to dark brown over yellowish brown or strong brown	beach
Khok Khian series (Ko)	sandy loamy of sandy clay loam over sandy clay loam	gray to light brownish gray over light gray with brownish or yellowish color	alluvium
Khok Khian fine clayey variant (Ko-f.c)	sand loam or sandy clay loam over sandy clay	gray to light brownish gray over light gray with brownish or yellowish color mottles	alluvium
Lat Ya series (Ly)	sandy loam or loam over slightly gravelly clay	very dark grayish brown to grayish brown or brown over strong brown to yellowish red	sandstone, quartzite and shale
Map Bon, coarse-variant (Mb-co.l)	sandy loam over coarse sandy loam	dark grayish brown to brown over strong brown to yellowish red	granite and quartzite
Map Bon, strong brown variant (Mb-st.br)	sandy loam over sandy clay loam or gravelly sandy clay loam or gravelly clay loam	dark grayish brown to brown over strong brown	granite and quartzite
Phatthaya series (Py)	loamy sand or sand throughout	dark grayish brown to brown over brown to reddish yellow	quartizite and granite
Rangae series (Ra)	silty clay loam or silty clay or clay over silty clay or clay with brownish or yellowish color mottles	black to dark brown over gray to light gray and meet the buried A with black or brown color with in 7 m. depth	brackish water deposits
Sattahip series (Sh)	loamy sand or sand throughout	grayish brown or brown or light brown over pinkish gray or pink or light reddish brown	granite and quartzite on marine terrace or coalescing fan
Sattahip, mottled variant (Sh-m)	loamy sand or sand throughout	grayish brown or brown or light brown over pinkish gray or pink or light reddish brown with brownish or yellowish color mottles	granite and quartzite on marine terrace or coalescing fan
Songkhla series (Sng)	sandy loam over sandy clay loam	black to dark grayish brown over gray to light gray and meet brown color within 75 cm.	transported material from granitic rock
Thanyaburi series (Tan)	clay loam to clay over clay	black to very dark gray over dark gray to gray or brown with brownish yellow or strong brown mottles and meet jarosite mottles between 50-100 cm.	brackish water deposits
Tha Chin series (Tc)	clay throughout	black to dark gray over greenish gray or olive or grayish green	marine deposits
Tha Sala series (Tsl)	clay loam or clay over clay over sandy clay loam or sandy loam	dark gray to light brownish gray over gray or light gray with brownish or yellow color-mottles	alluvium
Tha Yang series (Ty)	slightly gravelly sandy loam or loam over gravelly to very gravelly clay loam or clay but gravelly increase with depth	very dark grayish brown to grayish brown or brown over strong brown to yellowish red	residuum and local alluvium sandstone, quartzite, phyllite and shale
Warin series (Wn)	loamy sand to sandy loam over sandy clay loam	dark grayish brown to dark brown over yellowish red or reddish yellow	old alluvium
Alluvial Complex of Poorly drainaged Soil	sandy loam or sandy clay	black to dark grayish brown	alluvium



LEGEND

- Amphoe (District) Boundary
- Tambon (Subdistrict) Boundary
- Railway
- Port Development Area
- Industrial Estate
- Urban Development Area

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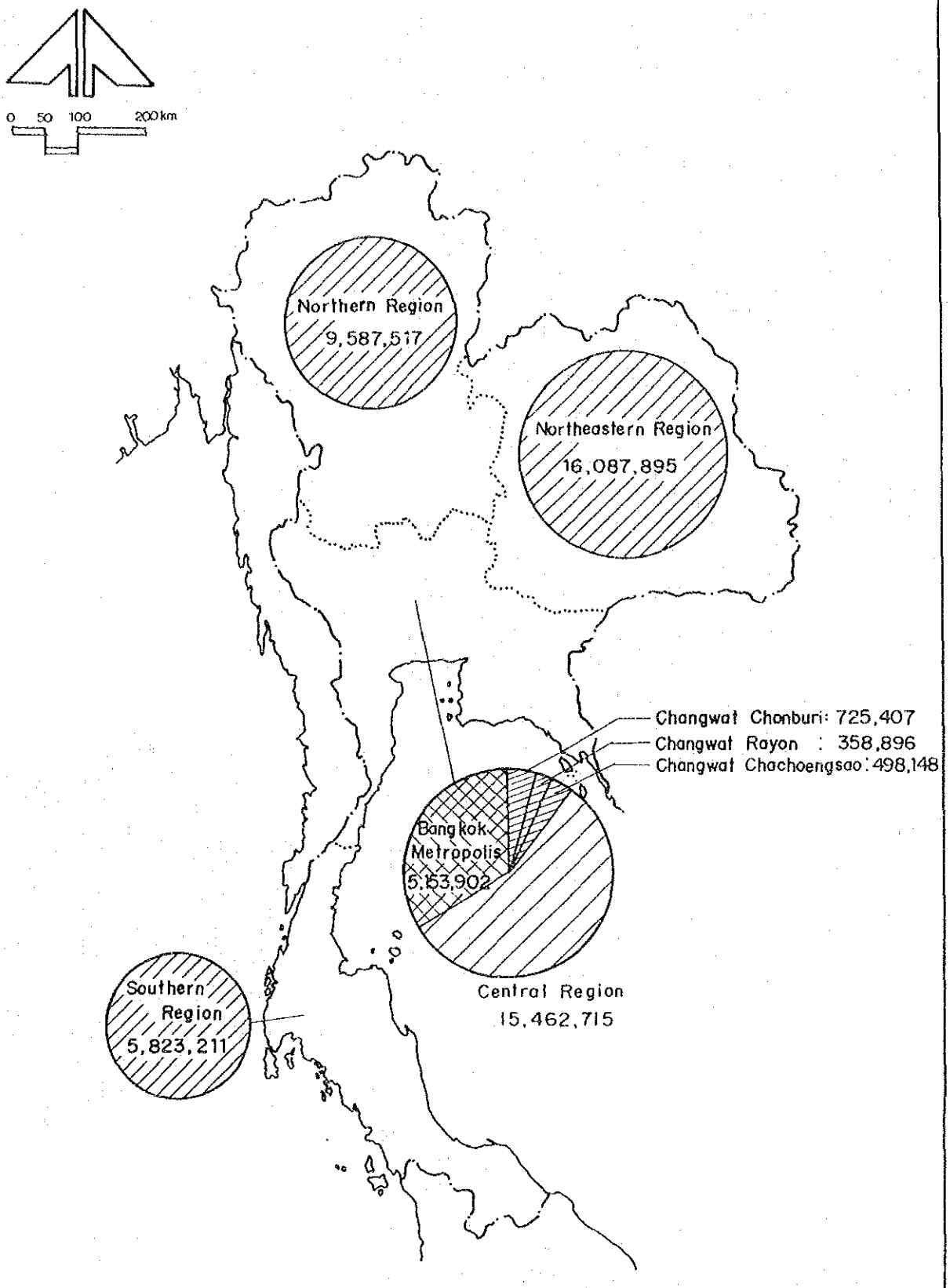
Fig. 2.2.1
Administrative Boundary and Study Area



LEGEND

Whole Kingdom : 46, 961, 338 Persons

SOURCE : Statistical Summary of Thailand, 1981. NSO

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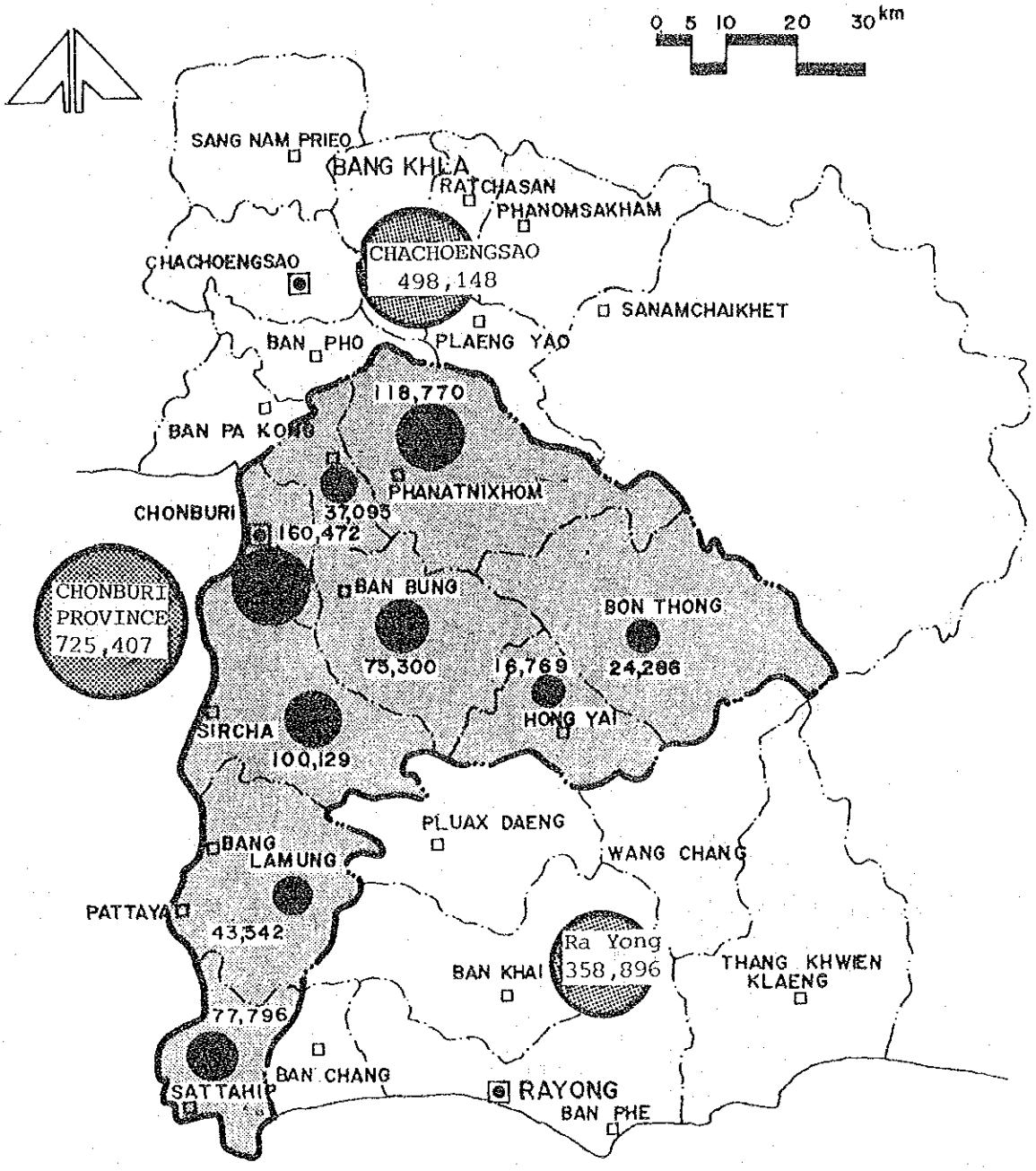
Fig. 2.2.2
Population of Thailand by Region in 1980



LEGEND

500,000 persons
300,000
100,000
500,000

Provincial Boundary (Changwat)
District Boundary

Source ; Statistical Summary of Thailand 1981, NSO

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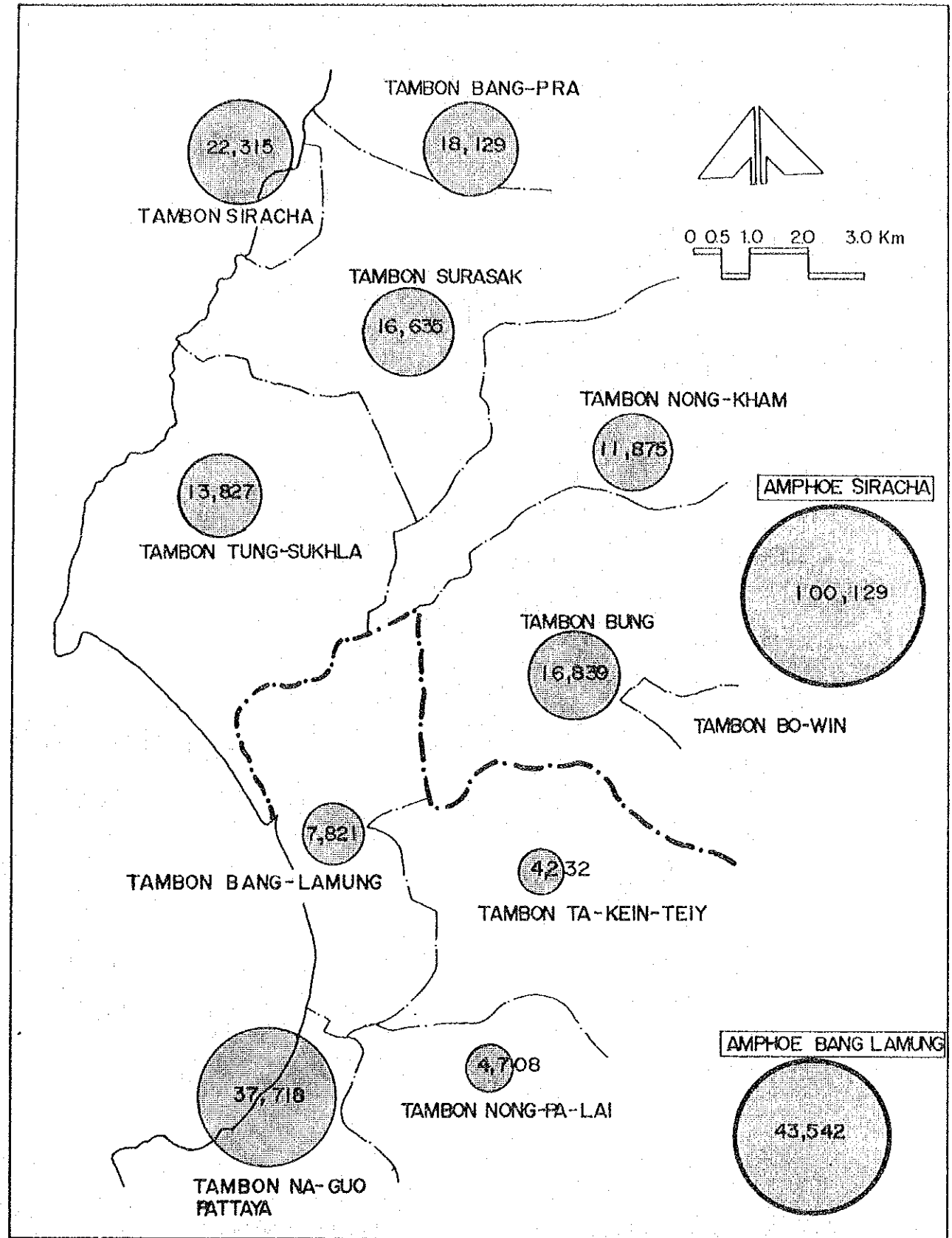
Fig. 2.2.3
Population Distribution in Changwat Chonburi in 1980



LEGEND
Amphoe (District) Boundary
Tambon (Subdistrict) Boundary
30,000 persons
20,000
10,000
5,000

Source: Headoffice of Changwat Chonburi

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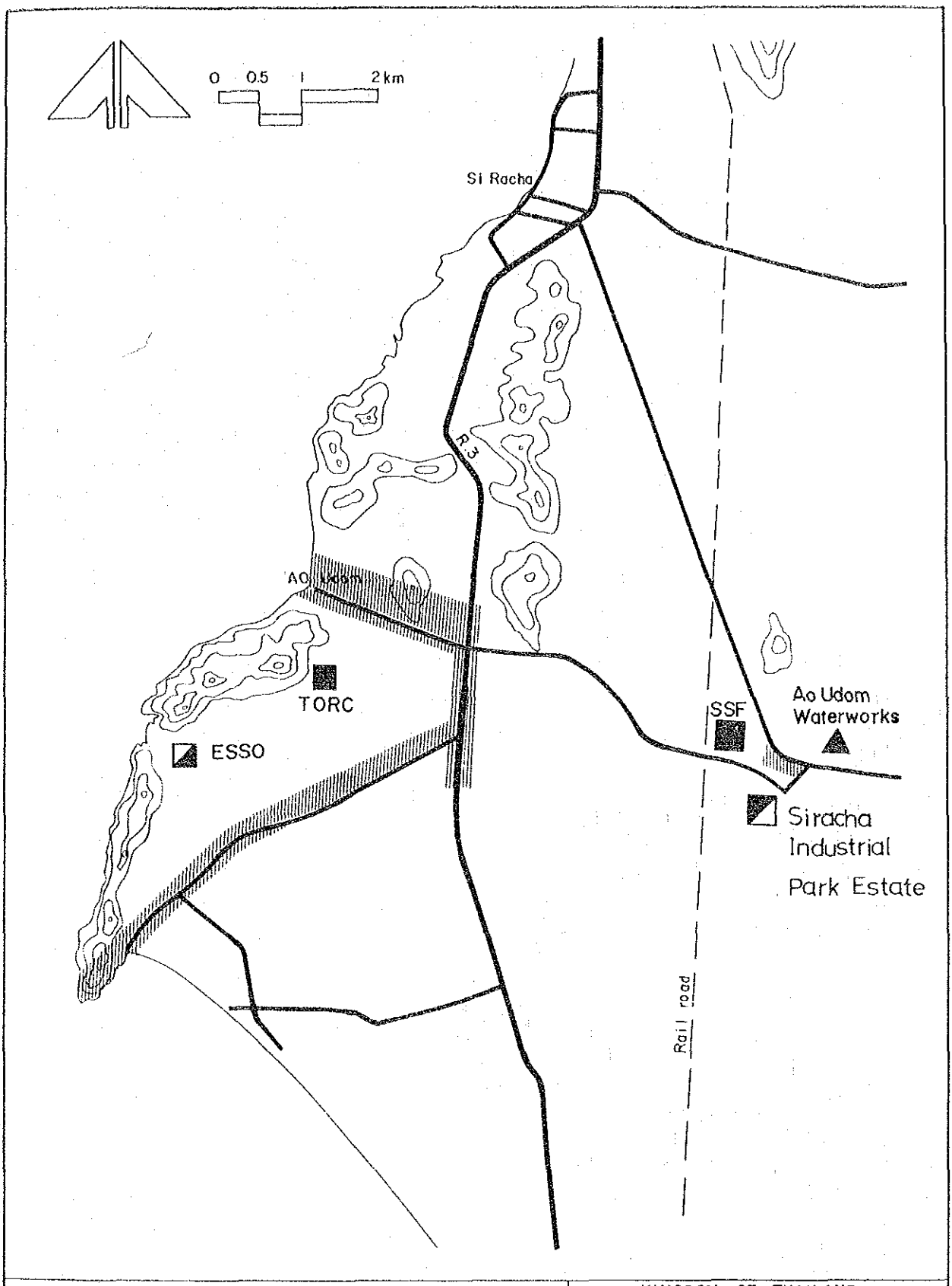
Fig. 2.2.4
Population by Tambon in 1981



LEGEND

- Surface water use
- Ground water use
- Sea water use
- Service Area of Ao Udom Waterworks

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Fig. 2.2.5
Existing Industries in Siracha Laem Chabang Area

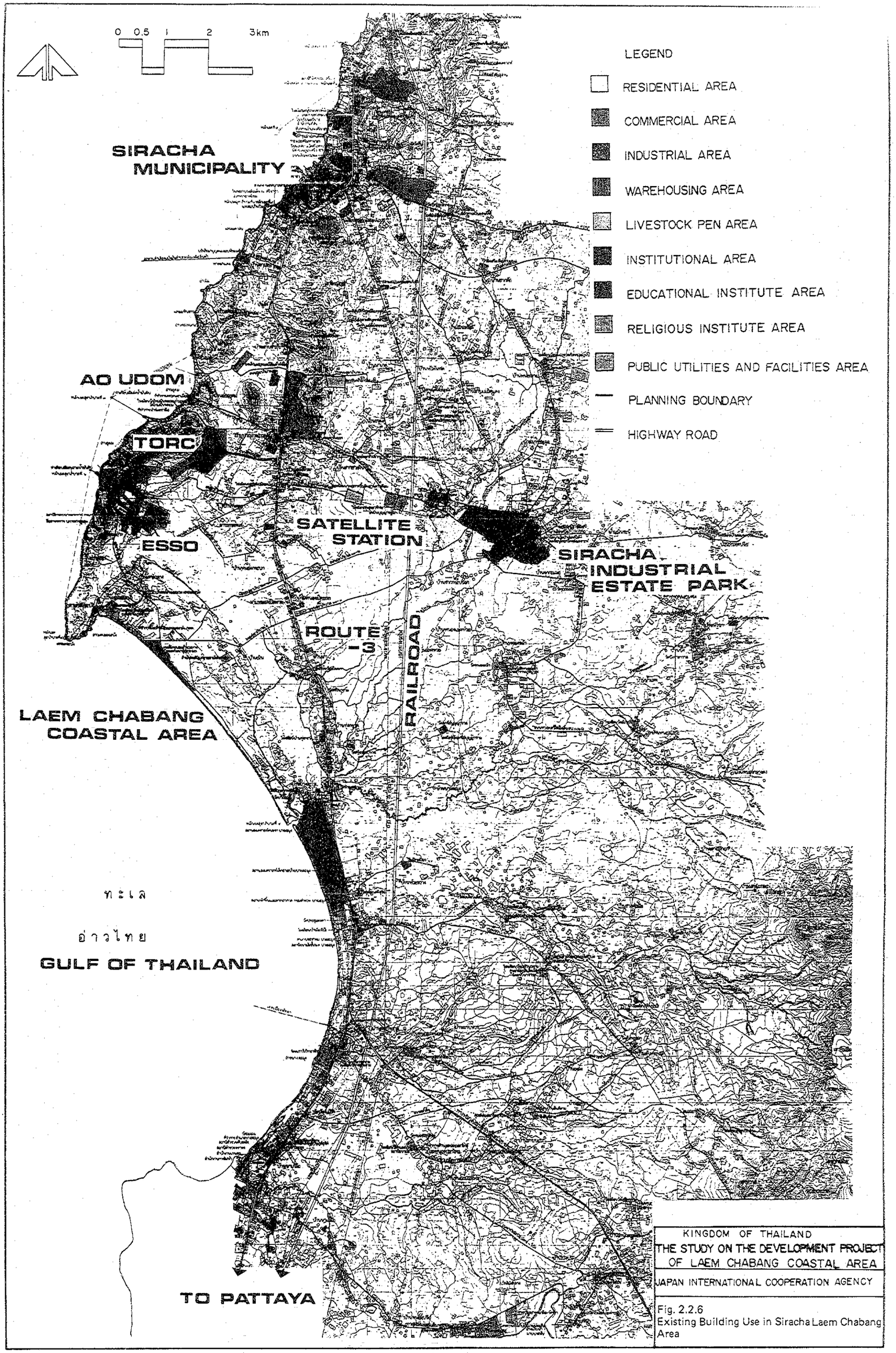

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Fig. 2.2.6
Existing Building Use in Siracha Laem Chabang Area

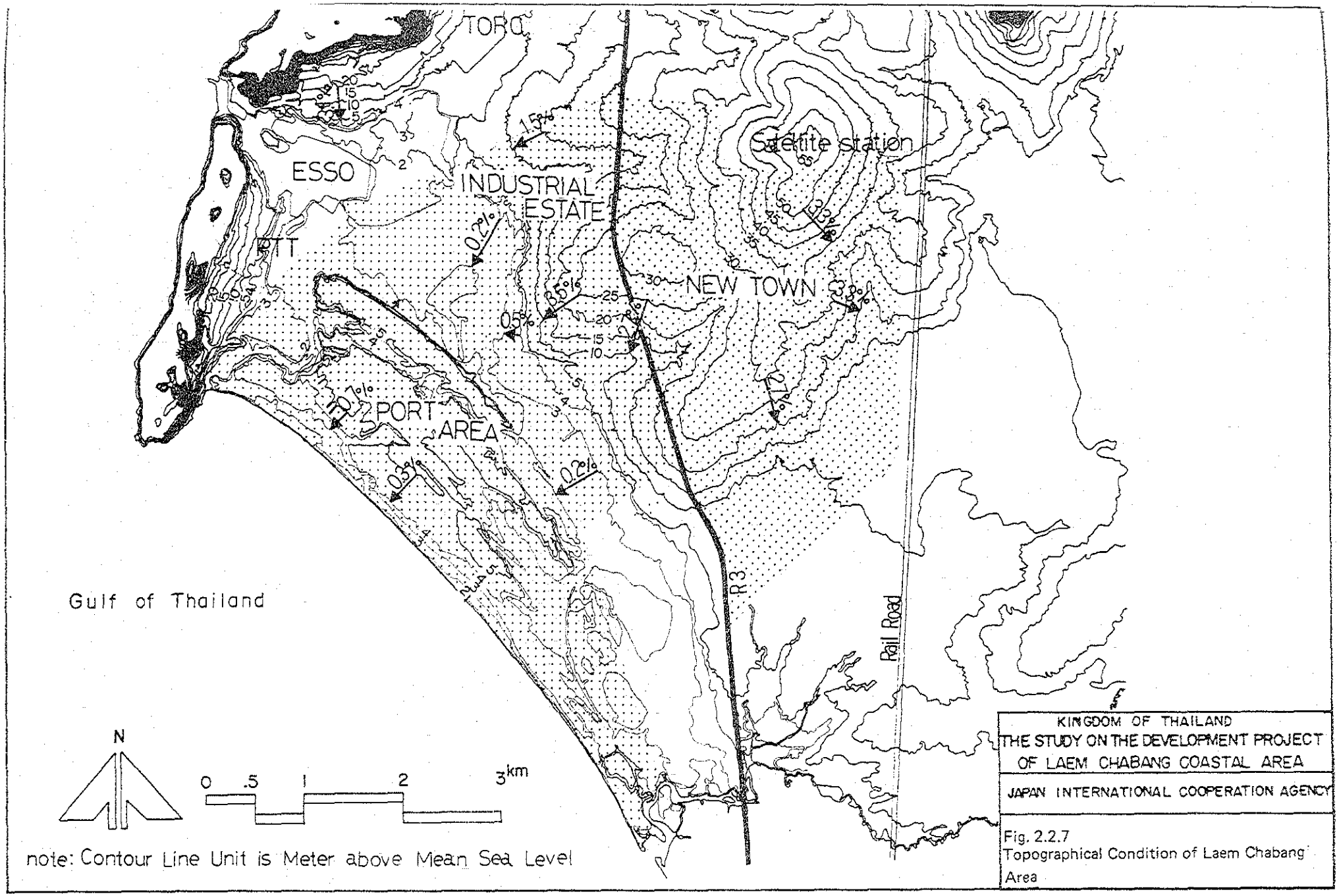
TORC
ESSO
PTT
INDUSTRIAL ESTATE
Satelite station
NEW TOWN
PORT AREA
R3
Rail Road
Gulf of Thailand
N
0 .5 1 2 3km
note: Contour Line Unit is Meter above Mean Sea Level
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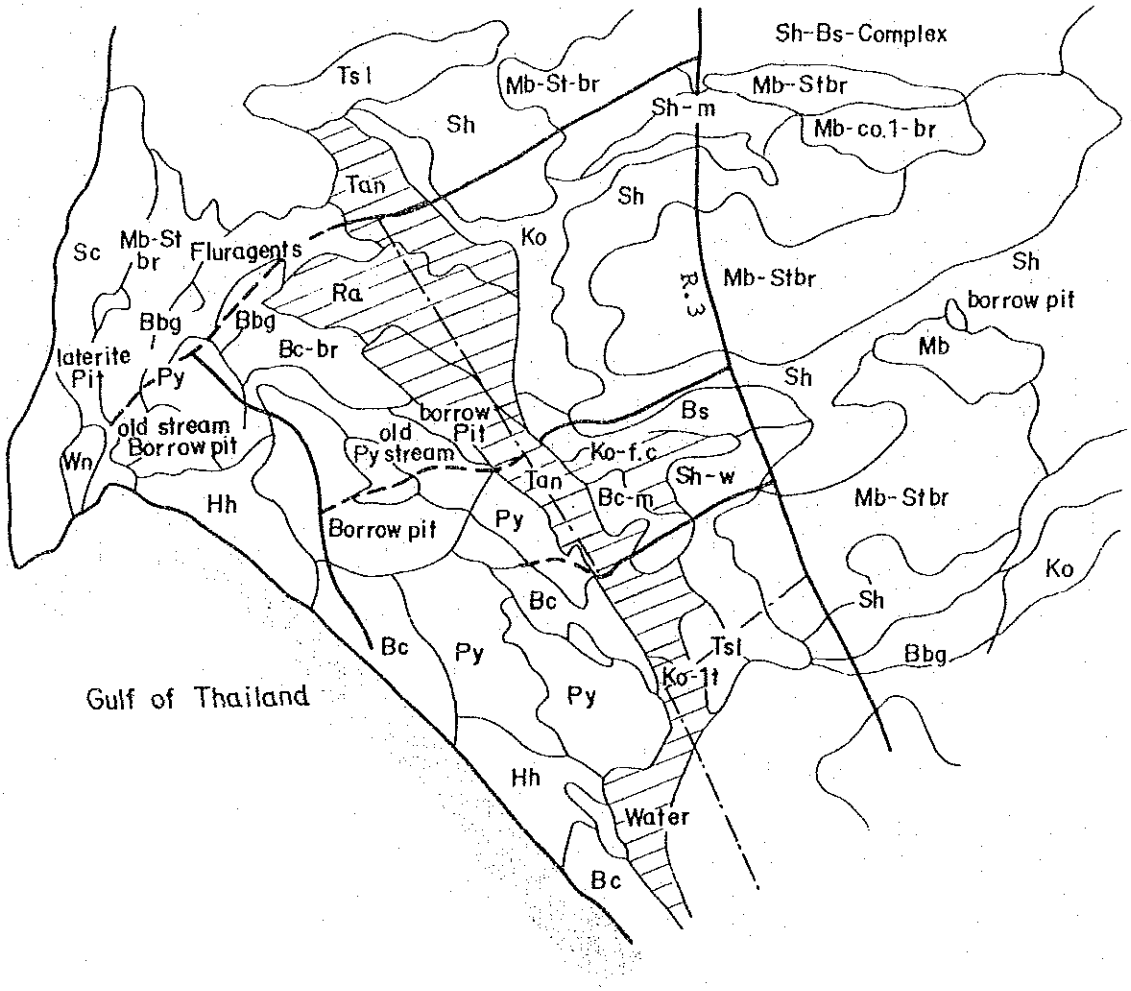
Fig. 2.2.7
Topographical Condition of Laem Chabang Area



LEGEND

SOURCE: Ministry of Agriculture and Cooperatives, Land Development Department.

For soil characteristics, Table 2.2.5 can be refered.

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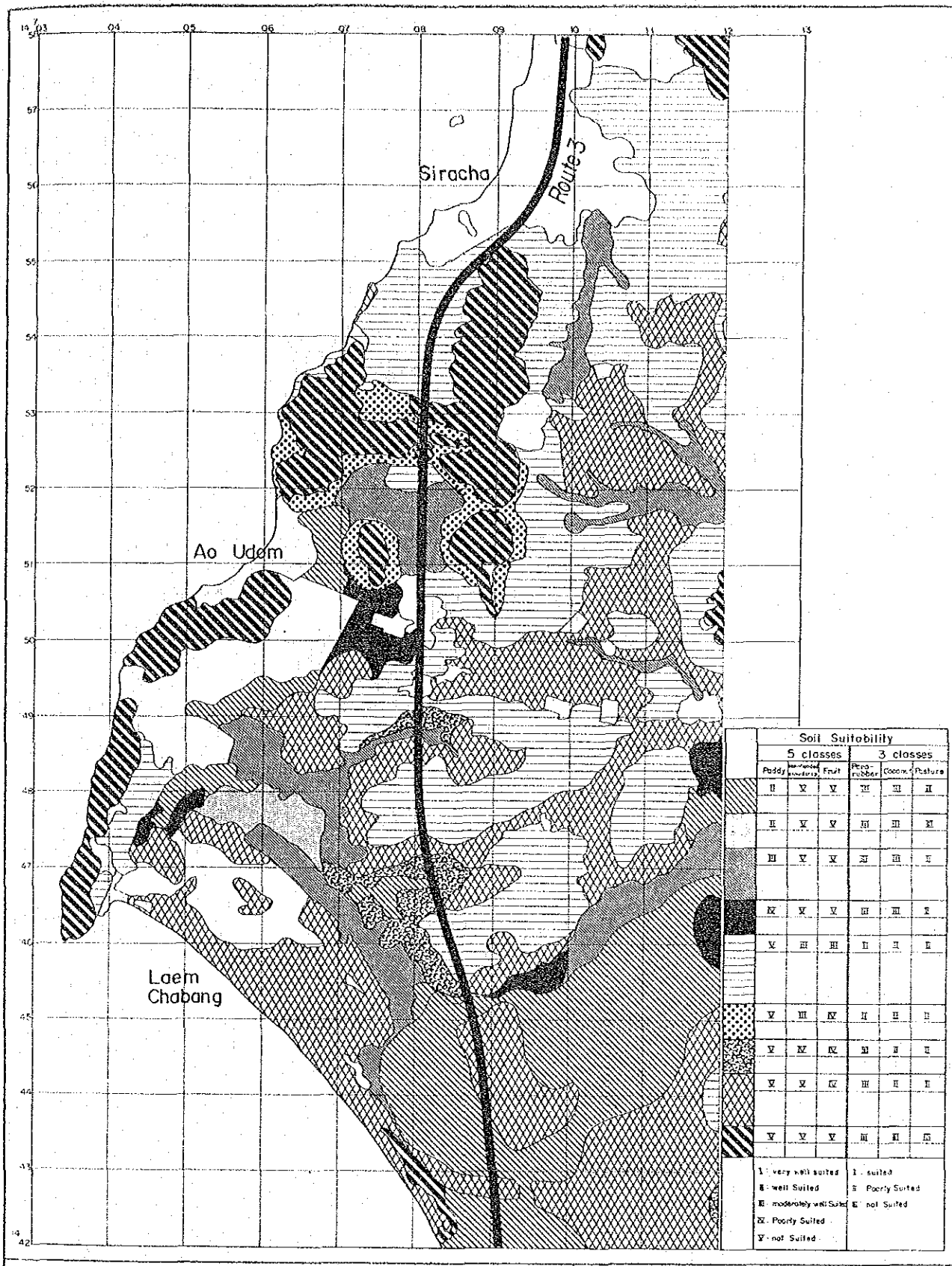
Fig. 2.2.8
Geological Map of Laem Chabang Area



LEGEND

SOURCE : Ministry of Agriculture and Cooperatives,
Land Development Department

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Fig. 2.2.9
Soil Suitability for Agliculture of
Laem Chabang Area

3. MASTER PLAN

3.1 Basic Development Policy and Land Use Plan

3.1.1 Basic Development Policy

Development plan for the Laem Chabang Complex was formulated in accordance with three basic development policies: 1) to create a new growth center of the Eastern Seaboard, 2) to promote an integrated development, and 3) to provide an environment with amenity. Brief explanations for these are given below.

1) New Growth Center

In line with the government policy to redistribute the migration into the Bangkok Metropolitan area, the Eastern Seaboard development is designed to attract a considerable amount of population from the metropolitan area and the rest of the country. Laem Chabang, as well as Map Ta Phut, is planned to be a growth core which will absorb major portion of migrants. Population of the Laem Chabang - Si Racha area is projected to reach around 260,000 in 2001 based on this development plan compared to the capital city of Changwat Chonburi with 210,000 according to ESS as shown in Table 3.1.1. To realize the expected functions of the new growth center, it is required to provide it with sufficient urban facilities such as a business and commercial area for economic activities. Present and future distribution of urban areas are illustrated in Fig. 3.1.1.

Laem Chabang Complex has a possibility to become a subcapital adjacent to Bangkok such as the city of Yokohama located next to Tokyo in Japan that showed rapid growth in the past. (Fig. 3.1.2)

2) New Port City with Integrated Development

Laem Chabang Complex is composed of three components of an industrial estate, a port and a new town. Development plan of the complex must seek a balanced and integrated development of these different functions.

On the other hand, Laem Chabang must be the international entrance that is able to propsper with supreme culture and economy based on the international activity. Namely, Laem Chabang Complex is to be constructed as a new port city including not only port related facilities but business and commercial facilities that international business activities and cultural function can be held in the area.

3) Environment with Amenity

Development of Laem Chabang Complex is to be proceeded also with the view point of creating a living environment with amenity. Attention should be paid specifically to (1) creation of a clean environment making utmost use of the existing water basin and stream and vegetation, (2) creation of an international atomosphere with an international deep sea commercial port, and (3) separation of different functions of manufacturing, business and commerce and residence to avoid congestion and conflict ensuring an effective operation of each activity.

3.1.2 Land Use Plan

1) Siracha-Laem Chabang Land Use Pattern

An integrated land use plan has to be formulated that would allow the absorption of the impact of the large scale development on the existing Siracha - Laem Chabang community, which currently comprises mainly Siracha municipality and surrounding scattered industrial facilities and villages. A proposed basic land use pattern is illustrated in Fig. 3.1.3, integrating the following major functions.

- Residential function
- Commercial, business, institutional and cultural function
- Industrial function
- Transportation function
- Recreational function
- Reservation

(1) Residential Function

Main residential zone will extend from the east side of the existing Siracha city to the north down to the Huai Yai river to the south, occupying the area between Rt. 3 and the railway. The area of residential zone will be about 3,700 ha and population density is estimated at 70 persons per ha with the total population of 262,000 in the year 2001.

Within the residential zone, two major clusters of new residential development is planned. One is a new town located next to the proposed industrial estate site and is to be developed probably by NHA and partially by private sector. The other is a area mainly for private residential development located near the existing Siracha urban area.

The reasons for allocating the residential development areas in these two areas are as follows:

- The planned population growth in Siracha - Laem Chabang development planning area would require large scale housing development.

- The existing public and commercial functions in Siracha urban area can be activated and utilized by the population residing nearby.

- Both migrants and non-migrants are free to select either of the two new residential areas.

(2) Commercial and Business Function

A new commercial zone is planned in the neighborhood of the new town, the industrial estate and the port. The existing commercial facilities in the Siracha urban area are to be utilized as well.

(3) Industrial Function

The area extending between the shore and Rt. 3 provides a zone large enough for an industrial estate of 450 ha and some existing industries of TORC, ESSO, PTT and future expansion of industries.

(4) Transportation Function

Laem Chabang coastal area is planned to provide a considerable area for transportation functions including a public port, railway and highway network. Bypass of Rt. 3 will be required in order to cope with traffic in and around the Laem Chabang Complex.

(5) Recreational Function

Large Scale recreational facilities are inappropriate to be included in the plan in view of the relatively poor existing recreational resources in Siracha - Laem Chabang area. For the weekend type recreation, the river mouth and some part of upper stream of the Huai Yai can be used as marina, yacht harbor and fishing spot.

(6) Reservation

Mountain forest could be set aside to preserve wood resources and not to jeopardize natural environment. The area that extends over the railway to the east must be utilized for agricultural field only and be restrictive against the urban development.

2) Land Use Plan of Laem Chabang Complex

(1) Framework of Development

Basic framework of development for each sector is summarized below.

Sector	Item		Short-term Development (1991)	Master Plan (2001)
(1) Industrial Estate	Employees		20,300(9,500)	34,000(31,000)
	Gross Area	(ha)	290	450
		(Rai)	1,800	2,800
(2) Port Area	Employees		11,000	34,000
	Gross Area Wharf	(ha)	116	260
		(Rai)	725	1,600
	Gross Area Hinterland	(ha)	250	500
		(Rai)	1,560	3,100
(3) New Town	Population		24,000	120,000
	Dwelling Units		5,100	26,100
	Gross Area	(ha)	130	930
		(Rai)	820	5,800

Note: Figures in ( ) are number of workers working in factories in operation.

(2) Basic Policy for Land Use Layout

Layout of the industrial estate, the port area and the new town were delineated with the following principles dully considered.

- To minimize mingling of different kinds of functions; manufacturing, commercial, and residential.

- To minimize traffic congestion and ensure efficient traffic flow of cargoes and commuters.

- To utilize the areas already acquired by IEAT (450 ha) and PAT (1,100 ha).

- To accommodate long-term land demand.

(3) Land Use Plan

The basic land use plan for the Master plan has been worked out as shown in Fig. 3.1.4. Area allocation is presented in Table 3.1.2. During the course of the study, two major issues were discussed concerning the land use. One is the location of the new town; first alternative was in the eastern part of R.3, and the second alternagive was on the both sides of R.3 adjacent to industrial estate.

As the final conclusion, First Alternative was preferred from the view point of long term perspective, provided that the necessary measures is promptly taken for land expropriation.

The other issue was whether or not Export Processing Zone (EPZ) must be placed next to the port customs fence. The final decision was that EPZ should be next to the port area. The land use plan in the long-term is prepared in accordance with these two principles.

Table 3.1.1 FUTURE POPULATION IN PRINCIPAL URBAN AREAS

Urban Area	1981	1991	2001
Chonburi DPA /1	(133,800)	(163,100)	(210,800)
Pattaya DPA	(36,500)	(67,900)	(102,950)
Rayong-Map Ta Put DPA	(73,900)	(100,350)	(149,800)
Chachoengsao DPA	(36,000)	(45,950)	(54,500)
Sattahip DPA	(18,800)	(24,400)	(25,800)
Laem Chabang Siracha DPA	(69,000)	*(120,000)	*(262,000)
Existing Urban	(69,000)	(69,000)	(69,000)
Laem Chabang New Town	-	*4,000	*120,000
Other Residential Increase	-	* (27,000)/2	*(73,000)/3

/1 DPA: Development Planning Area by ESS

/2 (1) Natural growth population in area:
9,800 (Employee by ESS, Table III.1.1 of Sectoral Report) x 1.92 = 19,000

(2) Induced population in other area:
8,100 (population in Table 3.4.2)

(3) Total population in other area in 1991:
19,000 + 8,100 = 27,000 (population)

/3 (1) Natural growth population in other area:
15,700 (Employee by ESS, Table III.1.1.1) x 1.92 = 31,000 (population)

(2) Induced population in other area:
38,000 (population in Table 3.4.2)

(3) Natural growth of induced population in other area:
38,000 x 9%** = 4,000 (population)

(4) Total population in other area in 2001:
31,000 + 38,000 + 4,000 = 73,000 (population)

** The rate was assumed to be the same as in the new town population. (See Sectral Report Table III.1.1 and III.1.11.

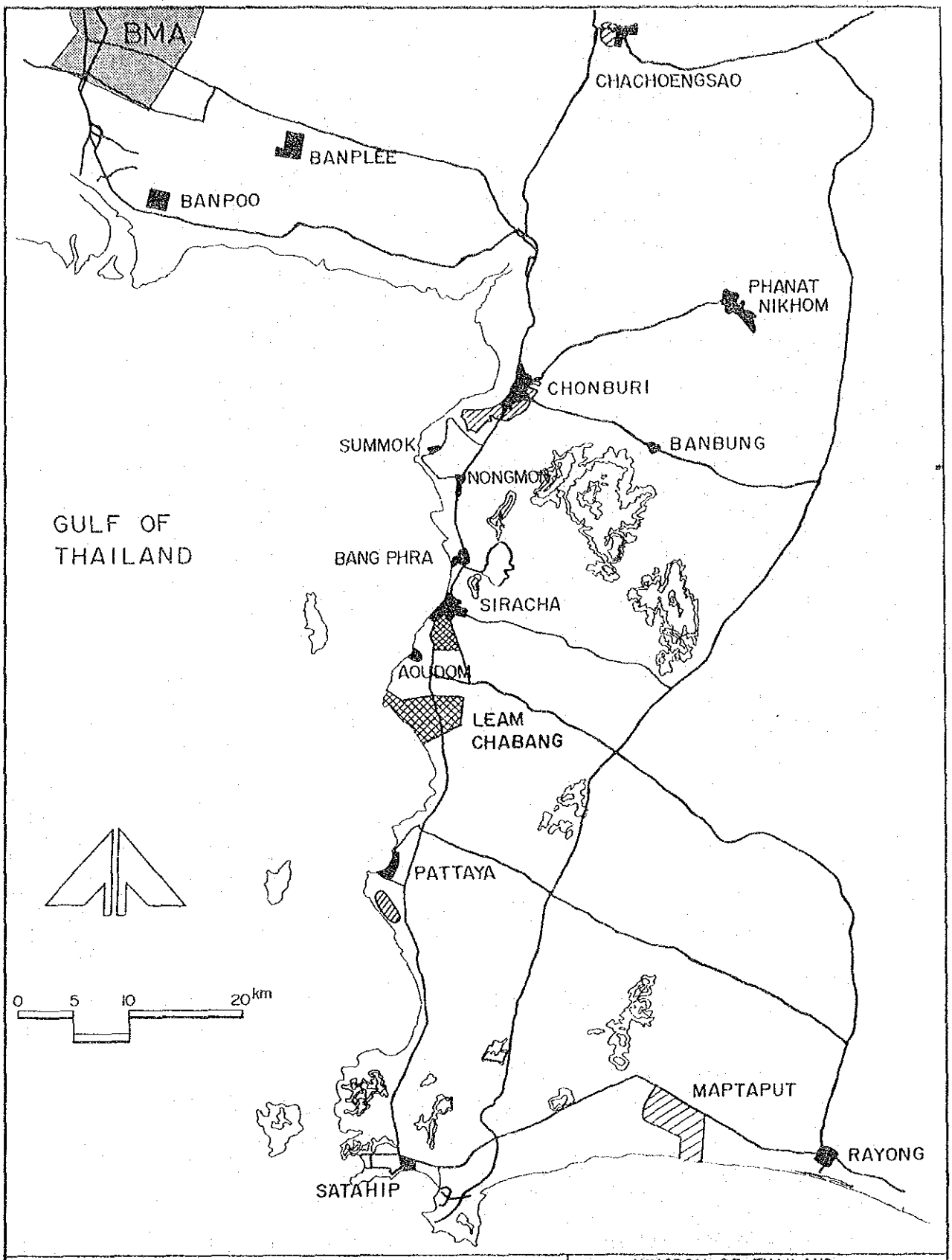
Source: ( ) ESS

* JICA Study Team

Table 3.1.2 LAND USE PLAN OF MASTER PLAN

Item	(ha)	(Rai)	(%)
1) Industrial Estate	(448)	(2,800)	14.9
(1) EPZ	84	525	
(2) GIE	233	1,456	
(3) Centre	7	44	
(4) Roads	64	400	
(5) Parks	11	68	
(6) Other 1)	49	307	
2) Port Area	(756)	(4,725)	25.1
(1) Wharf Area	258	1,613	
(2) Distribution & Storage Area 1)	143	894	
(3) Business & Commercial Area 2)	53	331	
(4) Road	147	918	
(5) Parks	74	463	
(6) Railroad (spur)	8	50	
(7) Others 3)	73	456	
3) New Town	(930)	(5,813)	30.9
(1) Residential Use	484	3,025	
(2) Community Use	33	206	
(3) Schools	62	388	
(4) Roads	205	1,281	
(5) Parks	56	350	
(6) Others 4)	90	563	
4) Sub-total	2,134	13,338	70.9
5) Others	(879)	(5,494)	29.1
(1) Reserved Area			
1 Industrial Use 5)	565	3,531	
2 Port Use	223	1,394	
3 Business & Commercial Use	62	388	
(2) Others			
1 Railroad Spur	6	38	
2 Connecting Roads 6)	23	143	
6) Total	3,013	18,832	100.0

Note: 1) Canal (7ha) and Buffer Green (42ha)
2) Including some local roads
3) Waste Water Treatment Plant (10ha) + Canal (63ha)
4) Water Filtration Plant (12ha), Water Distribution Basin (4ha), Canal (9ha), Buffer Green (47ha), Power Line and Gas Pipeline (18ha).
5) Northern part is 216ha, Southern part is 349ha.
6) R3 Bypass and the road from Siracha Industrial Park to R3 Bypass are not included.



LEGEND

- Existing Urban Area.
- Urban development Proposed by ESS.
- LAEM CHABANG Development.

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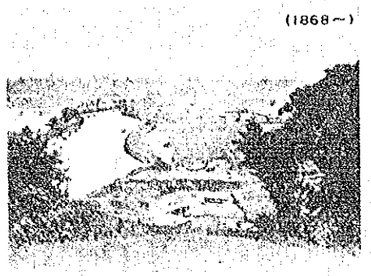
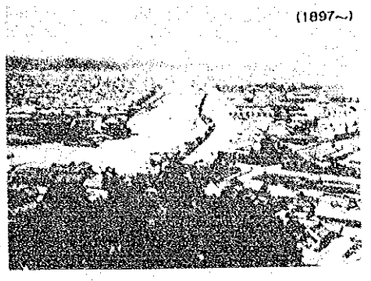
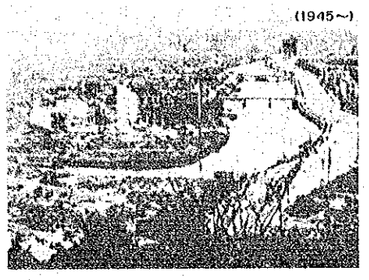
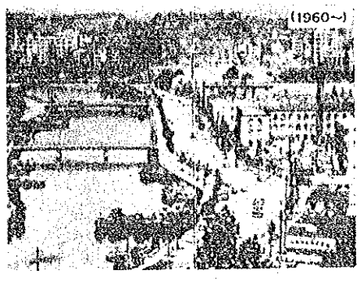
Fig. 3.1.1
Future Urban Area Distribution in the Eastern Seaboard

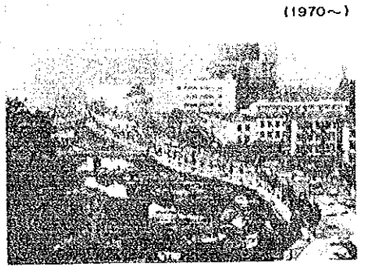
Ha-Ooka River



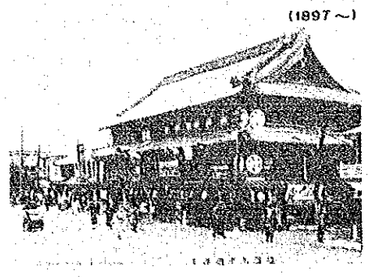


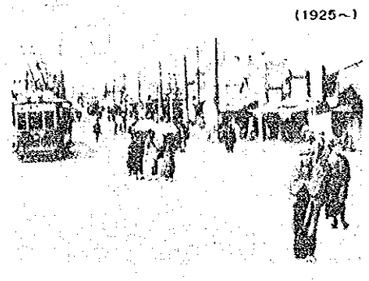


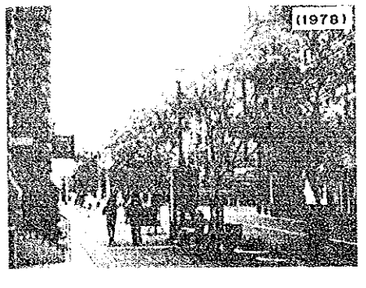




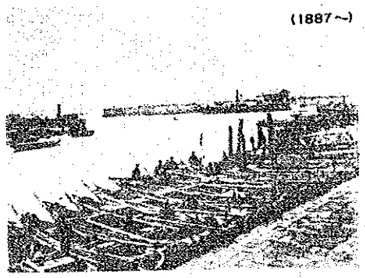
Bashamichi St.

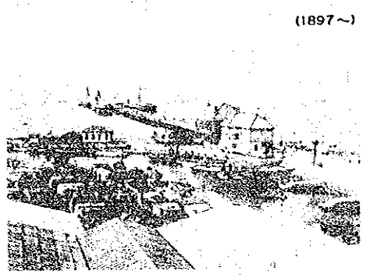


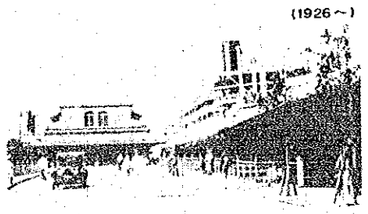


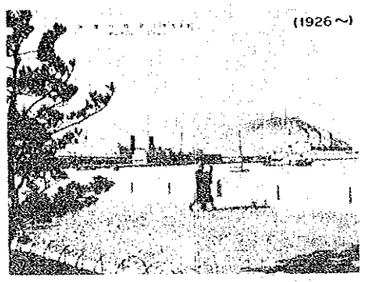


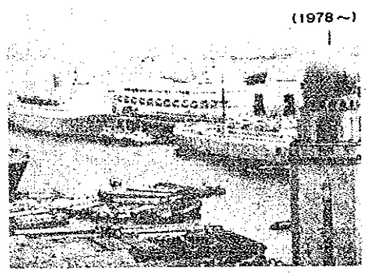
Port

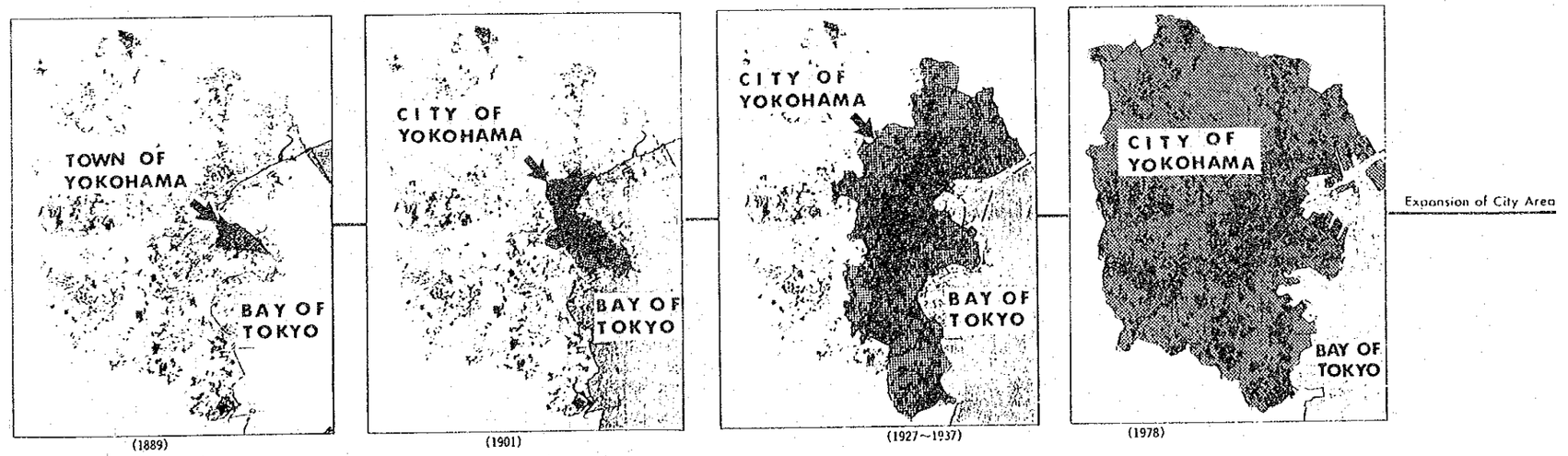












SORCE: DEVELOPMNT PROCESS OF PORT CITY YOKOHAMA. Planning & Cuodination Bureau, the City of Yokohama

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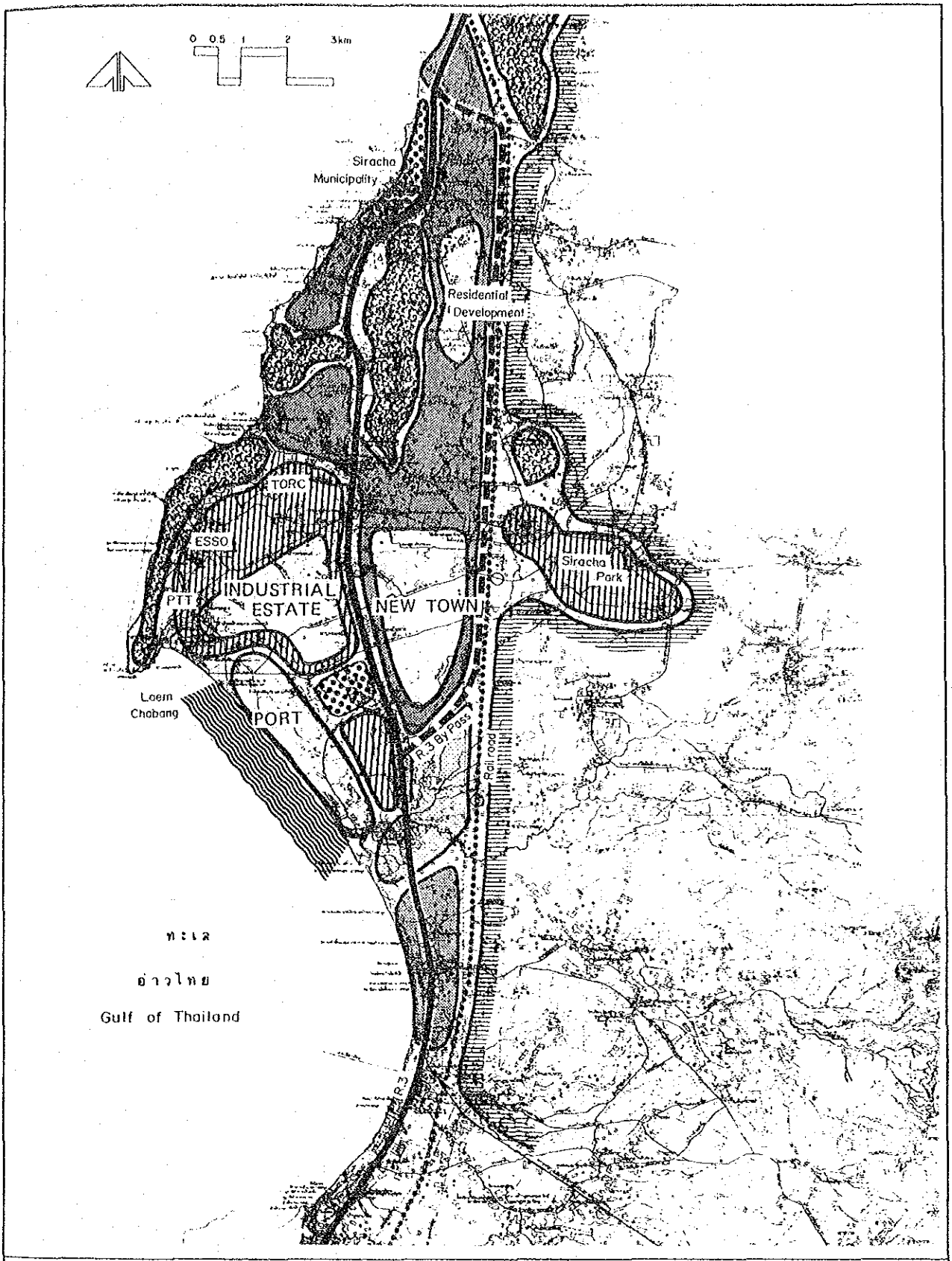
Fig. 3.1.2
Development Process of Port City of Yokohama in Japan



LEGEND

- Residential Area
- Port Area
- Rural Area (Un developed Area)
- Commercial Area
- Recreational Area
- Industrial Area
- Reserved Area

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Fig. 3.1.3
Siracha-Laem Chabang Land Use Pattern

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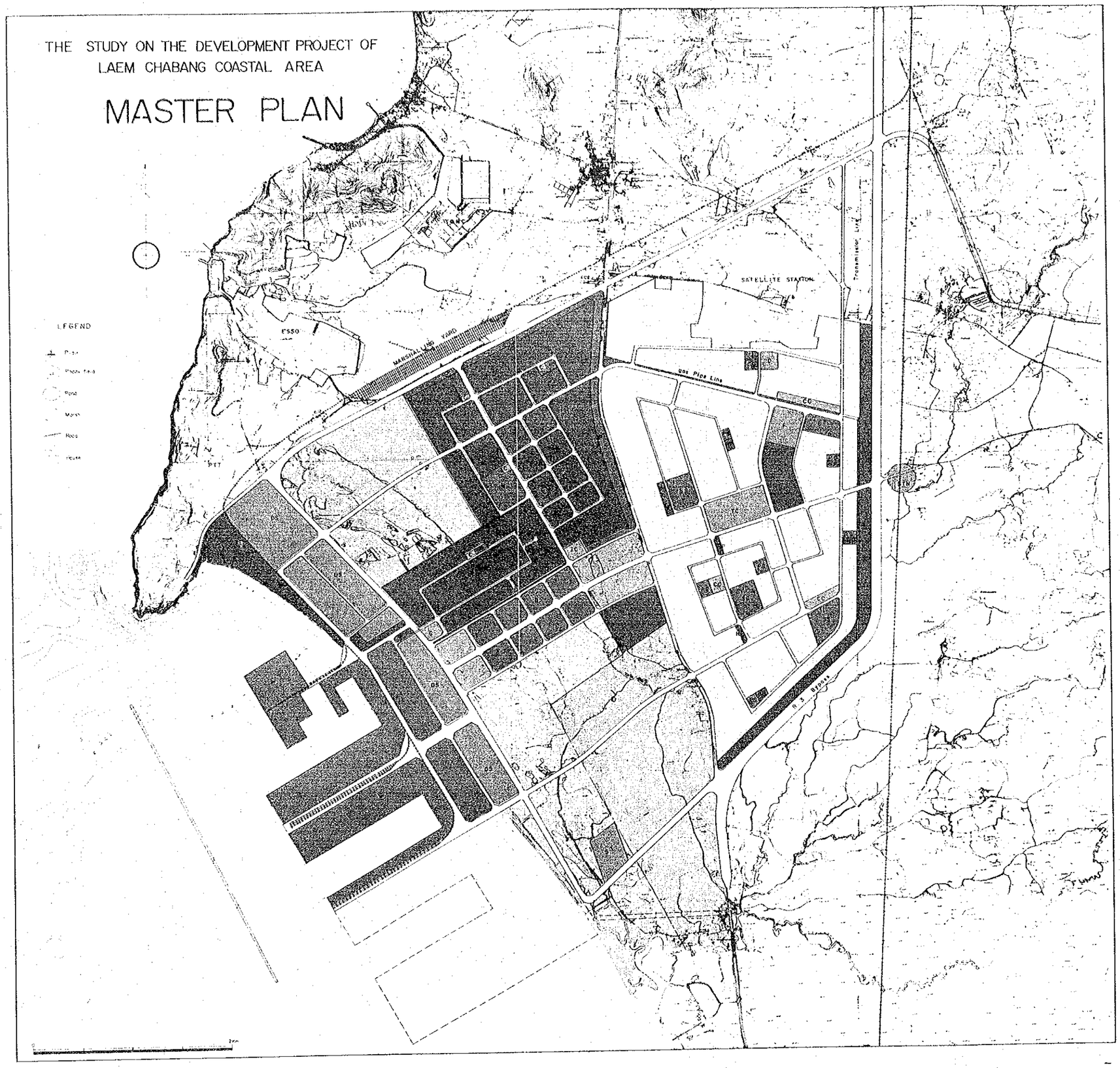
MASTER PLAN



LEGEND

- EPZ (Export Processing Zone)
- GIE (General Industrial Estate)
- WHARF AREA
- DISTRIBUTION and STORAGE AREA
- BUSINESS and COMMERCIAL AREA
- RESIDENTIAL AREA
- PARK
- RESERVED AREA (Industrial Use)
- RESERVED AREA (Port Use)
- RESERVED AREA (Business and Commercial Use)

CP	CENTER PARK
DP	DISTRICT PARK
NP	NEIGHBORHOOD PARK
TC	TOWN CENTER
CC	COMMUNITY CENTER
IC	INDUSTRIAL ESTATE CENTER
C	INDUSTRIAL SUB CENTER
SS	SECONDARY SCHOOL
PS	PRIMARY SCHOOL
ST	SEWERAGE TREATMENT PLANT
F	WATER FILTRATION BASIN
D	WATER DISTRIBUTION BASIN
BG	BUFFER GREEN
———	RAIL ROAD
STN	RAIL ROAD STATION
———	ROAD

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Fig. 3.1.4
Land Use Plan (Master Plan)

3.2 Industrial Development Plan

3.2.1 National Industrial Policies and Programs

1) Thai Economy and Role of Manufacturing Sector

The industrial sector in Thailand in the past two decades has contributed significantly to the rapid growth and diversification of the country's economic activities. Industrial growth has averaged at 11.6% per annum during 1960-70 and 10.0% during 1970-79, which were faster than the GDP growth of 8.2% and 7.8% for the corresponding periods. During the periods, there has been a rapid transformation of the economy from traditional to modern.

At present, agriculture accounts for 24% of GDP compared with just over 30% at the beginning of the 70s. The manufacturing sector, on the other hand, now accounts for about 21% of GDP compared with just under 18% at the beginning of the 70s.

2) Current Situation of Manufacturing Sector and Its Development Issues

It is said that the past favorable growth of manufacturing sector in general was based on production for the domestic market, including significant amounts of import substitution in consumption goods. The domestic market was sufficiently large and profitable to sustain adequate level of outputs under a protected condition by the tariff barriers. By the late 70s, however, industrial development through the first phase of import substitution was almost completed and ceased to contribute to the industrial growth as before.

The government, in the Fifth National Economic and Social Development Plan (1982-86), envisages major changes in industrial development policies to meet the new challenges of the 80s. Export oriented strategy and rationalization of domestic industries are seen to be the basic strategies for an efficient long term growth of the industrial sector. The government intends to introduce several new or improved measures such as new tax rebate schemes, a generous investment package, and export

processing zones including bonded manufacturing warehouses in order to promote exports.

3.2.2 Trend in Industrial Location in Bangkok and Its Surrounding Areas

According to the industrial statistics in 1982, a total number of factories in Thailand was about 86,000 which has been increasing at an average annual rate of about 9% since 1979. About 20,000 (22.4%) factories are in the Bangkok Metropolitan Area and 36,000 (41.6%) are located in the Central region including Bangkok. The locational conditions in the existing industrial areas in Bangkok has been deteriorating year by year and the advantage of agglomeration has been shrinking.

From a long term viewpoint, three major development axes are recognized as a general trend as shown in Fig. 3.2.1 and 3.2.2. The first one is directed to the north extending towards and beyond the Don Muang Airport. The second is to the west extending towards Samut Sakhorn along the highway No. 4 and 35. The third is to the east along the highway No. 34 towards the Eastern Seaboard. In the vicinity of Laem Chabang, the Siracha Industrial Park was developed by a private company, in which such industries as garment, footware, foods and detergents are located. A sugar mill and broiler meat processing factory are also located in adjacent areas. This indicates increasing interests of industrial investors in the Eastern Seaboard and gradual shift from the Bangkok area. (Fig. 3.2.1, 3.2.2)

3.2.3 Review of the Previous Studies

There are two main previous studies related to the industrial development at Laem Chabang: Eastern Seaboard Study (ESS) and Industrial Opportunities Identification Study (IOS) which were conducted by Coopers & Lybrand Associates in 1982.

ESS provides a spatial framework for the development of the Eastern Seaboard covering three Changwats of Chachoengsao, Chonburi and Rayong. It sets out an overall growth scenario for the sectoral development, the

induced employment and the associated urban development with the manufacturing sector as a key element of the said scenario. Map Ta Phut and Laem Chabang were identified as dual growth poles of the Eastern Seaboard development, while other subpoles in the region are proposed at Chonburi, Rayong, Chachoengsao and Sattahip. As to the intra regional distribution of industrial activities, light industry, export processing and port related industry were proposed for Laem Chabang on the basis of its natural and infrastructural conditions.

An extensive industrial survey was conducted in ESS on 58 selected manufacturing companies mainly to find out their perceptions about the Eastern Seaboard, and their likely reaction to the proposed industrial incentives. The findings stated are almost similar to the findings of the survey conducted by the Study Team specifically for the Laem Chabang Project. It is worth mentioning that the Team's survey confirmed foreign potential investors in general not being so reluctant to locate investment outside Bangkok, particularly at Laem Chabang as local industrialists expressed in the previous studies.

IOS, which is complementary to ESS, carried out a detailed investigation on how to accelerate the industrial growth of the area. The specified development prospects identified are as follows:

. Resource based industries
. Export processing industries
. Downstream manufacturing industries
. Ship repairing and service industries
. Polluting industries (Map Ta Phut)
. Other light industries

The IOS's judgement for the expected role of foreign investments and the principle followed for identification of the above prospects seem quite reasonable particularly for the proposed export processing zone in Laem Chabang. As an impact on the Eastern Seaboard, the IOS projected direct additional employment of some 11,850 jobs in 1991 in the ESS's industrial development zones which are broken down into locations as below.

Laem Chabang	52%
Rayong/Map Ta Phut	19%
Sattahip	10%
Chon Buri	10%
Chachoengsao	9%
	100%

Based on the above projections and assumptions, direct employment at Laem Chabang would be a little over 6,000, which is about 30% less than the projection made in this study.

3.2.4 Industrial Development Potentials of Laem Chabang Coastal Area

1) Existing Industries in the Eastern Seaboard and Regional Development Projects

Manufacturing employment in the Eastern Seaboard in 1981 totalled 51,300 jobs which is about 3% of the national total of the manufacturing sector. It is also said that about 60% of this employment was located in rural areas being related to agricultural processing industries. There are eight large scale infrastructure development projects under the Eastern Seaboard Development Program in the field of water, port, railways and industrial estates and five large scale manufacturing projects being initiated by the public sector.

2) Characteristics of Laem Chabang as an Industrial Location

Characteristics of Laem Chabang are listed below.

(1) A large scale deep sea commercial port, which will be connected with Chachoengsao-Sattahip line of the SRT by a spur line, will become available.
(2) The area is directly connected to Bangkok by National Highways Route 3 and 34.
(3) The Utapao Airport in Sattahip, which is accessible within half an hour drive by car, is now partially opened for commercial use.
(4) The area will become a key transportation hub of the country.

(5) Land for industrial estate has already been acquired by the Government close to the proposed port.

(6) Physical conditions are better than those in Bangkok, particularly for foundation and drainage.

(7) Current industrial locations are sprawling into Chonburi and Sirach from the eastern fringe areas of Bangkok.

(8) An export processing zone will be established.

(9) Industrial linkage is expected to be established both with the heavy chemical industries planned in Map Ta Phut and those in Sirach Industrial park and oil refineries.

(10) Ample agricultural and livestock resources supplied from the hinterland and energy resources such as natural gas and electricity are easily available.

(11) An international resort place in Pattaya is located in the vicinity and facilities for convention and recreation are easily accessible.

(12) A new town of over 100,000 population with various urban facilities will be established in conjunction with the development of the port and the industrial estate.

(13) Within 30km radius from Laem Chabang, there are about 150,000 labor forces, about 50% of which are engaged in agriculture sector.

(14) Water will be supplied through a pipeline from the Nong Kho Reservoir, though not sufficient in a long run.

(15) To enhance the proposed coastal industrial activities at Laem Chabang, an inland type back up industrial estate could be developed in future at the area around the junction of R-36 and R-331 which is strategically located to link Map Ta Phut, Utapao and Laem Chabang.

3) Views of the Selected Industrial Operators and Investors on the Industrial Location at Laem Chabang

The industrial location survey on the proposed Laem Chabang Industrial Estate and Export Processing Zone was conducted with the assistance of the Thai Chamber of Commerce and the Thai Association of Industries. Though the total number of samples was only 120, they were selected to represent fairly their respective subsector. Out of 120 samples, 44

questionnaires were properly filled with necessary information and collected for analysis.

Concerning the key factors for selection of the future plant site, 73% of the answers specified "Availability of Utility" as the top priority factor, which was followed by "Easy access to Raw Materials". Some 27 companies have new investment plans by 1987 mostly for the expansion of existing factories. 15 companies showed their interest in Laem Chabang, 5 of which answered with the factory area requirement totalling about 100 rai.

A local company which assembles automobiles is interested in Laem Chabang for implementation of their long term plan which requires about 500 rai. Main reasons for their preference to Laem Chabang are its excellent accessibility to commercial deep seaport, railway, and highways, better geological and topographical conditions and the availability of fully serviced land with reasonable land cost.

3.2.5 Planning Policy and Framework

1) Planning Policy

The industrial development plan in the Study has been formulated in line with the following planning policies.

- To create an attractive environment for industrial investors, workers, and the adjacent communities.
- To maximize the use of the existing resources such as publicly owned lands, labor force, and water.
- To invite industries meeting government industrial policies, the characteristics of the area's socio-economy, and physical and environmental conditions.
- To coordinate closely with the port and urban development in such a manner as to achieve the maximum long term benefit of integrated package development.

. To ensure a future expansion potential within and outside the area keeping the flexibility to comply with any unforeseen changes in the future.

2) Planning Framework

Prior to the estimation of future industrial land demand in Laem Chabang, considerations were given to the following points.

. Ease in land acquisition
. Balanced distribution of industrial activities
. Balance between commercial port and urban development

In order to assess the role of Laem Chabang in the industrial development of the Eastern Seaboard, attempts were made to estimate the land demand in Laem Chabang by two different approaches.

Laem Chabang's shares in the total employment in the central region (Approach A) and in the Changwat of Chonburi (Approach B) were estimated, and then converted into land demand based on correlation of manufacturing employment and land demand.

(1) Approach A

Case I (5% of gross manufacturing employment of Central region)

. 5,477 rai = 5,500 rai

Case II (5% of net manufacturing employment of Central region)

. 3,143 rai = 3,200 rai

(2) Approach B

75% of net increase of planned industrial estate in urban area of Changwat Chonburi

. 2,758 rai = 2,800 rai

Considering the above planning policy and the availability of adjacent land for future expansion, it is proposed to set the industrial area at 2,800 rai for the year 2001. As to the allocation of the land for and GIE, it is proposed to allocate 700 rai and 2,100 rai for EPZ and GIE

respectively considering the recommendations of ESS and IOS and the size of the existing EPZs in the neighboring counties.

3.2.6 Types of Industries and Industrial Mix

1) Criteria for Identification of Industries

As mentioned earlier, there will be two types of industrial areas, EPZ and GIE in Laem Chabang. Based on the results of the foregoing subsections 3.2.1 through 3.2.5, the following criteria were established for identifying potential types of industries.

- Export oriented industries
- Labor intensive industries
- Local resources oriented industries
- Infrastructures such as deep seaport oriented industries
- Industrial linkage building industries
- Less water consuming industries
- Agglomeration of Bangkok oriented industries
- Relocating industries from Bangkok
- High technology industries

Furthermore, the following additional criteria were established for cross-checking.

- Industries identified by BOI
- Industries identified by IOS
- Industries that have registered comparatively high growth
- Industries that are attractive to foreign investors.

2) Candidate Industries

(1) GIE

GIE in Laem Chabang will have approximately 2,100 rai of area and is required to contain diverse industrial activities to meet the

government industrial policy and the area's characteristics. Candidate types of industries are identified as follows.

Consumer related group (JSIC Code /1 No.18,19,20,21,22,23,24,25)

- Foods Industries
- Textile Industries
- Lumber and Wood Poducts
- Furniture and Fixtures
- Paper Products
- Publishing, Printing and Related Industries

Basic material group (JSIC Code /1 No.26,28,29,30,31,32)

- Chemical and Related Products
- Leather Tanning and Leather Products
- Ceramic, Stone and Clay Products
- Iron and Steel Products
- Non-Ferrous Metals and Products

Processing & assembly group (JSIC Code /1 No.33,34,35,36,37,39)

- Fabricated Metal Products
- General Machinery and Its Attachments
- Electrical Machinery Equipment and Supplies (incl. electronics)
- Transportation Equipment
- Precision Instruments and Machinery
- Miscellaneous Manufacturing Industries

/1 Ref. Sectoral Study Appendix 1-109

(2) EPZ

The main purposes of establishing EPZ are summarized below.

- Job creation
- Foreign exchange earning

. Enhancement of regional industrialization
. Technology transfer

In Thailand the first EPZ was established within the Lat Krabang Industrial Estate in 1980 as a pilot project with about 170 rai of land. As of February, 1984, 8 firms have established factories in it. The types of activity include stationery, bolts and nuts, lenses, electronic equipment, clothes, artificial flowers and trees, and latex rubber gloves. Recently there has been a surge of inquires for unsold lots from abroad partly due to quota systems practised in developed countries for typical products of EPZ.

The candidate types of industries selected are listed below.

. Food products
. Textile mill products
. Apparel and other furnished products
. Furniture and fixtures
. Paper products
. Printing
. Chemical and related products
. Rubber products
. Leather products
. Fabricated metal products
. Electrical machinery, equipment and supplies (incl. electronics)
. Precision instruments and machinery, equipment and supplies
. Miscellaneous manufacturing industries

3) Industrial Mix

(1) GIE

From the Tables below, a gradual structural change in the Thai manufacturing sector is seen.

	Share in Manufacturing (%)	
	1975	1980
. Consumer related group	62.8%	59.6%
. Basic material group	22.8%	24.8%
. Processing & assembly	9.4%	12.0%
	100.0%	100.0%

Though not finalized yet, several large investment projects are proposed by the local investors to be located at Laem Chabang. One is a car manufacturing project which requires about 1,000 rai with a foundry included and 500 rai with the foundry excluded. Another is an electrical home appliances manufacturing project which requires 50 to 100 rai.

Judging from the trend of market growth, type of activities, amount of investment, employment and its impacts, they are expected to become nucleus factories in GIE. A ship repairing project for private investment is also proposed by BOI at Laem Chabang and the feasibility study is currently conducted by JICA.

Based on the above facts coupled with the RTG's policy to accelerate restructuring of manufacturing sector, the following model composition is proposed.

GIE

Category	Type	Composition
Consumer related group	Foods, textile, apparel, wood, wood products, furniture, rubber & plastic products leather products, mis. products	10% (22.8 ha)
Basic material group	Chemicals, ceramics, non metalic minerals, iron & steel, non-ferrous metals	30% (71.1 ha)
Processing & assembly group	General machinery, electrical machinery, transportation equipments, precision instruments	60% (139.1 ha)

(2) EPZ

In order to propose the industrial mix of the Laem Chabang EPZ as guide and basis of planning of the required infrastructure and utilities, the following points were considered.

- Trends of the EPZs in Asia /1
- Trends of the Japanese foreign industrial investment /2
- Trends of the American investment in the field of electronics industry in Thailand /3
- Foreign investment promotion policy of the RTG /3
- Locational characteristics of Laem Chabang

The result is shown below in terms of space allocation by the three categories. For acceleration of foreign investments at an early stage, it is necessary to allocate some area to the so-called standard factory building. It is proposed to allocate 10% of the space for this purpose.

/1 Ref. Sectoral Study Appendix 1-106
/2 Ref. Sectoral Study Appendix 1-100
/3 BOI information

EPZ

Category	Type	Composition
Consumer related group	Foods, textile, apparel, wood, wood products, furniture, rubber & plastic products leather products, mis. products	40% (33.6 ha)
Basic material group	Chemicals, ceramics, non metalic minerals, iron & steel, non-ferrous metals	15% (12.8 ha)
Processing & assembly group	General machinery, electrical machinery, transportation equipments, precision instruments	45% (38.0 ha)

3.2.7 Employment, Cargoes and Industrial Water

1) Employment

Based on the composition of the industries discussed above and the information on location planning units surveyed in Japan in 1981, the total number of employment at full development was estimated as below. An adjustment was made on number of employment in EPZ in accordance with the result of analysis for 18 EPZs in Asia /2 (6 in Malaysia, 3 in Philippines, 4 in Singapore, 3 in Taiwan, 1 in Korea and 1 in Thailand). The operation of EPZ was assumed to be on double shifts on the average.

	Total	Density
(1) EPZ	19,000 workers	36 workers/net rai
(2) GIE	15,500 workers	11 workers/net rai

/1 Ref. Sectotal Study Appendix 1-109

/2 Ref. Sectoral Study Appendix 1-107

2) Cargoes

Cargoes to be generated in the industrial estate and to be transported into the industrial estate were estimated by means of the data on industrial location surveyed in Japan in 1974 and then further broken down into port cargo and non port cargo by the data surveyed in Japan in 1978.

(Unit: 10^3 ton)

Item	Total cargos	Port cargos	Non Port/ Cargoes
GIE			
Output	1,264	563	701
Input	1,432	824	608
EPZ			
Output	176	165	11
Input	194	180	14

3) Industrial Water

Water requirements developed from the data surveyed in Japan in 1981 were applied assuming that water saving technology now prevailing in Japan would be equally adopted in Thailand at the full development stage. (Fig. 3.2.3) Industrial water demand was projected as below on the basis of water requirement per area as explaned more in detail in the Section 3.6.1 "Water Supply".

(1) GIE 24,800 m^3/day
(2) EPZ 8,500 m^3/day

3.2.8 Physical Conditions of the IEAT Site

The site is located in the west of the Siracha Satellite Station. Generally it is of flat land, but it actually is a patch work of intricate small flat lands and depressions. The land is at present used mainly for paddy fields and cassava filed. Geology of the IEAT site is characterized by deposited layer 5 to 7 meters thick clayey sand on the granite rock base extending almost over the whole area. The site has two small river basins.

3.2.9 Layout of GIE & EPZ

1) Basic Development Policies

There are several development policies serving as a basis for the layout planning as follows.

(1) Laem Chabang is well known for its beautiful setting which should be preserved. It is essential to prepare a land use plan paying due attention to the conservation of the existing natural environment to the extent possible, while seeking the most efficient use of available land resources.

(2) EPZ with a gross area of 700 rai will be located as near to the public berths as possible, and GIE with 2,100 rai will be laid in the rest of the area.

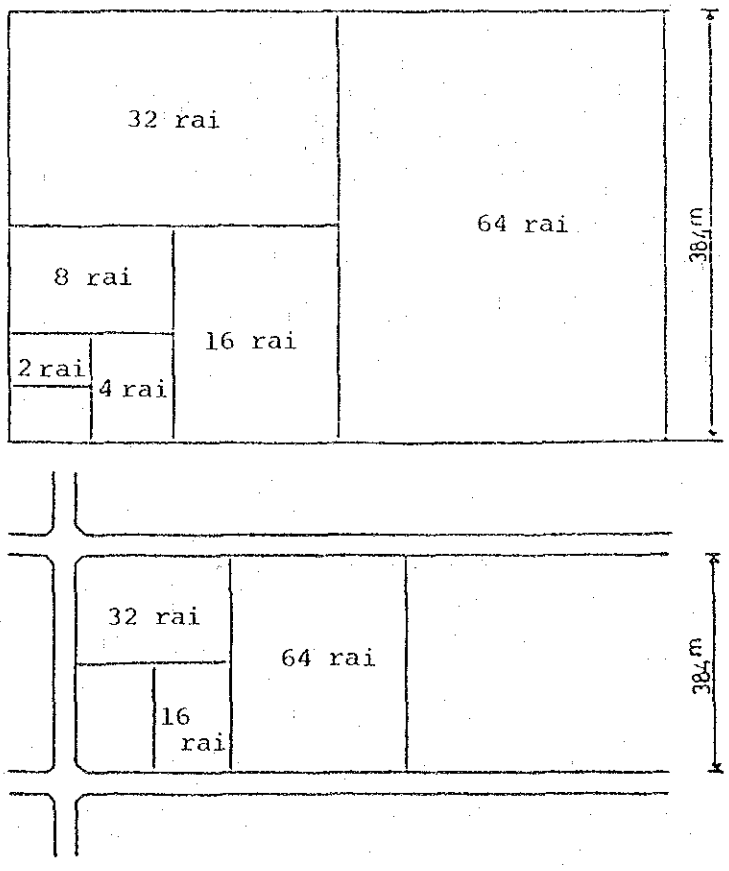
(3) The factory land ratio is aimed at around 65% and open spaces are set aside roads, parks and greenery, so that the estate area will have features similar to an industrial park.

(4) Plan shall have flexibility, adaptability and adjustability to meet unforeseen changes in the future.

2) Principles for Factory Lots Subdivision and Layout Plan

(1) Subdivision Plan

A minimum lot size of the estate is assumed to be 2 rai based on an analysis of the available data in Thailand such as the Whole Kingdom Industrial Output, 1975 and the one of five existing industrial estates in Thailand. A factory plot subdivision module is given in the figure below.



(2) Consideration required for factory grouping

Factory lot layout is grouped by classifying industries into several groups. A detailed examination of each type of industries according to their employment situation, scenic view, degree of dependence on major facilities and types of pollution will be done. Grouping was made by the following criteria.

- Labour intensity
- Type of pollution
- Requirement for open space
- Proximity to the port
- Factory size

3) Land Use Plan of GIE & EPZ

The area proposed in this plan constitutes an integral part of the Laem Chabang Coastal Area development that includes residential area, business and commercial area and port area. In order to create attractive environment of the area while keeping functional integration, the entire estate shall be surrounded by green belt as a buffer. The estate center is located near the business and commercial area and EPZ center is located near the port area. The factory land is placed within this framework. Perimeter road for EPZ is planned.

4) Land Use of GIE

(1) Factory Land

The factory plot area is about 1,410 Rai (226 ha) which is zoned for large, medium and small scale factories respectively. Zones for large and medium scale industry are laid out along the Route 3 (Sukhumvit Road) and near the business and commercial zone. Small scale industry zone is laid out in between the large and medium scale zones considering the grouping by type of activities.

(2) Main facilities

A sports park is one of symbols of the estate and is located in the central area. The estate center and three sub-centers are laid out in such manner as to allow easy access by workers. Green belt with 100 meters wide is laid out along the Route 3.

(3) Road

The road network of GIE is planned to provide an efficient circulation of surface traffic. In case the proposed car manufacturing project finalized, those subdividing roads in the center zone could be eliminated. District distribution road (V_3) will connect, on a straight line, the business and commercial area and intra urban primary road (V_2).

5) Land Use of EPZ

(1) Factory Land

The net factory plot area is about 525 Rai (84 ha) which is divided into zones for the standard factory building (SFB), small scale industry and medium scale industry. The SFB zone covers 10% of the factory land and is laid out near the EPZ center. The medium scale industry zone is laid out at the center district of EPZ.

(2) Main Facilities

EPZ center is located at the main entrance and one sub-center is located at the center district of EPZ. Guard house is located on the district disbributor road (V_3) in the estate. Warehouse is placed at the SFB zone.

(3) Road

Local road (V_4) directly connects EPZ with the port area through a bridge over the primary road (V_2). Perimeter road is placed in the green belt of the EPZ boundary.

(4) Entrance

Two entrances shall be established for workers. One is at the EPZ center and the other at the guard house.

6) Land Use Composition

The table below summarizes the land use composition of GIE and EPZ.

GIE

	Item	Area (m^2)	(Rai)	Ratio (%)
1.	Estate center & sub c.	45,000	28	1.3
2.	Factory land	2,330,665	1,456	69.4
3.	Green Belt	364,660	227	10.8
4.	Park	90,000	56	2.7
5.	Road	489,525	306	14.6
6.	Channel	42,150	27	1.2
	Total	3,360,000	2,100	100.0

EPZ

	Item	Area (m^2)	(Rai)	Ratio (%)
1.	EPZ center & sub	25,000	16	2.2
2.	Factory land	844,665	528	75.4
3.	Green Belt	56,820	36	5.1
4.	Park	15,000	9	1.3
5.	Road	148,875	93	13.3
6.	Channel	29,640	18	2.7
	Total	1,120,000	700	100.0

3.2.10 Considerations for the Promotion of Industrial Siting in Laem Chabang

Success of GIE & EPZ development entirely depends on how fast and effectively the country can attract industrial investors. However, fully serviced physical facilities alone can not function efficiently without

necessary support of policy measures. Major points to be considered are as follows.

(1) To establish workable guidelines for standardization of automotive and machinery parts and components to help those industries increase production to bring about cost reduction to the extent that they can export a part of their production. Continued efforts are required for materizlization of the ASEAN industrial cooperation program in this field.

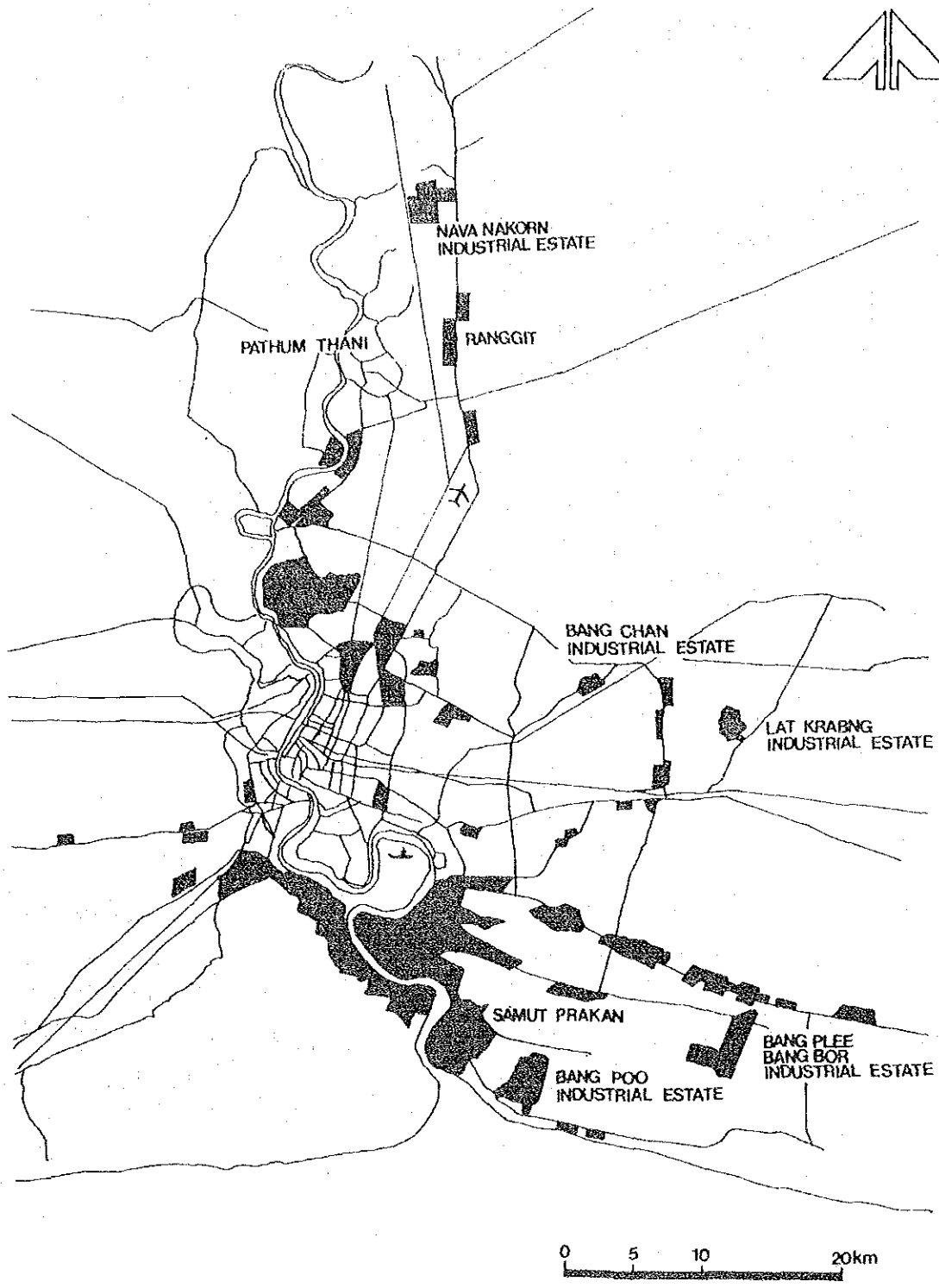
(2) To streamline the taxation system to encourage the establishment of easier contractor-subcontractor relations in the manufacturing field.

(3) To effectuate quick tax rebate for export producers.

(4) To provide credit facilities on more liberal terms to the local export producers and to small and medium scale industries that wish to relocate themselves from Bangkok.

(5) To enhance the vocational school in Sattahip or to locate another specified trade oriented technical training center in Laem Chabang to meet the requirement of industries.

(6) To embark on positive promotional activities in major developed countries.



LEGEND

FACTRIES

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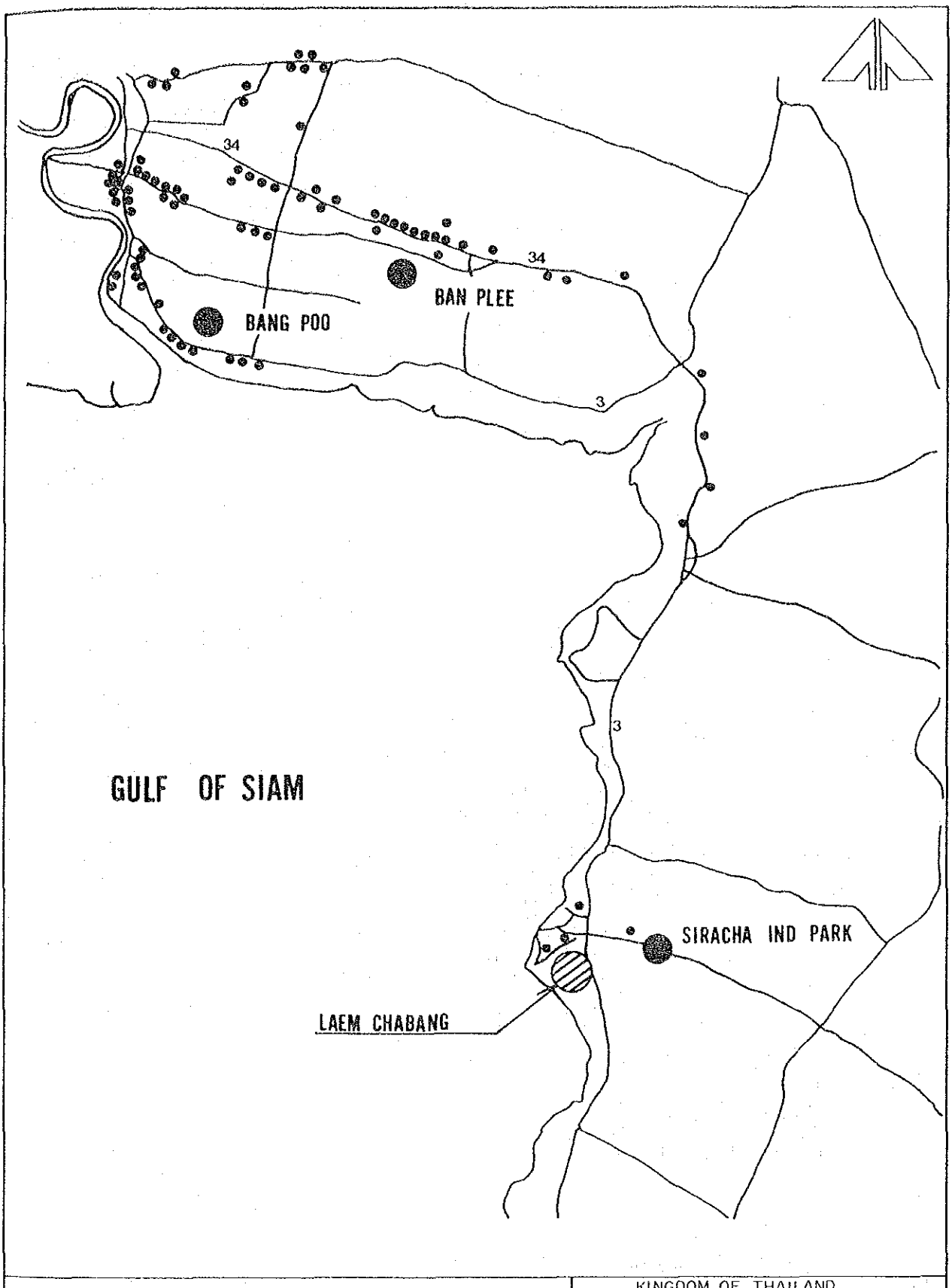
Fig. 3.2.1
Trend of Industrial Location (BKK)



LEGEND

- FACTORY
- INDUSTRIAL ESTATE

KINGDOM OF THAILAND
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Fig. 3.2.2
Trend of Industrial Location along R-34 and R-3

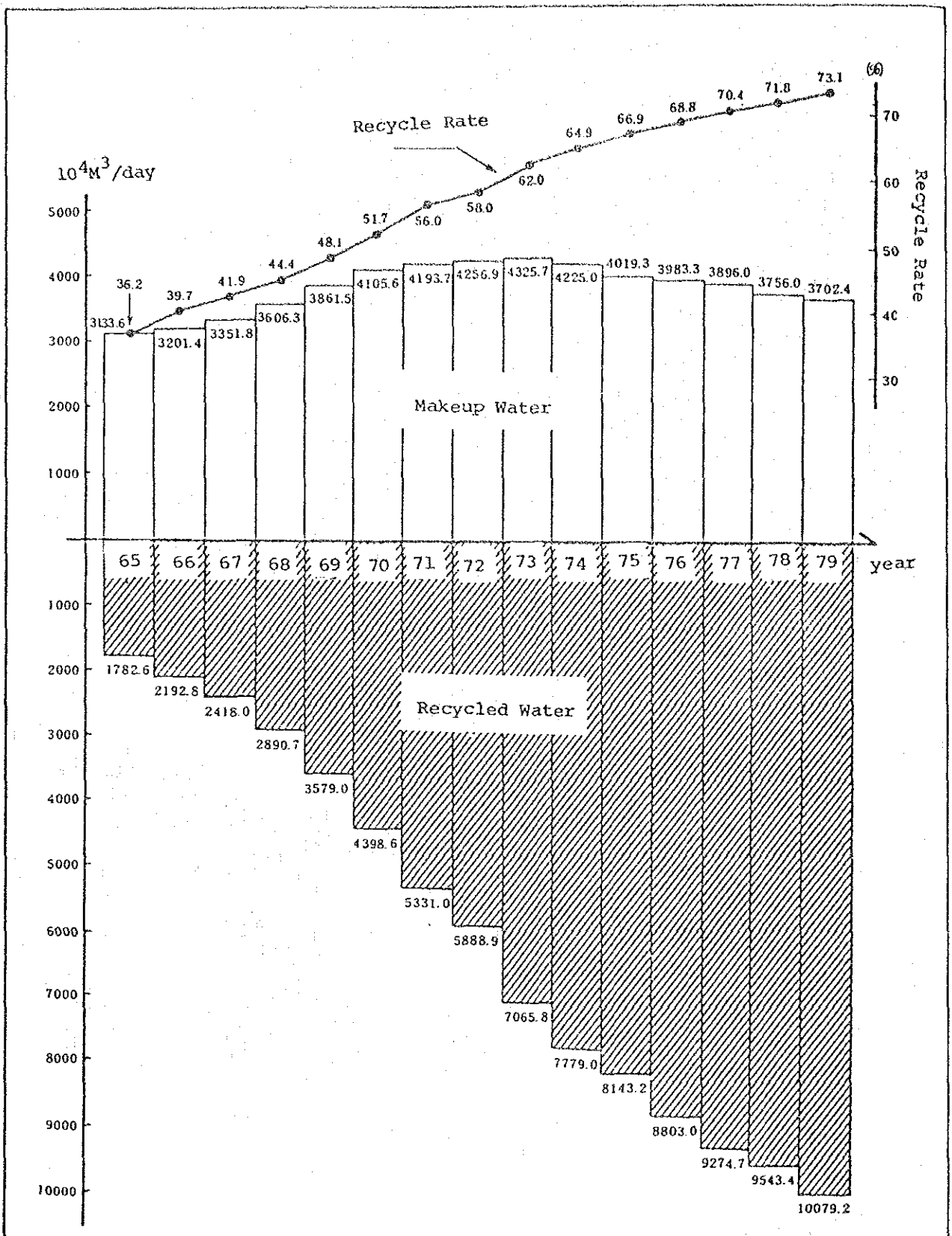

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Fig. 3.2.3
Change of Water Recycle in Japan

3.3 Port Development Plan

3.3.1 Prospect of Laem Chabang Deep Sea Port

It seems obvious that the success of the Laem Chabang Coastal Area Development Project will depend heavily on the success of Laem Chabang Port as the Thailand's primary deep sea port. Its successful port operation will not only generate a large amount of vaied jobs, directly or indirectly, but also create an environment that will give people necessary confidence to invest and to settle in the area.

The success of Laem Chabang Port can obviously be judged by the number of ships calling. Because of its deep draft, the port can accommodate ships much larger than those currently calling at Bangkok Port. An important question is whether or not large main line vessels, currently entirely by-passing Thailand, will amke direct calls at this port. The question is a difficult one since the matter is largely beyond the control of the Thai side, Government or private. Operators of main shipping lines determine their shipping routes on the basis of world-wide considerations, in which conditions for Thailand occupy only a part. The Study Team, therefore, carried out an analysis of shipping operations examining the economic circumstances in which Laem Chabang Port will have to be operated.

The analysis was focused on the transport of containers because of its overriding importance in today's ocean shipping. Four distinctive analyses were carried out for the purpose: a review of ocean transport of containers in the world, a survey of shipping companies in Bangkok and Tokyo, a comparison of marine and land transport costs of containers by the direct call system and the feeder system, and an analysis of Thailand's position in the container transport in Asia. The results of the first three analyses are briefly summarized in this section. More details can be found in Appendices attached to the Sectoral Report.

The conclusion is that the vessels calling at Laem Chabang would be increasingly larger and the number of lines calling would grow larger but the prospect is not high for large vessels currently on long distance routes such as US-Far East and Europe-Far East to make direct calls at

Laem Chabang at least for the moment. But larger container vessels on other routes will be expected to call Laem Chabang more often. The following explains why.

1) Cargo throughout compared with other ports

Figure 3.3.1 shows major ports in Asia which handled significant amounts of containers in 1983. Table 3.3.1 summarizes numbers of import and export containers handled in these ports and their ranking in terms of the total number of loaded containers in 1983. The total also lists the number of shipping lines serving for the US West Coast-Far East route and the Far East-Europe route.

With the total number of loaded containers of 256 thousands in 1983 the Bangkok port ranks at number 11 out of the total of 39 ports. However, primarily due to the shallow draft it ranks at only 18 in terms of the number of shipping lines calling. The port of Bangkok handles containers far more than the Port of Kelang or Nagoya but it received only a third of what the Port of Kelang or Nagoya received in terms of the number of regular services.

The total number of containers handled in Bangkok in 1983 was 289 thousand units. This is no small number even in comparison with Hong Kong or Singapore, where comparable numbers were 1,660 and 1,210 thousand units. In 1982 combined container shipping services provided the total capacities of 1,885 thousand units for Hong Kong and 1,200 thousand units for Singapore, as shown in Table 3.3.2. Bangkok bound or Bangkok originated containers at present constitute 15% and 24% of the total capacities provided for Hong Kong and Singapore respectively.

The number of containers loaded or unloaded per ship in Bangkok at present is comparatively low as shown in Figure 3.3.2. According to a report prepared for the PAT by the ESCAP (Container Handling at Bangkok Port, Report of Advisory Service for the Port Authority of Thailand by Kohei Nagai, United Nations, May 1984), on average 2.85 ships arrive at the Bangkok Port including feeder and combo vessels per day. If limited to feeders, 1.63 ships arrive per day. The average capacity of ships was found to be 499 TEU, but many ships were of very small capacity.

Therefore, existing low lot size seems to be the result of too frequent services by too small vessels. The introduction of large vessels making direct calls would drive off inefficient and time consuming feeder services and a larger lot size would result.

2) Buyer's market of container transport service

There is a considerable excess capacity in the container ship fleet in the world, and this situation will continue for some time to come due to the large number of committed additions to the fleet. Some of the shipping operators have started to add more ports of call in order to improve their ships' utilization rate. This trend will be likely to intensify in the near future.

3) Cost saving to shipping companies

The overall marine transport cost to shipping companies when making direct calls at Laem Chabang will definitely be less than otherwise. Under the current fierce competition among shipping companies and resultant low rates, shipping companies are under strong pressure to cut down the operating cost. A clear opportunity for cost savings would not be missed. For services such as Thailand-Japan shuttle service, which is hardly making any profit despite the near full load condition, the introduction of larger vessels would be sought.

4) Time saving to shippers/consignees

Under the current feeder system, containers are generally laid on the ground for several days or more in Hong Kong or Singapore. This is a large amount of time relative to the total time in transit. The elimination of this transshipment would be a big marketing advantage to shipping companies as well.

5) Less combined cost of marine and land transport

Even including the additional land transport cost from Laem Chabang to Bangkok the overall cost is less through Laem Chabang by bigger container vessels. If tariff structure can be devised in such a way that

cost savings are shared between the shipping companies and the shippers, the new system should be less costly to both parties. A comparison of combined costs is also shown in Appendix of sectoral report.

6) Less need for transporting empty

Another one of favorable characteristics of container traffic of Thailand is its high percentage of loaded containers. Because of fairly well-balanced import and export container volumes only 11% of containers handled at the Bangkok port were empty in 1983. This is a significant advantage since the delivery and pickup of empty vans and their scheduling constitute as important factor in determining routing of shipping services.

7) Concentration of mainline truck services

In the field of long distance mainline truck services such as US West Coast-Far East and Europe-Far East the number of shipping companies or consortium of companies providing such services has been limited. In recent years operations of such services have increasingly been concentrated by means of larger vessels and fewer ports of call allowing the operating companies to utilize the large and expensive vessels as many as possible. Terminal operations at these selected ports are synchronized with the vessels' sailing schedule, further cutting down the turn around time of the vessels. Large sums of investment were made at a few ports such as Kaohsiung, Hong Kong and Singapore to develop facilities and systems which allow those large mainline vessels the minimum length of time in the port. Operators of these ports are actively promoting such functions of their ports. For such services, which have been optimized over the worldwide operations, it would require a significantly large cost savings and other advantages offsetting the operational disadvantage to add Laem Chabang port in their routes.

As the percentage of containerization of import and export cargoes of Thailand becomes higher, the very high growth as in the past can not be expected. But as long as the Thailand economy grows at a rate higher than most of the other countries, its container traffic would grow at a considerable rate. The 21% increment of container traffic from 1981 to

1983 was in absolute terms almost twice as large as the entire loaded container traffic at Penang in 1983, at which main line vessels make more frequent calls. It appears that all the market forces are working in favour of attracting larger and more vessels to the deep sea port of Laem Chabang although main trunk line vessels would be hard to come by. It is important, therefore, government policies should be formulated and implemented in order not to distort the market so that such market forces could exert their power naturally to achieve the most efficient system for all concerned.

3.3.2 Cargo Volume Forecasts

The traffic forecasts for the future general cargo volumes at Klong Toei and Laem Chabang Ports ahve been made applying the results of a correlation analysis between the cargo volume and the gross domestic product (GDP) based on data for the years 1974 through 1982 (high projection), and also by applying a time series analysis of imports and exports for the years 1974 through 1984 (low projection).

The traffic forecasts for future exports of agricultural bulk commodities have been made by using a trend line analysis based on data for the years 1960 through 1982 (low projection), and also by extrapolating the export volume in 1982 by the average growth rate of exports (high projection).

It was assumed that cargo volume at Laem Chabang Port can be calculated by deducting the capacity of Klong Toei Port from the total cargo volume forecast of Klong Toei and Laem Chabang Ports. The projected traffic volume is summarized in the Table below. Figures in parentheses indicate medium projections, which are the average of the high and low projections.

Traffic Volume

(Unit: 10^6 Ton)

Commodity		Total volume in Bagkok and Laem Chabang ports		Capacity of Bangkok Port	Potential Demand of Laem Chabang Port	
		1991	2001		1991	2001
Containers	Total	5.3- 6.3	8.1-13.1	3.0	2.3-3.3	5.1-10.1
	Import	2.7- 3.1	4.2- 6.8		(2.8)	(7.6)
	Export	2.6- 3.2	3.9- 6.3			
Break Bulk	Total	4.7- 5.0	5.7- 7.3	4.5	0.2-0.5	1.2- 2.8
	Import	4.4- 4.7	5.3- 6.6		(0.4)	(2.0)
	Export	0.3- 0.3	0.4-0.7			
Break Bulk	Domestic	0.23	0.86		0.23	0.86
Tapioca	Export	7.9- 8.1	7.9- 8.4		4.5	4.5
Sugar	Export	2.3- 3.0	3.1- 4.0	2.2	0.1-0.7	0.9- 1.8
					(0.4)	(1.4)
Molasses	Export	0.9- 1.2	1.1- 1.7	0.9	0 -0.3	0.2- 0.8
					(0.2)	(0.5)
Total		21.3-23.8	26.7-35.3		7.3-9.5	12.7-20.8
					(8.5)	(16.8)

3.3.3 Natural Conditions

Meteorological conditions area not severe at Laem Chabang. Topographical advantages of shallow depth and narrow width of the Bay of Bangkok protect the new port area from the direct influences of the ocean and therefore give ideal shelter to the port area. Natural conditions of Laem Chabang are summarized as follows.

(1) Currents are not fast.

- average 0.4 m/sec
- maximum 0.7 m/sec

(2) The winds are generally weak and very strong winds are rare. Real tropical storms (typhoons) are unknown in central Thailand.

- monthly average 1 - 4 m/sec
- daily maximum 3 - 4 m/sec

(3) The waves are not high.

Design wave height Direction W - SW

H = 2.3 m

T = 7.0 sec.

(4) Tide levels are as follows:

H.H.W. = MSL + 1.75 m

L.L.W. = MSL - 2.25 m

Subsoil around the new port site consists of the following two layers.

(1) Upper layer

. Thickness, depth and composition of the sediment vary from place to place.
. Sediment composition ranges from soft clay to fine to coarse sand with shell fragments.

(2) Lower layer

. Weathered rock consisting of slightly clay to clayey fine to coarse sand with local gravel.
. Strongest weathering in the top part of the layer.

Unweathered rock exists approximately 20 m below the sea-bed or ground level.

3.3.4 Ship Size, Berth Demand and Waterfront Demand

The maximum ship sizes in various categories which should call on Laem Chabang Port and berth dimension were assumed as follows based on the examples in Thailand and other countries.

Ship Size

	Deadweight Tonnage (DWT)	Hold Volume	Ship Dimension L (m)	W (m)	D (m)	Average Cargo per ship	Berth Length (m)	Depth (m)
Containers	33,000	-	269.8	32.2	12.0	500-600 TEU/Ship	300m	13.0
Break Bulk	40,000	-	217	28.3	11.9	4,000 t/ship	260m	13.0
Tapioca	142,000	160,000m^3 (Bulk density 0.6t/m^3)	284.2	45.6	16.5 (11.5)*	80,000 Weight/ton	340m	13.0
Sugar	25,000	26,000m^3 (0.84t/m^3)	190	25	10.5	20,000 Weight/ton	225m	11.5
Molasses	25,000	26,000m^3	190	25	10.5	20,000 Weight/ton	225m	11.5

* full loading of tapioca

The berth requiremtnts for the master plan stage were estimated assuming the cargo handling performance in similar situations. The water front demand in the port area then were calculated based on the berth requirements and other factors. Results are summarized in the following tables.

Berth Requirements

Commodity	Traffic Demand (10^6 ton) 1991	2001	Average Load/ Unload per ship	Ship Size	No. of Ship Calls/ Annum 1991	2001	Handling Spped	Berth time (hour/ Ship)	No. of Berth 1991	2001
Container	2.8	7.6	500 TEU	33,000DWT (2,000TEU)	564	1,500	20 TEU/h x 2	12.5 (15.5 including idle time)	3*	7/1
Break Bulk	0.4	2.0	3,000t	40,000DWT -15,000DWT	117	677	-	(-13m 160mx2B (-10m) 185mx5B	1	7**
Break Bulk (Domestic)	0.23	0.86	-	1,500DWT	-	-	-		(280m)	(1100m) ***
Tapioca	4.5	4.5	80,000t	142,000DWT	57	57	1,000 t/h	80	1	1/2
Sugar	0.4	1.4	20,000t	25,000DWT	23	68	1,000 t/h	20		
Molasses	0.2	0.5	20,000t	25,000DWT	9	25	500 t/h	40	1	1/3

* 1 TEU=10t Four gantry cranes are to be installed for three berth. An average throughput is about 1.2 million tons per annum.

** 1,400t per meter per annum based on the throughput at the conventional berths of Klong Toei and other ports.

*** 800t per meter per annum.

/1: ρ=0.40 (1991; 0.27) (= berth occupancy rate)

/2: ρ=0.52-0.6

/3 ρ= 0.27-0.35 (1991; 0.1-0.13)

Water Front Demand

Group	Depth (L.L.W.)	Water Front	Allowable Water Height
. Ship building and repair yard (Possibly private wharves for future factories)	(-5 m minimum) (-11 m desirable)	400 m	2.0 m /1
. Agri-bulk export terminal	(-13 m)	340 m	1.8 m /2
	(-12 m)	225 m	1.2 m
. Container terminal	(-13 m)	900 m	0.75 m /2
. Break bulk terminal	(-13 m)	395 m	0.75 m /2
. Quaywalls for domestic shipping	(-5 m)	280 m	0.3 m
. Basin for auxiliary port ships/3	(-3 - 5 m)	-	0.3 m

/1: The ship building facilities will not require a sheltered area if the wave height is less than 2 m, but the bulk carriers in the agri-bulk terminal are more sensitive to wave action.
/2: NEDECO Study, 1978.
/3: Such as tugs, pilotboats, water and bunker oil supply boats, lift barges and dredgers.

3.3.5 Labor and Land Requirement

Number of employment to be generated as a result of various port activities was broadly estimated at 14,000 in 2001. Estimation was made referring to the past records of Kobe Port in Japan which indicated that around 0.9 persons were required for handling 1,000 t of cargoes.

3.3.6 Alternative Layouts

Two alternative layout plans were analyzed. One is a pier type layout and the other an island type layout. The former is almost the same layout as the original pier type layout proposed in the NEDECO Study of 1978 except the deep berth for the heavy industries.

The latter aims at preserving the natural coastal line to be utilized for a park adjoining to the existing sea shore. The port is separated

from the land and the customs area is free from the persistent troubles at the port area in general.

The layouts for the two types are shown in Figures 3.3.3 and 3.3.4. The cost of the pier and the island type were calculated at 13,000 and 14,070 x 10^6 respectively.

The result of discussions on the comparison of two types of layout is summarized in the following table. Based on this consideration the pier type was chosen as the most suitable layout.

With some minor revisions, the pier type layout shown in Fig. 3.3.5 is proposed.

Comparison between Pier and Island Type

	Pier Type	Island Type
Construction Cost		xx 8% expensive than the pier ty in the master plan stage. Roughly 20% expensive in short term
Calmness within the harbour		x Since the turning basin near entrance is surrounded berths, the energy dispersion incident waves is less than pier type.
Compactness of layout in the short term		x The irregular shape rivet lin are exposed to the SW wave in the short term plan and the master plan, implying the cos increases for the wave protection.
Accessibility to the natural water front	x Only the shore line in the northern portion can be accessible for the general public	o The waterway can be utilized a park for the general public
		x The waterway has to be dredge about 2-3m depth from the existing bottom to keep water in the trench.
		xx It would probably be difficul to keep the water way clean i the area is intensively utilized.
Relation with the city behind	x Interference between the business area and the port area may occur. The mixing up of the land use may occur.	o An additional land can easily obtained by reclaiming the waterway.
Security of the port area	-	o Access to the port area can b completely controlled.
Connecting bridge	-	x An additional bridge may be necessary for security.

xx: disadvantageous, x: slightly disadvantageous, o: advantageous