E. Factory Lot Subdivision Plan

1. Examination Based on Existing Cases

6-35 The cases at existing industrial estates Thailand and the result of factory hearing survey carried out in the field were analyzed, and they were used as materials for examination of factory lot subdivision plan.

a. Subdivision of Bang Chan industrial estate

6-36 The mean lot area of Bang Chan Industrial Estate (52 businesses) is 6.7 Rai (10,775 m^2), and it is of relatively large scale.

6-37 When the breakdown is observed, the number of lots of 2 Rai (3,200 m^2) - 4 Rai (6,400 m^2) is the largest, and the number of these lots occupy 34.6% (18 businesses) of the number of all the lots. The share of the number of lots of 4 Rai - 6 Rai (9,600 m^2) is the second with 19.2%. The number of businesses having lots of areas of 6 Rai or less occupies 55.7% of the number of all the businesses in this industrial estate. The minimum lot area of this industrial estate is 1 Rai (1,600 m^2), but the number of lots of such an area is only one, and 2 Rai is considered to be the most optimum scale. As for large lot areas, the number of businesses having lots of 20 Rai (32,000 m^2) or more occupies 9.6% of all, and the maximum scale is 52 Rai (83,200 m^2) of an automotive business.

6-38 As for the category of business, transportation machinery is the largest with mean lot area of 25.3 Rai (40,407 m^2). Besides, metal and machinery 11.2 Rai (17,894 m^2), furniture 9.3 Rai (14,946 m^2), plastics 9.3 Rai (14,896 m^2), and construction material 8.0 Rai have large lot areas.

Table 6-1 DISTRIBUTION OF LOT AREA BY SCALE

Size of Lots	No. of Businesses	Component Ratio (%)
1 Rai (1,600 m^2) or less	0	-
1 - 2 Rai (3,200 m^2)	1	1.9
2 - 4 Rai (6,400 m^2)	18	34.6
4 - 6 Rai (9,600 m^2)	10	19.2
6 - 8 Rai (12,800 m^2)	7	13.5
8 -10 Rai (16,000 m^2)	3	5.8
10 -14 Rai (22,400 m^2)	5	9.6
14 -20 Rai (32,000 m^2)	3	5.8
20 Rai or more	5	9.6

Source : JICA Team

b. Scale of factory land surveyed at factories in the vicinity of Bangkok

6-39 The mean land scale obtained as a result of factory survey (111 businesses) was 6.7 Rai. When one textile business (having an area of 90 Rai) is excluded, the average is 5.9 Rai, which is less than that of Bang Chan Industrial Estate.

6-40 As for classification by size, the number of small size factories of 1 Rai - 2 Rai is the largest with the share of 22.5% (25 factories), and 18% (20 factories) of 2 Rai - 4 Rai, 17.1% (19 factories) of 1 Rai or less follow, and the number of factories of 6 Rai (9,600 m^2) or less occupies 70.2% of all the factories. The number of factories of 20 Rai (32,000 m^2) is 6.3% (7 factories) of all.

6-41 When the figures are observed by the type of industry chemical is of the largest size with the average of 23.5 Rai, and food of 6.7 Rai, ceramics of 6.52 Rai and textile of 4.75 Rai (around 1.0 ha) follow.

6-42 When the figures are observed by the area, the mean factory land area of businesses located in Samut Sakhon is 18.29 Rai (2.9 ha), which is considerably larger than those in other areas. The next large scale is 10.3 Rai (1.6 ha) of Phra Pra Daeng.

Table 6-2 DISTRIBUTION OF FACTORY LAND BY SIZE

Size of Lots	No. of Businesses	Component Ratio (%)
1 Rai (1,600 m^2) or less	19	17.1
1 - 2 Rai (3,200 m^2)	25	22.5
2 - 4 Rai (6,400 m^2)	20	18.0
4 - 6 Rai (9,600 m^2)	14	12.6
6 - 8 Rai (12,800 m^2)	9	8.1
8 -10 Rai (16,000 m^2)	2	1.8
10 -14 Rai (22,400 m^2)	10	9.0
14 -20 Rai (32,000 m^2)	5	4.5
20 Rai or larger	7	6.3

Source : JICA Team

c. Summary

6-43 Although mean lot area was 6.7 Rai in both cases described above, there is a considerable dispersion in size in the factory survey. Although the share of the number of business having lots of 6 Rai or less was about 60% in Bang Chan Industrial Estate, it was about 70% in the factory survey, and the number of businesses having lots of 2 Rai or less occupies about 40% of the total in the factory survey.

6-44 Textile industry, which is considered as the main category of business to make entry into SIE, is not located at all at Bang Chan Industrial Estate, but textile factories were main factories in the factory survey.

6-45 When both cases are rearranged by the composition of category of business to be introduced to SIE, it is as shown in the following table.

Table 6-3 COMPARISON TABLE

Category of Business	Bang Chan I.E.			Factory Survey		
	Mean	Maximum	Minimum	Mean	Maximum	Minimum
	Rai	Rai	Rai	Rai	Rai	Rai
1. Textile	-	-	-	4.75 (7.18)	30.0 (90.0)	0.2
2. Metal and machinery	11.2	16.0	6.4	2.86	10.0	0.4
3. Food	6.5	11.7	3.4	11.3	35.0	0.75
4. Chemical	5.9	29.6	2.0	23.5	50.0	4.0
5. Rubber	-	-	-	4.8	10.0	0.25
6. Wood and furniture	9.3	21.8	2.9	6.73	35.0	0.75
7. Ceramics	6.1	17.0	2.0	6.52	30.0	0.75
8. Paper	3.4	-	-	12.0	-	-
9. Electrical & Transportation machinery	6.5 25.3	10.4 52.0	2.0 4.0	0.83 3.0	1.2 4.0	0.28 2.0
Overall mean	6.7	-	-	6.7	-	-

Source : JICA Team

2. Standard Unit of Factory Lot

6-46 In the case of an existing industrial estate, it was found that planning is made with the minimum unit of 2.0 Rai (3,200 m^2). Out of the businesses visited during the factory survey, the mean lot size of businesses excluding those in Changwat Samut Sakhon is relatively small as 4.4 Rai (total of 94 businesses was 412.9 Rai) and the number of businesses having lots of 2 Rai or less occupies 40% of all the businesses. It is considered necessary, from the result of observation of these figures, to secure the minimum lot area of around 2.0 Rai (3,200 m^2). Furthermore, factories having lot of 1 Rai (1,600 m^2) or less are observed in all categories of business, and it is necessary to prepare standard factories for accepting transfer of these petty businesses. From the consideration described above, the standard units at SIE were determined as follows.

1	3,000 m^2 (50 m x 60 m)
2	6,000 m^2 (100 m x 60 m)
3-1	12,000 m^2 (100 m x 120 m)
3-2	12,500 m^2 (100 m x 125 m)
4	25,000 m^2 (200 m x 125 m)
5	50,000 m^2 (200 m x 250 m)

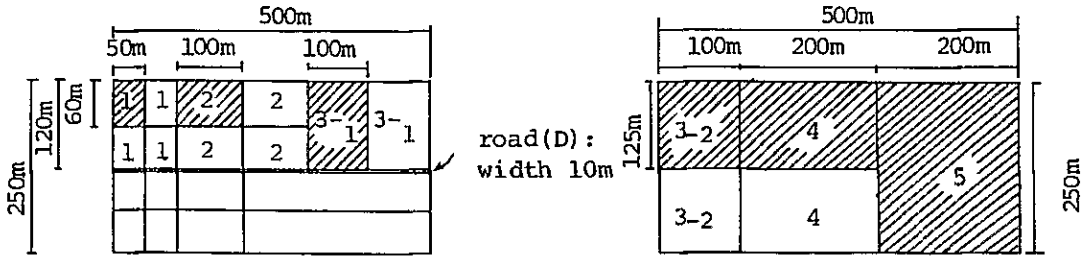

Fig. 6-7 MODEL OF STANDARD UNITS

Lot subdivision was made based on the rule of arranging factories of relatively large scales in the outer area of the industrial estate (along R-3242 and railway) and of arranging factories of small and medium scales in the inner area (see Fig. 6-8).

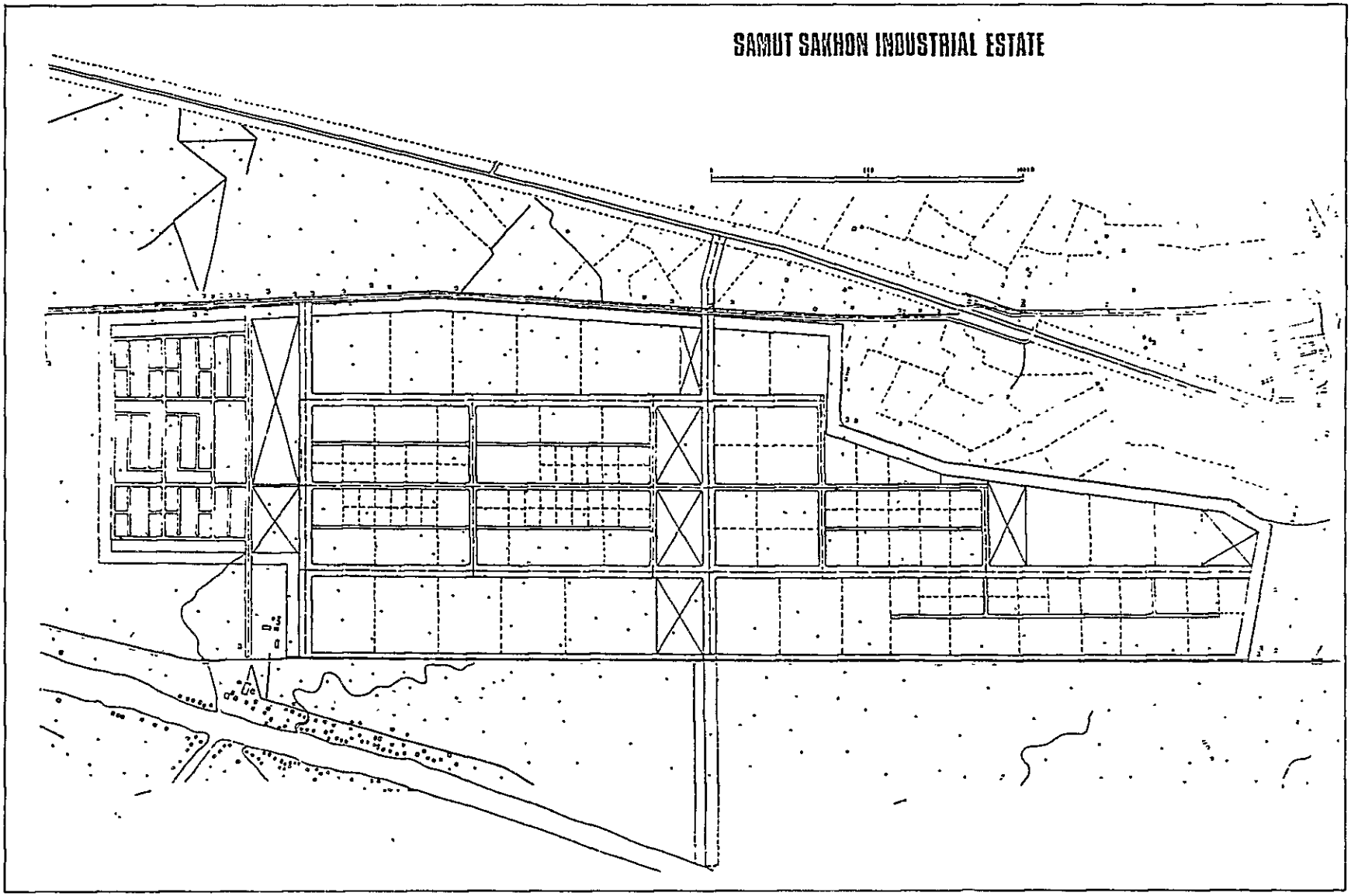

Fig. 6-8 FACTORY LOT SUBDIVISION PLAN

3. Standard Factory Buildings

6-47 The standard factory buildings are those pre-built buildings on standardized specifications in lot shape, style and size of building complete with all of electric power supply, water supply and discharge, lighting fixture, natural lighting, ventilation and snitation. The purpose of provision of these standard factories is upbringing of small and petty businesses, and allow them to use such building space on retal basis.

6-48 For establishment of the size, the result of the factory survey was used as the reference. The number of businesses which are willing to move to SIE was 29 (two items, i.e., "yes" and "likely to move"). The number of business of lot area of 1 Rai or less was 9 (31.0%) out of them including 7 businesses of lot area of 0.6 Rai (960 m^2) or less with minimum size of 0.2 Rai (320 m^2). If it is assumed that the total number of businesses to make entry into SIE is around 150 and is further assumed that about 20% of them make entry to the standard factories, the number of businesses to make entry into standard factories will be around 30.

6-49 Two types can be considered as for the size of standard factory building. A type will be of building area of 500 m^2 with lot area of 1,200 m^2. B type will be of building area of 300 m^2 with lot area of 780 m^2. Model plans are shown as follows (see Fig. 6-9, 6-10).

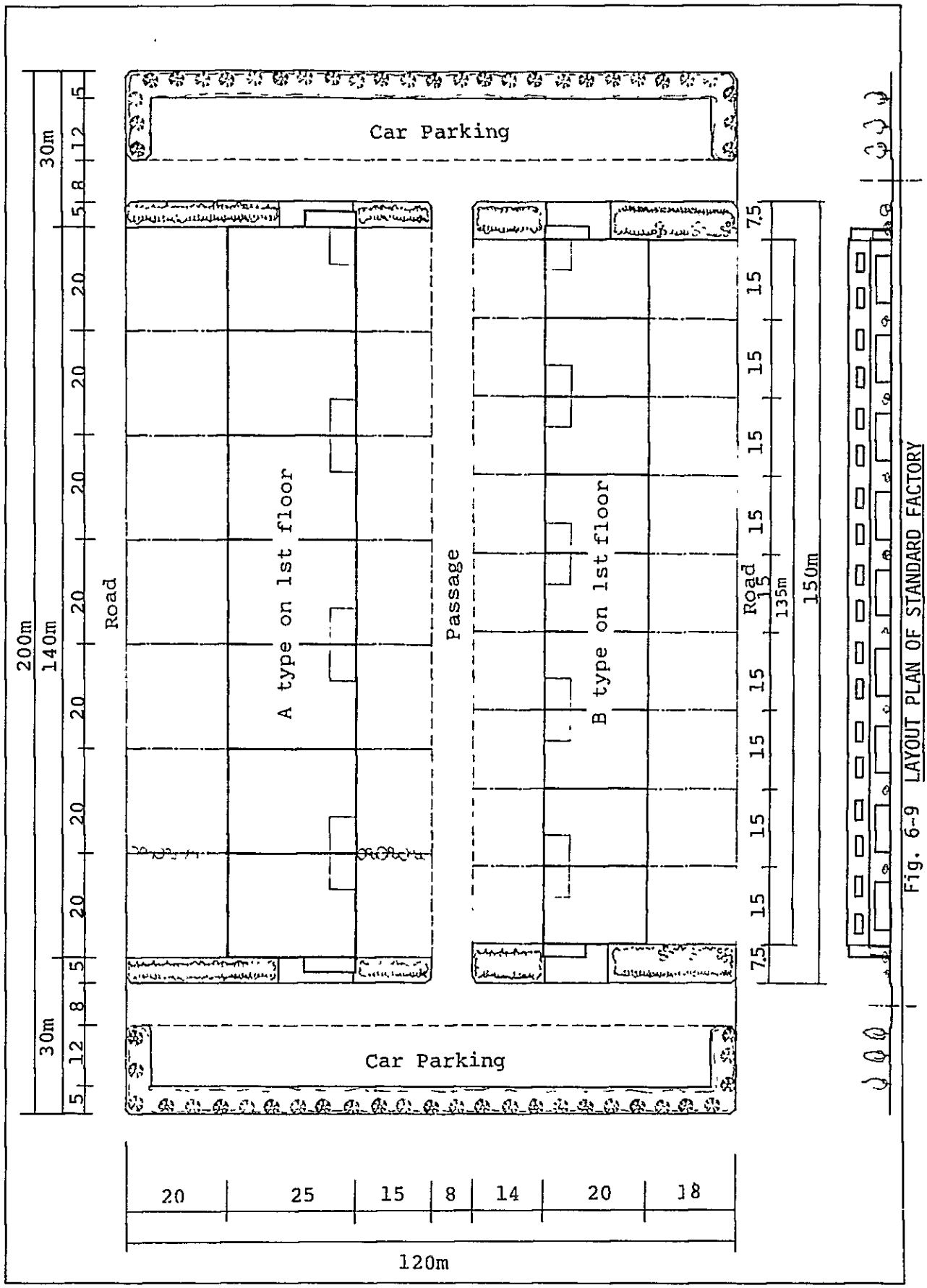

Fig. 6-9 LAYOUT PLAN OF STANDARD FACTORY

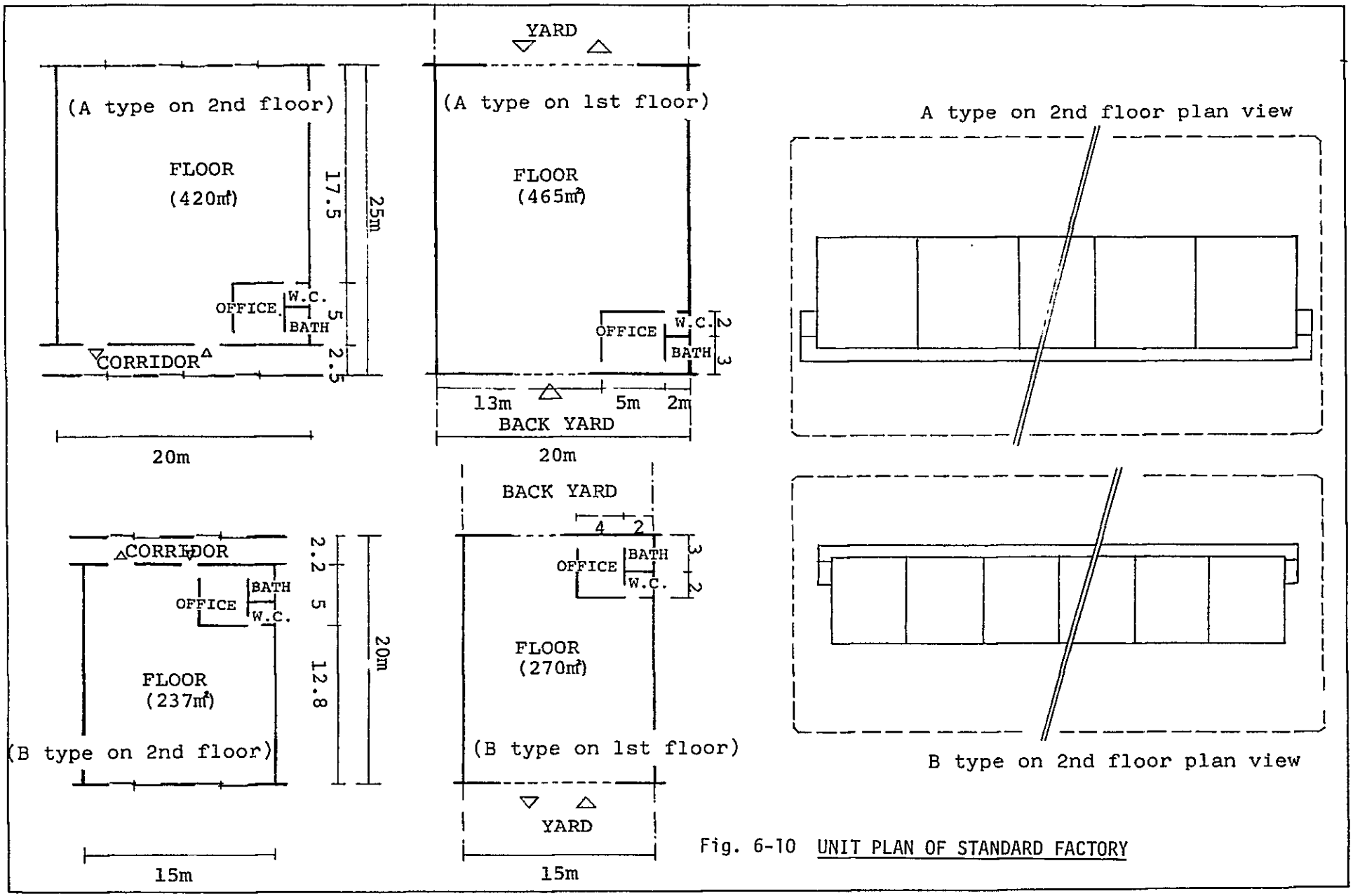

Fig. 6-10 UNIT PLAN OF STANDARD FACTORY

F. Planning of Main Facilities

1. Examination of Facilities

6-50 Discussions were made with the staffs of IEAT regarding main facilities required for the industrial estate during the field survey. The contents and size of the required facilities were studied based on the result of these discussions.

a. Facilities required for administration of the estate

The administration center will be provided with the aim of unitization of operation and administration of the industrial estate, and an office of IEAT (with office, meeting room or assembly hall, exhibition room, training room, library and parking area introduced) will be provided. Furthermore, a repair workshop will further be provided.

b. Facilities for public services

Post office, fire station, security office (guardmen's station), bus stops and so forth will be provided as the facilities for providing public services. Facilities other than bus stops will be located at the main center.

c. Facilities for commerce and services

Bank, shops, restaurants and gas filling station.

d. Facility for health care

Clinic (to be located in the main center)

2. Contents and Size of Facilities

6-51 a. Administration

i) IEAT office

Composed of departments of operation and management of the industrial estate, planning, public relations and so forth. The required area for 30 staff members is 300 m^2 (total floor area) including offices and meeting room.

ii) Assembly hall

A hall which can be used for lectures, movies and for entertainment will be provided. The required area is 500 m^2 if the capacity of 300 persons is assumed.

iii) Exhibition room

This room will be of the size that can be used for small meetings, training and practice besides exhibitions. The required area is 100 m^2 if the capacity of 50 persons is assumed.

iv) Training room

Two rooms (50 m^2 x 2), each for 10 - 15 persons, will be provided. The required area is 100 m^2.

v) Library

A library for 20 - 30 persons will be provided. The required area is 100 m^2.

vi) Repair workshop

A workshop capable of performing maintenance and repair of all the facilities in the industrial estate will be provided. The required area is 300 m^2 if 5 persons are to work here.

vii) Parking area

A parking area of 1,800 m^2 will be provided. (480 m^2 for passenger cars, 1,290 m^2 for small buses, and 60 m^2 for bicycles)

6-52 b. Public service facilities

i) Post office

100 m^2

ii) Fire station

Management will be made by the municipal government of Samut Sakhon, and will be equipped with two fire engines (one out of them will be chemical fire engine), an ambulance, an equipment storage room and dispatch preparation room. Total required area is 200 m^2.

iii) Security office

The required area is 50 m^2 for office and anteroom if two or three guardmen are to be stationed.

6-53 c. Commerce and service facilities

i) Bank

Bank office : 60 m^2

ii) Shops

Retailers of food, clothing, stationary, sundry, etc. The required area is 100 m^2.

iii) Restaurant

A restaurant of the capacity of 300 persons (turnover 2 times). Total required area is 300 m^2.

iv) Gas filling station

A gas filling station of a large scale requires the area of 500 m^2.

v) Clinic

The required total floor space is 200 m^2 for periodical health examination, for routine treatment of sicknesses and for emergency treatment for about 16,500 employees of the industrial estate, based on the assumption that the number of patients is 50 persons per day.

6-54 d. Sub centers

Sub centers, each having the following facilities, will be provided at two places. The area is 0.5 ha at one place, 1.0 ha in total.

i) Small meeting room

For 10 - 15 persons, also used for training. 50 m^2

ii) Small hall

For 50 persons. 100 m^2

iii) Shops

70 m^2

iv) Restaurant

For 200 persons (turnover 2 times). 200 m^2

v) Parking area

G. Layout Planning

1. Method of Layout

6-55 It can be anticipated that lots of the total of 1,200 Rai (192 ha) will be demanded as factory lots, and in addition, estimated composition of types of industry has also been clarified. The businesses expected to make entry into this industrial estate can be generally classified into nine types are already described, and the size of each one of these types has also been assumed. Representative types of business expected to make entry into SIE are textile and clothing, machinery and metal, food and chemical (secondary products). Then these ten types of business (others were divided into two types) were examined from the standpoints of working conditions, transportation characteristics (bring in and out of raw materials and products as well as their dimensions), lot utilization (factory building, appearance, image) as well as of environmental disruption such as water discharge volume, water quality, noise, vibration, odor and dust emission of each type of industry.

Table 6-4 EVALUATION BY TYPE OF INDUSTRY

	Workers' Density	Dependency on Heavy Truck	Appearance and Image	Water Discharge Volume	Water Quality	Vibration and Noise	Odor	Dust Emission	
1. Textile	higher			higher	not good				2 places; east and west sides of water treatment plant
2. Metal and machinery				high	not good	higher			East side toward R-3242
3. Food				higher	not good	high	higher		East side in central part
4. Chemical				hgih	not good		high		West side toward R-3242
5. Rubber	higher		bad				higher		East side toward bottom
6. Wood and furniture	higher		not good			higher			West side in central part
7. Ceramics		high	bad			higher		much	East side toward bottom
8. Paper	high								West side toward main center
9-1 Electrical		high	good						East side toward access road
9-2 Transportation machinery		high	good						

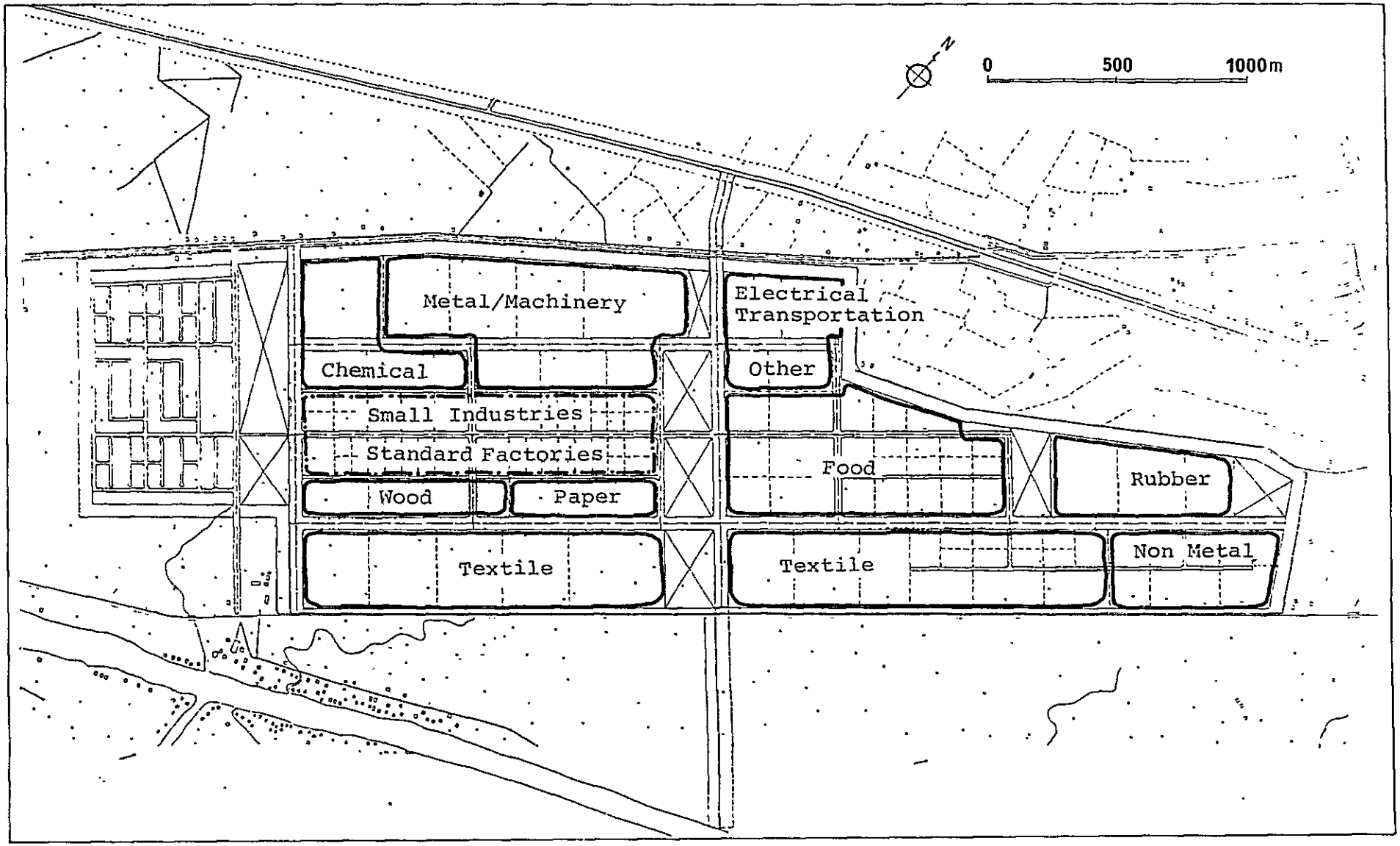

Fig. 6-11 SITE LAYOUT BY TYPE OF INDUSTRY

2. Layout Plan

6-56

- Businesses of textile and clothing will be located at two places on east side and west side toward railway with the waste water treatment plant as the center, with the fact that the largest land demand is expected and also with water discharge volume and water quality taken into account.
- Businesses of metal machinery will be located in the west block along R-3242, because it is of the second largest land demand, although they involve environmental disruption sources such as noise and vibration.
- Businesses of food will be located in the central part of the east block close to the waste water treatment plant with water quality and odor taken into account.
- Businesses of chemical will be located in the west block toward R-3242.
- Businesses of rubber will be located in the deep portion of the east block with wind direction taken into account.
- Businesses of wood and furniture will be located in the central portion of the west block.
- Businesses of ceramics will be located in the east block toward railway (because dust emission may occur).
- Businesses of paper will be located in the central portion in the west block.
- Businesses of electrical and transportation machinery will be located along the access road from the standpoint of product image and appearance.

H. Composition of Land Use

6-57 The composition of land use is as follows.

Table 6-5 COMPOSITION OF LAND USE

1. Industrial estate area			
	Total	291.15 ha	1,819.7 Rai
Factories sites		200.62	1,253.8 (68.9%)
Roads		39.95	249.7 (13.7%)
Parks and greens		11.80	73.8 (4.1%)
Dike		24.70	154.4 (8.5%)
Utilities		10.78	67.4 (3.7%)
Administration		3.30	20.6 (1.1%)
2. Residential area			
	Total	42.39 ha	265.0 Rai
Housing (including road)		25.88	161.8 (61.1%)
Roads (Main)		2.31	14.4 (5.4%)
Greens/Recreations		4.78	29.9 (11.3%)
Dike		6.72	42.0 (15.8%)
Shopping center		1.00	6.3 (2.4%)
Primary, Kindergarten		1.70	10.6 (4.0%)
3. Total		333.54 ha	2,084.7 Rai

Ⅶ. BASIC DESIGN

VII. BASIC DESIGN

A. Land Preparation and Storm Water Drainage

1. Reclamation Policy

7-01 The average elevation of the site from para. 2-13 is being +1.1 m. There are 2 possible methods of design under these circumstances, both allowing a margin of about 30 cm to cope with the floods which have reached a maximum level of +1.9 m in the past. The first of these methods is to fill the whole area up to +2.2 m, and the second is to build a +2.2 m bund around the perimeter and drain the water out with pumps. In the case of Bang Chan I.E., the tenant enterprises drew up an agreement on the height of the reclamation and employed the first method. In the case of Lat Krabang I.E., however, IEAT is using the second method.

7-02 Initial cost for the first method (filling the whole area) are estimated at approximately Baht 110 million, even when local materials are used, and at Baht 55.3 million for the second method. Maintenance, running costs and depreciation on the drainage pumps would be Baht 3.2 million p.a. If the whole area were to be filled, consolidation settlement would necessitate additional filling after about 5 years. This would represent an annual cost of Baht 17.2 million p.a. NPV over the 15 years period of the project, with an annual interest rate of 10%, would be Baht 182 million for the first method and Baht 82 million for the second. The second method is therefore more advantageous.

Table 7-1 COMPARISON OF LAND PREPARATION COST

	Land fill	Dike and Pump
Initial cost	Embankment 1.1m x 332ha x 30 = Baht 110 Million	Dike, Bund and Pump 40.6 1 / Land 184 Rai x 80,000 = 14.7 Total Baht 55.3 Million
Maintenance Cost	0.55m x 332ha x 30 = Baht 86 Million 86/5years = Baht 17.2 Million p.a.	20% for pumping facilities 8.86 x 0.2 = Baht 1.8 Million p.a.
Operation Cost		Power 0.94 x 1,500hours x 60KW = Baht 0.08 Million p.a. 92 x 8sets x 60KW x 12months = Baht 0.04 Million p.a.
Depreciation		10 years for pumping facilities Baht 1.24 Million p.a.
Total	Baht 17.2 Million p.a. for 5 years	Bath 3.2 Million p.a. for 15 years

Note : These costs are estimated only for the comparison of land fill and dike/pump system.

1 / See Cost Estimate

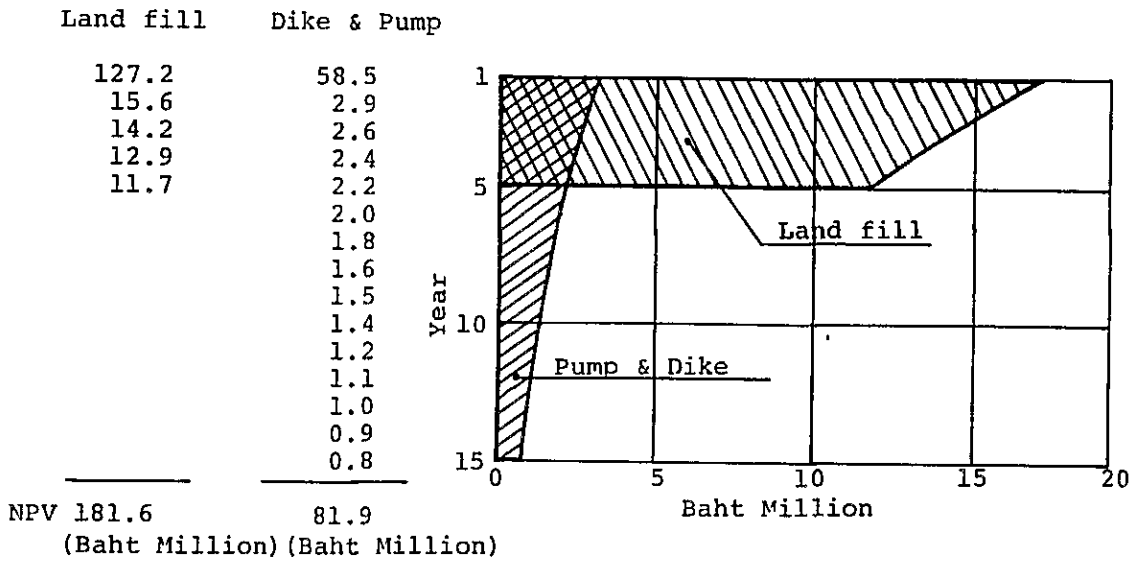

Fig. 7-1 COMPARISON OF LAND PREPARATION COST

7-03 Furthermore, the procurement of the 4 million cum of earth which would be needed to fill the whole area would be extremely difficult in Samut Sakhon, and the proportion of project costs taken up by the cost of reclamation would probably reach 20%. Taking these facts into account, it would seem more desirable to employ the second method.

2. Bund

7-04 Consolidation settlement is likely with bund or if the whole area is filled. The rough calculations for 1 m, 2 m and 3 m banking heights by Terzaghi and using soil survey data 1 / obtained during the construction of R-35 was carried out. The results are shown in Table 7-2. For a final banking height of 1.1 m, it is necessary to allow for settlement of approximately 52 cm 2 /

Table 7-2 EMBANKMENT HEIGHT AND SETTLEMENT

Initial Embankment Height (m)	Final Settlement (m)
1.0	0.27
2.0	0.68
3.0	1.01

Table 7-3 EMBANKMENT HEIGHT AND CONSOLIDATION PERIOD

Initial Embankment Height (m)	Consolidation Period for 52 cm Settlement (days)	Remarks
1.52	400	for 90% Settlement
2.0	250	
3.0	98	

1 / Refer to Annex 7-1, page 1 2 / Refer to Annex 7-1, page 2

7-05 The surchage method would be effective in obtaining this 52 cm settlement quickly. This method involves carrying out extra filling initially to accelerate consolidation, and removing this extra fill when the desired amount of settlement has been obtained. To complete this during the 6 months of the dry season, it would be necessary to carry out initial banking of approximately 2.6 m 1 /. Since the site is prone to consolidation and has a negligible N value, it will also be necessary to consider the stability when carrying out banking. According to the results 2 / of studies, there is a possibility of circular failure in comparatively shallow layer during initial banking, even with banking of only 2 m. To avoid this failure, it will be necessary to carry out the banking over a period of more than 3 months, to secure the increase of cohesion of the ground by the progress of consolidation. When R-35 was constructed, it took approximately 100 days to achieve the final banking height of 3 m.

7-06 The above-mentioned studies led us to design configurations for bunds as shown in Fig. 7-2. Banking would be carried out over 2 months and left for 3 months. The extra fill would be removed at the end of this time. Bunds will be constructed around SIE, except in the section adjoining the Mae Klong Railway, where the railway itself will act as a bund.

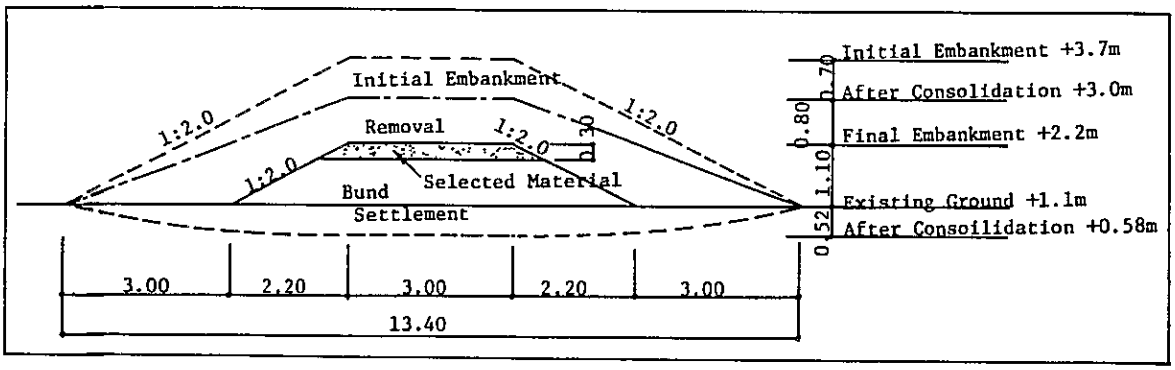

Fig. 7-2 TYPICAL CROSS SECTION OF THE BUND

3. Dikes and Drainage Pumps

7-07 Rainwater falling inside the site will be collected in dikes dug on the inside of the bunds and drained outside by drainage pumps. Large capacity pumping installations would be needed for the rapid removal of rain falling over short periods. Dikes, by accumulating rainwater, perform the dual functions of reducing the pumping capacity required and spreading out the operating time.

7-08 The dikes and pumps will have the capacity to drain rainwater over a 24 hours within 24 hours. They will be designed according to the following stipulations:

i) Return Period : 10 years

1 / Refer to Annex 7-1, page 3
2 / Refer to Annex 7-1, page 4

ii) Rainfall Intensity : Probable rainfall intensity for the return period of 10 years in Fig. 2-5 will be approximated according to Talbot.

$i=\frac{7700}{t+26}$ where i is rainfall intensity (mm/h) and t is duration (min.)

iii) Run-off coefficient : c = 0.7

iv) Catchment area : A=331.6 ha.

The total volume of run-off over a 24-hours, therefore, would be 293,000 cum 1 /, and the required reserve capacity for the dikes 130,000 cum 2 /. To reserve this amount of water it will be necessary to enclose an area of 14.3 sqm using 9,200 m of dikes. The required pumping capacity will be 205 cum/min., and the water will be drained via 4 pumping stations.

7-09 A study of water levels at the end of each channel according to the level of water at the pumping stations when the pumps are switched on was carried out with a reaching time of 30 min. The results are shown in Annex 7-2. This study revealed that varying the level at the pumping station between 1 and 2 m had little effect on levels at the ends of channels, but that changes between 2 and 3 m at pumping stations made a considerable difference. On the basis of these facts, the maximum level for commencing pump operation was set at 2 m and the size of the various channels was decided. (see Fig. 7-3)

7-10 4 pumping stations, each with a capacity of 60 cum/min. will be required. However, these figures represent the necessary capacity to cope with a level of rainfall which will likely occur once in 10 years, and smaller capacity installations would be sufficient for shorter periods (e.g. approx. 40 cum/min. once every 2 years). Moreover, stand-by equipments should be provided for use during maintenance, inspection or power failures, and 2 pumps (motor and diesel) will be placed in one pumping station. These will have a capacity of 2/3 of the maximum output. It is planned to install four 1 cum/min. capacity pumps to drain water at Lat Krabang I.E.

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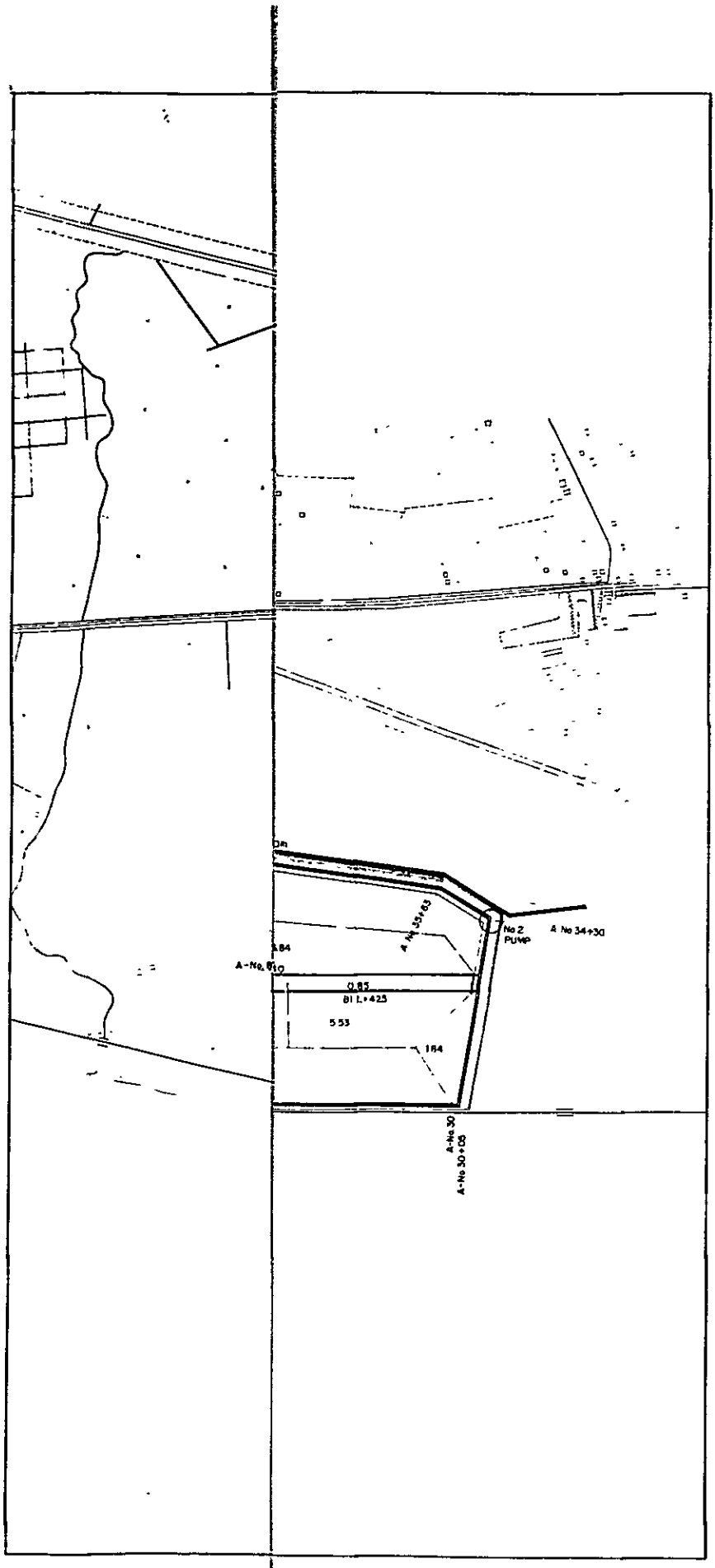
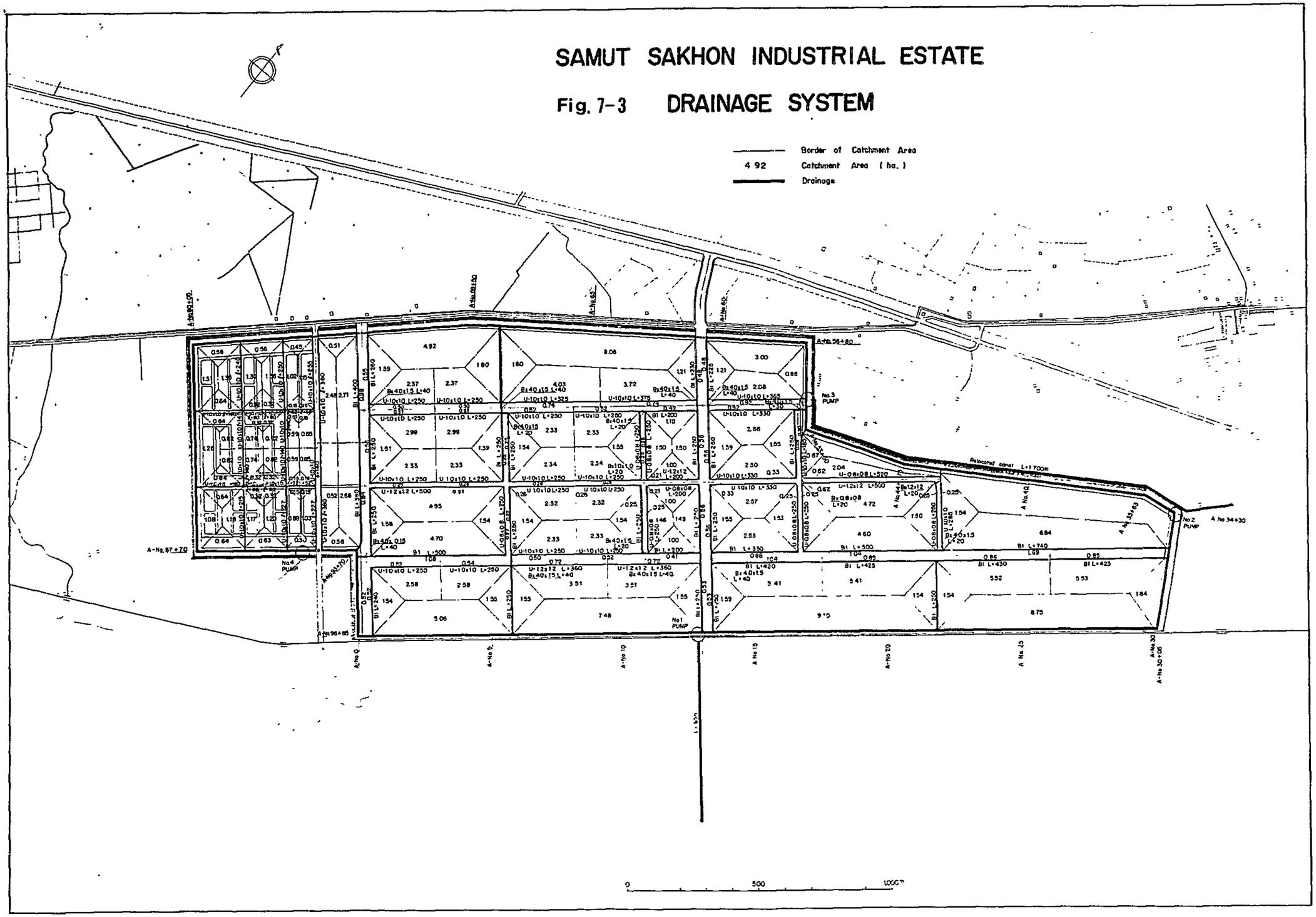
1 / Outflow volume $Q = C \times i \times A$

2 / Reserve Volume : $C.a.A/6(1-\frac{b}{t}\ln\frac{t+b}{b}-\frac{b}{2(t+b)})$, $i=b/(t+a)$


No 2
PUMP
A No 34+30
A No 35+63
A-No 30
A-No 30+05
0.85
5.53
1.84

SAMUT SAKHON INDUSTRIAL ESTATE

Fig. 7-3 DRAINAGE SYSTEM



B. Transportation

1. Generated Traffic Volume

7-11 The volume of cargo which will be generated from SIE was estimated by types of factories and amounts to approximately 6,000 tons per day, as shown in Table 7-4. An analysis of modes of transport around Bangkok reveals that approximately 3/4 of cargo is carried by truck, and this trend is likely to continue in the future. Truck loading volumes, according to a 1979 survey, are shown in Table 7-6. These figures include trucks travelling empty. The 6,000 tons of cargo per day generated by SIE is allocated on the same basis, and traffic volume was estimated to 1,726 vehicles per day for both directions (see Table 7-7).

Table 7-4 DAILY PRODUCT BY TYPE OF INDUSTRY

Type of Industry	No. of Workers	Productivity (Kg/Worker)	Product (t/day)
1. Textile	7,020	189.5	1,330
2. Metal & Machinery	2,112	976.4	2,062
3. Food	1,512	189.5	287
4. Chemical	1,308	517.0	676
5. Rubber	1,260	517.0	651
6. Wood & Furniture	1,080	96.8	105
7. Non Metal Mineral	840	308.1	259
8. Paper	468	96.8	45
9. Elec. & Etc.	612	976.4	598
Total	16,212		6,013

Table 7-5 MODAL SPLIT

Mode	Percentage
Truck	76.0
Railway	1.6
Inland Waterway	22.4

Source : Transportation Management Information System 1976

Table 7-6 LOAD/VEH. AND COMPOSITION

Classification	Composition	Load/veh.
4-Wheel truck	35.3%	0.9 t/veh.
6-Wheel truck	46.7	2.6
10-Wheel truck	18.0	6.2

Source : DLT

Table 7-7 GENERATED FREIGHT VOLUME BY MODES

Modes	Freight(t/day)	Veh. Volume (veh./day)
1. Truck		
4-Wheel truck		609
6-Wheel truck		806
10-Wheel truck		311
Sub total	4570	1726
2. Railway	96	-
3. Inland Waterway	1347	-
Total	6013	

7-12 50% of all workers at SIE are likely to commute from outside of SIE. Modal split such as in Bang Chan I.E. suggest that 20% of these will use private cars and that of the remaining 80%, 70% will travel by pick-up truck or microbus and 30% by public bus. Taking the average number of passengers as 12 per vehicle for pick-up trucks or microbuses, 42 per vehicle for public buses and 2.3 per vehicle for private cars, it is estimated that the amount of traffic generated by commutes will be 2,300 vehicles per day for both directions.

Table 7-8 GENERATED TRAFFIC FOR COMMUTING

No. of Workers	Modes		No. of Workers	Passenger per Veh.	Traffic Volume
16,500	Commute Mass transit (50%) (80%)	Pick-up Micro bus (70%)	4,620	12	770
		Public bus (30%)	1,980	42	94
	Private car (20%)		1,650	2.3	1,435
	House Labour (50%)		8,250	-	-
Total					2,299

Note : Traffic volume for both directions

2. Study of Existing Traffic Facilities

7-13 Table 7-9 shows traffic capacity-volume ratios in terms of road traffic for existing transportation facilities linking Bangkok and Samut Sakhon, in the event that traffic generated by SIE is introduced. The most convenient of the roads which currently link Bangkok and SIE is R-4, but on R-3091 between R-4 and SIE, congestion is foreseen at present and in the future as well. The R-35 can not handle the traffic demand with the present number of lanes, but if it is expanded into 4 lanes, it will become the most satisfactory road. As far as the other roads, in their present state they will not be capable of handling the traffic generated from SIE. Also no matter which road is used, a bottle neck is likely to form at the Chao Phraya River crossing in Thon Buri. Therefore, for the purpose of better traffic distribution, the construction of the outer belt is considered to be desirable.

Table 7-9 TRAFFIC VOLUME AND CAPACITY

Road	Lane No.	Capacity (veh./day)	1979		2000		
			Traffic vol. 1/	v/c 2/	Traffic vol.	v/c(1) 3/	v/c (2) 4/
R-4	4	48,000	19,659	41.0%	43,600	90.8%	95.5%
R-35	2	9,000	7,677	85.3	-	-	-
(R-35)	4	48,000	-	-	24,100	50.2	54.9
R-3091	2	8,000	7,708	96.4	24,200	302.5	423.3
R-3043	2	8,000	less than 1,000	-	less than 1,000	-	133.3
R-3243	1	500	less than 1,000	-	less than 1,000	-	797.2

1/ Source of future traffic volume: DLT Bangkok Truck Terminal Project
2/ v/c : Traffic volume - Capacity Ratio
3/ v/c(1) : v/c by normal traffic
4/ v/c(2) : v/c by normal traffic and generated traffic from SIE

7-14 The Mae Klong line in its present operational condition (Refer to para. 2-48) is quite low in its functional value, but if it were to be extended to cross the Chao Phraya River to join with the built up area of Bangkok, it is likely that its usage would increase for commuting purpose. Also from the fact that the railway demand at present is about 100 tons per day (equivalent to 6 freight train cars) and also because heavy trucks are presently restricted from entering the city limits of Bangkok from 6-9 a.m. and 3-9 p.m., the reconsideration of railway transport is desirable for the purpose of relieving the traffic situation inside the city of Bangkok.

7-15 Among the canals which connect Bangkok and Samut Sakhon, Khlong Phasi Charoen provides inland water transport only during ebbtide in order to keep the canal water fresh, therefore this canal has a limitation on its transportational capability. Khlong Maha Chai and Khlong Sahakon can be used constantly but unloading facilities are only available at the port of Samut Sakhon. It is desirable

to make attempts at the most effective use of these canals by implementing maintenance and control such as dredging. From the records in Khlong Phasi Charoen, it is estimated that there is traffic of about 90 vessels of the 20-30 ton class per day, and a water depth of over 1.5 m as well as installation of facilities for large vessels in the future are necessary.

3. Road Network within the Estate

7-16 As shown in Table 7-10, the roads within the estate were classified into 4 classes according to the function of each road. The Access/Primary roads are for the heavy vehicles and also constitute the development axis for the estate, so they were planned as divided 4 lane roads with wide shoulder for parking of vehicles arriving at the estate during the night. Thus, these roads were provided with the features of a road for exclusive use of automobiles. The Secondary roads were provided with sidewalks as the interior roads of the estate, while still keeping the features of a trunk road by being divided and 4-lane. The Tertiary road was established as an undivided 2-lane road with sidewalks, which would allow both the traffic of large vehicles and that of pedestrians. The Service roads are access roads for various industries and were provided with sufficient width for large vehicles to pass. For roads inside the housing area, by using the estate of NHA as a reference, 12 m wide Main roads and 10 m wide Feeder roads were provided.

Table 7-10 CHARACTERISTICS OF IN-SITE ROADS

Classification	Lane No.	Median	Shoulder	R.O.W	Sidewalk
Access and Primary road	4	o	full	40m	×
Secondary road	4	o	semi	40	4.0m
Tertiary road	2	×	semi	20	3.0
Service road	1	×	semi	10	×

7-17 The carriageway are to be paved with asphalt. The 5 ton equivalent axle number of $N=16.70 \times 10^6$ was estimated based upon the traffic volume occurrence of the respective vehicle classes in 10 years. From the ground base of this area as shown in Annex 2-19, the apparent cohesion at depths of 0 m - 3 m from results obtained from vane test is assumed to be 1.0 t/m^2 in natural soil conditions, and a CBR of 0.4 leads to the observation that these areas are unfit road bases for paved roadways. Therefore, the soil must be replaced or banked with a buffer layer of latelite or sand (CBR more than 10%). The thickness required is 48 cm 1 /, the required equivalent bituminous thickness is 31.4 cm 2 /, and the pavement structure is as shown in Fig. 7-4.

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1 / $H=28.0 \times N^{0.1}/CBR^{0.6}$ $N=16.78 \times 10^6$

2 / $T_A=3.84 \times N^{0.16}/CBR^{0.3}$

Table 7-11 DESIGN AXLE LOAD BY TYPE OF VEHICLE

Type of Vehicle	Axe				
	W1	W2	W3	W4	W5
Passenger car	6 t	10 t	-	-	-
Micro-bus and Pick-up	6	10	-	-	-
4-Wheel truck and Bus	6	10	-	-	-
6-Wheel truck	6	6	10	-	-
10-Wheel truck	6	9	9	9.5	9.5

Source : I.S.O.

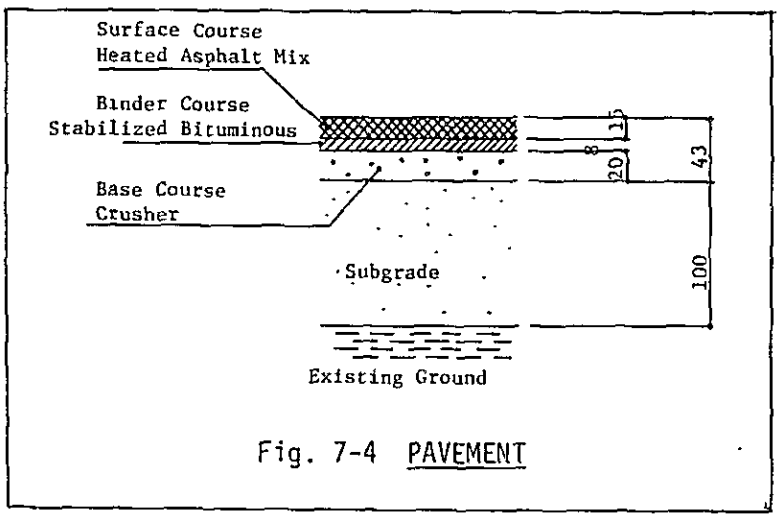


Fig. 7-4 PAVEMENT

7-18 As ancillary facilities for the roads, street lighting will be provided from the Primary roads to the Tertiary roads. Also at the intersection with R-35, a traffic signal will be required for the non-signalized intersection which cannot handle the traffic from SIE, as shown in Fig. 7-5.

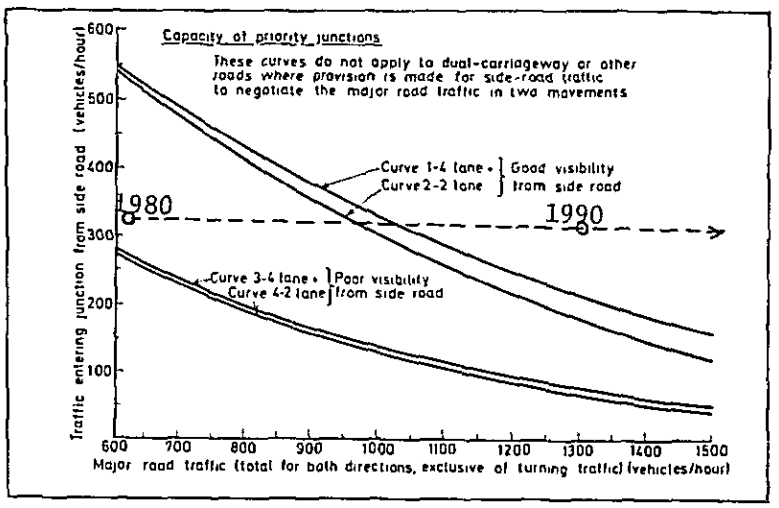


Fig. 7-5 MAXIMUM VOLUME OF SIDE-ROAD TRAFFIC THAT CAN CROSS VARYING FLOWS ON THE MAIN ROAD

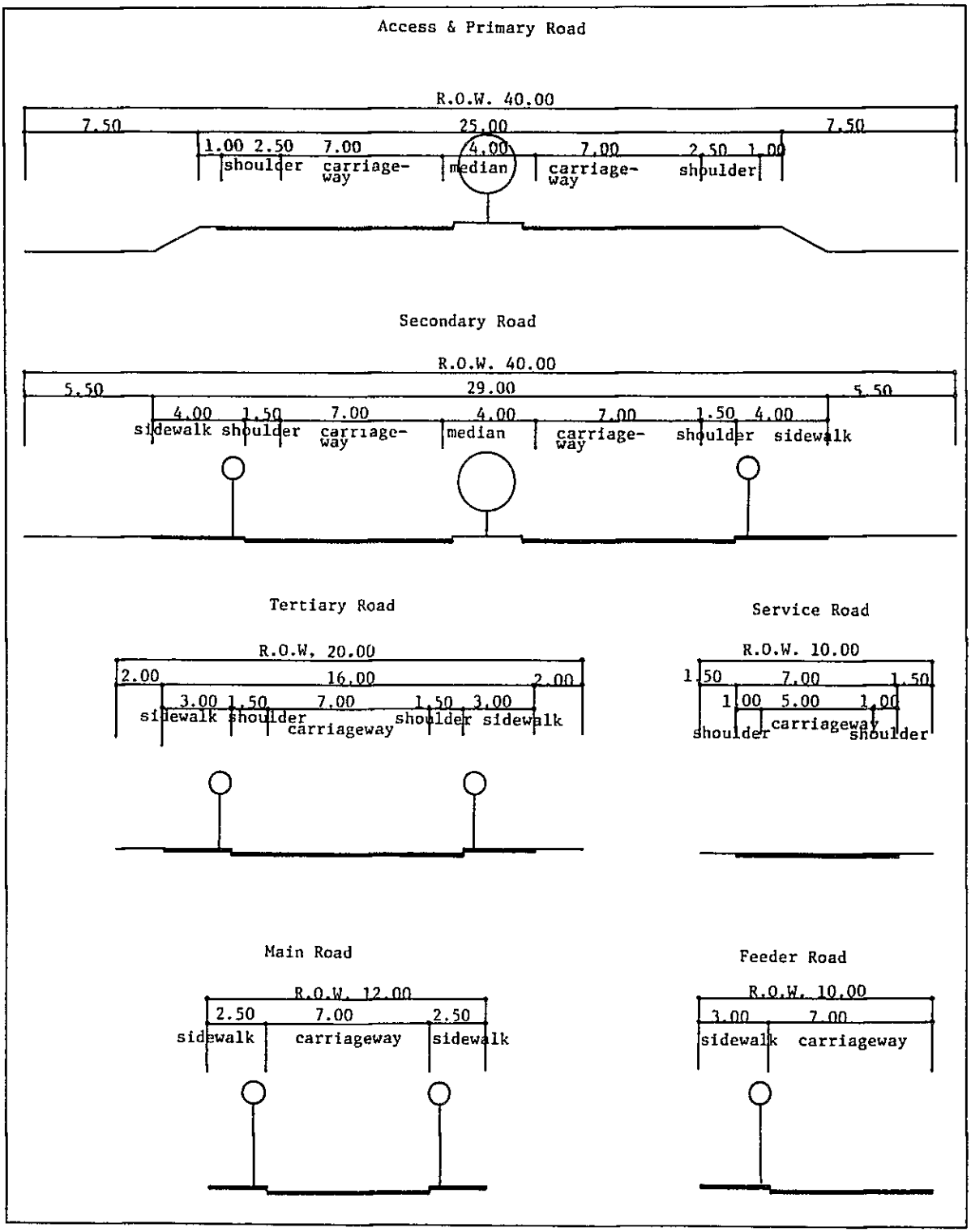
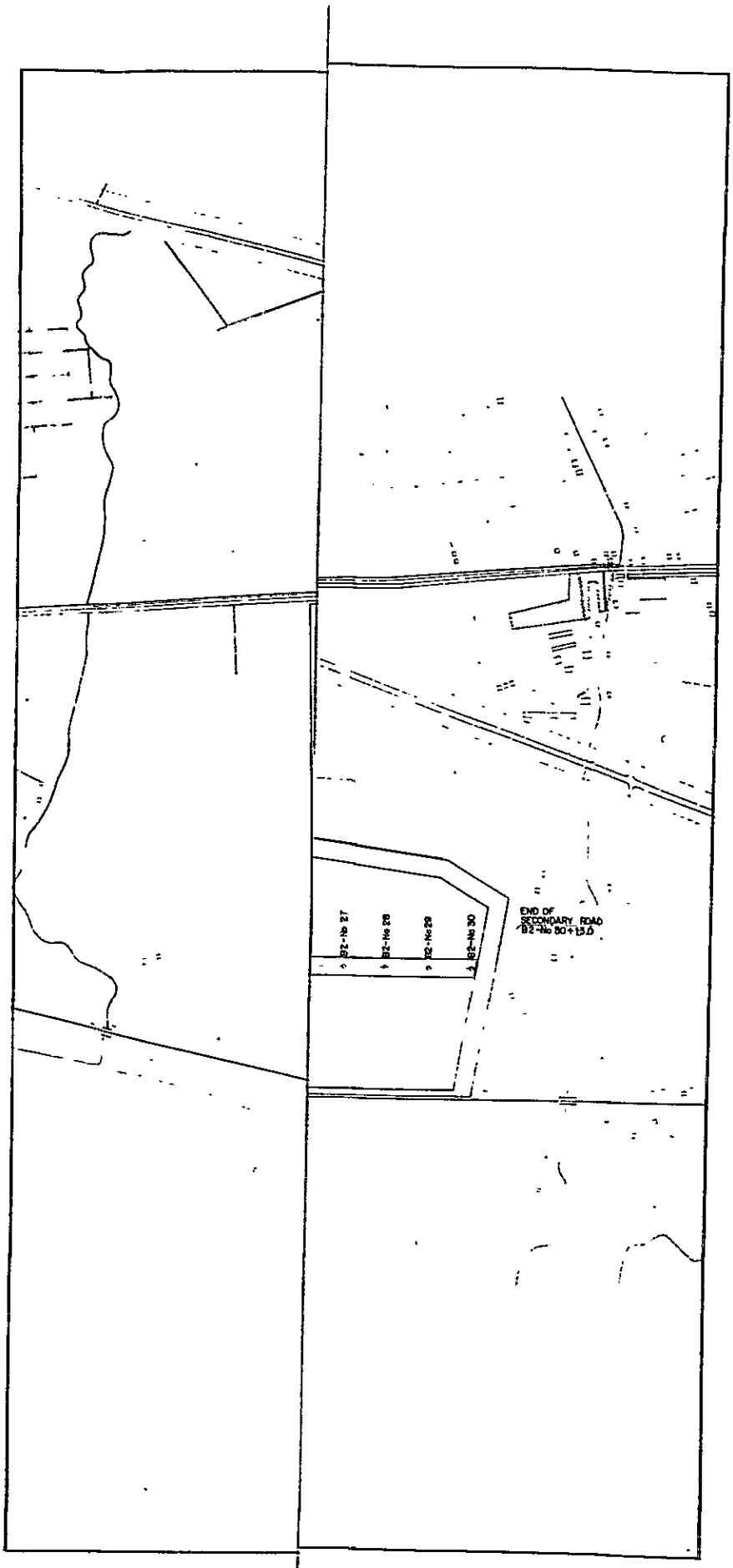


Fig. 7-6 TYPICAL CROSS SECTIONS OF IN-SITE ROADS


END OF
SECONDARY ROAD
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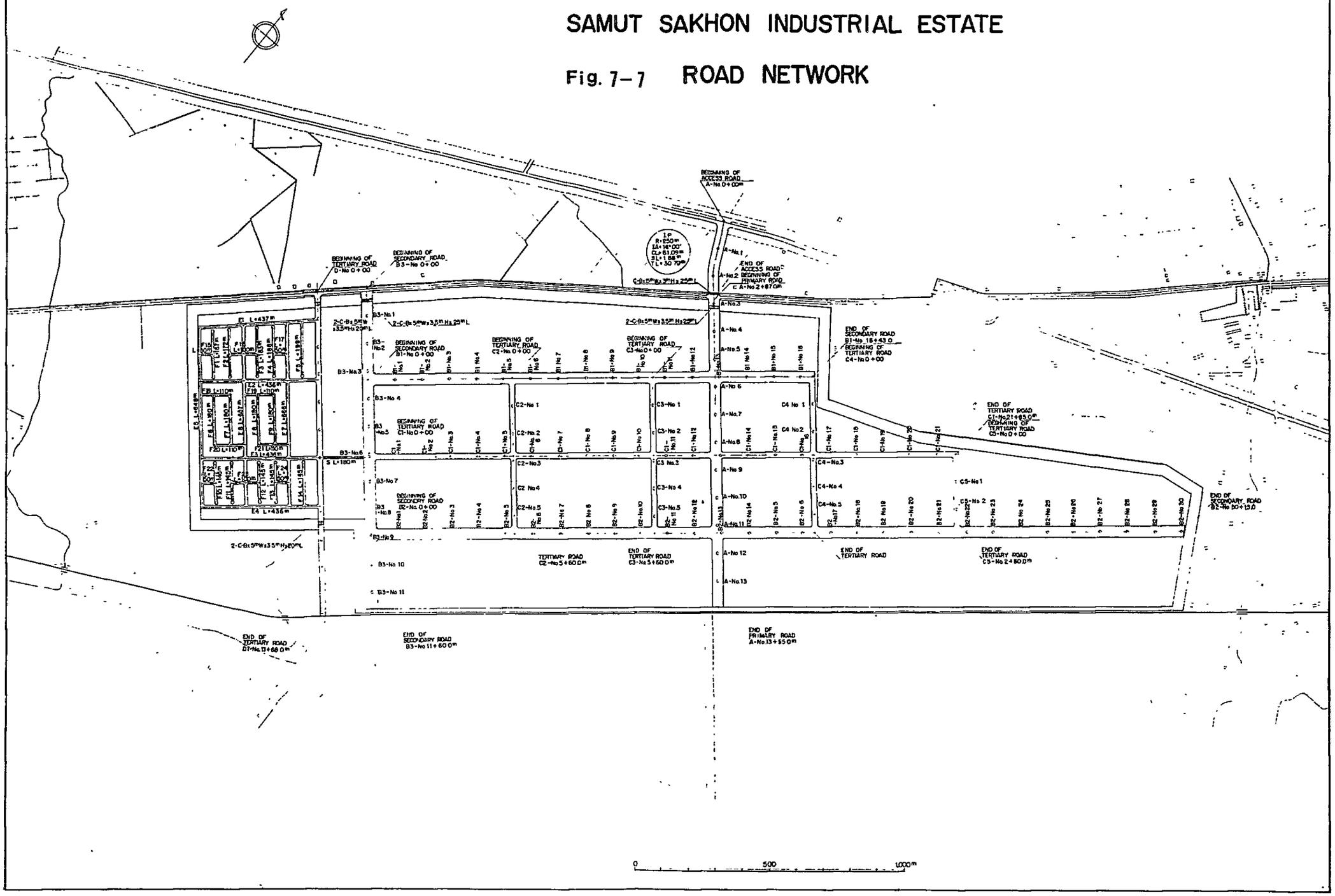
SAMUT SAKHON INDUSTRIAL ESTATE

Fig. 7-7 ROAD NETWORK



C. Water Supply System

1. Estimate of Water Demand

7-19 As mentioned in para. 2-58, Samut Sakhon does not have a water supply system prepared which utilizes surface water, and therefore there is no other alternative than to depend on underground water. Accordingly it is desirable not to invite those large water consuming industries as shown in Table 7-12 to SIE. Among those industries, dyeing industry falls in the category of textile and apparel identified as one of the expected industries as listed in Table 4-3 and others are classified as resource oriented industries and most probably will not be located in SIE. In this study, an average water demand of the dyeing industry as subclassification of textile was used and the total industrial water demand was estimated at 18,000 CMD.

Table 7-12 LIST OF LARGE WATER CONSUMING INDUSTRIES

1. Sugar manufacturing
2. Dyeing
3. Pulp manufacturing
4. Paper manufacturing
5. Chemical Fertilizer
6. Steel manufacturing

7-20 For the water demand at SIE, considerable differences arose as a result of the comparison made between the data obtained by the interview of water consumption per area for the existing factories (Case 1), the water consumption per area in the case of Japan (Case 2), and the interview results of water consumption per employee (Case 3). The water consumption of existing industrial estates is an average of approximately 90 CMD in relation to the factory sites, and when this figure is applied to SIE, water demand of approximately 18,000 CMD (Case 4) can be estimated. When this figure is then broken down into the water demand of the respective industries by the ratio obtained from Case 2, excepting the metal and rubber industries, a practically identical tendency can be observed. (Case 5)

Table 7-13 SUMMARY OF WATER CONSUMPTION BY AREA AND NO. OF WORKERS

Type of Industries	cum/ha/day	cum/ha/day	cum/head/day
1. Textile	180.5	506	0.89
2. Metal & Machinery	422	144	1.73
3. Food	36.9	453	0.25
4. Chemical	66.7	343	1.55
5. Rubber	60	334	1.92
6. Wood & Furniture	-	34	0.08 1/
7. Non Metal Mineral	28.4	143	0.69
8. Paper	-	208	0.66 1/
9. Electric & Etc.	312.5	145	0.51
Remarks	by Interview survey	Japan	by Interview survey

1/ Figures in Japan

Table 7-14 WATER CONSUMPTION AT THE EXISTING INDUSTRIAL ESTATES

Industrial Estate	Factory Site	Water Consumption	
	(ha.)	cum/day	cum/ha/day
Bang Chan	73.13	1,400	19.1
Lat Krabang	100.34	14,400	143.5
Bang Poo	539.8	64,800	120.0
Nava Nakorn	121.44	12,000	98.8
Bang Phli Ban Bo	63.36	-	71.9
Average			90.7

Source : IEAT

Table 7-15 ESTIMATE OF WATER CONSUMPTION

Type of Industry	Land Use		No. of Workers	Water Consumption (cum/day)				
	Composition (%)	Area (ha)		Case 1	Case 2	Case 3	Case 4	Case 5
1. Textile	30	59.2	7,020	10,686	29,955	6,248	-	8,388
2. Metal & Machinery	20	39.5	2,112	16,669	5,688	3,654	-	1,584
3. Food	15	29.6	1,512	1,092	13,409	378	-	3,798
4. Chemical	10	19.7	1,308	1,314	6,757	1,988	-	1,890
5. Rubber	5	9.9	1,260	594	3,307	2,419	-	918
6. Wood & Furniture	5	9.9	1,080	(-)	337	(86)	-	90
7. Non Metal Mineral	7	13.8	840	392	1,973	580	-	558
8. Paper	3	5.9	468	(-)	1,277	(309)	-	342
9. Electric & Etc.	5	9.9	612	3,094	1,436	312	-	432
Total	100	197.4	16,212	33,751	64,089	15,974	17,766	18,000

Notes, Case 1 : Water consumption by area (by Interview survey)
Case 2 : Water consumption by area (by Japan)
Case 3 : Water consumption by No. of workers
Case 4 : Water consumption by the average of the existing I.E. (90 cum/day)
Case 5 : Water consumption broken down to each industry by the rate of case 2

7-21 The water consumption rate in Samut Sakhon is 20 cum/family/month (with an average of 4 per family, and 167 liters/head/day). However, the water supply for the residential area was established at PWD's water supply standard of 200 liters/head/day. Thus, the total water supply for the residential area was established to be approximately 3,700 CMD, based on the resident population of 18,150. The total of the industrial and the domestic use is estimated at 21,700 CMD.

2. Water Source

7-22 The situation of the wells in Samut Sakhon are shown in Table 7-16. In this region, practically all the wells use the ϕ100 turbine pump, and the output rate of this pump is 0.6-1.2 cum/min. (36-72 cum/h). The draw down of each well is around 4.1 m-25.0 m. From these observations, the quantity of the water pumped is not necessarily the possible quantity of water that can be pumped, but is the quantity pumped in line with the demands. On the other hand, when the quantity of the water pumped is estimated for the water pumped from the Nakhon Luang Aquifer (depth of -150 m), the data as shown in Table 7-18 is obtained according to the diameter of the casings and drawdowns of the respective wellls. As a result of this estimation, it is considered possible to secure the water quantity of 120 cum/h for each well, because at least 150 cum/h/well is thought to be the pumping rate possible, and that the Samut Sakhon Municipal Waterworks has been getting a pumping rate of 120 cum/h/well since 1972. Therefore the number of wells required for SIE is calculated as 8 wells to obtain the maximum daily consumption of 21,700 CMD, and the installation of casings of ϕ300 mm and submerged turbine pumps of ϕ150, 30 kW are necessary.

Table 7-16 EXISTING WELLS IN SAMUT SAKHON

Well Location	Depth (m)	Aquifer	Casing Dia. (mm)	Static Water Level (m)	Pump	Yield (cum/h)	Draw Down (m)
1. Ban Bang Pla	150	N.L.	150	-32.4	T	5.0	16.4
2. Ban Bang Pla	150	N.L.	150	-12.5	T 100	48.0	25.0
3. Ban Krathum Baen	159	N.L.	150	-20.0	T	12.0	16.0
4. Ban Hue Phlong	141	N.L.	150	-14.8	T 100	46.0	7.1
5. Wat Chet Rie	124	N.L.	150	-12.5	T	10.0	8.4
6. Samut Sakhon	217	N.	150	-11.8	T 100	74.0	10.1
7. Ban Pak Khlong Khlu	142	N.L.	150	-24.5	B	3.0	-
8. Ban Chu Tong	142	N.L.	150	-14.3	T	60.0	4.1
9. Ban Bang Pla	150	N.L.	150	-12.5	T 100	48.0	25.0

Notes, N.L. : Nakhon Luang Aquifer
N. : Nonthaburi Aquifer
T : Turbine Pump
B : Bailer Pump

Source : PWD

Table 7-17 WATER SOURCES IN OPERATION

Organization	Wells	Depth (m)
1. Municipal Waterworks	100-200 cum/h x 8 wells	226
2. Provincial Waterworks	20- 30 cum/h x 6 wells	30
3. Bang Chan I.E.	250 cum/h x 4 wells	-
4. Lat Krabang I.E.	250 cum/h x 4 wells	168

Table 7-18 EXPECTED YIELD (CUM/H)

Dia. of Casing (m)	Draw Down (m)				Pump Dia. (m)
	10	20	40	80	
0.2	262	258	241	171	0.1
0.3	277	272	254	180	0.15

Notes, $Q = \Pi \times k \times (H^2-H_0^2)/2.3 \times \log (R/r_0)$

Q : Yield
k : Permeability (1×10^{-3} cm/sec)
H : Depth from normal water level to the impermeable Stratum
H_0 : Depth from lowered water level to the impermeable Stratum (135-Draw down m)
R : Radius of cone of depression
r_0 : Radius of the influenced area (500 m)

7-23 Concerning the water quality, as shown in Annex 2-20, the salinity in Nakhon Luang Aquifer shows a large varience, but there is a salinity of about 200 ppm at the west of the site, failling at the limit of the water quality standard for industrial use. Desired water quality standard is shown for the respective industries in Annex 7-3, but practically, water having salinity of 100-200 ppm has been used conventionally for industries. Also in the case of Bang Chan I.E., among the respective industries, purification units are used by individual plants, which use sand and activated charcoal for filtration or ion exchange resins, and so this does not seem to present any particular problems.

7-24 Concerning the water source, there is no other alternative than to use underground water for the foreseeable future due to the following reasons.

i) The water supply system in Samut Sakhon is not sufficiently developed at present and the existing water supply system provides all water from underground water.

ii) Tha Chin River in Samut Sakhon is not suitable for domestic and industrial uses due to increasing salinity.

iii) The fresh water canals of the surrounding area are secured for the agricultural use and they have to depend on Tha Chin River and Chao Phraya River for additional water supply in the dry season but there is still a tendency of a water shortage.

iv) Though there is a future plan to supply water to SIE by MWWA and PWWA from Nakhon Chaisi, which is a upper stream of Tha Chin River, it is not in the stage of implementation program and can not catch up with the proposed time of operation of SIE.

However as it is not preferable for SIE to fully depend on the underground water from a security point of view, it is recommended that IEAT will continue to pay keen attention for earlier realization of surface water supply in close consultation and coordination with the authorities concerned. The underground water situation has been summarized by DMR but there is considerable inconsistency between the various studies so it is recommendable to verify the water quantity and qualities by undertaking necessary test borings at an early stage.

3. Saving of Water

7-25 When the rainfall and evaporation quantities in SIE are studied for each month, the results are as shown in Table 7-19. The runoff quantities shown are in entire site, while the evaporation quantity is that of the evaporation from the water surface of the dike. The difference in the above 2 quantities is the smallest in January, and is approximately 21,000 cum. The annual figure for this difference is approximately 5 million cum and this means that 74% of the water consumption quantity of SIE which amounts at 6.75 million cum is discharged. By the monthly figures in the dry season of January and February, this difference becomes about 50% of the monthly water consumption of 560,000 cum. The water quantity in the dike is about 82,800 cum with an average depth of 1.5 m, this quantity amounts to about 15% of the monthly consumption. Therefore, if rain water is utilized for industrial purposes, the quantity is limited by the reservoir capacity. However,practically this possible quantity is considered to be 7-8% since a certain margin must be allowed. Further, if the water in the dike is to be used for industrial purpose, it is necessary to install purification facilities.

7-26 One of the ways to save the water consumption is to recycle the wastewater for the industrial use. This recycle system is divided into the following 2 categories.

a. In the factory processes, where the water can be circulated, the water is recycled to save the total water consumption.

b. Recycling of wastèwater after treatement in the central treatment plant. This system has the following constraints which must be overcome:

   i) The recycled water will be utilized only in the limited purpose, e.g., for cooling, liquid transportation, sprinkle or flush water of toilets.

   ii) The recycled water from the treatment plant can not be utilized as the industrial water as it is. At least turbidity must be reduced by additional sedimentation or SS filtration units even if the quality of effluent will be stable, and it will cost about 50% of a secondary treatment plant. Therefore, when the recycled water is sold to industries, the additional investment will not be withdrawn.

   iii) To recycle the treated water for industrial use, another supply system within SIE will be needed to avoid the mixture with the fresh water, and they must be easily discriminated from the sanitary aspect.

Table 7-19 DISCHARGED WATER BY MONTHS

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Rainfall (mm)	8.9	29.1	28.0	70.0	185.1	150.4	171.3	206.8	402.1	234.2	47.6	10.4	5,118.0
Total Rainfall (1,000 cum)	29.5	96.5	92.8	232.1	613.7	498.7	568.0	685.7	1,332.2	776.5	157.8	34.5	
Evaporation (mm)	98.0	88.8	108.8	105.7	90.2	81.8	78.3	71.2	58.1	58.7	69.3	87.0	
Total Evaporation (1,000 cum)	8.1	7.4	9.0	8.8	7.5	6.8	6.5	5.9	4.8	4.9	5.7	7.2	82.6
Difference (1,000 cum)	21.4	89.1	83.8	223.3	606.2	491.9	561.5	679.8	1,328.4	771.6	152.1	27.3	5,036.4

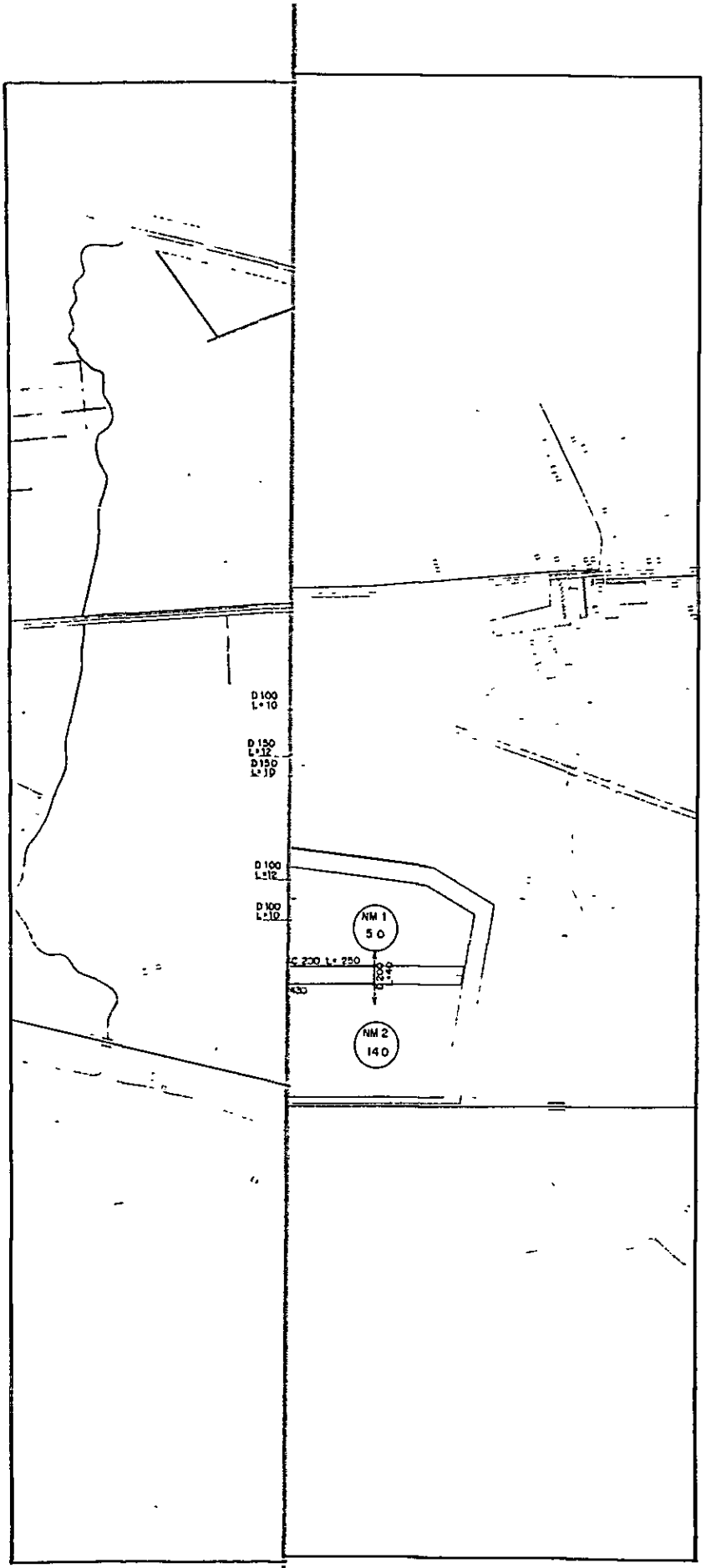
Notes, Catchment area : 331.57 ha

Evaporation area on the surface of dike : 9.0 m x 9,200 m (Av. water depth 1.5 m)

4. Water Distribution System

7-27 The water that has been pumped from the 8 wells located all over the site is sent through water pipe and temporarily stored in water reservoirs. These water reservoirs will be located in 2 places, one each for the industrial and the residential areas. These reservoirs will be linked together to maintain a balance in their water quantities. As far as the capacities of these resrvoirs, it will be the amount of daily consumption or 18,000 cum for the industrial area, while for the residential area it will be an 8 hours portion of the daily consumption or 1,300 cum. The distribution system will utilize elevated water tanks for pressure. The tanks for the industrial water supply will hold a 2-hours portion of the daily consumption (operating 8 hours per day) and this water will be stored in 2 tanks of 40 m high (capacity 4,500 cum). The residential area will have a water tank of 20 m high holding a 3-hours portion of the daily consumption rate. (Capacity 570 cum)

7-28 The water supply will be piped to the respective industries by means of a closed network, as a provision against accidents. The water consumption at each block will be estimated by the land use plan by industrial classification as shown in Fig. 6-10. The piping system is to meet the following requirements upon installation: The water flow speed in the piping will be less than 3.0 m/sec. For the residential area, the total water head lost will be less than 12 m and 30 m for the industrial area, taking the allowance of head into account. Further, as a provision against fires, one outdoor fire hydrant will be installed for every 5 ha of area (see Fig. 7-8).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L=10
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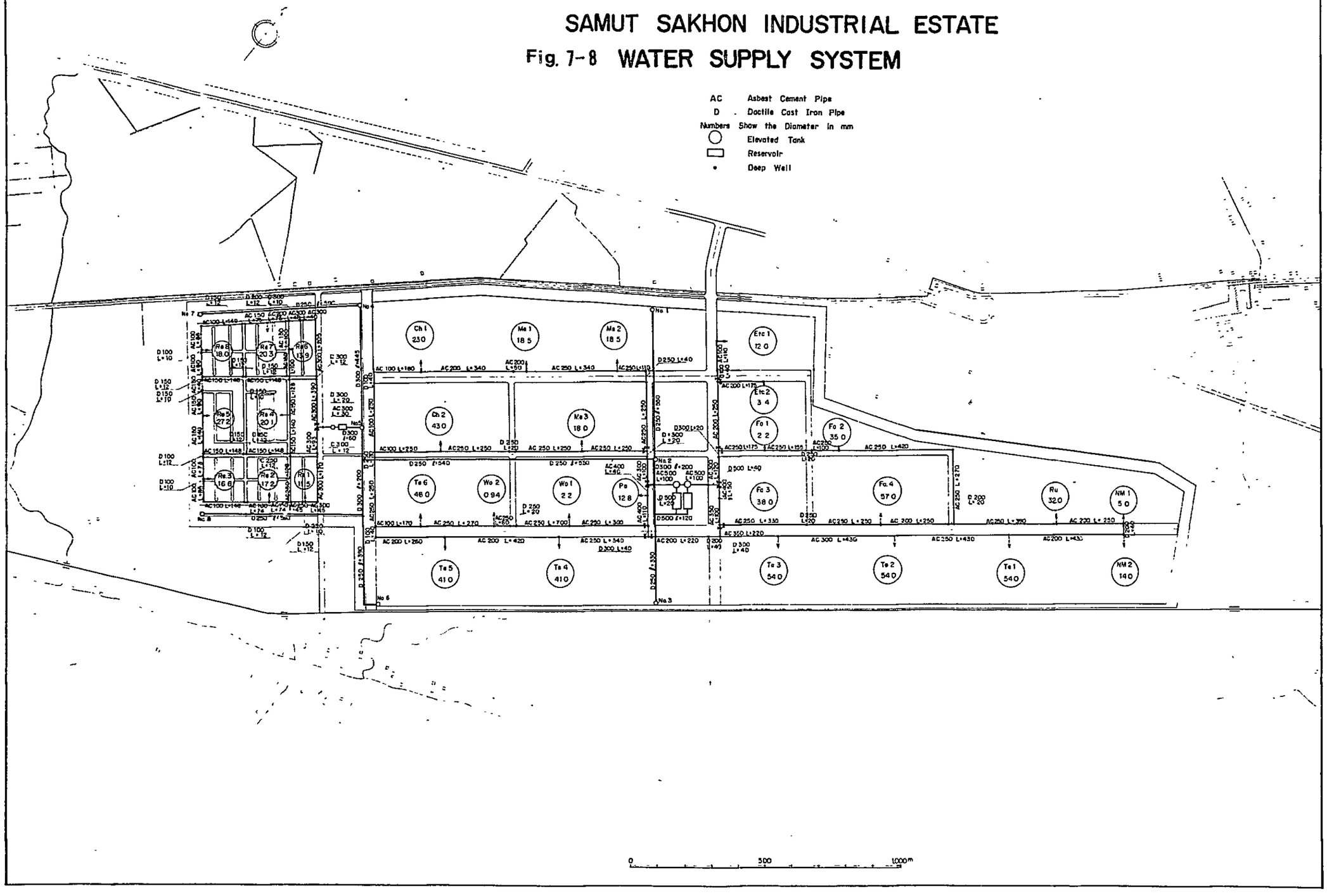
D 100
L=10
NM 1
50
C 200 L= 250
200
L=40
430
NM 2
140

SAMUT SAKHON INDUSTRIAL ESTATE

Fig. 7-8 WATER SUPPLY SYSTEM



D. SEWAGE DISPOSAL FACILITY

1. Policy on disposal

a. General

7-29 With basic consideration given to promotion of industry and prevention of pollution, information relating to the following factors was obtained through field investigation, for use in the study of the proposed sewage disposal facility.

1) IEAT, MOI and NEB

Agencies are of the opinion that complete pollution prevention facilities must be provided for industrial plants, and that each polluting establishment must bear the full cost of disposal of its own wastes which cannot be processed by common-use facilities, while at the same time the industrial estate is to be provided with a common facility for sewage treatment for disposal.

2) Methods of sewage treatment and disposal presently in use at industrial estate

A result of inspections of the methods of sewage treatment used in existing industrial estates, disclosed that a common treatment facility was not constructed because only low-pollution industries were selected to occupy Bang Chan I.E. There, each enterprise has installed storage tanks and water from the tanks is used for sprinkling, and ditches are provided for drainage. In Bang Poo I.E., treatment by use of an oxidation pond with a floating aerator was adopted. In Lat Krabang I.E. the reduction of waste water BOD to 20 ppm has been proposed by the use of activated sludge process, but construction has not been begun.

3) Methods of sewage treatment and disposal at the level of individual firms

Almost all sewage disposal systems operated by individual enterprises in Thailand use the sprinkling method and natural decomposition of sewage in reservoirs. This practice and the attitude behind it tells of the low level of understanding held by factory managers on the need for protection of the environment. Some enterprises are using an activated sludge process for sewage treatment and the tendency seems to be for increased understanding on the need for protection of the environment.

b. Treatment policy of SIE

7-30 In view of the above, all sewage from SIE shall be disposed (following treatment in conformity with standards designated by MOI) by discharge to nearby rivers. Regarding this policy human wastes and factory wastes are to be treated in a common facility. Factory wastes which cannot be treated in common facilities must be treated at the expense of the enterprises, at their own facilities established for that purpose. In designing the treatment facilities, economy of construction cost, simplicity of management and operation, and economy of operating cost were taken into consideration.

7-31 To study how construction cost would vary according to the level of treatment, discharge standards were divided into three stages for comparison, as shown in Table 7-20. Comparing these three stages, costs vary in proportion to treatment level, and therefore from the viewpoint of cost, a low treatment level will reduce the economical burden. It is concluded that second stage treatment be adopted, in respect of the agriculture and marine products industries in Samut Sakhon, and also the limit of the abilities of each enterprise to bear the costs for construction and operation of treatment facilities. The flow of each stage is shown in Annex 7-4.

Table 7-20 TREATMENT LEVEL AND CONSTRUCTION COST

Treatment Level		1st. Stage Treatment	2nd. Stage Treatment	3rd. Stage Treatment
Method		Oxidation Pond	Activated Sludge	Activated Sludge + Fixed Aeration
Effluent BOD (ppm)		less than 40	less than 20	less than 10
Construction Cost 1/		20,833	54,167	125,000
Area	Rai	71.3	23.4	39.1
	Cost 2/	28,520	9,360	15,640
Total Cost		49,353	63,527	140,640
Cost		Low	Medium	High
Maintenance		Easy	Need Expert Control	Need Expert Control
Stability of Treatment		Unstable	Stable	Stable
Problem to Effluent		Problem	None	None
Sludge		not dewater	dewater	dewater

1/ unit : Bahts Thousand

2/ Cost of Land : 400,000 Baht/Rai

7-32 The environmental standards for industrial wastes in Thailand and Japan are shown in Annex 7-5. In Thailand and Japan, considerable difference exists as to standard for BOD and SS but as to other items they are almost same. The relation between treatment level and construction costs, shown in Fig. 7-9, is such that the point where two curves intersect in the most economical, and the treatment level corresponding to that point is the 2nd Stage. As to post-treatment of water quality, though standard are different between Thailand and Japan, the cost increased rapidly with elevation of treatment level in any country. In view of the foregoing, it is concluded that reasonable target treatment value for sewage is 20 ppm for both BOD and SS.

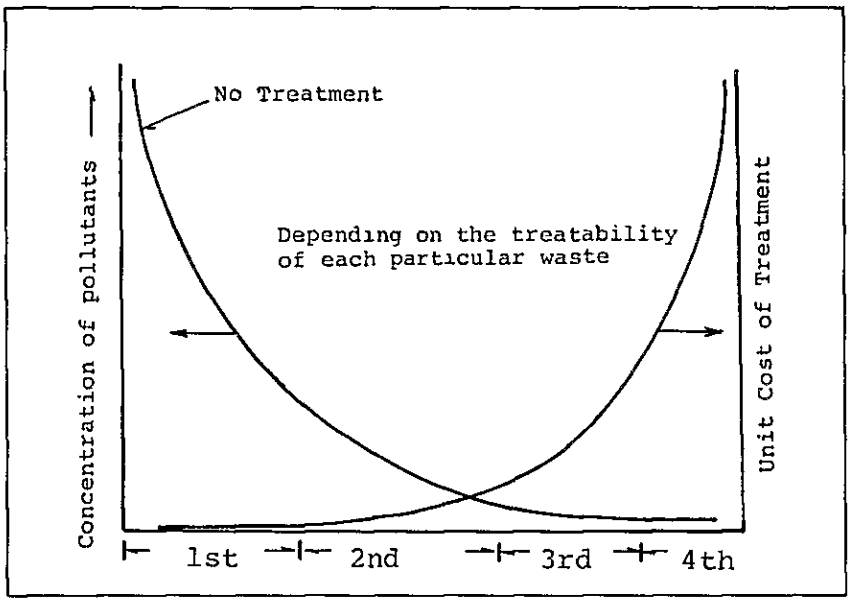


Fig. 7-9 STAGES OR DEGREE OF TREATMENT

Source : Environment and Appropriate Technology for Rural Thailand

c. Pretreatment Process

7-33 As shown in Table 7-21, the quality of both industrial and domestic waste water is considered to be acceptable in general to the common treatment facility. However, when actual application for occupancy is made by each factory, it is necessary for IEAT to investigate and confirm the specific nature of each waste water and guide them to install an individual pretreatment unit for removal of toxic substances and heavy metals which can not be technically removed by the common treatment facilities of activated sludge system. Annex 7-5 shows allowable effluent standards enforced in Japan and the one recommended for IEAT by Dr. Chakrabarty, UNIDO expert. For information, three methods for pretreatment are shown in Annex 7-6.

2. Estimation of Quantity and Quality of Water

7-34 The unit pollution load for specific industries in Thailand is not known. The estimation of quality and volume of water of industrial waste from SIE was calculated in accordance with the units derived by Japan Sewage Works Association, as shown in Table 7-21.

Table 7-21 EXPECTED QUANTITY AND QUALITY OF THE WASTEWATER

Type of Industry	Wastewater (cum/day)	BOD		COD		SS	
		ppm	load (kg)	ppm	load (kg)	ppm	load (kg)
1. Textile	7,456	180	1,342	100	746	200	1,491
2. Metal & Machinery	1,408	10	14	20	28	100	140
3. Food	3,376	500	1,688	400	1,350	400	1,350
4. Chemical	1,680	150	252	100	168	100	168
5. Rubber	816	10	8	20	16	50	41
6. Wood & Furniture	80	10	1	10	1	30	2
7. Non Metal Mineral	496	10	5	50	25	200	99
8. Paper	304	100	30	100	30	40	12
9. Electric & Etc.	384	100	38	100	38	100	38
10. Domestic Wastewater	3,000	250	750	200	600	200	600
Average 1/		250		200		250	
Total	19,000		4,118		3,002		3,941

Note : Amount of Wastewater is estimated assuming 90% of supplied water will be discharged.

1/ Rounded numbers

3. Sewage Treatment System

7-35 The following is the result of study made to determine the most economic and efficient treatment process for the 2nd Stage System.

a. Volume of water to be treated

The volumes of water to be treated are shown by the hourly maximum and the daily maximum as shown in Table 7-22. For the design of pumps, maximum water volume per hour is used and for design of equipment, maximum volume per day is used.

Table 7-22 FLOW RATE OF TREATMENT SYSTEM

Treating Method	Total Waste Water (cum/day)	Flow Rate			Remarks
		cum/h	cum/min	cum/sec	
Activated Sludge	19,000	1,188	19.8	0.33	Max. hour
		792	13.2	0.22	Max. day

b. Treatment processes

The flow is shown in outline in Fig. 7-10.

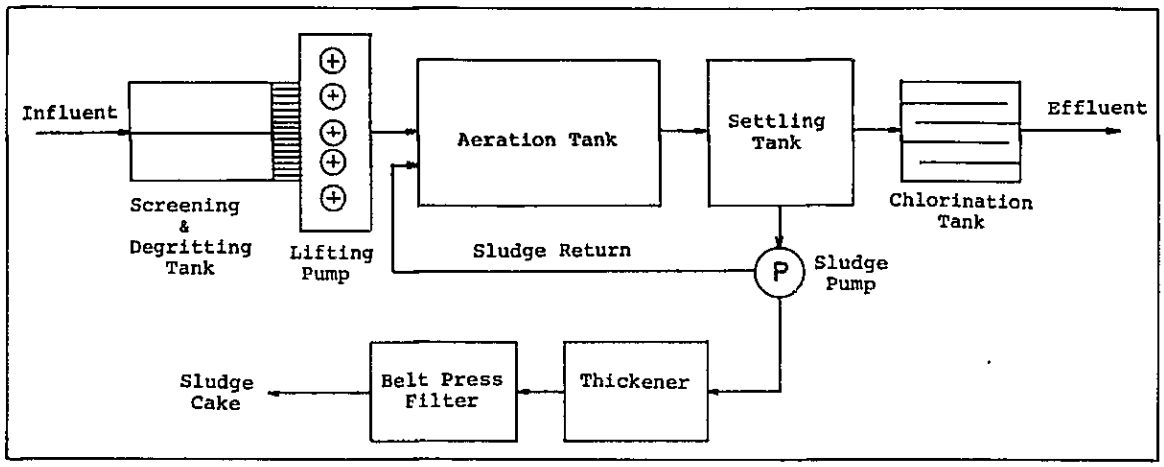


Fig. 7-10 FINAL TREATMENT SYSTEM FLOW

c. Treatment intent

The intent is to attain a 92% reduction in BOD and SS, and obtain a 20 ppm level effluent for both items. The effects are shown in Table 7-23.

Table 7-23 TREATMENT EFFECT

Influent		Screen & Degrit		Airation	System	Total
		%	ppm	%	ppm	%
BOD (ppm)	250	20	200	90	20	92
SS (ppm)	250	20	200	90	20	92

d. Specification of equipment for treatment system

The specifications for the equipments of the treatment plant are shown in Table 7-24, and the layout is in Annex 7-7.

Table 7-24 SPECIFICATION OF EQUIPMENTS

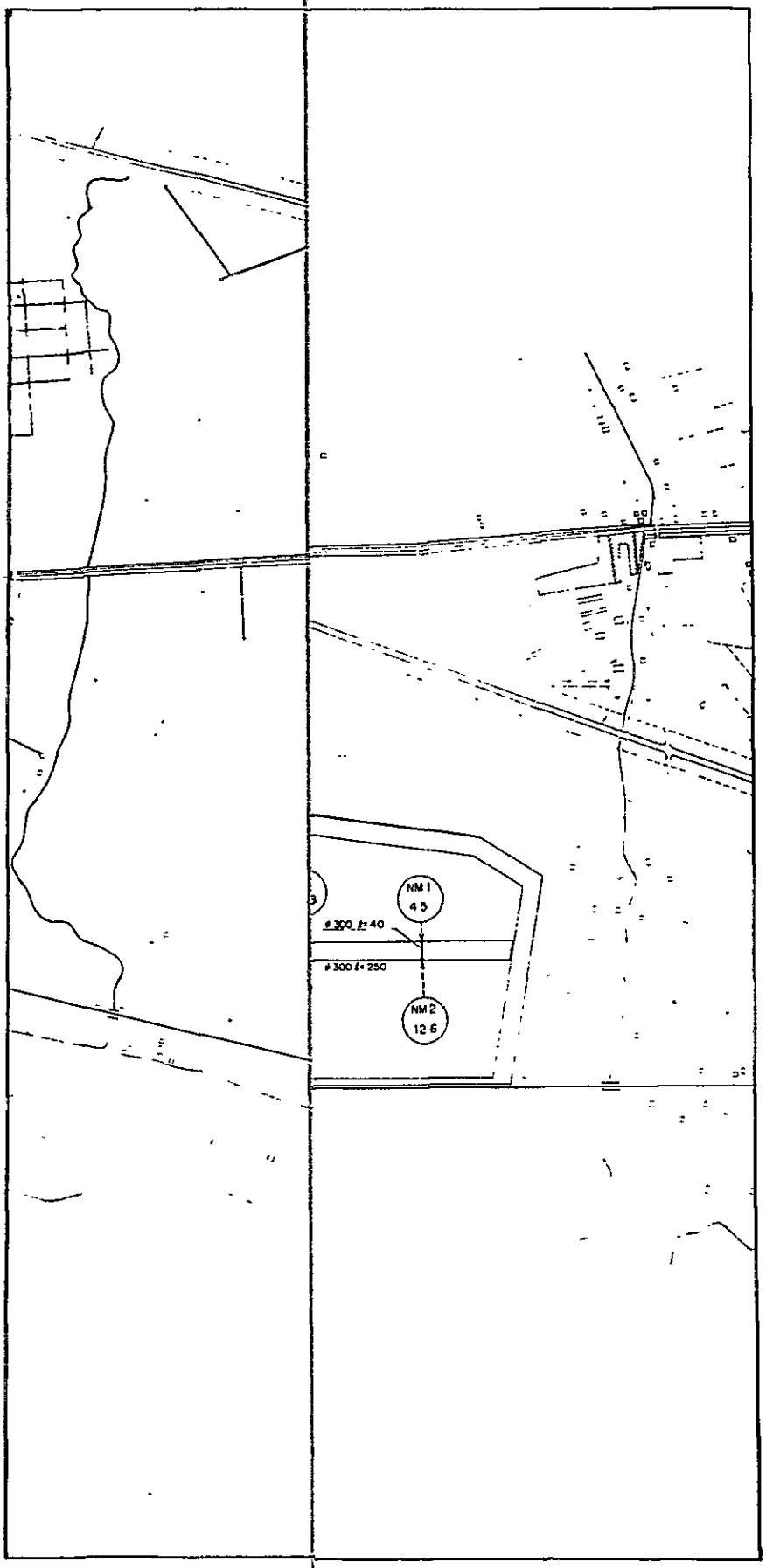
Name of Equipment	Specifications
Degritting & Screening Tank	Tank : $3.7m^{W} x 10.4m(9m)^{1} x 0.7m^{wd}$ x2 Tanks Motor Drive Barscreen : $3.7m^{W} x 2.3m^{1}$ x25m pitch x 70° Inclination Motor Drive Gate : 1m x 1m x 1 set Wooden Gate : $3.7m^{W} x 2.0m^{h}$ x2 sets
Lifting Pump Pit	Tank : $8m^{W}$ x $15m^{1}$ x $4m^{swd}$ x 1 Tank Lifting Pump : Vertical Centrifugal Pump ϕ230mm x $10m^{h}$x18kwx5 sets (1set for spare)
Aeration Tank	Tank : 26m square x $4m^{swd}$ x 2 Tanks x 4 series Aerator : 11.25kw x 8 sets
Final Settling Tank	Tank : ϕ20m round x $3.0m^{swd}$ x 4 Tanks
Dewatering System	Belt Press Filter : 2m belt wide x 3 sets (1 set for spare) 150kg/m/h.d.s. 10 hrs running Coagulant (Organic 0.7-0.8% d.s.) Cake water content 75%
Chlorination Tank	Tank : $2m^{W}$ x $2m^{swd}$ x 12m x 5 waterways Chlorination Equipment : 100g/min

e. Construction cost

The approximate construction cost of the final treatment plant is estimated and given in Annexes 7-8 and 7-9. According to the estimate, construction cost for the entire facility is Baht 57.53 million. Mechanical and electrical systems cost: Baht 38.42 million. Structure and building cost: Baht 19.12 million. The ratio of the two is 2:1. The schedule for payment of costs for construction is to be 48% in the first year, 25% in the second year, 16% in the third year and 11% in the final year.

4. Wastewater Collecting System

7-36 The wastewater collection system will utilize a natural down flow system, and since the land area is almost completely flat, these pipe works were designed with a gradient of 0.1%. The maximum length of the piping is thus 2.4 Km with the final depth about 3 m below the ground. The treated water will be piped over the Mae Klong Railway and then will be released into the canal which will be built to serve as the axis for SIE along with its future expansion. This canal water will then flow into the Khlong Maha Chai. In the industrial area disposal is done on a 8 hours basis, while the residential area


NM 1
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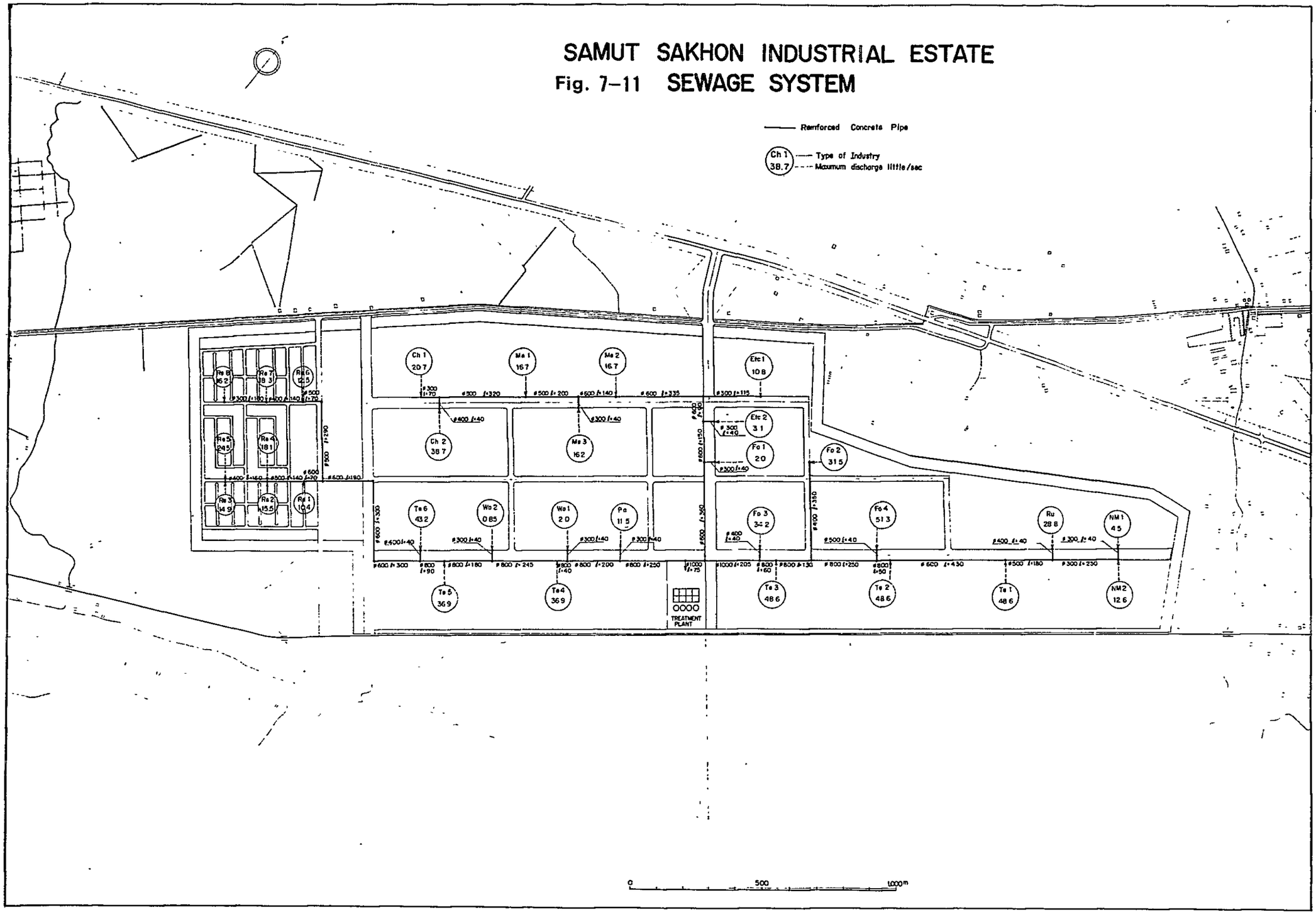
ø 300 /+ 40
ø 300 /+ 250
NM 2
126

SAMUT SAKHON INDUSTRIAL ESTATE

Fig. 7-11 SEWAGE SYSTEM



has 24 hours water disposal, as assumed in the estimate of water demand. Therefore, the peak hour factor of 2.0 was used (see Fig. 7-11).

5. Management of the Final Treatment Plant

a. Cooperation between IEAT and industries

7-37 To manage the central treatment plant, IEAT shall assign plant personnel who are well acquainted with every detail of the industrial processes, are familiar with the pretreatment of wastewater and the influences of industrial wastewater on activated sludge treatment. These persons are to have advanced, specialized knowledge in this regard provide a basis for close cooperation with the factory operators. For the operation and management of pretreatment processing at factories, periodic inspections shall be made. Laboratory analysis of industrial wastes shall be performed periodically with factory personnel present.

b. Monitoring of discharged water quality

7-38 Monitoring of discharged water quality shall be performed by personnel of the final treatment plant. Samples shall be taken of influent, effluent, river water and other water sources near the point of discharge.

Test items and their frequency shall be as follows:

i) Routine tests

Daily tests shall be made items deemed necessary for managements of the facility, such as weather, temperature, water temperature, appearance, turbidity and pH.

ii) Interim tests

These tests shall be made three times a month, in addition to the routine tests, and odor, evaporation residual, dissolved matter, suspended solid, dissolved oxygen, saturation rate of oxygen (%), BOD, COD, ammonia nitrogen, nitrite nitrogen, nitrate nitrogen, coliform MPN test, and others shall be examined as deemed necessary.

iii) Precision tests

These tests shall be made twice a month, to the following items, in addition to items of the interim tests: ignition residue, total nitrogen, organic nitrogen, total phosphorus, phosphate phosphorus, chlorine ion, fluorine ion, cyanide, iodine demand, n-hexan extractable material, anion surface active agents, phenols, organic phosphate, copper, zinc, cadmium, total mercury, alkyl mercury, total chromium, hexavalens chromium, soluble manganese, soluble iron, arsenic, bacterial density, and others as deemed necessary. The above tests shall be done under the direct supervision of the necessary staff and by use of proper test apparatus. Personnel in charge of tests shall keep full test records which are to be accessible to authorities concerned.

E. Electricity Supply System

1. Power Demand

7-39 The estimated demand in SIE both for industrial and domestic use amounts to 64 MW. The calculations are outlined as follows:

a. The power demand per area for different types and sizes of factories were calculated from the data obtained through an interview survey of factories in Bangkok and its environs (Bang Kun Tien, Phra para Daeng, Phasi Charoen, Raja Burana and Samut Sakhon) as shown in Annex 7-10. This, however, resulted in relatively high figures for some types of industries, suggesting that the reliability of interview is limited. In general, few of the factories surveyed had a sufficient land area and in most cases the power demand per area was likely to be high.

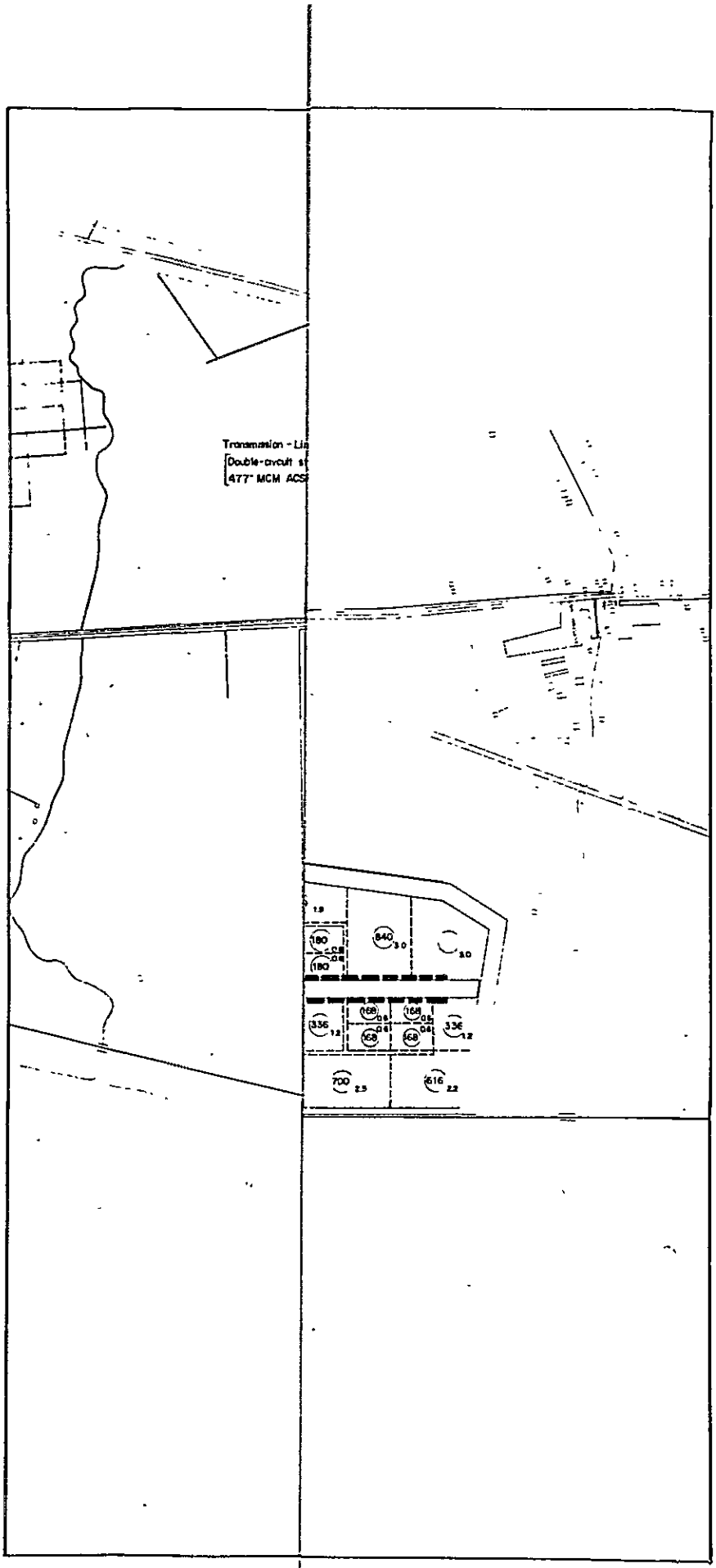
b. Table 7-25 shows the power demand per area in case of Japan and Indonesia by types of industries. The power demand in SIE was estimated with partial adjustment for these figures, and with an additional estimate for the major electric facilities which are not included in the estimate based on the area size.

c. In the residential area, a total power demand of 5,800 KW was estimated on the basis of the power demand of 1,200 W/family in the NHA's existing housing estates.

2. Electricity Supply System

7-40 As for the supply of electricity to SIE, while the supply capacity of the present Samut Sakhon-1 substation is 50 Mw, and that of the Samut Sakhon-2 substation will be 15-25 Mw, the power demand by SIE is estimated to be approximately 64 Mw. This demand seems to be quite large when compared with that of other demands, so the new Samut Sakhon-2 substation can be constructed close to or within SIE by EGAT. Therefore, since the Samut Sakhon-2 substation is scheduled to begin construction by October 1982, It is deemed important for IEAT to begin contacts with EGAT at an early stage.

7-41 The electricity supplied from the Samut Sakhon-2 substation to the industrial and the residential areas will be 22 KV. The distribution lines in SIE are planned as triple and quadruple system. For the residential area, high voltage transformers connected with EGAT's substation will supply stepped down voltage of 380V for domestic use. (see Fig. 7-12). Except where lines cross major roads, overhead lines are planned. Electricity will be supplied throughout the site of each factory from points above the roads, at the factory owners expense. In the wiring plan, major road crossings within SIE were avoided, but partial underground wiring has been considered for places where this is not possible. A minimum overhead clearance of 5 m is planned where wires must cross ordinary roads.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700
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616
2.2

SAMUT SAKHON INDUSTRIAL ESTATE

Fig. 7-12 POWER SUPPLY SYSTEM

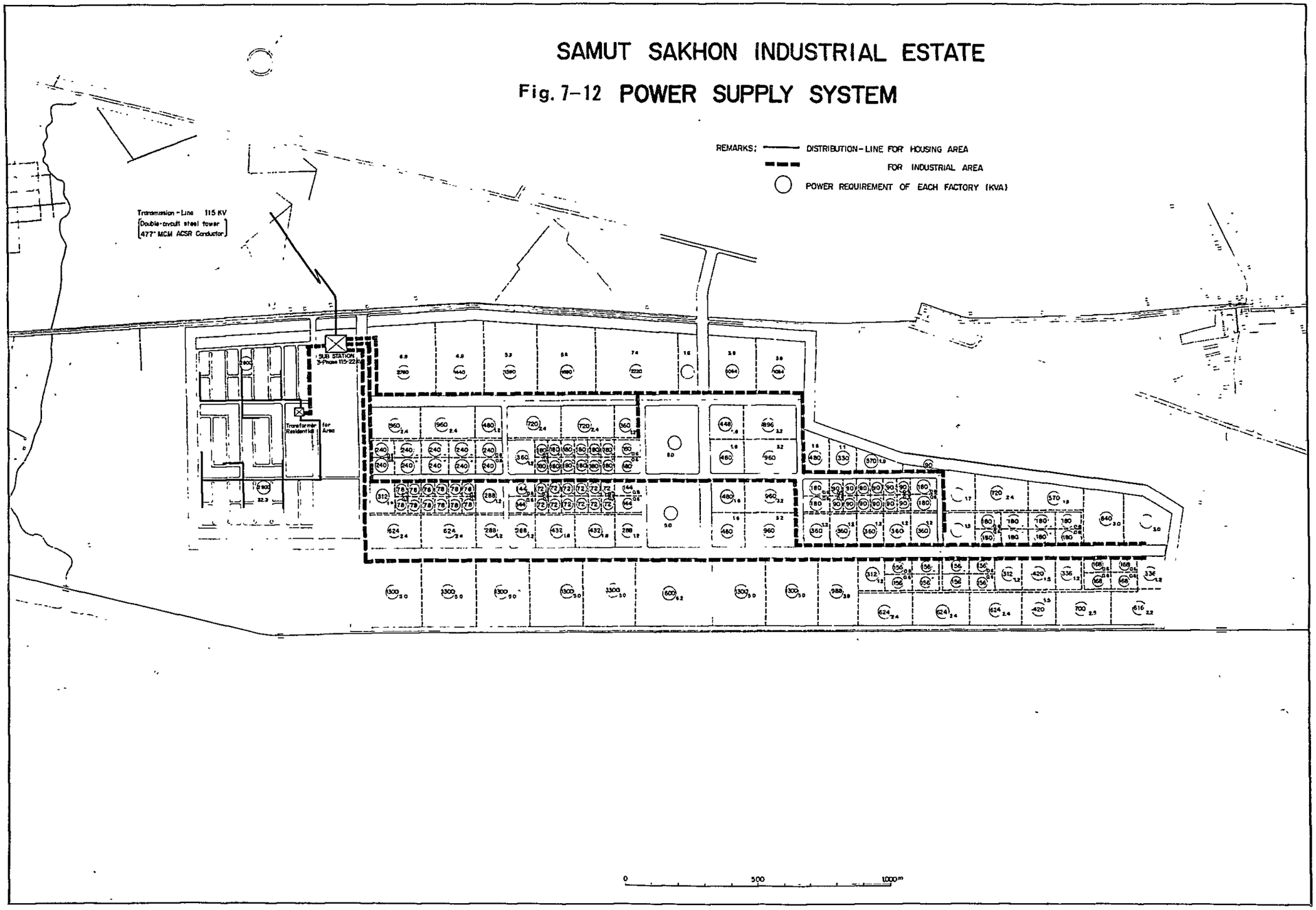


Table 7-25 POWER DEMAND IN SIE

Type of Demand	Area (ha)	Power Demand by Area(kw/ha)				Total Demand (kW)
		Bangkok	Indonesia	Japan	SIE	
1. Textile	57.6	583	150	261	260	14,976
2. Metal & Machinery	38.4	470	230	322	300	11,520
3. Food	28.8	259	300	630	300	8,640
4. Chemical	19.2	1,069	170	408	400	7,680
5. Rubber	9.6	461	200	575	300	2,880
6. Wood & Furniture	9.6	178	100	200	180	1,728
7. Non Metal Mineral	13.4	377	170	317	280	3,752
8. Paper	5.8	-	250	470	300	1,740
9. Electric & Etc.	9.6	312	120	280	280	2,688
Sub Total						55,604
10. Waste Water Treatment Plant						600
11. Common Facilities & Etc.						2,000
Total in Industrial Area						58,204
12. Housing Area						5,800
Grand Total						64,004

F. Telecommunication System

1. Telephone Demand

7-42 The telephone density by the estimate of TOT is shown in Annex 7-11. Telephone demand in SIE was calculated at 1,800 lines and 80 lines on the basis of the density for BMA and province respectively (in 1980), and thus a large difference is observed between these 2 estimates. For the number of telephone subscribers by their sector, the percentage of those in the manufacturing sector is about 3.4%, and further, the percentage of workers in this sector in relation to the total work force is about 5.2% (1976). From these fact, it is thought that the telephone density in the manufacturing sector will be 3.4/5.2=65% of average density. In case of Bang Chan I.E., there are 50 telephone circuits among 52 factories present, and thus the circuit number and the number of factories just about match (see Table 7-28). The number of factories locating SIE are estimated as 179 factories based upon the average land size of 6.7 Rai, and therefore a demand for around 200 telephone circuits are foreseen. From the view point of the telephone exchange facilities, about 1,000 circuits are the minimum requirement for the establishment of one relay station, and any number of circuits less than this can be managed with PBX. Also to follow the TOT's program, PBX will serve the purpose for the time being, and it is considered desirable in the future to make the connection directly through a relay station to each factory. Therefore, the number of circuits is to be 500, and the space which can serve as a relay station in the future will be provided.

Table 7-26 TELEPHONE DEMAND IN SIE

	1980		1990	
	BMA	Province	BMA	Province
Telephone Density	6.7	0.3	25.0	2.0
Telephone Demand	1769	79	6600	528

Note : Telephone Density by TOT estimate

Total resident in SIE : 26,400

SAMUT SAKHON INDUSTRIAL ESTATE

Fig. 7-13 TELECOMMUNICATION SYSTEM

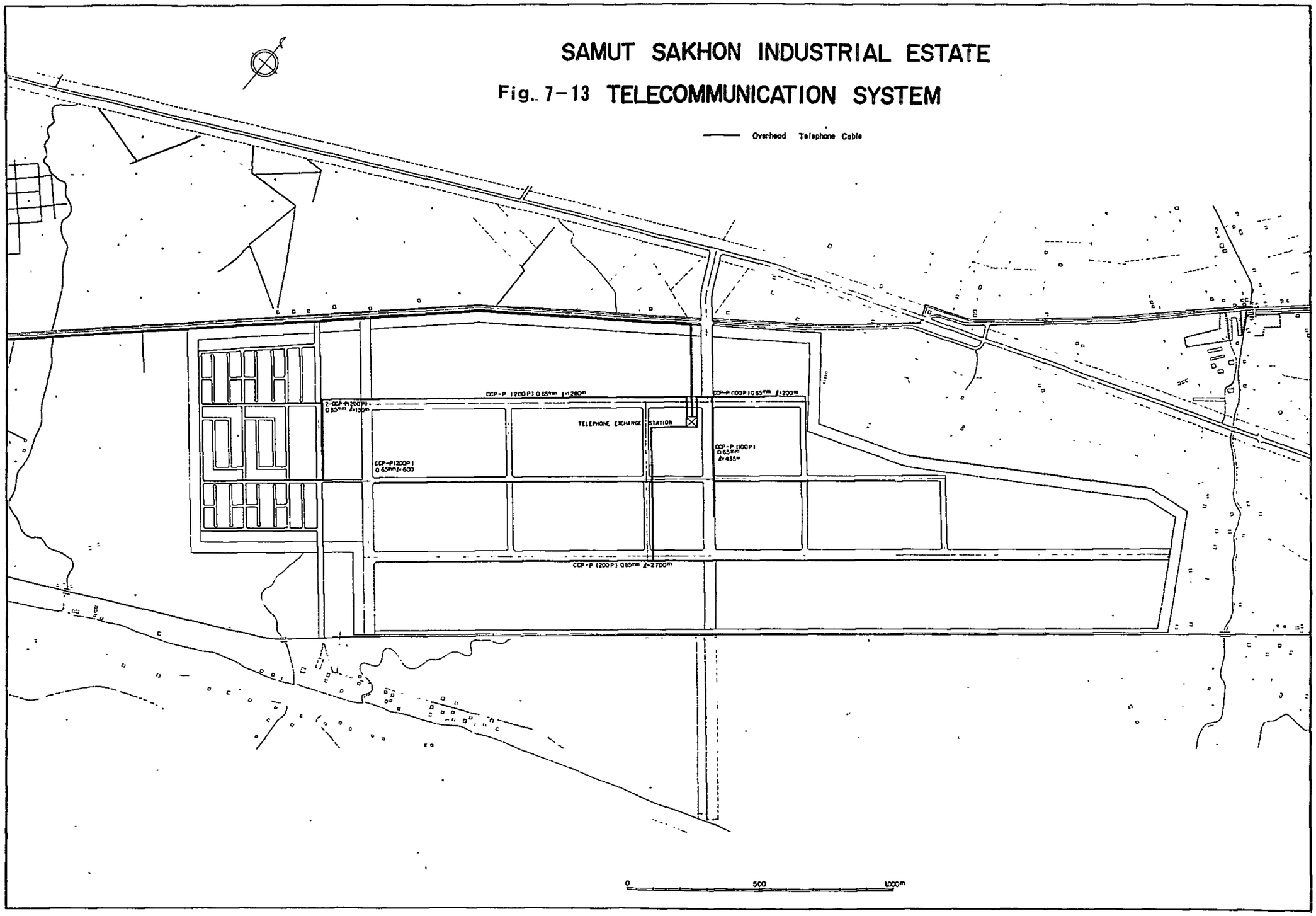


Table 7-27 TELEPHONE SUBSCRIBERS BY USERS' CATEGORY

Users' Category	Composition (%)
1. Government	14.7
2. Business Office	5.2
3. Industries & Factories	3.4
4. Agriculture	0.1
5. Shops	41.1
6. School & Colleges	1.9
7. Hotels	2.3
8. Doctors & Nurses	0.7
9. Hospitals	1.1
10. Cinema & Theaters	0.3
11. Clubs & Unions	1.2
12. Restaurants	0.7
13. Other Business	6.3
14. Residences	21.0
Total	100.0

Table 7-28 TELEPHONE INSTALLATIONS IN THE EXISTING I.E.

Industrial Estate	No. of Factories	Installations
1. Bang Chan	52	50 circuits (PBX) container type
2. Lat Krabang 1 /	-	500 circuits mobile exchange
3. Ban Poo 1 /	-	1000 circuits

1 / Under construction

2. PBX and Wiring

7-43 As for the telephone exchange facilities within the estate, a PBX will be installed. A telephone traffic for industries of about 4.0 HCS is assumed, and so 50 circuit connections to the Samut Sakhon exchange station using 100 p cable is planned. For the electricity, a 48V-40A rectifier will be installed as well as a 48V-270A battery as an emergency power source. Within the estate 100 p and 200 p cables will be installed along the trunk roads in accordance with the established number of subscribers by blocks (see Fig. 7-13).

G. Solid Waste Disposal

1. Output of Solid Waste

7-44 Reference studies concerning the output of solid waste in Thailand is not available and estimates are made based on the figures available in Japan for the output of industrial solid wastes in the respective industries. The output of industrial solid wastes in SIE is estimated to be a total of 320,000 ton/year, as shown in Table 7-30. Of the solid industrial wastes, in Japan about 30% is disposed as landfill. If the Bang Chan I.E. is taken into consideration, where the industries have secured land for their future expansion, and where solid wastes from each industry are largely disposed within the factory lot, only about 15% of the waste is disposed of in public areas. Therefore the actual output of solid wastes requiring disposal becomes 53,200 ton/year. Domestic solid waste is estimated at 600 g/head/day, based on the relation between the current out put and the per capita GNP as shown in Fig. 7-14, and the total amount from the housing area is estimated at about 4,000 ton/year.

Table 7-29 ESTIMATE OF SOLID WASTE

Type of Industry	No. of Workers	Solid Waste	
		t/Worker	t
1. Textile	7,020	1.71	12,000
2. Metal & Machinery	2,112	95.4	201,500
3. Food	1,512	2.57	3,900
4. Chemical	1,308	43.2	56,500
5. Rubber	1,260	4.11	5,200
6. Wood & Furniture	1,080	5.37	5,800
7. Non Metal Mineral	840	20.9	17,600
8. Paper	468	19.5	9,200
9. Electric & Etc.	612	3.22	2,000
Total	16,212		319,800

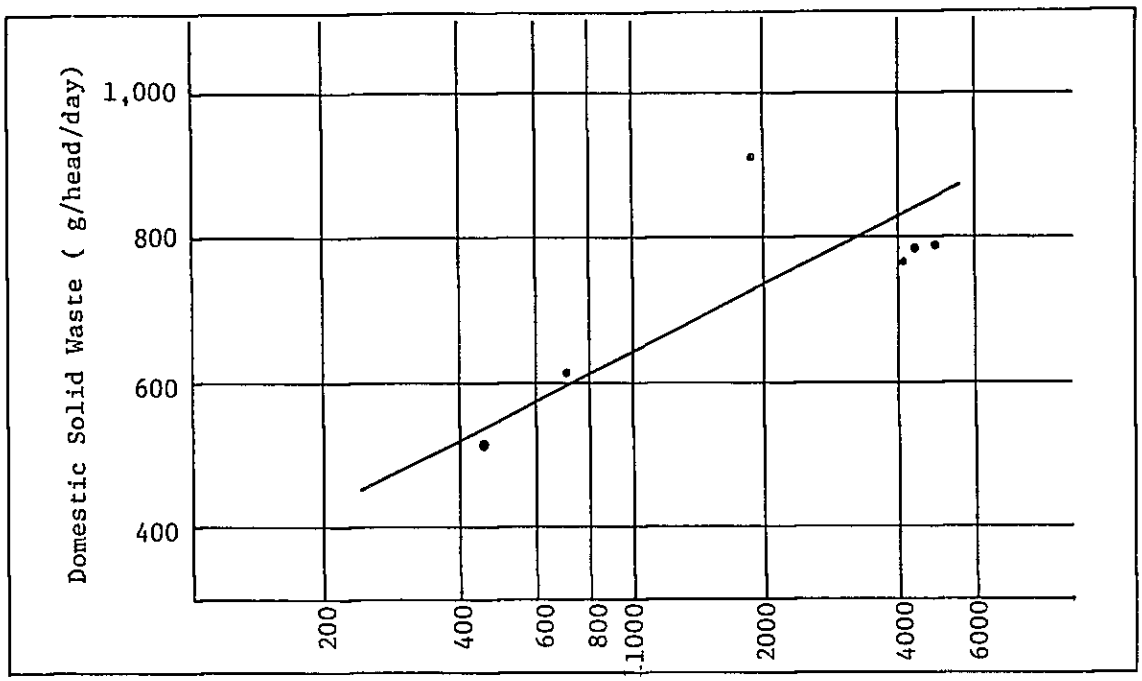


Fig. 7-14 RELATION BETWEEN DOMESTIC SOLID WASTE AND PER CAPITA GNP

2. Solid Waste Disposal

7-45 Waste materials have considerable void inside, and its weight per unit volume is 0.17 before disposal, and about 0.4-0.5 after disposed as land fill. For the management of the waste material output by SIE to be done by land fills to a depth of 3 m, a land area of 3.5 ha/year becomes necessary. Also for sanitary consideration, a 50 cm earth covering must be applied over 3 m layer. If 5 such landfill layers are permitted and the operation of the factory will commence slowly at the beginning, land fills using this method will be possible for 7-8 years.

7-46 It is recommended that the respective factories transport the waste material to designated dumping sites, and NHA in charge for the residential area, work in conjunction with the municipality of Samut Sakhon to undertake the collection and transport of domestic waste to thus prevent its illegal disposal.

H. Public Facilities

1. Policy of Designing

7-47 The kinds and sizes of the installed facilities are discussed in Chapter VI-6. In this chapter, the policy and objectives will be observed more practically, and the organization of the designing conditions will be made so that the guideline for the execution designing will be established. Among these facilities, facilities which stand to become land marks are selected and considered below.

a. Watch tower

A watch tower will be built in the central area of the estate, from which the panorama of the whole estate can be viewed. The tower will also function as a land mark, a symbol and for security and fire watch purposes.

b. Water tower

In this study, 3 water towers will be located within the estate. In order to effectively and actively utilize these towers, it shall be planned for each tower to be of a different shape and color.

Concerning the determinations for the locations of the watch and water towers, it would be the most effective for them to project out from an area where the heights of the surrounding structures are at an even height or continuously extended flat areas (see Fig. 7-15).

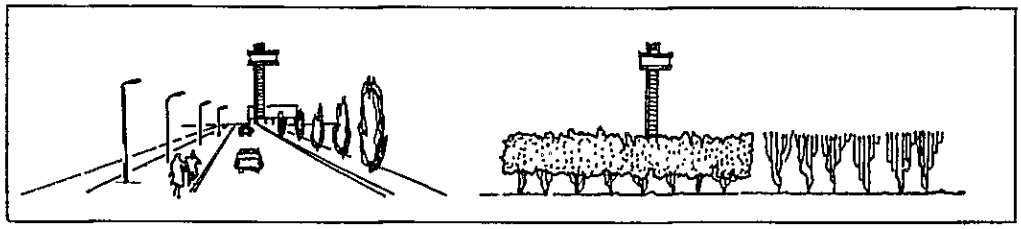


Fig. 7-15 PERSPECTIVE OF ELEVATED TANK AND WATCH TOWER

c. Park and open spaces

Since factories have an industrial atmosphere, park and open spaces should occupy a different portion of this estate and should be filled with greenery. In contrast to the usual factory grounds or streets lined with trees, the covering of a large and consolidated area with greenery is most effective.

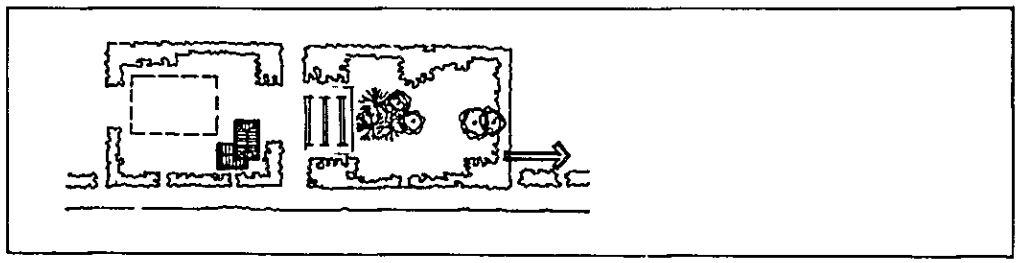


Fig. 7-16 LAYOUT OF PARK

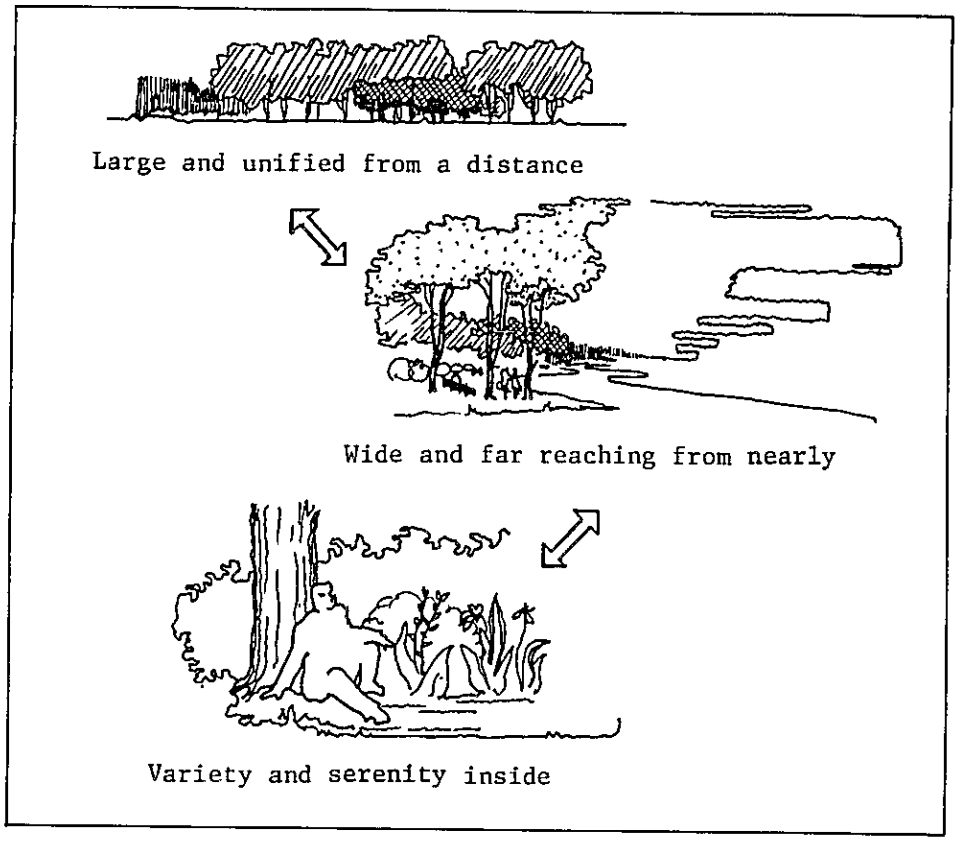


Fig. 7-17 CONCEPT OF PARK

2. Landscaping

7-48 For those facilities which extend in a linear manner, such as street, trees along a street, street lightings, electric poles and side gutters, their beauty of perspective as well as the rythem of repetition must be emphasized. From this point of view, they must be definitely linear and a repetition of an identical pattern of a specific distance to obtain the best possible effects with these facilities.

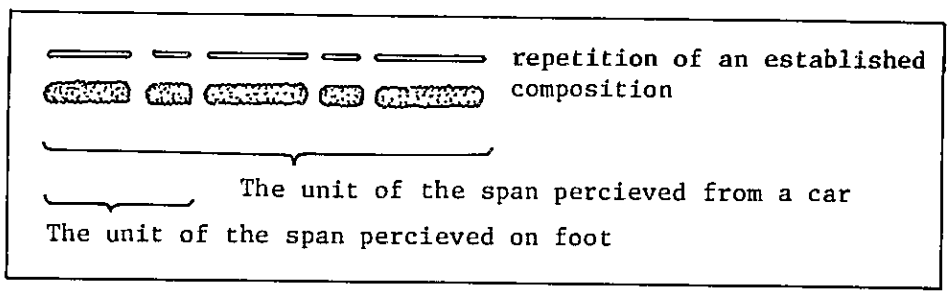


Fig. 7-18 LINEAR FACILITIES

7-49 From the view point of the existing crime situation, fences can be constructed around the individual factories. However, unnecssarily large and sturdy fence, which are ugly and tasteless, will be avoided since this industrial estate will be provided with a collective security force. Facility installation standards, as shown in Fig. 7-19, will be provided to each factory for the purpose of preserving a sense of overall harmony in this estate.

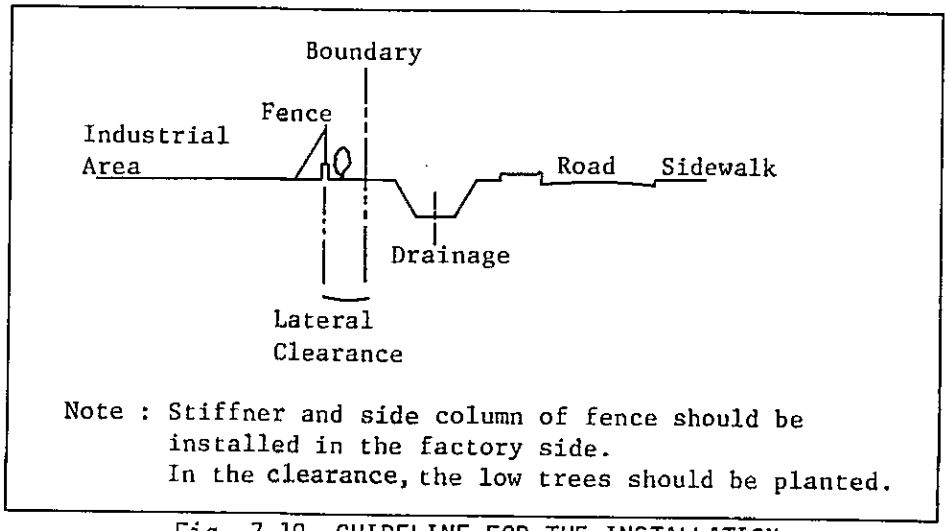


Fig. 7-19 GUIDELINE FOR THE INSTALLATION OF BOUNDARY FENCES

7-50 By providing facility installation standards for the size and position of tall signs, bill boards and advertising, uniformity will be achieved throughout the estate.

7-51 Generally, the parking on the streets is not desirable for both landscaping and security reasons. Therefore, it will be clearly indicated in the estate lease agreement and in the facility installation standard that each factory must respectively build a parking lot of an appropriate size for the number of cars expected. Also, for the purpose of providing greenery, a minimum greenery standard will be applied around the factories, so that the promotion and maintenance of greenery for the purpose of creating an aesthetic sense of unity and harmony throughout the estate will be achieved.

3. Construction Stipulations

7-52 Generally speaking, since the industrial estate is a collective body of factories located in a certain area for similar objectives, the mutual solidarity and unity should be clearly presented within its overall image. For this purpose, the following construction stipulations, which relate to the overall estate, are presented.

i) Construction regulations

A maximum limit will be placed on the total area of the building according to the size of each lot.

ii) Limitation for the heights of the buildings and the slope angle from the boundary of the lot.

The distance of the buildings from the lot boundaries will be regulated by the grade of the road running in front of it. The

figures below are examples:

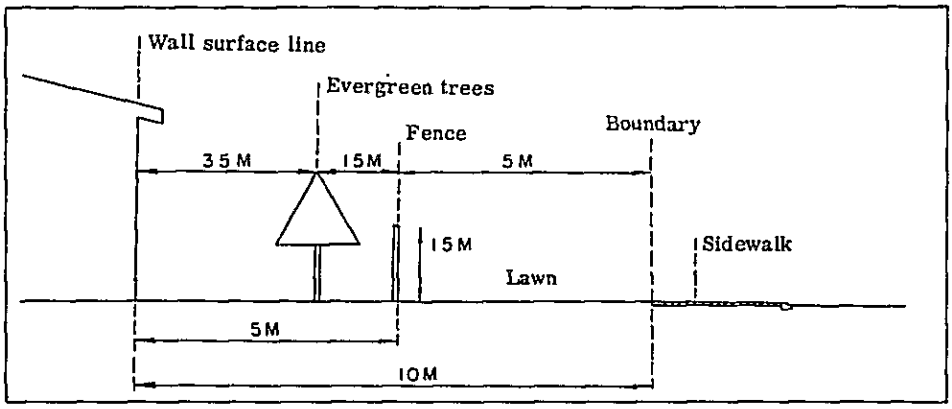


Fig. 7-20 GUIDELINE FOR LATERAL CLEARANCE FROM SECONDARY/TERTIARY ROAD

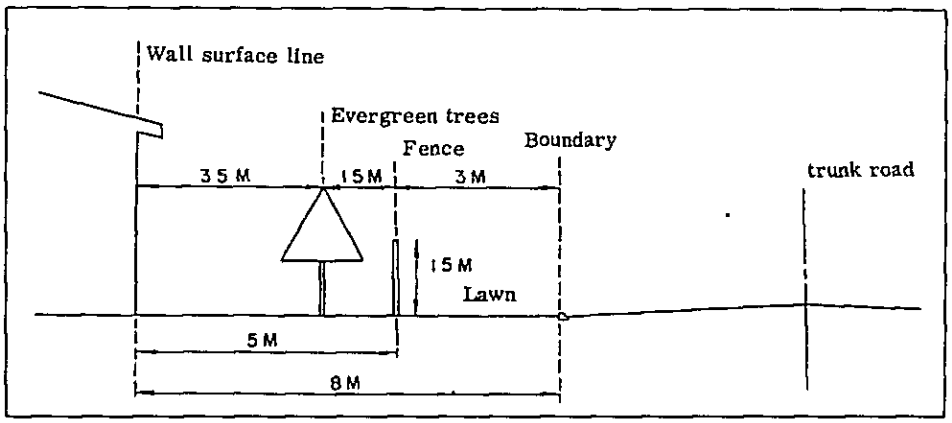


Fig. 7-21 GUIDELINE FOR LATERAL CLEARANCE FROM SERVICE ROAD

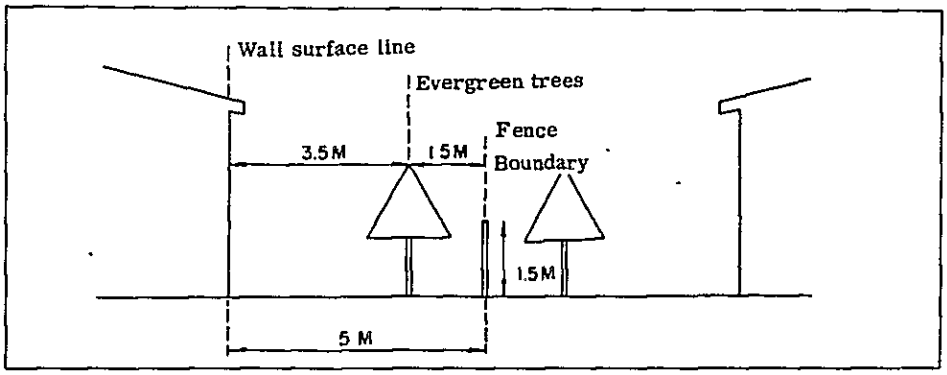


Fig. 7-22 GUIDELINE FOR LATERAL CLEARANCE FROM NEIGHBOURING FACTORY

iii) Designation of entrance/exits

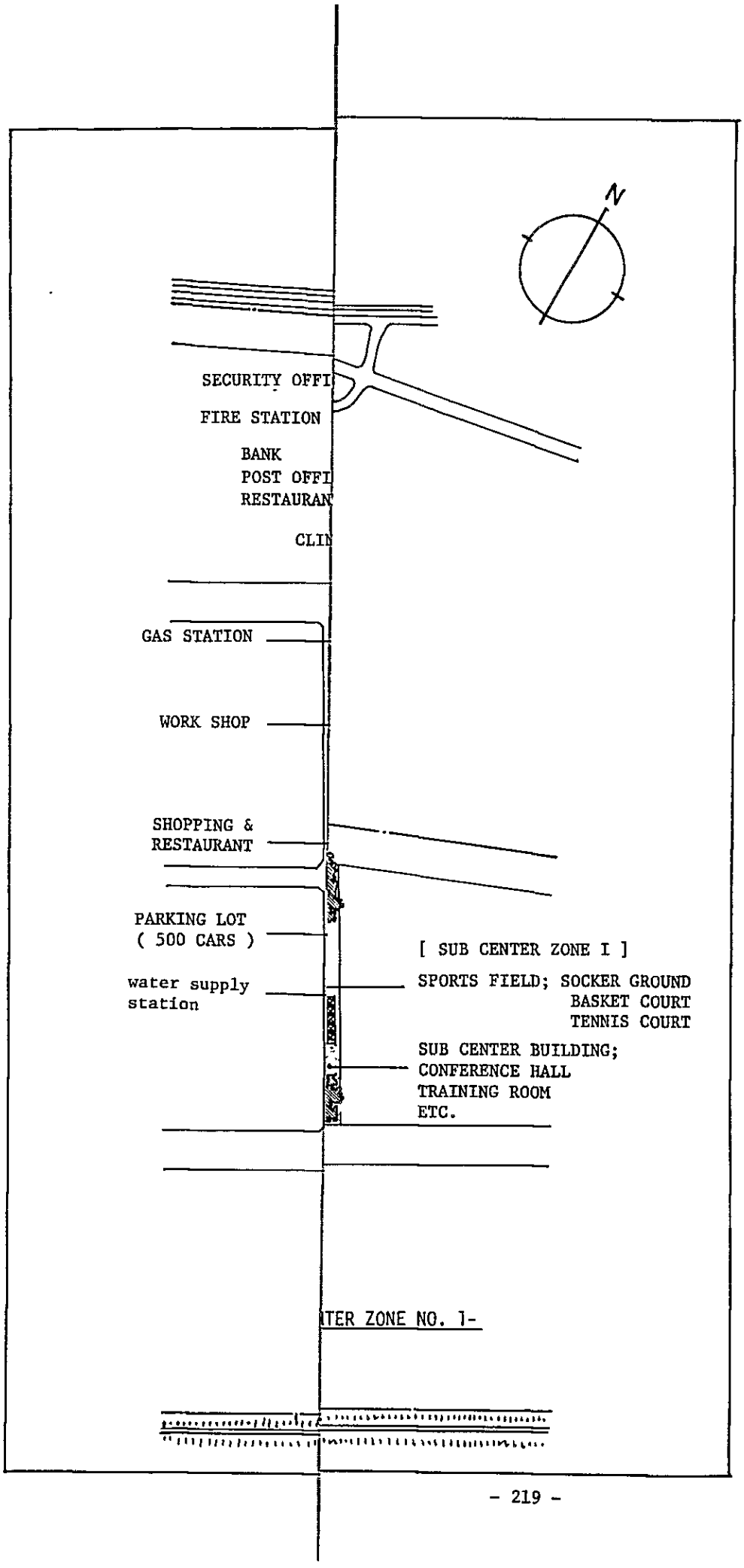
The number of entrance/exits of factories to roads within the estate will be basically limited to 2. Also these entrance/exits must be at least 20 m from all intersections, and 30 m away from major intersections.

iv) Fire and safety measures

The use of fireproof or fire retarding materials and the proper regulation of fire codes and other measures to prevent the spread of fires will be required.

4. Image Planning

7-53 The location plans are shown in Fig. 7-23 & 24 for the collective housing center in which common facilities are concentrated. These plans are made for the purpose of improving the overall image of SIE by the considerations of its functions, scale and interrelationship with other such facilities.


N
SECURITY OFFI
FIRE STATION
BANK
POST OFFI
RESTAURAN
CLI
GAS STATION
WORK SHOP
SHOPPING &
RESTAURANT
PARKING LOT
(500 CARS)
water supply
station
[SUB CENTER ZONE I]
SPORTS FIELD; SOCKER GROUND
BASKET COURT
TENNIS COURT
SUB CENTER BUILDING;
CONFERENCE HALL
TRAINING ROOM
ETC.
NTER ZONE NO. 1-

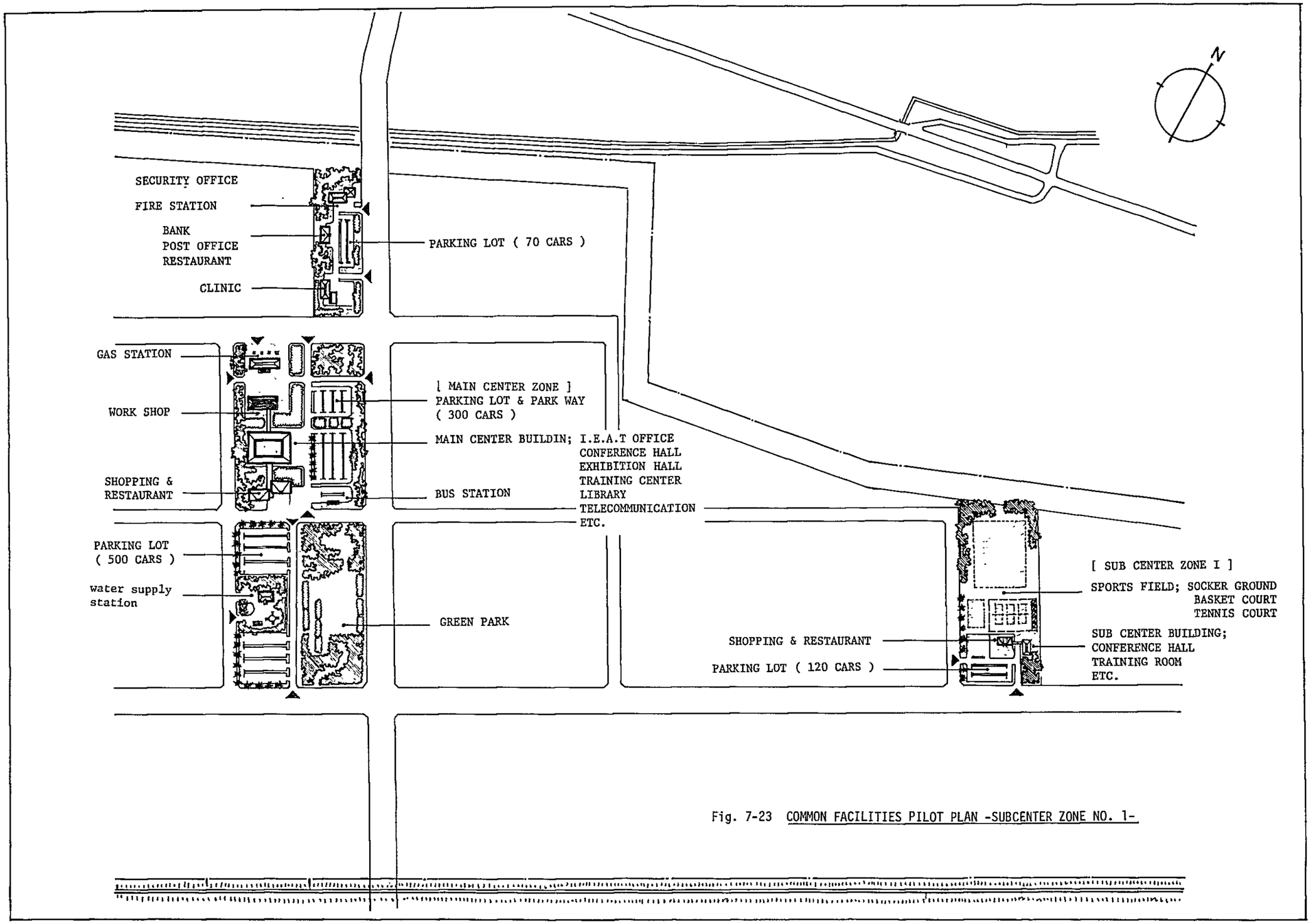
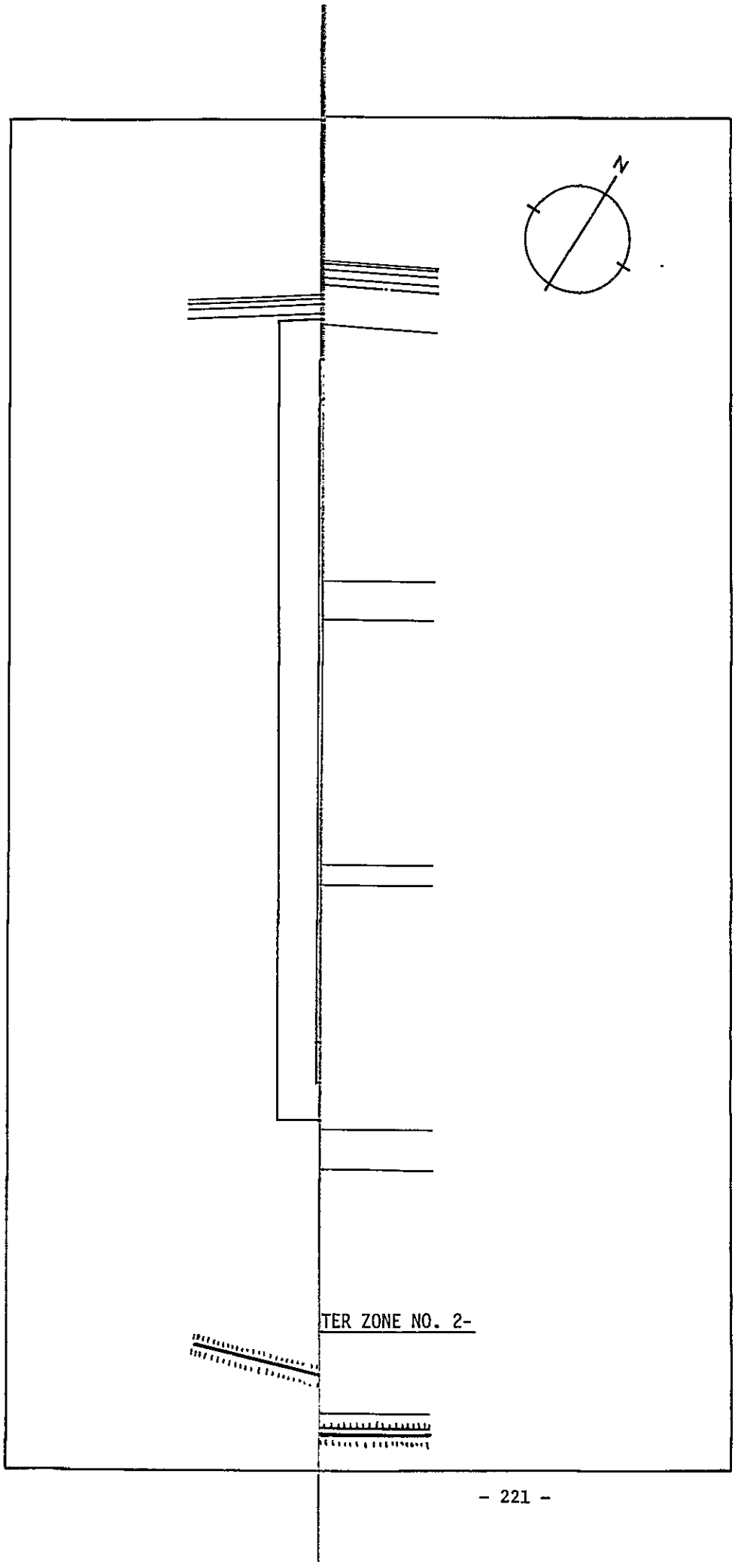


Fig. 7-23 COMMON FACILITIES PILOT PLAN -SUBCENTER ZONE NO. 1-


N
TER ZONE NO. 2-

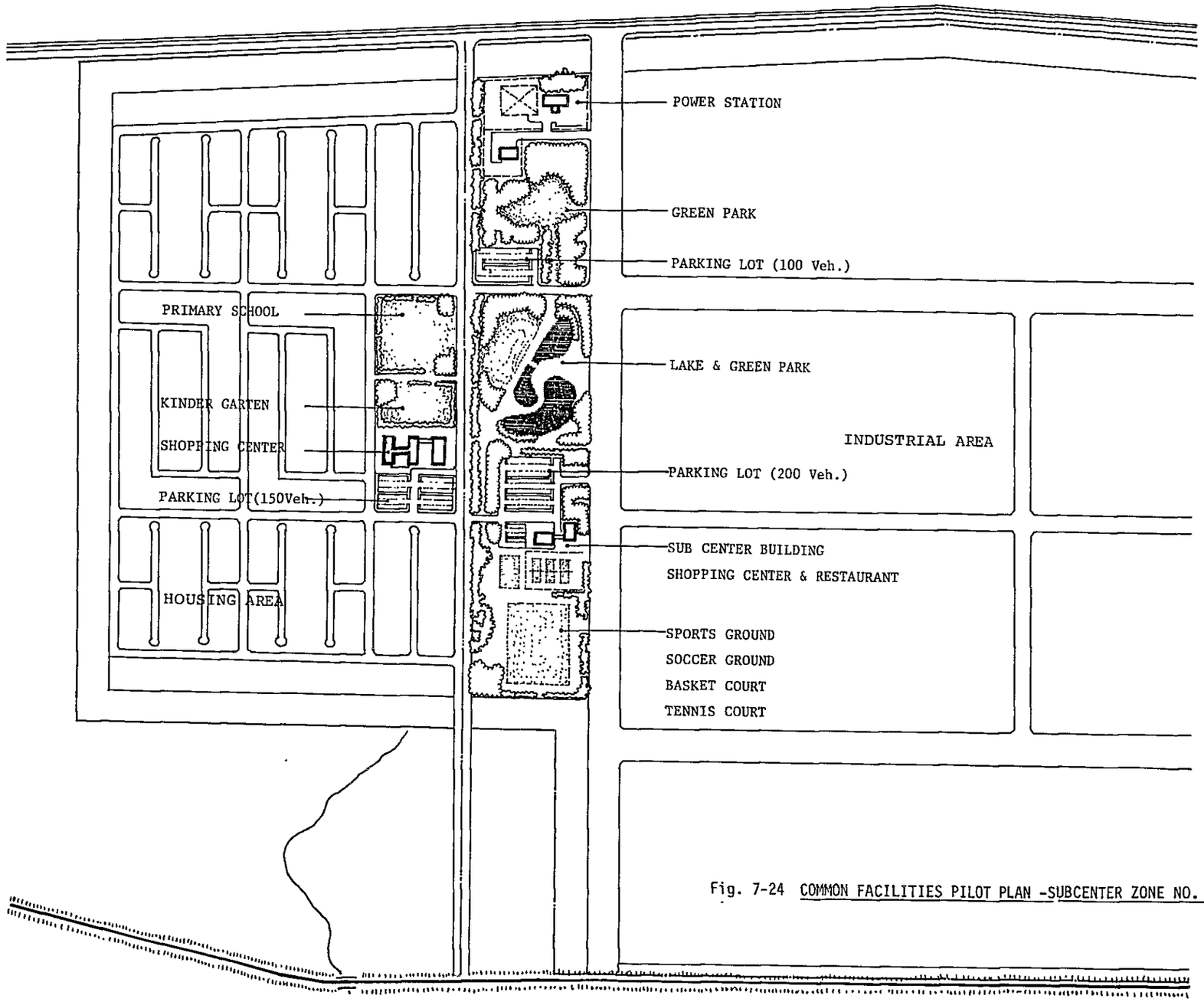


Fig. 7-24 COMMON FACILITIES PILOT PLAN -SUBCENTER ZONE NO. 2-

Ⅷ. CONSTRUCTION PROGRAM AND COST ESTIMATE

VIII. CONSTRUCTION PROGRAM AND COST ESTIMATE

A. Construction Cost

1. Cost Sharing

8-01 With regard to electricity supply facilities included in cost of the SIE development, EGAT will construct and operate the new substation, as described in para. 7-40, and PEA and IEAT will each bear 50% of the initial cost of the network supplying electricity from the substation. PEA will carry out directly negotiations with the tenant enterprises concerning maintenance, supervision and the construction of feeder lines. In the cases of both Bang Chan and Lat Krabang I.E., they are located in the jurisdiction of MEA, which is carrying out construction, maintenance and supervision.

8-02 In the area of communication facilities, an agreement covering Lat Krabang I.E. was concluded between TOT and IEAT in 1978. This called for each party to bear 50% of the initial costs and for TOT to carry out maintenance and operation. It is expected that the same system will be employed at SIE. In case of Bang Chan I.E., IEAT provided only the land for a telephone exchange, and contracts have been concluded between TOT and the individual tenant enterprises.

8-03 The cost of developing utility installations in the residential area will be born by IEAT, while NHA will develop buildings and their appurtenant works independently. IEAT will bear any other costs relating to developments inside SIE. It has been decided, however, that work relating to facilities outside the estate, such as the widening of R-35, will be carried out by the relevant agencies.

2. Unit Construction Cost

8-04 The per unit costs of construction were calculated on a 1980 base from the records of existing industrial estates, such as Lat Krabang I.E.. Such data as "Price List of Construction Materials" (Thailand Institute of Scientific and Technological Research), and the SMMC Price List were also used. Unit costs for the principal construction materials and labour costs are shown in Table 8-1 & 3.

8-05 On the basis of IEAT survey, land prices were set at 175,000 Baht/Rai for the 80 m belt of land alongside the existing road and 9,000 Baht/Rai for other sections. Engineering and supervision costs resulted in 6.8% of the base cost by roughly accumulating the cost for each item. The item, Others, which comprise of temporary works and preparation works, were fixed at about 5% of the base cost.

8-06 Construction costs are shown in Annex 8-1 & 2, divided into the various types of works and classified into foreign exchange and domestic currency, material costs, labour costs, tax overhead and profit. The foreign portion includes some indirect costs, since even basic construction materials that are produced domestically rely in part on imported raw materials, as shown in Table 8-2.

Table 8-1 MATERIAL COST

Description	Unit	Price (Baht)
1. Cement	t	1,115
2. Steel Bar (R15-R25)	t	7,970
(D15-D25)	t	8,290
(R9)	t	8,610
(D10)	t	8,790
3. Steel Form 300 x 1500	pcs	-
4. Wooden Form	m^3	5,490
5. Plywood Form (4' x 8')	pcs	540
6. Ready Mixed Concrete (300 kg)	m^3	770
(350 kg)	m^3	820
7. Sand for Subbase	m^3	100
for Base Course	m^3	95
for Concrete Aggregate	m^3	125
8. Crusher for Base Course	m^3	160
for Concrete	m^3	165
9. Latelite	m^3	100
10. Grassing	m^2	25
11. RC Pile 100 dia.	m	715
120 dia.	m	960
12. Bitumin	t	3,700
13. Oil Premium Gassoline	l	9.80
Regular Gassoline	l	9.26
Kerosine	l	8.71
High Speed Diesel	l	7.30
Low Speed Diesel	l	7.12
Fuel Oil 600	l	3.78
Fuel Oil 1,200	l	3.64
Fuel Oil 1,500	l	3.61
14. ACP 3 m length 80 dia.	pcs	45
100 dia.	pcs	77
150 dia.	pcs	111
200 dia.	pcs	160
15. RC Pipe 300 dia.	m	95
400 dia.	m	165
600 dia. (Flange)	m	230

Table 8-2 RATE OF IMPORT

Material	Cement (1,000t)	Crude Steel (1,000t)
Domestic Product	5,054 (93.5%)	163 (11.8%)
Import	352 (6.5%)	1,214 (88.2%)
Domestic Consumption	5,409	1,377
Remarks	1978	1976

Table 8-3 LABOR COST

Description	Wage (Baht/day)
1. Foreman	100-120
2. Carpenter	80-110
3. Steel Bending Worker	65- 90
4. Mason	100
5. Plaster	-
6. Welder	100-150
7. Operator (Crane, Shovel) (Bulldozer) (Truck)	100 100 70-100
8. Mechanic	100
9. Electrician	70-100
10. Unskilled Worker	40- 50

Note: 1 day : 8 hours

3. Construction Schedule and Cost

8-07 The construction schedule was set as shown in Fig. 8-1 following the discussions with IEAT.

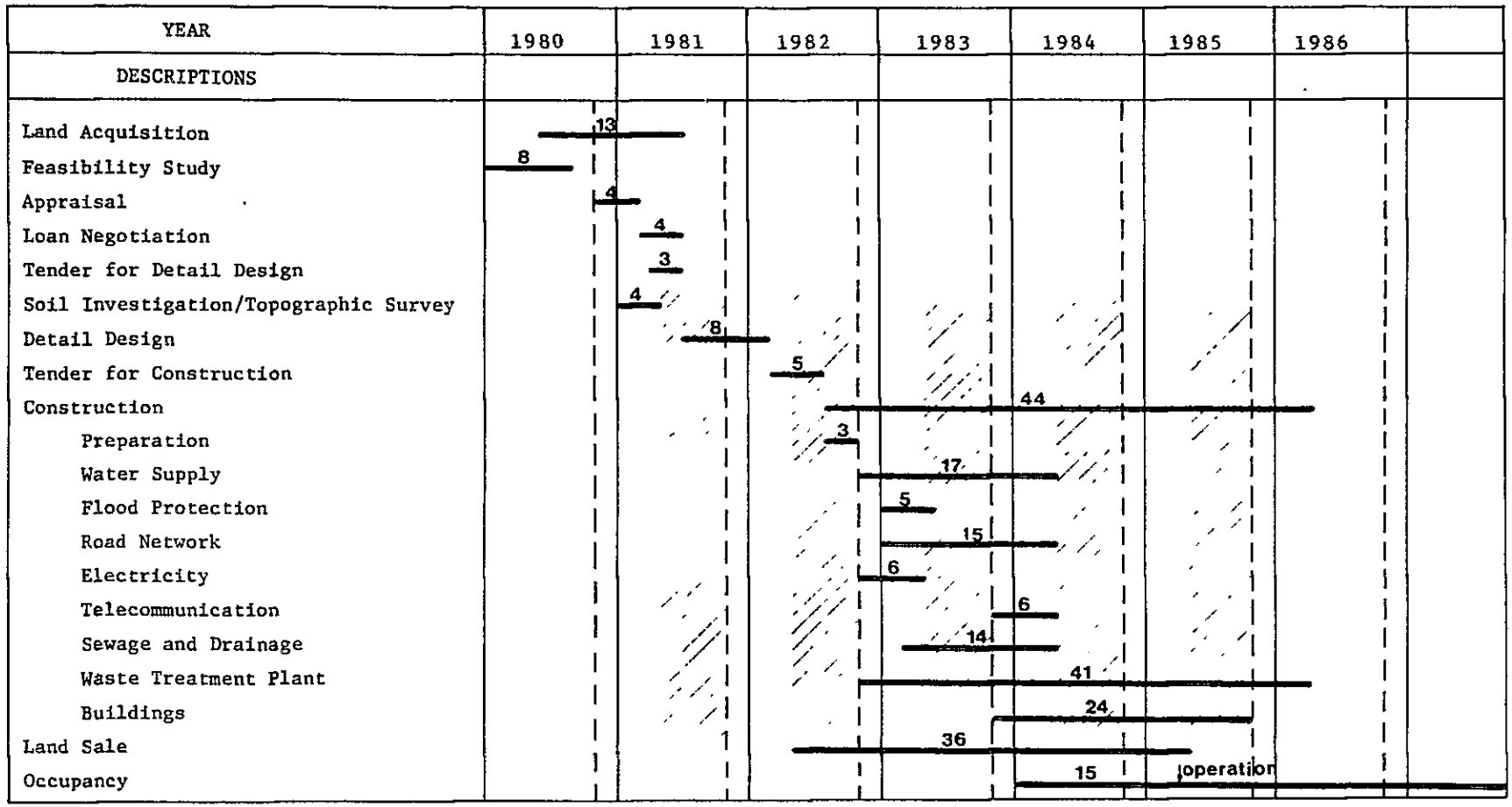
i) IEAT will commence acquisition of land as soon as the feasibility study is completed. The land will therefore be purchased in 1980 and any deficit will be paid for from the 1981 budget starting in October.

ii) Loan negotiation will commence and field and soil surveys will be taken on completion of land purchase. Detail design will start as soon as loan negotiations are concluded.

iii) Detail design will be followed by the formulation of tender documents and the calling of tenders. Work will begin in October 1982.

iv) Construction work will be carried out over a total of 2.5 years. The sewage treatment plant, however, will be built in 4 stages up to 1986 as it was considered better that its design incorporate feedback data gained after enterprises actually commence operations.

8-08 Costs for each year and costs generated by the industrial area and residential area on the basis of this construction schedule have been set out in Table 8-4, 5, & 6 by domestic and foreign currencies and in Annex 8-2 to 8-4. Foreign portion is estimated at 41.6% and the increasing portion by the residential area is at 11.3% of overall construction costs.



——— : calendar year

– – – : fiscal year (from Oct.1 to Sept. 30)

Rainy season : From May to Oct.

Numbers in Months

Fig. 8-1 IMPLIMENTATION SCHEDULE

Table 8-4 COST PROJECTION TOTAL

Unit: 1,000 BAHT

	1980	1981	1982	1983	1984	1985	1986	
LAND AQUISITION	43115	0	0	0	0	0	0	43115
LAND DEVELOPMENT	0	0	19789	176782	98036	9837	6737	311181
SITE PREPARATION	0	0	2611	0	0	0	0	2611
ROAD	0	0	3872	65037	48271	0	0	117180
DRAINAGE	0	0	0	6201	24228	0	0	30429
WATER SUPPLY	0	0	13306	17684	3782	0	0	34772
POWER SUPPLY	0	0	0	3385	0	0	0	3385
SEWAGE DISPOSAL	0	0	0	31576	19424	9837	6737	67574
TELECOMMUNICATION	0	0	0	990	2331	0	0	3321
FLOOD CONTROL	0	0	0	51909	0	0	0	51909
OTHERS	0	0	0	0	0	0	0	0
BUILDING	0	0	0	24317	38115	23464	0	85896
STANDARD FACTORY BUILDING	0	0	0	21033	30217	10401	0	61651
ADMINISTRATIVE BUILDING	0	0	0	3284	6248	9517	0	19049
COMMERCIAL, ETC.	0	0	0	0	1650	3546	0	5196
ENGINEERING & ARCH. SERVICE	0	20250	8528	2332	2332	550	0	33992
OTHERS	0	0	23920	0	0	0	0	23920
BASE COST	43115	20250	52237	203431	138483	33851	6737	498104
CONTINGENCIES	4311	3473	13001	66929	58235	17413	4003	167366
PHYSICAL	4311	2025	5224	20343	13848	3385	674	49810
PRICE	0	1448	7778	46586	44387	14027	3329	117556
TOTAL FINANCING	47426	23723	65238	270360	196718	51264	10740	665470

Table 8-5 COST PROJECTION LOCAL PORTION

Unit: 1,000 BAHT

	1980	1981	1982	1983	1984	1985	1986	
LAND AQUISITION	43115	0	0	0	0	0	0	43115
LAND DEVELOPMENT	0	0	11428	86038	58822	3531	2521	162340
SITE PREPARATION	0	0	979	0	0	0	0	979
ROAD	0	0	2337	38530	29715	0	0	70582
DRAINAGE	0	0	0	3229	15720	0	0	18949
WATER SUPPLY	0	0	8112	11819	3097	0	0	23028
POWER SUPPLY	0	0	0	2435	0	0	0	2435
SEWAGE DISPOSAL	0	0	0	13992	8726	3531	2521	28770
TELECOMMUNICATION	0	0	0	262	1564	0	0	1826
FLOOD CONTROL	0	0	0	15771	0	0	0	15771
OTHERS	0	0	0	0	0	0	0	0
BUILDING	0	0	0	15692	23109	16177	0	54978
STANDARD FACTORY BUILDING	0	0	0	13627	19468	6656	0	39751
ADMINISTRATIVE BUILDING	0	0	0	2065	2644	7331	0	12040
COMMERCIAL, ETC.	0	0	0	0	997	2190	0	3187
ENGINEERING & ARCH. SERVICE	0	10125	3753	928	928	550	0	16284
OTHERS	0	0	13654	0	0	0	0	13654
BASE COST	43115	10125	28835	102658.	82859	20258	2521	290371
CONTINGENCIES	4311	1792	7479	35678	36613	10996	1641	98511
PHYSICAL	4311	1012	2883	10266	8286	2026	252	29037
PRICE	0	780	4596	25412	28327	8970	1389	69474
TOTAL FINANCING	47426	11917	36314.	138336	119472	31254	4162	388882

Table 8-6 COST PROJECTION FOREIGN PORTION

Unit: 1,000 BAHT

	1980	1981	1982	1983	1984	1985	1986	
LAND AQUISITION	0	0	0	0	0	0	0	
LAND DEVELOPMENT	0	0	8361	90744	39214	6306	4216	148841
SITE PREPARATION	0	0	1632	0	0	0	0	1632
ROAD	0	0	1535	26507	18556	0	0	46598
DRAINAGE	0	0	0	2972	8508	0	0	11480
WATER SUPPLY	0	0	5194	5865	685	0	0	11744
POWER SUPPLY	0	0	0	950	0	0	0	950
SEWAGE DISPOSAL	0	0	0	17584	10698	6306	4216	38804
TELECOMMUNICATION	0	0	0	728	767	0	0	1495
FLOOD CONTROL	0	0	0	36138	0	0	0	36138
OTHERS	0	0	0	0	0	0	0	0
BUILDING	0	0	0	8625	15006	7287	0	30918
STANDARD FACTORY BUILDING	0	0	0	7406	10749	3745	0	21900
ADMINISTRATIVE BUILDING	0	0	0	1219	3604	2186	0	7009
COMMERCIAL, ETC.	0	0	0	0	653	1356	0	2009
ENGINEERING & ARCH, SERVICE	0	10125	4775	1404	1404	0	0	17708
OTHERS	0	0	10266	0	0	0	0	10266
BASE COST	0	10125	23402	100773	55624	13593	4216	207733
CONTINGENCIES	0	1681	5522	31251	21622	6416	2362	68855
PHYSICAL	0	1012	2340	10077	5562	1359	422	20773
PRICE	0	668	3182	21174	16060	5057	1941	48082
TOTAL FINANCING	0	11806	28924	132024	77246	20009	6578	276588

Ⅸ. ORGANIZATION AND MANAGEMENT

IX. ORGANIZATION AND MANAGEMENT

A. Organization

1. Points to be Noted Concerning the Managerial and Administrative Organization of SIE

9-01 Points to be noted in establishing managerial and administrative organization of SIE are as follows:

i) IEAT is already operating the industrial estate at Bang Chan and is now constructing another industrial estate at Lat Krabang. IEAT is now accumulating a wealth of know-how concerning management and administration of industrial estates through experience at these sites. SIE is located at equadistant from BMA compared to the above mentioned industrial estates, and there are many similarities in their nature. Therefore, in managing SIE, know-hows obtained at these industrial estates can be fully utilized.

ii) SIE is approximately 35 km from IEAT headquarters, so personnel exchanges will be easy. Therefore, it is desirable that such departments as the planning and control department and the marketing department of the IEAT headquarters are not included in the SIE and that they are operated by IEAT headquarters.

iii) Attention at SIE is focused on its wastewater treatment system. Therefore, in order to conserve the environment, observations and a pollution measuring system will be used more diligently than that at other industrial estates.

iv) IEAT will be placed under a policy committee consisting of the Factory Dept. and the Promotion Dept. of MOI, MOC, NESDB, Ministry of Interior, MOF, Bureau of Budget, BOI, Industry Association, Bank Association, and IEAT. Therefore, basic policy for management of SIE will follow decisions and recommendations made by the policy committee. Concerning wastewater treatment of SIE, it is advisable that a Wastewater Treatment Committee consisting of IEAT, NHA and representatives of firms in the estate will be established to measure the volume of wastewater, analyze it and conduct related operations.

2. Management and Administrative Organization of SIE and Its Functions and Roles

9-02 Figure 9-1 shows a possible organization for SIE management and administration. The portion surrounded by dotted lines, that is the Planning and Marketing Sections are not to be included by the SIE organization and these functions are to be carried out by IEAT headquarters. There will be one estate manager, two chiefs of sections and the total of engineers, technicians and clerks of the two sections will be 15. General works and draftmen will consist of 21 members. The total for the SIE organization is 39. The Central Water Treatment Plant will have two engineers, one technicians, five workers and two drivers.

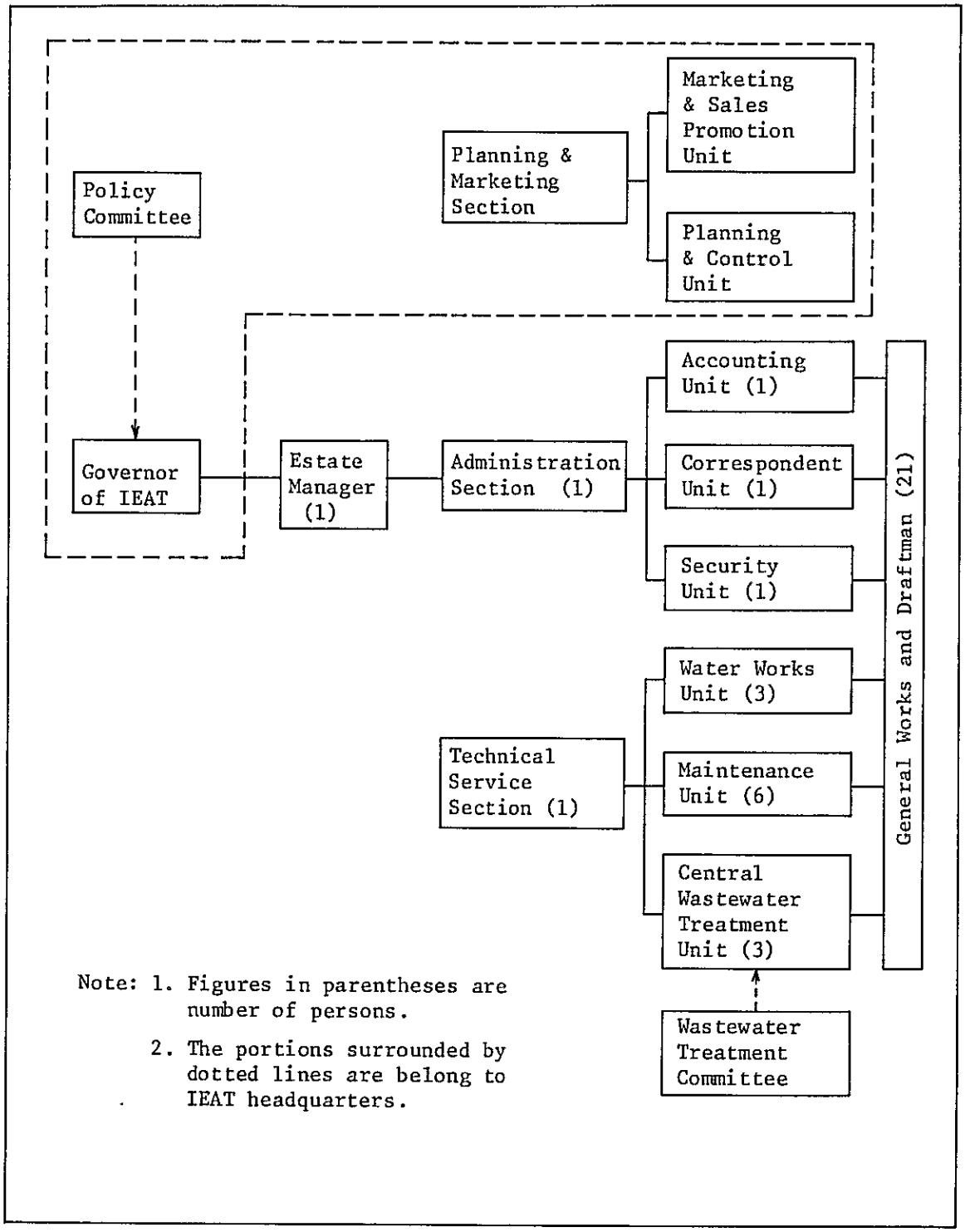


Fig. 9-1 ORGANIZATIONAL STRUCTURE OF SIE OFFICE

9-03 The Planning and Marketing Section consists of the Sales Promotion Unit and Planning and Control Unit. They are already operating at IEAT headquarters. Therefore, IEAT will function on behalf of SIE. Points to be noted concerning the opreration of SIE are as follows:

i) Industrial enterprises to be located in SIE have been discussed in Chapter IV. In actual sales, it is desirable that industrial composition of SIE will be as recommended in Chapter IV. If the number of firms in the food processing and textile industries, which produce large volumes of wastewater of which BOD components are large, exceeds the planned figure, the volume of wastewater may exceed treatment capacity.

ii) It is necessary to maintain a desirable share between factories relocated from Bangkok and those newly established when the factory lots are purchased. Land should be provided to accommodate the factories intent on relocation within the Samut Sakhon area.

9-04 The Technical Service Section will consist of the Water Works Unit, Central Wastewater Treatment Unit and Maintenance Unit and will be in charge of water supply, wastewater treatment and repairs and maintenance. Refer to Section B concerning wastewater treatment. From the beginning of 1982 when this project will operate full scale, it is advisable to receive guidance by a management advisor concerning all aspects of operation. Qualification of the management advisor is listed in Annex 9-1.

B. Wastewater Management System

9-05 To accept factory wastewater in the central wastewater treatment facility involves many difficult problems, such as the volume of wastewater, analysis of the quality of wastewater, elimination facility, treatment after acceptance and fees. Therefore, it is advisable to establish a committee and a special organization for implementation of the management of factory wastewater discharge.

The factory Wastewater Treatment Committee will engage in the following:

i) Management of sewerage and the treatment facility

ii) Finance, planning and factory management

iii) The decision concerning the standard water quality for acceptance to the central wastewater treatment facility.

iv) Discussion of a fee system

There will be organization for implementation under the committee. The organization will conduct the following:

i) Administration of the Committee

ii) Instruction, designation and examination of the elimination facility and periodic examinations after its establishment.

iii) Examination of wastewater, collection and analysis of measurement data, authorization of water quality concerning collection of fees.

iv) Analysis of wastewater

It is advisable that the Wastewater Control Committee consists of the following:

Chairman — One sanitary engineer

Special engineers
- One each mechanical engineer
  chemical engineer
- One representative from NHA
- and several representatives of industries.

Implementation Organization
- Two engineers (mechanist 1, chemist 1)
- Four technicians
- Five drivers (car 2, truck 1, wagon 1)

In 1982 (January-December) when the treatment facilities enter operation, technical guidance by a technical advisor will be needed. Qualification of the technical advisor is stated in Annex 9-2.

C. Recommendations

1. Financial Assistance

9-06 Firms to be located in SIE can obtain investment tax incentives based on BOI. See Chater I (1-18, 1-19) concerning the contents of incentives. However, approximately half of the firms to be located in SIE are relocations from BMA, and their demand for funds related to relocation is strong. Therefore, it is advisable that financial assistance measures, such as preferential application of IFCT loans, are established.

2. Establishment of a Business Information Center (BIC)

9-07 Although SIE is close to BMA, there is an information gap between it and the Bangkok City. In order to close this gap, it is advisable for the IEAT office in SIE to open a business information center to provide firms in SIE with information concerning the economy, industry, markets, finance and labor force.

X. FINANCIAL ANALYSIS

X. FINANCIAL ANALYSIS

A. Funds Required

1. Assumption of the Base Case

10-01 In Making financial analysis in this chapter, we assumed a base case called Case 1-0 adopting various values which so far have been examined in the preceding chapters. The sensitivity analysis to be studied in Section E of this chapter is to observe changes in financial appraisal indexes in accordance with variations of the aforesaid values from the base case. Costs, prices or values to be examined in this chapter are based on real prices with 1980 as the base year.

2. Funds Required

10-02 The SIE's construction costs in the base case amount to 666 million Baht with 1980 as the base year. Adding interests of 33 million Baht during the construction period, the total amount of funds required reaches 699 million Baht (see Table 10-1).

Table 10-1 CONSTRUCTION COST PROJECTION
(1980 Year Constant Price)

Unit : Baht Thousand

	Foreign Portion	Domestic Portion	Total
Land Aquisition	0	43,115	43,115
Land Development	148,841	162,340	311,181
Site Preparation	1,632	979	2,611
Road Network	46,598	70,582	117,180
Drainage System	11,480	18,949	30,429
Water Supply	11,744	23,028	34,772
Power Supply	950	2,435	3,385
Sewage System	38,804	28,770	67,574
Telecommunication	1,495	1,826	3,321
Flood Protection	36,138	15,771	51,909
Building	30,918	54,978	85,896
Standard Factory Building	21,900	39,751	61,651
Administrative Building	7,009	12,040	19,049
Commercial Building	2,009	3,187	5,196
Engineering Service	17,708	16,284	33,992
Others	10,266	13,654	23,920
Base Cost	207,733	290,371	498,104
Contingency	68,855	98,511	167,366
Physical	20,773	29,037	49,810
Price	48,082	69,474	117,556
Total Financing	276,588	388,882	665,470
Interesting During Construction	33,318	0	33,318
Grand Total	309,906	388,882	698,788

Note: For detail see Chapter VIII & Annex 8-1 - 8-4.

10-03 Of the total, the foreign portion stands at 44.3% and the domestic portion comes to 55.7%.

Foreign portion	310 Baht million	44.3%
Domestic portion	389	55.7
Total	699	100.0

10-04 Of the base costs, 10% are reserved for physical continqency as there are some uncertainties in the conditions of soil and underground water veins, the details of the construction plan and the estimates in the construction costs. Each year 6% of the foreign portion and 7% of the domestic portion of the base costs are reserved for inflation during the 1980-1986 period, that is, from the acquisition of land to the completion of the construction works. The ratio of this reserve to the base costs from 1981 to 1986 comes to 23.6%.

3. Fund Raising Program

10-05 The required sum of 699 million Baht is financed by the government, foreign capital, and internally in the ratio shown in Table 10-2.

Table 10-2 FUND RAISING PLAN

	Amount (Baht Mil.)	Composition (%)
Government Contribution	60	8.6
Internally Cash Generation	329	47.1
Long-term Foreign Loan	310	44.3
Total	699	100.0

10-06 The content of Baht 60 million for Gevernment Contribution is consit of three parts; one is Baht 47,426,000 for Land Acquision (added 10% of physical contingency to the base cost), second is Baht 11,862,000 for domestic portion of Engineering Service (added 10% of physical contingency and 7% of price contingency to the base cost), and third is Baht 1,078,000 for the deficit produced by the operation in 1980 and 1981.

10-07 In the base case, the terms of the long-term foreign loan are assumed to be as follows: Repayment in 15 years with a 5-year grace with an interest of 3.5% a year. However, as for this project, repayment shall start in the year following the final year of loan (the year when the construction works will be completed). The loan program is shown in Table 10-3. Loan will be made in the middle of each year and the interests generated during the construction period will be paid at the end of the year. The repayment program is shown in Table 10-4.

Table 10-3 DISBURSEMENT OF LONG-TERM FOREIGN LOAN

(Unit: 1,000 Baht)

	1980	1981	1982	1983	1984	1985	1986	Total
DISBURSMENT	0.	13000.	30000.	137000.	85000.	30000.	17000.	312000.
APPLICATION	0.	12033.	29904.	135927.	85034.	29809.	17201.	309908.
INVESTMENT IN CONSTRUCTION	0.	11806.	28924.	132024.	77246.	20009.	6578.	276587.
INTEREST	0.	227.	980.	3902.	7787.	9800.	10622.	33318.
REPAYMENT	0.	0.	0.	0.	0.	0.	0.	0.
INCREASE IN FOREIGN EXCHANGE	0.	967.	96.	1073.	-34.	191.	-201.	
BEGINNING BALANCE	0.	0.	967.	1063.	2136.	2103.	2293.	
ENDING BALANCE	0.	967.	1063.	2136.	2103.	2293.	2092.	

Table 10-4 REPAYMENT OF LONG-TERM FOREIGN LOAN

	Repayment (1,000 Baht)	Interest (1,000 Baht)	Total (1,000 Baht)
1981		227	227
1982		980	980
1983		3,902	3,902
1984		7,787	7,787
1985		9,800	9,800
1986		10,622	10,622
1987	31,200	10,374	41,574
1988	31,200	9,282	40,482
1989	31,200	8,190	39,390
1990	31,200	7,098	38,298
1991	31,200	6,006	37,206
1992	31,200	4,914	36,114
1993	31,200	3,822	35,022
1994	31,200	2,730	33,930
1995	31,200	1,638	32,838
1996	31,200	540	31,740
Total	312,000	87,912	399,912

10-08 In the base case, the interest rate of long-term foreign loan is set to be 3.5%, and in Section E Sensitivity Analysis, the other cases of interest rate of 5.0%, 6.5%, and 8.0% are also calculated as the case 3-1, 3-2 and 3-3. The comparison of main indicators on these cases are shown in Table 10-5. It is said from Table 10-5 that total financing required on the base case (interest rate is 3.5%) is Baht 698,788,000, but when the interest rate changes from 5.0% to 6.5% and 8.0%, total financing required increases from Baht 714,245,000 (4.8% up to the Base case) to Baht 730,794,000 (10.3% up) and Baht 748,070,000 (15.7% up) respectively. Long-term foreign loan is Baht 312,000,000 on the base case, but it increases from Baht 327,000,000 (4.8% up to the base case) to Baht 344,000,000 (10.3% up) and Baht 361,000,000 (15.7% up) respectively when the interest rate changes. Total repayment of long-term foreign loan (included interest) is Baht 431,279,000 on the base case, but it increases from Baht 457,521,000 (6.3% up the base case) to Baht 521,124,000 (20.9% up) and Baht 588,000,000 (36.4% up) respectively, when the interest rate changes. Retained earnings is Baht 375,072,000 on the base case, but it decreases from Baht 333,553,000 (10.9% down to the base case) to Baht 288,155,000 (23.2% down) and Baht 239,584,000 (36.0% down) respectively, when the interest rate changes. Debt-Service Coverage Ratio is 5.20 on the base case, but it decreases from 4.64 to 4.16 and 3.79 respectively, when the interest rate changes, and it is said that no problem exsists in any cases. Internal Rate of Return and Benefit-Cost Ratio (discount rate: 8%) are 10.3% and 1.025 respectively on the base case, and these indicators don't change at all, when the interest rate changes. The reason is that any interest rate is not included on the process of these calculation.

Table 10-5 SUMMARY OF KEY INDICATORS FOR CHANGING THE INTEREST RATE OF LONG-TERM FOREIGN LOAN

Unit: Baht Thousand

	Case 1-0 (Base Case)	Case 3-1	Case 3-2	Case 3-3
Interest Rate of Long-Term Foreign Loan	3.5%	5.0%	6.5%	8.0%
Construction Cost				
Total Financing	665,470	665,470	665,470	665,470
Interest During Construction	33,318	48,775	65,324	82,600
Grand Total	698,788	714,245	730,794	748,070
Financing Plan				
Government Contribution	60,000	60,000	60,000	60,000
Internal Cash Generation	328,888	328,883	328,883	328,883
Long-Term Foreign Loan	309,908	325,362	341,911	359,187
Total	698,788	714,245	730,794	748,070
Repayment of Long-Term Foreign Loan(Including short term debt)				
Repayment	312,000	327,000	344,000	361,000
Interest	119,279	130,521	177,124	227,000
Total	431,279	457,521	521,124	588,000
Retained Earnings	375,072	333,553	288,155	239,584
Debt-Service Coverage Ratio (14 year's average)	5.20	4.64	4.16	3.79
Internal Rate of Return	10.3%	10.3%	10.3%	10.3%
Benefit Cost Ratio (Discount Rate: 8%)	1.025	1.025	1.025	1.025

B. Revenue Plan

1. Sources of Revenue

10-09 Sources of the SIE's revenue are roughly divided into the revenue from land and factory and that from the supply of services. Details of each category are as follows:

- Revenue from land and factory
  - . Sale of factory lots
  - . Sale of house lots to NHA
  - . Installment sale of factory lots
  - . Lease of factory lots
  - . Lease of standard factories
  - . Lease of buildings for commercial purposes
- Revenue from the supply of services
  - . Maintenance and administration fees
  - . Water supply and sewerage charges

2. Pricing

10-10 In determining selling prices and rentals of the sites and facilities, the following must be taken into consideration.

i) To cover all the expenditure during the project life (15 years).

ii) To set reasonable prices or rentals to the tenants of SIE.

In this project, the per-Rai cost of factory site comes to Baht 367,000 taking account of that of housing site to be sold to NHA, which is 10% higher than the cost of factory site. Factory site in the Lat Krabang Industrial Estate is being sold at Baht 400,000 per Rai in 1980 by IEAT. This price furnishes a guide as for this project, because SIE resembles the Lat Krabang Industrial Estate very much in respect to the distance from the center of Bangkok, facilities and other conditions. IEAT suggests Baht 400,000 in the 1980 price as the per-Rai selling price of factory site in SIE. IEAT must pay the taxes concerning the sale of factory plot, because the adaptation of government law to the IEAT has changed from this year. They are totally 3.85% to the price of land sale; commercial tax is 3.5% to the price of land sale, municipal tax is 10% to the amount of commercial tax. Considering these points, the price of factory site in this project was set at Baht 420,000 per Rai.

10-11 Although the house site to be sold to NHA cost around Baht 420,000 per Rai, they were prices at this level without expecting any profit.

10-12 The installment sale price of factory site was decided on the basis of the per-Rai selling price of Baht 400,000 mentioned in 10-10, taking account of per-annum interests of 15%. In the installment sale, 25% of the total amount shall be paid down and the rest will be paid in installments for three years.

10-13 The rental of factory site was set at the level equivalent to the amount of 20-year installment payment on a basis of the per Rai selling price of factory site (Baht 40,000 per Rai except tax). The rental stands at Baht 37,700 per Rai.

Note: The rental is calculated by the following methods.

$$a = A \times \frac{r(1+r)^{n-1}}{(1+r)^{n}-1}$$

a : Rental (Baht 37,700)
A : Basic price (Baht 400,000)
r : Annual interest rate (8%)
n : Installment period (20 years)

The rental will be paid in the beginning of each year.

10-14 The annual rental of standard factories was set at Baht 1,280 per square meter. It consists of the rental of the factory itself equivalent to a sum of 20-year installment payment calculated on the basis of the aggregate of construction costs, administration and personnel expenses, interests (at an annual rate of 8%) and profits, and the rental of a factory site with an area of 15 Rai.

10-15 The annual rental of buildings for commercial purposes was set at Baht 3,510 per square meter. It consists of the rental of the building itself equivalent to the sum of 20-year installment payment calculated on the basis of the aggregate of construction cost, administration and personnel expenses, interests (at an annual rate of 8%) and profits, and the rental of a site with an area of 3 Rai.

10-16 All the maintenance and administration expenditure will be borne by tenants as costs (see 10-25 for details).

10-17 Water supply and sewerage charges have been set as follows: 2.5 Baht per cubic meter for water supply and 5.0 Baht per cubic meter for sewerage. Daily water consumption is estimated at 21,700 tons (18,000 tons for industrial use and 3,700 tons for household use), when the industrial estate is full of tenants, assuming that factories use water 300 days and households 365 days a year. On top of this, administration and personnel expenses are added. Consequently, water supply and sewerage charges come to 7.6 Baht per cubic meter.

10-18 The unit selling prices, rentals, and service charges are shown in Table 10-6.

Table 10-6 UNIT SELLING PRICES, RENTALS AND SERVICE CHARGES

Source of Revenue	Unit Price (Baht)
Sale of factory lots	420,000/Rai
Sale of housing lots to NHA	420,000/Rai
Installment sale of factory lots	400,000/Rai (with interest at 15%)
Lease of factory lots	37,700/Rai. year
Lease of standard factories	1,280/m^2.year
Lease of buildings for commercial purposes	3,510/m^2.year
Maintenance and administration	2,700/Rai.year
Water supply and sewerage	7.6/m^3

3. Sales Plan

10-19 The factory lots for sale covers an area of 1,254 Rai, of which 90% or 1,129 Rai is to be sold in cash or by installments and the remaining 10% or 110 Rai is to put out to lease. Land sale will start in 1982 and end by 1985, with 20% of the land scheduled for sale for 1982, 45% for 1983, 25% for 1984 and 10% for 1985. The composition of cash and installment for 1982 is set at 20% and 80%, respectively. From 1983 on, the percentage of cash payment will gradually increase from 40% in 1983 to 70% in 1984 and 90% in 1985. These percentage have been set in consideration of the fact that in 1982 purchasers will hesitate to pay in cash because land sale at that year will be based on drawing. As the industrial estate near completion, it will become less difficult to make a cash payment.

10-20 Land lease will start in mid-1984 when land division is to be completed. The projected lease area is 55 Rai for 1984 and 55 Rai for 1985.

10-21 The sale of the housing site (179 Rai) to NHA will be made in 1982 when the detailed plan is to be completed. Out of the total dwelling site covering an area of 265 Rai, 178.7 Rai (consisting of 161.8 Rai for housing, 6.3 Rai for shopping centers and 10.6 Rai for public facilities) is to be sold to NHA. The remaining 86.3 Rai (consisting of roads, green zones and ponds) will not be sold to NHA but will be possessed and administered by IEAT.

10-22 Lease of the standard factory will start upon completion of the factory in 1985. The total floor area to be put out to lease will be 12,000 m^2, of which 6,000 m^2 will be put on to lease in 1985 and the remaining 6,000 m^2 in 1986.

10-23 Lease of the commercial buildings will start upon completion of the building in 1985. The total floor area to be put out to lease will be 1,200 m^2, of which 600 m^2 will be put out to lease in 1985 and the remaining 600 m^2 in 1986.

10-24 Table 10-7 shows the time of sale and area for each revenue source.

Table 10-7 SALES PLAN

Revenue Source	Unit	1982	1983	1984	1985	1986	Total
Sale of Factory Lots	Rai	46	203	197	102		548
Sale of Housing Site to NHA	Rai	179					179
Sale of Factory Lots on Installment Basis	Rai	180	305	85	11		581
Lease of Factory Lots	Rai			55	55		110
Lease of Standard Factory (Floor Area)	m^2				6,000	6,000	12,000
Lease of Commercial Building (Floor Area)	m^2				600	600	1,200

4. Revenue Plan

10-25 As maintenance fee, IEAT will collect 2,700 Baht per Rai from the tenants and NHA for an area of 1,433 Rai consisting of 1,254 Rai of factory lots for sale or lease and 179 Rai to be sold to NHA. The collection of the fee will start in 1984 with the initial percentage set at 10% of 1,433 Rai. Thereafter, the percentage will rise by 20 percentage points annually until 1989 and by 10% for 1990, and thus from 1990 on the collection will be made for a total of 1,433 Rai.

10-26 As water supply and sewage disposal charges, 7.6 Baht per cubic meter used annually will be collected. The total water supply until 1990 of 6,750,000 m^3 will consist of 5,400,000 m^3 of industrial water and 1,350,000 m^3 of water for households. The water use is to start from 1984 and then increase by 10% in 1984. Until 1989 it will increase by 20% annually and in 1990 it will rise further by 10% to use up the total supply of 6,750,000 m^3 and will continue thereafter.

10-27 The annual revenue from sale of the plant site and the housing site as well as from lease of the plant site, the standard factory and the commercial building site can be computed by multiplying the area for sale or lease each year by each unit price. The projected revenue for each year is shown in Table 10-8.

Table 10-8 REVENUE PROJECTION

Unit : Baht thousand

	1982	1983	1984	1984	1986	1987	1988	1989	1990	1991
Land Sale	103,003	227,056	122,257	47,954						
Land Leased			2,073	4,147	4,147	4,147	4,147	4,147	4,147	4,147
Standard Factory Leased				7,680	15,360	15,360	15,360	15,360	15,360	15,360
Commercial Bldg. Leased				2,106	4,212	4,212	4,212	4,212	4,212	4,212
Water and Sewage Charges				5,130	15,390	25,650	35,910	46,170	51,300	51,300
Maintenance Fees				383	1,158	1,933	2,708	3,483	3,869	3,869
Land Sale to NHA	75,180									
Total	178,183	227,056	124,330	67,400	40,267	51,302	62,337	73,337	78,888	78,888

C. Operating Cost

1. Personnel Expenses and Overhead Cost

10-28 The administrative organization of SIE is described in Section A of Chapter IX. The required manpower, broken down by class, and the annual cost therefor are as follows:

Table 10-9 PERSONNEL EXPENSES

Class	Number	Cost (Baht)	Total Cost (Baht)
Manager	1	404,200	404,200
Chiefs of Section	2	144,000	288,000
Engineers	4	126,000	504,000
Technicians	10	54,000	540,000
Workers	14	28,800	403,200
Drivers	8	27,000	216,000
Total	39		2,355,400

Note: Cost includes salary, fringe benefit and other expenses.

As seen in this table, the annual personnel expenses come to Baht 2,355,000. However, this cost is for a full operation of SIE. Manpower required at the early stage of the Project will naturally be smaller. It is assumed that the annual total cost will be 10% of Baht 2,355,000 in 1980 and 1981. It will increase at an annual rate of 20% until 1985, and will rise by 10% in 1986 to reach the amount for full operation.

10-29 Overhead cost covers office expenses, travelling expenses, purchasing and maintenance costs of automobiles and other miscellaneous expenses. The overhead cost is estimated at 80% of personnel expenses.

2. Sales Promotion Expenses

10-30 Expenses for promoting the sale of plant sites are set at Baht 500,000 for each of the four years from 1982 to 1985. The expenses include the production cost of brochures and the cost of publicity and advertising.

3. Maintenance Cost

10-31 Maintenance cost is estimated at the same amount as calculated in 10-25 (Revenue Plan), that is, Baht 3,869,000 a year for a full operation. Increase rates in respective years are supposed to be the same as calculated in 10-25.

4. Water Supply and Wastewater Disposal

10-32 Cost of water supply and wastewater disposal is estimated at 90% of Baht 51,300,000, an amount calculated in 10-26 (Revenue Plan). Increase rates in respective years are supposed to be the same as calculated in 10-26.

5. Depreciation

10-33 For the depreciation of the construction cost of SIE, a method which IEAT selected for other industrial estates has been employed, making reference to the Revenue Code published by the Ministry of Finance. The method which the Project has taken up is a straight line depreciation, and salvage values are set at nought. The depreciations of facilities are shown in Table 10-10. They are to be started in 1986 when most of the construction works are over.

Table 10-10 RATE OF DEPRECIATION

Items	Rate of Depreciation
Land Acquisition	0%
Site Preparation	0
Roads Network	2.5
Drainage System	2.5
Water Supply	7
Power Supply	7
Sewage System	7
Telecommunication	4
Flood Protection	2.5
Standard Factories	5
Administration Building	5
Commercial Building	5
Engineering Service	20
Technical Assistance & Training	20
Others	2.5

Note: Straight Line Method

6. Cost of Land for Sale

10-34 Cost of the lands for sale, which falls under the category of construction cost, is not be depreciated. This cost is equivalent to land acquisition cost plus site preparation cost. Costs of the land for sale in respective years are as follows:

1982	Baht 8,457 thousand
1983	Baht 10,584 thousand
1984	Baht 5,892 thousand
1985	Baht 2,346 thousand

7. Operating Cost

10-35 As shown in the foregoing, the operating cost is an aggregate of costs stated in (10-28)-(10-32) (see Table 10-11). An aggregate of operating cost, interests, depreciation expenses and land-for-sale cost makes a total cost for each year.

Table 10-11 OPERATING COST

Unit: Baht Thousand

Year	Operating Cost	Salaries & Wages	Administration	Promotion	Repair & Maintenance	Water & Sewage
1980	423	235	188	0	0	0
1981	423	235	188	0	0	0
1982	1,751	706	545	500	0	0
1983	2,619	1,177	942	500	0	0
1984	3,466	1,648	1,318	500	0	0
1985	9,316	2,120	1,696	500	383	4,617
1986	19,248	2,355	1,884	0	1,158	13,851
1987	29,257	2,355	1,884	0	1,933	23,085
1988	39,266	2,355	1,884	0	2,708	32,319
1989	49,275	2,355	1,884	0	3,483	41,553
1990	54,278	2,355	1,884	0	3,869	46,170
1991	54,278	2,355	1,884	0	3,869	46,170
1992	54,278	2,355	1,884	0	3,869	46,170
1993	54,278	2,355	1,884	0	3,869	46,170
1994	54,278	2,355	1,884	0	3,869	46,170

D. Financial Statements and Profitability

1. Income Statement

10-36 Income statement based on income plan (Section B) and operating cost (Section C) is given in Table 10-12 (for details, refer to Annex 10-1). According to this table, income after tax will register a large surplus for four years from 1982 to 1985 when factory and housing lots are put on sale. However, it will go into the red in 1986 because there will be no income other than rents that year and thereafter. Annex 10-1 projects that income after tax again will be in the black in 1996 and thereafter.

2. Cash Flow

10-37 Cash flow of the Project is shown in Annex 10-2. The debt service coverage ratios (DSCR) for the years from 1980 to 1994 are shown in Table 10-13. The ratio indicates the capability of debt repayment. As seen in the table, the debt repayment capability for the 15-year life of the Project stands at a highly favorable level of 5.20 (DSCR > 1). The ratio will be below 1 in 1987 and thereafter, representing an annual income smaller than an annual payment. However, this will provide no problem because internal reserves accumulated before 1987 can be used for payments.

Table 10-12 A SUMMARY PRO FORMA INCOME STATETMENT

Unit : Baht thousand

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
REVENUE	0.	0.	178183.	227056.	124330.	67400.	40267.	51302.	62337.	73372.
EXPENDITURE	423.	650.	14427.	27453.	28527.	26699.	62478.	71275.	80093.	89010.
OPERATING COST	423.	423.	1751.	2619.	3466.	9316.	19248.	25257.	39266.	49275.
INTEREST	0.	227.	4219.	14250.	19169.	15037.	11684.	10473.	9282.	8190.
DEPRECIATION	0.	0.	0.	0.	0.	0.	31545.	31545.	31545.	31545.
COST OF LAND SOLD	0.	0.	8457.	10584.	5892.	2346.	0.	0.	0.	0.
INCOME BEFORE TAX	-423.	-650.	163756.	199603.	95803.	40701.	-22210.	-19973.	-17756.	-15638.
(LESS) COMMERCIAL & LOCAL TAX	0.	0.	6860.	8742.	4707.	1846.	0.	0.	0.	0.
INCOME AFTER TAX	-423.	-650.	156895.	190861.	91096.	38855.	-22210.	-19973.	-17756.	-15638.

	1990	1991	1992	1993	1994
REVENUE	78888.	78888.	78888.	78888.	78888.
EXPENDITURE	92921.	83514.	82422.	81330.	80238.
OPERATING COST	54278.	54278.	54278.	54278.	54278.
INTEREST	7098.	6006.	4914.	3822.	2730.
DEPRECIATION	31545.	23230.	23230.	23230.	23230.
COST OF LAND SOLD	0.	0.	0.	0.	0.
INCOME BEFORE TAX	-14033.	-4626.	-3534.	-2442.	-1350.
(LESS) COMMERCIAL & LOCAL TAX	0.	0.	0.	0.	0.
INCOME AFTER TAX	-14033.	-4626.	-3534.	-2442.	-1350.

3. Balance Sheet

10-38 The balance sheets of the Project are given in Annex 10-3. The current ratio stands above 100% every year, and therefore has no problem. The debt equity is below 100% every year, presenting no problem.

Table 10-13 DEBT SERVICE COVERAGE RATIO

	DSCR
1980	-
1981	Δ 1.86
1982	41.82
1983	15.75
1984	6.31
1985	3.86
1986	1.80
1987	0.53
1988	0.57
1989	0.61
1990	0.64
1991	0.66
1992	0.68
1993	0.70
1994	0.73
1981 - 1994	5.20

Note: Debt Service Coverage Ratio

$$= \frac{\text{Revenue - Operating Cost}}{\text{Loan Repayment + Interest on Loan}}$$

4. Profitability Indicators

10-39 The internal rate of return (IRR) of the Project is 10.3 percent on the basis of real price in 1980 (refer to Annex 10-4). In the case of an industrial development project or an industrial estate development project, IRR should be above 8 percent. This requirement is fully met by the Project. If the discount rate is set at 8%, the benefit-cost ratio (B/C) is 1.025, and the net present value (NPV) is Baht 13,032 thousand. These indicators show that the Project is feasible.

E. Sensitivity Analysis

1. Changes in Selling Prices of Lands for Sale

10-40 Changes in IRR in response to changes of land selling prices from those of Base Case were studied. The following conditions were set for the four cases below.

	Selling Price of Factory Lots & Housing Lots (Baht 1,000/Rai)	Leasing Price of Factory Lots	Leasing Price of Standard Price (Baht 1,000/m^2)	Leasing Price of Commercial Building
Case 2-1	441 (5% up)	39.6 (5% up)	1.34 (5% up)	3.69 (5% up)
Case 2-2	467 (10% up)	41.5 (10% up)	1.41 (10% up)	3.86 (10% up)
Case 2-3	390 (5% down)	35.8 (5% down)	1.22 (5% down)	3.31 (5% down)
Case 2-4	378 (10% down)	33.9 (10% down)	1.15 (10% down)	3.16 (10% down)

The results of the sensitivity analysis are given in Table 10-14. When the above four prices increase 5%, IRR rises to 15.8%, and when the prices increase 10%, IRR jumps to 22.7%. In contrast, when the prices decrease 5%, IRR falls to 5.9%, and when the prices decrease 10%, IRR drops sharply to 2.2%. Thus IRR responds very sensitively to changes in land selling prices.

2. Changes in Interest Rate

10-41 Interest rate on a long-term foreign loan was varied for study, as shown below.

	Interest Rate (%)
Case 3-1	5.0
Case 3-2	6.5
Case 3-3	8.0

The results of sensitivity analysis are shown in Table 10-14. In each of the above cases, IRR is 10.3%, that is, the value in Base Case. This is because interest rate is not included in the calculation process of IRR. However, net income varies considerably in each case as seen in Fig. 10-1. See (10-08) and Table 10-5.

3. Changes in Construction Cost

10-42 A study was made of the following cases which were given different construction costs.

	Construction Cost
Case 4-1	up 5%
Case 4-2	up 10%
Case 4-3	down 5%
Case 4-4	down 10%

The results of the sensitivity analysis are given in Table 10-14. When construction cost increases 5%, IRR declines to 6.1%, and when the cost is up 10%, IRR deteriorate sharply to 3.0%. On the other

hand, when the cost decreases 5%, IRR goes up to 16.0%, and when the cost drops 10%, IRR improves remarkably to 24.1%. Changes in construction cost also have a large effect on IRR.

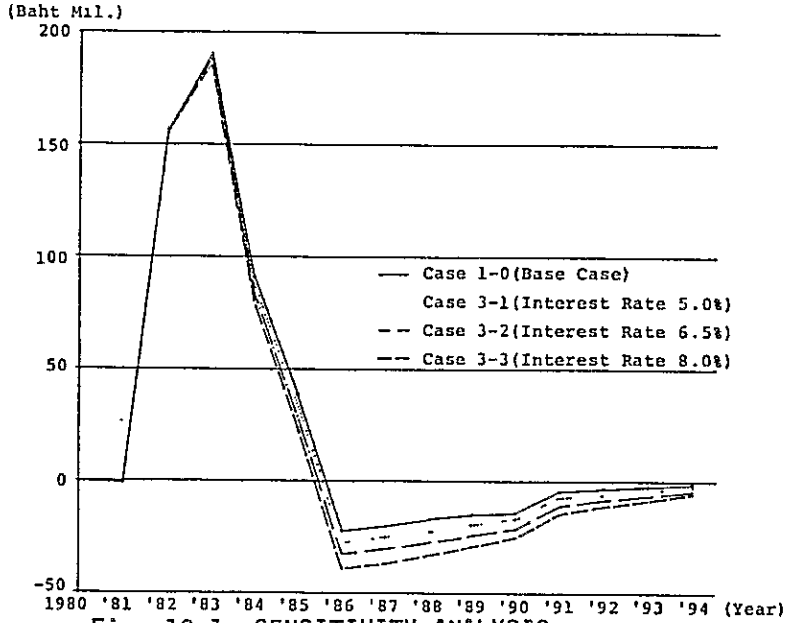


Fig. 10-1 SENSITIVITY ANALYSIS
(Charge of Interest Rate)

Table 10-14 SUMMARY OF SENSITIVITY ANALYSIS

	Changes of Condition		Internal Rate of Return (%)
Case 1-0	Base Case		10.3
Case 2-1	Sales Price	5% up	15.8
Case 2-2	"	10% up	22.7
Case 2-3	"	5% down	5.9
Case 2-4	"	10% down	2.2
Case 3-1	Interest	5.0%	10.3
Case 3-2	"	6.5%	10.3
Case 3-3	"	8.0%	10.3
Case 4-1	Construction Cost	5% up	6.1
Case 4-2	"	10% up	3.0
Case 4-3	"	5% down	16.0
Case 4-4	"	10% down	24.1

F. Evaluation

10-43 As shown in Section E, the Project looks favorable from every angle of the financial analysis, and is worth executing. The sensitivity analyses in Section E show that a decrease of 5% in land selling and other prices and an increase of 5% in construction cost are the boundaries of the permissible range. Price and cost changes exceeding these boundaries is undesirable.

XI. ECONOMIC ANALYSIS

XI. ECONOMIC ANALYSIS

A. Outline

1. Purpose of This Chapter

11-01 This chapter aims at studying, from the viewpoint of the national economy, how the SIE Project can efficiently make use of resources within or outside Thailand. A study will aslo be made of the possible impact of the Project on the Samut Sakhon area, BMA and the entire Thailand.

2. Kinds of Economic Benefit and Economic Cost

The economic benefits and costs arising from the SIE Project are enumerated below.

11-02 Economic benefits

- Direct benefits
  - . Benefits from the SIE construction
  - . Benefits from the plant construction in SIE
  - . Value added to arise from the production activities of the plants in SIE
  - . Foreign currency savings as a result of replacement of imports by products in SIE
  - . Acquisition of foreign currencies through export of products of SIE
  - . Accumulation of technological and managerial know-how in the Samut Sakhon area
  - . Benefits from the industrial accumulation in the Samut Sakhon area
- Indirect benefits

  [Urban development in the Samut Sakhon area]
  - . Improvement of infrastructure
  - . Improvement of public facilities
  - . Pollution abatement
  - . Housing development and urbanization

  [Effects on related industries]
  - . Increase in demand for raw materials
  - . Development of construction, transportation, commercial and service industries
- Improvement of the urban environment within GBA as a result of the movement of enterprises from GBA
- Increase in employment opportunity, resulting from the developments mentioned above

11-03 Economic cost

- Direct cost
  - . Construction cost of SIE
  - . Operating cost of SIE

. Construction cost of the plants in SIE
. Operating cost of the plants in SIE
. Cost to arise from the movement of plants from GBA

- Indirect cost

. Cost for improving infrastructure outside SIE
. Cost for improving public facilities

3. Method of Economic Analysis

a. Adjustment of transfer costs

11-04 When economic cost is calculated, customs, commodity taxes, interests, insurance premiums and other costs which fall under the category of transfer cost should be excluded from construction cost. In addition, depreciation expenses should be excluded from operating cost because they are not a real cost.

b. Benefit with or without SIE

11-05 An increase in benefit, as a difference in benefit between the case where SIE has been constructed and the case where it has not been constructed, represents a real economic benefit. SIE is to have plant sites covering a total area of 1,254 Rai, 1,239 Rai of which are for selling and leasing, and 15 Rai of which are for a standard factories. As studied in Chapter IV referring to land demand, 50% of the SIE's plant sites will be used by the existing plants which will move mostly from GBA, and the other 50% by new plants based on new investments. However, according to the survey of land demand relating to the Project, enterprises planning to move from GBA to SIE wish to acquire sites 8 to 10 times larger than those they now use. Nevertheless it is conservatively estimated that they desire to have plants about 3 times larger in scale than their existing plants. It can therefore be considered that only one third of the investments by enterprises moving to SIE (50% of the SIE's plant sites to be purchased by these enterprises) corresponds to their existing investments and that the remaining two thirds correspond to their new investment. Furthermore, should SIE be abortive, not all of their new investments would be canceled. It is highly likely that at least one third of such investments will be made in plants in industrial estates other than SIE. Economic benefits are to be calculated, taking into account the foregoing points.

11-06 The calculation of economic cost (Section B) and economic benefit (Section C) covered only calculable items endorsed with definits reasons.

B. Calculation of Economic Cost

1. Economic Cost of SIE

11-07 Construction cost of SIE was studied in the financial analysis in Chapter X. Economic cost of SIE can be calculated by subtracting customs, commodity taxes, transportation costs, interests and others from the construction cost. The results of the calculation, method of which is shown in Annex 11-1, are as follows:

	(Baht 1,000)	(%)
Economic Cost of SIE	595,117	100.0
Plant Sites	497,226	83.6
Housing Sites	97,891	16.4

The economic cost for plant sites will naturally come up over a period of 7 years from 1980 to 1986.

2. Operating Cost of SIE

11-08 Assuming that the life of the Project is 20 years, the operating cost of SIE for these years is counted as part of the economic cost. The operating cost is set at the value calculated in the financial analysis.

3. Plant Construction Cost

11-09 The costs of plant construction by enterprises in SIE are counted as part of the economic cost. The figures used for calculating the plant construction cost are as follows:

Plant Sites in SIE	1,239 Rai
Number of Employees per Rai	13.5
Investment per Employee (by industry)	128-380 (Baht 1,000)

A multiplication of these figures results in the plant construction cost. However, land acquisition costs, transportation costs, taxes, interest rates and so forth should be deducted from the obtained cost, so that it can be an economic cost. As stated in Section A, of the total investments by the enterprises locating themsevles in SIE, 83% are their new investments and 17% are their existing investments. Among their existing equipment and facilities, machines and the like can be used in SIE. Accordingly, in the case of movement of existing plants to SIE, new investments are to be made only for constructing buildings and related facilities and the ratio of these investments to total existing investments is estimated at 30%. Thus the economic cost of plant construction comes to the figure given below. For investment per employee (by industry) and plant construction cost, refer to Annex 11-2.

	Unit: Baht 1,000
Plant Construction Cost	3,763,000
. Land Acquisition Cost	Δ 495,600
. Taxes, etc.	Δ 376,300
Total	2,891,100
(of the total,)	
. New Investments	2,399,600
. Investments resulting from Plant Movements	491,500
[Investments in Buildings (30%)]	(147,450)

Economic Cost	
. New Investments	2,399,600
. Investments in Buildings Resulting from Plant Movements	147,450
Total	2,547,050

4. Aggregation of Economic Cost

11-10 As stated above, the economic cost is the total of the construction cost of SIE, the operating cost of SIE and the construction cost of plants. The results of the calculation are shown in Table 11-1. Operating cost of the plants to be constructed in SIE should be counted as part of the economic cost. However, it will be studied on the basis of value added in production at the plants as part of the examination of the economic benefit.

Table 11-1 ECONOMIC COST

Unit: Baht 1,000

Year	S I E		Construction Cost of the Factories of Locating Industries		Total
	Construction Cost	Operating Cost	New Investment	Investment to the Building by Movement	
1980	39,600	423	-	-	40,023
1981	18,126	423	-	-	18,549
1982	48,232	1,751	239,960	14,745	304,688
1983	200,320	2,619	479,920	29,490	712,349
1984	145,314	3,466	479,920	29,490	658,190
1985	38,046	9,316	479,920	29,490	556,772
1986	7,588	19,248	479,920	29,490	536,246
1987		29,257	239,960	14,745	283,962
1988		39,266			39,266
1989		54,278			54,278
1990		54,278			54,278
1991		54,278			54,278
1992		54,278			54,278
1993		54,278			54,278
1994		54,278			54,278
1995		54,278			54,278
1996		54,278			54,278
1997		54,278			54,278
1998		54,278			54,278
1999		54,278			54,278

C. Calculation of Economic Benefit

1. Benefit from the SIE

11-11 First of all, wages to be paid to unskilled workers during the construction of the SIE are regarded as a benefit from the SIE. These wages presumably account for about 60% of the total wages to be paid domestically, amounting to Baht 64,700,000 for the 1981-1986 period (details of the SIE's construction cost are shown in Annex 8-2).

2. Benefit from the Construction of Factories in SIE

11-12 The benefit from the construction of factories in SIE is estimated to be Baht 388,000,000, equivalent to the six times of Baht 64,700,000, the benefit from SIE mentioned above. The reason is that the construction cost of the factories in SIE will be six times of the construction cost of SIE. This benefit will naturally come up over a period of 6 years from 1982 to 1987.

3. Benefit from Factory Production

11-13 The benefit from factory production lies on the value added which will generate from the productive activity of the SIE's tenants. It is the balance between the value added by the construction of the SIE and the one which would have been produced even if the SIE is not constructed. As examined in Section B, the factory site supply and demand in and around BMA would almost balance until 1985 owing to construction of the industrial estate. If the SIE is not constructed, the factory site supply would fall short. In this case, prospective tenants will have to acquire a factory site in other place than the SIE, or to be content with the present location without making any new investment. The value added coming from the difference between the aforesaid two cases will be regarded as an economic benefit. In calculating the economic benefit, we have used the following figures, all of which are based on the 1980 price.

- Per-worker Value Added by Productive Activity in the Estate — 118,000 Baht 1/
- Total Area of the Factory Site in the Estate (including those of the Standard Factories) — 1,269 Rai
- Number of Workers in the Estate per Rai — 13.5 persons

Demand for Factory Site	(A)	(B)	(A)-(B)
For Building a New Factory	50%	17%	33%
For Transfer of an Existing Factory	(50%)	(28%)	(22%)
. New Investments	33%	11%	22%
. Investment in Existing Facilities	17%	17%	0%
Total	100%	45%	55%

1/ Estimated from NESDB data

Note: (A) : A case where the SIE is constructed.

(B) : A case where the SIE is not constructed.

Accordingly, the economic benefit from the construction of the SIE per annum may be estimated at 1,111,800,000 Baht by the following formula:

$$1,269 \times 13.5 \times 118,000 \times 0.55 = 1,111,800,000$$

As a matter of course, the benefit will begin to generate in 1985 when the factories constructed in the estate come into operation, and from 1990 it will come out on a full scale (at the sum of 1,111,800,000 Baht).

4. Total Amount of Economic Benefit

11-14 The economic benefit of this project is an aggregate of the benefit from the construction of the SIE and the value added by the productive activity in the estate (see Table 11-2).

Table 11-2 ECONOMIC BENEFIT

Unit: 1,000 Baht

	Benefit from the Construction of SIE	Benefit from the Construction of the Factories in SIE	Benefit from Factory Production in SIE	Total
1980				
1981	3,534			3,534
1982	6,280	38,800		45,080
1983	25,600	77,600		103,200
1984	22,570	77,600		100,170
1985	6,390	77,600	111,180	195,170
1986	300	38,800	333,540	372,640
1987			555,900	555,900
1988			778,260	778,260
1989			1,000,620	1,000,620
1990			1,111,800	1,111,800
1991			1,111,800	1,111,800
1992			1,111,800	1,111,800
1993			1,111,800	1,111,800
1994			1,111,800	1,111,800
1995			1,111,800	1,111,800
1996			1,111,800	1,111,800
1997			1,111,800	1,111,800
1998			1,111,800	1,111,800
1999			1,111,800	1,111,800

D. Cost-Benefit Analysis

11-15 The economic internal rate of return (EIRR) for 20 years up to 1999, which is calculated taking the above-mentioned economic costs and benefit as a base case (Case 1), stands at 23.2%. The benefit-cost ratio after a discount of 15% (a prospective interest rate) comes to 1.49. In this case, the net present value stands at Baht 902 million. (The calculation process of EIRR is shown in Annex 11-3). Since an economic analysis of this project from a national point of view has shown satisfactory results, we may say that the project is worthy of carrying out.

E. Sensitivity Analysis

11-16 Sensitivity analysis was made as for the following three cases.

i) A case where the value added is 20% less than originally expected (Case 2)

ii) A case where the SIE construction costs rise 20% (Case 3)

iii) A case where the SIE is not constructed and new investment reaches 50% (Case 4)

Results of the calculation for these three cases are shown in Table 11-3. In each case, the EIRR is satisfactory.

Table 11-3 SUMMARY OF SENSITIVITY ANALYSIS

	Change in Condition		EIRR (%)
Case 1	Base Case		23.2
Case 2	Added Value	20% down	21.1
Case 3	SIE Construction Cost	20% up	22.3
Case 4	New Investment without SIE	50%	18.0

F. Other Benefits

1. Economies of Foreign Currencies

11-17 The SIE will turn out textiles, metals, machinery, foodstuffs, rubber products, lumber and furniture, all of which are important export goods of Thailand. Exports of the SIE's products are expected to account for nearly 15% of the total output in the SIE. In 1980 price, annual exports amount to Baht 567 million and an aggregate of exports until 1999 will reach Baht 7,380 million. On the other hand, the foreign share in the costs of constructing the SIE comes to 44.3%, or Baht 310 million and the foreign share in the costs of constructing factories in the SIE runs to 35%, or Baht 1,332 million. The total amount of foreign capital outlay reaches Baht1,642 million.

Accordingly, we may save foreign currencies equivalent to Baht 5,729 million, the balance between the aforesaid aggregate exports until 1999 and the foreign share of the costs required for constructing the SIE and factories in the estate. The amount of Baht 3,156 million, 55% of the above-mentioned Baht 5,738 million, may be regarded as the benefit from economies of foreign currencies. However, since it has already been comprised in the value added referred to in 11-12, it is not be included in the benefit.

2. Increase in Employment Opportunities

11-18 In terms of the employment of unskilled workers, we have already examined, the benefit from the construction of the SIE and the construction of factories in SIE in Section C (11-11). In addition, from the viewpoint of employment of unskilled workers, an improvement in the infrastructure, public facilities and housing in the Samut Sakhon District accelerated by the implementation of this project, will produce benefit comparable to that from the construction of factories in the SIE.

3. Acceleration of the Urban Development in the Samut Sakhon District

11-19 With the implementation of the SIE project, infrastructure such as roads, water supply and sewerage systems, electric power supply and telephone networks may be ameliorated, giving benefit not only to the SIE tenants but inhabitants in this area at large.

Factories in the SIE are expected to hire 16,500 workers contributing to an increase in the population by 26,400 when their families are taken into account. Of 16,500 workers, 8,250 will commute between Bangkok and the SIE. In addition, economic activity relating to the SIE will increase the population by slightly more than 20,000. Thus, with the implementation of this project, the population of Samut Sakhon City will increase by nearly 40,000 to the level almost double the present population of 46,380. Consequently, the implementation of the SIE project would remarkably step up the improvement of public facilities such as schools, hospitals, parks, public halls and garbage disposal plants, together with public transportation means such as railways, buses and taxis in the Samut Sakhon City.

4. Repercussion to the Related Industries

11-20 The construction of the SIE and factories in the estate, as well as operating of these factories, will augment not only, the demand for construction materials such as gravel, cement, steel, and ceramics, but also the demand for manufacturing materials. Thus, the SIE will produce an important effect on the related industries in the Samut Sakhon District and contribute to their further development. In addition, the growth of the population in this area by around 40,000 will inevitably augment business opportunities in such industries as construction, transportation and trade, and step up their development.

It is expected that new monetary demand will be generated by the construction of SIE. The money except self-supplied by the tenants will have to be supplied from various kinds of bank. The amount of monetary demand required is roughly estimated to be Baht 3,300 million in total; Baht 1,900 million for the construction of factories in SIE, Baht 700 million for operating fund with factory production, and Baht 700 million for relating industries. As the result, these requirements will increase the monetary supply from the banks and at the same time it is expected that substantial amounts of the saving and deposit account will be established by these industries and their employees with the banks. Accordingly a new money circulation system will be formed in SIE for the benefits of the relevant banking institutions.

5. Amelioration of Living Environment in the GBA

11-21 Approximately a half of prospective tenants are now carrying out productive activity in the GBA. Many of them are in the densely-populated areas in the GBA, affecting inhabitants with industrial waste, smoke and noise. Commutation of a large number of employees worsens traffic conditions in these areas. The move of these enterprises to the SIE will amelioration of the living environment in these areas, though to a limited extent.

XII. ENVIRONMENTAL IMPACT STATEMENT

XII. ENVIRONMENTAL IMPACT STATEMENT

The purpose is to investigate justification of the project by analyzing expected impacts on the socio-economic conditions of the area as well as national economy as a whole. Contents of the project are as follows:

A. Outline of Project

1. Developer:

Industrial Estate Authority of Thailand (IEAT)

2. Type of Project

Industrial Estate

3. Scale of Development

Industrial Estate Area	1,819.7 Rai.
Residential Area	265.0 Rai.
Total	2,084.7 Rai.

4. Location

SIE is situated in Amdroe Muang Samut Sakhon of the Changwat the south-west of BMA (see Chapter II).

5. Position of the Project in the National Economic and Social Development Plan

The Project has been authorized by the Fourth NESDP, Thailand.

The purpose is to decentralize industrial location to mitigate pollution and traffic congestion arising from heavy concentration of industry in BMA and to promote further industrialization (see Chapter III).

6. Population

Number of workers:	16,500
Number of residents:	18,150

7. Water Supply (See Chapter VII)

Supply to industrial facilities:	18,000 m^3/day
Supply to residential area:	3,700 m^3/day
Total	21,700 m^3/day

Source : Presently, groundwater from a deep well; in the future, supply by MWWA is anticipated.

8. Drainage

Rainwater is to be collected by dikes and open ditches to be provided around the estate, and to be pumped to Khlong Maha Chai.

9. Effluent and Sewage Treatment

Industrial effluent volume:	16,000 m^3/day
Sewage (residential area) volume:	3,000 m^3/day
Total	19,000 m^3/day

Sewage is treated by activated sludge process. Pretreatment facilities to be obligatory at industry. And after facilities discharged the effluent to sewer.

B. Environment of Changwat Samut Sakhon (See Chapter II)

The area of Changwat Samut Sakhon is 839.867 Km^2 (525,000 Rai.) The coastline is 35 Km long. The land is not highly elevated above sea level and the influence of the tide extends to upper Tha Chin River.

1. Weather and Meteorological Conditions

Mean monthly temperature 25° - 35°C; peak in April Prevailing winds: SW in summer; NE in cooler months Mean annual rainfall: 1,500 mm; peak, 400 mm/M in September.

2. Rivers

Tha Chin River flows at the center, thence, major five canals leading to Chao Phraya and Mae Klong Rivers. Water quality of Tha Chin River shows partly 1 mg/ℓ of disolved oxygen (DO) in summer. Burden of organic matters due to wastes from industries, dairies and cultures are heavy.

3. Population in Affected Area (See Chapter II)

Changwat Samut Sakhon
- Present (12/1978) : 258,633
- Projected (2000 A.D.) : 368,500

Samut Sakhon City
- Present : 46,380 (1/1980)
- Projected (1997 A.D.) : 83,800 (3.15% p.a., simple)

4. Industry (See Chapter II, Section D)

The Dominant industry in Changwat Samut Sakhon is fishery. It producted 1/3 of the total production of the changwat. Other industries are salt making, rice growing, fruit-growing and dairies. The manufacturing industries include textile and clothing, pottery, iron, and steel, food, chemical, in order of scale.

5. Public Service Facilities (See Chapter III, Section B)

i) DTCP is planning to increase the city area to 2.7 times more than that of the present.

ii) Public Service facilities (See Chapter II)

Main traffic depends on roads and railroads and waterway facilities are available.

Water supply volume and source in Samut Sakhon City is Groundwater; 8,380 m^3/day to 5,225 households.

Raw sewage is discharged into Tha Chin River; there is at present no sewage treatment being performed.

Electric power of 220V is supplied to the city, and number of household received the electric power are 5,378. Capacity of telephone circuits is 1,000 circuits. Solid waste is collected by the city and thrown away without burning. The city office has two fire engines, 3 fire boats and six pumps by hand. For medical service, there is Government Hospital in Maha Chai area. For educational facility, total number of schools (in the Whole Changwat) is 129 with students of 36,538.

C. Environmental Impacts

A summary of the following points is provided as Table 12-1.

1. Influence on Land Use

The site would present the least problem regarding land use.

2. Influence on Storm Drainage of Rain Water (See Chapter VII, Section A)

Aggravation of flooding due to storm drain from the estate can be prevented by planning to drain to Khlong which is considered to have enough handling capacity. Sites 2, 5, 6, 9 and 15 are better situated for this purpose.

3. Use of Groundwater (See Chapter VII, Section C)

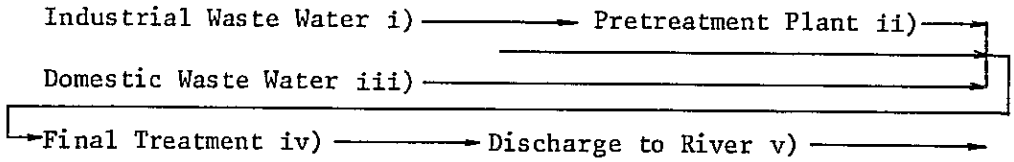
Pumping of groundwater can cause land subsidence, depletion of groundwater reserved and change of water quantity. Reliable evaluation of the influence of use of groundwater can not be made at present because of lack of technical information.

4. Influence of Discharge into Rivers (See Chapter V, Section G)

Places where disposed water might be discharged have high capacity to accommodate discharge. Less influence is expected, however, when water is discharged to Khlongs since Khlongs are not much used for agricultural and marine production. It is preferable to select Site 5 facing Khlong Maha Chai or Site 9 facing Tha Chin River.

5. Wastewater Treatment System

The treatment is to be made in accordance with the under mentioned schematic flow to reduce the load in terms of absolute level of pollution.



Details of the flow shown above is as follows;

i) Discharged industrial wastes are to contain various organic and inorganic components.

ii) Factories handling or producing toxic or dangerous materials are to be required to have pretreatment plants to reduce the concentration of such wastes, to meet pretreatment effluent standard for and to insure no adverse influence is imported to subsequent treatment processes.

iii) Domestic sewage shall be delivered directly to the final treatment plant.

iv) The final treatment plant shall be so designed as to stabilize discharged water. To assure good hygienic and health conditions chlorination is to be done at this plant.

v) The quality of discharged water is to be less than 20 ppm in BOD and SS, in compliance with MOI standard.

6. Treatment and Disposal of Solid Wastes

Solid wastes having less potential for adverse influence when disposed of as material for landfill the estate. Responsibility for the waste other than this is to be held the establishments producing those wastes.

Solid wastes produced in the final treatment plant are to be used as fill within the estate.

Solid wastes from the housing are to be disposed of by NHA and the city office.

7. Abatement of Air Pollution

Harmful gas emissions such as of acid and alkali gas and odorous gas is to be prevented by causing establishments producing such gas to install pollution abatement equipment and compelling them to comply with Thailand's Exhaust Concentration Standard.

8. Road-Transportation

Site 5, Site 11, and Site 9 are directly linked to Route 3242. This lightens burden of auxiliary roads.

9. Prevention of Fire

Fire hydrants are to be installed where necessary. The water supply system is to be designed so as to facilitate fire fighting activities.

Table 12-1 ENVIRONMENTAL IMPACTS AND ITS COUNTERMEASURES

Items	Present Conditions	SIE's Impact	Countermeasures
Land Use	Agriculture, Aquaculture and Wasteland	Decrease of Agricultural Land	Use waterland and minimize agricultural land. Sites 5 & 9 are suitable.
Flood	Occasional in rainy season	Controllable	Select the nearest Khlong to the Tha Chin River mouth. Sites 5 & 9 are suitable.
Ground water	Sole source of supply for potable and industrial use	No impacts on the existing wells. Tap new aquifer	500M spacing is maintained between the wells.
Waste water discharge	Direct discharge to nearby Khlongs	Treated waste water of 19,000 M^3/day will be discharged	Select the nearest Khlong to the Tha Chin River mouth which is not primarily used for agriculture and fisheries. Sites 5 & 9 are suitable. Control quality of waste water at BOD 20 mg/l, SS 20 mg/l.
Solid waste disposal	City service is available at the built-up area.	Produce sludges at the treatment plant in addition to the industrial and domestic waste	Harmless solid waste including sludge will be dumped in the place in SIE reserved for the purpose. Others will be handled by NHA, City and individual factory.
Industrial Exhaust Gas	Almost none	Negligible	Guide the located industries to follow the standard established by the Government
Traffic	Roads, canal and railway	Daily traffic volume cargo- 1,726 passenger- 2,300	Select best sites (5 or 9) which have easier access to R-35.
Fire	The City has 2 cars, 3 boats and 5 pumps		Hydrants are provided in SIE and fire fighting cars are expected to be provided by the City.

D. Pollution Monitoring

It is proposed to set up a special committee composed of the technical staff of IEAT and representatives of the occupants to guide the industrial operators to follow the environmental standards and regulations established by both the Government and IEAT and to formulate the necessary policies to maintain effective monitoring system. Routine works shall be done by the IEAT staff.

E. Social and Economic Evaluation (See Chapter XI)

1. Benefits

Economic benefit due to the SIE project, as described in XI, are expected to amount to Baht 452.674 million during the construction period (from 1981 to 1986). Benefits due to industrial production are to be Baht 111.18 million in 1985, and are to increase every year thereafter to reach Baht 1,111.8 million in 1990.

The population of Samut Sakhon will be doubled, and this will increase employment opportunities for workers needed to provide infrastructure, public facilities and services, and housing. The effect of this is expected to be a benefit equal in magnitude to that gained by construction of SIE. Benefit due to implementation of the SIE Project will also include the ripple effects to related industries. Increased demand for raw materials for products, and expansion of business opportunities in many areas of industry and business will also result.

Moreover, improvement of city's environment in BMA is to be made, and public pollution and traffic congestion will be reduced.

2. Reducing Environment Impact

It is planned to minimize environment impacts, such as the reduction in the area of farm land by selecting a site which is not intensively used as farm land. Minimizing traffic congestion is planned by selecting a site close to a national arterial road. Reducing noise pollution was planned by making provision for a greenbelt around the estate and between the housing area and industrial zone.

It is planned that wastes produced in the complex are to be treated under the supervision of IEAT, and that the burden placed on the environment outside the estate be minimized.

F. Recommendation

The project is so planned as to minimize environment impact, and from the national view point, implementation of the project is desirable since economic benefits outweigh the impacts on the environments.

ANNEX

SCOPE OF WORK

I. Introduction

The Study will be carried out through the Japan International Cooperation Agency (hereinafter called JICA), which is the official agency responsible for the implementation of technical cooperation programs of the Government of Japan.

II. Background

S.I.E. is one of six industrial estate projects planned in the Fourth National Economic and Social Development Plan (1977 - 1981). The Industrial Estate Authority of Thailand (hereinafter called IEAT) has been studying it by themselves and in March 1979 with a cooperation of Engineering Consulting Firms Association (ECFA), Japan, the IEAT carried out a preliminary study on the S.I.E. The study showed a very positive result suggesting considerable benefits could derived from the project. The S.I.E. is aimed to accommodate some of industries which may cause pollution problems if located in the urban areas. Therefore, the S.I.E. will likely to reduce pollution from factories, traffic congestion and other socio-economic problems of the Bangkok Metropolitan Area (hereinafter called BMA), while it will provide necessary extension room for new industries and help realize a satellite city in outskirts of the BMA.

III. Objective

The objective of the Study is to assist the Government of Thailand to examine the viability of S.I.E. from technical, financial, economic and institutional viewpoints and to provide a clear basis for implementation decision.

IV. Scope of the Study

4.1 Industrial Development Plan in BMA and Thailand and Formulation of a Conceptual Plan of Samut Sakhon Area Development

1) Analysis of Thai national economic development plan and industrialization
2) Analysis of industrialization in BMA and its problems
3) Characteristics of Samut Sakhon area and its role in promotion of industrial development.

4.2 Identification of the Candidate Types of the Industries and Estimation of Land Demand

1) Analysis of the possible industries to be introduced to S.I.E.

2) Analysis of trend of industrial investment and possibility of relocation into S.I.E.

3) Investigation of land demand unit

4) Estimation of land demand

5) Evaluation of alternative plans of industries to be introduced

4.3 Evaluation and Selection of the Candidate Sites

1) Analysis and evaluation of the candidate sites by volume of development

2) Analysis and evaluation of the candidate sites by their locational conditions

3) Analysis and evaluation of the candidate sites from the satellite city viewpoint

4) Integrated evaluations and recommendation on the final site.

4.4 Ways and Means of Development and Management of S.I.E. and its Implementation Schedule

1) Implementation schedule

2) Ways and means and level of development

3) Administration and management

4.5 Formulation of S.I.E. Master Plan

1) Land use plan

2) Land improvement plan

3) Road network plan

4) Drainage system

5) Water supply system

6) Sewerage system

7) Solid waste disposal system

8) Electricity supply system

9) Telecommunication system

10) Building facility plans

11) Park and green plan

4.6 Environmental Assessment of S.I.E.

1) General survey on the existing environmental conditions

2) Estimation of load of pollution and level of pollution control facilities

3) Recommendation on the treatment facilities

4.7 Basic Design of S.I.E.

1) Preparation of topographical map
2) Preparation of the basic design
3) Estimation of work volume
4) Estimation of construction cost

4.8 Financial and Economic Analysis of S.I.E.

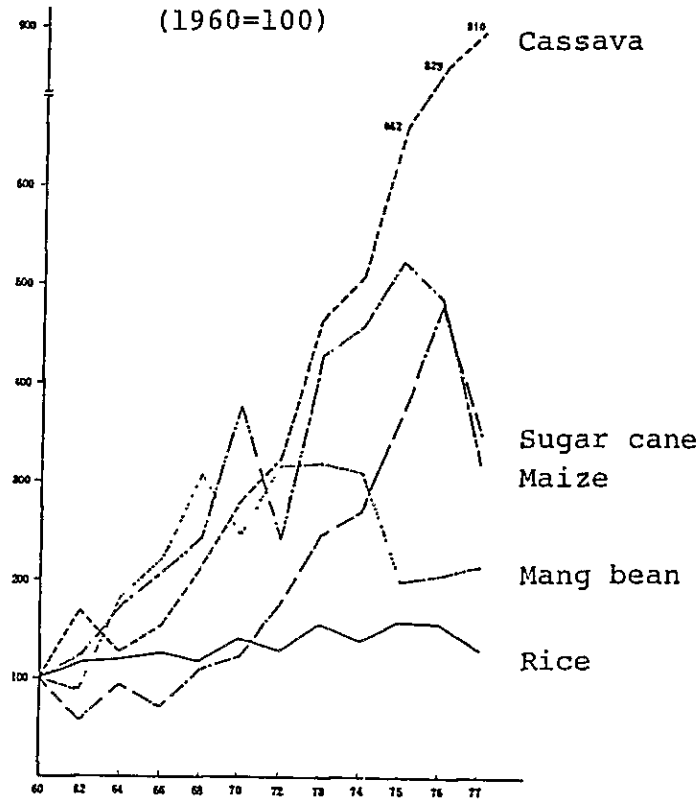
1) Estimation of the total project costs and its funding
2) Financial analysis
3) Economic analysis

KEY STATISTICS OF THAILAND

ITEM	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1. Population	36.37	37.48	38.59	39.69	40.78	41.87	42.96	44.09	45.10	46.26*
Growth (%)			2.9					2.6		
2. Labour Force	16165	16631	17105	17591	18100	18166	19096	19592	20091	20542*
Growth (%)	-	2.9	2.8	2.8	2.9	2.9	2.6	2.6	2.5	2.2*
3. GDP, 1972 mp	150.09	157.09	164,63	180.15	189.95	204.46	221.30	236.50	257.13	275.10*
Growth (%)	-	4.7	4.8	9.4	5.4	7.4	8.4	6.9	8.7	7.0*
4. Agriculture	144.7	153.3	154.3	177.7	177.0	190.2	203.0	194.6	229.9	-
1963=100										
Growth (%)	4.0	5.9	0.7	15.2	-0.4	7.5	6.7	-4.1	18.1	-
5. Industries	-	100.0	113.8	135.1	143.9	157.2	183.2	211.7	235.2	263.4*
1971=100										
Growth (%)	-	-	13.8	18.7	6.5	9.2	16.6	15.5	11.1	12.0*
6. Trade Balance Million	-12237	-9519	-8384	-9958	-121245	-21828	-12080	-22979	-25794	-37857
7. External Public Debt Million	482.6	535.0	653.2	721.2	1122.1	1273.3	1618.4	2281.8	3678.6	5454.2
8. International Reserve Million	906	877	1052	1306	1858	1775	1893	1915	2121	(US$) 1749.1
9. Export (fob)	14772	17275	22491	32226	49799	45007	60797	71198	83065	108270
10. Import (cif) Million	27009	26794	30875	42184	64044	66835	72877	94177	108859	146127
11. Wholesale Price Indices	102.8	103.1	111.2	136.6	176.1	182.6	189.8	199.9	209.4	236.5
12. Consumer Price Indices	-	-	-	-	-	-	100.0	108.4	117.9	130.0

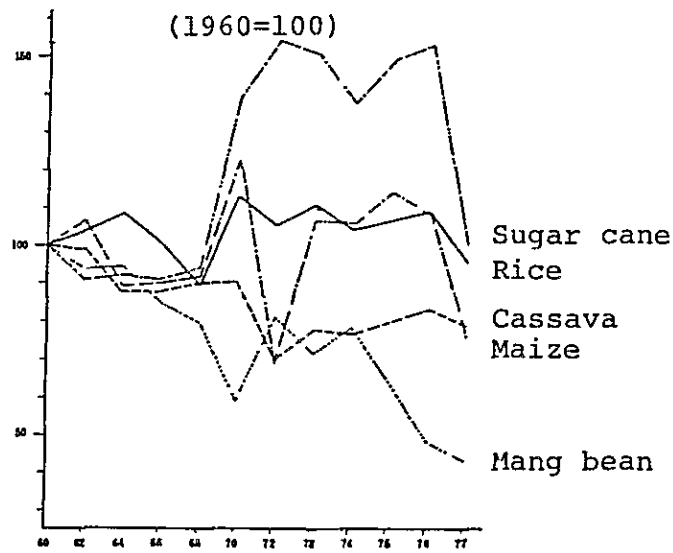
TREND IN AGRICULTURE

1. Production of Main Agricultural Products



Source: Agricultural Statistics of Thailand

2. Productivity per Land Unit



Source: Agricultural Statistics of Thailand

GROSS NATIONAL PRODUCT BY INDUSTRIAL ORIGIN AND NATIONAL INCOME AT CURRENT PRICE

Industrial origin	1974		1975		1976		1977		1978*	
	Millions of Baht	%	Millions of Baht	%	Millions of Baht	%	Millions of Baht	%	Millions of Baht	%
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1. Agriculture	84,735	31.22	94,063	31.65	102,770	30.45	107,679	28.11	120,425	27.11
Crops	62,229	22.93	69,666	23.44	75,603	22.40	76,852	20.06	88,718	19.97
Livestock	10,583	3.90	11,473	3.86	12,260	3.63	14,494	3.78	13,791	3.11
Fisheries	7,273	2.68	8,454	2.85	9,792	2.90	11,134	2.91	12,670	2.85
Forestry	4,650	1.71	4,470	1.50	5,115	1.52	5,199	1.36	5,246	1.18
2. Mining and quarrying	4,530	1.67	4,062	1.37	5,174	1.53	8,151	2.13	9,823	2.21
3. Manufacturing	49,359	18.19	54,353	18.29	63,536	18.83	72,769	19.00	85,037	19.14
4. Construction	10,704	3.94	12,873	4.33	15,784	4.68	20,167	5.26	24,951	5.62
5. Electricity and water supply	2,789	1.03	3,274	1.10	3,732	1.11	4,368	1.14	5,004	1.13
6. Transportation and communication	15,966	5.83	17,250	5.80	19,986	5.92	22,663	5.92	25,658	5.78
7. Wholesale and retail trade	53,964	19.89	54,409	18.31	62,946	18.65	73,019	19.06	88,098	19.83
8. Banking, insurance and real estate	12,835	4.73	14,968	5.04	16,275	4.82	19,577	5.11	22,484	5.06
9. Ownership of dwellings	4,174	1.54	4,415	1.48	4,842	1.44	5,270	1.38	5,844	1.32
10. Public administration and defence	10,533	3.88	12,321	4.14	13,571	4.02	15,531	4.05	18,859	4.24
11. Service	21,779	8.30	25,224	8.49	28,865	8.55	33,863	8.84	38,013	8.56
Gross Domestic Product (GDP)	271,368	100.00	297,212	100.00	337,481	100.00	383,057	100.00	444,196	100.00
Plus : Net income from abroad	798	—	— 219	—	—1,261	—	—2,014	—	—2,246	—
Gross National Product (GNP)	272,166	—	296,993	—	336,220	—	381,043	—	441,950	—
Less : Indirect taxes	32,244	—	31,119	—	33,468	—	43,850	—	52,335	—
Capital consumption allowances	17,794	—	21,014	—	24,247	—	28,878	—	34,620	—
National Income	222,128	—	244,860	—	278,505	—	308,315	—	354,995	—
Per Capital GNP (Baht)	6,874	—	7,093	—	7,826	—	8,652	—	9,799	—

Source : National Accounts Division, Office of the National Economic and Social Development Committee.

EMPLOYMENT BY TYPE OF INDUSTRY

Type of Industry	1960		1970		1977	
	Actual Number	Share (%)	Actual Number	Share (%)	Actual Number	Share (%)
Agriculture	11,322	82.4	13,202	79.3	15,434	78.2
Mining and Quarrying	30	0.2	87	0.5	99	0.5
Manufacturing	470	3.4	683	4.1	1,046	5.3
Construction	69	0.5	182	1.1	217	1.1
Electricity, gas & water	16	0.1	25	0.2	40	0.2
Trade	779	5.7	876	5.3	1,046	5.3
Transportation & communication	166	1.2	268	1.6	395	2.0
Services	654	4.8	1,184	7.1	1,460	7.4
Others	234	1.7	146	0.9	-	-
Total	13,749	100.0	16,652	100.0	19,737	100.0

Source: Year Book of Labor Statistics, ILO

FACTORY RESITERED AT THE MINISTRY OF INDUSTRY (1978)

Region	Rice Mill	Other Manufacturing No.	Share (5)	Total
Bangkok	155	12,799	(47)	12,954
Central Except Bangkok	4,544	7,334	(27)	11,881
North	7,728	1,950	(7)	9,678
North East	16,225	3,222	(12)	19,447
South	4,451	1,825	(7)	6,276
Total	33,166	27,130	(100)	60,296

Note: Samut Sakhon is included in Central

Source: Factory Works, Ministry of Industry

SHARE OF MANUFACTURING PRODUCTS BY REGION (1977)

Whole Kingdom	North	North East	South	Central	Bangkok
Food	11.9	12.5	8.5	37.3	29.9
Beverages	6.8	12.9	3.8	42.5	34.1
Tobacco & snuff	7.0	3.0	0.1	49.9	40.0
Textiles	5.2	8.0	0.3	48.0	38.5
Wearing apparel & made-up textile goods	3.0	1.9	2.1	51.56	41.4
Wood and cork	10.2	20.2	12.5	31.6	25.4
Furniture & fixtures	2.0	0.0	0.0	54.4	43.7
Paper & paper products	0.5	0.0	0.0	55.2	44.3
Printing, publishing & allied industries	1.8	0.3	0.3	54.1	43.5
Leather & leather products not footwear	23.0	3.0	0.9	40.6	32.6
Rubber & rubber products	14.4	0.0	38.7	26.0	20.9
Chemicals & chemical products	2.7	1.6	2.2	51.8	41.6
Petroleum refining & coal	0.2	0.0	0.0	60.4	39.4
Non-metallic mineral products	7.5	0.0	8.8	46.4	37.2
Basic metal industries	0	0	26.4	40.8	32.8
Metal products not machinery and transport equipment	5.6	11.5	6.1	42.6	34.2
Repairing of non electrical machinery	2.4	0.7	8.2	49.2	39.5
Electrical machineries and supplies	2.7	5.8	1.1	50.1	40.2
Transport equipment	1.8	1.3	6.8	50.0	40.1
Miscellaneous n.e.c.	37.3	10.4	8.3	24.4	19.6
Total value added	6.6	6.3	5.7	45.6	35.8

CHANGE IN SHARE OF MANUFACTURING PRODUCTS
FROM 1974 - 1977

Whole Kingdom	Bangkok	Central	Other
Food	-4.9	0.7	4.2
Beverages	2.0	8.7	-10.7
Tobacco and snuff	-5.2	2.4	2.8
Textiles	-2.6	4.7	-2.1
Wearing apparel and made-up textile goods	1.1	1.4	-2.5
Wood and cork	-4.1	0.6	3.5
Furniture and fixtures	-4.2	3.9	0.3
Paper and paper products	-4.1	4.2	-0.1
Printing, publishing and allied industries	-4.1	4.0	0.1
Leather and leather products not footwear	-13.9	-8.4	22.3
Rubber & rubber products	-5.7	-2	7.7
Chemicals and chemical products	-5.9	1.8	4.1
Petroleum refining and coal	-0.2	0.1	0.1
Non-metallic mineral products	-2.3	4.8	-2.5
Basic metal industries	0.6	6.9	-7.5
Metal products not machinery and transport equipment	-3.8	2.6	1.2
Repairing of non electrical machinery	-2.2	5.3	-3.1
Electrical machineries and supplies	-4.5	3.1	1.4
Transport equipment	-4.3	3.2	1.1
Miscellaneous n.e.c.	-14.4	-11.4	25.8
Total value added	-3.1	2.5	0.6

Source: NESDB

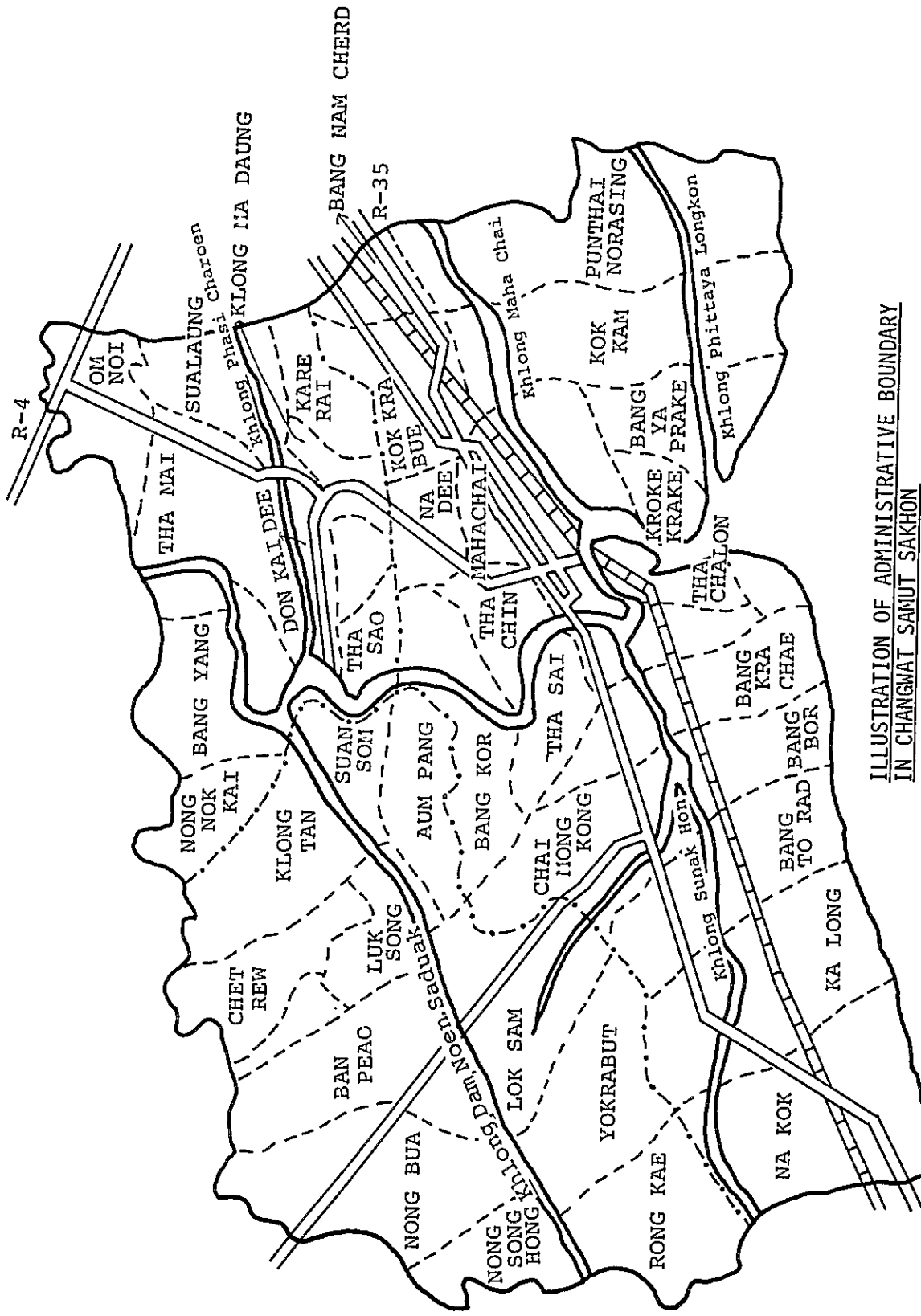


ILLUSTRATION OF ADMINISTRATIVE BOUNDARY
IN CHANGWAT SAMUT SAKHON

POPULATION IN THE SAMUT SAKHON PROVINCE (1979)

	Tambon	Population
Amphoe Muang	Punthai	6,162
	Bang Ya Prake	111,309
	Tha Sai	6,660
	Tha Chin	4,120
	Bang Kra Chae	5,605
	Bang Nam Cherd	4,978
	Bang To Rad	5,441
	Na Dee	4,817
	Na Kok	3,347
	Bang Kor	5,989
	Bang Bor	3,870
	Kok Kam	7,127
	Kok Kra Bue	3,009
	Ka Long	3,498
	Chai Mong Kong	2,325
	Sub total	79,257
Amphoe Ban Phaeo	Chet Rew	2,586
	Luk Song	4,091
	Aum Pang	4,893
	Klong Tan	7,335
	Lok Sam	9,276
	Yokrabut	9,357
	Rong Kae	8,391
	Suan Som	5,066
	Ban Paeo	7,697
	Nong Song Hong	7,536
	Nong Bua	7,913
	Sub total	74,141
Amphoe Krathum Baen	Sualaung	9,188
	Om Noi	10,372
	Bang Yang	4,391
	Tha Mai	5,429
	Klong Ma Daung	6,056
	Tha Sao	3,944
	Nong Nok Kai	2,658
	Don Kai Dee	3,310
	Kare Rai	2,164
	Sub total	47,512
Muang Samut Sakhon	Mahachai	29,718
	Tha Chalon	13,018
	Kroke Krake	3,786
	Sub total	46,522
Tambon Krathum Baen		11,201
	Total	258,633

Source: Samut Sakhon Provincial Government

TABLE OF PLANTING AREA BY CROP BY AMPHOE (1977 - 1978)

	Amphoe Muang Samut Sakhon	Amphoe Ban Phaeo	Amphoe Krathum Baen	Whole Changwat
Gross area	480.126 km^2 300,150 Rai 57.2%	239.098 149,460 28.5	120.643 75,390 14.3	839.867 525,000 100
Paddy field total	45,295	89,642	78,056	212,993
Single crop Two crops	36,500 8,795	84,042 5,600	48,318 29,738	168,860 44,133
Fruit total	26,409	41,311	15,505	83,225
Orange	10	4,720	408	5,138
Grapes	20	5,080	2,486	7,586
Pudsa	12,598	2,810	34	15,442
Banana	746	6,570	3,368	10,684
Lamut	829	2,230	1,885	4,944
Mango	338	3,150	2,992	6,480
Lemon	12	960	758	1,730
Jack fruit	16	41	275	332
Coconut	11,775	15,550	3,259	30,584
Plum	15	176	10	201
Shaddock	50	24	30	104
Vegetable total	1,034	40,843	5,092	46,969
Pepper	112	15,955	125	16,192
Cucumber	250	9,895	540	10,685
Chinese cabbage	-	585	60	645
Tomato	35	4,138	367	4,540
Long beams	135	3,780	250	4,165
Egg plant	10	2,870	60	2,940
Mara	-	2,560	2,340	4,900
Green vegetables	60	-	350	410
Corn	382	525	660	1,567
Potatoes	-	355	-	355
Mushrooms	50	-	320	370
Kashade	-	180	20	200
Orchid	12	323	317	652

Note: Pepper, long beans, Mara, green vegetables and so forth are planted a number of times per year. Therefore, these figures are different from actual farmland areas.

Annex 2-4 CATCH OF FRESH WATER FISH (tons)

	1970	1971	1972	1973	1974	1975	1976	1977
Whole country	112,714	116,788	131,383	140,885	158,876	160,692	147,294	122,374
Central plain	66,468	72,102	72,967	80,102	68,570	74,422	81,836	79,644
Samut Sakhon (Province)	365	401	461	781	1,209	2,235	2,249	2,607

Annex 2-5 CATCH OF MARINE FISH (tons)

	1970	1971	1972	1973	1974	1975	1976	1977
Whole country	1,335,690	1,470,289	1,548,157	1,538,016	1,351,590	1,394,608	1,551,792	2,067,533
Region 2	562,559	732,557	740,781	767,226	631,557	656,805	654,080	884,332
Samut Sakhon	171,875 (12.9)	197,852 (13.5)	199,205 (12.9)	208,873 (13.6)	225,495 (16.7)	286,699 (20.6)	218,740 (14.1)	302,840 (14.6)

Annex 2-6 NUMBER OF FISHING BOAT REGISTERED

	1975	1976	1977
Whole country	7,963	9,388	11,407
Samut Sakhon	967 (12.1)	745 (7.9)	662 (5.8)

Annex 2-4
Annex 2-5
Annex 2-6

GROSS PROVINCIAL PRODUCT AT CONSTANT 1972 PRICES

Samut Sakhon

unit: Millions of Baht

Industrial Origin	1973	1974	1975	1976	1977	1978[E]
Agriculture	621.7	791.3	758.8	737.4	827.3	822.5 (48.8)
Crops	210.5	216.6	202.4	219.2	209.7	224.4 (13.3)
Livestock	23.8	29.5	33.9	32.8	36.7	39.7 (2.4)
Fisheries	387.4	545.2	522.5	485.4	580.9	558.4 (33.1)
Forestry	-	-	-	-	-	-
Mining and quarrying	20.3	19.3	21.7	23.0	28.1	30.3 (1.8)
Manufacturing	93.6	102.3	111.6	125.4	141.2	150.8 (8.9)
Construction	52.7	40.0	36.1	73.3	90.4	97.4 (5.8)
Electricity and water supply	7.7	10.3	16.4	17.2	21.5	23.5 (1.4)
Transportation and communication	98.8	85.5	77.9	83.4	94.4	100.9 (6.0)
Wholesale and retail trade	177.8	210.0	182.0	225.0	248.5	248.9 (14.8)
Banking, insurance and real estate	20.0	27.1	28.3	27.8	33.7	35.0 (7.0)
Ownership of dwellings	34.9	36.7	37.4	37.5	39.8	41.4 (2.5)
Public administration and defense	27.2	27.8	30.6	32.3	36.2	40.6 (2.4)
Services	68.4	69.8	75.4	78.9	89.9	95.4 (5.7)
Gross provincial product (GPP)	1,223.1	1,420.1	1,376.2	1,461.2	1,651.0	1,686.7
Per capita GPP (Baht)		6,397	6,116	6,409	7,147	7,239

SHARE OF 1978 GROSS PROVINCIAL PRODUCT AT 1972 PRICE

Unit: %

Industrial Origin	B.K.K.	S.K.	C.	W.K.
Agriculture	1.8	48.8	31.5	27.1
Crops	1.8	13.3	23.4	19.9
Livestock	0	2.4	3.6	3.4
Fisheries	0	33.1	3.6	2.5
Forestry	0	-	0.9	1.2
Mining and quarrying	0	1.8	1.9	1.6
Manufacturing	30.0	8.9	29.8	21.3
Construction	7.5	5.8	2.8	5.3
Electricity and water supply	1.2	1.4	1.5	1.8
Transportation and communication	8.6	6.0	5.7	6.3
Wholesale and retail trade	16.1	14.8	14.8	16.2
Banking, insurance and real estate	12.4	2.0	0.9	4.8
Ownership of dwellings	1.0	2.5	2.4	1.6
Public administration and defence	5.1	2.4	3.2	4.2
Services	16.2	5.7	5.7	10.0
Gross provincial product (GPP)	100	100	100	100
Per capita GPP (Baht)	16,339	7,239	8,350	5,731

INDUSTRY IN SAMUT SAKHON BY SIZE OF EMPLOYMENT (1970 - 1979)

Type of Industry	Less than 10	10 ∿25	26 ∿50	51 ∿100	100 ∿200	200 ∿500	over 500	Total	Share (%)
Textile	4	14	11	15	6	6		56	16.8
Food	16	8	1	2	1			28	8.4
Ice	8	5	3					16	4.8
Fish Powder	7	7		1				15	4.5
Nylon & plastic	6	4	5	2	1			18	5.4
Wooden	30	3						33	9.9
Furniture	1	1		1				3	0.9
Paper	1	2					1	4	1.2
Printing	5							5	1.5
Chemical	4	5	5	1	2	1		18	5.4
Fire flower	1	2	1					4	1.2
Stick	1	2						3	0.9
Rubber	1	4	4	3	2	2		16	4.8
Ceramic	1	2	1	6	1	1	1	13	3.9
Concrete block	4	0	2					6	1.8
Metal	4	6	5	6	3			24	7.2
Motor repaired	28	6	3	2	2			41	12.3
Electric equipment	0	0	1	1				2	0.6
Boat repaired	12	2	1					15	4.5
	3	1						4	1.2
	1	4	2	2				9	2.7
Total	139	78	45	42	18	10	2	334	
Share (%)	41.6	23.4	13.5	12.6	5.4	3.0	0.6		100.0

FACTORY REGISTERED IN SAMUT SAKHON PROVINCE (1970 - 1979)

Type of Industry \ Year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	Total
Textile (total)	7	1	15	9	3	2	8	5	5	1	56
Spinning & weaving	3	1	8	2	1	1	3	4	2	1	26
Printing of textile	3	0	5	4	1	1	5	0	1	0	20
Finished cloth	1	0	2	3	1	0	0	1	2	0	10
Food	4	2	5	2	1	2	3	3	3	3	28
Ice making	1		4		2	3		3	2		15
Fishes powder			3		4	3	3	2			15
Nylon & plastic	1	1	6		3	1	1	1	3	1	18
Wooden	4		9	1	5	3	6	1	4	1	34
Furniture			1		1			1			3
Paper	1						1	1	1		4
Printing			1	1		2	1				5
Chemical			2		1	4	5	4	1	1	18
Fire flower				1			3				4
Stick	1	2									3
Rubber		3	1	4	3	2	2		1		16
Ceramic	3	1	1	3	1	1	1	2			13
Bottle football	1	3				1		1	3		9
Concrete block				1		2	1		1	1	6
Metal	3	3	4	3	1	4	2	2	1	1	24
Motor repaired	2	3	11		6	4	7	4	3	2	42
Electric equipment							2				2
Boat repaired	1		6	1		1		1	2	3	15
Freeze storage	1		1					2			4
Total	30	19	70	26	31	35	46	33	30	14	334