(10) Port Development

1) The volume of cargo to be handled in the port and the required mooring facilities are summerized as shown in Table S10-1.
2) The port layout for the short term is shown in Fig. S10-1.
3) The detailed layout for the public terminal area is shown in Fig. S10-2.
4) New Facilities in the Public Terminal Area

(i) The Cargo Handling Equipment

	Nominal Capacity	Number
Ship Loader	1,250 t/h	1 unit
Stacker/Reclaimers	1,250 t/h	1 unit
Bucket Elevator	1,250 t/h	1 unit
Belt Conveyor		1,900 m
Forklift	2t	5 unit
Pay Loader	0.8 m^3	3 unit
Truck	10 t	7 unit
Mobil Crane	40 t	1 unit

(ii) The Vessels for harbour service

	Capacity	Number
Tug Boat	3,000 Hp	1unit
Tug Boat	2,000 Hp	2 unit
Pilot Boat	300 Hp	2 unit

(iii) Navigation Aids

	Number
Light Bouy	14 unit
Light Beacon	1 unit

(iv) Transit and Storage Facilities

		1987	2000
		Planned Area (m^3)	Planned Area
Poatsh	open yard	6,000	16,000
Tapioca	werehouse	14,400	28,800
Cement	transit shed	2,500	5,000
Sand	open yard	7,500	14,700
Steel Products	open yard	5,000	9,000
Metal Processing Product	transit shed	2,500	20,000
	open yard	2,500	18,000
Petro chemical tank yard		7,500	7,500

Table S10-1 Mooring Facilities in Short Term Plan

Center		Total Volume of Cargoes t/y	Ship Size DWT	Quay Depth m	Berth Length m	Necessary Number of Berth	Necessary Total Length m	Cargo Handling Capacity	Berth Occupancy Rate	Quay Type	Commodities
1. Fertilizer Center	Domestic	520,000	3,000	-6.5	105	3	315	100 T/H (Bag) 100 T/H (liquid)	55.7	L Type Quay	Fertilizer (Bag) Urea (Bag) Phosphate acid (Liquid)
	Foreign	980,700	20,000	-11.0	210	1	210	1,000 T/H	35.4	Piled Wharf	Sulfer (Bulk) Phosphate Ore (Bulk) Muriate of potash (Bulk)
2. Soda Ash	Domestic	300,000	3,000	-6.5	105	2	210	100 T/H	42.8	L Type Quay	Soda Ash (Bag) Ammonium Chloride (Bag)
	Foreign	200,000	20,000	-11.0	210	1	210	500 T/H	9.0	Piled	Soda Ash (Bulk)
3. Public Terminal Area	Domestic (1)	187,000	3,000	-6.5	105	1	105	100 T/H	53%	Dolphin	MEG, VCM, Caustic Soda (Liquid)
	Domestic (2)	349,000	3,000	-6.5	105	4	420	100 T/M		L Type	Steel products Cement, Sand Metal Product & Material
	Foreign	1,445,000	20,000 60,000	-11.0	280	1	280	1,000 T/H	52.3	Piled Wharf	Potash Tapioca
Total		3,981,700	-	-	-	13	1,750	-	-	-	

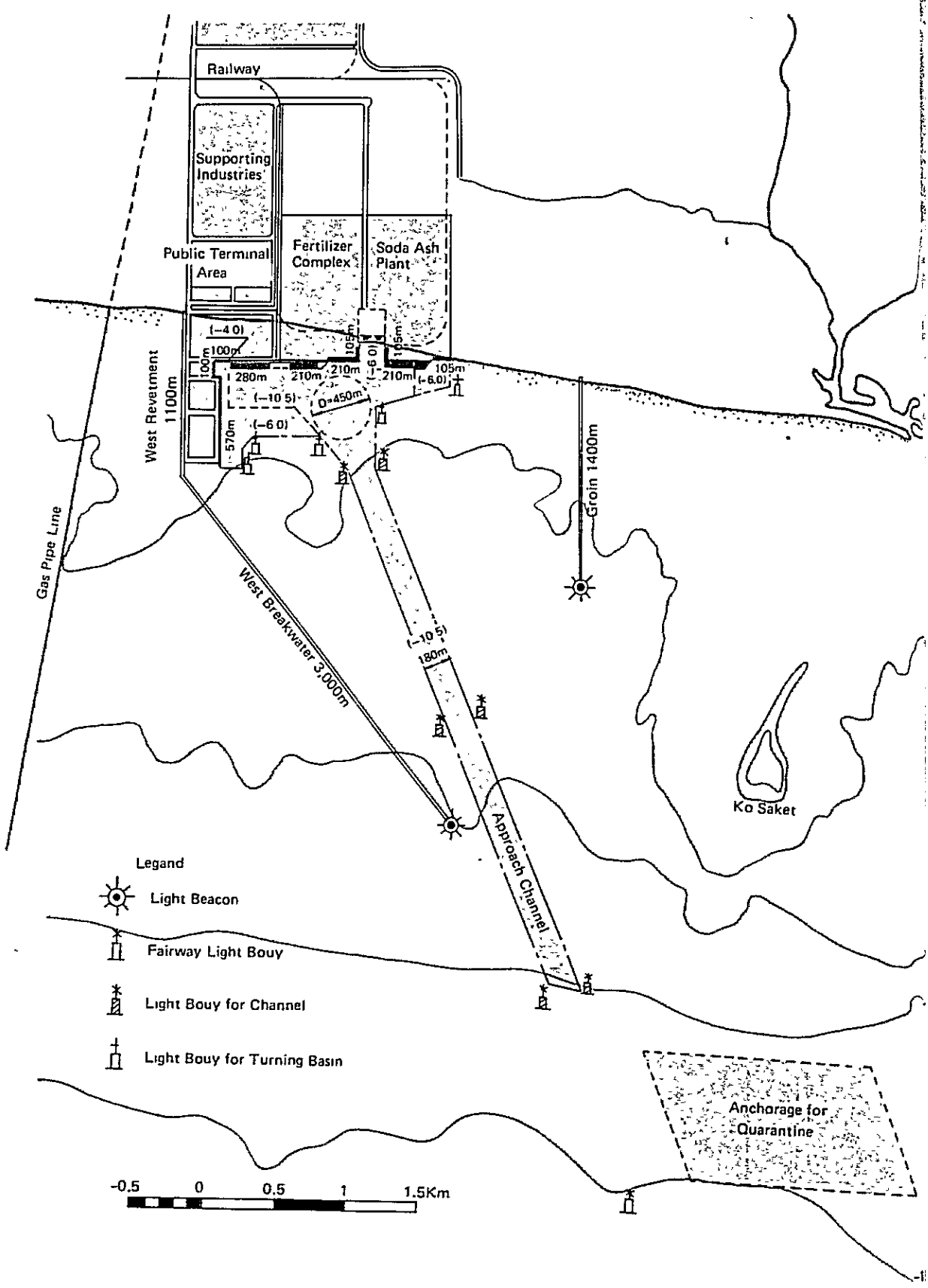


Fig. S10-1 Short Term Port Layout

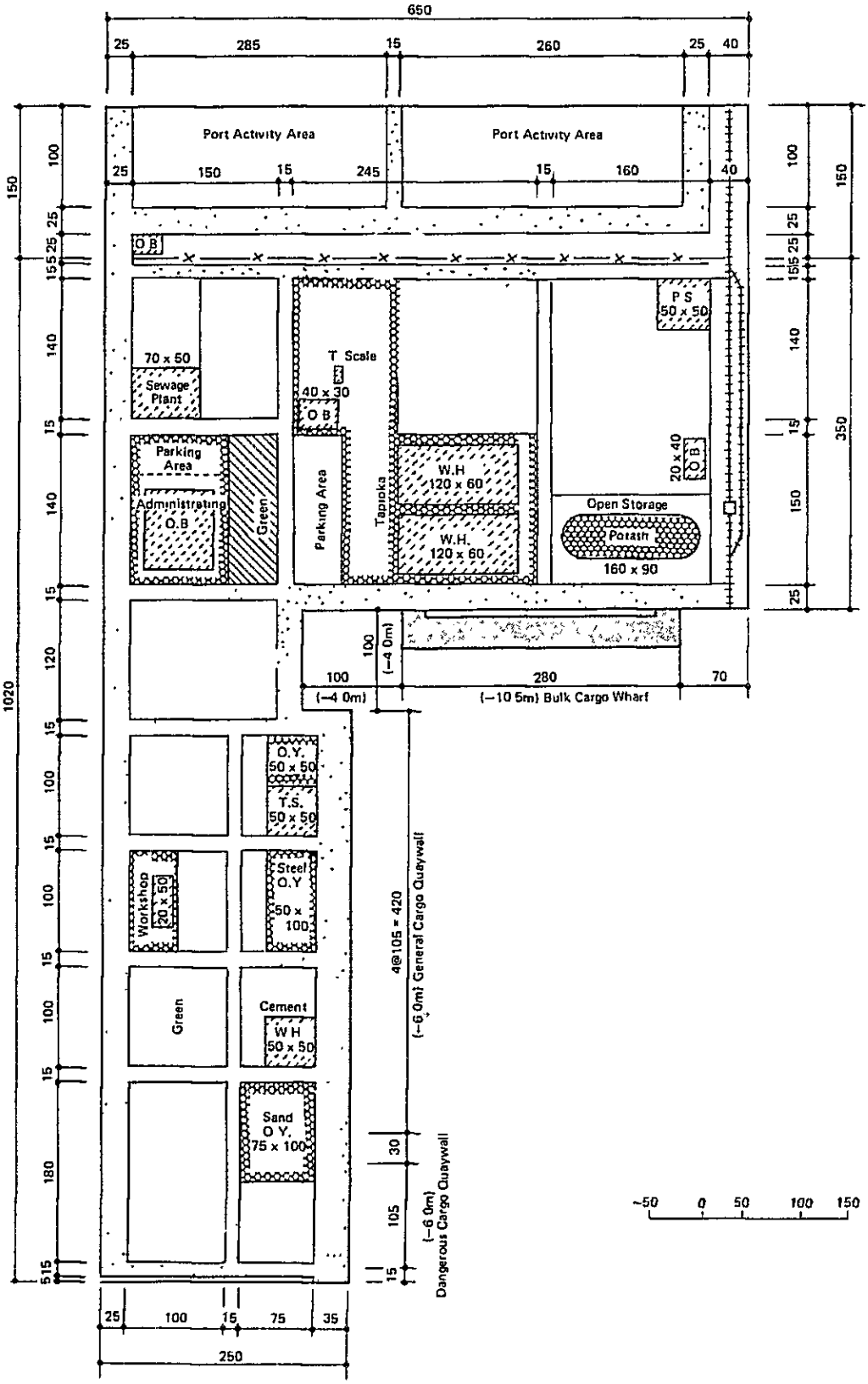


Fig. S10-2 Short Term Plan
Layout of Commercial Port Area

(11) Industrial Development Plan

The proposed three key industries, Soda Ash Plant, Petrochemical Complex, and Fertilizer Complex as import alternatives and key industries will be allocated based on the latest layout concept of heavy and chemical industries complex. The layout is determined also on a full consideration for the project in the short term plan and its further development in the master plan. Major consideration has been made in regard to the given conditions of infrastructures in determining the layout. Soda Ash Plant and Fertilizer Complex in the short term plan will be located at the shore line to enable efficient loading/unloading of their products and raw materials, i.e. export of soda ash, and import of phosphate rock for the Fertilizer Complex. Consequently, pipeline and power cable have to be provided to supply the natural gas as raw materials and the electric power as power for the plant. Railway sidings have to be provided, because railway will play a role to transport the products and raw materials to and from the industrial complex.

Petrochemical Complex is expected to be located inland far closer to the gas separation plant than to the seashore while the chemical tank yard containing VCM, Caustic Soda and EG will be located at the shore line for convenience of coastal transportation, based on the request of PTT.

Fudamental technical requirements and the scale of production are summarized in Table S.11-1.

Table S11-1 Technical Requirements for the Short-term Development Plan

Project	Soda Ash	Petro-chemical	Fertilizer	Supporting Industry	Total
1. Main Raw Materials					
Salt (T/Y)	562,200	91,200			653 400
Ammonia (T/Y)	128,000				128 000
Ethane (T/Y)		350,000			350,000
Propane (T/Y)		130,000			130,000
Natural gas (CH_4 rich) (MMSCFD)	9 4 (as fuel)	15 (as fuel)	54 (as raw mat's & fuel)		78 4
Sulfur (T/Y)			203,300		203,300
Phosphate rock (T/Y)			704 000		704 000
Muriate of potash (T/Y)[1]			73,400		73 400[1]
Carbon dioxide gas (m^3/Y)	132 8 × 10[6]				132 8 × 10[6]
Inputs for supporting industry				191,000	191 000
					2 433 100 T/Y (except gases)
2. Utilities					
Electricity (kW)	24,800	72,700	15 700	3 400	116 600
Fresh water (m^3/H)	1,280	1,500	1 470	50	4 300
Portable water (m^3/H)	12	25	15	22	74
3 Total Manpower Requirement	840	1,550	1,050	1 200	3,440
4. Land Area Requirement (without areas housing and waste disposal) (ha)	55	200	55	50	360
5. Final Products (T/Y)					
Soda ash	400,000				400 000
Ammonium chloride	400,000				400 000
LDPE resin		100,000			100 000
HDPE resin		100,000			110 000
Caustic soda (as 50% NaOH solution)		103,200			103 200
VCN		80,000			80 000
MEG		50 000			50 000
PP resin		70,000			70 000
Ammonia			128 000 900t/D		128 000
(Phosphoric acid)			(25 000) 670t/D		(25 000)
DAP/MAP			approx		
NPK fertilizers			1 000,000 1 000t/D		1 000 000
Outputs from supporting industry				166 000	166 000
					2 632 200 T/Y
6. Waste Disposal					
Solid disposal (T/Y)	144,000	2,000	1 100 000		1 246 000
Waste water (m^3/H)	450	540	500		1 490

(12) Urban Development Plan (Short Term)

At the 1st Phase, the New Town will have a population of some 18,300 or 4,360 households.

The investment cost at the initial stage for the new urban complex should be minimized by largely depending on the existing facilities in Ban Chang. Table S.12-1 and Fig. S.12-1 show the land allotment and land use plan at the 1st phase, respectively.

Table S12-1 Land Allotment

	Area (HA)	Ratio (%)
Residential Use (Net)	62	47
Town Center	5	4
Neighborhood Shopping Center	1	1
Community Center	2	2
Secondary School	8	6
Primary School	1 (3)*	1
Kindergarten	1	1
Sub-total	10	8
Central Park	10	8
Neighborhood Park	3	2
Playground	1	1
Pedestrian Way	3	2
River and Mall	0	0
Sub-total	17	13
Road	31	23
Sewage Treatment and others	3	2
Total	131	100

Gross density: 140 persons/ha (22 persons/rai)

* The figure in ( ) shows the area of the existing facilities which is not included in the total planning area.

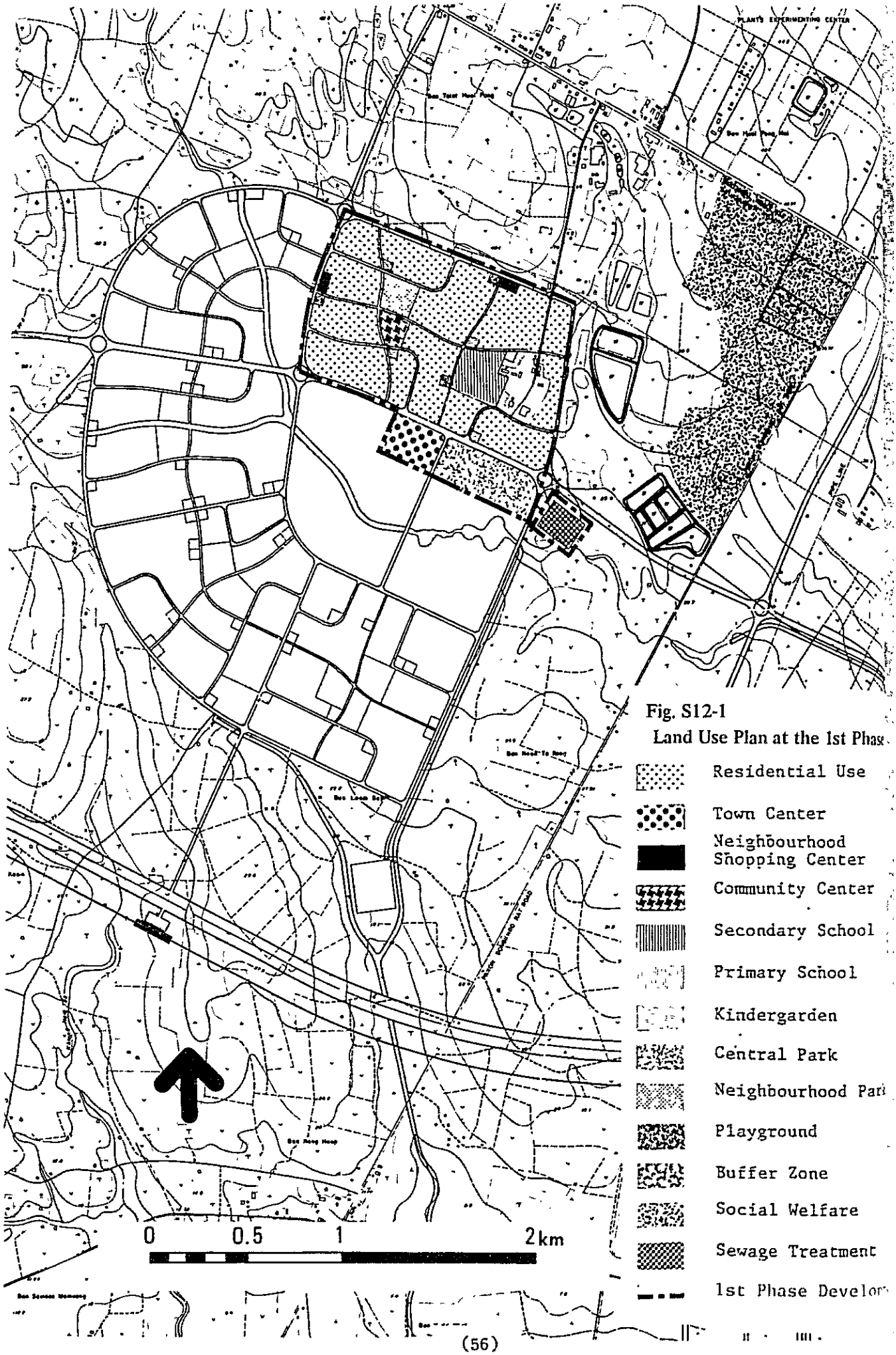


Fig. S12-1
Land Use Plan at the 1st Phase

(13) Plan for Related Infrastructures (Short Term)

1) Road

Roads to be constructed at the 1st Phase are as shown in Fig. S. 13-1, thereby insuring the smooth and efficient traffic movement at a minimized construction cost.

2) Water Supply

Portable water supply will be made at the 1st Phase as follows, in accordance with the master plan.

(i) Quantity of Water

Industrial complex	926 m^3/day (daily max.)
Port area	150 m^3/day (daily max.)
(For ship use)	420 m^3/day (daily max.)
Urban area	6,863 m^3/day (daily max.)

(ii) Purification Facilities

Purified water (calculated based on the water demand per capita planned for 2000)	9,200 m^3/day (daily max.)

(iii) Industrial Water

The industrial water requirement as of 1987 will be 36.16 million m^3/Y.

3) Sewarage and Treatment of Effluents

Sewarage treatment system in the Port and Urban Area will be made at the 1st Phase as described below, in accordance with the master plan.

Quantity of Sewarage Discharge

Port area	150 m^3/day (daily max.)
Urban area	8,300 m^3/day (daily max.)

4) Stormwater Drainage

Based on the master plan, the following drainage network will be constructed. Some balancing reservoir will be provided at the streamend of urban area to lessen development cost of the industrial complex.

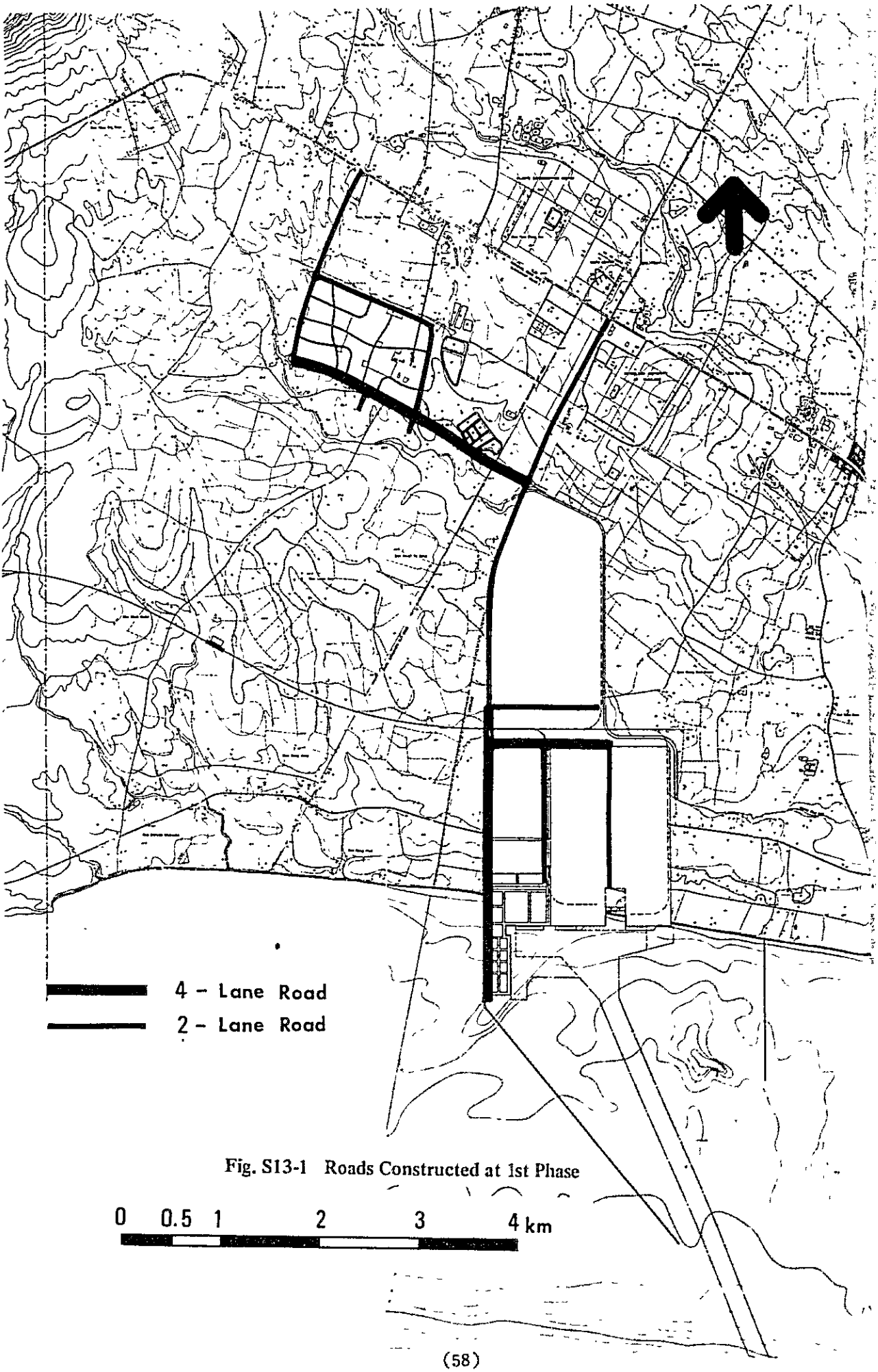


Fig. S13-1 Roads Constructed at 1st Phase

(14) Implementation study

1) Development

It is desirable that one agency takes responsibility for the whole development. In the case of regional development, a local or municipal body is the suitable agency. But, in Thailand, it is not practical that the provincial government alone organize the implementation body, because the provincial government has little capacity for such a regional development and besides the development plan is a national project. Even if the central government conducts the development, it is unlikely that only one agency can manage the whole development because the project has to involve various kinds of matters which are supervised by several different agencies. Another way is to organize a new agency which takes the whole responsibility of the implementation. But this idea seems not to be realistic, because of strong resistance from the existing agencies. Therefore, a committee consisting of officials from all the relevant authorities is the best way to co-ordinate the authorities of the existing agencies. There are several committees and working groups relating to the project.

In order to conduct the development efficiently, we propose to an umbrella committee uniting the existing Committees and Working Groups.

This committee should have power to decide policy and the plan of implementation. Although mutual cooperation among these agencies is needed in construction stage, it seems to be very difficult to adjust the competence of those agencies. Therefore, we propose nominating a certain agency which takes charge of the construction of the planned facilities. The leading agency sets up a new organization to implement the plan, to which other agencies concerned dispatch their staffs in charge, if necessary. The Royal Thai Government has already appointed the "Industrial Estate Authority of Thailand (IEAT)" as the agency to be responsible for the implementation of the development plan in Map Ta Phut. IEAT should have power to do the following tasks in accordance with the plan and policy decided by the Committee.

(i) To construct some infrastructures and public utilities by itself

(ii) To co-ordinate, supervise and inspect the construction work done by other agencies or private sectors

(iii) To give them appropriate instruction, if necessary

Considering the existing organization of IEAT, some of the facilities are likely to be constructed by other existing agencies.

(Participation of private sectors in the implementation)

Provision of necessary infrastructures and public utilities makes strong inducement for private sectors to invest in the Industries.

Therefore, these facilities should be originally constructed by the public sectors and be afterward redeemed by leasing or selling them. But, it will be necessary for the public sectors to request private sectors for investment in specific facilities at the construction stage.

2) Administration

(i) Administrative Agency

For the organization for administration and operation of the New Industrial Port and Estate, three alternatives are considered.

(a) New state enterprise

A new state enterprise to administrate and operate both the industrial port and industrial estate is established.

(b) The existing authorities

The industrial complex is administrated by an existing organization such as PAT for the industrial port and IEAT for industrial estate.

(c) Steering comittee

PAT and IEAT operate the industrial port and the industrial estate respectively, but a steering committee to adjust and harmonize their activities will be established. Each alternative has advantages and disadvantages. New state enterprise is selected as the premise for financial analysis.

(ii) The functions of the New State Enterprise (NSE).

The role of NSE for providing the infrastructures is defined as follows, and will become the basic assumtion for the financial analysis of the NSE.

(a) Electricity

NSE will bear construction cost of the high tension line and the new substation within NSE excluding the portion born by industries, and of the network supplying electricity from the new substation to the urban and port areas. The construction cost of each service wire from the new substation to the individual factories (tenant enterprise) will be born by the industries as the part of the plant cost.

(b) Tele-Communication System

NSE will only have to provide the land for the telephone exchange and the post office.

(c) Water Supply System

The operation and construction for the receiving reservoir are excluded from NSE's responsibility.

NSE is responsible for the construction and operation of the water purification facility, the water pipeline to urban and port areas, and the industrial water pipeline from the receiving reservoir, to the battery limits.

(d) Sewage and Solid Waste Disposal Facilities

NSE will construct and operate the waste water and solid waste treatment facilities and the disposal pipelines in the urban and port areas excluding the industrial area. In the industrial area, those facilities will be constructed and operated by the industries.

(e) Drainage System

NSE will improve, construct and operate the existing drainage and new drainage system.

(f) Road Network System

With regard to the road network system, NSE has the responsibility of the existing and new roads in the region except maintenance of the bypass road.

(g) Railway

NSE will only provide land within the development area for SRT to construct and to operate the spur.

(h) Port facilities

NSE has responsibility for construction of breakwaters, channel and basins, commercial terminals and land preparation, and for administration, operation and maintenance of port facilities at the commercial terminal including cargo handling and port service.

The private terminals should be constructed and operated by the industries themselves.

(i) Others

With regard to housing, NSE will only take care of the land acquisition and preparation. Social-infrastructures such as hospital, school and so on, will be done by local government and the private sectors.

3) The Operation of the Port

(i) The function of the NSE port office

(a) Services concerning vessels

- o Pilot service
- o Towage service
- o Supply of portable water

(b) Services concerning cargo

- o Longshore handling of cargo
- o Storage of cargo

(c) Other services

- o Security and fire fighting
- o Emergency medical care

(ii) The number of the labourers and the handling equipment

(a) The loading of tapioca and potash

In loading of the tapioca, it will be handled using the stacker/reclaimer and the belt conveyor and loaded into the ship by the ship loader.

In loading of the potash it will be transported by the bucket elevator and the belt conveyer then loaded by the same ship loader used for the tapioca loading.

No. of labourer is 12. There are two shifts of 6 workers each.

The required cargo handling equipment

stacker/reclaimer	1,250 t/h	1 unit
bucket elevator	1,250 t/h	1 unit
ships loader	1,250 t/h	1 unit
belt conveyor	1,900 m	

(b) The loading of petro-chemical products

All commodities are liquid bulk and will be transported from the tank by the underground pipeline and loaded by the loading arms.

The number of workers is 9.

The required cargo handling equipment

loading arm for the liquid	100 t/h	3 unit

(c) The loading and unloading of general and dry bulk cargo

The commodities classified in this category are the products and the raw materials of the metal process industries, steel products, bagged cement and sand.

The number of workers is 84.

The equipment

payloader 3 units
forklift 5 units

Basides a 40 ton crane and 12 workers is necessary to handle the heavy commodities.

(d) The workers and the equipment for the harbour service

Three tug boats and two pilot boats are necessary to assist the manoeuvering of the vessels in the harbour basin and the channel.

56 marine workers are required to operate these vessels assuming two shifts a day.

(e) Finance, central and engineering section

The number of personnel is decided based on the example of Sattahip Port.

The total number of personnel is 350.

4) Industrial Estate Office

In order to administrate the construction and operation of the industrial estate the organization of the site office is assumed to be based on the example of the site offices of existing industrial estates. The total number of personnel is 40.

(15) Investment Cost Estimation

1) Construction Program

It was understood that the Thai Government's intention was to begin the operation of the first phase industries by the end of 1987. Accordingly, the total construction period will be 4 years.

The construction schedule of short term development is shown in Table S15-1.

2) Cost Estimation

Construction cost of short term development is 41,605.6 million Baht. The breakdown of construction cost are shown in Table S15-2 through S15-9.

The Basic premises are as follows;

(a) Price is expressed in Baht and US$, based on 1983 prices.

(b) Exchange rate is calculated as: US1$=23.0฿ and 1฿=10.4¥ (1983)

(c) Duty for imported construction materials, equipment and plants are excluded from the cost estimation.

Business tax and municipal tax are also eliminated from cost estimation.

Table S15-1 Construction Schedule of Short Term Development Program

Item	Unit	Quantity	1983	'84	'85	'86	'87	'88	'89	'90
Investigation/Engineering	Ls	1								
Tender/Evaluation/Award	Ls	1								
Land Acquisition	ha	711.4								
Mobilization/Demobilization	Ls	1								
Industrial Complex										
Site Preparation	ha	410								
Road	m	10,600								
Water Supply	Ls	1								
Drainage	Ls	1								
Power Supply	Ls	1								
Plant Construction	Ls	1								
Port Area										
Site Preparation	ha	17								
Dredging/Reclamation	m^3	11,100,000								
Protective Facilities	m	6,070								
Mooring Facilities	m	1,130								
Road	m	3,050								
Buildings/Pavement	Ls	1								
Water Supply/Drainage/Sewerage	Ls	1								
Power Supply	Ls	1								
Handling Equip/Ships	Ls	1								
Urban Area										
Site Preparation	ha	157								
Road	m	33,600								
Water Supply/Drainage	Ls	1								
Sewerage/Solid Waste	Ls	1								
Power Supply	Ls	1								
Housing/Public Facilities	Ls	1								
Railway										
Site Preparation	ha	127.4								
Railway	km	23.6								

Table S15-2 Construction Cost (Short Term Development Program)

Item	Unit	Quantity	Unit Price (฿)	Amount (Thousand ฿)			Total Amount (Thousand US$)
				Total	Local Currency	Foreign Currency	
1. Industrial Complex	Ls	1		1,000,500	584,100	416,400	43,500
2. Port Area	Ls	1		2,751,700	1,215,900	1,535,800	119,640
3. Urban Area	Ls	1		484,800	328,000	156,800	21,080
4. Railway	Ls	1		313,300	209,500	103,800	13,620
Sub-total				4,550,300	2,337,500	2,212,800	197,840
5. Telecommunication	Ls	1		126,500	54,400	72,100	5,500
6. Housing & Public Facilities	Ls	1		1,176,500	1,092,400	84,100	51,150
7. Plant Construction	Ls	1		35,752,300	11,891,000	23,861,300	1,554,450
Sub-total				37,055,300	13,037,800	24,017,500	1,611,100
Total Construction cost				41,605,600	15,375,300	26,230,300	1,808,940

Table S15-3 Industrial Complex

Item	Unit	Quantity	Unit Price (฿)	Total Amount (thousand ฿)	Remarks
1. Land Acquisition	ha	410	312,500	128,130	
2. Site Preparation	Ls	1		351,780	
3. Road	m	10,600		37,660	
4. Water Supply	Ls	1		137,480	
5. Drainage	Ls	1		20,870	
6. Power Supply	Ls	1		202,030	
Sub-total				877,950	
Investigation & Engineering	Ls	1		47,590	
Physical Contingency	Ls	1		74,960	
Total				1,000,500	

Table S15-4 Port Area

Item	Unit	Quantity	Unit Price (฿)	Total Amount (thousand ฿)	Remarks
1. Land Acquisition	ha	17	312,500	5,310	
2. Site Preparation	Ls	1		5,440	
3. Port Facilities				(2,011,370)	
Drainage	m^3	11,000,000	46	510,600	
Reclamation	m^3	2,400,000	4	9,600	
Protective Facilities	m	6,070		791,050	
Mooring Facilities	m	1,130		434,780	
Navigation Aids	Ls	1		12,000	
RElated Facilities	Ls	1		253,340	
4. Cargo Handling Equipment	Ls	1		100,000	
Sub-total				2,436,020	
Investigation/Engineering	Ls	1		114,000	
Physical Contingency	Ls	1		201,680	
Total				2,751,700	

Table S15-5 Urban Area

Item	Unit	Quantity	Unit Price (฿)	Total Amount (thousand ฿)	Remarks
1. Land acquisition	ha	157	312,500	49,060	
2. Site Preparation				19,290	
3. Road	m	33,600		78,830	
4. Water Supply	Ls	1		78,740	
5. Drainage	Ls	1		44,730	
6. Sewerage	Ls	1		51,040	
7. Solid Waste Disposal	Ls	1		12,690	
8. Power Supply	Ls	1		65,450	
9. Pedestrian Way	m	2,990	1,620	4,840	
10. Park	m^2	140,000	486	6,800	
Sub-total				411,470	
Investigation/Engineering				37,120	
Physical Contingency				36,210	
Total				484,800	

Table S15-6 Railway

Item	Unit	Quantity	Unit Price (฿)	Total Amount (thousand ฿)	Remarks
1. Land Acquisition	ha	127.4		37,250	
2. Trunk Line				(167,200)	
Truck Structure	kg	23.6		82,960	
Truck Work	km	23.6		58,740	
Bridge	Unit	11		25,500	
3. Marshaling Yard	Ls	1		21,570	
4. Communication/ Signalling	Ls	1		20,000	
5. Lighting Facilities	Ls	1		3,260	
6. Maintenance Office	Ls	1		2,900	
Sub-total				252,180	
Investigation/ Engineering	Ls	1		28,860	
Physical Cintingency	Ls	1		32,260	
Total				313,300	

Table S15-7 Telecommunication

Item	Unit	Quantity	Unit Price (฿)	Total Amount (thousand ฿)
1. Telephone System	Ls	1		77,710
2. Telex Telegraph	Ls	1		14,560
3. Local Cable System	Ls	1		29,520
4. P.C.M. Cable System	Ls	1		4,710
Total				126,500

Table S15-8 Housing

Item	Unit	Quantity	Unit Price (฿)	Total Amount (thousand ฿)
1. Housing	Ls	1		723,150
2. Education Facilities	Ls	1		52,330
3. Community Facilities	Ls	1		275,000
Sub-Total				1,050,480
Investigation Engineering	Ls	1		52,520
Physical Contingency	Ls	1		73,500
Total				1,176,500

Table S15-9 Plant Construction

Item	Unit	Quantity	Unit Price (฿)	Total Amount (thousand ฿)
1. Supporting Industry	Ls	1		844,200
2. Petrochemical	Ls	1		15,890,700
3. Soda Ash	Ls	1		5,912,200
4. Fertilizer	Ls	1		13,096,200
Total				35,752,300

(16) Financial Analysis of Industrial Port

1) The construction cost of Map Ta Phut new industrial port comes to Baht 2,751.7 Million which covers cost of breakwaters, channels, basins, commercial terminals, land preparation and its related facilities.

Construction cost of private wharves for production plants are excluded from above cost estimation.

Also the operation and maintenance of private wharves which handle cargoes exclusively for the production plants are not considered here.

2) The funds necessary to excute the project are to be raised as follows.

Table S16-1 Funds Raising Plan (unit Baht ,000-)

	Foreign Currency Portion	Domestic Currency Portion	Total
Funds Required	1,535,800 (55.5%)	1,215,900 (44.5%)	2,571,700 (100.0%)
Funds Raising	Borrowing	Government Funds	
Interest Rate	3.5% P.S	fro of interest	
Grace Period	10 years		
Loan Period	30 years		

3) The revenues of the port consist of port charges, leasing fee for port facilities and interest on deposits P.A.T's port tariff rates are applied in estimation of port charges.

Handling charges of cargoes through the private wharves are excluded from the revenues. On the other hand, expenses are consisting of personnel cost, administration cost, maintenance and repair cost, operation cost, depreciation cost and paid interest.

4) The study of financial statement shows.

(i) The project is not profit making under current port tariff rates.

(ii) The project is able to service the debt, however additional payments for replacement of facilities bring about the shortage of funds.

By raising the tariff rates by 50%, the net operating income becomes positive, and by 10% increase of tariff rates the net cash flow of the project also becomes positive.

(See tables 6-2, 6-3 in appendix)

5) The financial rate of return (F.R.R) of the project calculated is 0.82% which is lower than the loan interest rate of 35% P.A.

The result of sensitivity analysis shows that the F.R.R is 2.67% after raising current tariff rates by 10% and 4.48% after raising tariff rates by 20%, which is well above the level of loan interest rate.

(17) Financial Analysis of Industrial Estate

1) The development cost of Map Ta Phut industrial estates comes to Baht 767,000,000 based on 1983 prices.

Out of the total cost foreign portion stands at Baht 295,200,000 (38.5%) and domestic portion comes to Baht 472,500,000 (61.5%).

The construction cost per Rai of industrial estate is Baht 638,537 for waterfront area and Baht 205,578 for inland area.

2) The funds required to execute the project are raised under the following two financial packages

Table S17-1 Funds Raising Plan (unit Baht ,000-)

	Foreign Portion	Domestic portion	Internal Cash Generation	Total
Case 1-1	8.6% 5 years (including 3 years grace period)	16.0% 5 years (including 3 years grace period)		
	295,200 (38.5%)	119,824 (15.6%)	352,676 (45.7%)	767,700 (100%)
Case 1-2	11.0% 5 years (including 3 years grace period)	16.0% 5 years (including 3 years grace period)		
	295,200 (38.5%)	136,122 (17.7%)	336,378 (43.8%)	767,710 (100%)

Foreign currency portion will be borrowed first and any internal generated cash will serve to reduce the amount of domestic currency borrowing.

3) The sources of revenus relative to the development and administration of Map Ta Phut industrial estates are as follows.

Source of revenue	unit price	
Sale of factory lots	Water front area	Baht 744,000/Rai
	Inland area	Baht 240,000/Rai

10% price margin is included and sales will be made 5 years installment basis).

Maintenance charge for industrial estates	Baht 2,000/Rai
Water supply charges	
Service water	Baht 3.3/m^3
industrial water	Baht 1.6/m^3

Sale of factory lots

(unit Rai)

Table S17-2 Land Sales Plan

	1985	1986	1987	Total
Waterfront area				
Soda Ash	335.6			694.4
Fertilizer	358.8			
Inland area				
Petrochemical	1,262.5			
Supporting industry	157.5	157.5		1,577.5
Total	2,114.4	157.5		2,271.9

4) Operating cost consists of personnel cost, administration cost, maintenance cost for industrial estates and water supply cost, with these expenses and cost of land for sale constitute the total operating cost.
5) The study of financial statements shows that:
   (i) During the project life the operating revenue will be possible to meet operating cost remaining positive net operating income.
   (ii) The project is able to service the debt under the financial packages of both case 1-1 and case 1-2.
   (iii) The negative cash flow of case 1-2 during the 1988 – 1991 period can be covered by the accumulated net cash flow before 1988.
6) The F.R.R (financial rate of return) of this project is 19.82% which is well above the level of average interest rate, and demonstrates the profitability of the project.
7) The result of sensitivity analysis shows that both financial healthines and profitability can still be maintained in case where the price margin of factory site will be 5%.
   However, the delay of land sales seriously affects the project and land construction program must be well adjusted with that of land sales so that the project may secure both financial healthines and profitability.

(18) Economic Analysis

1) Method of Evaluation

Evaluation is made by computing the IRR and the B/C Ratio.

The 12 percent discount rate used by the World Bank, and the 14 percent discount rate which is presently the Thailand Bank Rate are applied to the B/C Ratio evaluation.

2) Cost

The component of the costs which is considered in this analysis as follows;

(i) Construction cost for Map Ta Phut Industrial Estate (MIE)

(ii) Operating cost for MIE

(iii) Construction cost for the factories in MIE

(iv) Operating cost for the factories in MIE

Operating cost for the factories in MIE can be eliminated from the cost because the value-added d generated by the factories is to be counted in this analysis.

3) Benefit

The purpose of the development of infrastructures is to effectively support the productive activity. So, the benefits are enumerated as follows;

(i) Value-added generated by the planned Industries

(ii) Reduction of cargo transportation cost excluding the ones handled by the industrial complex

The benefit created by the individual infrastructure in relation to the production in Industrial Complex will be included in the value-added.

4) Evaluation

IRR = 15.7%

B/C Ratio Discount Rate 12% ; 1.30

ditto 14% ; 1.12

These figures show that this project is feasible. In order to confirm the feasibility under the different condition, the following case study is examined in sensitivity analysis.

Table S18-1 Case Study

Number of case	Case Condition			IRR (%)
	Cost	Benefit	Project life	
1	as estimated	as estimated	25 years	15.7
2	as estimated	as estimated	20 years	14.8
3	10% higher	as estimated	25 years	14.3
4	10% higher	as estimated	20 years	13.3
5	as estimated	10% lower	25 years	14.2
6	as estimated	10% lower	20 years	13.1
7	10% higher	10% lower	25 years	12.8
8	10% higher	10% lower	20 years	11.7

Case No. 8 is most pessimistical condition, nevertheless its IRR is just under the World Bank's 12 percent standard.

Thus, this project is expected to be feasible from view point of the national economy.

OUTLINE OF THE STUDY

OUTLINE OF THE STUDY

1. Background of the study

In the fifth national economic and social development plan, which started from 1981, the main emphasis is placed on economic development to attain national harmony. In order to correct the regional imbalance and to check the over-growth of the Bangkok Metropolitan Area, six regions are designated as development areas, including the Eastern Seaboard.

The Eastern Seaboard development comprises industrial, urban and tourism development and the provision of transportation facilities.

The development plan in Map Ta Phut, which aims at the establishment of the heavy industries and consequently the promotion of national industrialization, is one of the leading projects in the Eastern Seaboard development.

This area is selected as the site for heavy and chemical industries since a subaqueous gas pipeline, carrying natural gas produced in the Gulf of Thailand, comes a shore in this area, the dew point control plant for gas had already started its operation and the construction of the gas separation plant has been decided upon by the Royal Thai Government. (already under construction in June, 1983)

The Royal Thai Government (RTG) carried out F/S studies concerning Petrochemical, Fertilizer and Soda Ash industries utilizing the natural gas and decided on an F/S study and the study of the Master Plan for the Rayong Industrial Port to support the productive activities for these industries.

The Government of Japan, after receiving the request from the RTG, carried out the studies, including the field investigation at Map Ta Phut from July 1982 until March 1983. Meanwhile, the RTG requested an additional, more thorough, study concerning industrial development, urban, railway and related infrastructures in this area. The study corresponding to the expanded scope of work was begun at the end of March, 1983.

2. Purpose of Study

The purpose is firstly to review the kinds and scales of the industries to be induced to the Map Ta Phut industrial complex and to identify its production scheme based on discussions with the relevant authorities in the Royal Thai Government.

Then in the next step, the Short Term Development Plan for 1987 and the Master Plan for 2000 concerning the development of infrastructures such as port, railway, urban facilities etc. is to be proposed in order to support industrial and urban activities in the region.

Matters to be studied for this purpose are as follows;

(i) The Natural Conditions
(ii) The Industrial Development Plan
(iii) The Port Development Plan
(iv) The Urban Development Plan
(v) The Related Infrastructures Plan
(vi) The Pre-environmental Assessment

(vii) The Basic Design, Construction Program, Cost Estimation
(viii) The Administration and Operation
(ix) The Financial Analysis
(x) The Socio-Economic Analysis

3. Formation of the Survey Team

3-1 Methods of Investigation

The methods of investigation are generally classified as hearings, discussions, reconnaissance, collection of existing data and the natural condition survey. Names of the authorities and organization visited by the team for the discussions, hearings, and collection of the data are listed as follows;

The Asian Institute of Technology (AIT)
The Communication Authority of Thailand (CAT)
The Center for Integrated Plan and Operation (CIPO)
The Department of Mineral Resources (DMR)
The Department of Highway (DOH)
The Electricity Generating Authority of Thailand (EGAT)
The Express Transportation Organization of Thailand (ETO)
The Industrial Estate Anthority of Thailand (IEAT)
The Industrial Finance Corporation of Thailand (IFCT)
The Meteorological Department
The Ministry of Communication (MOC)
The Ministry of Industry (MOI)
The Town and City Planning of Ministry of Interior
The National Environmental Board (NEB)
The National Economic and Social Development Board (NESDB)
The National Fertilizer Corporation (NEC)
The National Housing Authority (NHA)
The National Statistical Office in NESDB
The Port Authority of Thailand (PAT)
The Provincial Electricity Authority (PEA)
The Petroleum Authority of Thailand (PTT)
The Provincial Water Works Authority (PWWA)
The Rayong Provincial Government
The Royal Thai Irrigation Department (RID)
The State Railway of Tahiland (SRT)
The Telephone Organization of Thailand (TOT)
The Department of Harbour (DOH)
The National Education Commission (NEC)
The Sattahip Commercial Port
The Bank of Thailand

The Mah and Boonhkrong Corporation Ltd.
The Siam Cement Co., Ltd.
The OECF Bangkok Office
The Bank of Tokyo

The natural condition survey was carried out from July to October 1982 around the Map Ta Phut coastal area covering such items as waves, winds, tidal currents and tide levels, geological conditions, inland ashore, and topographic conditions, etc.

Field observation was conducted at the following places;
The Bangkok Port (Khlong Toei Port)
The Sattahip Port
The Song Khla Port
The Phuket Port
The Laem Chabang and the Circumference
The Nongkhor, Bang Phura and Dokkhrai Resrviors
The Vicinity of the Samesaen Island by Boat
The Map Ta Phut Project Site
The Rayong, Siracha and Chonburi areas
The Ban Chang, Ban Map Ta Phut
The Eastern Seaboard by Helicopter
The Prachub Khirikhan Province
The Bamnet Nahrong (Rock Salt Mining)
The Ban Pha In
The Ban Pha Kong (Power Station)
The Urban Complexes surrounding Bangkok
The Urban Complex and Industrial Complex in Lat krabang.
The Purification Facilities in Bangkok and Rayong
The Solid Disposal Facility of Rayong
The Chachoengsao-Sattahip Railway Line

3-2 The Study Team

(1) The First Investigation in the Kingdom of Thailand

The first investigation was conducted by the port planning team and the natural condition survey team.

The members of the port planning team were as follows; (from July 22 to September 29, 1982)

Mr. Kazuo NISHIMURA (Project Director)
Management and Development Organization
Senior Adviser, The Overseas Coastal Area Development Institute of Japan (OCDI)

Mr. Kenziro KOHRIKI (Team Leader)
Port Development Planning
Director, OCDI

Mr. Hideo KAYAHARA (Co-Team Leader)
Cargo and Traffic Forecast, Port Management and Operation and Financial Analysis
Deputy Director, OCDI

Mr. Mutsuhiro FUJITA
Industrial Study, OCDI

Mr. Tsutomu ASAKAWA
Natural Condition Analysis, OCDI

Mr. Eiichi MATSUURA
Regional Planning and Environmental Assessment, OCDI

Mr. Takeshi MIYAGAWA
Socio-Economic Analysis, OCDI

Mr. Shozi ISHIMOTO
Structural Design, Construction and Cost Estimation, OCDI

The members of the natural condition survey team were as follows; (from July 22 to October 12, 1982)

Mr. Takeyasu KIKUTA (Team Leader for Natural Condition Survey)
Geophysicist
Deputy Manager
Kokusai Kogyo Co. Ltd.

Mr. Takeshi YOSHIHARA
Soil Investigation
Chief Engineer
Kokusai Kogyo Co. Ltd.

Mr. Yoshikazu IBUSUKI
Grand Topographic Survey
Cheif Engineer
Kokusai Kogyo Co. Ltd.

Mr. Mitsuru FUKASAWA
Sub-Marine Geology
Kokusai Kogyo Co. Ltd.

Mr. Nobutoshi TOBARI
Hydrographic Survey
Kokusai Kogyo Co. Ltd.

Mr. Yukio SATO
Geophysical Prospecting
Kokusai Kogyo Co. Ltd.

Mr. Noboru KUSUMI
Hydrographic Survey
Kokusai Kogyo Co. Ltd.

Mr. Hidetaka TANAKA
Oceanographic Survey
Kokusai Kogyo Co. Ltd.

Mr. Hirofumi YAMAUCHI
Hydrographic Survey
Kokusai Kogyo Co. Ltd.
Mr. Toichiro MAEKAWA
Geophysical Prospecting
Kokusai Kogyo Co. Ltd.
One of members stayed on for Mapping and returned to Japan on February 11, 1983.

(2) Presentation of the Interim Report (I) for the industrial port planning and Supplementary Investigation in the Kingdom of Thailand

For the presentation of the Interim Report (I), a team was dispatched to Thailand from December 20 to 29, 1982. The members of the team were as follows;

Mr. Kazuo NISHIMURA (Project Director)
Management and Development Organization
Senior Adviser, OCDI
Mr. Kenziro KOHRIKI (Team Leader)
Port Development planning
Director, OCDI
Mr. Mutsuhiro FUJITA
Industrial Study, OCDI
Mr. Eiichi MATSUURA
Regional Planning and Environmental Assessment, OCDI

The supplementary investigation team stayed in the Kingdom of Thailand from January 5 to 26, 1983, of which the members were as follows;

Mr. Kenziro KOHRIKI (Team leader)
Port Development Planning
Director, OCDI
Mr. Hideo KAYAHARA
Cargo and Traffic Forecast, Port Management and Operation and Financial Analysis
Deputy Director, OCDI
Mr. Takeshi MIYAGAWA
Socio-Economic Analysis, OCDI
Mr. Shozi ISHIMOTO
Structural Design, Construction and Cost Estimation, OCDI

(3) The Third Investigation in the Kingdom of Thailand

The third investigation was conducted from March 27 to June 15, 1983 concerning Industrial and Urban Development and the Related Infrastructures.

The members of the team were as follows;

Mr. Kazuo NISHIMURA (Project Director)
Management and Development Organization
Senior Adviser, OCDI

Mr. Kenziro KOHRIKI (Team Leader)
Port Planning and Transportation Planning
Director, OCDI

Mr. Kohkichi NAKANO (Co-Team Leader)
Urban Planning-1, Land Use Planning, OCDI

Mr. Mutsuhiro FUJITA
Industrial Planning-1, Industrial Complex Planning, OCDI

Mr. Genji SATO
Urban Planning-2, Housing Planning, OCDI

Mr. Tadashi USHIJIMA (Co-Team Leader)
Industrial Planning-2, Industrial Utility and Waste Treatment Planning
UNICO International Co.

Mr. Hideharu HISANO
Infrastructual Planning-1, Public Facilities and Traffic Planning
Nikken Sekkei LTD.

Mr. Yoshiaki NAKAMURA
Industrial Planning-3, Plant Planning
UNICO International Co.

Mr. Ikuo AOKI
Infrastructual Planning-2, Water Supply, Sewerage and Drainage
Nikken Sekkei LTD.

Mr. Minoru UMEOKA
Industrial Planning-4, Land Preparation
UNICO International Co.

Mr. Eiichi MATSUURA
Environmental Assessment
OCDI

Mr. Tatsumi OKU
Telecommunication Planning
The Nippon Telecommunications Consulting Co., Ltd.

Mr. Katsuyoshi TANABE
Financial Analysis
OCDI

Mr. Takeshi MIYAGAWA
Socio-Economic Analysis
OCDI

Mr. Shozi ISHIMOTO
Cost Estimation
OCDI

Mr. Susumu NARUSE
Coordinator
Japan International Cooperation Agency

(4) Presentation of the Draft Final Report

For the presentation of the Draft Final Report, a team was dispatched to Thailand during 10 days from September 12 to 21, 1983. The members of the team were as follows;

Mr. Kazuo NISHIMURA (Project Director)
Management and Development Organization
Senior Adviser, OCDI

Mr. Kenziro KOHRIKI (Team Leader)
Port Planning and Transportation Planning
Director, OCDI

Mr. Kohkichi NAKANO (Co-Team Leader)
Urban Planning-1, Land Use Planning, OCDI

Mr. Genji SATO
Urban Planning-2, Housing Planning, OCDI

Mr. Katsuyoshi TANABE
Financial Analysis, OCDI

Mr. Takeshi MIYAGAWA
Socio-Economic Analysis, OCDI

Mr. Susumu NARUSE
Coordinator, JICA

3-3 The Counterparts

The counterparts in the Royal Thai Government were comprised of two groups, the group which assisted the daily data collection and other investigation activities in the Kingdom of Thailand and the group which advised the study team regarding the guidelines and conclusions, representing the opinion of the Royal Thai Government.

The former group was set up within the Port Authority of Thailand and the function of the latter group was performed by the Working Group of the Rayong Industrial Port Development.

The members of the both groups are listed as follows;

(1) The Counterpart Team (PAT)

Mr. Pricha Vudhivai
Chief of Data Collection and Analysis Section, Planning Analysis Division, Industrial Estate Authority of Thailand (IEAT)

Ms. Janthnee Jongnitayagal
Senior Economist of Industrial Economic and Planning Division, Office of the Under-Secretary of State for Ministry of Industry (MOI)

Mr. Chalermchai Meekun-Iam
Second-Grade Engineer of Engineering Section, Design Division, Engineering Department, P.A.T.

Mr. Sommart Tharanatham
Third-Grade Engineer of Construction Section, Civil Engineering Division, Engineering Department, P.A.T.

Mr. Suraphol Sirisriboonruang
Officer attached to the Statistical Section, Technical Office, P.A.T.
Mr. Preecha Jarungchitphacharon
Assistant Chief of Ship Handling Operation Accounting Section, Accounting Division, P.A.T.
CDR. Paisarn Visutakul
Director of Marine Survey Division, P.A.T.
Mr. Praphon Iamsudha
Wharf Superintendent, Port of Bangkok, P.A.T.
Mr. Pree-d Jareonsuke
Chief of Marine Survey Section, Marine Servey Division, P.A.T.

(2) The Working Group of the Rayong Industrial Port Development
Mr. Kovit Kuvanonda (Chairman)
Director of Planning Division, Ministry of Communication (MOC)
Ms. Janthnee Jongnitayagal
Senior Economist of Industrial Economics and Planning Division, Office of the Under-Secretary of State for Ministry of Industry (MOI)
Mr. Tophong Vachanasvasti
Assistant of Infrastructure Project Division, and Chief of Transportation and Communication (MOC)
Ms. Usanee Uyasatian
Environmental Officer of Environmental Impact Evaluation Division, Office of the National Environmental Board (NEB)
CAPT. Sommai Poomipol
Chief of Hydrographic Survey Division, Hydrographic Department, Royal Thai Navy
LT. CDR. Chamnong Chetananda
Director of Survey and Chart Production Division, Harbor Department (MOC)
LT. Preecha Netrayon
Deputy Director, Marine Department (PAT)
CDR. Paisarn Visutakul
Director of Marine Survey Division, Marine Department (PAT)
Mr. Chalermchai Meekun-Iam
Second-Grade Engineer of Engineering Section, Design Division, Engineering Department (PAT)

These two group were reorganized on March, 1983, when the study with the expanded scope of work started and the Industrial Estate Authority of Thailand was designated as the counterpart organization.

The new members of both groups are listed as follows;

(3) The Counterpart Team (IEAT)
Mr. Jaroen Vattasingh (Project Director) : Industrial and Urban Planning IEAT

Mr. Pricha Vudhivai	:	Industrial and Urban Planning	IEAT
Mr. Vitoon Nimmansoontorn	:	Economic and Financial Analysis	IEAT
Mr. Narong Pongsermpol	:	Economic Analysis	IEAT
Mr. Sukhum Kosaisaevee	:	Transportation and Utility Planning	IEAT
Mr. Suksit Suksumake	:	Utility Planning, Economic and Financial Analysis	IEAT
Mr. Kitti Sophonpak	:	Utility Planning	IEAT
Mr. Boonyok Tamtai	:	Coordination and Project Secretary	IEAT
Ms. Poolsuk Sailabada	:	Economic Analysis	IEAT
Miss Titimah Vichirat	:	Financial Analysis	IEAT
Mr. Sataporn Poolsin	:	Draftman	IEAT
Miss Rarintip Pansmai	:	Clerk and Typist	IEAT

(4) The Steering Committee

Mr. Wanchak Voradilok (Chairman)
IEAT's governor

Mr. Prateep Chuntaketta (Vice Chairman)
IEAT's Deputy governor

Mr. Tara Rojnthana
Director of Technical Office, PAT

Mr. Pree Buranasiri
Director of Research and Construction Department (NHA)

Mrs. Charatsri Teepirach
Director of Comprehensive Planning Division, Department of Town and City Planning

Mr. Kovit Kuvanonda
Director of Planning Division, MOC

Mr. Adul Leelapatranuruk
Representative for PTT

Mr. Pisake Showchaiya
Director of Regional Planning Division, NESDB

Mr. Chakmont Phasukvanich
Section Chief of Industrial Planning, Economic Projects Division, NESDB

Assist. Prof. Kumroprak Surasavadi
CIPO

Mr. Manas Sa-guandekul
CIPO

Mr. Jaroen Vattasingh
IEAT

4. Progress of the Study

(1) The First Investigation in the Kingdom of Thailand

The inception report describing the study method, items, members and itinerary for the study was explained to the counterparts of the Port Authority of Thailand. According to the results of the presentation and discussion, the study was started.

The natural condition survey team carried out the observation of wind, wave, soil and geography etc. starting from 4th of August, 1982 around Map Ta Phut coastal area.

The port planning team visited the project site of the Map Ta Phut area and observed the Eastern Seaboard region during 4 days starting from 1st of August, 1982. Some of them visited the planned sites for Rock Salt Mining near Bamnet Nahrong and other members visited the proposed site for an Iron and Steel Making Plant in Purachab Khirikhan province. Four members including the project director and Mr. Tara, PAT technical advisor visited Song Khula and Phuket ports where expansion is to be implemented with the assistance of the Asian Development Bank.

Except for these observations, the port planning team stayed in Bangkok and conducted hearings, discussions and the collection of data.

The preliminary analysis of the obtained data was carried out and the guideline of the following works was decided upon in a provisional report. The report was submitted to PAT and the Working Group at the end of September, 1982 to summarize the first investigation.

On the other hand, the team of the natural condition survey continued the observations until the middle of October, 1982.

(2) Presentation of the Interim Report (I) and the Supplementary Investigation in the Kingdom of Thailand

Based on the analysis of the obtained data, an Interim Report for the industrial port planning was compiled. A team was dispatched to Thailand from 20th to 29th of December, 1982 for its presentation and discussions with PAT and the Working Group.

As the result of the discussions, the target year of the Short Term Development Plan was decided to be the end of 1987.

It was also decided as one of the basic premises for the study that the industries were to be the Petrochemical, Fertilizer and Soda Ash industries for the Short Term Development Plan and that the Iron and Steel complex would be established in Master Plan stage.

The team leader remained in Bangkok after the presentation and joined in the supplementary investigation which was performed from 5th to 26th of January, 1983.

The team carried out the collection and analysis of detailed data.

(3) Interim Report (II)

The Interim Report (II) for the port planning, which was revised based on the comments concerning the Interim Report (I) and the data obtained by the supplementary investigation in the Kingdom of Thailand, was presented to JICA in March, 1983.

(4) The Third Investigation in the Kingdom of Thailand

The phase II study reinforcing the study on the urban, railway and related infrastructures in addition to the industrial port planning, as agreed between the Japanese Government Contact Mission and the Royal Thai Government, starting from the end of March, 1983.

At the same time, the responsibility of the counterparts was transfered to the Industrial Estate Authority of Thailand and the Steering Committee to present the RTG was established.

The team was dispatched to Thailand to study from 27th of March to 15th of June, 1983. They returned to Japan after presenting the Interim Report (III) which proposed the preliminary Master Plan and the Short Term Development Plan.

(5) Presentation of the Draft Final Report

For the presentation of the Draft Final Report which was made giving due consideration to the comments on the Interim Report (III) by the Steering Committee and adding the Financial and Socio-Economic Analysises, a team was dispatched to Thailand from 12th to 21st of September, 1983.

(6) Final Report

The Final Report was submitted to JICA at the end of November, 1983.

PART I MASTER PLAN

Water Purification Facility

Route 3

Ban Chang

Urban Area

Route 3

Power Station

Ban Map Ta Phut

Butler Zone

Butler Zone

Sewage Treatment Plant

Marshaling Yard

Solid Waste Disposal Area

Railway

Petro Chemical (I)

Down Stream Industries

Other Industries

Supporting Industries (II)

By-Pass

Supporting Industries (III)

Fertilizer

Soda Ash

Petro Chemical (II)

Port Related Activity Area

Port

Gas pipeline

Iron & Steel

Trainning Jetty

Breakwater

Ko-Saket

Master Plan S : 1/50,000

CHAPTER I

EXISTING CONDITION

CHAPTER 1 EXISTING CONDITIONS

Chachoengsao, Chonburi and Rayong provinces in the Central Region make up Thailand's Eastern Seaboard. The area covers about 11,000 Sq km, or 2 percent of the country's total of 542,373 Sq km. The present conditions of the Eastern Seaboard and the region around the study area can be defined in terms of population, topography, traffic, economy and land use.

1.1 Topography

The topography of Thailand is divided into Northern, Peninsular, Central plain, Southeastern and Northeastern Thailand. Southeastern Thailand is separated from the central plain by the Chao Phraya plain on the north, and by the gulf of Thailand on the south and west. The east faces a flattopped mountain on the border of Cambodia and Thailand. In this area, a dissected upland extends north and to the center, and a coastal plain stretches south and west. The many small rivers that flow in this area all run to the south. An embayment is formed along the coastline and many rocky islands covered with tropical forests are scattered on the waters. Mangrove swamps can be seen around the estuarine mud but there are also many white sand beaches. Fig. 1.1-1 shows the topography of the Southeastern region's surface strata, which is divided into 3 zones.

Zone I covers regions of alluvium in Chachoengsao, Chonburi and Samut Prakarn Provinces; Zone II, the northern plateau; and Zone III, the southern plateau.

The study area covers a long stretch of coast from the Sattahip Peninsula on the west to the Khao Laem Ya headland on the east, including Rayong Bay in the center.

The western side of the study area is bordered by the Khao Chom Hai and Khao Khrok mountain ranges and the eastern side comprises a flood plain and tributaries of the Khlong Yai (Rayong River).

The flood plain has created areas with poor drainage north of Rayong and southeast of Map Ta Phut but coastal dunes provide protection.

These areas are used for mixed farming with tree crops and orchards. On the south side of Route 36 there is rich farm land, farmed by people who immigrated there under the Rayong Land Settlement Scheme 24 years ago.

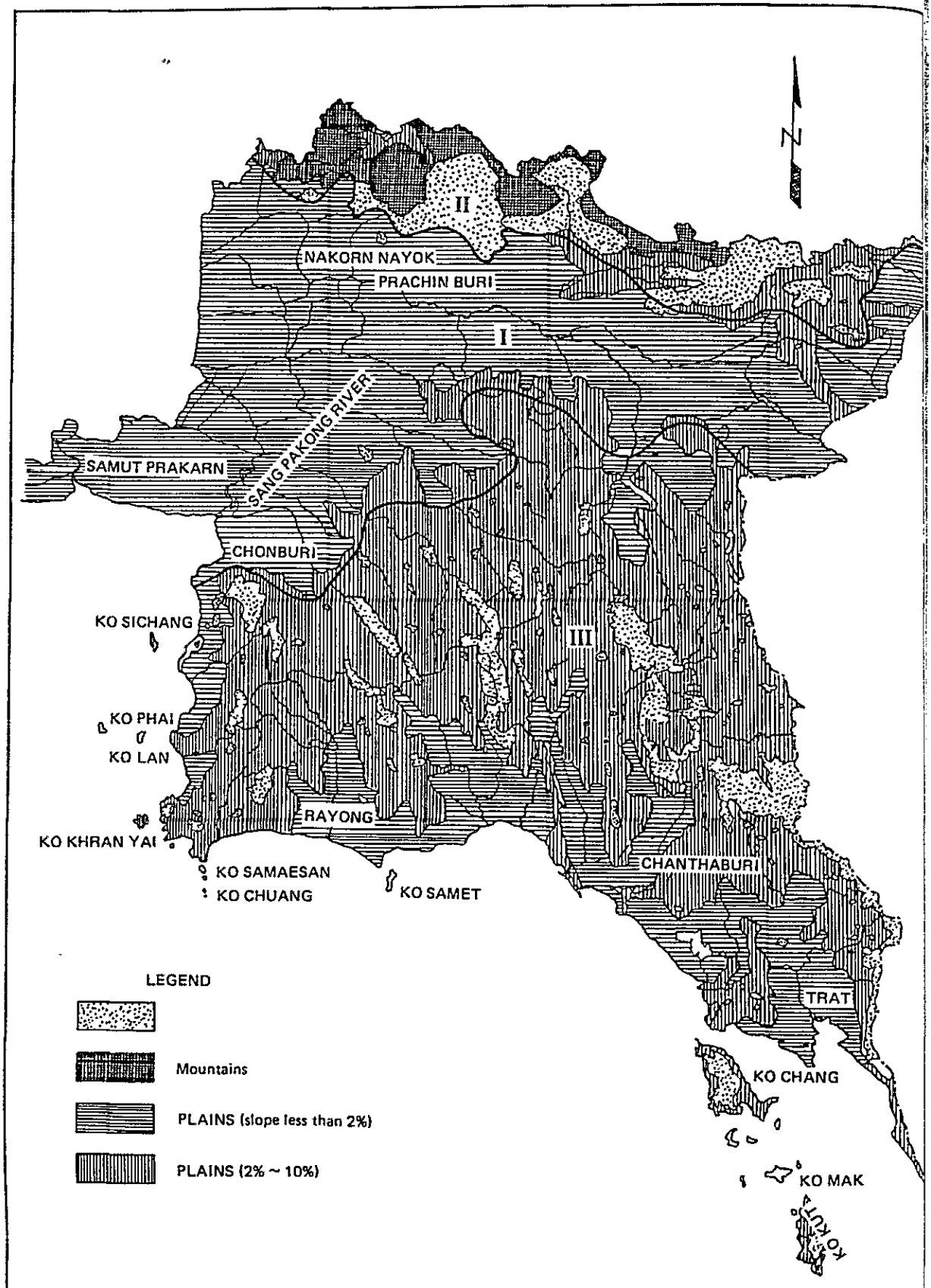


Fig. 1.1-1 Surface Configuration of Eastern Region

1.2 Land use

Land use on the coastline and coastal plain (hereafter called the coastal area) differs from that on the plateau behind the coastal area. The coastal area is a corridor formed by densely populated Siracha, Pattaya, Sattahip and Rayong, while the plateau is mostly agricultural developed.

The Rayong Valley, formed by the Rayong River, is currently a base for primary industry mainly rice paddies.

Population centers in the coastal area serve as centers of commerce for their respective hinterlands:

Chonburi is a core city dealing in light industry; Siracha is a commercial city with many fisheries; Pattaya is the most famous beach resort in the Orient; Sattahip is a naval port city; and Rayong is a hub for regional agriculture as well as a commercial city.

Fig. 1.2-1 shows administrative divisions: Chachoengsao Province is divided into 9 districts, Chonburi Province into 9 districts and Rayong Province into 6 districts.

The study area includes, as shown in Fig. 1.2-2, 8 sub-districts of the Rayong District, and part of the Ban Chang and Ban Khai Districts.

Lands in this area are used for orchards and tapioca but their productivity is not very high.

U-Taphao Airfield, situated in the west end of the study area is presently used as naval airport and for international cargo flights. Its scale is first class. Because of the presence of military facilities, there are Restrictive Zones as shown in Fig. 1.2-3.

Fig. 1.2-1 Boundary Distributions

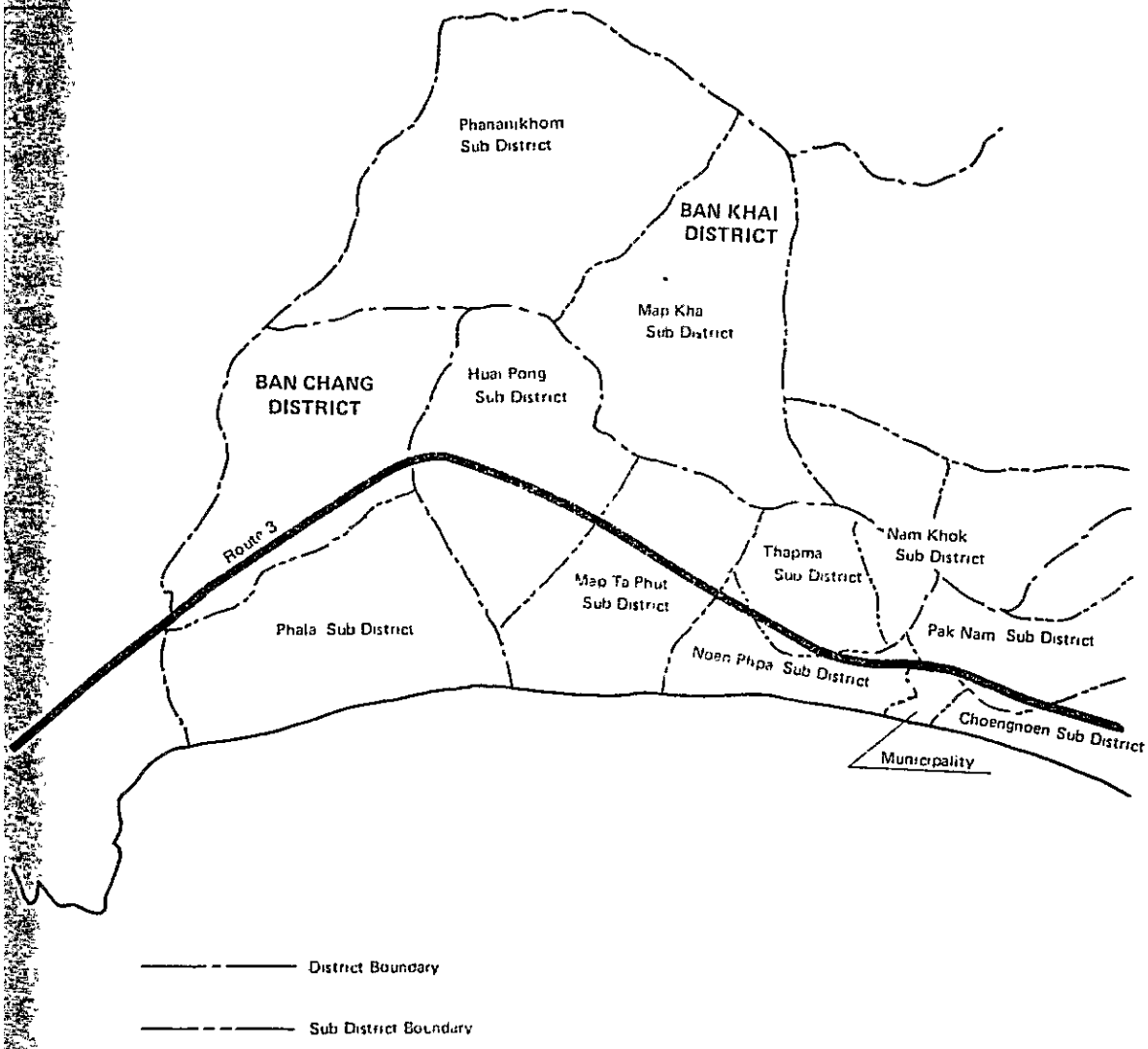


Fig. 1.2-2 Rayong-Map Ta Phut Districts

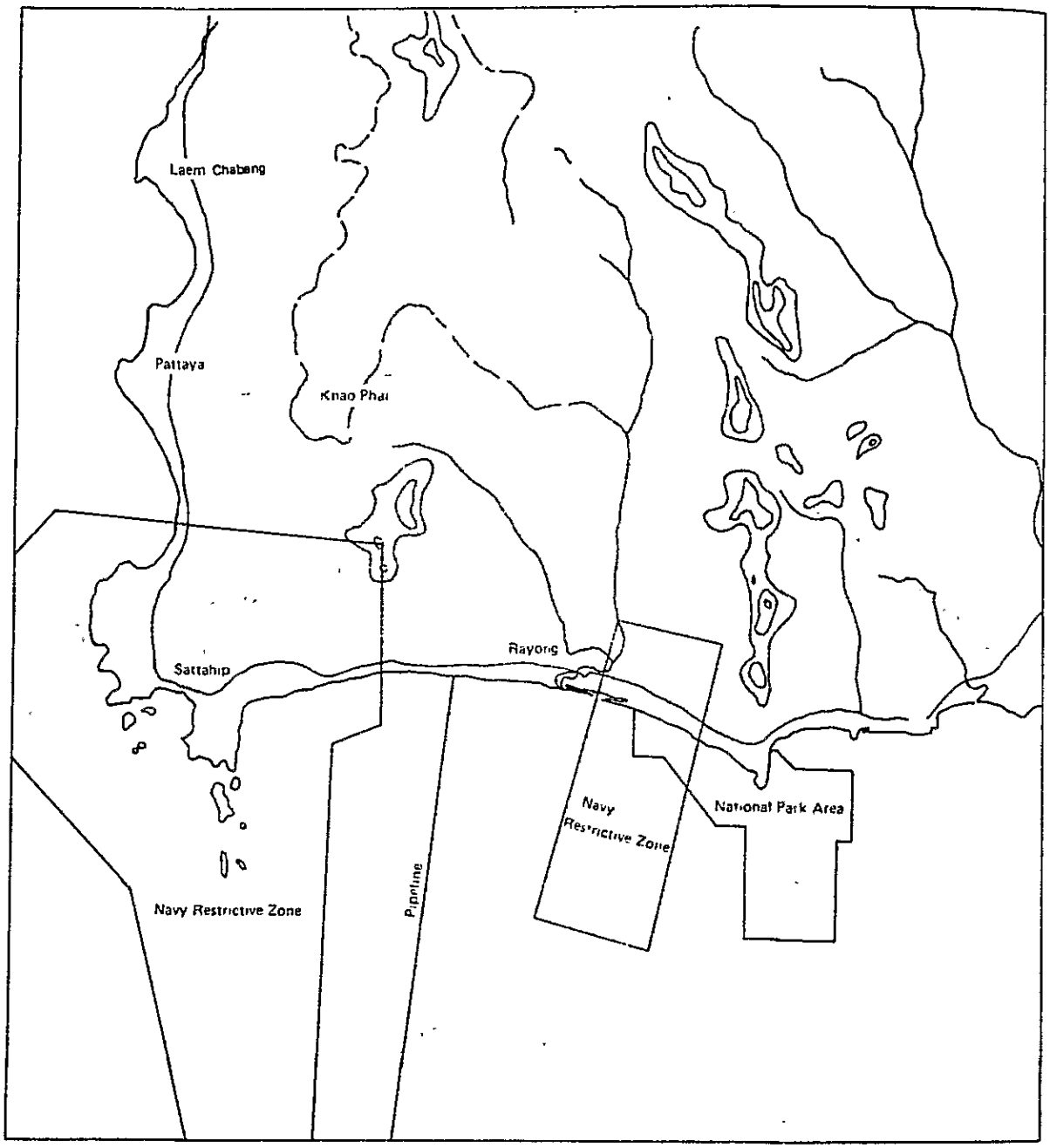


Fig. 1.2-3 Restrictive Area

1.3 Population

The total population of Thailand in 1981 was 47,850,000, of which the Central Region had 6,531,700 (18.4 percent); the East Region 2,152,800 (6.0 percent); the West Region, 2,920,000 (8.2 percent); the Northeast Region, 11,965,600 (33.7 percent); the North Region, 7,597,400 (21.4 percent); and the South Region, 4,382,300 (12.3 percent). Regional population proportions have not changed in the 10 years between 1970 and 1981.

16 – 18 percent of the total population lives in urban areas of which 61 percent is concentrated in the Bangkok – Chonburi regions; the areas contain about 11 percent of the total national population. The Eastern Seaboard includes 3 of the 7 provinces of the East Region Chonburi, Rayong and Chachoengsao.

Table 1.3-1, shows population by sex, number of households and density in urban and other areas as of December 31, 1981.

According to this table, 55 percent of the total population of the East Region resides in the Eastern Seaboard. There are as many men as women and the average household has six members. The density of population in the East Region is about 81.1/sq. km; in the Urban Area of Chonburi Province, 3,645.9/sq. km; and in the Non-urban Area, 138.4/sq. km. Likewise in Rayong Province, the density of population is 6,101.9/sq. km and 99.1/sq. km; and in Chachoengsao Province, 2,312.6/sq. km and 83.9/sq. km. The extremely high density of population in Rayong Province stands out.

Table 1.3–3 shows the rate of population growth and the migration rate in Eastern Seaboard from 1970 to 1981. In Chachoengsao Province, the annual growth rate was 2.0 percent in the 10 years between 1970 and 1981; in Chonburi Province, 2.5 percent; and in Rayong Province, 2.8 percent. The migration rates in Chachoengsao Province were –0.7 percent from 1970 to 1975, and 0.3 percent from 1975 to 1981. Likewise in Chonburi Province the rates were 0.7 percent and 0.0 percent and in Rayong Province, 1.4 percent and 0.1 percent.

Fig. 1.3-2 shows distributions of population in 1970 and 1980 for each District and Urban Center.

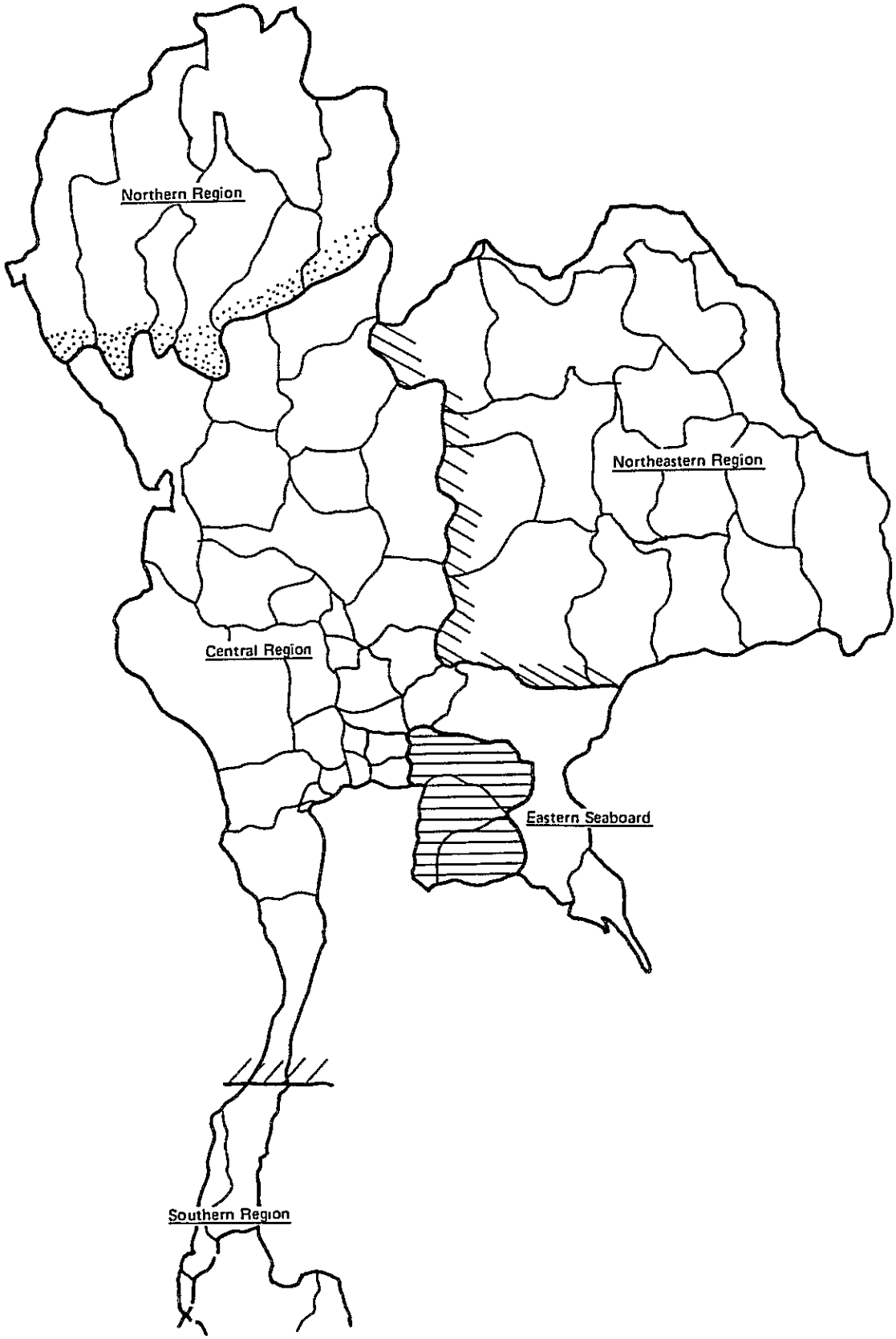


Fig. 1.3-1 Location of Region

Table 1.3-1 The Population on Eastern Seaboard

(31st Dec. '81)

Provinces		Population			Sex Ratio	Household Size	Density (Person per 1 km²)
		Total	Male	Female			
Whole Kingdom		47,875,002			101.1	6.2	92.9
East Region		2,944,955	1,499,443	1,445,512	103.7	6.2	81.1
Chanthaburi	Total	340,341	172,522	167,819	102.8	6.2	56.2
	Muni	48,583	24,247	24,336	99.6	5.8	1,361.6
	Non-Muni	291,758	148,275	143,483	103.3	6.3	48.5
Chonburi	Total	738.221	384,492	353,729	108.7	6.6	164.6
	Muni	122,392	61,702	60,690	101.7	5.3	3,645.9
	Non-Muni	615,829	322,790	293,039	110.2	7.0	138.4
Rayong	Total	377,063	193,614	183,449	105.5	6.0	114.0
	Muni	50,158	25,576	24,582	104.0	5.4	6,101.9
	Non-Muni	326,905	168,038	158,867	105.8	6.1	99.1
Cha-choengsao	Total	498,092	247,278	250,814	98.6	6.1	91.9
	Muni	44,610	22,353	22,257	100.4	5.3	2,312.6
	Non-Muni	453,482	224,925	228,557	98.4	6.2	83.9
Trat	Total	140,288	72,078	68,210	105.7	5.6	49.8
	Muni	13,049	6,556	6,493	101.0	4.7	5,178.2
	Non-Muni	127,239	65,522	61,717	106.2	5.7	45.2
Prachiaburi	Total	648,585	329,065	319,520	103.0	6.2	55.0
	Muni	39,463	19,901	19,562	101.7	4.8	2,246.0
	Non-Muni	609,122	309,164	299,958	103.1	6.3	51.7
Nakomnayok	Total	202,365	100,394	101,971	98.5	5.9	83.8
	Muni	9,968	4,954	5,014	98.8	5.3	2,957.9
	Non-Muni	192,397	95,440	96,957	98.4	6.0	79.8

Source: Population Data 1970-1981 Series II
Population Planning Section, PMD, NESDB

Table 1.3-2 Urban Population on Eastern Seaboard (1975–1981)

Province	Population		Average Growth Rate % (1975–1981)
	1975	1981	
1. Chachoengsao	61,000	69,200	2.1
· Chachoengsao Municipality	(30,700)	(36,000)	(2.7)
2. Chonburi	234,200	272,600	2.6
· Chonburi Municipality	(83,200)	(92,500)	(1.8)
· Phanatni Khom Municipality	(13,000)	(13,500)	(0.6)
· Siracha Municipality	(17,000)	(19,500)	(2.3)
· Pattaya Municipality	(24,700)	(36,500)	(6.7)
3. Rayong	82,300	90,000	1.1
· Rayong Municipality	(32,500)	(37,300)	(2.3)
· Tang Khwien Municipality	(11,600)	(14,700)	(4.1)
· Map Ta Phut	(11,500)	(7,400)	(–7.0)
Eastern Seaboard Urban Total	377,500	431,800	2.3

Source: ESS'

Table 1.3-3 Growth and Migration Rates in the Eastern Seaboard 1970–1981.

Area	AGR			Migration rates		Comments
	1970-'75	1975-'81	1970-'81	1970-'75	1975-'81	
CHACHOENGSAO PROVINCE:						
Chachoengsao District	0.5	0.5	0.5	-1.8	-1.5	Densely populated rice area
Bang Khla District[c]	1.7	1.8	1.8	-0.6	-0.2	
Phanomsarakham District[c]	2.3	2.0	2.2	0.0	0.0	
Ban Pho District	0.2	3.5	2.0	-2.1[a]	1.5[a]	Densely populated rice area
Bang Nam Prieo District	0.7	1.1	0.9	-0.6	-0.9	Densely populated rice area
Bang Pakong District	1.0	1.2	1.1	-1.3	-0.8	Densely populated rice area
Sanamchaikhet Subdistrict	9.1	11.2	10.2	6.8	9.2	Rapid settlement and deforestation
Chachoengsao Municipality[b]	4.0	2.7	3.3	1.7	0.7	
g Khla Municipality	0.7	0.8	0.8	-0.6	-0.2	
Chachoengsao Province total	1.5	2.3	2.0	-0.7	0.3	
CHONBURI PROVINCE:						
Chonburi District	3.3	2.1	2.7	1.0	0.1	
Phanatnikhom District	3.8	2.5	3.1	1.5	0.5	Bo Thong Sub-district expanding rapidly
Siracha District	2.9	1.4	2.1	0.6	-0.6	
Ko Si Chang Subdistrict	-1.9	3.8	1.2	-4.2[a]	1.8[a]	
Phan Thong District	1.6	1.4	1.5	-0.7	-0.6	Densely populated rice area
Ban Bung District[c]	1.8	1.8	1.8	-0.5	-0.2	
Bang Lamung District[c]	3.4	2.5	2.7	1.1	0.5	Incl. Pattaya immig. continues due to tourism
Sattahip District	4.4	2.8	3.6	2.1.	0.8	Large navy base
Chonburi Municipality	1.4	0.8	1.1	-0.9	-1.2	Expansion constrained by municipality limits
Phanatnikhom Municipality	0.9	1.0	1.0	-1.6	-1.0	
Siracha Municipality	2.4	3.5	2.9	0.1	1.5	Recent rapid expansion
Chonburi Province total	3.0	2.0	2.5	0.7	0.0	
RAYONG PROVINCE:						
Rayong District[c]	3.1	1.6	2.3	0.8	-0.4	
Klaeng District[c]	3.0	2.4	2.7	0.7	0.4	Wang Chan expanding rapidly
Ban Khai District	2.5	1.1	1.8	0.2	-0.9	Pluak Daeng Sub-district expanding rapidly
Rayong Municipality[b]	4.0	3.5	3.7	1.7	1.5	
Rayong Province total	3.7	2.1	2.8	1.4	0.1	

a Irregular result
b Growth rates probably unreliable due to boundary changes.
c Including associated subdistricts as bracketed in Table 2.1.
Source ESS

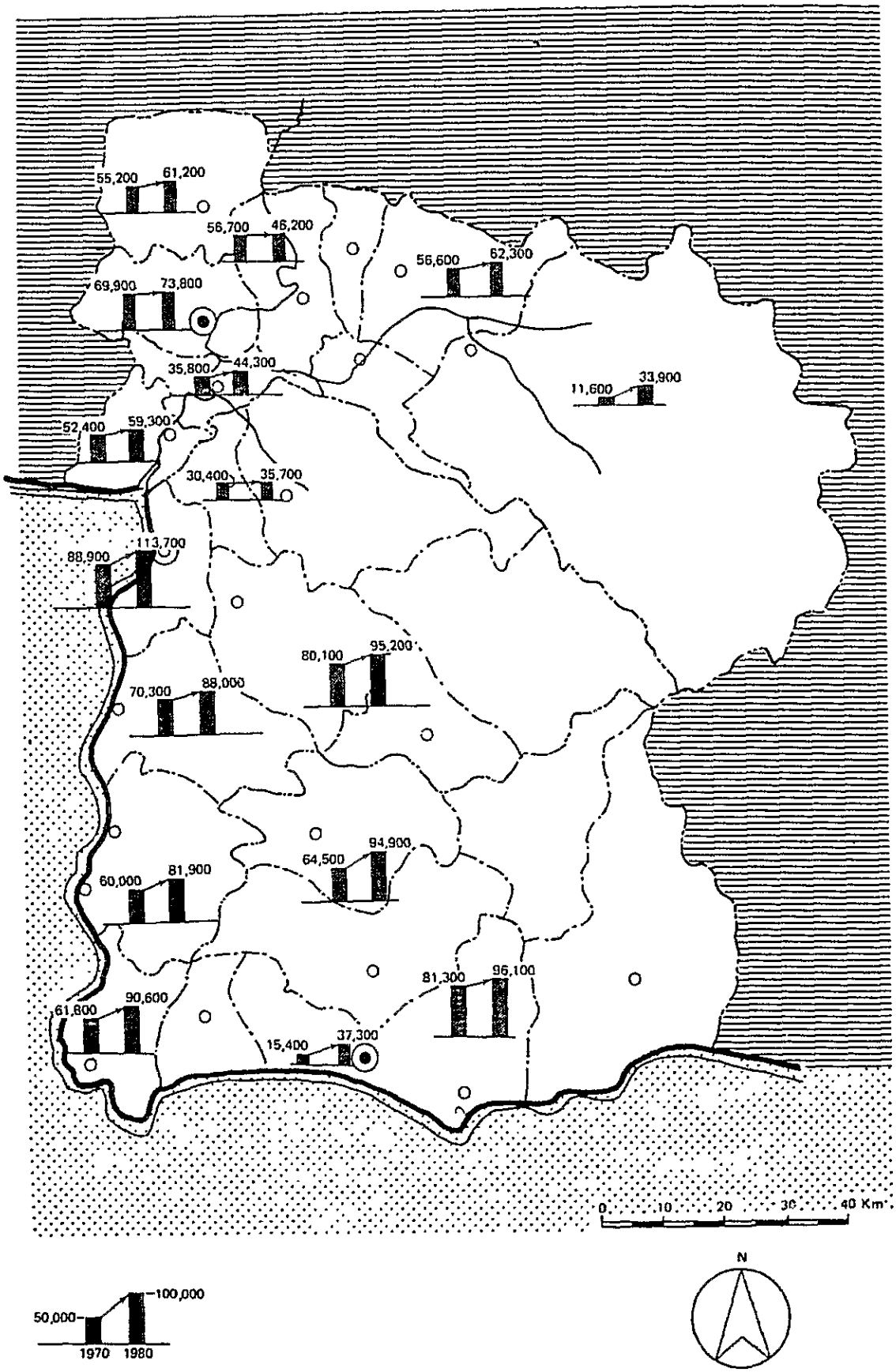


Fig. 1.3-2 Population Growth Distributions

1.4 Transport Network

1.4.1 Road

(1) General

The regional road network includes National and Provincial Highways. The road network has been lengthed and widened during the past 10 – 15 years.

The Sukhumbit Highway (Route 34 – Route 3) is the main access road to the Eastern Seaboard and Route 304 is open as a trunk road to Bangkok, Chachoengsao and Northeast Thailand.

The following roads are being considered for future expansion:

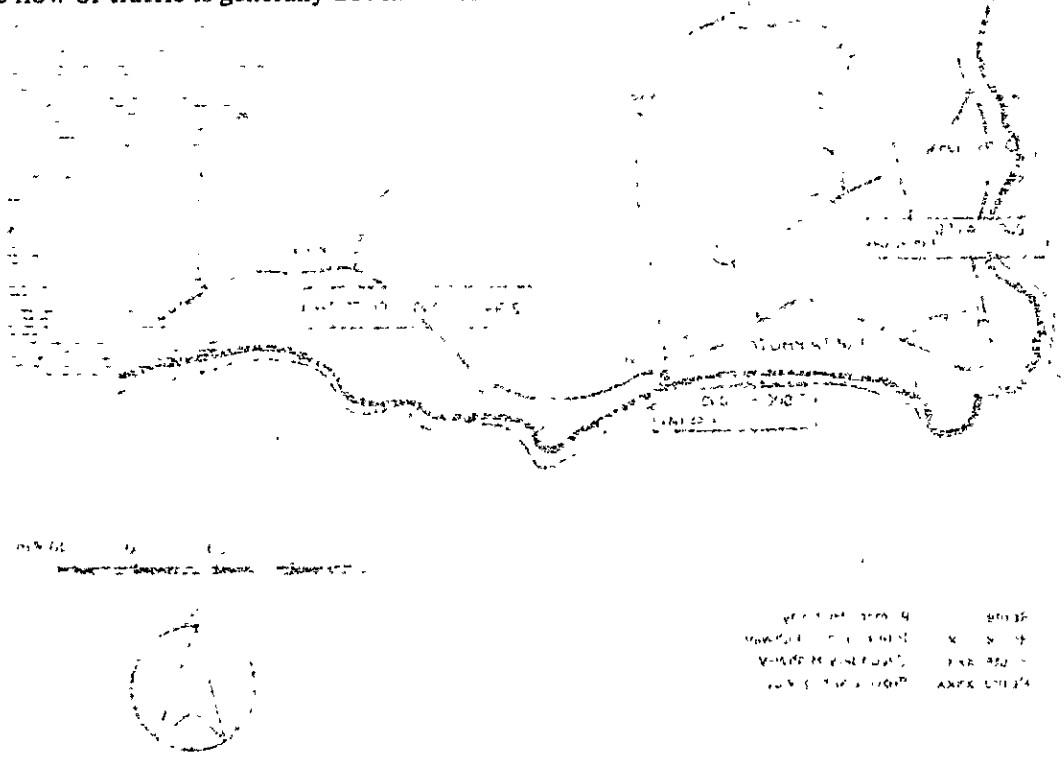
a. Expansion between Chonburi – Ban Bung – Phanat Nikhom
b. Expansion construction inland from Sattahip to Route 331,
c. Expansion plans for Route 36 (Pattaya – Rayong) and Route 344 (Ban Bung – Klaeng)

(2) Traffic Volume and Flow

The daily average traffic volume in 1981, according to the Eastern Seaboard Study – Interim Report by Coopers & Laybrand associates, is shown in Fig. 1.4-1.

The densest flow, ranging from about 20,000 – 25,000 vehicles a day (round trip), occurs northward between Siracha and Bangkok.

Route 3, south of Siracha to Pattaya, handles 8,000–10,000 vehicles a day and further south (Pattaya – Sattahip) 2,000 – 4,000 vehicles a day. Between Sattahip and Rayong the daily volume is 3,000 – 6,000 vehicles, and further east the figure drops to 2,500 – 3,000 vehicles. The flow of traffic is generally Southeast to Northwest.



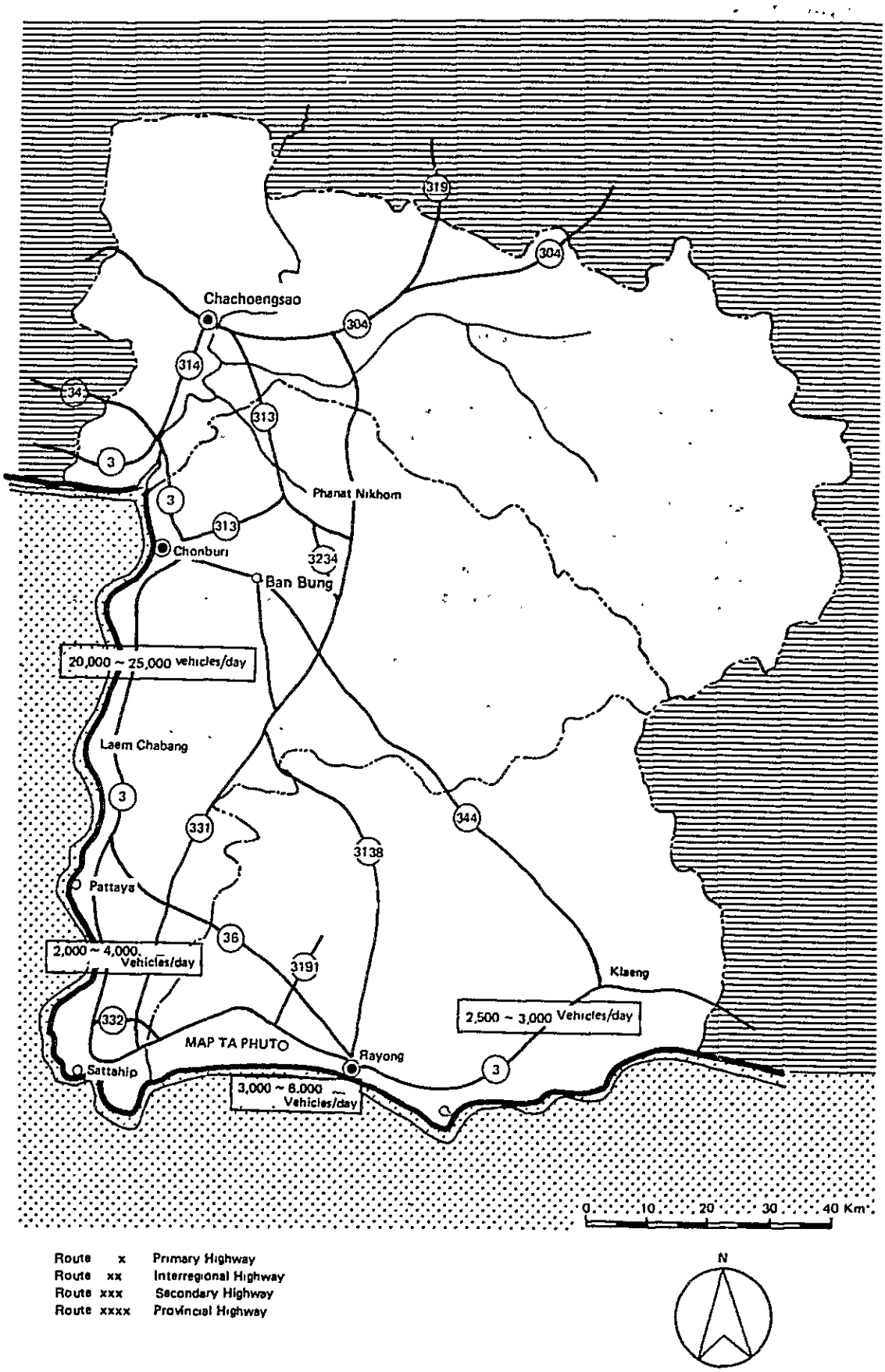


Fig. 1.4-1 Road Network

1.4.2 Railway

(1) The Existing Eastern Line

The present railway system in the northern areas of the Eastern Seaboard is called the Eastern line. The line extends from Bangkok, east for 60 km, to Chachoengsao, and further north to Prachanburi. The railway travels 225 km from Bangkok to Cambodia.

The Eastern line is a single track and the average traffic between Chachengsao and Bangkok is 11 runs/eastward per day.

(2) The Chachoengsao – Sattahip Rail Link

A new railway, stretching 143 km from Chachoengsao to Sattahip, is set for completion in 1984.

The outline of the plan is as follows:

- Single track
- 9 stations
- Design speed: 100 km/h
- Load between the axles: 20t.

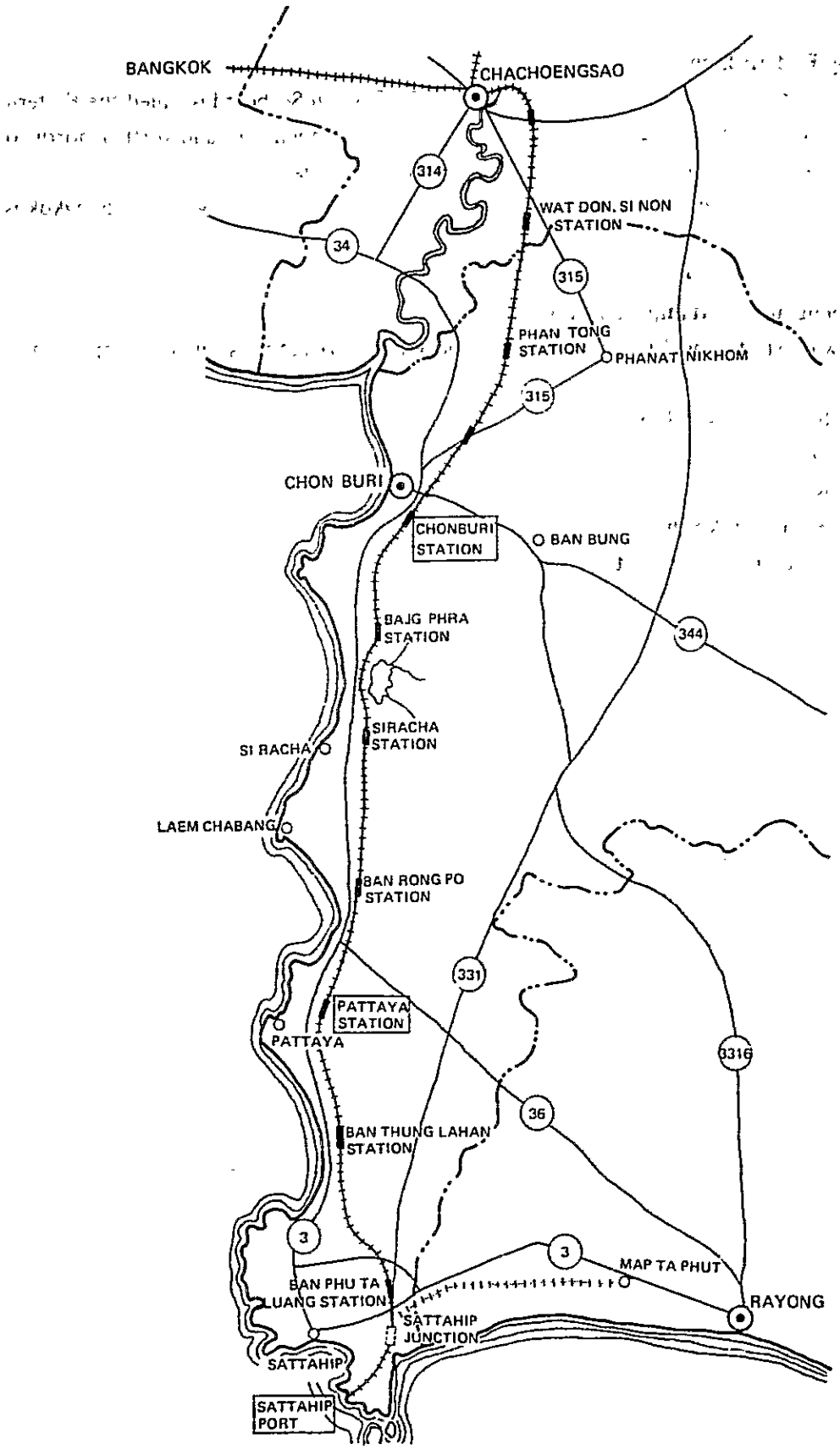


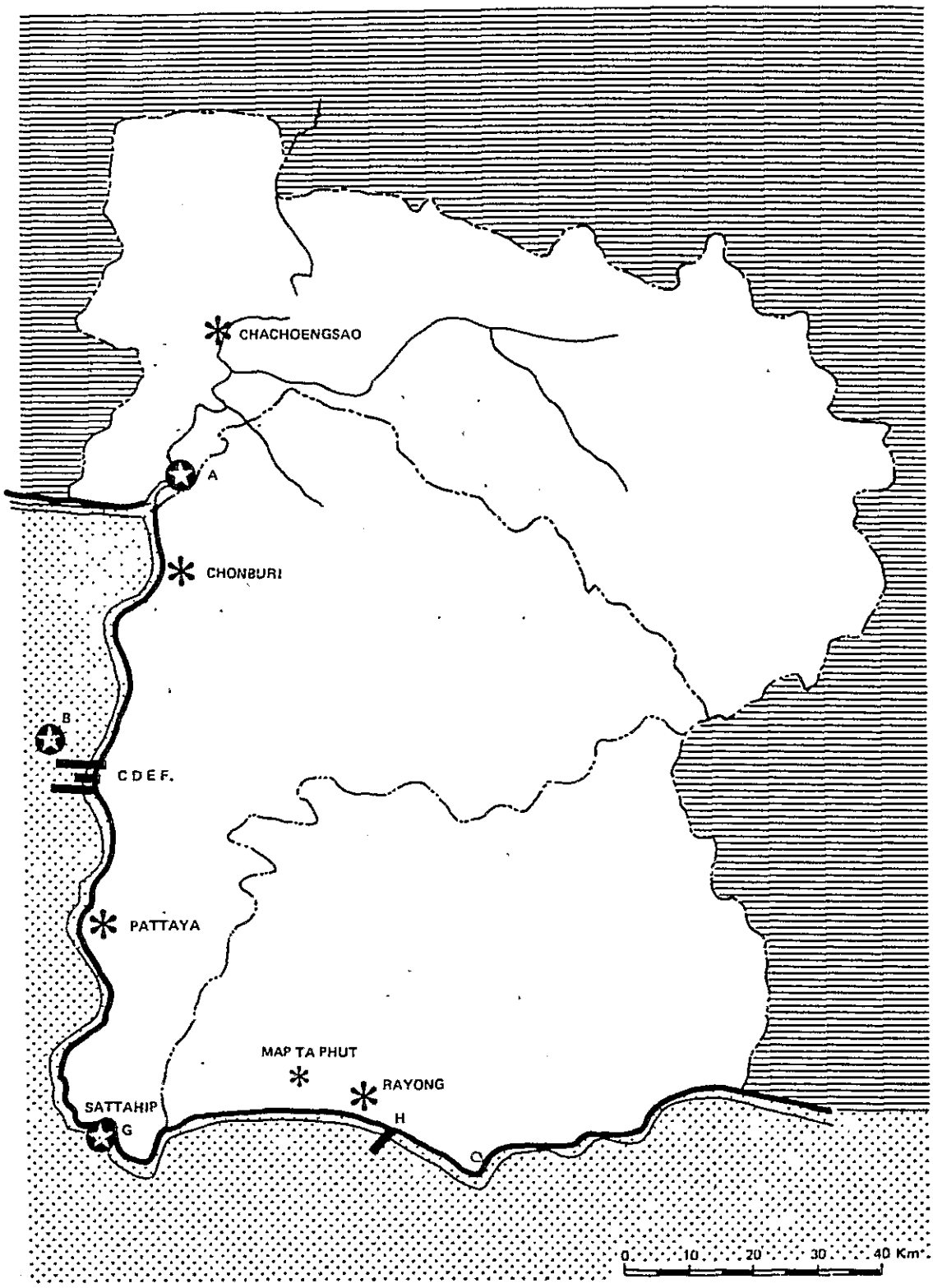
Fig. 1.4-2 Railways

1.4.3 Port Facilities

In the Eastern Seaboard, Commercial Port Facilities are found in the locations shown in Fig. 1.4-3. The facilities are described in the table below.

Table 1.4-1 Commercial Port Facilities

Name of Location	Contents of Facilities
A. An extensive area of lighterage facilities on the Bang Pa Kong River	o Loading facilities for tapioca o Berthing capability for a 100–300t selfpropelled steel barge o Berths for traditionally towed barges of 50–150t (for loading tapioca and transporting it to Siracha).
B. Off Sichang Island deepwater anchorage	o Anchorage area for large freighters which cannot be berthed at the Port of Bangkok. o Cargo handling capability of about 4.5 million tons/yr (mostly tapioca) o Anchorage area for ocean-going vessels of 180–200,000 dwt. o 4 mechanical loading towers with a loading rate of 14–17,000 tons/day. o Full loading capacity, of 3.0–3.5 million tons per year. o Loading capacity from lighters to large vessels of 7,000 tons/day. (Using ship gear of large vessels)
C. The Mah and Boonkrong Tapioca Jetty	o Cargo handling capability of 1.2 million tons/yr o Silo with 100,000 tons of storage capacity o Jetty with a 3,000 m extension for berthing vessels of 120,000 dwt. o Loading rate of 14,000 tons/day (24 hours working)
D. The deepwater oil Terminals	o ESSO and TORC oil refineries' oil receiving terminals 1.0–1.5 km off the coast (buoy mooring type). o Mooring capacity of 100,000 dwt or 80,000 dwt.
E. The oil product jetties	o Jetties for products of the above refineries. o Small coastal tankers used for transporting oil to Southern Thailand. o Barges of around 2,000 dwt used to transport oil to Bangkok
F. The Udom Bay Tapioca Jetty	o Small lighterage jetty under construction for the past several years.
G. The Sattahip Commercial Port	o Water depth of navigable waterways: −11.0 m; Width of waterway: 150 m; water depth at the largest berthing facilities: −11.0 m; port which can berth 20,000 maximum dwt vessels. o Port built by American Navy for military purposes o (Presently controlled by P.A.T.)
H. The Rayong Ethylene Jetty	o Thai Petrochemical Industries jetty; 1,000 m long for vessels of 12,000 dwt. o Handling capacity for import cargo of bulk liquid ethylene of 130,000 tons/yr.



A An extensive area of lighterage facilities
B. Siracha Deepwater Anchorage
C. Tapioca Jetty (The Mah and Boonkrong Co.,Ltd.)
D. Oil Terminals
E. Oil Product Jetty
F. Tapioca Jetty (Ao Udom)
G. Sattahip Commercial Port
H. The Ethylene Jetty

Fig. 1.4-3 Port and Port Facilities

1.5 Urban Infrastructure

1.5.1 Water supply

There are 6 reservoirs in the Eastern Seaboard and Nong Kho Reservoir is presently under construction. Effective water storage volume and water collection area are given below.

Name of Reservior	Catchment Area	Effective Water Storage Volume
Bang Phra	130 km^2	110^6 x $10^6 m^3$
Mab Prachau	37	15
Dok Krai	291	50.8
Phu Ta Luang	–	2.3
Klong Bang Phai	113	12
Nong Kho	51	19

In Rayong area, water is supplied via pipeline from the pumping station at the Rayong River to 47% of the population.

Presently there are two filtration plants but the water supply is not sufficient.

Where there is no pipeline, wells and storage tanks are used.

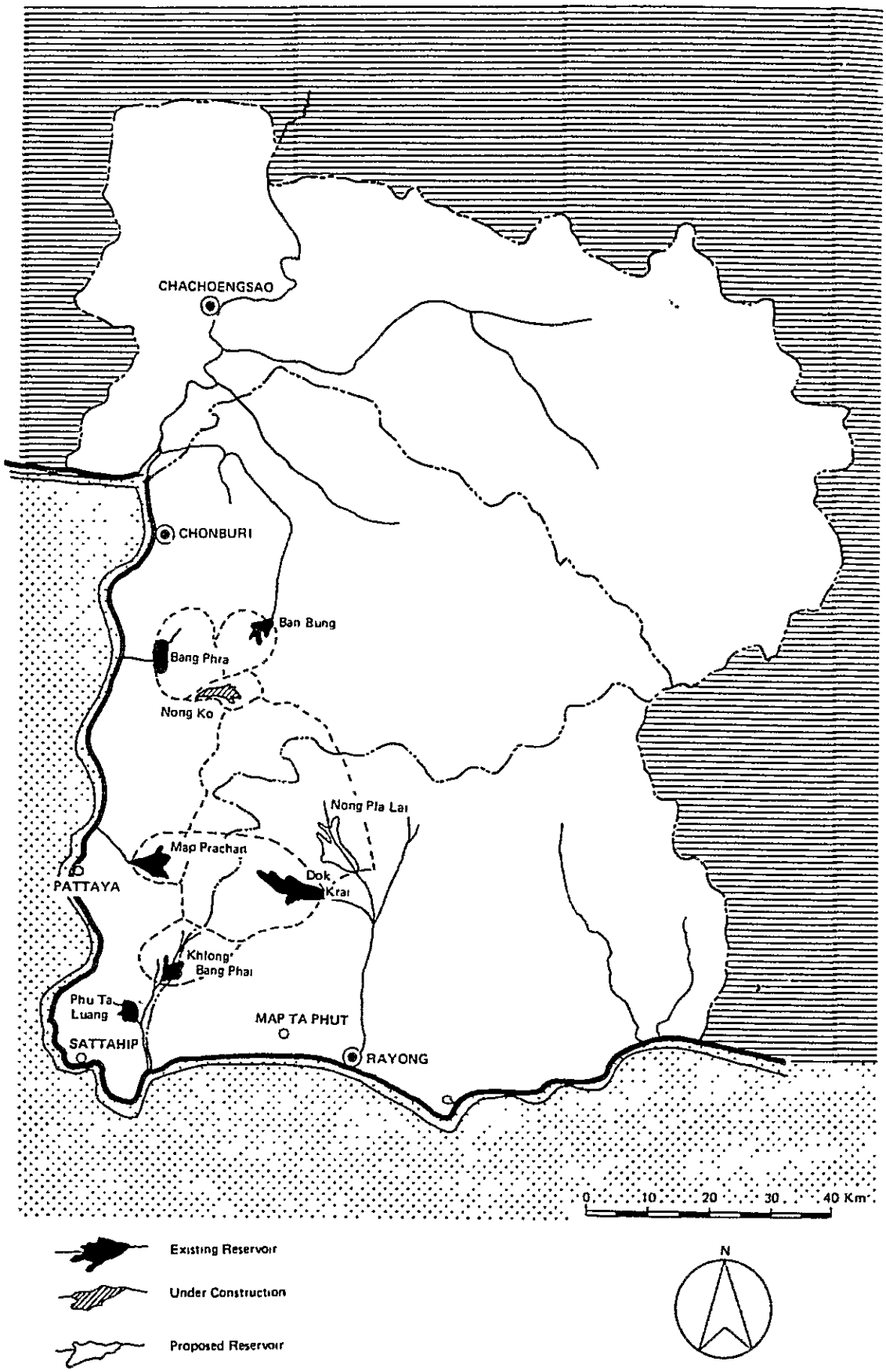


Fig. 1.5-1 Location of Reservoirs

1.5.2 Power Supply

Power supply to the Rayong area is provided by a 115 kv line from Sattahip and distributed by a substation at Rayong.

Also, a new transmission line of 230 kv is to be constructed from Udom bay and a transformer substation of 230/115 kv will be built in Rayong.

1.5.3 Drainage and Flood Control

The Rayong River lies in the west and the north of the Rayong area. Its tributaries are the Nong Pla Lai, Dok Krai and Khlong Tub Ma Rivers. Rayong's municipal district experienced serious flooding in the past but the problems have been solved by a tributary on the east side of the city and a water gate.

1.5.4 Sewerage and Sewage Disposal

As in other towns of Thailand, sewerage and sewage disposal systems are not complete. This is especially true of storm water and sewerage systems, which use a common flow system.

1.5.5 Telecommunications

Telecommunications systems in Rayong area are not sufficient to meet the present demand.

The Telephone Organization of Thailand plans to install a new exchange at Map Ta Phut in 1985.

1.6 Present Economical and Industrial Conditions

Economic and industrial accomplishment in Thailand has primarily developed from an agricultural base.

Meanwhile the government has aimed at promoting secondary industry as part of its national development policy. Particularly encouraging those secondary industries involved with checking imports or developing exports in order to elevate the overall industrial structure.

Also it has aimed at balancing unequal intraregional income differentials by decentralizing the high density municipalities and by developing regional economies. The objectives of this policy are:

(a) To improve the fragile economic structure of farming communities
(b) To improve the productivity of both agriculture and industry
(c) To promote economic development and maintain national security
(d) To improve the overall international balance of payments
(e) To achieve a balanced expansion of public services
(f) To achieve a growth rate of 6.6 percent of GDP

Following is an elaboration of these objectives:

1.6.1 Agriculture

Agriculture accounts for the greatest share in the economy of Thailand, 28 percent of GDP and 77.5 percent of the working population respectively.

Rice is the number one agricultural product, attaining an annual production of 20 million tons. It is also one of the largest export items. (Annual Japanese production is 12 million tons) Other main products include cassaba, rubber, corn, beans and sugar cane.

1.6.2 Manufacturing Industry

Industrial production accounts for 28 percent of GDP and 14.3 percent of working population. Its stunted growth rate thus far does not put it in a league with agriculture as a major controlling force in the economy.

Major industrial outputs breakdown as follows: food industry (20 percent), petroleum products (20 percent), textile industry (15 percent) and chemical industry (15 percent). The annual industrial output amounts to 160 billion Baht (1975).

In categorizing these industries according to municipal type, regional resource type, basic material type and high processing type, the resultant grid shows the regional resource type accounting for the greatest share and contrastedly the high technology processed type accounting for the least.

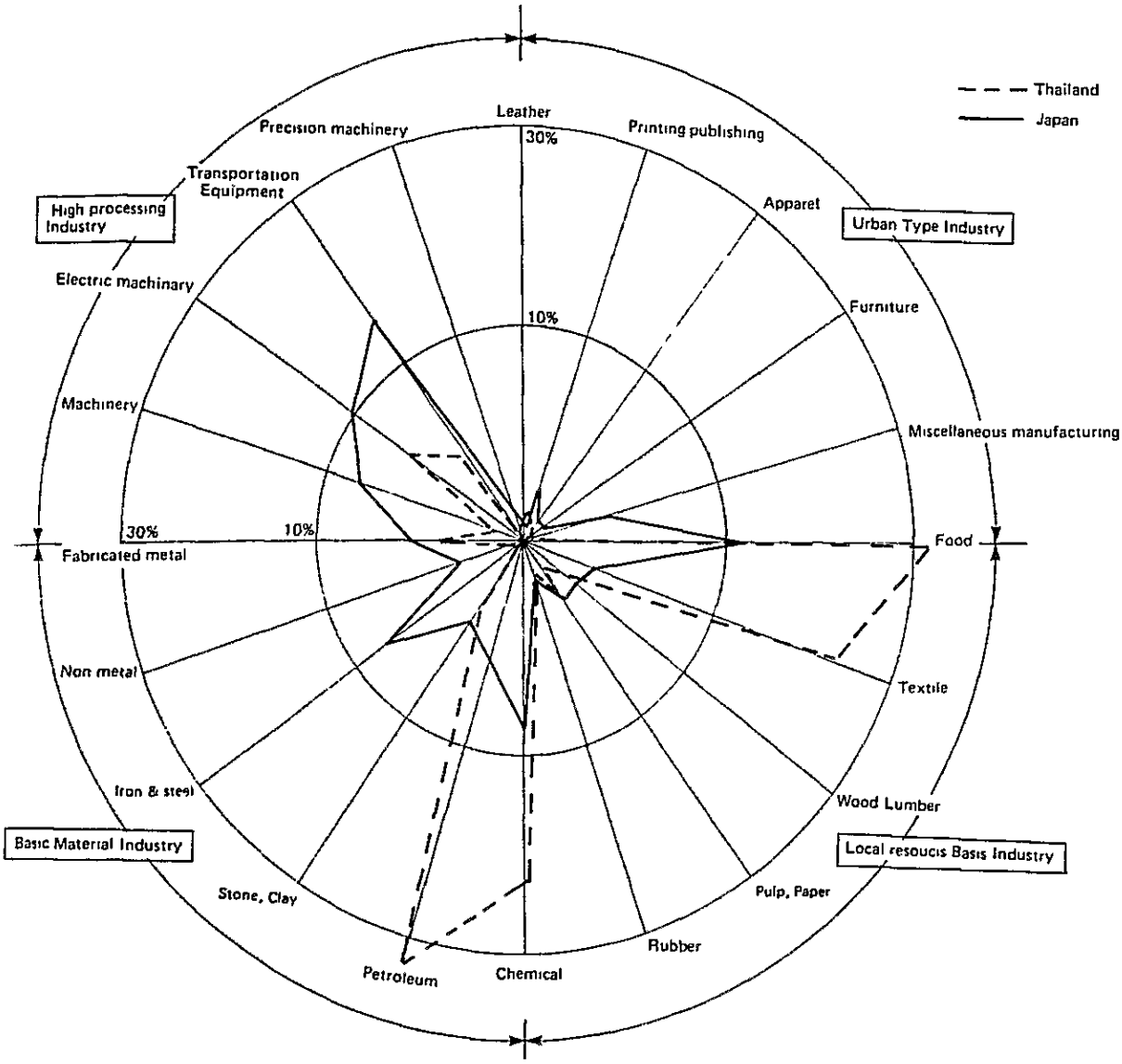


Fig. 1.6-1 Industrial Manufacturing Compornents.
Thailand & Japan (1975)

CHAPTER 2

DEVELOPMENT CONCEPTS OF NEW INDUSTRIAL PORT

CHAPTER 2 DEVELOPMENT CONCEPTS OF NEW INDUSTRIAL PORT

2.1 Allotment of Functions to the Ports

2.1.1 The Fifth National Economic and Social Development Plan

The basic concept for the development aims at "economic progress with national harmony". The six major national development objectives are:

(a) Restoration of the country's economy and finances
(b) Adjustment of the economic structure and improvement in production capabilities
(c) Development of the social structure and distribution of social services
(d) Poverty alleviation in backward areas
(e) Coordination of economic development with national security management
(f) Reformation of the National Development Administration System and deconcentration of land ownership

As one of the specific policies for "economic progress with national harmony", special areas have been designated for development in order to correct regional imbalances in economic development and limit the expansion of Bangkok.

(i) 3 provinces on the Eastern Seaboard
(ii) 8 Western provinces
(iii) The southern part of Northeastern Thailand
(iv) 3 provinces of North Thailand
(v) The boundary zone in South Thailand
(vi) Local core cities and the outskirts of Bangkok

2.1.2 Development of the Eastern Seaboard

On August 5, 1982, Dr. Phisit Pakkasem, Assist. Secretary General, NESDB; Director of the Eastern Seaboard Study Project submitted a report on "National Policy Objectives for the Development of the Eastern Seaboard" at the Pattaya Conference.

The development program for the Eastern Seaboard through the year 2001 is given below.

(1) Industrial Growth

Six zones on the Eastern Seaboard have been selected as development zones. Development targets for each are:

(a) Leam Chabang Zone ..... Export processing and light industries
(b) Map Ta Phut Zone ..... Heavy and petrochemical (polluting) industries
(c) Sattahip Zone ..... Ship repair, ship building and transhipment industries
(d) Chonburi Zone..... Urban service industries
(e) Rayong Zone ..... Agri-industry, especially fishery and rubber-related industries
(f) Chachoengsao Zone ..... Agri-industry, especially livestock and meat-packing

(2) Tourism Industry

The tourism industry maintains a high position in Thailand's economy. Foreign currency

revenue from tourism is second only to rice. 25 percent of that foreign currency revenue comes from the Eastern Seaboard.

The annual number of tourists along the Eastern Seaboard is expected to reach 3,000,000 by year 2001 up from 780,000 in 1981. The tourism industry is planning diversification into the East and Southeast Asian markets, aside from the prevalent European and American markets.

The subject areas are Pattaya & its offshore island, Bang Saen & Kbao Khiew National Parks, and Ban Phe.

(3) Urban Growth

Areas where urban growth needs to be promoted and facilities need expansion are Chonburi, Siracha-Laem Chabang, Pattaya, Sattahip, Map Ta Phut-Rayong, Ban Phe and Chachoengsao. Priority will be given to Chonburi and Pattaya.

Decentralization of the Bangkok metropolitan area will be achieved in 3 stages.

First Phase . . . . . Development of "outer Bangkok" mainly along the national highways, which is currently taking place.

Second Phase . . . . Development of the Eastern Seaboard, in a multicentered pattern with two new towns at Map Ta Phut and Laem Chabang, together with development in existing towns.

Third Phase . . . . . As soon as Eastern Seaboard urbanization has achieved selfsustaining growth, secondary cities in other regions will assume their roles in the decentralization process.

(4) Transport Development

In order to facilitate industrial growth and find practical ways to urbanize the Eastern Seaboard, the timing and scale of the construction of transport facilities are vital. Particularly the construction of deepwater ports and railway links, as they serve a number of heavy industrial projects.

(a) Ports

The decision on the two deepwater ports (Sattahip and Laem Chabang) will have a major effect on the future economic development of the Eastern Seaboard. The development of the ports should fulfil three important criteria:

- Minimization of total transport costs
- A base for long-term development
- Facilitation of industrial growth

(b) Railways

The Chachoengsao – Sattahip line is under construction and scheduled for completion in 1984. Additional rail links will be the Laem Chabang spur, Sattahip-Map Ta Phut spur, and a link from the Eastern Seaboard to the Northeast. The phasing of the links will depend on the progress of industrial development.

(c) Roads

The existing network is good for another 20 years. Development of the two deepwater ports will generate only limited road traffic. An inter-urban road link is necessary for inter regional access and local road bottlenecks need to be widened.

(d) Airport

A proposed second international airport at Nong Ngo Hao will have the greatest impact on the Eastern Seaboard both in terms of local accesibility and attraction for industry.

2.1.3 Allotment of Functions to the Ports

Thailand's port facilities are concentrated in Bangkok for the following reasons:

(i) More than 11 percent of the total population lives in Bangkok-Thonburi.

(ii) Secondary and tertiary industries are concentrated in the Bangkok Metropolis.

(iii) The land transport route and water way network radiate from Bangkok to the hinterland in various districts.

For this reason, the importance of Klong Toei Port remains. But, because it is as river port, maintenance dredging is inevitable. Also, the further deepening of the channel and depth maintenance in the Chao Phraya River, which enables large ship traffic, will require considerable expenditure which is not justified at this time.

The necessity of the deep sea port has long been acknowledged. Laem Chabang and Sattahip were studied as potential port sites.

Laem Chabang is located 130 km from Bangkok, near Pattaya. Natural geographic conditions on this seashore are quite suitable for a deep sea port. The port construction plan has been studied for more than 10 years and the procurement of the adjacent coastal land has been almost completed.

In Sattahip, port facilities initially constructed by the U.S. Navy, are now used for public purposes. This port is also being studied for a main deep sea port because of its low additional cost for expansion.

Recently natural gas produced in the Gulf of Siam has been transported by submerged pipeline to the Rayong area to be utilized in an electric power plant. Construction has begun on a gas separation plant in order to draw gas-based industry to the area. The Royal Thai Government expects the heavy industries to form a foundation for growth on the Eastern Seaboard. Initially, the Sattahip port was considered to best serve this industrial complex. But the long distance between the port and the industrial complex, and the spatial limits for expansion in Sattahip Port were assessed crucial by some people. The necessity of port facilities in front of the industrial complex was deemed important.

The most important issue for the Royal Thai Government is the synchronization of the phase construction plan for these three ports with the total development of the Eastern Seaboard.

(1) Laem Chabang Port

The Laem Chabang Port is planned to accommodate ships which can not be accommodated in Klong Toei, such as the large container ships and bulk carriers importing raw materials for industries. The functions of the Laem Chabang Port are;

(i) To provide relief for the Klong Toei Port, especially for general and containerized cargoes

(ii) To serve the light and export-oriented industrial complex adjacent to the port

(iii) To serve urbanization in the hinterland area beyond Bangkok

(2) Rayong Port

The Rayong Port is planned as an industrial port, to support a heavy-chemical industrial complex in the adjacent area. It is not practical, because of the geographical location, to allocate to Rayong Port the functions described for Laem Chabang.

Leam Chabang and Rayong Ports should be studied independently as two ports with different characteristics.

(3) Sattahip Port

The function of the Sattahip Port had best be reconsidered after the determination of the roles of the two ports, because it function will be closely interrelated to the above two ports.

2.2 Basic Concepts for the Development of the New Industrial Port

2.2.1 Function and Utility of a Port

The role of ports can be summarized into the following two categories:

(i) As a nodal point between land and marine transportation systems

(ii) As a base for industrial development

Ports are rarely limited to one function but, in fact, serve many, and are characterized respectively according to the extent of these functions.

Many European and American ports fit in the role of the above-mentioned nodal point. Because population is concentrated in the abundant inland plains on these continents, ports are constructed where natural conditions are good and where they can be easily linked to inland cities by roads, railways, canals, etc. The road, railway, and water surface transportation systems are operated by a self-supporting accounting system, collecting revenue from cargoes carrying by these modes.

Port facilities in these countries are managed and operated in the same manner.

In an economy based on the cycle of raw material importation, manufacturing, and exportation, key policies include the improvement of industries and the acceleration of trade. In most cases, port facility improvement, necessary in supporting these economic activities, is financed by the public section.

Since Japan is completely surrounded by seas, and the few plains that do exist are mostly found near the coast, the population is most dense in the coastal areas. For this reason, many people, regard ports as indispensable for the transportation of goods necessary for their daily lives. This makes it easy for the government to allocate public funds for improving port facilities.

The basic concept that the public sector provide funds for the improvement of port facilities before there is need applies even if the port is used exclusively by private companies.

Japan's rapid economic growth since around 1955 can be attributed to the rapid growth of secondary industries. Chemical and heavy industries such as steel and petrochemicals have played an important role.

Chemical and heavy industries are mainly situated along the coast for the following reasons:

(i) Most raw materials are imported;

(ii) Marine transportation charges are relatively cheap for long hauls;

(iii) Land reclaimed with dredged materials during port construction forms a good industrial base and is inexpensively available.

The definition of the industrial port is that which supports the activities of coastal industries. In Japan, these ports have been developed by local public sectors under the guidance and financial assistance of the central government.

Sometimes less port revenue is generated than is needed to pay for the cost of port construction or even maintenance and management. However, the port encourages new industry, bringing regional economic growth. Long term economic benefits, like the establishment of industrial enterprise, more than makes up for construction costs.

Not only in Japan, but in Singapore, Korea, Taiwan, and the Philippines, the public sector provides funding for the development of industrial ports in order to attract new industries. The New Industrial Port at Rayong, then, should be constructed following two basic concepts;

2.2.2 Full support from the public sector

The principal purpose of the development of the New Industrial Port is to support the various industries to be located in the Map Ta Phut Industrial Complex adjacent to the port.

Port facility use, which may differ by industry, is classified as follows:

(i) Facilities used exclusively by one company

(ii) Facilities shared by certain specific companies

(iii) Facilities used commonly by various companies

In developing a port, the crucial question is always who will bear the cost.

Generally, the company that intends to use the facility must pay for it. In Thailand, for example, facilities were developed by specific users such as cement factories, petrochemical factories and tapioca exporters. Though private companies had only to construct a wharf or jetty required to handle cargoes, quite few of them constructed breakwaters, channels, basins, etc. This "benefit principle" seems common in port facilities.

On the other hand, new ports require new rules, ie; the development of a new port in Rayong has to be considered as an incentive to regional industry. The port must be recognized as a basic infrastructure in the same way, roads, water supply and electricity are.

The New Industrial Port should be constructed under the strong guidance and full support of the public sector. The port will be used exclusively by the industries located in the industrial complex, but the cost of the port facilities should not be borne by those industries in proportion to their usage without thinking of the limitations of their competitive economic forces.

Economic and social impact generated by the establishment of an industrial complex will be so profound and long-lived, that an economic evaluation of port development should be examined from a national perspective.

2.2.3 Integration of heavy industries in the Map Ta Phut Industrial Complex

If heavy industries are integrated within one area, they will enjoy the following advantages:

(a) Shared use of railways, roads, ports, electricity and water supply system, etc.

(b) Easy and economical exchange of semi-products, raw materials, fuels etc., between industries, through connecting pipeline

(c) Use of waste heat or waste gas from neighboring industries

(d) Establishment of related/catering industries

Although the concentration of various industries will have a significant environmental impact, collaborative treatment for industrial discharge can be done at a low cost.

Worldwide industrial production is largely dominated by the advanced nations. Therefore, it is essential that Thailand strengthen its efforts to rationalize production in order to join the ranks of the newly industrialized countries and become a top competitor in the world market.

Decentralizing industry is integral in the advanced stages of a country's balanced development. But, in order to build the economic capability for such decentralization, industry must, at first, be integrated.

With this in mind, Thailand would do best to concentrate industry in the Map Ta Phut Industrial complex.

CHAPTER 3

INDUSTRIAL DEVELOPMENT PLAN

CHAPTER 3. INDUSTRIAL DEVELOPMENT PLAN

3.1 Necessities of Industrialization for Thailand

3.1.1 Direction of Industrialization

(1) Diversion from agriculture as the sole main industry

Agriculture is the primary industry in Thailand. With natural geographical advantages, it should continue to be developed in the future. However, agriculture is vulnerable to such unpredictable variables as weather, world market competition, and economic uphevals, consequently leaving the country's economy unstable.

Thus in order to counterbalance this vulnerability, it is necessary to develop secondary and tertitary industries less effected by such unpredictable variables.

(2) Improvement of trade balance

Most of energy resources and industrial raw materials are currently imported from foreign countries. Consequently Thailand's economy is heavily burdened by a trade defecit, that is only anticipated to increase in the future. In order to improve the balance of payments, exports must be promoted and specifically the industrialization for export will be crucial.

(3) Utilization of domestic resources

Presently the development of domestic resources is restricted to primary production either in the mineral realm such as natural gas, rock salt, pottasium and oil, or in the agricultural products such as cassaba, sugar cane, rubber, and coconut. It is recommendable to process these primary products into value-added manufactured products for export.

Under the foregoing circumstances, the government has recognized the necessity of promoting secondary industries under "The Fifth Five-Year National Economic and Social Development Plan".

An industrialization plan, incorporating the following promotional policies is advocated:

(a) Providing assistance to various industries with competitive powers for export
(b) Promoting import substitute industries to check imports
(c) Promoting decentralization of industries from large cities into regional area
(d) Promoting small and medium industries
(e) Converting industries the long energy efficient lines.

3.1.2 Advantages in Thailand for Industrialization

(1) Location

Thailand is geographically located in the center of Southeast Asia thereby occupying the strategic node point of east and west Asia.

Its location as a crossroads makes it a prime relay center for overland transportation with neighboring countries.

This strategic location, having the influence area of 3,000 km with consumer population of 2 billion, place Thailand at the crossroads of trade in Asia.

It is favorably located in terms of production, commerce and distribution of industrial products. However, in order to take advantage of this potential, the infrastructure to support industrial activities needs to be developed.

(2) Abundant work force

In the past 20 years, a doubling in population has created a reserve of youth within the work force.

Furthermore the demand for employment opportunities is expected to grow in future due to the promotion of education by government, transferred personnel from surplus agricultural industries, and the desire for increased income to keep pace with escalations in the standard of living.

Hence there already exists an available resevoir of personnel to supply the industrialization, which by its very nature will be self-generating in expanding the labor market.

(3) Prospective market

Along with the increases in income and higher standards of living, industrial development will demand considerable urbanization of the region and changes of personel living.

The considerable amount of investment will be necessary to facilitate the conversion of the main industries from an agricultural to manufacturing industry.

Increasing housing and public facilities will be required for the new urban population. Fundamental to the introduction of industry is the establishment of educational system to train professionals for these new technical fields.

These factors will give rise to big demand for consumer goods.

3.2 Industrial Development Plan in Map Ta Phut and Natural Gas-Based Industries

3.2.1 Introduction

The main objective of the study presented in this chapter is to review the recent progress in the development of several heavy industrial projects which are being undertaken under the Eastern Seaboard Development Program, to identify possible projects which would be attracted to the area of the proposed industrial estate in Map Ta Phut in consultation with various Thai authorities concerned, and to estimate fundamental technical requirements such as for raw materials, utilities, manpower, infrastructure, land and disposal of industrial wastes, etc., all of which are essential inputs for the planning of the proposed industrial estate in Map Ta Phut.

In accordance with the terms of reference, the study will be made on the basis of the following two different phases of development:

(a) First phase (short-term) development plan with the target year of 1987, and

(b) Second phase development plan (master plan) with the target year up to around 2000.

3.2.2 Industrial Development Plan and Its Background

The recent discovery and development of natural gas deposits in the Gulf of Thailand has created a strong impetus for the establishment of heavy industries that would be new both to the area of Map Ta Phut and the country as a whole.

At present, the industrial development is being promoted under the Fifth Economic and Social Development Plan (1981–1986) which aims at attaining, during this period, the following targets:

– Annual growth rate:

GDP (real),	6.6%
Manufacturing industry,	7.6%
Export oriented industry,	15%

– Contribution of manufacturing industry to GDP 21% in 1981 to 22.1% in 1986

It is therefore considered as one of the most fundamental tasks of this plan to promote the industrialization of the country's economic structure and to increase the share of industrial products in the exports from the country, so that Thailand could become one of the so-called new industrial countries in the near future. Another important task is the promotion of the diversification and decentralization of location of economic activities in the course of the achievement process to the country's heavy industrialization, which in other words, it is considered as one of the basic characteristics in the fifth plan, that the industrialization of Thai economy as a whole is closely linked to regional development and countermeasure for solving the problems of over-dense population in Bangkok.

Apparently, the Eastern Seaboard Development Program, more specifically, the establishment of heavy industries based on natural gas resources in the proposed industrial estate in Map Ta Phut, is the highlight of the Fifth Economic and Social Development Plan (1981– 986).

In this connection, a variety of studies have been conducted and a number of proposals have been presented to the Government of Thailand especially for those heavy industrial projects which utilize natural gas and/or natural gas fractions made available from the Gulf of Thailand,

among which are the gas separation, ammonia and urea, methanol, ethylene and its derivatives, soda ash and ammonium chloride, direct reduction steel and iron, LNG projects, and others.

3.2.3 Overview of Possible Projects in the Map Ta Phut Industrial Estate Based on Natural Gas

Within the Eastern Seaboard Development Program that is the key component of the Fifth Economic and Social Development Plan (1981–1986), Map Ta Phut area is nominated as for the industrial estate for the establishment of heavy industries based on natural gas resources, and related downstream and supporting industries.

In addition to the gas separation plant which is now under construction in the area, there are, at this moment, three on-going projects (under planning) that are fertilizer complex, a petrochemical complex and a soda ash plant.

The following is an overview of possible projects and utilizations which can be considered on the basis of the indigenous natural gas resources available in the country.

(1) Utilization of Natural Gas

Methane is the main component of natural gas, followed by ethane, propane, butane, and heavier hydrocarbon fractions. The content of acidic gas such as hydrogen sulfide, carbon dioxide, etc. varies greatly depending on the deposits.

Natural gas is often used as a fuel due to the following superior properties:

(a) It is a clean fuel, namely tar-free, smokeless, soot-free and ashless.

(b) It is generally low in sulfur.

(c) Since it is a gas, it is easy to handle and control.

(d) Its low corrosiveness leads to long equipment life and reduces maintenance to a minimum.

However, the most effective way of utilizing natural gas and making full use of its characteristics is not as a fuel but as an economical hydrocarbon source.

Typical projects utilizing natural gas and its derivative are shown in Figure 3.2-1.

(2) Natural Gas Used as Fuel

Natural gas is most commonly used as a fuel in private households, in commercial establishments and in industry.

(a) Household and Commercial Use

In cities like Bangkok where fuel oil and other forms of fuel are widely used, the introduction of a utility gas system will reduce the consumption of those fuels. In areas where coal or coke-derived gases have been used, it is also possible to replace these gases by natural gas. The construction of utility gas distribution system will decrease the consumption of higher-priced forms of energy and will benefit city residents.

In thinly inhabited areas, however, it is not feasible to establish a gas distribution system aimed only at households and commercial establishments.

(b) Industrial Use

Natural gas is an ideal fuel for industrial use because it has a high calorific value, does not pollute and is easy to handle.

The very low level of sulfur in natural gas is also greatly appreciated in most industries.

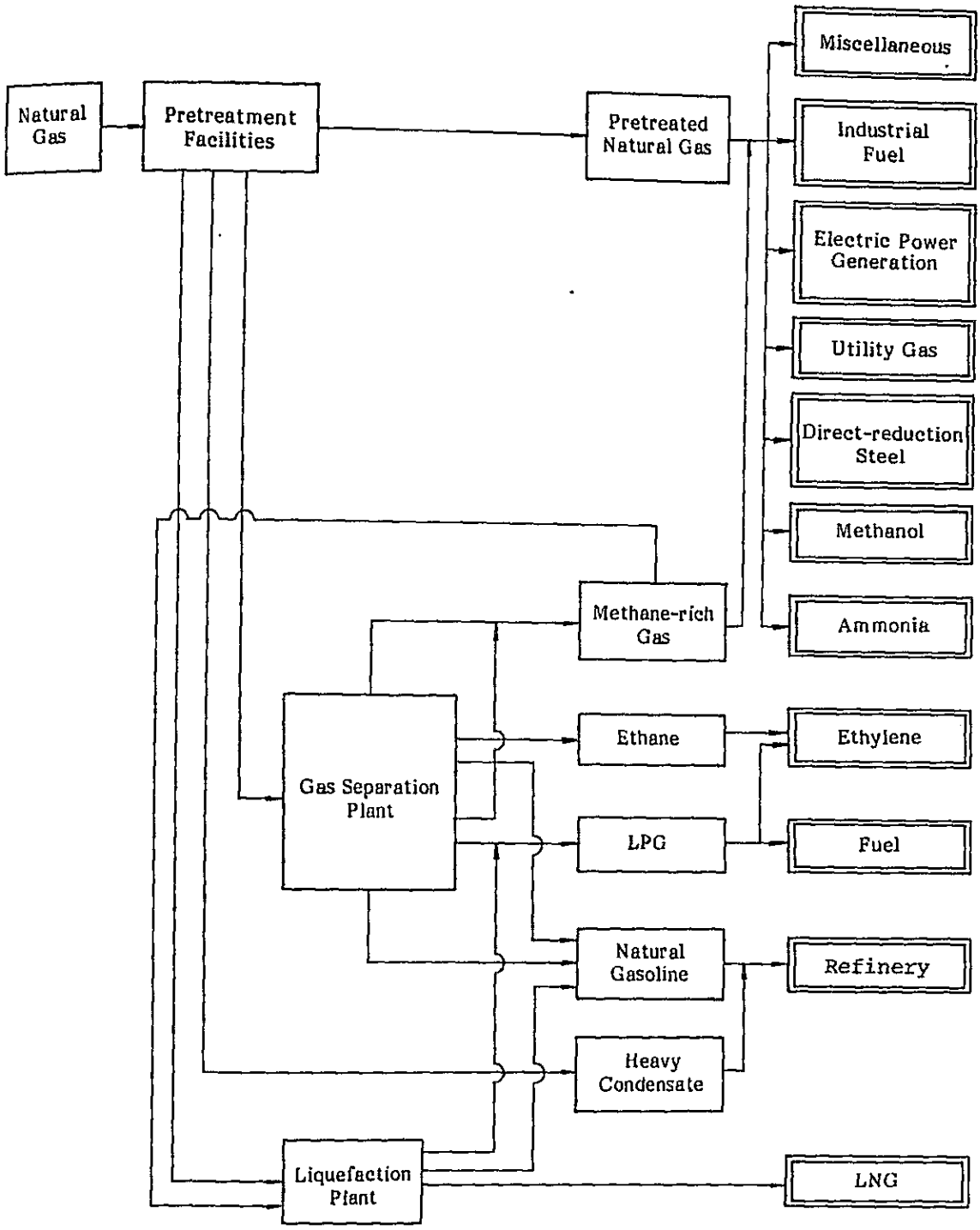


Fig. 3.2-1 Natural Gas Utilization

(i) Iron and steel

Natural gas is used as the reduction agent in direct reduction iron production. The advantages of the direct reduction process are summarized as follows:

- small initial investemnt and small additional investment required for expansion
- adaptability to small- and medium-scale plant (200,000 to 1,000,000 MT/Y)
- utilization of cheap, easily-handled reducing agent such as natural gas

(ii) Glass

In the galss industry, large amounts of heat are required, but the glass must be kept free from contamination by the products of combustion, and consequently, the use of natural gas can be advantageous in this industry.

(iii) Ceramics

The ceramics industry has increasingly been using natural gas because it is a clean fuel, an essential for ceramics manufacture.

(iv) Cement

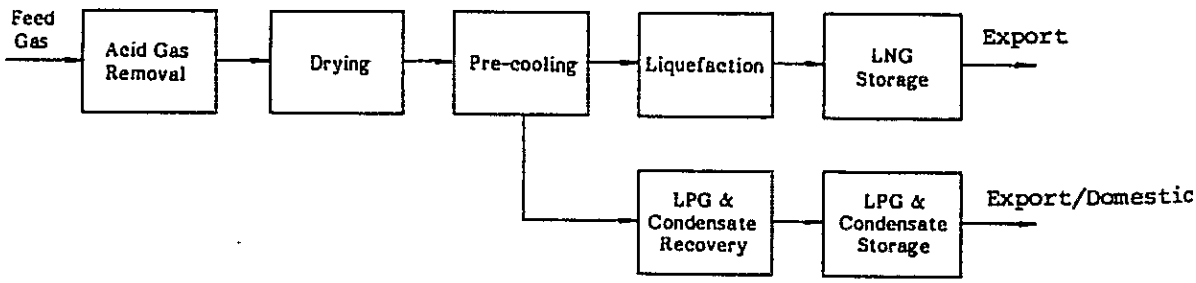
In the cement industry, the cost of fuel accounts for 25–40% of the total cost of the product, and consequently, a cheap, plentiful and easily-controlled energy source is required.

(3) Liquefied Natural Gas (LNG)

As natural gas is an ideal form of energy for many industries, the demand for natural gas in industrialized countries is increasing steadily. In addition, the increased price of crude oil since the first oil crisis has stimulated the implementation of natural gas export projects.

Since the difficulties involved in ocean transport of natural gas have been eliminated by liquefaction technology, industrialized countries such as the U.S.A., Western European countries and Japan, where large amounts of energy are consumed, import a great deal of LNG as a clean energy source.

The LNG process is as follows:



The process consists of acid gas removal, drying, pre-cooling, LPG and natural gasoline recovery and liquefaction.

Acid gases, such as carbon dioxide and hydrogen sulfide, are eliminated from the feed gas at a pressure of 700 psia, and then the water content is reduced to a level which will not cause freeze-out at the cold end of the process. The feed gas from the dryer is cooled and fractionated. Finally it is liquefied in a multi-component refrigeration unit and then subcooled to a level of −260°F. The product LNG is stored in low-temperature tanks and exported through the shipping

facility in LNG carriers. The production of LNG is usually carried out at the same time as the separation of other hydrocarbons, and therefore, the cost of LNG liquefaction differs greatly from case to case, depending upon the composition of the natural gas being processed.

Further, the water content, hydrogen sulfide content and carbon dioxide content of the gas affect the treatment cost of the natural gas.

(4) Liquefied Petroleum Gas (LPG)

LPG consists of liquefied hydrocarbons with three and four carbon molecules (expressed as C_3 and C_4, respectively).

Only hydrocarbons with carbon numbers of 1 to 4 remain in a gaseous state at ordinary temperatures, and pressure. Two methods are available for liquefying such gaseous hydrocarbons. One is to put them under pressure at ordinary temperatures, and the other is to cool them to below their boiling points at ordinary pressure.

Hydrocarbons which are comparatively easily to liquefy by pressurizing at ordinary temperatures are those with carbon numbers of 3 and 4. LPG is the liquefied product of such hydrocarbons.

LPG is commonly used as a fuel in private households, industry and motor vehicles. In addition, it can also be used as a petrochemical feedstock.

(5) Ammonia

Along with the worldwide increase in population, the demand has grown for fertilizer, the main raw material of which is ammonia. In addition, ammonia has grown in importance as a basic feedstock for the chemical industry.

As a result, the ammonia industry has made great strides in developed countries. However, their competitive position in the international market has decreased sharply in recent years due to the increase in the prices of hydrocarbons in the past ten years.

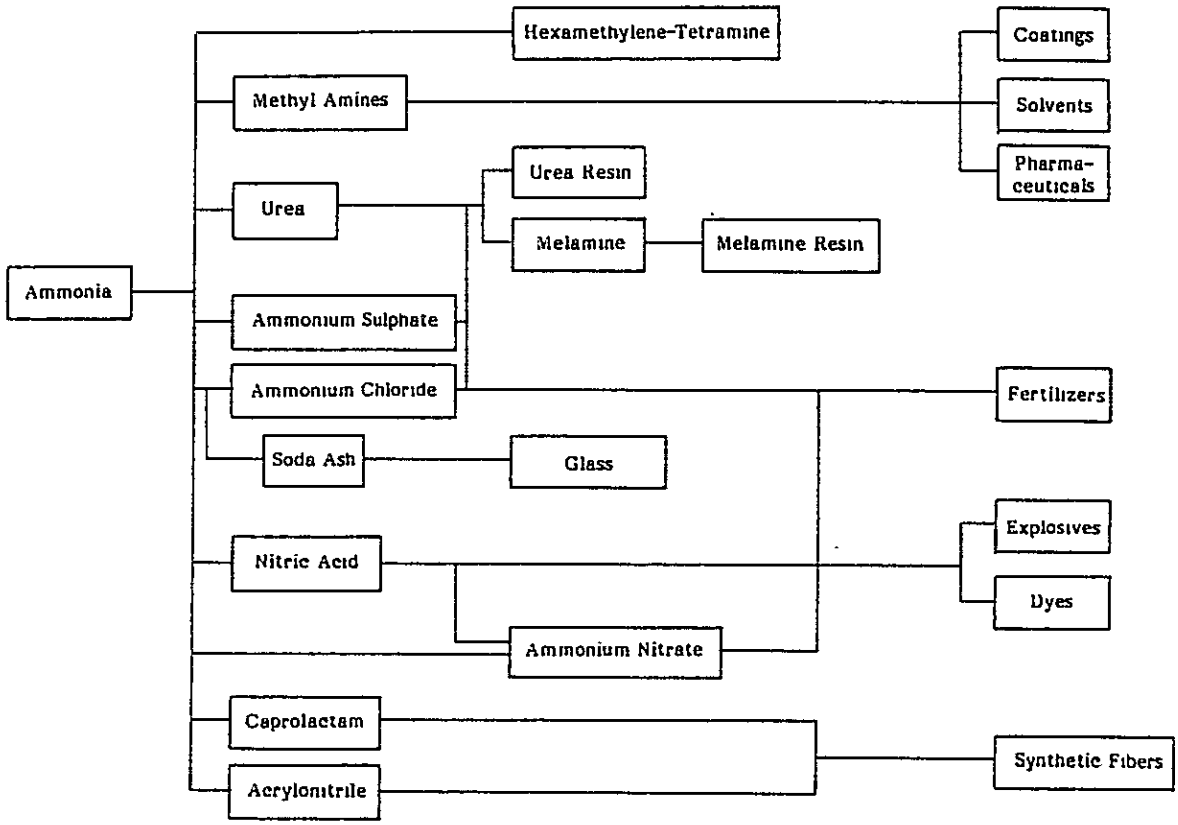
Several ammonia manufacturing processes have been developed so far. They can be classified into five categories as follows:

(a) water electrolysis processes
(b) natural gas steam reforming processes
(c) naphtha steam reforming processes
(d) heavy fuel oil partial oxidation processes
(e) coal gasification processes

A comparison of these five types of processes from the technical and econimic points of view shows the natural gas methods to be the best, and it is anticipated that the natural gas methods will continue to be the leading ammonia production processes in the future. Consequently, natural gas producing countries will be in a very competitive position in the international market for ammonia and its derivatives, such as urea.

Typical ammonia derivatives and their applications are shown below.

Ammonia Derivatives and Their Uses



Although most ammonia is used for fertilizer production, the balance is used for synthesizing many organic chemicals such as caprolactam, acrylonitrile, etc.

(6) urea

Urea is the most commonly used nitrogen fertilizer derived from ammonia. At present, several urea production processes are being used on an industrial scale. However, all of those processes are based on a fundamental process.

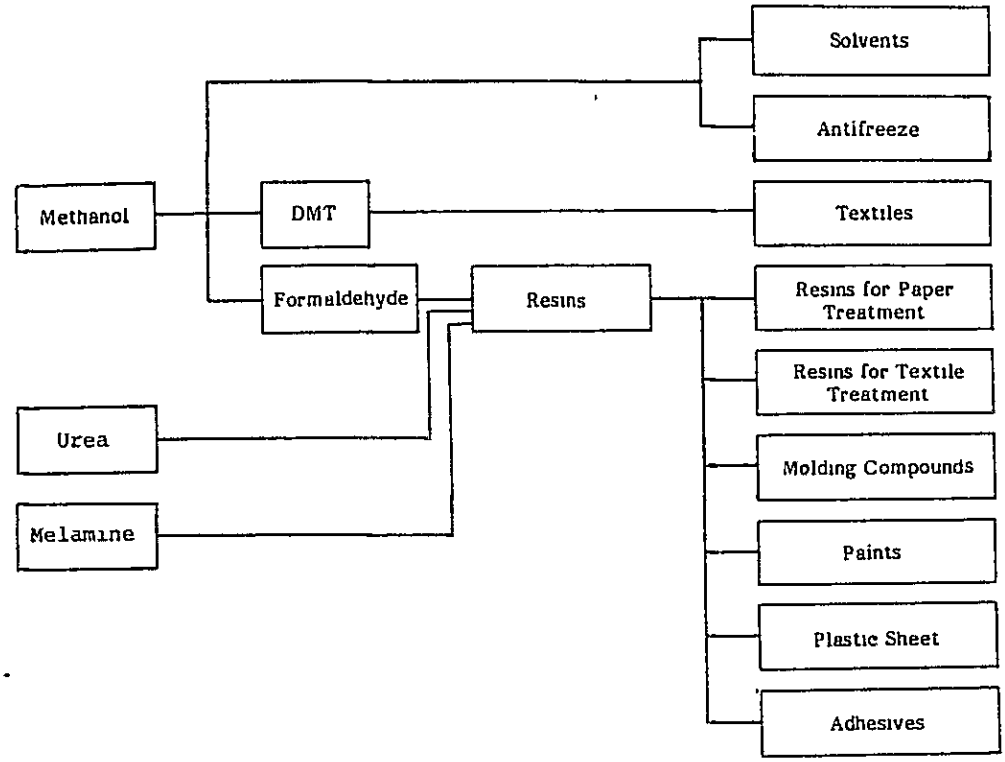
The production cost of urea is governed by the production cost of ammonia, and the production cost of ammonia is controlled by the cost of the raw material hydrocarbons. Consequently, the economics of urea production depend to a large extent on the cost of the original raw material, which can be natural gas, naphtha, heavy fuel oil, etc. Due to the relatively high price of oil, and the prevalence of natural gas processes in ammonia production, such petroleum fractions as naphtha and fuel oil are necessarily at a disavantage to natural gas, both technically and economically, and as a result, countries that produce natural gas are in an advantageous position in the international ammonia and urea markets.

(7) Methanol

Methanol synthesis from natural gas is both technically easier and much more economical

than synthesis from other hydrocarbon sources, just as in the case of ammonia. Furthermore, methanol production in large-sized plants has led to significant reductions in production costs. Therefore, the construction of a large-scale methanol plant could also be considered as a possible gas-based project.

Uses of Methanol



(8) Petrochemicals

Petrochemical plants produce various chemical products starting either from natural gas or petroleum. These plants can be classified broadly into two categories characterized by the production facilities involved, that is, olefin complexes and aromatics complexes.

The production of ethylene is so important in the production of petrochemicals that the scale of a petrochemical complex can even by evaluated in terms of its ethylene production capacity. Therefore, it can be said that the initial phase for the development of a petrochemical industry is the manufacture of ethylene.

(Figure 3.2-2 shows an overall flow chart of petrochemical products.)

At present in most of the ethylene plants in the world, either natural gas fractions, such as ethane, propane, butane and natural gasoline, or petroleum fractions, such as naphtha and gas oil, are used as feedstock for the production of ethylene. However, the general tendency throughout the world is that gas-based ethylene plants are becoming more competitive than ethylene plants based on petroleum fractions.

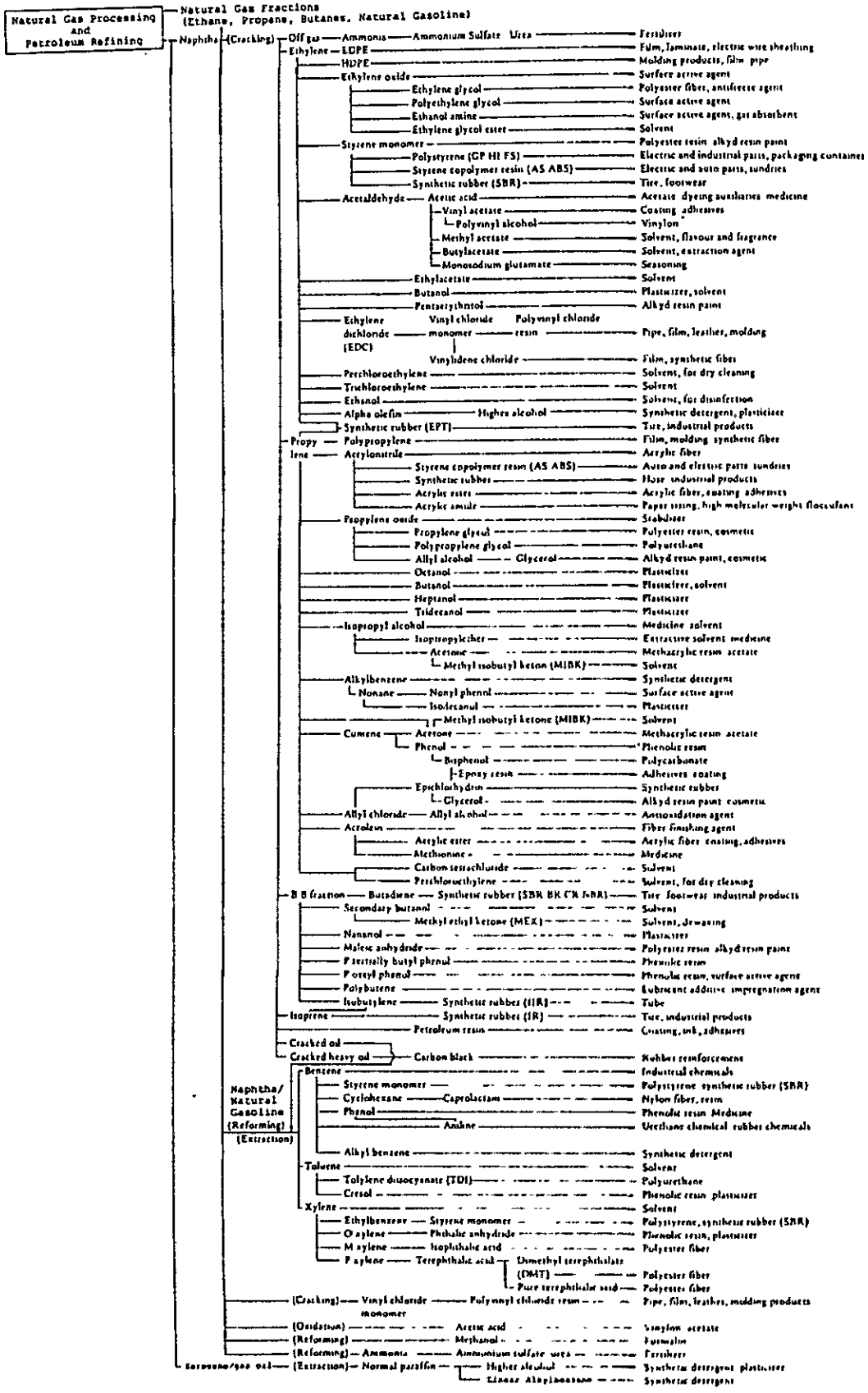


Fig. 3.2-2 Petrochemical Products

3.3 Current Status of Heavy Industrial Projects to be Located in the Map Ta Phut Industrial Estate

3.3.1 General

In accordance with the discussions made with several Thai authorities responsible for the execution of the Eastern Seaboard Development Program, and also taking fully into account the recent progress in the development activities of the heavy chemical industry projects in line with the Fifth Economic and Social Development Plan (1981–1986), the following projects have been identified, as possible projects which would be attracted to the area of the proposed Industrial Estate in Map Ta Phut, with the purpose for estimating the requirements of raw materials, utilities, land, infrastructure services, number of workers, product distribution, treatment and disposal of waste materials, all of which are essential inputs for the planning of the industrial port and estate.

– For a short term development (first phase) plan with the target year of 1987;

(a) Gas separation plant (now under construction)
(b) Soda ash plant
(c) Petrochemical complex
(d) Fertilizer complex
(e) Supporting industries

– For a master plan (second phase development) with the target year up to around 2000;

(f) Steel & Iron complex
(g) Further developments of the above-mentioned projects and related downstream and supporting industries.

Current status of each of the projects is summarized below.

3.3.2 Gas Separation Plant

This project has been promoted under the ownership of Petroleum Authority of Thailand (PTT), and the first unit of the gas separation plant at a capacity of 350 MMSCFD (in terms of feed natural gas) is now being constructed by a consortium of Japan and the United States consisting of Randall Corp., Tokyo Engineering Corp., and Mitsui & Co., Ltd. The first unit plant is expected to be mechanically completed by the end of 1984, and is supposed to commence its commercial operation from 1985. The gas separation process consists principally of carbon dioxide removal (by Benfield process) and dehydration, recovery of ethane and heavier natural gas fractions (by cryogenic operation) from methane, and fractionation of thus recovered hydrocarbon fractions in accordance with demands from the petrochemical project and LPG market in the country.

The specific natural gas fractions to be separated are ethane, LPG or propane and butanes, and natural gasoline which is generally composed of C_5 heavier hydrocarbons. Ethane will be used exclusively for the proposed petrochemical complex as feedstock for the production of ethylene which is the basic and essential starting material for the implementation of petrochemical industry, and at the same time, a part of propane will also be supposed to be utilized for the petrochemical complex as feedstock for the production of propylene by means of

dehydrogenation, according to the proposed scheme by PTT.

LPG (progane and butanes) and natural gasoline will be transmitted by pipelines from the gas separation plant to the marine terminal to be situated in Laem Chabang, a distance of about 60 km.

The sale gas, which is mainly composed of methane, will be supplied to EGAT's Bang Pakong and South Bangkok thermal power stations through the existing 28 inches pipeline, and a part of the gas, will, of course, have to be transmitted to the proposed fertilizer complex as feedstock for the production of ammonia, as well as for the use of industrial fuel for the fertilizer complex, soda ash plant, petrochemical complex, and other industries which could be attracted to the area of the proposed industrial complex in Map Ta Phut, Rayong.

In addition to the supply of the above-mentioned hydrocarbon fractions, a part of carbon dioxide separated in the gas separation plant will have to be transmitted to the proposed soda ash plant, because this soda ash plant will be operated based on a complete coproduction process of ammonium chloride, in other words, there is not the generation of carbon dioxide within the battery limit of the proposed soda ash plant as in the case of the Solvay process which includes the calcination of lime stone to produce lime and carbon dioxide. It is considered in this connection that the gas separation plant will be a core plant which will provide feedstocks and fuel for all of the other large industrial projects proposed for the Map Ta Phut industrial estate.

The amount of natural gas fractions to be separated in the first unit of the gas separation plant is expected to be as follows:

Ethane[1/]:	350,000 MTA
Propane[2/]:	217,000 MTA
LPG (propane/butanes mixture[3/]:	239,000 MTA
Natural gasoline:	64,300 MTA
Carbon dioxide:	430×10^6 Nm^3/year
Sales gas (methane rich)[4/]:	243 MMSCFD[5/]

3.3.3 Soda Ash Plant

This soda ash project was initially committed by ASEAN countries in 1976. On the basis of a series of feasibility studies conducted under the technical a ssistance by JICA, and also in accordance with the regional agreement among the member countries, ASEAN Soda Ash Co., Ltd. was established in June 25, 1982 with equity participation from the five ASEAN countries

---

Notes: 1/ with 92 wt% of ethane.
2/ with more than 99.5 wt% of propane.
3/ with 30 wt% of propane and 70 wt% of butanes.
4/ with the following estimated analysis:

	Vol. %
Carbon dioxide,	0.44%
Nitrogen,	1.96%
Methane,	95.72%
Ethane,	1.86%
Propane,	0.02%
Total	100.00%

5/ Calculated based on 330 stream days per year.

and also from some Japanese manufacturerers.

In view of local conditions and requirements, especially in relation to environmental aspects, the proposed project is supposed to be based on so-called dual purpose process and the plant will be operated on the complete co-production of ammonium chloride, without any reuse of ammonia recovered from coproduct ammonium chloride by means of reaction with slaked lime (lime water), and therefore, there will be no generation of calcium chloride whose disposal to the sea generally brings up certain concerns for environmental reasons.

Based on the expected demands for soda ash in Thailand and the other ASEAN member countries as well, the production capacity has been set up at 400,000 MAT of soda ash with coproduction of ammonium chloride of 400,000 MTA. It is expected that all of the coproduct ammonium chloride will be absorbed in the fertilizer market in the country.

This project, therefore, requires about 570,000 MTA of salt and 128,000 MTA of liquid ammonia in addition to 133 million standard cubic meters of carbon dioxide, all of which are expected to be domestically supplied, from the the rock salt development and mining project, the proposed fertilizer complex, and the aforementioned gas separation plant, respectively.

3.3.4 Petrochemical Complex

Various kinds of investment studies have been conducted since more than 10 years ago for the development of the petrochemical industry especially in connection with the feasibility for the construction of a petrochemical complex consisting of an olefin plant and downstream units. Recent discovery and development of the offshore natural gas deposits in the Gulf of Thailand followed by the construction of the gas separation plant, has offered a new great potential to lead the project of the country's first petrochemical complex to the actual implementation phase. All of recently made studies[1/] have concluded that the establishment of a gas-based petrochemical complex will be viable in Thailand.

Under such circumstances surrounding the petrochemical industry development in the country, the Eastern Seaboard Development Committee prepared in December 1982 and distributed in January 1983, the prospectus for Thailand's petrochemical complex to possible private investors, both foreign and national, in order to request proposals from prospective investors interested in participating in the complex.

The proposed petrochemical complex outlined in the prospectus consists of the following units and capacities:

Note: 1/ for example, those conducted under the technical assistance from IFC, and JICA.

(a) Upstream Units

(i) Olefins plant[1/]: 300,000 MTA of ethylene and 73,000 MTA of propylene

(ii) Central utilities plant:

(b) Downstream Units

(i) Low density polyethylene (LDPE) plant: 100,000 MTA[3/]

(ii) High density polyethylene (HDPE) plant: 110,000 MTA

(iii) Vinylchloride monomer (VCM) plant[2/]: 80,000 MTA

(iv) Ethylene glycol (EG) plant: 50,000 MTA

(v) Polypropylene (PP) plant: 70,000 MTA

It is considered that the proposed capacities are designed so as to meet the country's domestic consumption in 1990.

With proposals submitted by prospective investors in the downstream projects that will, according to the prospectus, be totally financed by the private sectors, evaluations and selections have been made in June, 1983, and a pilot company will soon be established with an initial capital of 70 million Bahts. This pilot company will be to coordinate the detailed planning and implementation of the entire petrochemical complex and finally to evolve as the owner of the upstream units consisting of the olefins plant and central utilities plant. According to a recent information, the initial capital for the pilot company would be shared as in the following percentages:

PTT:	49%
Bureau of Crown Property:	2%
International Finance Corporation (IFC):	9%
LDPE producer:	12.5%
HDPE producer:	13.5%
VCM producer:	4.8%
PP producer:	9.2%
TOTAL:	100.0%

It is expected that, after contractual agreements, construction would be commenced by August 1984 so that the commissioning and start-up of the plants is scheduled for October, 1987.

Notes: 1/ The olefins plant will be designed to include a thermal cracker of ethane or ethane/propane mixed feed, and a catalytic dehydrogenation unit of propane, which will produce, in total, 300,000 MTA of ethylene and 73,000 MTA of polymer grade propylene.

2/ In order to supply chlorine to the VCM plant, an electrolysis plant of salt having a capacity of 48,000 MTA of chorine with a coproduction of 53,200 MTA of caustic soda (as 100% NaOH) has to be installed.

3/ An LDPE plant having a capacity of about 70,000 MTA, has already been constructed by Thai Petrochemical Industries Co., on the eastern side of Rayong city, approximately 25 Km east of the proposed Map Ta Phut industrial estate.
This plant, which has to be operated initially based on imported ethylene, is expected to be provided with ethylene by a pipeline from the proposed olefins plant in Map Ta Phut.

3.3.5 Fertilizer Complex

As same as in the case for the petrochemical industry of Thailand, the discovery and development of the substantial reserves of natural gas in the Gulf of Thailand, together with the existence of a considerable size of domestic fertilizer demands, which has so far been covered by imports from foreign countries, has created a new situation that the establishment of an international size of fertilizer complex can be justified. This is also supported by the recent development of potash mines in the country. Reflecting such situation, various study reports and proposals have been submitted to the Government of Thailand by prospective foreign investors in accordance with her request and their interest.

The National Fertilizer Corporation (NFC) of Thailand was established on October 6, 1982 to be the authorized agency responsible for all phases of project execution covering conceptutal formulation, process selection and design, financing, construction and operation. The shareholders of NFC consist of the Government through PTT, Ministry of Industry (MOI) and Marketing Organization for Farmers (MOF) for 45%, and 27 fertilizer manufacturing, blending, importing and distributing companies for 45%, and 16 commercial banks for 10%, with the initial paidup capital of 50 million Bahts.

At present a feasibility study is being carried out by the consultants[1/] hired by NFC with main objectives to analyze alternative configurations (scheme and capacities) and to recommend the optimal configuration for the proposed fertilizer complex on the basis of the characteristics of the country's agriculture sector and projected fertilizer demands among others. Draft final reports are expected to be submitted by the consultants to NFC by the end of July or August, 1983, and therefore, at this moment there is no decisive information on the optimal scheme and capacity for the proposed fertilizer complex, based on which design and construction will be made.

Nevertheless, according to the information verbally presented at the meeting with NFC and its consultans on April 1983, four alternative configurations, all of which include an international size of ammonia plant, were being studies, and a fertilizer complex including the following process units and capacities would be supposed to be recommended as the optimal configuration for the proposed fertilizer complex in the country.

Ammonia plant:	268,600 MTA
Urea plant:	353,000 MTA
Sulfuric acid plant:	553,800 MTA (as 100% H_2SO_4)
Phosphoric acid plant:	221,500 MTA (as P_2O_5)
MAP/DAP/NPK:	
Urea granulation:	

Note: 1/ Foster Wheeler International

It was, however, noted that no ammonia supply to the soda ash project is considered.

A certain alternation seems to be necessary, for example as indiciated below, concerning the production capacity of ammonia plant, since the shortage of ammonia can be anticipated, if the soda ash project is implemented.

Ammonia plant:	1350 MTD	(450,000 MTA)1/
Urea plant:	1200 MTD	(400,000 MTA)1/
Sulfuric acid plant:	1850 MTA	(616,700 MTA)1/
Phosphoric acid plant:	660 MTA	(220,000 MTA)1/
MAP/DAP/NPK:		
Urea granulation:		

It is considered that this sort of the alternation may be allowed, because the feasibility study for the proposed fertilizer complex itself has not yet been completed, as well as for the reason that there is no fundamental change2/ made for the configuration which was provisionally presented by NFC and its consultant in last April. Therefore, technical requirements for the fertilizer project will be estimated based on the above mentioned concept.

This fertilizer complex is also being promoted with the target year of implementaiton around 1987/8.

3.3.6 Steel & Iron Complex

Some feasibility studies have been conducted for the implementaion of a steel and iron complex on the basis of the direct reduction process which utilizes the natural gas. Although at present there is no definite plan authorized by the Government for the development and implementation of the country's steel and iron project, the production of sponge iron and various steel products is also one of the possible projects.

In view of projected size of demands for steel products, and also availability of natural gas and infrastructures which includes a deepsea port, the JICA study team suggested and recommended to Thai counterpart authorities that the steel & iron complex be optimally located in the proposed industrial Estate of Map Ta Phut.

This idea was accepted by Thai counterpart authorities, provided that the project may be studied so as to be integrated in the seocnd phase development plans (master plan) for the proposed industrial estate with the target year of around 2,000.

Notes: 1/ Figures expressed in MTA are based on 8000 stream hours/year (333 stream days/year) of operation at the daily capacity.

2/ Apparently, problems of the scheme and capacity of phosphoric acid as to whether it is produced domestically based on imported phosphate rock and sulfur, or instead it is imported, are much more influential for the present study for the Map Ta Phut industrial estate.

3.4 Other Industries

In addition to the large/heavy gas-based industries discussed before, there may be a large number of industrial projects which would be implemented in the country. Possibilities of locating these projects in the proposed industrial estate in Map Ta Phut should be carefully examined in view of market and marketing (both domestic and export), distribution and transportation of raw materials and products, future availability of infrastructure and utilities and their service costs, production and manpower, investment cost, and financial and economic viability in light with the country's long-term economic and industrial policies, etc.

As for the possibilities for establishing other industries, the following categories of industries will only be enumerated in this section:

(a) Other gas-based industries
(b) High energy or electricity consumption industries
(c) Downstream industries of large/heavy gas-based industries
(d) Industries based on other resources
(e) Supporting industries

Examples of projects and industries classified into such categories are as shown below:

(1) Other gas-based industries
- LNG
- Methanol
- Carbon black

(2) Industries of high energy or electricity consumption
- Ferroalloys
- Glass industry
- Cement industry
- Aluminum smelting
- Ceramics industry

(3) Downstream industries of gas-based large/heavy industries
- Petrochemical downstream projects
  - e.g. Plastics processing industries (LDPE/HDPE/PP)
    PVC and its processing
- Downstream projects of ammonia, urea, methanol, etc.
  - e.g. Urea-formaldehyde adhesive
    Melamine, and urea and melamine moulding compound
    Nitric acid and ammonium nitrate
- Downstream industries of steel and iron
- Utilization of byproduct gypsum (Gypsum board/plaster/cement retarder)
- Glass manufacture
- Dry ice

(4) Industries based on other resources

- Agroindustries
  - e.g. Starch and fermentation alcohol
    Palm oil processing and its derivatives
- Plywood industry (in connection with urea-formaldehyde adhesive)

(5) Supporting industries

- Construction industries
  - e.g. Ready-mixed concrete
    Concrete products (piles, blocks and pipe)
    Steel containers and structures
    Electrical wiring
    Heat insulation
    Painting and coating
    Piping and plumbing
    Instrumentation, etc.
- Maintenance
  - e.g. Foundry
    Machine shop
    Welding and sheet metal workshop
    Heat treatment
    Wood workshop
    Refractories
    Industrial gases (oxygen, nitrogen, acetylene)
    Heavy equipment and vehicle repair
    Electrical machinery repair
    Electronics workshop, etc.

At present, there is no information at all as to what kind of supporting and downstream industries could be implemented in the area of the proposed Map Ta Phut Industrial Estate.

In this study, therefore, it has been assumed that some of the supporting and downstream industries as stipulated above could, in any case, be established and for which 100 ha and 120 ha of land have been allocated respectively, within the proposed industrial estate in Map Ta Phut.

3.5 Technical Requirements for the Identified Projects

3.5.1 General

On the basis of the nature and characteristics of the identified projects that would be attracted to the area of the proposed Map Ta Phut industrial estate, technical requirements will be defined in this section.

The technical requirements will include the following fundamental items which will be taken into account in the formulation of the master plan of the proposed industrial estate with the target year of around 2000, as well as in the preparation of a feasibility study for a short-term development plan with the target year of 1987:

(a) Raw materials requirements
(b) Utilities requirements
(c) Land requirements
(d) Labor requirements
(e) Disposal of industrial wastes
(f) Products outputs to the market

3.5.2 Short-term Development (First Phase Development) Projects

On the basis of the discussions made in the previous sections, a fundamental scheme for the short-term development plan has been drawn as indicated in Fig. 3.5-1 and technical requirements for the proposed projects are summarized in Table 3.5-1

For the implementation of the proposed projects for the short-term development plan with the target year of 1987, the following requirements will have to be satisfied as total of the three additional projects to the gas separation plant which is now under construction.

(a) Raw materials requirements

Salt:	653,400 MTA
Ethane:	350,000 MTA
Propane:	130,000 MTA
Natural gas (sale gas/rich in methane)[1/]:	78.4 MMSCFD
Sulfur (imported):	203,300 MTA
Phosphate rock (imported):	704,000 MTAS
Muriate of potash (imported)[2/] :	73,400 MAT[2/]
Inputs for Supporting Industries:	191,000 MTA

(b) Utilities requirements

The total utilities requirements for the three additional projects within the short-term development plan are estimated as follow:

Electricity:	113,200 KW
Industrial water:	4,250 m^3/h
Potable water:	52 m^3/h (as max. hourly rqt)

Natural gas requirements for the use as industrial fuel are included in those for raw materials.

Note: 1/ Including fuel requirements
2/ The import of MOP may be substituted by domestically available carnallite. In this case, 315,000 MTA of carnallite would be needed, according to NFC.

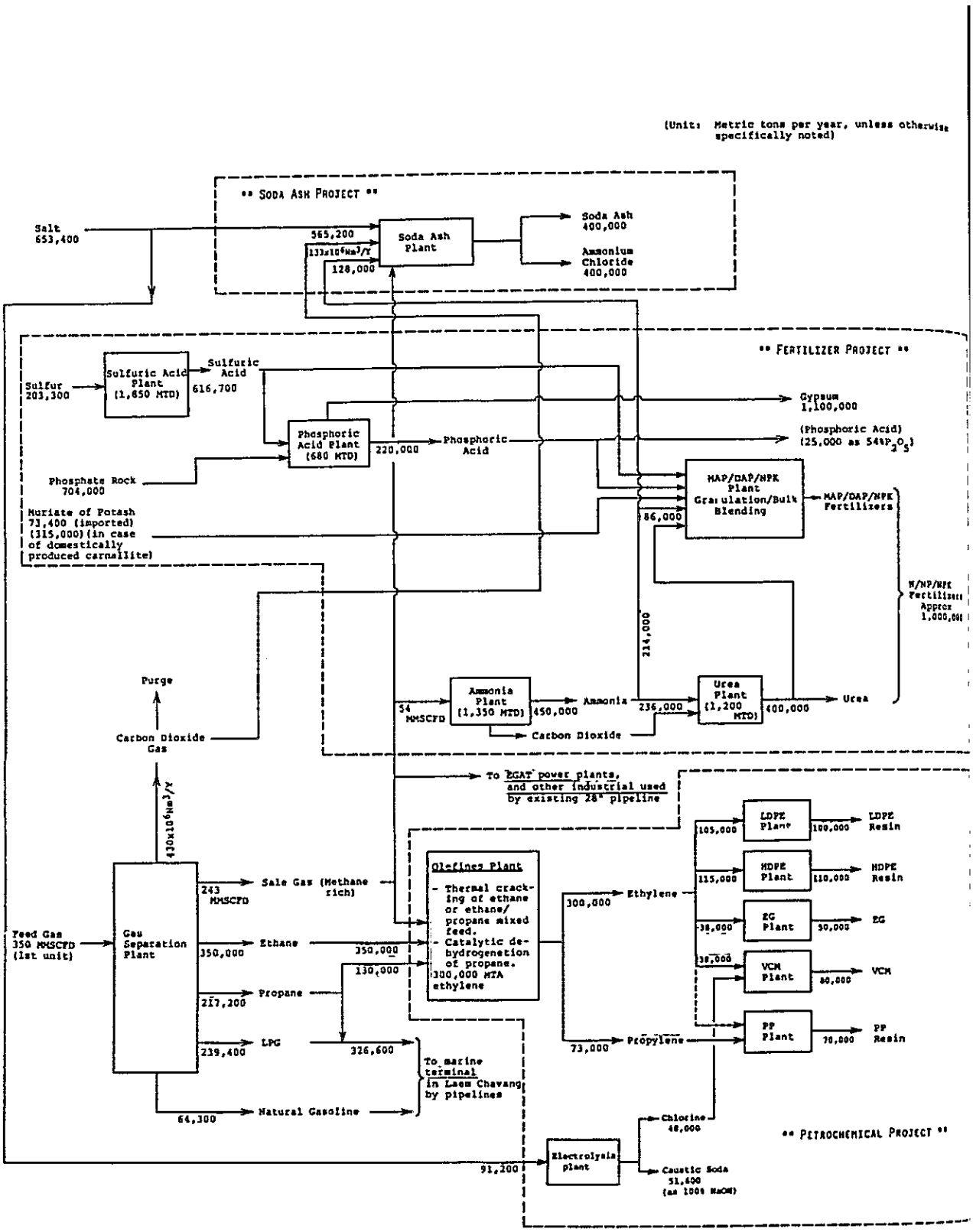


Fig. 3.5-1 Expected Scheme for the Short-term (First Phase) Development with the Target year of 1987

Table 3.5-1 Technical Requirements for the Short-term (First Pahse) Development Plan

Project	Soda Ash	Petrochemical	Fertilizer	Supporting Industry	Total
1 Main Raw Materials					
Salt (T/Y)	562,200	91,200			653,400
Ammonia (T/Y)	128,000				128,000
Ethane (T/Y)		350,000			350,000
Propane (T/Y)		130,000			130,000
Natural gas (CH_4 rich) (MMSCFD)	9.4 (as fuel)	15 (as fuel)	54 (as raw mat's & fuel)		78.4
					203,300
Sulfur (T/Y)			203,300		203,300
Phosphate rock (T/Y)			704,000		704,000
Muriate of potash (T/Y)[1]			73,400		73,400[1]
Carbon dioxide gas (m^3/Y)	132.8 x 10^6				132.8 x 10^6
Inputs for supporting industry				191,000	191,000
					2,433,100 T/Y (except gases)
2. Utilities					
Electricity (KW)	24,800	72,700	15,700	3,400	116,600
Fresh water (m^3/H)	1,280	1,500	1,470	50	4,300
Potable water (m^3/H)	12	25	15	22	74
3. Total Manpower Requirement	840	1,550	1,050	1,200	3,440
4. Land Area Requirement (without areas housing and waste disposal) (ha)	70	170	60	50	310
5. Final Products (T/Y)					
Soda ash	400,000				400,000
Ammonium chloride	400,000				400,000
LDPE resin		100,000			100,000
HDPE resin		110,000			110,000
Caustic soda (as 50% NaOH solution)		103,200			103,200
VCM		80,000			80,000
MEG		50,000			50,000
PP resin		70,000			70,000
Ammonia			128,000		128,000
(Phosphoric acid)			(25,000)		(25,000)
DAP/MAP			approx. 1,000,000		1,000,000
NPK fertilizers				166,000	166,000
Outputs from supporting industry					2,632,200 T/Y
6. Waste Disposal					
Solid disposal (T/Y)	144,000	2,000	1,100,000		1,246,000
Waste water (m^3/H)	450	540	500		1,490

(c) Land requirements

The total land area requirement is estimated at around 310 ha. with the exception of an area for gypsum pond expected to be needed for the proposed fertilizer complex.

(d) Labor requirements

The total labor requirement is estimated at 3,440 persons.

(e) Disposal of industrial wastes

The total labor requirement is estimated at 3,440 persons.

Solid waste:	1,246,000 MTA
Waste water:	1,490 m^3/h

(f) Products outputs to the markets

The amounts of salable outputs to the outside of the proposed industrial estate are estimated as follows:

Soad ash:	400,000 MTA
Ammonium chloride:	400,000 MTA
LDPE resin:	100,000 MTA
HDPE resin:	110,000 MTA
VCM:	80,000 MTA
Caustic soda (as 50% NaOH solution):	103,200 MTA
EG:	50,000 MTA
PP resin:	70,000 MTA
Phosphoric Acid (as 54% P_2O_5):	25,000 MTA
Fertilizers (urea /MAP/DAP/NPK):	approx. 1,000,000 MTA
Outputs from Supporting Industries:	166,000 MTA
TOTAL:	2,504,200 MTA

3.5.3 Second Phase Development (Master Plan) Projects

As mentioned before, it has been assumed that the second phase development (master plan) projects in the proposed industrial estate in Map Ta Phut with the target year of up to around 2000, would consist mainly of the duplication of the aforementioned three projects[1/] which are soda ash, petrochemical and fertilizer complex, and the steel & iron complex project. This assumption has been made in order to formulate a master plan for the indusrrial estate in Map Ta Phut with identification of its infranstructure requirements and scale of the fundamental technical requirements. Since the purpose of this study is not to discuss the detailed scheme of each individual industry itself which would be located in Map Ta Phut in the year around 2000, nevertheless, this sort of assumption can be allowed as far as a long-term plan for the industrial estate and its infrastructure has to be made subordinately always on the basis of requirements from industrial projects which would have to be identified at first independently of what kind of infrastructural services could be made available there.

An assumption of a 6% per year for average growth rate of demand in Thailand, as a whole, which is slightly less than recent increase of real GDP, may justify the idea that the project capacities undertaken within the short-term (first phase) development plan with the target year

Note: 1/ There are still considerable uncertainties.

of 1987, would be doubled in the year around 2000, 13 years later after the completion of the first phase.

With regards to the steel & iron complex, it is assumed that, taking into account the projected size of demand for steel products in the country in the year around 2000, the total capacity of the steel & iron project[1/] would be approximately 6 million tons per year, in spite of the fact that the commercially proven normal size of one train of the direct reduction steel plant ranges from several hundreds thousand tons to one million tons per year. Therefore, this assumption is also for the sake of estimating approximate scale of utilities and infrastructural requirements in the year of around 2000, and in other words, it can be considered that the study for the formulation of a master plan for the industrial estate with the target year of around 2000, has been made at a scale so as to be able to attract the aforementioned size of steel & iron complex based on imported iron ore.

On the basis of the discussions made above, the fundamental technical requirements have been estimated and are summarized in Table 3.5-2. The scale of production is summarized in Table 3.5-3, after the completion of the second phase development plan. Fig. 3.5-2 and 3.5-3 schematically indicate a conceptual plan for the industrial complex in the year around 2000.

Note: 1/ If this size of the steel & iron project would be implemented at once, the blast furnace process will be more realistic rather than the direct reduction process.

Table 3.5-2 Technical Requirements for First Phase (Short-term) and Second Phase (Master Plan) Development

		1st phase (1987)					2nd phase (2000) *3/					
		Soda Ash	Petrochem.	Fertilizer	Downstream	Supporting	Soda Ash	Petrochem.	Fertilizer	Iron Steel	Downstream	Supporting
1. Main Raw Material												
Salt	T/Y	562,200	91,200	-			1,124,400	182,400	-			-
Ammonia	T/Y	128,000	-	-			256,000	-	-			-
Ethane	T/Y	-	350,000	-			-	700,000	-			-
Propane	T/Y	-	130,000 *1/	-			-	260,000 *1/	-			-
Natural gas (CH_4 rich)	MMSCFD	9.4 *1/	15 *1/	54 *2/			18.8 *1/	30 *1/	108 *2/	293 *2/		-
Sulfur	T/Y	-	-	203,300			-	-	406,600			-
Phosphate rock	T/Y	-	-	704,000			-	-	1,408,000			-
Muriate of potash	T/Y	-	-	73,400 *5/			-	-	146,800			-
Carbon dioxide	10^6N m^3/Y	132.8	-	-			265.6	-	-	9,108,000		-
Iron ore pellet	T/Y	-	-	-			-	-	-	1,457,000		-
Scrap	T/Y	-	-	-			-	-	-	467,600		-
Lime (Lime Stone)	T/Y	-	-	-			-	-	-	(888,800)		-
Ferromanganese	T/Y	-	-	-			-	-	-	37,300		-
Ferrosilicon	T/Y	-	-	-			-	-	-	4,600		-
Aluminium	T/Y	-	-	-			-	-	-	13,400		-
Fluorite (calcium fluoride)		-	-	-			-	-	-	10,200		-
Carbonizing Material	T/Y	-	-	-			-	-	-	14,800		-
Supporting ind. inputs		-	-	-	-	191,000	-	-	-		-	191,000
Downstream "		-	-	-	-	-	-	-	-		538,000	-
2. Utilities												
Electricity	KW	24,800	72,700	15,700	-	3,400	49,600	145,400	31,400	1,011,000	25,000	3,400
Fresh water	m^3/H	1,280	1,500	1,470	-	50	2,300	2,700	2,650	4,500	1,055	50
Portable water	m^3/H	12	25	15	-	22	22	40	27	105	38	22
3. Total Manpower Requirement		840	1,550	1,050	-	1,200	1,410	2,600	1,800	7,010	2,560	
4. Land Area Requirement	ha	60	200	60	-	50	100	410	100	600	120	100
5. Waste Disposal												
Solid waste	T/Y	144,000	2,000	1,100,000	-	-	288,000	4,000	2,200,000	*4/ 322,400	-	-
Waste water	m^3/H	450	540	500	-	3	810	970	900	4,050	53	3

Notes: *1/ as fuel
*2/ as raw material and fuel
*3/ inclusive those of the 1st phase
*4/ excluding scales, fly ash and fine lime which amount to 2,018,000 MTA in total.
*5/ 315,000 MTA in case of the use of domestically produced carnallite, according to NFC.

Table 3.5-3 Scale of Production (in terms of Salable Outputs) for First Phase (Short-term) and Second Phase (Master Plan) Development

Projects	Final Products	1st Phase*2)	2nd Phase*3)
Soda Ash Plant	Soda Ash	400,000t/y	800,000t/y
	Ammonium Chloride	400,000	800,000
Petrochemical Complex	LDPE resin	100,000	200,000
	HDPE resin	110,000	220,000
	Caustic Soda (as 50% NaOH)	103,200	206,400
	VCM	80,000	160,000
	MEG	50,000	100,000
	PP resin	70,000	140,000
Fertilizer Complex	Ammonia*1)	128,000	256,000
	Phosphoric Acid	(25,000)	(50,000)
	Urea		
	DAP/MAP	1,000,000	2,000,000
	NPK-Fertilizer		
Steel & Iron Complex	Hot Steel		946,000
	Hot Coil		2,176,000
	Cold Steel		582,000
	Cold Coil		1,984,000
	Byproduct*4)		
Down Stream Industry		–	429,000
Supporting Industry		166,000	166,000

Notes: *1) as salable output *2) with target year of 1987
*3) with target year of around 2000, inclusive the 1st phase
*4)

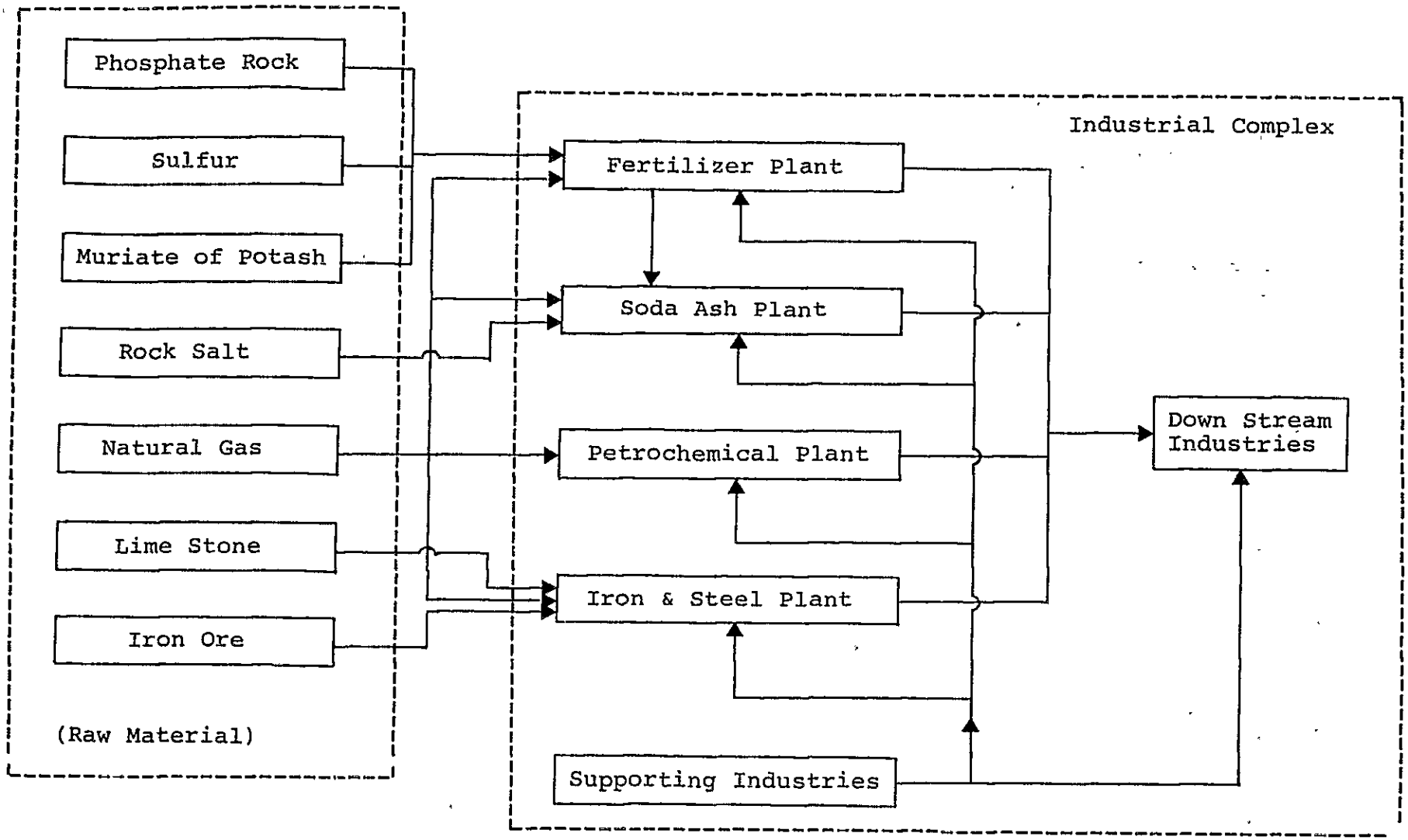


Fig. 3.5-2 Conceptual Plan for Industrial Complex at the year 2000

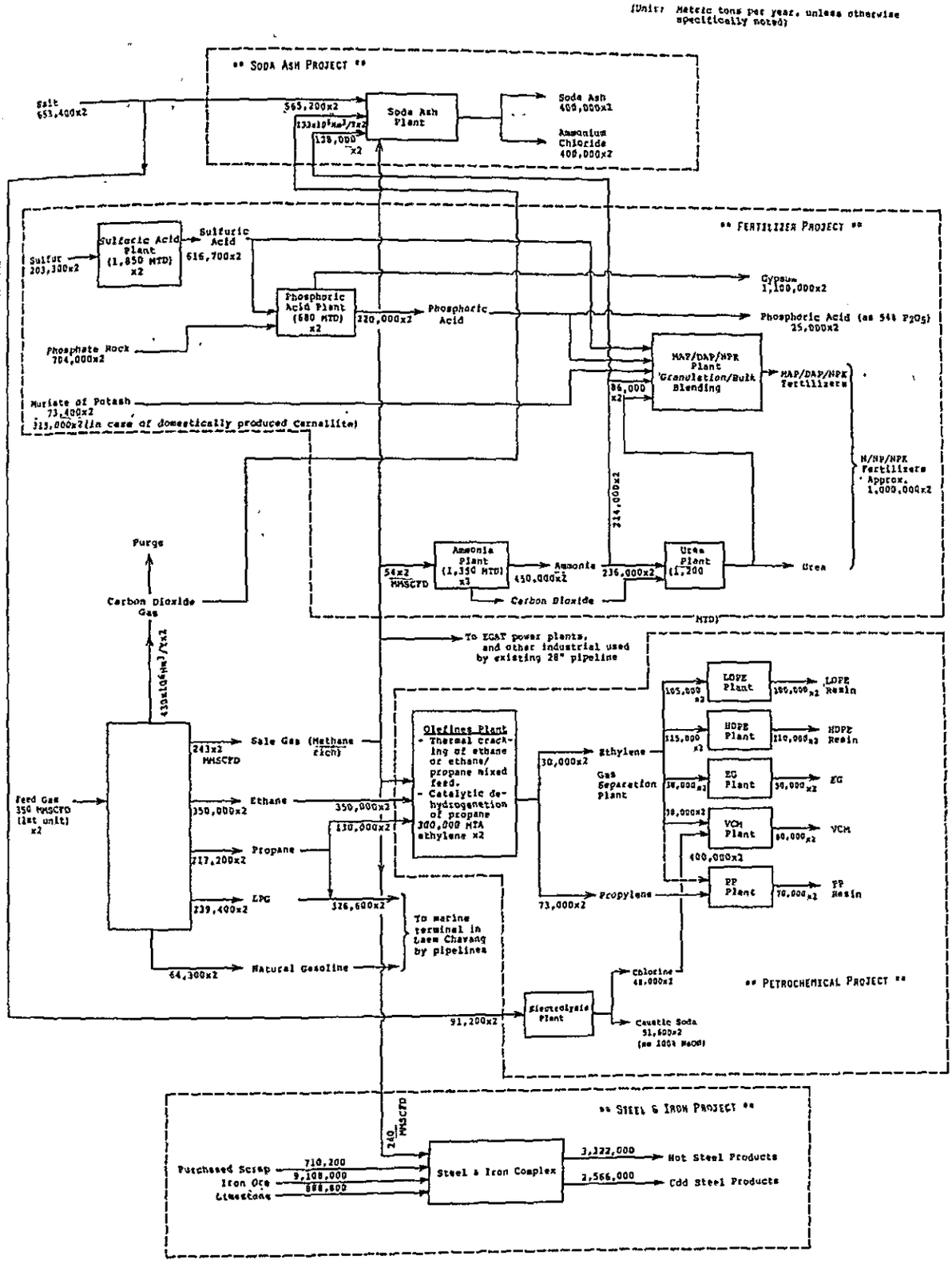


Fig. 3.5-3 Expected Scheme for the Second Phase Development (Master Plan) with the Target Year of 2000