3.2 Cost Estimation

3.2.1 Conditions of cost estimation

(i) Price

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

(ii) Exchange rate

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

(iii) Duty and Tax

Duty for imported construction materials, equipment and plants are excluded from the cost estimation. Business tax and municipal tax are also eliminated from the cost estimation.

(iv) Contingency

The contingency is considered to be 10 percent through 15 percent of construction cost for unknown physical conditions.

Contingency for fluctuation in prices is not estimated.

(v) Engineering fee

Included in this fee is the cost for a natural condition survey as well as engineering study and supervision.

3.2.3 Scope of Cost Estimation

The scope of cost estimation is shown in Table 10.2-1 in Part I, Chapter 10 and the range of cost estimation is shown in Fig. 3.2-1.

3.2.3 Cost Estimation

The cost estimation based on the above-mentioned premises is 41,605.6 million Boat. The breakdown of construction costs are shown in Table 3.2-1 through 3.2-9.

Excluding the construction cost of housing & public facilities, telecommunications and the private investment for the production plants within the factories, the total construction cost will be 4,550.3 million Baht.

For reference, the breakdown of construction cost of purification plant and electric facilities which should be alloted for industrial complex, port area and urban area, are shown in Table 8-8 and 8-9 in Appendix 8.

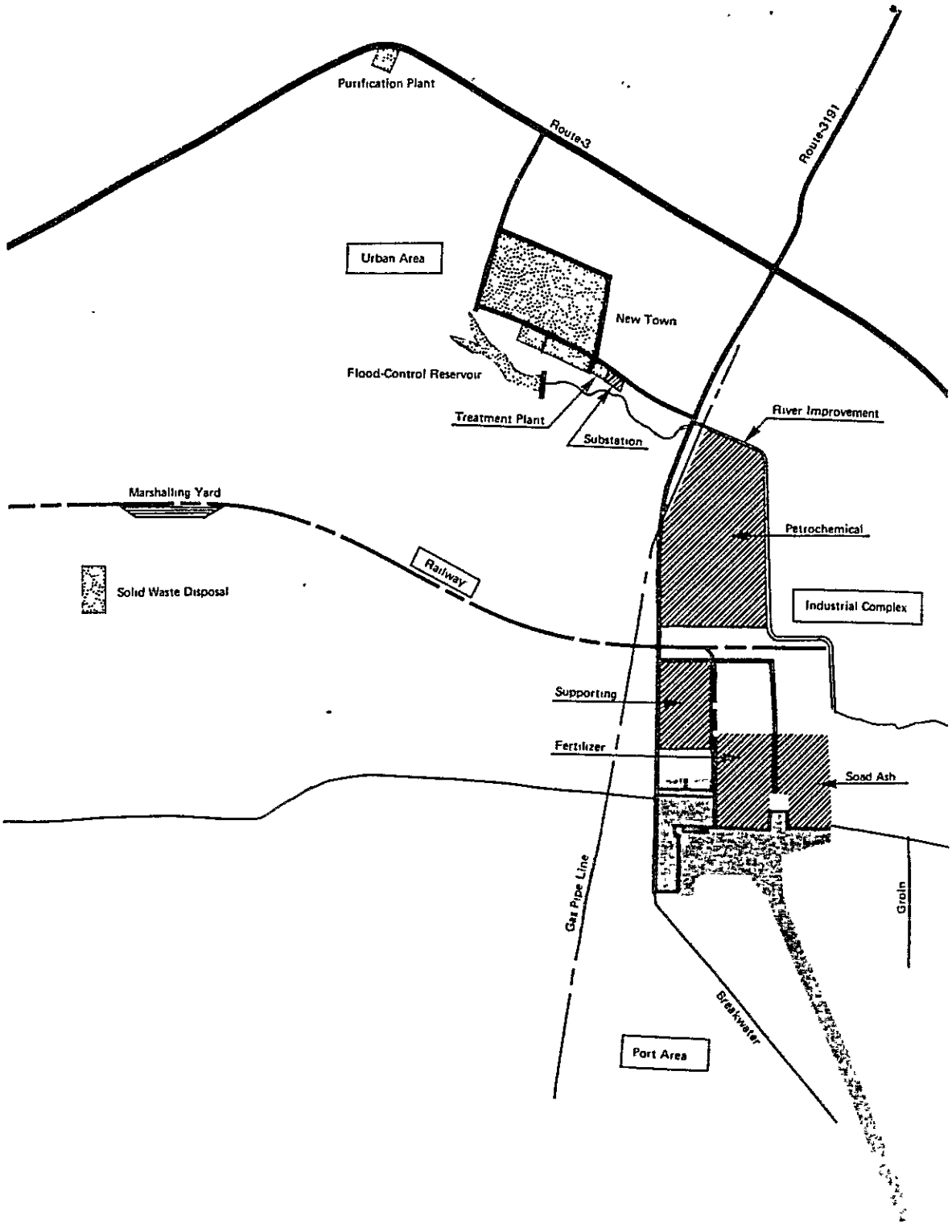


Fig. 3.2-1 Range of Cost Estimation

Table 3.2-1 Construction Cost (Short Term Development Program)

Item	Unit	Quantity	Unit Price (฿)	Amount (Thousand ฿)			Total Amount (Thousand US$)	Remarks
				Total	Local Currency	Foreign Currency		
1. Industrial Complex	Ls	1		1,000,500	584,100	416,400	43,500	Table 3.2. -3
2. Port Area	Ls	1		2,751,700	1,215,900	1,535,800	119,640	Table 3.2. -4
3. Urban Area	Ls	1		484,800	328,000	156,800	21,080	Table 3.2. -5
4. Railway	Ls	1		313,300	209,500	103,800	13,620	Table 3.2. -6
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	Table 3.2. -7
6. Housing & Public Facilities	Ls	1		1,176,500	1,092,400	84,100	51,150	Table 3.2. -8
7. Plant Construction	Ls	1		35,752,300	11,891,000	23,861,300	1,554,450	Table 3.2. -9
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 3.2-2 Construction Projection (Short Term Development Program)

Item	Total			1984			1985		
	Amount (thousand ฿)			Amount (thousand ฿)			Amount (thousand ฿)		
	Total	Local	Foreign	Total	Local	Foreign	Total	Local	Foreign
1. Industrial Complex	1,000,500	584,400	416,400	131,060	113,920	17,140	627,830	342,080	285,750
2. Port Area	2,751,700	1,215,900	1,535,800	39,760	6,930	32,830	559,920	270,560	289,360
3. Urban Area	484,800	328,000	156,800	59,290	41,270	18,020	107,490	75,180	32,310
4. Railway	313,300	209,500	103,800	46,660	36,540	10,120	110,440	70,620	39,820
Sub-total	4,550,300	2,337,500	2,212,800	276,770	198,660	78,110	1,405,680	758,440	647,240
5. Telecommunication	126,500	54,400	72,100	0	0	0	0	0	0
6. Housing & Public Facilities	1,176,500	1,092,400	84,100	0	0	0	10,850	4,340	6,510
7. Plant Construction	35,752,300	11,891,000	23,861,300	794,500	274,500	520,000	10,735,400	3,567,600	7,167,800
Sub-total	32,055,300	13,032,800	24,017,500	794,500	274,500	520,000	10,746,250	3,571,940	7,174,310
Total investment Cost	41,605,600	15,370,300	26,230,300	1,071,270	473,160	598,110	12,151,930	4,330,380	7,821,550

Item	1986			1987			1988			1989			1990		
	Amount (thousand ฿)			Amount (thousand ฿)			Amount (thousand ฿)			Amount (thousand ฿)			Amount (thousand ฿)		
	Total	Local	Foreign	Total	Local	Foreign	Total	Local	Foreign	Total	Local	Foreign	Total	Local	Foreign
1. Industrial Complex	211,640	109,750	101,890	29,970	18,350	11,620									
2. Port Area	1,293,630	610,510	683,120	858,390	327,900	530,490									
3. Urban Area	131,370	91,520	39,850	186,650	120,030	66,620									
4. Railway	156,200	102,380	53,820	0	0	0									
Sub-total	1,792,840	914,160	878,680	1,075,010	466,280	608,730									
5. Telecommunication	72,480	29,690	42,790	54,020	24,710	29,310									
6. Housing & Public Facilities	252,820	240,410	12,410	450,180	431,430	18,750	171,100	152,670	18,430	156,110	141,730	14,380	135,440	121,820	13,620
7. Plant Construction	17,897,100	5,957,700	11,939,400	6,325,300	2,091,200	4,234,100									
Sub-total	18,222,400	6,227,800	11,994,600	6,829,500	2,547,340	4,282,160	171,100	152,670	18,430	156,110	141,730	14,380	135,440	121,820	13,620
Total investment Cost	20,015,240	7,141,960	12,873,280	7,904,510	3,013,620	4,890,890	171,100	152,670	18,430	156,110	141,730	14,380	135,440	121,820	13,620

Table 3.2-3 Industrial Complex

Item	Unit	Quantity	Unit Price (฿)	Amount (thousand ฿)			Total Amount (Thousand US$)	Remarks
				Total	Local Currency	Foreign Currency		
1. Land Acquisition	ha	410	312,500	128,130	128,130	0		
2. Site Preparation				(351,780)	(207,420)	(144,360)		
Preparatory Work	ha	410	20,000	8,200	7,380	820		
Earth Work	m^3	3,070,000	30	92,100	73,680	18,420		
Revetment	m	845	48,805	41,240	20,340	20,900		
Quaywall	m	820	252,000	206,640	103,320	103,320		
Reclamation	m^3	900,000	4	3,600	2,700	900		
3. Road				(37,660)	(23,880)	(13,780)		
Trunk Road	m	10,600		31,710	20,610	11,100		Right of way; 15m – 40m
Bridge	Unit	2		5,950	3,270	2,680		
4. Water Supply								
(1) Industrial Water Supply				(99,960)	(23,930)	(76,030)		
Steel Piping	m	11,700		93,320	18,860	74,460		Steel pipe; ϕ700m/m-ϕ1,200m/m
Box Culvert	m	250	26,540	6,640	5,070	1,570		
(2) Portable Water Supply				(37,520)	(25,500)	(12,020)		
Purification Plant	Ls	1		3,870	1,940	1,930		
Steel Piping	m	8,850		32,200	22,550	9,650		Steel pipe; ϕ250m/m-ϕ500m/m
Conc. Piping	m	2,450	590	1,450	1,010	440		A.C. pipe; ϕ250m/m
5. Drainage				(20,870)	(15,660)	(5,210)		
River Improvement	m	4,500	1,845	8,330	6,230	2,070		
Watercource	m	26,020		12,570	9,430	3,140		
6 Power Supply				(202,030)	(100,830)	(101,200)		
High-tension/Substation	Ls	1		193,980	94,390	99,590		
Street Lighting	Ls	1		8,050	6,440	1,610		
Sub-total				877,950	525,350	352,600	38,170	
Investigation/Engineering	Ls	1		47,590	19,040	28,550		
Physical Contingency	Ls	1		74,960	39,710	35,250		
Total				1,000,500	584,100	416,400	43,500	
					(58.4%)	(41.6%)		

Table 3.2-4 Port Area

Item	Unit	Quantity	Unit Price (฿)	Amount (thousand ฿)			Total Amount (Thousand US$)	Remarks
				Total	Local Currency	Foreign Currency		
1. Land Acquisition	ha	17	312,500	5,310	5,310	0		
2. Site Preparation				(5,440)	(4,390)	(1,050)		
Preparatory Work	ha	17	20,000	340	310	30		
Earth Work	m^3	255,000	20	5,100	4,080	1,020		
3. Port Facilities				(2,011,370)	(1,007,980)	(1,003,390)		
Dredging	m^3	11,100,000	46	510,600	204,240	306,360		
Reclamation	m^3	2,400,000	4	9,600	7,200	2,400		
Breakwater	m	3,000		568,290	284,150	284,140		
Revetment	m	1,670	90,275	150,760	77,980	72,780		
Groin	m	1,400		72,000	41,040	30,960		
Quaywall	m	850		193,700	96,850	96,850		
Wharf	m	280	861,000	241,080	96,430	144,650		
Navigation Aids	Ls	1		12,000	1,200	10,800		
Road	m	3,050		9,320	6,060	3,260		
Pavement	m^2	121,800		47,070	30,600	16,470		
Buildings	m^2	28,800		159,050	135,190	23,860		
Water Supply	Ls	1		7,530	4,800	2,730		
Drainage	Ls	1		4,240	3,180	1,060		
Sewerage	Ls	1		6,090	3,670	2,420		
Power Supply	Ls	1		20,040	15,390	4,650		
4. Cargo Handling Equipments	Ls	1		*313,900	57,850	256,050		
5. Tug Boats etc.	Ls	1		**100,000	0	100,000		
Sub total				2,436,020	1,075,530	1,360,490	105,910	
Investigation & Engineering	Ls	1		114,000	39,760	74,240		
Physical Contingency	Ls	1		201,680	100,610	101,070		
Total				2,751,700	1,215,900	1,535,800	119,640	
					(44.2%)	(55.8%)		

* Included in this amount is the cost of following equipments

Slip Loader	1250 t/h x 1
Staker/reclaimer	1250 t/h x 1
Bucket Elevator	1250 t/h x 2
Belt Conveyer	1900 m
Mobile Crane	40 t x 2
Forklift	5
Pay Loader	3

**This amounts is the follwoing ship's purchase price

Tug Boat	3000 ps x 1, 2000 ps x 2
Pilot Boat	2

Table 3.2-5 Urban Area

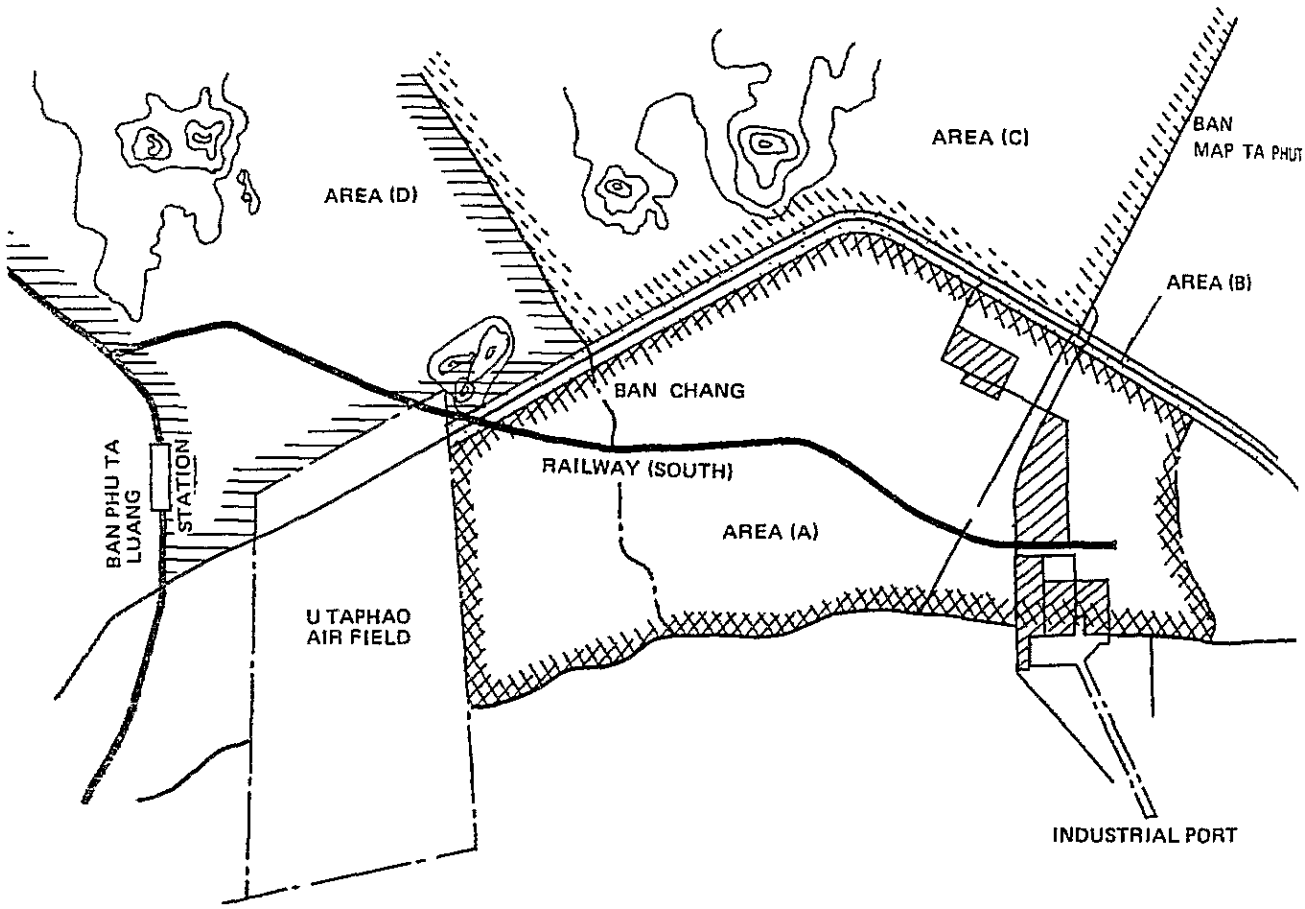
Item	Unit	Quantity	Unit Price (฿)	Amount (thousand ฿)			Total Amount (Thousand US$)	Remarks
				Total	Local Currency	Foreign Currency		
1. Land Acquistion	ha	157	312,500	49,060	49,060	0		
2. Site Preparation				(19,290)	(15,710)	(3,580)		
Preparatory Work	ha	136.5	20,000	2,730	2,460	270		
Earth Work	m³	828,000	20	16,560	13,250	3,310		
3. Road				(78,830)	(51,240)	(27,590)		
Trunk Road	m	6,600		31,000	20,150	10,850		Right of way; 16m – 30m
Distributor/Access Road	m	27,000		47,830	31,090	16,740		Right of way, 6.5m – 12m
4. Water Supply				(78,740)	(49,300)	(29,440)		
Purification Plant	Ls	1		29,100	14,550	14,550		
Steel Piping	m	7,550		34,630	24,240	10,390		Steel pipe; ϕ300m/m-ϕ1,000m/m
Conc. Piping	m	34,760		15,010	10,510	4,500		A.C pipe; ϕ150m/m
5. Drainage				(44,730)	(33,550)	(11,180)		
Watercourse	m	17,660		42,730	31,950	10,780		
Flood-Control Reservoir	m³	100,000	20	2,000	1,600	400		
6. Sewerage				(51,040)	(30,760)	(20,280)		
Treatment Plant	Ls	1		30,110	15,060	15,050		
Piping	m	37,500		20,930	15,700	5,230		R.C pipe; ϕ200m/m – ϕ600m/m
7. Solid Waste Disposal	m²	55,000		12,690	8,880	3,810		* Development Unit Cost
8. Power Supply				(65,450)	(43,970)	(21,480)		Salable Area 80 ha
High-tension/Substation	Ls	1		26,900	13,100	13,800		∴ 484,800,000 ÷ 80 = 6,060,000 ฿/ha
Transmission Line	Ls	1		38,550	30,870	7,680		$(484{,}800{,}000 \div \frac{80{,}000}{1600} = 969{,}600$ ฿/Rai)
9. Pedestrian Way	m	2,990	1,620	4,840	3,870	970		
10. Park	m²	140,000	48.6	6,800	5,440	1,360		
Sub Total				411,470	291,780	119,690		
Investigation/Engineering				37,120	11,960	25,160	17,890	
Physical Contingency				36,210	24,260	11,950		
Total				484,800	328,000	156,800	21,080	
					(67.7%)	(32.3%)		

Item	Unit	Quantity	Unit Price (฿)	Amount (thousand ฿)			Total Amount (Thousand US$)	Remarks
				Total	Local Currency	Foreign Currency		
1. Land Acquisition		(127.4 ha)		*(37,250)	(37,250)	(0)		
Within Promalgated Area	ha	79.4		24,810	24,810	0		
Outside Promalgated Area	ha	48.0		12,440	12,440	0		
2. Trunk Line				(167,200)	(105,010)	(62,190)		
(1) Truck Structure				(82,960)	(63,370)	(19,590)		
Preparatory Work	ha	47.2		944	850	94		
Embankment	m^3	662,000		55,740	44,592	11,148		
Sodding	m^2	162,000		2,430	2,430	0		
Latteraite	m^3	47,200		8,968	5,829	3,139		
Aggregate Base	m^3	42,500		14,875	9,669	5,206		
(2) Truck Work				(58,740)	(27,610)	(31,130)		
Concrete Sleeper	Unit	36,350		28,353	21,265	7,088		
Truck (80 lb)	ton	1,888		24,544	2,454	22,090		
Spike (80 lb)	set	7		1,120	112	1,008		
Truck Installation	km	23.6		4,720	3,776	944		
(3) Bridge	Unit	11		25,500	14,030	11,470		
3. Marshaling Yard				(21,570)	(12,420)	(9,150)		
(1) Truck Structure				(9,070)	(6,550)	(2,520)		
Preparatory Work	ha	25		500	450	50		
Embankment	m^3	88,000		3,520	2,817	703		
Latteraite	m^3	10,000		1,900	1,235	665		
Aggregate Base	m^3	9,000		3,150	2,048	1,102		
(2) Truck Work	m			12,500	5,870	6,630		
4. Communication/Signalling	Ls	1		20,000	18,000	2,000		
5. Lighting Facilities	Ls	1		3,260	1,880	1,380		
6. Maintenance Office	Ls	1		2,900	2,460	440		
Sub-total				252,180	177,020	75,160	10,960	
Investigation/Engineering	Ls	1		28,860	11,500	17,360		
Physical Contingency	Ls	1		32,260	20,980	11,280		
Total				313,300	209,500	103,800	13,620	
					(66.9%)	(33.1%)		

* Land Acquisition Area is shown in following table and figure.

Land Acquisition Area

	AREA (A)	AREA (B)	AREA (C)	AREA (D)	TOTAL
South Routh (ha)	93.4	1.0	–	33.0	127.4
Cost (฿/Rai)	50,000	300,000	20,000	30,000	



Railway Alignment

Table 3.2-7 Telecommunication

Item	Unit	Quantity	Unit Price (฿)	Amount (Thousand ฿)			Total Amount (Thousand US$)	Remarks
				Total	Local Currency	Foreign Currency		
1. Telephone System	Ls	1		77,710	10,880	66,830		
2 Telex Telegraph	Ls	1		14,560	14,000	560		
3 Local Cable System	Ls	1		29,520	29,520	0		
4 P.C.M Cable System	Ls	1		4,710	0	4,710		
Total				126,500	54,400	72,100	5,500	
					(43.0%)	(57.0%)		

Table 3.2-8 Housing & Public Facilities

Item	Unit	Quantity	Unit Price (฿)	Amount (Thousand ฿)			Total Amount (Thousand US$)	Remarks
				Total	Local Currency	Foreign Currency		
1. Housing				(723,150)	(723,150)			
Detached house	Unit	440	600,000	264,000	264,000	0		
Semi-detached house	Unit	870	350,000	304,500	304,500	0		
Town house	Unit	1,740	55,000	95,700	95,700	0		
Flat (low house)	Unit	1,310	45,000	58,950	58,950	0		
2. Education Facilities				(52,330)	(44,480)	(7,850)		
Secondary school	Unit	1	30,000,000	30,000	25,500	4,500		
Primary school	Unit	1	18,900,000	4,730	4,020	710		
Kindergarten	Unit	4	4,400,000	17,600	14,960	2,640		
3. Community Facilities				(275,000)	(233,750)	(41,250)		
Town	m^2	25,000	8,000	200,000	170,000	30,000		
Local center	m^2	15,000	5,000	75,000	63,750	11,250		
Sub-total				1,050,480	1,001,380	49,100	45,670	
Investigation & Engineering	Ls	1		52,520	21,010	31,510		
Physical Contingency	Ls	1		73,500	70,010	3,490		
Total				1,176,500	1,092,400	84,100	51,150	
					(92.9%)	(7.1%)		

Table 3.2-9 Plant Construction

Item	Unit	Quantity	Unit Price (฿)	Amount (Thousand ฿)			Total Amount (Thousand US$)	Remarks
				Total	Local Currency	Foreign Currency		
1. Supporting Industry	Ls	1		844,200	485,500	358,700	36,700	
2. Petro Chemical	Ls	1		15,890,700	5,490,100	10,400,600	690,900	
3. Soda Ash	Ls	1		5,921,200	1,938,700	3,982,500	257,450	
4. Fertilizer	Ls	1		13,096,200	3,976,700	9,119,500	569,400	
Total				35,752,300	11,891,000	23,861,300	1,554,450	

1) Physical Contingency is assumed to be 8 percent of as-build plant cost.
2) Project management, field expenses including supervision and indirect cost are assumed to be 15 percent of as-build plant cost. Indirect cost comprises license fee, investigation and engineering, training, and consultant.
3) Fertilizer and Soda-Ash plant cost involves wharf construction cost in each.
4) Pre-operation expenses, initial working capital and interest during construction are excluded in this cost estimation.

CHAPTER 4
FINANCIAL ANALYSIS

CHAPTER 4. FINANCIAL ANALYSIS

4.1 Financial Analysis of the Industrial Port

4.1.1 Purpose of the Financial Study

The purpose of this financial analysis is to examine the effect of the project investment on the implementation body concerned, in other words, to analyze how the costs and profits incurred in carrying out the project effect the financial status of the management body and to propose how its financial healthiness may be ensured.

The effects of investment related to the development of the new industrial port at Map Ta Phut are analyzed and evaluated herewith by the following methods.

(1) Analysis and evaluation of the project by financial statements, in other words
   (i) To study the projected profit and loss of the project
   (ii) To evaluate the debt repayment ability in light of the projected cash flow of the project
   (iii) To study the appropriate level of port tariff for the new industrial port
(2) Analysis and evaluation of the project by D.C.F. method.

4.1.2 Assumptions of the Financial Analysis

This financial analysis will be made under the following assumptions as base case.

(1) Map Ta Phut new industrial port will start its full operation in 1988, the target year of Eastern Seaboard Development projects and the period of this study covers 27 years up to 2,014.
(2) It's accounting will be in accordance with business accounting system.
(3) The construction cost of Map Ta Phut new industrial port comes to Baht 2,751,700,000 (see table 3.2-4) which covers cost of breakwaters, channels, basins commercial terminals, land preparation and its related facilities. Construction cost of private wharves 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 in this analysis.
(4) The funds necessary to execute this project are to be raised as follows.

Table 4.1-1 Funds Raising Plan

(Unit: Baht, ,000-)

	Foreign Currency Portion	Domestic Durrency Portion	Total
Funds Required	1,535,800	1,215,900	2,751,700
	55.5%	44.5%	
Funds Raising	Borrowing	Government Funds	
Interest Rate	3.5% P.A.		
Grace Period	10 years	Free of interest	
Loan Period	30 years		

In Thailand two ports (Klong Toei and Sattahip) are under P.A.T.'s administration. However, the major facilities of Klong Toei port were constructed by the Transport Department at that time and transferred to P.A.T. while those of Sattahip port were initially made by the U.S. Navy and were later released for public use under P.A.T's administration.

In view of the above it is assumed that the initial investment at Map Ta Phut industrial port will be shared by the Government who will invest the whole of the domestic currency portion of the project.

(5) For the depreciation of fixed assets a straight line method was employed, the service life of each asset was in accordance with P.A.T's standard except for the breakwater, groin, revetment, quaywall and wharf to which 50 years were applied instead of 28 years and for road and pavement 25 years of I.E.A.T's standard was applied. The salvage value was set at nil.

Table 4.1-2 Service Life of Facilities

Item	Depreciation Rate %	Period of Depreciation (years)
Breakwater	2.00	50
Revetment	2.00	50
Groin	2.00	50
Quaywall	2.00	50
Wharf	2.00	50
Navigation aids	4.55	22
Road	4.00	25
Pavement	4.00	25
Buildings	3.57	28
Water supply	3.57	28
Drainage	3.57	28
Sewarage	3.57	28
Power supply	3.57	28
Shiploaders	7.69	13
Belt conveyor	7.69	13
Cranes	7.69	13
Tug boats	4.55	22

Harbour facilities (dredging and reclamation), land acquisition and site preparation have been excluded from depreciation as non depreciable assets. Investigation/Engineering and contingency were also excluded from depreciation.

(6) As is described in 2.1.3 it is assumed that Map Ta Phut port will be operated by a New State Enterprise which is exempted from taxes on corporate profit and payment of taxes is not considered here.

(7) It is assumed that 80% of the net cash flow balance is placed on deposit and 20% is retained as cash. 9% is assumed as the interest on money for deposit.

(8) It is also assumed that payment of interest during construction period is to be made either by NSE's own fund or government subsidy.

4.1.3 Revenue Projection

(1) Revenue from port charges

Revenues from port charges were estimated on the basis of P.A.T's port tariff rates.

The current port tariff rates are revised new rates effective from 1 December 1982 onward.

Special port tariff rates for Map Ta Phut New Industrial Port on a cost basis were not employed and the port maintains its competitive power against the other ports in terms of port charges.

Table 4.1-3 Port Charges and Dues

1. Changes on Ship	
Channel Due	Baht 3.00 (Vessels of 500 – 1,500 N.R.T.)/N.R.T.
	Baht 5.00 (Vessels of above 1,500 N.R.T.)/N.R.T.
Wharf Rate	Baht 1.50/N.R.T. for calling vessels
Water Supply	Baht 20.00/m^3
Towage Charge	Baht 1,450 (less than 2,000 HP)/hour
	Baht 5,000 (over 2,000 HP)/hour
Pilotage	Baht 1,600 + (ship's length -165 ft) x 10 ..... (A)
	A + 0.1A x (ship's draughts -10 ft)
2. Charges on Cargoes	
Landing Charge	Baht 29.00/mt ..... import
(Quay Charge)	Baht 1.50/mt ..... export
	Baht 29.00/mt x 0.7 ..... domestic
Handling Charge	Baht 39.5/mt ..... import
	Baht 60.0/mt ..... export (tapioca/potash)
	Baht 39.5/mt and 52.5/mt.. domestic
Rent	Baht 4.20/mt/day ..... import/domestic cargoes at open storage/transit shed
	Baht 25.00/mt/week ..... import/domestic cargoes at werehouse
	Baht 13.00/mt/week ..... export cargoes at warehouse
	Baht 4.00/mt/week ..... export cargoes at open storage

Out of the above charges and dues three items below were set as follows,

(a) Pilotage charge: current tariff rate for pilotage of the harbour department was applied.

(b) Charges for outward domestic cargoes:

charges for outward domestic cargoes were not specifically prescribed in P.A.T's tariffs, it is assumed the same tariff of port charges for inward domestic cargoes are applied to cargoes for outward domestic cargoes.

(c) Handling charges for tapioca and potash export:

cargo handling service by P.A.T. usually applies upto the apron of the quay, whereas the loading of cargoes into the ship is usually handled by stevedores. At the new industrial port N.S.E. also takes charge of loading of bulky cargoes into the ship by the installation of cargo handling equipment (belt conveyor, ship loader and etc.)

Baht 60.00 was set as the handling charge for tapioca and potash export against Baht 39.5 x 1/2 for usual cargo handling charges.

The above charge was fixed taking handling and loading charges of bulky cargoes applied by private sectors into consideration.

The annual total revenue from the port charges is Baht 175,670,000 with the breakdown given in Table 4.1-4.

It is assumed that average storage period of cargoes is 7 days.

Table 4.1-4 Revenues of Port Charges

(Unit: Baht ,000-)

Item	Revenues
1. Charges On Ships	
Channel Dues	11,382
Wharf Rates	2,678
Water Supply	2,182
Towage Charge	12,630
Pilotage Charge	12,886
Sub Total	(41,758)
2. Charges On Cargoes	
Landing (Quay) Charges	13,353
Handling Charges	101,461
Rent	19,098
Sub Total	(133,912)
Total	175,670

The annual number of calling vessels, tonnage (N.R.T.), water supply quantity of each vessel and annual cargo volumes are shown in Table 2.1-3.

(2) Lease of Utilities

(a) Lease of Land

The Area for port activities 54,500 m^2 (34.0625RAI) in the newly developed port are to be leased to tenants and the price of leased land is set at Baht 1,187,000/ year.

(b) Lease of the quaywall for petro chemical industry

A quaywall with a length of 135 m (including a 30 m buffer for dangerous cargoes) is to be leased at a cost of Baht 2,000,000/year, exclusively for shipment of petro chemical products.

(c) Above lease price is comprised of depreciation, maintenance and interest of construction cost for each utility and these components are set as follows.

(i) Depreciation cost: depreciation rate from Table 4.1-2 was employed
(ii) Maintenance cost: the ratio shown in Table 4.1-6 was employed.
(iii) Interest cost: calculation of interest is performed by the following formula

$$I = A - \frac{c}{n}$$

I = cost of interest
c = construction cost of utilities
n = service life of utilities
γ = interest rate (assumed to be 4.0% P.A)

$$A = c \times \frac{\gamma (1+\gamma)^n}{(1+\gamma)^n - 1}$$

A = annual equal installment of principal and interest

Table 4.1-5 Rent for Land and Quaywall

(Unit: Baht ,000-)

Items	Port Activity Area (54,500 m^2)	Quaywall for Petro-Chemicals	Total
Construction Cost	17,010	38,800	55,810
1. Depreciation Cost	489	776	1,265
2. Maintenance Cost	233	194	427
3. Interest	465	1,030	1,495
Total (1 – 3)	1,187	2,000	3,187

Note: Contracts of lease are renewed at the internal of ten years.

4.1.4 Expenditure

The expenditures are divided into six items: personnel cost, administration cost, operational cost, maintenance and repair cost, depreciation cost and paid interest. They are to be calculated as follows.

(1) Personal cost

Based on the financial data of P.A.T. in 1982, annual per capita cost has been set at Baht 52,000 (which is 5% over the average per capita cost of employees at Sattahip port in 1982). The required number of employees at the proposed port division of N.S.E. is 350 as is shown in Figure 2.1-2.

(2) Administrative cost

The ratio of administrative cost to the personnel cost based on P.A.T's data is 38%, hence the annual per capita administrative cost is Baht 19,760.

(3) Maintenance and repair cost

The maintenance/repair costs of various facilities, computed on the basis of the ratio of such costs to the construction costs are shown for each facility in Table 4.1-6.

4% was determined as the maintenance dredging cost of the channel as follows.

The volume of the sedimented material in the channel was estimated at an average of 450,000 m^3/year based on the Bijeker Method, where the total quantity of capital dredging in the channel is 11,000,000 m^3.

Table 4.1-6 Cost of Maintenance and Repair by Facilities

Facilities	Persentage of Construction Cost %
Dredging	4.0
Breakwater	0.2
Revetment	0.2
Groin	0.2
Quaywall	0.5
Wharf	0.5
Navigation Aids	3.0
Road	1.0
Pavement	1.0
Buildings	1.5
Power Supply	2.0
Drainage	0.5
Sewarage	2.0
Belt Conveyor	4.0
Cranes	5.0
Ship Loader/Reclaimer	2.0
Tug Boats and Other Vessels	10.0

Note: Maintenance cost of water supply is included in water cost.

(4) Operational cost

Operational cost consists of the costs for water consumption, electricity, and fuel for port facilities.

(a) Water cost

Water cost consists of the costs for fresh water, chemicals, electricity, maintenance and repair and is estimated at Baht 3.00/m^3. Yearly water consumption is estimated at 152,900m^3 (109,100m^3 for ship's use and 43,800m^3 for general consumption) and the total water cost comes to Baht 459,000.

(b) Electricity

The total cost of electricity comes to Baht 5,100,000/year. The details are as follows.

① Demand

(i) Cargo Handling Equipment
1,335 kw x 70% = 935 kw

(ii) Lighting

		(L/F)*	
Office	60 kw x	80% = 48 kw	*L/F = load factor
Warehouse	75 kw x	80% = 60 kw	
Transit shed	5 kw x	80% = 4 kw	173 kw
Open yard	50 kw x	80% = 40 kw	
Road	15 kw x	100% = 15 kw	
Dumping area (for the railway side line)	10 kw x	60% = 6 kw	

(i) + (ii) = 1,108 kw ≒ 1,100 kw x @ Baht 95/kw x 12 months
= Baht 1,254,000/year

② Energy

1,764,000 kwH (Cargo Handling Equipment) + 766,500 kwH (Lighting) = 2,530,500 kwH
2,530,500 kwH x @ Baht 1.52/kwH = Baht 3,846,000/year

① + ② = Baht 1,254,000 + Baht 3,846,000 Baht
= Baht 5,100,000.–

(c) Fuel cost

Fuel cost comes to Baht 9,329,000 as below,

Table 4.1-7 Fuel Cost

(Unit: Baht ,000-)

	Oil consumption (kℓ/Yr)	Unit price Baht/ℓ	Amount (Baht 1,000)
1. Marine Diesel Oil			
Tug Boat	1,404		
Pilot Boat	46		
Sub Total	1,450	5.25	7,613
2. Light Oil			
Mobile Crane	20		
Fork Lift	62		
Pay Loader	68		
Trucks	90		
Sub Total	240	6.0	1,440
3. Gasoline			
Cars	29	9.5	276
4. Total (1+2+3)	1,719		9,329

Table 4.1-8 Management and Operation Cost

(Unit: Baht ,000-)

Item	Amount/year
(1) Personnel Cost	18,200
(2) Administration Cost	6,916
(3) Maintenance and Repair Cost	48,498
(4) Operational Cost	
Water Cost	459
Electricity	5,100
Fuel Cost	9,329
Total	88,502

(5) Depreciation cost

As for depreciable assets, the service life of each facility has been set in accordance with P.A.T's standards as shown in Table 4.1-2.

Each facility is to be replaced at the end of the year during which its service life expires.

The fixed assets schedule is presented in Table 4.1-9.

Table 4.1-9 Fixed Assets Schedule

(Unit: Baht ,000-)

Year	Investment		Depreciation	Fixed asset at end of the year			
	Non Depreciable Assets	Depreciable Assets		Construction in Process	Now Depreciable Assets	Net Fixed Assets after Depreciation	Total
1984	39,760			(39,760)	39,760		39,760
1985	260,150	299,770		(599,680)	297,910	299,770	599,680
1986	485,790	807,840		(1,873,310)	785,700	1,107,610	1,893,310
1987	60,930	797,460		(2,751,700)	846,630	1,905,070	2,751,700
1988			63,043		846,630	1,842,027	2,688,657
1989			63,043		846,630	1,778,984	2,625,614
1990			63,043		846,630	1,715,940	2,562,570
1991			63,043		846,630	1,652,897	2,499,527
1992			63,043		846,630	1,589,854	2,436,484
1993			63,043		846,630	1,526,811	2,373,441
1994			63,043		846,630	1,463,768	2,310,398
1995			63,043		846,630	1,400,724	2,247,354
1996			63,043		846,630	1,337,681	2,184,311
1997			63,043		846,630	1,274,638	2,121,268
1998			63,043		846,630	1,211,595	2,058,225
1979			63,043		846,630	1,148,552	1,995,182
2000		313,900	63,043		846,630	1,399,409	2,246,039
2001			63,043		846,630	1,336,365	2,182,995
2002			63,043		846,630	1,273,322	2,119,952
2003			63,043		846,630	1,210,279	2,056,909
2004			63,043		846,630	1,147,236	1,993,866
2005			63,043		846,630	1,084,193	1,930,923
2006			63,043		846,630	1,021,149	1,867,779
2007			63,043		846,630	958,106	1,804,736
2008			63,043		846,630	895,063	1,741,693
2009		112,000	63,043		846,630	944,020	1,790,650
2010			63,043		846,630	880,977	1,727,607
2011			63,043		846,630	817,933	1,664,563
2012		56,390	63,043		846,630	811,280	1,657,910
2013		313,900	63,043		846,630	1,062,137	1,908,767
2014			63,043		846,630	999.094	1,845,724

(6) Interest on long term loans

54.9% of the project cost is covered by foreign long term loans and 45.1% by government funds.

The balance of loans and amount of interest paid are shown in Table 4.1.10.

Table 4.1-10 Long Term Loan Schedule

(Unit: Baht ,000.)

Year	Project cost			Loan Repayment Amount	Loan Balance at End	Interest on Loan
	Government Funds	Long Term Loan	Total			
1984	6,930	32,830	39,760		39,760	575
1985	270,560	289,360	559,920		322,190	6,213
1986	610,510	683,120	1,293,630		1,005,310	23,231
1987	327,900	530,490	858,390		1,535,800	44,469
1988					1,535,800	53,753
1989					1,535,800	53,753
1990					1,535,800	53,753
1991					1,535,800	53,753
1992					1,535,800	53,753
1993					1,535,800	53,753
1994					1,535,800	53,753
1995				1,642	1,534,158	53,724
1996				16,110	1,518,048	53,414
1997				50,266	1,467,782	52,252
1998				76,790	1,390,992	50,029
1999				76,790	1,314,202	47,341
2000				76,790	1,237,412	44,653
2001				76,790	1,160,622	41,966
2002				76,790	1,083,832	39,278
2003				76,790	1,007,042	36,590
2004				76,790	930,252	33,903
2005				76,790	853,462	31,215
2006				76,790	776,672	28,527
2007				76,790	699,882	25,840
2008				76,790	623,092	23,152
2009				76,790	546,302	20,464
2010				76,790	469,512	17,777
2011				76,790	392,722	15,089
2012				76,790	315,932	12,401
2013				76,790	239,142	9,714
2014				76,790	162,352	7,026
Total	1,215,900	1,535,800	2,751,700	1,373,448	—	—

4.1.5 Evaluation by Financial Statements

The income statement, the cash flow statement and the balance sheet (Table 6-1 in appendix 6) were prepared under above-mentioned conditions.

The summary of financial indices is presented in the following table.

Table 4.1-11 Summary of Financial Indices

(Unit: Baht ,000-)

	Construction and Grace Period (1984~1994)	Repayment Period-(1) (1995~2004)	Repayment Period-(2) (2005~2014)	Total
1. Net Operating Income	△218,199	△43,029	87,008	△174,220
2. Investment (Initial investment + replacement)	2,751,700	313,900	482,290	3,547,890
3. Cash flow from Operation + Interest	673,862	1,040,555	908,644	2,623,060
4. Debt Service (Repayment + interest)	450,759	1,058,698	959,105	2,468,562
5 Net cash flow	(3 – 4) 223,103	[3 – (2+4)] △332,043	[3 – (2+4)] △532,751	△641,691

Note: Cash flow from operation = net operation income + depreciation.

From the study of the financial statements we learn the following.

(1) Although the net operating income remains in the red through the project period, it is possible to meet operating expenses and to depreciate the facilities with the operating revenues.

The payment of interest on the long term loan balance serves to reduce the net operating income during the construction and grace period.

In the course of repayment, the burden of interest payment will decrease and flow of net income after depreciation becomes sufficient to cover payment of interest in 2007, thence not operating income increase year by year. In this sense, the revenue and expenditure status of this project poses no specific problems.

(2) The net cash flow balance stands as negative at the end of the project life. However the project is able to service the debt for repayment of long term loans together with its interest (The amounts of cash flow from operation plus interest exceeds that of debt service through the project life.)

The negative cash flow is brought about not by repayment of loan and interest but by the cash payment for the replacement of facilities after servicing the debt.

The net cash flow balance becomes negative in 2000 and the shortage of funds amounts to Baht 641.7 Million as is shown in the following table. This must be covered either by additional borrowing or government subsidy.

Table 4-1-12 the required sum of Baht 641.7 Million is less than that of the total facility replacement cost up to 2014 (Baht 796.2 Million), thus a portion of the replacement of facilities can be self-financed.

Table 4.1-12 Negative Cash Flow

(Unit: Baht ,000-)

Item / Year	Negative cash flow	Balance	Replacement
2000	− 13,501	− 13,501	313,900
2001	− 27,891	− 41,393	
2002	− 25,203	− 66,596	
2003	− 22,516	− 89,112	
2004	− 19,828	− 108,940	
2005	− 17,140	− 126,080	
2006	− 14,453	− 140,533	
2007	− 11,765	− 152,299	
2008	− 9,078	− 161,376	
2009	− 118,390	− 279,766	112,000
2010	− 3,702	− 283,468	
2011	− 1,015	− 284,483	
2012	− 54,717	− 339,200	56,390
2013	− 309,539	− 648,739	313,900
2014	(+7.048)	− 641,691	
Total	641 691	−	796,190

(3) For reference purpose, case studies where the level of the current tariff rate is raised by an average 5% or 10% may be carried out to examine the status of the financial statements.

Table 4.1-13 Financial Indices after Raising of Tariff Rates

(Unit: Baht ,000-)

Period / Tariff increase	Item	Construction and Repayment Period (1984~1994)	Repayment Period-(1) (1995~2004)	Repayment Period-(2) (2005~2014)	Total
5%	Net operating income	−139,213	146,484	269,023	276,294
	Net cash flow	302,090	−142,532	−350,734	−191,176
10%	Net operating income	−60,199	356,938	682,459	979,198
	Net cash flow	381,104	67,923	62,701	511,728

The table shows that by raising tariff rates by 5% the net operating income becomes positive but the net cash flow still remains as negative, the revenue is not sufficient to self finance the replacement of facilities.

However, by a 10% increase of tariff rates the net operating income as well as the net cash flow remains positive throughout the project life.

For details please see Table 6-2 and 6-3 in appendix 6.

4.1.6 Evaluation by Financial Rate of Return

In evaluating the projects by the DCF method the F.R.R. (financial rate of return) is determined by the following formula wherein the Benefit is the net operating income plus depreciation and interest paid, and the Cost is the initial construction cost and the cost for replacement of facilities during the project life.

It is to be noted that in the final year of the project the outstanding value of each depreciable facility together with undepreciable assets (excluding investigation/engineering fee and contingency) will be added to the Benefit and outstanding balance of borrowing will be deducted therefrom.

$$\sum_{i=1}^{n} \frac{Bi - Ci}{(1 + \gamma)^{i-1}}$$

Bi = Benefits in i-th year
Ci = Costs in i-th year
γ = Internal rate of return

By using the above method, the financial rate of return is calculated in order to evaluate the financial feasibility of the project.

The FRR obtained from the operation of this project is 0.82 as shown in Table 4.1-14.

A level of F.R.R. above that of the interest rate of loan is desirable for execution of the project. In this analysis the interest rate for foreign borrowing was assumed to be 3.5% P.A. which is higher than F.R.R. of 0.82%.

We consider that the above depends essentially on the nature of the project: the development of completely new industrial port which requires more than 50% of the project cost be invested in "non-profitable facilities", namely facilities other than wharves, warehouses, and transit sheds which are directly related to revenue.

In order to secure financial profitability raising the level of tariff rates must be taken into consideration. The port tariff applied to revenue projection is that of P.A.T. common to the other two ports under their management and not one calculated to be self-supporting on cost basis.

Having inherited basic port facilities from U.S. Navy, Port of Sattahip has still suffered from operating losses since 1974.

Therefore, it might be reasonable to consider raising the level of tariff rates to some extent.

The following alternative will be studied for calculation of the F.R.R.

Case 1: Case where the level of tariff rates is raised by 5%
Case 2: Case where the level of tariff rates is raised by 10%
Case 3: Case where the level of tariff rates is raised by 20%

Table 4.1-14 F.R.R. Calculation Sheet

(Base Case F.R.R 0.82%)

(Unit: Baht ,000)

Year	Cost (C)	Benefit (B)	(B – C)	Net Present Value (B – C)
1984	39,760		−39,760	−39,760
1985	559,920		−559,920	−555,382
1986	1,293,630		−1,293,630	−1,272,748
1987	858,390		−858,390	−837,686
1988		90,865	90,865	87,954
1989		90,865	90,865	87,241
1990		92,241	92,241	87,845
1991		95,105	95,105	89,839
1992		98,194	98,194	92,004
1993		101,513	101,513	94,343
1994		105,080	105,080	96,867
1995		108,854	108,854	99,532
1996		112,320	112,320	101,869
1997		114,284	114,284	102,811
1998		114,708	114,708	102,355
1999		113,836	113,836	100,754
2000	313,900	113,094	−200,806	−176,289
2001		90,865	90,865	79,124
2002		90,865	90,865	78,483
2003		90,865	90,865	77,847
2004	90,865	90,865	90,865	77,216
2005		90,865	90,865	76,590
2006		90,865	90,865	75,969
2007		90,865	90,865	75,353
2008		90,865	90,865	74,743
2009	112,000	90,865	−21,135	−17,245
2010		90,865	90,865	73,536
2011		90,865	90,865	72,940
2012	56,390	90,865	34,435	27,449
2013	313,900	90,865	−223,035	−176,147
2014		90,865	90,865	71,181
Residuary Value		1,367,690	1,367,690	1,071,408

The result of calculation shows that F.R.R. is 1.60% for case 1, 2.67% for case 2, and 4.48% for case 3.

The F.R.R. of 4.48% obtained by raising the tariff rates by 20% is well above the loan interest rate, thus showing the financial profitability of the project.

The details of calculation as well as Benefits and Costs are shown in Table 4.1-15, 4.1-16 and 4.1-17.

4.1.7 Conclusion

The financial analysis shows that both the soundness and profitability of this project can be ensured by raising the current tariff rates.

By raising the tariff rates by 10%, the project is able to maintain self supporting financing operations and the F.R.R. obtained by raising the tariff rates by 20% exceeds the level of loan interest rate showing the profitability of the project. The revision of the tariff rates is acceptable since the increase falls within the reasonable range and is well within the entire benefit of this project.

Table 4.1-15 F.R.R Calculation Sheet

(Case 1 F.R.R 1.60%)

(Unit: Baht ,000-)

Year	Cost (C)	Benefit (B)	(B – C)	Net Present Value (B – C)
1984	39,760		−39,760	−39,760
1985	559,920		−559,920	−551,088
1986	1,293,630		−1,293,630	−1,253,203
1987	858,390		−858,390	−818,409
1988		99,648	99,648	93,508
1989		100,294	100,294	92,630
1990		102,703	102,703	93,358
1991		106,358	106,358	95,157
1992		110,288	110,288	97,115
1993		114,510	114,510	99,243
1994		119,048	119,048	101,549
1995		123,864	123,864	103,991
1996		128,452	128,452	106,141
1997		131,621	131,621	107,044
1998		132,887	132,887	106,369
1999		133,441	133,441	105,128
2000	313,900	133,776	−180,124	−139,668
2001		112,063	112,063	85,523
2002		111,581	111,581	83,812
2003		111,258	111,258	82,251
2004		111,121	111,121	80,854
2005		111,253	111,253	79,673
2006		111,596	111,596	78,658
2007		112,165	112,165	77,813
2008		112,978	112,978	77,140
2009	112,000	113,447	1,447	973
2010		106,997	106,997	70,770
2011		108,025	108,025	70,323
2012	56,390	108,607	52,217	33,456
2013	313,900	105,945	−207,955	−131,139
2014		99,648	99,648	61,848
Residuary Value		1,367,690	1,367,690	848,879

Table 4.1-16 F.R.R Calculation Sheet

(Case 2 F.R.R 2.67%)

(Unit: Baht ,000-)

Year	Cost (C)	Benefit (B)	(B – C)	Net Present Value (B – C)
1984	39,760		-39,760	-39,760
1985	559,920		-559,920	-545,375
1986	1,293,630		-1,293,630	-1,227,293
1987	858,390		-858,390	-793,218
1988		108,432	108,432	97,596
1989		109,734	109,734	96,203
1990		113,175	113,175	96,642
1991		117,613	117,613	97,823
1992		122,383	122,383	99,146
1993		127,509	127,509	100,615
1994		133,017	133,017	102,236
1995		138,877	138,877	103,967
1996		144,586	144,586	105,429
1997		148,960	148,960	105,797
1998		151,522	151,522	104,820
1999		153,467	153,467	103,408
2000	313,900	154,523	-159,377	-104,601
2001		134,885	134,885	86,227
2002		136,190	136,190	84,799
2003		137,793	137,793	83,569
2004		139,717	139,717	82,534
2005		141,985	141,985	81,695
2006		144,623	144,623	81,052
2007		147,659	147,659	80,604
2008		151,123	151,123	80,351
2009	112,000	152,965	40,965	21,215
2010		150,942	150,942	76,140
2011		155,253	-155,253	-76,280
2012	56,390	157,981	101,591	48,618
2013	313,900	158,427	155,473	72,471
2014		143,140	143,140	64,989
Residuary Value		1,367,690	1,367,690	620,965

Table 4.1-17 F.R.R Calculation Sheet

(Case 3 F.R.R 4.48%)

(Unit: Baht ,000.)

Year	Cost (C)	Benefit (B)	(B – C)	Net Present Value (B – C)
1984	39,760		–39,760	–39,760
1985	559,920		-559,920	–535,889
1986	1,293,630		–1,293,630	–1,184,973
1987	858,390		–858,390	–752,545
1988		125,999	125,999	105,721
1989		128,613	128,613	103,283
1990		134,120	134,120	103,084
1991		140,123	140,123	103,075
1992		146,574	146,574	103,193
1993		153,506	153,506	103,435
1994		160,957	160,957	103,801
1995		168,903	168,903	104,251
1996		176,855	176,855	104,474
1997		183,639	183,639	103,826
1998		188,790	188,790	102,157
1999		193,519	193,519	100,222
2000	313,900	196,017	–117,883	–58,430
2001		181,028	181,028	85,878
2002		185,779	185,779	84,350
2003		191,086	191,086	83,036
2004		196,990	196,990	81,927
2005		203,536	203,536	81,017
2006		210,771	210,771	80,296
2007		218,748	218,748	79,758
2008		227,521	227,521	79,397
2009	112,000	232,968	120,968	40,402
2010		239,022	239,022	76,404
2011		249,911	249,911	76,457
2012	56,390	259,709	203,319	59,533
2013	313,900	263,817	–50,083	–14,035
2014		260,338	260,338	69,826
Residuary Value		1,367,690	1,367,690	366,830

4.2 Financial Analysis of the Industrial Estate

4.2.1 Purpose of the Financial Analysis

In line with the Eastern Seaboard Development Projects, the Industrial Estate Authority of Thailand (I.E.A.T.) has been appointed as the implementation body of the development project in the Map Ta Phut area.

This Authority is expected to play a leading role in the New State Enterprise (N.S.E.) which is in charge of development and operation of the New Industrial Complex at Map Ta Phut.

I.E.A.T. has already been developing and operating industrial estates in Thailand (Bang Chan, Lat Klabang and Samut Sakhon) with an accumulated wealth of know how concerning industrial estate development projects.

One of the main tasks of N.S.E. under this project is the construction and development of an industrial estate where new heavy industries such as petrochemicals, fertilizer and soda ash are to be established.

While the purpose of financial study is to examine the effect of the investment of this project on the development body. In this chapter we are going to sutdy the following items.

(1) To study the financial healthiness of the project by the financial statements – namely to study the revenue/expenditure status of the project and also evaluate the debt repayment ability in light of the projected cash flow.

(2) To study the financial feasibility of the project by D.C.F. method.

4.2.2 Assumptions of the Financial Analysis

This financial study will be made under the following assumptions.

(1) As is described in chapter 10 of Part I in estimating the development cost of the industrial estate the following are assumed.

(a) N.S.E.'s responsibility is the provisions of the Industrial Plot, related facilities and the necessary infrastructure within the industrial complex. The construction work outside of the industrial complex is carried out by the relevant authorities such as E.G.A.T., C.A.T., P.T.T. and etc.

(b) The infrastructure within the factory limit generally will be planned and constructed by each factory to be compatible with its' own production plant. N.S.E. is not responsible for the construction of the infrastructure within the factory limit. For the detailed breakdown of construction cost alloted to N.S.E. please refer to Table 4.2-1 and Table 4.2-2.

(2) It's accounting will be in accordance with the business accounting system.

(3) N.S.E. is a state enterprise and is exempted from taxes on corporate profit and payment of corporate taxes is not considered here.

(4) Depreciation of the facilities are not considered in this project for the following reasons.

(a) In disposing of factory sites, N.S.E. intends to sell the land on installment basis, therefore, factory sites with various facilities are goods to be sold to tenants and the total cost of the facilities including revetment and quaywall are accounted for in the sales price of land.

(b) Cost of common utilities such as roads, water supply, sewarage and drainage are also included in the sales price of factory sites and recovered by the land sales.

(5) Sales of land will start during the development period (1985–1987) and the project life is assumed to be for 12 years up to 1996.

Table 4.2-1 Construction Cost of Industrial Estate

(Unit: Baht ,000)

	Total Cost	Foreign Portion	Domestic Portion	Inland Area	Seafront Area	
1. Land Acquisition	128,130	0	128,130	89,690	38,440	
2. Site Preparation	351,780	144,360	207,420	60,940	290,840	
Preparatory work	8,200	820	7,380	5,740	2,460	
Earth Work	92,100	18,420	73,680	55,200	36,900	
Revetment	41,240	20,900	20,340	–	41,240	(81,260)
Quaywall	206,640	103,320	103,320	–	206,640	(–)
Reclamation	3,600	900	2,700	–	3,600	
3. Road	37,660	13,780	23,880	26,360	11,300	
4. Water Supply	137,480	88,050	49,430	96,240	41,300	
5. Drainage	20,870	5,210	15,660	14,610	6,260	
6. Power Supply	8,050	1,610	6,440	5,640	2,410	
Sub-Total	683,970	251,400	424,520	293,480	390,490	
7. Investigation Engineering	28,190	16,910	11,280	10,470	17,720	
8. Contingency	55,540	25,280	30,260	20,350	35,190	
Total	767,700	295,200	472,500	324,300	443,400	(251,800)
Selling Area	363.5ha (2,271.9Rai)			252.4ha (1,577.5Rai)	111.1ha (694.4Rai)	
Basic Cost per Rai (Baht/Rai)	Baht 337,915			Baht 205,578	Baht 638,537	Baht 362,615

Note: Construction cost of the hightension line and the substation for power supply is excluded from projected cost in Table 3.2-3, which is assumed to be invested by E.G.A.T./P.E.A.

In the case where a revetment is constructed in place of the quaywall for the seafront area basic cost of the area per Rai comes to Baht 362,615.-

(6) The funds required to execute this project amount to Baht 767,700,000 based on 1983 prices (see Table 4.2-1)

Out of the total cost, the foreign portion stands at 38.5% and the domestic portion comes to 61.5%.

The following two financing packages will be studied,

Table 4.2-2 Cost Distribution of Industrial Estate

Item	Total			1984			1985			1986			1987		
	Amount (thousand ฿)			Amount (thousand ฿)			Amount (thousand ฿)			Amount (thousand ฿)			Amount (thousand ฿)		
	Total	Local	Foriegn	Total	Local	Foreign	Total	Local	Foreign	Total	Local	Foreign	Total	Local	Foreign
1. Land Acquisition	128,130 100%	128,130 (100)	0 (0)	102,500 90%	102,500	0	25,630 20%	25,630	0						
2. Site Preparation	(351,780)	(207,420)	(144,360)				(288,520)	(169,640)	(118,880)	(63,260)	(37,780)	(25,480)			
(1) Preparatory Work	8,200 100%	7,380 (90)	820 (10)				8,200 100%	7,380	820						
(2) Earth Work	92,100 100%	73,680 (80)	18,420 (20)				73,680 80%	58,940	14,740	18,420 20%	14,740	3,680			
(3) Revetment	41,240 100%	20,340 (49.3)	20,900 (50.7)							41,240 100%	20,340	20,900			
(4) Quaywall	206,640 100%	103,320 (50)	103,320 (50)				206,640 100%	103,320	103,320						
(5) Reclamation	3,600 100%	2,700 (75)	900 (25)							3,600 100%	2,700	900			
3. Road	37,660 100%	23,880 (63.4)	13,780 (36.6)				18,830 50%	12,240	6,590	7,530 20%	4,890	2,640	11,300 30%	6,750	4,550
4. Water Supply	(137,480)	(49,430)	(88,050)				(67,480)	(19,460)	(48,020)	(62,500)	(24,870)	(37,630)	(7,500)	(5,100)	(2,400)
(1) Industrial Water Supply	99,960 100%	23,930 (23.9)	76,030 (76.1)				59,980 60%	14,360	45,620	39,980 40%	9,570	30,410			
(2) Service Water Supply	37,520 100%	25,500 (68)	12,020 (32)				7,500 20%	5,100	2,400	22,520 60%	15,300	7,220	7,500 20%	5,100	2,400
5. Drainage	(20,870)	(15,660)	(5,210)				(10,480)	(7,860)	(2,620)	(6,260)	(4,700)	(1,560)	(4,130)	(3,100)	(1,030)
(1) River Improvement	8,300 100%	6,230 (75)	2,070 (25)				4,200 50%	3,150	1,050	2,490 30%	1,870	620	1,610 20%	1,210	400
(2) Water Course	12,570 100%	9,430 (75)	3,140 (25)				6,280 50%	4,710	1,570	3,770 30%	2,830	940	2,520 20%	1,890	630
Sub-Total	675,920	424,520	251,400	102,500	102,500	0	410,940	234,830	176,110	139,550	72,240	67,310	22,930	14,950	7,980
6. Power Supply (Streat Lighting)	8,050 100%	6,440 (80)	1,610 (20)				480 6%	380	100	7,570 94%	6,060	1,510			
Total	683,970	430,960	253,010	102,500	102,500	0	411,420	235,210	176,210	147,120	78,300	68,820	22,930	14,950	7,980
Investigation/Engineering	28,190 100%	11,280 (40)	16,910 (60)	16,910 60%	6,770	10,140	4,230 15%	1,690	2,540	4,230 5%	1,690	2,540	2,820 10%	1,130	1,690
Contingency	55,540 100%	30,260 (54.5)	25,280 (45.5)	0			38,580	20,960	17,620	14,710	7,830	6,880	2,250	1,470	780
Grand-Total	767,700 100%	472,500 (61.5)	295,200 (38.5)	119,410	109,270	10,140	454,230	257,860	196,370	166,060	87,820	78,240	28,000	17,550	10,450

Table 4.2-3 Conditions of Borrowings

	Foreign Portion	Domestic Portion
Case 1-1	8.6% 5 yrs including 3 yrs grace period	16.0% 5 yrs including 3 yrs grace period
Case 1-2	11.0% 5 yrs including 3 yrs grace period	16.0% 5 yrs including 3 yrs grace period

Borrowing from typical private financial sources was supposed for the foreign portion and the usual financial source of N.S.E. (loan from semi-governmental institution) was supposed for the domestic portion.

(7) For each case, it is assumed that a certain portion of the required funds will be covered by internal cash generation as is shown in Table 4.2-4.

Table 4.2-4 Funds Raising Plan

	Foreign Portion	Domestic Portion	Internal Cash Generation	Total
Case 1-1	295,200 (38.5%)	119,824 (15.6%)	352,676 (45.9%)	767,700 (100%)
Case 1-2	295,200 (38.5%)	136,122 (17.7%)	336,378 (43.8%)	767,700 (100%)

Borrowing will be done on the following assumptions.

(a) During the construction period borrowing will be carried out so as to retain the smallest necessary working fund cash surplus (Baht 1 million) after payment of construction costs (including interest incurred in 1984).

(b) The interest rates of the foreign loan are less than for the domestic loans. Therefore currency portion will be borrowed first and any internally generated cash will serve to reduce the amount of the domestic currency borrowing.

(8) Repayment will start in 1988, (the year when the development of the industrial estate will be completed) loans will be made in the middle of each year and interest incurred thereon will be paid at the end of the year. The loan and repayment schedule is shown in Table 4.2-5 and 4.2-6.

Table 4.2-5 Finance program (Case 1-1)

(Unit: ฿,000)

	Foreign portion			Domestic portion		
	Borrowing	Repayment	Balance	Borrowing	Repayment	Balance
1984	125,820		125,820			
1985	169,380		295,200	114,851		114,851
1986			295,200	4,973		119,824
1987			295,200			119,824
1988		62,910	232,290			119,824
1989		147,600	84,690		57,426	62,398
1990		84,690	0		57,912	2,486
1991					2,486	0
Total	295,200	295,200	–	119,824	119,824	–

Table 4.2-6 Finance program (Case 1-2)

(Unit ฿,000)

	Foreign portion			Domestic portion		
	Borrowing	Repayment	Balance	Borrowing	Repayment	Balance
1984	129,418		127,418			
1985	167,782		295,200	122,175		122,175
1986		295,200	295,200	13,947		136,122
1987			295,200			136,122
1988		63,709	231,491			136,122
1989		147,600	83,891		61,088	75,035
1990		83,891	0		68,061	6,974
1991					6,974	0
Total	295,200	295,200	–	136,122	136,122	–

4.2.3 Revenue Projection

(1) Sources of Revenues

The sources of N.S.E. 's revenues are divided into the following items'

(i) Revenues form sale of land

(ii) Maintenance and administration fees for public utilities

(iii) Water supply charges

(2) Pricing

In determining the selling prices of factory sites and service charges the following must be considered.

(i) It is necessary to cover all expenditures during the project life.

(ii) To set reasonable prices and utility charges for tenants of N.S.E. in order to attract investors.

(a) Pricing of factory sites

In the project of Map Ta Phut Industrial estate the cost per Rai of a factory site is set as follows (see Table 4.2-1)

Sea frontage site (Soda Ash and Fertilizer)	639,000 Baht/Rai
Inland site (Petrochemical and supporting industries)	206,000 Baht/Rai

Development cost of sites for the soda ash and fertilizer complex are higher than those of the petrochemical and supporting industries' complex. The waterfront sides of the soda ash and fertilizer complex are equipped with revetments and quaywalls for ship berthing, while the sites for the petrochemical and supporting industries are without such facilities. The breakdown of the constructioncost for the factory sites are shown in Table 4.2-1 Under current government law the land developer must pay the following taxes and fees for the sale of land.

Land transfer fee	2.5%
Commercial tax	3.50%
Municipal tax	0.35% (10% of commercial tax)
Total	6.35%

With these taxes and N.S.E.'s 10% margin on the top of the basic cost per Rai of factory sites, the following prices are set for each factory site.

Table 4.2-7 Sale Price of Factory Sites

(Unit: Baht/Rai)

	Basic cost	Margin 10%	Taxes 6.35%	Sale price
Factory Site at Seafront (Soda Ash and Fertilizer)	639,000	63,900	40,576	743,476 ≒ 744,000
Factory Site at Inland (Petrochemical and Supporting industries)	206,000	20,600	13,081	239,681 ≒ 240,000

It is assumed that the sale price of factory sites will increase 5% annually so that it may give incentive for early purchase of the land in order to obtain land at a better price.

The above prices for inland areas are considered to be reasonable compared with those of other industrial estates under I.E.A.T. development and which are currently up for sale.

(b) Maintenance and administration fee

The maintenance and administration fee charged to tenants for usage of the common utilities of the industrial estate was set at Baht 2,000/Rai. This covers the maintenance and administration costs of common utilities such as roads and drainage in the industrial estate maintained by N.S.E.

(c) Water supply charges

The water supply charges have been set as follows;

Baht 3.3/m^3 for service water and Baht 1.6/m^3 for industrial water. Treatment of waste water in the industrial estate will be independently disposed by the tenants within their factory limit and the sewarage charge was not considered here.

(3) Revenues projection

(a) Revenue from sales of land

The total salable land in the Industrial estate amounts to 2,271.9 Rai. It is anticipated that land sales will start in 1985 and will be all sold out by the end 1986 so that Map Ta Phut industrial complexes will start its full operation in the beginning of 1988.

Table 4.2-8 shows the estimated sales area for each factory site. It is N.S.E.'s policy to sell the land under installment payment with the following conditions.

(i)	Down payment	20%
(ii)	Installment period	5 years
(iii)	Installment payment	semiannual 10 equal installment
(iv)	Interest	12% to be paid semiannually on the unpaid balance

Table 4.2-8 Sales Plan

(Unit Rai)

Factory site	1985	1986	1987	TOTAL
Water Front Site				
Soda Ash	335.6 (100%)			694.4
Fertilizer	358.8 (100%)			
Inland Site				
Petro-chemical	1,262.5 (100%)			1,577.5
Supporting Industries	157.5 (50%)	157.5 (50%)		
Total	2,114.4	157.5		2,271.9

(b) Maintenance and administration charges

An annual charge of Baht 2,000/Rai will be collected from tenants and the total revenue from this charge will be Baht 4,543,800.

The collection of the fee will start in 1988 when the land development will be completed and all the sites will be in the possession of tenants.

(c) Water supply charges

Charges of Baht 3.3/m^3 for service water and Baht 1.6/m^3 for industrial water will be collected from tenants. The consumption of water supply in the industrial estate has been estimated as follows.

(i) Service water 270,100 m^3/year

(ii) Industrial water 34,400,000 m^3/year

(water consumption of 1.76 million m^3/year at Gas Separation plant is not included here.)

The water use of service water is to start from 1985 and for industrial water from 1988 respectively.

The projected revenues for each year from these sources are shown in Table 4.2-9.

Table 4.2-9 Revenue Projection

(Unit: Baht ,000-)

Items	1985	1986	1987	1988	1989	1990	1991	1992
1. Sales of Factory Sites	212,643	221,115	204,588	187,364	170,139	154,914	6,731	
Down payment	171,487	7,939						
Installment		137,189	143,540	143,540	143,540	143,540	6,350	
Interest	41,157	75,987	61,049	43,824	26,597	9,374	381	
o Seafront Area	128,125	127,298	117,379	107,460	97,540	87,621		
Down payment	103,327							
Installment		82,661	82,661	82,611	82,661	82,661		
Interest	24,798	44,637	34,718	24,798	14,879	4,960		
o Inland Area	84,518	93,816	87,209	79,904	72,599	65,293	6,731	
Down payment	68,160	7,938						
Installment		54,528	60,878	60,878	60,878	60,878	6,350	
Interest	16,358	31,350	26,331	19,026	11,720	4,415	381	
2. Maintenance charge				4,544	4,544	4,544	4,544	4,544
3. Water Supply charge	446	713	713	55,931	55,931	55,931	55,931	55,931
Service Water	446	713	713	891	891	891	891	891
Industrial Water				55,040	55,040	55,040	55,040	55,040
Total (1 + 2 + 3)	213,089	221,828	205,302	247,839	230,614	213,389	67,207	60,475

4.2.4 Projection of Operating Cost

(1) Personnel costs

The administrative organization of N.S.E. at Map Ta Put Industrial estate is described in Fig. 2.1-3.

The required manpower, broken down by class, and the annual cost therefore are as follows:

Table 4.2-10 Personnel Costs

(Unit: Baht)

Class	Number	Unit Cost/Month	Table Cost/Year
Manager	1	18,900	226,800
Chief Engineer	1	16,600	199,200
Section Chiefs	2	14,500	348,000
Economists Engineers	5	8,500	510,000
Technicians	10	5,000	600,000
Typists	4	4,300	206,400
Securities	3	3,950	142,200
Drivers	4	3,650	175,200
Workers	10	3,100	372,000
Total	40		2,779,800

As shown in this table, the annual personnel expenses come to Baht 2,779,800. However, this cost is for the full operations of N.S.E. During the construction period (1984–1987) the administrative works of the industrial estate will not be in full operation and the manpower required will naturally be smaller.

It is assumed only 50% of personel will be required in 1985 and 1986, 80% in 1987 and full scale of manpower will be required in 1988.

Table 4.2-11 shows the annual increase of personel cost.

Table 4.2-11 Annual Increase of Personnel Cost

(Unit. Baht)

1985	1986	1987	1988
1,389,900	1,389,900	2,223,840	2,779,800

(2) Administration cost

The administration cost covers office expenses, travelling expenses, advertisement and other miscellaneous expenses. According to I.E.A.T's data the administration cost is estimated at 36% of the personnel cost and come to Baht 1,000,728.

The annual increase of administration cost is same as that of the personnel cost.

(3) Maintenance cost

The maintenance cost of the industrial estate consists of such maintenance costs as road and drainage, grass cutting of green belt, sludge removal, electricity for road lighting and maintenance of office buildings. Cumulative computation of each component was made for estimating the maintenance cost of the industrial estate and it comes to Baht 2,055,000-.

(4) Water supply cost

The cost of water supply consists of the costs of fresh water, chemicals, electricity, maintenance and labour and its breakdown is shown in Table 4.2-12. In the below costs estimation for service water labour cost will be excluded from cost calculation, as it has already been included in the personel costs.

The cost of service water comes to Baht 3.00/m^3 while the cost of industrial water comes to 1.40/m^3, chemicals, electricity and labour costs are not required for the supply of industrial water.

Table 4.2-12 Breakdown of water costs

Items	Amount	
	Serviec water	Industrial water
Fresh water cost (From Dok Krai reservoir to Map Ta phut)	Baht 1.30/m^3	Baht 1.30/m^3
Chemicals	Baht 0.30/m^3	–
Electricity	Baht 0.40/m^3	–
Maintenance	Baht 1.00/m^3	Baht 0.1/m^3
(Labour)	(Baht 0.30/m^3)	–
Total	(Baht 3.3/m^3) Baht 3.0/m^3	Baht 1.4/m^3

The total water cost is estimated at Baht 48,970,300 and was calculated as follows.

	Annual consumption	Unit cost	Water cost
Industrial water	34,400,000 m^3	Baht 1.4/m^3	Baht 48,160,000
Service water	270,100 m^3	Baht 3.0/m^3	Baht 810,300

The water cost is calculated from 1985 for service water and from 1988 for industrial water, and the annual increase of those costs corresponds to the fees for water supply services.

(5) Cost of land for sale

This cost accounts for the basic cost portion of the revenue from land sales and the respective amount for each year are as follows:

(unit. Baht, 000)

1985	147,248
1986	124,612
1987	123,249
1988	123,249
1989	123,249
1990	123,249
1991	5,451

(6) Operating cost

The following is an aggregate of the costs stated (1)–(4) and is shown is Table 4.2-13. With these expenses and cost of land for sale constitute the total operating cost as is shown in Tables in appendix 6.

Table 4.2-13 Operating cost

(Unit. Baht ,000)

	1985	1986	1987	1988	1989	1990	1991	1992
Personnel	1,390	1,390	2,224	2,780	2,780	2,780	2,780	2,780
Administration	500	500	801	1,001	1,001	1,001	1,001	1,001
Maintenance				2,055	2,055	2,055	2,055	2,055
Service Water	400	648	648	810	810	810	810	810
Industial Water				48,160	48,160	48,160	48,160	48,160
Total	2,295	2,538	3,025	54,806	54,806	54,806	54 806	54 806

4.2.5 Evaluation by Financial Statements

The income statement and the cash flow statement were prepared under the above mentioned conditions. The results are shown in the tables attached as an appendix 6.

The following table shows the net operating income and net cash flow during the project period.

Table 4.2-14 Summary of Financial Indices

(Unit. Baht ,000)

		Construction period (1984-1987)	Repayment period (1988-1991)	After repayment (1982-1996)	Total (1984-1996)
Case 1-1	Net operating income	74,645	52,695	28,349	155,689
	Net cash flow	117,078	12,871	28,348	158,297
Case 1-2	Net operating income	48,654	35,070	28,348	112,072
	Net cash flow	107,386	−21,053	28,348	114,681

The net cash flow is an index to show the debt service repayment ability of the project.

The study of the financial statements shows that

(i) Net operating income and net cash flow are both positive for case 1-1 and case 1-2 during the project life.

(ii) The project is able to service the debt under the financing packages of both case 1-1 and case 1-2.

The negative net cash flow of case 1-2 during the 1988–1991 period can be covered by the accumulated net cash flow before 1988.

In view of the above we consider that the financial healthiness of this project can be achieved

4.2.6 Evaluation by Financial Rate of Return

The financial rate of return was calculated as is shown in Table 4.2-15.

The Benefit is the aggregate of net operating income, cost of land sold and interest paid, while the Cost is construction cost.

The F.R.R. of 19.82% is well above the level of the interest rates for both foreign and domestic borrowing showing the financial possibility of this project.

Table 4.2-15 Financial Rate of Return Calculation Sheet
(Case 1, F.R.R. 19.82%)

(Unit: Bhat '000-)

Year	Cost (C)	Genefit (B)	(B – C)	Net present value (B – C)
1984	119,410		-119,410	-119,410
1985	454,230	197,248	-256,939	-214,436
1986	166,060	205,248	39,188	27,296
1987	28,000	188,638	160,638	93,379
1988		181,136	181,136	87,877
1989		165,005	165,005	66,809
1990		148,874	148,874	50,307
1991		11,974	11,974	3,377
1992		5,670	5,670	1,344
1993		5,670	5,670	1,114
1994		5,670	5,670	929
1995		5,670	5,670	767
1996		5,670	5,670	647
Total	767,700	1,126,516	358,816	0

4.2.7 Sensitivity Analysis

The following two alternatives will be studied in a sensitivity analysis.

Case 2: The case where the price margin in land sales is 5% instead of the 10% for the base case,

Case 3: The case where the schedule of land sales is delayed for two years for all factory sites.

For each case the same finance packages as in Table 4.2–14 will be applied.

The net operating income, net cash flow and F.R.R. of each case are shown in Table 4.2-16.

For the details of the financial statements please refer to tables attached as an appendix 6.

Table 4.2-16 Sensitivity Analysis

Case \ Period		Construction period (1984-1987)	Repayment period (1988-1991)	After repayment (1992-1996)	Total	F.R.R.
Case 2-1	Net operating income	41,622	22,642	28,348	92,612	17.05%
	Net cash flow	105,221	- 38,349	28,348	95,220	
Case 2-2	Net operating income	15,632	5,015	28,348	48,995	
	Net cash flow	95,528	74,272	28,348	51,604	
Case 3-1	Net operating income	-190,258	58,770	51,289	- 80,199	11.82%
	Net cash flow	- 27,917	-163,898	193,181	1,366	
Case 3-2	Net operating income	-212,337	48,967	51,289	-112,081	
	Net cash flow	- 49,996	-173,701	193,181	- 30,516	

For case 2, the revenue of the project is enough to cover debt service and the F.R.R. is 17.05%, which demonstrates both the financial healthiness and profitability of the project.

For case 3, due to the delay of land sales the domestic portion of investment must be wholly borrowed and the relative interest incurred is a heavy burder for the project.

In both Case 3-1 and 3-2 net operating income remains in the red through the project life There is no internally generated cash flow and a big shortage of funds in the course of the project must be covered by any other way. The F.R.R. calculated is 11.82% which is below the level of the average interest rates on borrowings.

Table 4.2-17 Financial Rate of Return Calculation Sheet
(Case 2, F.R.R. 17.05%)

(Unit: Baht ,000)

Year	Cost (C)	Benefit (B)	B - C	Net present value (B - C)
1984	119,410		-119,410	-119,410
1985	454,230	188,502	-265,728	-227,028
1986	166,060	196,094	30,034	21,923
1987	28,000	180,166	152,166	94,895
1988		173,378	173,378	92,376
1989		157,960	157,960	71,904
1990		142,542	142,542	55,436
1991		11,685	11,685	3,882
1992		5,670	5,670	1,609
1993		5,670	5,670	1,375
1994		5,670	5,670	1,175
1995		5,670	5,670	1,004
1996		5,670	5,670	858
Total	767,700	1,078,677	310,977	0

Table 4.2-18 Financial Rate of Return Calculation Sheet
(Case 3, F.R.R. 11.82%)

(Unit: Baht ,000)

Year	Cost (C)	Benefit (B)	B - C	Net present value (B - C)
1984	119,410	0	-119,410	-119,410
1985	454,230	-1,890	-456,120	-407,915
1986	166,060	-1,890	-167,950	-134,326
1987	28,000	216,569	188,569	134,877
1988		227,072	227,072	145,253
1989		210,009	210,009	120,140
1990		199,121	199,121	101,872
1991		181,337	181,337	82,969
1992		163,552	163,552	66,923
1993		12,620	12,620	4,618
1994		5,670	5,670	1,855
1995		5,670	5,670	1,659
1996		5,670	5,670	1,484
Total	767,700	1,223,510	455,810	0

4.2.8 Conclusion

The result of foregoing financial analysis demonstrates the soundness and profitability of the project.

However, the delay of land sales seriously affects the project and coordination by the development body of the land sales program and the construction program is required so that the project may secure both financial healthiness and profitability.

CHAPTER 5

SOCIO-ECONOMIC ANALYSIS

CHAPTER 5. SOCIO-ECONOMIC ANALYSIS

This chapter aims at studying, from the view point of the national economy, how efficiently the Map Ta Phut Industrial Estate (hereinafter MIE) Project can make use of resources within or outside Thailand. A study will also be made of the possible impact of the Project on Rayong Province, the Eastern Seaboard and the whole of Thailand.

5.1 Socio-Economic Effects

This project has the socio-economic effect as described below.

5.1.1 Establishment of a Foundation for Industrial Development and Improvement of the Industrial Structure

In Thailand, the foundation of industry is still paddy centered agriculture, but the industrial structure is slowly being changed by the socio-economic development planning started in the 1960's and by laws encouraging industrial investment.

The percentage of the GDP produced by primary industry dropped from 40.3 in 1960 to 20 8 in 1981, while the percentage of secondary industry increased from 21.6 to 28.3.

Agricultural products account for 70% of the total export value while industries related to agriculture form a large part of the manufacturing, commercial and service sectors. In Thailand, 77 5 percent of labour force is agricultural. At present, agriculture is still the core of Thailand's industrial structure. However, this is economically unsafe. It is necessary to accelerate strong industrialization and to accumulate in order to advance Socio-Economic stabilization.

The MIE development based on heavy and petrochemical industries will establish a foundation for the development of all coastal industries because the port will serve as a base for the distribution of products and raw material. Therefore, this project will not only establish an effective base for industrial development in Rayong province but also be an important part of the industrial development of the whole country, stimulating the creation of related industries in the surrounding region.

5.1.2 Accumulation of City Functions

The development of the MIE project will accelerate the formation of the city composed mainly of the people who will work at the new industrial complex and port.

The number of workers at the new industrial complex and port are estimated for 1987 (short term target year), as follows:

Table 5.1-1 Number of Employment

	1st Phase	2nd Phase
Heavy Industries		
Soda Ash	840	1,410
Petrochemical	1,550	2,600
Fertilizer	1,050	1,800
Steel	-	7,010
Port	500	1,000
Downstream Industries	-	2,560
Supporting Industries	1,500	1,500
Induced Industries Sub-total	5,440	17,880
Multiplier Effects*	6,490	17,980
Total	11,930	35,860

Generally, comprehensive city services include many valuable social services, create opportunities for employment, as well as increase the amenity of city life.

This project will establish the new town and then accelerate its modernization, encourage the settlement of population, increase the opportunities for employment, increase personnel incomes and help to form a new regional community.

At present, there are 38,000 people in the Rayong municipality, 7,800 in Map Ta Phut and 15,500 in Ban Chang.

According to our planning, the increase in population anticipated in these areas has been distributed as follows;

Table 5.1-2 Distribution of Population

1st Phase

	New Town	Ban Chang	Map Ta Pud	Rayong, etc.
Existing Residents	–	15,500	7,800	–
Population from Induced Industries	13,600	–	–	–
Population from Multiplier Effects	4,700	6,900	3,000	1,630
Total	18,300	22,400	10,800	1,630

2nd Phase

	New Town	Ban Chang	Map Ta Pud	Rayong, etc.
Existing Residents	–	20,000	10,750	–
Population from Induced Industries	44,700	–	–	–
Population from Multipher Effects	26,800	11,500	4,050	2,600
Total	71,500	31,500	14,800	2,600

Note: Quoted from Item 7.2.1, (4) Framework of Target Population in Part I.

Thus in 1987, the whole area (including Rayong, Map Ta Phut, new town and Ban Chang) will have a population of approximately 100,000 people.

As urban facilities, administration office, hospitals, schools, police office, post office, parks, banks, department stores, hotels, bus terminals and so on will be necessary.

5.1.3 Acceleration of Regional Development

As new industries will be established and a new town will be created through the development of this project, the amount of value added produced in the area will greatly increase and the district around the development area will become socio-economically abundant.

When priority is given to secondary industry rather than primary industry, there will be a significant migration of workers. Labour will be absorbed and the settlement of population will be accelerated. Industries related to the basic industry and to the port will grow, and the formation of employment in the area will diversify. Further more, regional living standards and convenience will be enormously improved, and as the accumulation of industries and port and urban functions bolster the external economy of the surrounding area, the prospects of regional development will be more elevated than ever.

5.1.4 Development of Coastal Shipping and Port-Related Industries

Present coastal shipping in Thailand is limited to the transportation of petroleum products from the vicinity of Siracha to Bangkok and the transportation of rubber and other agricultural products from Southern Thailand. Coastal shipping is not yet actively used for the transportation of general cargoes because of the shortage of cargo lots and the still inadequate capacity of local ports.

If cargo traffic intensifies and the possibility of mass transport cargoes increases through the

development of the new industrial port and local socio-economic growth, coastal shipping is likely to develop because of its economic merits.

5.1.5 Effect of Construction Investment

The development of this project will require a huge investment, and it can be expected to have direct and indirect effect and multiplier effect through the construction work.

The value added created by the construction work will be considered as a direct effect. According to the data of civil work in Japan, the value added is approximately 40 percent of the construction cost while salaries are about 50 percent of the value added.

The breakdown of the value added consists of salary, operating surplus, net indirect tax and other. The total amount of value added arising from this will be approximately 5,600 million Baht. 20 percent of the total amount of local portion for total construction cost including plants will be paid to workers which amounts to about 2,800 million Baht.

And then the purchase of construction materials will bring the value added to the enterprises which supply the materials to this project, producing more ripple effects.

The propagation of the effect of construction investment is shown in Fig. 5.1-1.

This effect of the construction investment can not be counted as benefit for Thailand as a whole since it is only income redistribution. But this has a great impact for the regional development in the Eastern Seaboard especially at Map Ta Phut area.

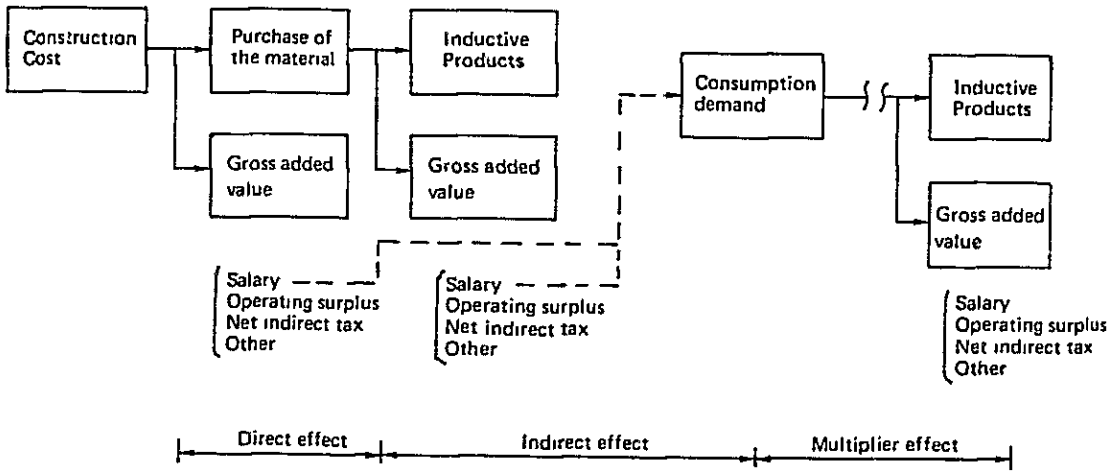


Fig. 5.1-1 Propagation of Effect

5.1.6 Improvement of Foreign Currency Balance

The products by the planned industries will enable to substitute the imported products by the domestic ones, and bring the saving of the foreign currency expenditure.

The net balance of the foreign currency will be affected tentatively during the construction period due to the payment of the foreign portion of the construction cost.

However, the balance will be improved greatly in long term.

Furthermore, the development of the basic industries will expedite the development of the related industries which have the import substitution by themselves and as the result, the improvement of the net balance will be accelerated.

5.2 Cost-Benefit Analysis

5.2.1 General

(1) Purpose of this analysis.

The purpose of this analysis is to evaluate the magnitude of impact which the implementation of this project will exert on the whole of Thailand.

(2) Definition of Cost and Benefit

(a) Cost

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

(i) Construction cost for Map Ta Phut Industrial Estate including industrial complex, urban area, port, railway, telecommunication and so on.

(ii) Operating cost for MIE

(iii) Construction cost for the factories in MIE

(iv) Operating cost for the factories in MIE

The construction cost for MIE is for the development of internal infrastructures including electricity, water supply, sewage, roads and so on. The construction cost of the railway is estimated for the branch line from the junction near Phu Ta Luang station because the purpose of this line is to support the transportation of raw materials and products to and from the planned factories in the Map Ta Phut Area.

The investment improving infrastructure outside MIE and providing facilities for public services is necessary, but this is excluding from this analysis.

(b) Benefit

The purpose of the development of infrastructures is to effectively support the productive activities. So, the value added which will be generated by the productive activity of the planned factories will be counted as the total benefit of this project. The benefit created by the individual infrastructures concerning productive activity will be included in the value added. The development of the transportation system will make the effective flow of cargos in this area, therefore they will raise the benefit by reducing the transportation cost of cargos which are not related to industrial complex.

The direct benefit are enumerated in the analysis as follows;

(i) Value added generated by the planned factories

(ii) Reduction of transportation costs for cargos excluding the ones handled by the industrial complex

(3) Method of cost-benefit analysis

The method of this analysis is as follows;

(i) Calculation of cost

(ii) Calculation of benefit as the difference between the "with this project" and the "without this project" cases

(iii) Calculation of shadow price for cost and benefit

(iv) Calculation of Internal Rate of Return (IRR) using the following formula and evaluation

$$\sum_{i=0}^{n} \frac{Bi-Ci}{(1+\gamma)^i} = 0$$

Bi: Amount of benefit in i-th year

Ci: Amount of cost in i-th year

γ: Discount rate

(v) Evaluation by B/C Ratio

(vi) Sensitivity analysis

The discount rate satisfing the above formula is equal to the Internal Rate of Return (IRR).

In the judgement of the project in the developing countries, there are several figures of the standard of IRR which are over 12% at the World Bank, over 10% at USAID, over 10% at ADB and over 7% in Japan.

These will be adopted as the standard of the evaluation for this economic analysis.

5.2.2 Cost

(1) Construction cost for MIE

The construction cost for MIE are considered in six categories, land acquisition, industrial complex, urban area, port area, railway and telecommunication.

They will natural come up over a period of 4 years from 1984 to 1987 corresponding to assumed phasing of the development.

They are shown in Table 5.2-1.

Table 5.2-1 Construction Cost for MIE

(Unit: 1,000 Baht)

Item	1984	1985	1986	1987	Total
1 Land Acquisition	167,430	52,320	0	0	219,750
2 Industrial complex	28,560	602,200	211,640	29,970	872,370
3 Port Area	38,700	555,670	1,293,630	858,390	2,746,390
4 Urban Area	25,220	92,500	131,370	186,650	435,740
5 Railway	16,860	102,990	156,200	0	276,050
6 Telecommunication	0	0	72,480	54,020	126,500
Total	276,770	1,405,680	1,865,320	1,129,030	4,676,800

(2) Administrative and operating cost for MIE

The administrative and operating cost for the industrial complex and the port area are clarified in part II, chapter 4.

The cost of the urban area and railway will be calculated as follows;

(a) Urban area

The number of staff necessary for the administration and operation of urban area are estimated one staff per 100 residents. 18,300 residents are estimated under the short term plan for the new town.

Therefore, the necessary staffs come to 183 persons.

(i) Personnel expenses

52,500 Baht for the annual personnel expenses per person are adopted in part II, chapter 4.

Therefore, 52,500 x 183 = 9,450,000 Baht per annum

(ii) General administrative expenses

These assumed to be 40 percent of the personnel expenses in part II, chapter 4.

Therefore, 9,450,000 x 0.4 = 3,780,000 Baht per annum

(iii) Maintenance cost

This cost will be estimated with ratios used in part II, chapter 4.

They are shown in Table 5.2-2.

Table 5.2-2 Maintenance Cost for Urban Area

(Unit: 1,000 Baht)

Item	Construction Cost	Ratio	Maintenance Cost
Road	78,830	0.01	788
Water supply	78,740	0.02	1,575
Drainage	44,730	0.005	224
Sewage	51,040	0.02	1,021
Power Supply	65,450	0.02	1,309
Present way	4,840	0.01	48
Park	6,800	0.04	272
Total			5,237

(b) Railway

According to SRT, the operating expenses were as follows;

Table 5.2-3 Operating Expenses

Physical Year	Operating Expenses per	
	Route – km (1,000 Baht)	Train – km (1,000 Baht)
1977	387	50.71
1978	400	51.77
1979	506	65.26
1980	672	83.37
1981	798	97.16

Source: 1982 information booklet SRT.

The total length of Railway didn't change from 1978 to 1981 as shown in Table 5.2-4, but the operating expenses increased, due mainly to increases in personnel expnses, fuel oil expenses and so on. Assuming the expenses in Table 5.2-3 rises averagely in the same way in future, the operating expenses are estimated at approximately 1,030,000 Baht per km in 1983.

Table 5.2-4 Total Length of Railway

Year	Route km and Length of track Route-km
1977	3,765
1978	3,735
1979	3,735
1980	3,735
1981	3,735

Source: 1982 information booklet SRT.

Total length of the planned new spur is 23.6 km.

Therefore, operating expenses will be estimated as follows; 1,030,000 Baht/km x 23.6 km = 24,308,000 Baht per annum.

For the economic analysis, the breakdown of the operating expenses into the personnel, the general administration and the maintenance is required and estimated as below.

(i) Personnel expenses

The personnel expenses shown in Table 5.2-5 recorded 50 percent of the operating expenses. But the planned railway is only a spur to support the transportation of commodities to and from the industrial complex. So the personnel expenses can be expected to be lower than these data. It is assumed that they will be 40 percent of the operating expenses.

Therefore, 24,308,000 x 0.4 = 9,723,000 Baht per annum

Table 5.2-5 Personnel Expenses of the Whole of SRT

Fiscal year	Baht '000	%
1977	765,233	52.57
1978	765,084	51.25
1979	1,006,595	53.23
1980	1,223,980	48.77
1981	1,378,174	46.25
		$\bar{x}$ 50.4

Source: 1982 information booklet SRT P54

(ii) General administrative expenses

It is assumed that they are 40 percent of the personnel expenses.

Therefore, 9,723,000 x 0.4 = 3,889,200 Baht per annum

(iii) Maintenance expenses

Subtracting the personnel and general administrative expenses from the overall operating expenses leaves the estimate for maintenance expenses.

This is 10,696,000 Baht per annum.

(c) Total administrative and operating costs

They are shown in Table 5.2-6.

Table 5.2-6 Administrative and Operating Cost

(Unit: 1000 Baht)

Item	Port	Industrial	Urban	Railway	Total
Personnel expenses	18,375	2,780	9,450	9,723	40,328
General administrative expenses	7,350	1,120	3,780	3,889	16,139
Maintenance cost	48,500	1,855	5,237	10,696	66,288
Total	74,225	5,755	18,467	24,308	122,755

(3) Construction cost for factories

The cost of factories constructed by the planned industries in MIE are shown in Table 5.2-7.

Table 5.2-7 Construction Cost of Each Factory

(Unit: 1,000 Baht)

	1984	1985	1986	1987	Total
Petro chemical	794,500	4,767,200	7,945,000	2,384,000	15,890,700
Soda Ash	0	1,782,000	2,970,000	1,169,200	5,921,200
Fertilizer	0	3,933,000	6,560,000	2,603,200	13,096,200
Supporting	0	253,200	422,100	168,900	844,200
Total	794,500	10,735,400	17,897,100	6,325,300	35,752,300

(4) Operating cost of the factories in MIE

This cost can be eliminated from the cost because the value added generated by the factories is to be counted in this analysis.

(5) Total cost

The construction cost for infrastructure in port, urban, railway and industrial complex and the plant cost are summed up as the construction cost..

The operating cost for MIE and railway consists of the personnel expenses, the general administrative expenses and the maintenance cost.

The cash flow of the total cost is shown in Table 5.2-8.

Table 5.2-8 Cash Flow of the Total Cost at Market Price

(Unit: 1,000 Baht)

	Year	Construction Cost	Operating Cost	Construction Cost of factories	Total
1	1984	276,770	5,646	794,500	1,076,916
2	1985	1,405,680	11,293	10,735,400	12,152,373
3	1986	1,865,320	16,940	17,897,100	19,779,360
4	1987	1,129,030	28,233	6,325,300	7,482,563
5	1988		122,747		122,747
6	1989		122,747		122,747
7	1990		122,747		122,747
8	1991		122,747		122,747
9	1992		122,747		122,747
10	1993		122,747		122,747
11	1994		122,747		122,747
12	1995		122,747		122,747
13	1996		122,747		122,747
14	1997		122,747		122,747
15	1998		122,747		122,747
16	1999		122,747		122,747
17	2000		122,747		122,747
18	2001		122,747		122,747
19	2002		122,747		122,747
20	2003		122,747		122,747
21	2004		122,747		122,747
22	2005		122,747		122,747
23	2006		122,747		122,747
24	2007		122,747		122,747
25	2008		122,747		122,747

5.2.3 Estimation of Benefit

(1) Value-added generated by the planned factories

The benefit from the production of the factories lies on the value added generated by the productive activity of the planned industries in MIE.

The value added can be estimated by different method as follows;

(i) The value added per employee in the planned industries are obtained from Thailand's industrial statistics. Multiplying this value by the number of employees, the value added in each industry is obtained.

(ii) From the industrial statistics, the ratio of the value added to the gross output value for the planned industries are calculated. Estimating the value of gross output and multiplying this value by the value added ratio, the value added are obtained.

(iii) From the results of F/S for each industry, the reasonable value added as comparing the each investment cost can be calculated.

(a) According to Thailand's industrial statistics, the basic and pertro-chemical industries exist on a small scale only, except the oil refineries being at the large and modern scale like the planned industries. (See Table 5.2-9).

So, it is very difficult to estimate the value added of the planned industries using the industrial statistics.

(b) However, comparing the basic and chemical industries in Thailand with the ones in Japan, the ratio of value added to the value of gross output is aproximately the same. (See Table 5.2-10).

The value of gross output is estimated by using the CIF unit prices and duties of the planned products which are presently imported, assuming that the condition of sales for them in the domestic market is the same as for the imports. (See Table 5.2-11).

The value added of the planned industries are obtained by multiplying the value added-ratio by the value of gross output. (See Table 5.2-12).

Table 5.2-9 Industrial Statistics of Thailand

(Unit: 1000 ฿)

code no	Industry		Number of manufacturing establishment 3	Total number of persons engaged 4	Total wages and salary paid 5	Total cost of production 6	Value of gross output 7	Value added 8	Per employee: wages and salary paid 5/4	Per employee: cost of production 6/4	Per employee: value of gross output 7/4	Per employee: value added 8/4	Percent %: wages and salary paid 5/7x100	Percent %: cost of production 6/7x100	Percent %: value added 8/7x100
3511	Basic industrial chemicals,	1974	50	5,070	111,112	1,040,719	1,630,067	589,348	21.9	205.3	321.5	116.2	6.8	63.8	36.2
		75	37	6,956	216,976	14,637,606	14,637,606	2,422,141	31.2	2,104.3	2,452.5	346.6	1.3	85.8	14.2
		76	64	7,037	209,543	996,391	1,502,794	506,403	39.8	141.6	213.6	72.4	13.9	66.3	33.7
		77	64	4,037	114,261	850,105	1,329,175	479,070	38.3	210.6	329.2	118.7	8.6	64.0	36.0
35299	Chemical products not elsewhere classified	1974	18	442	3,345	29,682	46,348	16,666	7.57	67.2	104.9	37.7	7.2	64.0	36.0
		75	14	792	5,633	26,543	124,170	97,627	7.1	33 5	156.8	123.3	4.5	21.4	78.6
		76	25	1,088	17,801	85,418	116,233	30,815	16.4	78.5	106.8	38.3	15.3	73.5	26.5
		77	-	-	-	-	-	-	-	-	-	-	-	-	-
35609	Other plastic products	74	55	1,028	36,420	127,519	182,399	54,880	8.7	42.1	60.2	18.1	14 5	70.0	30.0
		75	46	1,378	41,623	404,047	873,855	469,808	12.3	119.6	258.7	139.1	4.8	46.2	53.8
		76	-	-	-	-	-	-	-	-	-	-	-	-	-
		77	58	3,658	29,142	153,422	308,486	155,064	11.0	57.7	116.1	58.3	9.4	49.7	50.3
36209	Glass and Glass products	1974	34	12,508	344,975	1,197,066	2,219,769	1,022,703	37.6	95.7	177.5	81.8	15.5	53.9	46.1
		75	31	9,390	209,375	706,450	1,776,111	1,069,661	22.3	75.2	189.1	113.9	11.8	39.8	60.2
		76	35	8,832	278,102	862,974	2,054,700	1,191,726	35.8	97.7	232.6	134.9	11.1	40.4	59.6
		77	39	10,276	258,561	1,049,089	2,500,620	1,451,531	25.2	102.1	243.3	141.3	10.3	45.0	58.0
35720	Fertilizers and pesticides	1974	11	1,907	21,308	513,934	622,896	108,962	11.2	369.5	326.6	57.1	3.4	82.5	17.5
		75	15	2,670	43,152	714,973	918,407	203,434	16.2	267.8	344.0	76.2	4.7	77.8	22.2
		76	-	-	-	-	-	-	-	-	-	-	-	-	-
		77	-	-	-	-	-	-	-	-	-	-	-	-	-
35300	Petroleum refineries	1974	9	3,887	309,010	42,417,183	42,417,183	6,684,014	79.5	9,347.4	10,913.6	1565.2	0.7	85.7	14.3
		75	5	2,266	240,546	25,081,849	32,359,199	7,177,350	106.2	11,068.8	14,236.2	3167.4	0.7	77.8	22.2
		76	5	1,894	240,960	24,451,020	34,285,285	9,834,265	127.2	12,909.7	18,102.1	5192.3	0.7	71.3	28.7
		77	4	1,246	242,477	36,135,062	30,654,129	4,519,067	194.6	20,975.2	24,602 0	3626.9	0.8	85.3	14.7
36991	Concrete products	1974	42	7,074	209,276	936,821	1,486,484	549,663	29 6	132.4	310.1	77.7	14.1	63.0	37.0
		75	33	6,361	197,239	696,188	1,160,257	464,069	31.0	109.4	182.4	73.0	17.0	60.0	37.0
		76	41	5,924	194,617	777,822	1,239,094	461,272	32.8	131.3	209.2	77.9	15.7	62.8	37.2
		77	68	9,907	326,583	1,443,095	2,468,729	1,025,634	33.0	145.7	249.2	103.5	13.2	58.5	41.5
38130	Structural metal products	1974	34	25,915	893,380	5,249,926	9,155,087	4,505,161	34.7	202.6	376.4	173.8	9.2	33.8	46.2
		75	37	1,722	21,151	404,194	559,390	155,196	12.3	234.7	324.8	90.1	3.8	72.3	27.7
		76	28	1,448	15,580	196,628	234,624	37,996	10.8	135.8	162.0	26.2	6.6	83.8	16.2
		77	-	-	-	-	-	-	-	-	-	-	-	-	-
38191	Metal cans and shipping containers	1974	74	4,478	47,119	839,086	1,163,762	334,676	10.5	187.9	359.9	72.5	4.0	72.1	27.9
		75	74	7,329	108,298	1,366,380	1,875,086	528,706	14.8	186.4	258.5	72.1	5.7	72.1	27.9
		76	65	10,020	140,625	1,767,175	1,944,821	687,646	14.0	125.5	194.1	68.6	7.2	64.6	35.4
		77	62	10,006	104,260	1,737,515	2,708,587	971,072	10 4	173.6	270.7	97.1	3.8	64.2	35.8
38142	Wire and wire products	1974	31	1,475	28,939	377,448	500,656	123,208	19.6	255.9	339.4	83.5	5.8	75.4	24.6
		75	28	1,855	53,825	576,814	684,607	107,793	29 0	311.0	369 1	58.1	7.9	84.3	15.7
		76	29	1,648	36,724	828,363	1,201,406	373,043	22 3	502 6	729.0	226.4	3 1	68.9	31.1
		77	-	-	-	-	-	-	-	-	-	-	-	-	-
38229	Agricultural machinery and equipment	1974	19	1,039	30,344	1,023,962	1,375,376	351,414	29.2	985.5	1,323.7	338.2	2.2	74.4	25.6
		75	17	1,071	28,616	1,255,136	1,470,992	215,856	26.7	1,171.9	1,373 5	201.5	2.0	85.3	14.7
		76	-	-	-	-	-	-	-	-	-	-	-	-	-
		77	32	1,210	31,591	551,011	1,330,140	779,129	14.3	249.3	601.9	362.5	2.4	41.4	58.6
	Total	1974	3,034	509,243	9,680,961	104,575,466	163,748,543	59,173,082	19.0	205.4	321.6	116.2	5.9	63.9	36.1
		75	3,313	572,256	9,596,007	107,786,424	157,463,136	49,676,712	16.8	188 4	275.2	86.8	6.1	68.5	31.5
		76	3,227	522,309	16,983,887	117,974,145	190,356,516	72,382,371	32.5	225.9	364.5	138.6	8.9	62.0	38.0
		77	4,190	653,740	17,264,439	171,649,304	319,754,252	148,204,948	26.4	262.4	489.1	226.7	5.4	53.7	46.3

Source: Report of the 1976 and 1978 industrial census

Table 5.2.10 Comparing the Ratio of the Value Added of Thailand's with Japanese Chemical Industry

(Unit: 1000 ฿)

	Statistic year	Number of manufacturing establishment 3	Total number of persons engaged 4	Total wages and salary paid 5	Total cost of production 6	Value of gross output 7	Value added 8	Per employee: wages and salary paid 5/4	Per employee: cost of production 6/4	Per employee: valu of gross output 7/4	Per employee: value added 8/4	ratio %: wages and salary paid 5/7x100	ratio %: cost production 6/7x100	ratio %: value added 8/7x100
Thailand	1974	50	5,070	111,11	1040729	1630067	589,348	21.9	205 3	321.5	116.2	6 8	63.8	36.2
	1975	3.	6,956	216976	14637606	17059747	2,...,141	31.2	2,104.3	2,452.5	346.6	1.3	85.8	14.2
	1976	6.	7,037	209543	996391	1502794	506,403	29,8	141.6	213.6	72.4	13.9	66.3	33.7
	1977	64	4,037	114261	850105	1329175	479,070	28.3	210.6	329.2	118.7	8.6	64.0	36.0
Japan	1973	5,704	466,038	72843077	401805481	719054423	317,248,942	156.3	862.2	1,542.9	680.7	10.1	55.9	44.1
	1974	5,644	466,881	96330769	582778558	964644808	381,866,250	206.3	1,248.2	2,066.1	817.9	10.0	60.4	39.6
	1975	5,838	460,798	106259423	647060865	1003662404	356,601,539	230.6	1,404.2	2,178.1	773.9	10.6	64.5	35.5
	1976	5,759	444,190	113418942	739544423	1134257692	394,713,269	255.3	1,664.9	2,553.5	888.6	10.0	65.2	34.8
	1979	-	371,069	123487885	831875673	1361498654	529,622,981	332.8	2,241.8	3,669.1	1,427.4	9.1	61.1	38.9

1 Baht = 10.4 yen

Source , Thailand, Report of the 1976 and 1978 industrial census, code No. 3511 Basic industrial chemicals

Japan, Japanese industrial statistics, chemical industry

Table 5.2-11 Unit Price of the Gross Output Calculated by CIF Unit Price Plus Duties at 1979 Market Price

Unit price ₿/T

Soda Ash	3900
Ammonium chloride	2525
Ammonium	5620
Urea	2534
DAP/MAP	3640
NPK-Fertilizer	
Poly Ethylene	26,650
VCM	23,023
EG	21,138
PP	26,338
Caustic Soda	9,100

Note: Calculated from the Foreign Trade Statistics in 1979.

Table 5.2-12 Estimation of the Value of Gross Output and the Value Added at 1983 Market Price

Products	Planned Output Volume T/Y	Unit Price in 1979 ₿/T	Value of Gross Output in 1979 10^6 ₿	Total in 1979 10^6 ₿	Transforming 1979 Price to 1983 Price 10^6 ₿	Value added in 1983 10^6 ₿/Y
Soda Ash	400,000	3,900	1,560			
Ammonium Chloride	400,000	2,525	1,010			
Ammonuim	128,000	5,620	719			
Urea	400,000	2,534	1,014			22,801
DAP/MAP NPK-Fertilizer	600,000	3,640	2,184	15,100	22,801	x 35.3% = 8,049
PE	110,000	26,650	2,931			
VCM	80,000	23,023	1,842			
EG	50,000	21,138	1,057			
PP	70,000	26,338	1,844			
Caustic Soda	103,200	9,100	939			

Note. Whole sale price index of industrial products, 1979 = 136, 1983 = 205 (as estimated)
(1976 = 100)

(c) On the other hand, the F/S for each industry were already finished, and the results show that the establishment of these industries will be financially possible. In this way, the resonable value added returned by investment cost are obtained. (See Table 5.2-13).
(d) Based on the comparison of the value added obtained by different method, the value added from the industries are assumed as following Table 5.2-14.

All figures are based on 1983 prices.

The benefit will begin to be generated in 1988 when the factories constructed in MIE come into operation, and from 1990 it will come out on a full scale.

Table 5.2-13 Estimation of the Value Added Based on Investment Cost for Industries at 1983 Market Price

Industries	Number of Employee	Investment Cost 10^3 ฿	Value Added 10^3 ฿	
Petrochemical	1,550	15,890,000	3,900,000	
Soda Ash	840	5,921,000	1,450,000	
Fertilizer	1,050	13,096,000	3,200,000	Sub Total
Supporting Industries	1,500	844,000	206,000	8,550,000
Total	4,940	35,751,000	8,756,000	

Note: Assuming I/A to be 4.1 I: Investment cost
A: Value added

Table 5.2-14 Estimation of the Value Added at 1983 Market Price

Industries	Number of Employees	Value Added 10^3 ฿/Y
Petro chemical	1,550	8,000,000
Soda Ash	840	
Fertilizer	1,050	
Supporting Industries	1,500	200,000
Total	4,940	8,200,000

(2) Reduction of transportation cost for the cargos excluding the ones handled by the industrial complex.

On this project, some port cargos such as tapioca, steel products, cement, sand and some portion of the potash do not relate to the planned industries.

The reduction of transportation cost for these cargos can be expected as a benefit of this project.

The flow of these is shown in Table 5.2-15 in case of the "with this project" and in case of the "without this project".

Table 5.2-15 Flow of Port Cargos

Cargoes	With this project	Without this project
Tapioca	Trat, Chantaburi, Rayong → Map Ta Phut (by trucks)	Trat, Chantaburi, Rayong → Siracha or Sattahip (by trucks)
Steel product	Map Ta Phut → Trat, Chantaburi, Rayon (by trucks)	Sattahip or Bangkok → Trat, Chantaburi, Rayong (by trucks)
Cement and Sand	Bangkok → Map Ta Phut (by barges) → Trat, Chantaburi, Rayong (by trucks)	Bangkok → Trat, Chantaburi, Rayong (by trucks); or Bangkok → Sattahip (by barges) → Trat, Chantaburi, Rayong (by trucks)

According to the discussion in Thailand, the transportation cost by mode and format between Map Ta Phut and Bangkok are shown in the following table 5.2-16.

Table 5.2-16 Unit price by mode and format between Bankok and Map Ta Phut

Unit: ฿/Ton

Format / Made	Bulk	Liquid
1 by trucks	145	120
2 by barges	70 ~ 100	50 ~ 75
*3 by barges + by trucks	(60 ~ 100) + 40 = 100 ~ 140	(50 ~ 70) + 35 = 85 ~ 105

Source: ETO January, 1983

* via Sattahip port

Also, the transportation cost between Sattahip and Map Ta Phut by truck is 40 Baht per ton.

The reduction of transportation cost for these cargos with this project is summerized in Table 5.2-17.

Table 5.2-17 The Reduction of Transportation Cost

Cargos	Cargo Volume (T/Y)	Unit Price (¥/T)	Value of reduction (¥/Y)
Tapioca	760,000	40	30,400,000
Steel products	35,000	40	1,400,000
Cement	75,000	30	2,250,000
Sand	170,000	30	5,100,000
Total	1,040,000		39,150,000

The 750,000 tons potash will be transported from north-east Thailand to Map Ta Phut and be exported from this port. In case of the "without this project", it will be exported from existing ports such as Bangkok and Sattahip.

So, in case of the "with this project", the transportation cost of potash between Bangkok or Sattahip and Map Ta Phut will be estimated as a minus benefit. However, in the "without" case, new investment will be neccessary in order to export it. Therefore, this new investment cost should be compared with the minus benefit, but, in this analysis, they are not taken into account assuming that they off set each other.

(4) Total amount of benefit

The benefit of this project is an aggregate of the benefit from the value added by the productive activity in MIE, and the reduction of transportation cost for the cargos handled at the new port. The cash flow of the total benefit is shown in Table 5.2-18.

Table 5.2-18 Cash Flow of Benefit in Market Price

Unit: 1000฿

Physical Year		Value added generated by the planned factories	Benefit from the reduction of transportation cost	Total
1	1984			
2	1985			
3	1986			
4	1987			
5	1988	5,740,000	27,405	5,767,405
6	1989	7,380,000	31,320	7,411,320
7	1990	8,200,000	39,150	8,239,150
8	1991	8,200,000	39,150	8,239,150
9	1992	8,200,000	39,150	8,239,150
10	1993	8,200,000	39,150	8,239,150
11	1994	8,200,000	39,150	8,239,150
12	1995	8,200,000	39,150	8,239,150
13	1996	8,200,000	39,150	8,239,150
14	1997	8,200,000	39,150	8,239,150
15	1998	8,200,000	39,150	8,239,150
16	1999	8,200,000	39,150	8,239,150
17	2000	8,200,000	39,150	8,239,150
18	2001	8,200,000	39,150	8,239,150
19	2002	8,200,000	39,150	8,239,150
20	2003	8,200,000	39,150	8,239,150
21	2004	8,200,000	39,150	8,239,150
22	2005	8,200,000	39,150	8,239,150
23	2006	8,200,000	39,150	8,239,150
24	2007	8,200,000	39,150	8,239,150
25	2008	8,200,000	39,150	8,239,150

5.2.4 Estimation of shadow price

(1) Conversion factor

(a) Standard conversion factor (SCF)

Standard conversion factor is calculated by the following formula using foreign trade statistics.

$$SCF = \frac{M + X}{M(1 + tm) + X(1 + Sm - txm)}$$

M : Total value of import (CIF price)
X : Total value of export (FOB price)
tm : The weighted average of the rate for import duties
Sm : The weighted average of the rate for export subsidies
txm : The weighted average of the rate for export duties

The value of foreign trade from 1978 to 1981 in Thailand is shown in Table 5.2-19. According to this table, the SCF comes to 0.95.

Table 5.2-19 The value of Foreign Trade

(Million ฿)

Physical Year	Total amount of Import Value	Total amount of duties for Import	Total amount of Export Value	Total amount of duties for Export
1978	108,298,828	14,097,806	83,065,026	1,758,353
1979	146,161,283	16,570,249	108,178,975	2,743,549
1980	193,618,282	19,073,600	133,197,170	3,485,347
1981	219,025,765	21,751,261	153,000,660	3,133,185

Source: Bank of Thailand, Monthly Bulletine Oct., 1982

SCF 1978 = 0.94
SCF 1979 = 0.95
SCF 1980 = 0.95
SCF 1981 = 0.95
} average = 0.95

(b) Conversion factor for consumption (CFC)

The value of foreign trade for the main consumer goods and the value of their duties are shown in Table 5.2-20.

The CFC is calculated by the same formula as the SCF.

Table 5.2-20 Value of Foreign Trade for the Main Consumer Goods

million ฿

Fiscal year	Total Import value of consumer goods	Total value of Import duties for C.G.	Total Export value of C.G.	Total value of Export duties for C.G.
1978	12,942	3,172	23,182	-
1979	15,933	3,684	32,150	-
1980	19,286	4,107	35,177	-
1981	23,039	4,531	51,944	-

Source: Bank of Thailand, Monthly Bulletine Oct, 1982

According to the above table, the CFC comes to 0.93.

CFC 1978 = 0.919
CFC 1979 = 0.929
CFC 1980 = 0.930
CFC 1981 = 0.943

} average = 0.93

(c) Evaluation for skilled labour

For the wages included in the project cost, the market wage rate which is actually paid is applied to skilled labour, assuming that the market mechanism is functioning due to the shortage of supply of such workers. These wages are evaluated using the domestic price level, so it is essential to convert to the international price level, multiplying it by the CFC.

The conversion factor for skilled labour is equal to the CFC which is 0.93.

(d) Evaluation for unskilled labour

As for unskilled labour, since there seems to be an excess supply of such labour, the actual wage rate will exceed the opportunity cost, thus requiring a rate adjustment.

In general, the shadow wage rate for unskilled labour is estimated from the marginal productivity in rural area. In Rayong province, the population of the rural area was 327,000 persons in 1981 and the gross provincial product (GPP) of agriculture, mining and quarring was 3026.8 million Baht in 1980. Converting these to the level of 1983, the rural population becomes 348,000 persons and their GPP becomes 3,590 million Baht.

As mentioned above, the national income per person in the rural area of Rayong province is estimated at 10,300 Baht per annum. The shadow wage rate is 33 Baht per day, assuming that they work six days in a week.

On the other hand, the wage rate which is paid to unskilled labour in this project is 65 Baht per day.

Therefore, the conversion factor for unskilled labour is calculated as follows;

Conversion factor for usnkilled labour = 33.0/65.0 x CFC (= 0.93) = 0.52

Table 5.2-21 Gross Provincial Product at Current Market Prices

Millions of Baht

Industrial origin	1976	1977	1978	1979	1980
Agriculture	2,230.0	2,296.2	2,421.3	2,423.0	2,900.0
Crops	1,799.8	1,694.1	1,841.1	1,803.2	2,315.8
Livestock	87.3	132.5	109.2	138.6	176.8
Fisheries	324.5	466.2	464.6	361.6	313.0
Forestry	18.4	3.4	6.4	119.6	94.4
Mining and quarrying	30.4	59.0	38.1	107.4	126.3
Manufacturing	212.0	198.0	205.8	221.5	244.8
Construction	27.4	138.2	261.3	97.9	112.2
Electricity and water supply	14.9	19.9	24.5	24.5	26.5
Transportation and communication	94.5	75.2	66.9	24.9	104.0
Wholesale and retail trade	850.0	978.4	1,068.7	1,051.5	1,308.1
Banking, insurance and real estate	58.3	84.4	115.9	132.3	175.3
Ownership of dwellings	27.1	28.6	31.9	38.4	43.9
Public administration and defence	82.7	86.9	105.3	114.5	150.0
Services	141.4	182.9	235.6	290.8	373.6
GROSS PROVINCIAL PRODUCT, (GPP)	3,813.7	4,147.7	4,625.3	4,586.7	5,565.2
PER CAPITA GPP (BAHT)	12,150	12,692	13,704	13,158	15,284

Source; GPP statistic in Thailand.

Table 5.2-22 Population in Rayong Province

(i) Population and growth rate

Year	1976	1977	1978	1979	1980	1981
Population	313,885	326,796	337,514	349,117	364,119	377,063
Growth rate %	–	4.1	3.3	3.4	4.3	3.6

(ii) Population in 1981

Total	377,063	100%
Rural Area	326,905	86.7%
Municipality Area	50,158	13.3%

Source: Rayong local government

(e) Conversion factor of machinary (CFM)

The value of foreign trade of major machinary and the value of their duties are shown in Table 5.2-23.

The CFM is calculated by the same formula as SCF. It comes to 0.86.

Table 5.2-23 Value of foreign trade of major machinery

(Unit: Million Bath)

Year	Total import value of machinaries	Total value of import duties for machinaries	Total export value of machinaries	Total value of export duties for machinaries
1978	31,596	6,283	–	–
1979	36,235	6,242	–	–
1980	41,854	6,430	–	–
1981	52,783	7,887	–	–

Source: Bank of Thailand, Monthly Bulletine Oct, 1982.

CFM 1978 = 0.83
CFM 1979 = 0.85
CFM 1980 = 0.87
CFM 1981 = 0.87
} average = 0.86

(f) Evaluation of land

The area which should be acquired for this project is presently producing casave and rice. The area under cultivation and the yield of casave in Thailand are shown in Table 5.2-24.

Table 5.2-24 Area under cultivation and the yield of casava in Thailand

		1976	1980	1981
Area under Cultivation 1000 Rai	Whole kingdom	4,373	7,250	7,940
	Central region	2,151	2,500	2,908
Yield 1000 T	Whole kingdom	10,138	16,540	17,744
	Central region	5,044	6,043	6,990

Source: Agricultural Economic office

The yield per rai is as follows;

	1976	1980	1981 (unit: ton/Rai)
Whole Kingdom	2.31	2.28	2.23
Central region	2.34	2.42	2.40

The FOB price for tapioca in 1980 was 3,144 Baht per ton while the producer's price was about 33 percent of the FOB price, according to the ES study. Assuming that the market

interest of loans would be 14 percent, the value of marginal production for land in 1980 was calculated as follows;

$$3,144 \times 2.42 \times 0.33 \times \frac{1}{0.14} = 17,934 \text{ ฿/Rai}$$

Converting into the prices of 1983 using data from the index of market price for tapioca roots, the value of marginal production for casava field is obtained as follows:

17,934 ฿/Rai x 525.44/616.21 = 22,597 ฿/Rai

Examining the land for the cultivation of rice, its value of marginal production is estimated as 18,023 Baht per rai in 1983 price. (See Appendix 7)

In this study, the value of the marginal production for tapioca is adopted for further analysis.

The unit price for land acquisition for this project is 50,000 Baht per rai.

Therefore, the conversion factor for land comes to 0.43

22,600/50,000 x 0.95 = 0.43

(2) Conversion factor of Costs and Benefits

(a) Construction cost for MIE

The breakdown of the construction cost for MIE is shown in Table 3.2-1, at chapter 3, part II.

Since the amounts which were estimated in foreign currency portion are those to be paid with foreign currency, and taxes and duties of materials and machinaries imported for this project are not included in the cost estimate, all of the foreign currency is counted at CIF prices.

On the other hand, those listed in local portion must be converted to the border price using the conversion factors.

The process for calculating the conversion factor for the construction cost is shown in Table 5.2-25.

It comes to 0.925, but, in the planning of construction work for MIE, the land acquisition cost amounts to 60.4 percent ot them in 1984, so this conversion factor should be calculated separately for each year. These factors are shown in Table 5.2-26.

Table 5.2-25 Calculation of the conversion factor for the construction cost of MIE

Item	Devision component / Conversion fuctor / Composition ratio % ①	Foreign currency	Local Currency						Total conversion factor ②	① x ②
			Traded goods	Skilled labour	Unskilled labour	Untraded goods	Machinary	Land		
		1,000	1,000	0.93	0.52	0.95	0.86	0.43		
Land Acquesition	4.7	–	–	–	–	–	–	(100) 0.43	(100) 0.43	0.020
Industrial Complex	18.7	(47.7) 0.477	(14.1) 0.141	(3.7) 0.034	(5.6) 0.029	(22.0) 0.209	(6.9) 0.059	– –	(100) 0.949	0.177
Port Area	58.7	(55.0) 0.550	(13.5) 0.135	(4.4) 0.041	(6.7) 0.035	(17.5) 0.166	(2.9) 0.025	– –	(100) 0.952	0.559
Urban Area	9.3	(34.7) 0.347	(17.4) 0.174	(4.3) 0.040	(6.5) 0.034	(31.3) 0.297	(5.8) 0.050	– –	(100) 0.942	0.088
Railway	5.9	(36.8) 0.368	(27.2) 0.272	(5.2) 0.048	(7.7) 0.040	(15.0) 0.1425	(8.1) 0.07	– –	(100) 0.941	0.056
Telecom-munication	2.7	(57.0) 0.570	(5.6) 0.056	(6.1) 0.057	(9.1) 0.047	(22.2) 0.211	– –	– –	(100) 0.941	0.025
Total	100%	–	–	–	–	–	–	–	–	general conversion factor 0.925

Note: Figure in ( ) is composition ratio % by component of each item

Table 5.2-26 Conversion factor of construction cost for MIE in each year

Year	1984	1985	1986	1987
Conversion Factor	0.634	0.929	0.95	0.95

Note: See Appendix 7, Table 7-3.

(b) Administrative/Operating Cost

The administrative/operating cost consists of personnel expenses, general administrative expenses and maintenance cost.

For the personnel expenses, assuming that the share of unskilled and skilled labour are fifty and fifty, the conversion factor comes to 0.725.

For the general administrative expenses, the CFC is adopted as the conversion factor.

For the maintenance cost which consists of personnel, machinary and material expenses, the average of the CFC, CFM and Fuel/oil conversion factor is adopted as its conversion factor.

The results from above;

Conversion factor of the personnel expenses 0.725

Conversion factor of the general administrative expenses..... 0.930

Conversion factor of the maintenance cost..... 0.930

(c) Construction cost for the factories in MIE

The construction cost for the factories in MIE is shown in Table 5.2-7 and the breakdown into the foreign and local currency portion is shown in Table 5.2-27.

The breakdown of the local currency portion and the conversion factors for the construction cost for each factory are shown in Table 5.2-28 and Table 5.2-29.

Table 5.2-27 Factorie's Construction Cost

Unit; 1000 ฿

Factories	Total	Construction Cost	
		Local	Foreign
Petro chemical	15,890,700 (100)	5,490,100 (34.5)	10,400,600 (65.5)
Soda Ash	5,921,200 (100)	1,938,700 (32.7)	3,982,500 (67.3)
Fertilizer	13,096,200 (100)	3,976,700 (30.4)	9,119,500 (69.6)
Supporting	844.200	485,480 (57.5)	358,720 (42.5)
Total	35,752,300 (100)	11,890,980 (33.3)	23,861,320 (66.7)

Note; Figure in ( ) is percent %

Table 5.2-28 Breakdown of the Local Currency Portion

Unit; 1000 ฿

Factories	Labour	Material	Equipment
Petro chemical	4,536,700	317,800	635,600
Soda Ash	991,300	651,300	296,100
Fertilizer	2,798,000	654,800	523,900
Supporting	240,700	185,700	59,080

Table 5.2-29 Conversion factor of construction cost for each factory

Factories	Foreign Currency	Local Currency					Conversion factor
		Trade goods and S.	Skilled labour	Unskilled labour	Machinery	Untrade G. and S.	
	1,000	1,000	0.93	0.52	0.86	0.95	
Petro chemical	(65.5) 0.655	(1.4) 0.014	(11.4) 0.106	(17.1) 0.089	(3.2) 0.028	(1.4) 0.013	(100) 0.905
Soda Ash	(67.3) 0.673	(4.3) 0.043	(6.7) 0.062	(10.1) 0.053	(4.0) 0.032	(7.6) 0.072	(100) 0.937
Fertilizer	(69.6) 0.696	(2.3) 0.023	(8.5) 0.079	(12.8) 0.067	(3.2) 0.028	(3.6) 0.034	(100) 0.927
Supporting	(42.5) 0.425	(8.1) 0.081	(11.5) 0.107	(17.0) 0.088	(5.6) 0.048	(15.3) 0.145	(100) 0.894

Note: Figure in ( ) is composition ratio % by each factory

(d) Value added generated by the planned factories in MIE

The products created by the factories will mostly be sold on the domestic market, so the standard conversion factor of 0.950 is adopted. It comes to 0.950.

(e) Benefit from the reduction of transportation cost for the cargos handled at the new port

The reducting cost of transportation belongs to the local domestic currency portion and it will be come from truck's transportation. The conversion factor comes to 0.943, shown in Table 5.2-30.

Table 5.2-30 Calculation of Conversion Factor for the Transportation Cost by Trucks

Item	Composition ratio % ①	Conversion factor ②	① x ②
Personnel expenses	14.6	0.78	0.114
Fuel/Oil expenses	62.5	1.00	0.625
Hire and repair expenses	14.7	0.86	0.125
Other	8.2	0.95	0.078
Total	100	-	general conversion factor 0.943

Note: The source of composition ratio is OCDI, Pakistan Report

(3) Shadow prices of Costs and Benefits

Multiplying by each conversion factor, the cash flow of costs and benefits at shadow price is shown in Table 5.2-31.

Tabl3 5.2-31 Cash Flow of Costs and Benefits at Shadow Price

(Unit: 10^6 Baht)

No.	Year	Cost				Benefit		
		Construction cost of MIE	Administrative and operating cost for MIE	Construction cost for the factories in MIE	Total	Value-added generated by the planned factories in MIE	Benefit from the reduction of transportation cost	Total
1	1984	175,472	4,425	719,023	898,920			–
2	1985	1,305,877	8,850	9,856,302	11,171,029			–
3	1986	1,772,054	13,275	16,431,592	18,216,921			–
4	1987	1,072,579	22,124	5,817,223	6,911,926			–
5	1988		105,896		105,896	5,457,256	25,843	5,483,099
6	1989		105,896		105,896	7,016,472	29,535	7,046,007
7	1990		105,896		105,896	7,796,080	36,918	7,832,998
8	1991		105,896		105,896	7,796,080	36,918	7,832,998
9	1992		105,896		105,896	7,796,080	36,918	7,832,998
10	1993		105,896		105,896	7,796,080	36,918	7,832,998
11	1994		105,896		105,896	7,796,080	36,918	7,832,998
12	1995		105,896		105,896	7,796,080	36,918	7,832,998
13	1996		105,896		105,896	7,796,080	36,918	7,832,998
14	1997		105,896		105,896	7,796,080	36,918	7,832,998
15	1998		105,896		105,896	7,796,080	36,918	7,832,998
16	1999		105,896		105,896	7,796,080	36,918	7,832,998
17	2000		105,896		105,896	7,796,080	36,918	7,832,998
18	2001		105,896		105,896	7,796,080	36,918	7,832,998
19	2002		105,896		105,896	7,796,080	36,918	7,832,998
20	2003		105,896		105,896	7,796,080	36,918	7,832,998
21	2004		105,896		105,896	7,796,080	36,918	7,832,998
22	2005		105,896		105,896	7,796,080	36,918	7,832,998
23	2006		105,896		105,896	7,796,080	36,918	7,832,998
24	2007		105,896		105,896	7,796,080	36,918	7,832,998
25	2008		105,896		105,896	7,796,080	36,918	7,832,998

5.2.5 Economic Evaluation

(1) Internal Rate of Return (IRR)

There are several indices for evaluating the economic returns of a project. Here, however, the economic returns are evaluated in terms of the Internal Rate of Return (IRR).

The IRR is obtained by the formula shown in the item 5.2.1.

The project life is assumed to be 25 years starting from 1984 based on the average life peroid of various kind of facilities to be development.

The IRR is 15.7 percent as shown in Table 5.2-32.

(2) Evaluation

There are various judgement value of IRR to appraise the feasibility of this project.

The leading view is that the project is feasible if the IRR exceeds the oppotunity cost of capital, which is said by the World Band to be 12% in the developing countries. According to this standard, the IRR of 15.7 percent is a good figure, indicating that this project is feasible.

In order to conform the feasibility under the different condition, several cases are examined in following sensitivity analysis.

(3) Sensitivity analysis

The three different types of variation are considered, which are;

(i)	Cost estimation	as estimated 10% higher
(ii)	Benefit estimation	as estimated 10% lower
(iii)	Estimation of project life	as estimated 5 year shorter

The 8 cases obtained by joining together the above alternatives are examined. Each IRR is shown in Table 5.2-33.

(4) Conclusion

In sensitivity analysis, case No. 8 shown in Table 5.2-33 is most pessimistical condition, nevertheless its IRR is just under the World Bndk's standard.

In case of 12% discount rate, the B/C ratio comes to 1.30. In case of 14% discount rate which is the present bank rate in Thailand, the B/C ratio comes over 1.12. (See Table 5.2-34 Table 5.2-35)

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

Table 5.2-32 Calculation of IRR IRR = 15.7%

Unit: 1,000 Baht

Year		Cost (1)				Benefit (2)			(2) – (1)	Net present value Discount rate = 15.7 %
		Construction cost of MIE	Administrative and operating cost of MIE	Construction cost of factories in MIE	Total	Value-added generated by the planned factories in MIE	Benefit from production of transportation cost	Total		
1	1984	175,472	4,425	719,023	898,920				- 898,920	- 899,000
2	1985	1,305,877	8,850	9,856,302	11,171,029				-11,171,029	- 9,655,140
3	1986	1,772,054	13,275	16,431,592	18,216,921				-18,216,921	-13,608,500
4	1987	1,072,579	22,124	5,817,223	6,911,926				- 6,911,926	- 4,462,760
5	1988		105,896		105,896	5,457,256	25,843	5,483,099	5,377,203	3,000,590
6	1989		105,896		105,896	7,016,472	29,535	7,046,007	6,940,111	3,347,280
7	1990		105,896		105,896	7,796,080	36,918	7,832,998	7,727,102	3,221,150
8	1991		105,896		105,896	7,796,080	36,918	7,832,998	7,727,102	3,784,050
9	1992		105,896		105,896	7,796,080	36,918	7,832,998	7,727,102	2,406,270
10	1993		105,896		105,896	7,796,080	36,918	7,832,998	7,727,102	2,079,750
11	1994		105,896		105,896	7,796,080	36,918	7,832,998	7,727,102	1,797,530
12	1995		105,896		105,896	7,796,080	36,918	7,832,998	7,727,102	1,553,620
13	1996		105,896		105,896	7,796,080	36,918	7,832,998	7,727,102	1,342,800
14	1997		105,896		105,896	7,796,080	36,918	7,832,998	7,727,102	1,160,590
15	1998		105,896		105,896	7,796,080	36,918	7,832,998	7,727,102	1,003,100
16	1999		105,896		105,896	7,796,080	36,918	7,832,998	7,727,102	886,980
17	2000		105,896		105,896	7,796,080	36,918	7,832,998	7,727,102	749,340
18	2001		105,896		105,896	7,796,080	36,918	7,832,998	7,727,102	647,660
19	2002		105,896		105,896	7,796,080	36,918	7,832,998	7,727,102	559,770
20	2003		105,896		105,896	7,796,080	36,918	7,832,998	7,727,102	483,810
21	2004		105,896		105,896	7,796,080	36,918	7,832,998	7,727,102	418,160
22	2005		105,896		105,896	7,796,080	36,918	7,832,998	7,727,102	361,420
23	2006		105,896		105,896	7,796,080	36,918	7,832,998	7,727,102	312,380
24	2007		105,896		105,896	7,796,080	36,918	7,832,998	7,727,102	269,990
25	2008		105,896		105,896	7,796,080	36,918	7,832,998	7,727,102	233,350
										-25,810

Table 5.2-33 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

Table 5.2-34 Calculation of B/C Ratio discount rate = 12%

Unit: 1,000 Baht

	Year	Cost (1)				Benefit (2)			Net present value of Cost	Net present value of Benefit
		Construction cost of MIE	Administrative and operating cost of MIE	Construction cost of factories in MIE	Total	Value-added generated by the planned factories in MIE	Benefit from production of transportation cost	Total		
1	1984	175,472	4,425	719,023	898,920				898,920	–
2	1985	1,305,877	8,850	9,856,302	11,171,029				9,974,133	–
3	1986	1,772,054	13,275	16,431,592	18,216,921				14,522,418	–
4	1987	1,072,579	22,124	5,817,223	6,911,926				4,919,520	–
5	1988		105,896		105,896	5,457,256	25,843	5,483,099	67,278	3,483,544
6	1989		105,896		105,896	7,016,472	29,535	7,046,007	60,100	3,998,869
7	1990		105,896		105,896	7,796,080	36,918	7,832,998	53,645	3,968,084
8	1991		105,896		105,896	7,796,080	36,918	7,832,998	47,895	3,542,730
9	1992		105,896		105,896	7,796,080	36,918	7,832,998	42,769	3,163,569
10	1993		105,896		105,896	7,796,080	36,918	7,832,998	38,188	2,824,737
11	1994		105,896		105,896	7,796,080	36,918	7,832,998	34,094	2,521,892
12	1995		105,896		105,896	7,796,080	36,918	7,832,998	30,439	2,251,508
13	1996		105,896		105,896	7,796,080	36,918	7,832,998	27,181	2,010,523
14	1997		105,896		105,896	7,796,080	36,918	7,832,998	24,271	1,795,324
15	1998		105,896		105,896	7,796,080	36,918	7,832,998	21,669	1,602,823
16	1999		105,896		105,896	7,796,080	36,918	7,832,998	19,349	1,431,207
17	2000		105,896		105,896	7,796,080	36,918	7,832,998	17,275	1,277,814
18	2001		105,896		105,896	7,796,080	36,918	7,832,998	15,423	1,140,839
19	2002		105,896		105,896	7,796,080	36,918	7,832,998	13,771	1,018,595
20	2003		105,896		105,896	7,796,080	36,918	7,832,998	12,295	909,439
21	2004		105,896		105,896	7,796,080	36,918	7,832,998	10,978	812,046
22	2005		105,896		105,896	7,796,080	36,918	7,832,998	9,802	725,009
23	2006		105,896		105,896	7,796,080	36,918	7,832,998	8,752	647,355
24	2007		105,896		105,896	7,796,080	36,918	7,832,998	7,814	577,996
25	2008		105,896		105,896	7,796,080	36,918	7,832,998	6,976	516,042
	Total								30,884,955	40,219,945
									B/C = 1.30	

Table 5.2-35 Calculation of B/C Ratio discount rate = 14.0%

Unit: 1,000 Baht

	Year	Cost (1)				Benefit (2)			Net present value of Cost	Net present value of Benefit
		Construction cost of MIE	Administrative and operating cost of MIE	Construction cost of factories in MIE	Total	Value-added generated by the planned factories in MIE	Benefit from production of transportation cost	Total		
1	1984	175,472	4,425	719,023	898,920				898,920	-
2	1985	1,305,877	8,850	9,856,302	11,171,029				9,799,148	-
3	1986	1,772,054	13,275	16,431,592	18,216,921				14,017,329	-
4	1987	1,072,579	22,124	5,817,223	6,911,926				4,670,220	-
5	1988		105,896		105,896	5,457,256	25,843	5,483,099	62,697	3,246,358
6	1989		105,896		105,896	7,016,472	29,535	7,046,007	55,011	3,660,263
7	1990		105,896		105,896	7,796,080	36,918	7,832,998	48,244	3,558,564
8	1991		105,896		105,896	7,796,080	36,918	7,832,998	42,325	3,130,695
9	1992		105,896		105,896	7,796,080	36,918	7,832,998	37,117	2,745,530
10	1993		105,896		105,896	7,796,080	36,918	7,832,998	32,563	2,408,671
11	1994		105,896		105,896	7,796,080	36,918	7,832,998	28,566	2,113,029
12	1995		105,896		105,896	7,796,080	36,918	7,832,998	25,058	1,853,525
13	1996		105,896		105,896	7,796,080	36,918	7,832,998	21,979	1,625,778
14	1997		105,896		105,896	7,796,080	36,918	7,832,998	19,282	1,426 256
15	1998		105,896		105,896	7,796,080	36,918	7,832,998	16,914	1,251,078
16	1999		105,896		105,896	7,796,080	36,918	7,832,998	14,836	1,097,366
17	2000		105,896		105,896	7,796,080	36,918	7,832,998	13,014	962,640
18	2001		105,896		105,896	7,796,080	36,918	7,832,998	11,416	844,437
19	2002		105,896		105,896	7,796,080	36,918	7,832,998	10,014	740,709
20	2003		105,896		105,896	7,796,080	36,918	7,832,998	8,784	649,718
21	2004		105,896		105,896	7,796,080	36,918	7,832,998	7,705	569,963
22	2005		105,896		105,896	7,796,080	36,918	7,832,998	6,759	499,936
23	2006		105,896		105,896	7,796,080	36,918	7,832,998	5,929	438,553
24	2007		105,896		105,896	7,796,080	36,918	7,832,998	5,201	384,687
25	2008		105,896		105,896	7,796,080	36,918	7,832,998	4,562	337,455
	Total								29,863,593	33,545,211
									B/C = 1.12	

APPENDIX

APPENDIX

Appendix 1 Alternatives of the Port Layout

Table 1-1 Cost estimate for Master Plan

	Excavated Type		Reclaimed Type		Jetty Type	
	Quantity	Amount (Million Bahts)	Quantity	Amount (Million Bahts)	Quantity	Amount (Million Bahts)
1. Port Facilities						
Dredging and Reclamation	42,400,000 m^3	2,120	34,900,000 m^3	1,745	31,800,000 m^3	1,590
Breakwater	3,900 m	714	4,200 m	803	4,500 m	976
Revetment	9,120 m	831	8,440 m	909	7,400 m	852
Groin	1,700 m	114	1,700 m	114	1,700 m	114
Mooring Facilities	6,400 m	2,668	6,400 m	2,668	6,400 m	2,668
Navigation Aids		14		14		14
Sub-total		6,461		6,253		6,214
Investigation and Engineering		250		250		250
Phisical Contingency		646		625		621
Total		7,357		7,128		7,085
2. Land Procurement for Waterway	310,000 m^2	31	300,000 m^2	30	200,000 m^2	20
3. Additional Conveyers	-	-	3,000 m	145*	15,800 m	765*
Grand-total		7,388		7,303		7,870

* This amount is only an initial investment cost.
85% and 5% of amount are needed as an additional investment cost for every ten years and an annual operation cost, respectively.

Table 1-2 Comparison of Cost Estimate (Short Term Plan)

	Excavated Type		Reclaimed Type		Remarks
	Quantity	Amount (Million Bahts)	Quantity	Amount (Million Bahts)	
1. Port Facilities					
Dredging and Reclaimation	12,800,000 m³	640.0	17,600,000 m³	880.0	
Breakwater	2,900 m	518.4	2,700 m	523.8	
Revetment	3,835 m	348.5	6,715 m	604.0	
Groin	1,000 m	81.9	–	–	
Mooring Facilities	2,310 m	1,065.8	2,310 m	1,065.8	
Navigation Aids	1 Ls	11.0	1 Ls	11.0	
Road/Pavement in Public Terminal Area	1 Ls	55.7	1 Ls	55.7	
Buildings in Public Terminal Area	1 Ls	110.0	1 Ls	110.0	
Electric Supply/Water Supply/ Drainage in Public Terminal Area	1 Ls	61.6	1 Ls	61.6	
Sub-total		2,892.9		3,311.9	
Investigation and Engineering	4%	115.7	4%	132.3	
Physical Contingency	10%	289.3	10%	331.2	
Total		3,297.9		3,775.6	
2. Cargo Handling Equipments	1 Ls	157.6	1 Ls	157.6	
3. Tug Boats	1 Ls	80.0	1 Ls	80.0	
Grand-total		3,535.5		4,013.2	

Table 1-3 Comparison of Cost Estimation (Master Plan)

	Excavated Type-(2)		Jetty Type-(2)	
	Quantity	Amount (Million Bahts)	Quantity	Amount (Million Bahts)
1. Port Facilities				
Dredging and Reclamation	42,400,000 m^3	2,120	35,600,000 m^3	1,780
Breakwater	3,900 m	714	1,900 m	894
Causeway and Trestle			5,120 m	858
Revetment	9,330 m	834	3,300 m	380
Groin	1,700 m	114	1,400 m	95
Mooring Facilities	6,020 m	2,598	5,110 m	2,342
Navigation Aids		14	1 Ls	14
Sub-total		6,394		6,363
Investigation and Engineering		250		250
Physical Contingency		639		636
Total		7,283		7,249
2. Land Procurement for Waterway	310,000 m^2	31	150,000 m^2	15
3. Additional Conveyers	–	–	19,600 m	947
Grand-total		7,314		8,211

Table 1-4 Comparison of Cost Estimation (Short Term Development Plan)

	Jetty Type-(2)		Excavated Type-(2)	
	Quantity	Amount (Million Baht)	Quantity	Amount (Million Bahts)
1. Port Facilities				
Dredging and Reclamation	1,900,000 m^3	95	9,800,000 m^3	490.0
Breakwater	1,200 m	500	2,500 m	437.4
Causeway and Testle	4,500 m	750	–	–
Revetment	400 m	47	2,325 m	200.9
Groin			1,500 m	90.7
Mooring Facilities	1,375 m	805	1,725 m	867.6
Navigation Aids	1 Ls	6	1 Ls	11.0
Road/Pavement in Public Terminal Area	1 Ls	67	1 Ls	55.7
Buildings in Public Terminal Area	1 Ls	110	1 Ls	110.0
Electric Supply/Water Supply/Drainage	1 Ls	68	1 Ls	61.6
Sub-Total		2,791		2,650.4
2. Cargo Handling Equipments	1 Ls	304	1 Ls	157.6
3. Tug Boats	1 Ls	80	1 Ls	80.0
4. Land Preparation and Procurement of Commercial Center		16		
Grand Total		3,191		2,888.0

Table 1-5 Cargo Handling Volume

Unit: 1,000 T/Y

Center	Commodities	Foreign Shipping		Domestic Shipping	
		Export	Import	Outward	Inward
1. Gass Processing Center	Methanol	285	–	532	–
	LPG	160	–	–	–
	Natural Gasoline	59	–	109	–
2. Fertilizer Center	Urea	405	–	473	–
	Fertilizer	720	–	840	–
	Soda Ash	480	–	160	–
	Phosphate ore	–	1,090	–	–
	Sulphric acid	–	1,241	–	–
3. Ethylene Center	Ethylene	–	–	82	–
	LDPE	38	–	18	–
	HDPE	33	–	16	–
	PP	54	–	26	–
	PS	18	–	9	–
	EO/EG	18	–	–	–
	Propylene	–	127	–	–
	Benzen	–	53	–	–
4. Electrolysis Center	PVC	47	–	22	–
	Caustic Soda	31	–	58	–
5. Iron & Steel Center	Iron ore	–	8,367	–	–
	Scrap	–	1,337.4	–	–
	Ferro alloys	–	38.4	–	–
	Aluminium	–	12.3	–	–
	Carburizing Material	–	22.2	–	–
	Cold rolled product	–	–	1,929.6	–
	Hot rolled product	–	–	2,248.8	–
6. Public Terminal Area	Potash	400	–	–	–
	Tapioca	760	–	–	–
	Steel products	–	70	–	–
	Cement	–	–	–	150
	Sand	–	–	–	340
Total		3,508	12,358.3	6,523.4	490

Table 1-6 Scale of Mooring Facilities

	Type of Cargo	Origination	Package Format	Total volume of Cargoes	Domestic Shipping							Foreign Shipping							
					Vol. of Cargoes	Ship Size	Quay Water Depth	Berth Length	Necessary no. of Berths	Necessary Total Length	Cargo Handling Capacity	Berth occupancy rate	Vol. of Cargoes	Ship Size	Quay Water Depth	Berth Length	Necessary no. of Berths	Necessary Total Length	Cargo Handling Capacity	Berth Occupancy Rate
				t/y	t/y	DWT	m	m		m	t/h	%	t/y	DWT	m	m		m	t/h	%
Cargoes related to the Industrial Base	LPG	Gas Processing Center	High-Pressure gas (liquid)	287,000									287,000	5,000	-10	170	1	170	500	
	Propylene	Import																		
	Methanal	Gas Processing Center																		
	Natural Gasoline	"	Dangerous substance (liquid)																	
	Benzen	Import		1,145,000	699,000	3,000	-6	130	2	260	160	50	446,000	20,000	-10	200	1	200	400	17
	ED/EG	Ethylene C.																		
	Caustic Soda*	Electrolysis C.																		
	PVC	Electrolysis C.																		
	LDPE	Ethylene C.																		
	HDPE	"	Resin (in bags)	308,000	99,000	3,000	-6	120	1	120	30 Derrick Crane	57	209,000	20,000	-10	200	1	200	bag/h 2,000 (50 kg/bag x 2,000)	36
	PP	"																		
	PS	"																		
	Urea	Fertilizer C.	Domestic Trade: In bags																	
	Fertilizer	"	Foreign Trade: Bulk	3,062,000	1,298,000	3,000	-6	120	7	840	100 (2,000 bag/h)	60	1,764,000	60,000	-14	280	1	280	1,000	35
	Soda ash	"																		
General Cargoes	Rock Phosphate	Import	Bulk	1,520,000									1,520,000	60,000	-14	280	1	280	1,500	23
	Sulfuric acid	Import	Liquid	1,320,000									1,320,000	20,000	-10	200	1	200	500	68.3
	Steel row material	Import	Bulk	13,955,700	4,178,400	3,000	-6.5	120	15	1,800	100	87	9,777,300	100,000	-18	330	2	660	2,500	43
	Steel Product	Steel Center																		
	Rock Salt	Northeast Thai																		
	Tapioca	Hinterland	Bulk	2,270,000									2,270,000	60,000	-14	330	1	330	1,000	39
	Potash	Northeast Thai												150,000						
	Steel	Import																		
	Cement	Import	In bags	560,000	560,000	3,000	-6	120	8	960									one for tapioc and potash	
	Sand	Import	Bulk																	
	Total			24,427,700	6,834,400					3,300			17,593,300					2,320		

*Caustic soda is a violent poison but it is labelled as a dangerous substance.
**Steel is an import but is assumed to be handled at a domestic trade berth.

Table 1-7 Handling Equipment

Commodities	Package Format	Domestic Shipping	Foreign Shipping
High Pressure Gas	Liquid	100 t/h ~ 200 t/h Loading Arm	300 t/h ~ 500 t/h
Dangerous Liquid Substance	Liquid	100 t/h ~ 200 t/h Loading Arm	300 t/h ~ 500 t/h Loading Arm
Petrochemical Center	Bulk (Bagged)	Derrick crane in Ship 30 t/hr	Ship Loader for Baggage 2000 bag/hr 1 bag 50 kg 100 t/hr
Fertilizer Center	Bulk	Bag Ship Loader for Bag 2000 bag/hr 1 bag 50 kg 100 t/hr	Dry Ship Loader for Bulk 1000 t/hr
Tapioca Potash			Ship Loader for Bulk 1000 t/hr
Steel & Iron Center	Bulk	Mobilecrane 100 t/hr	Crab Torolly Type Unloader 2500 t/hr
Phosphate	Bulk		Crab Torolly Type uhloader 1500 t/hr
Sulphuric Acid	Liquid		Loading Arm 300 t ~ 500 t/h

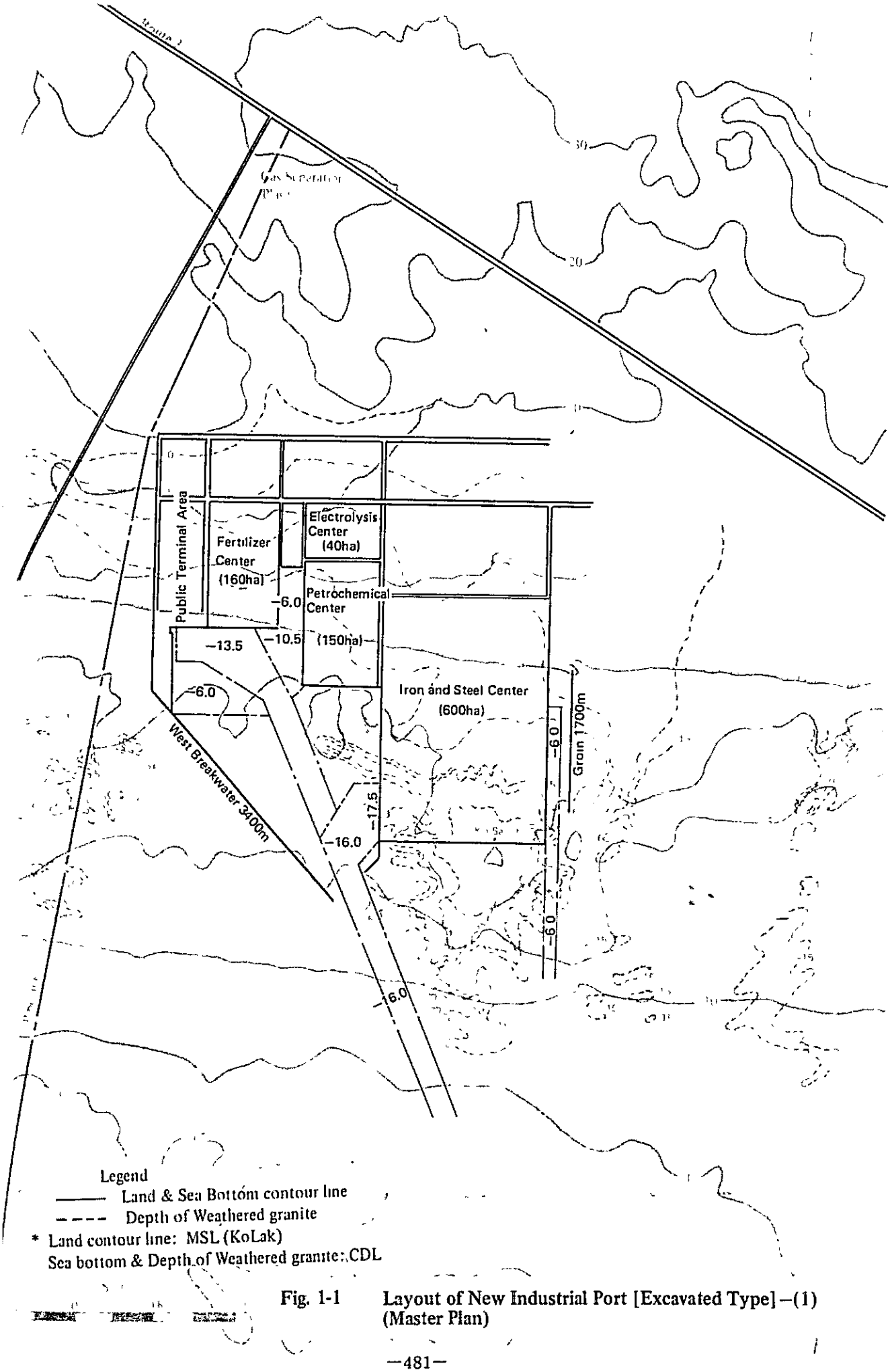


Fig. 1-1 Layout of New Industrial Port [Excavated Type]–(1) (Master Plan)

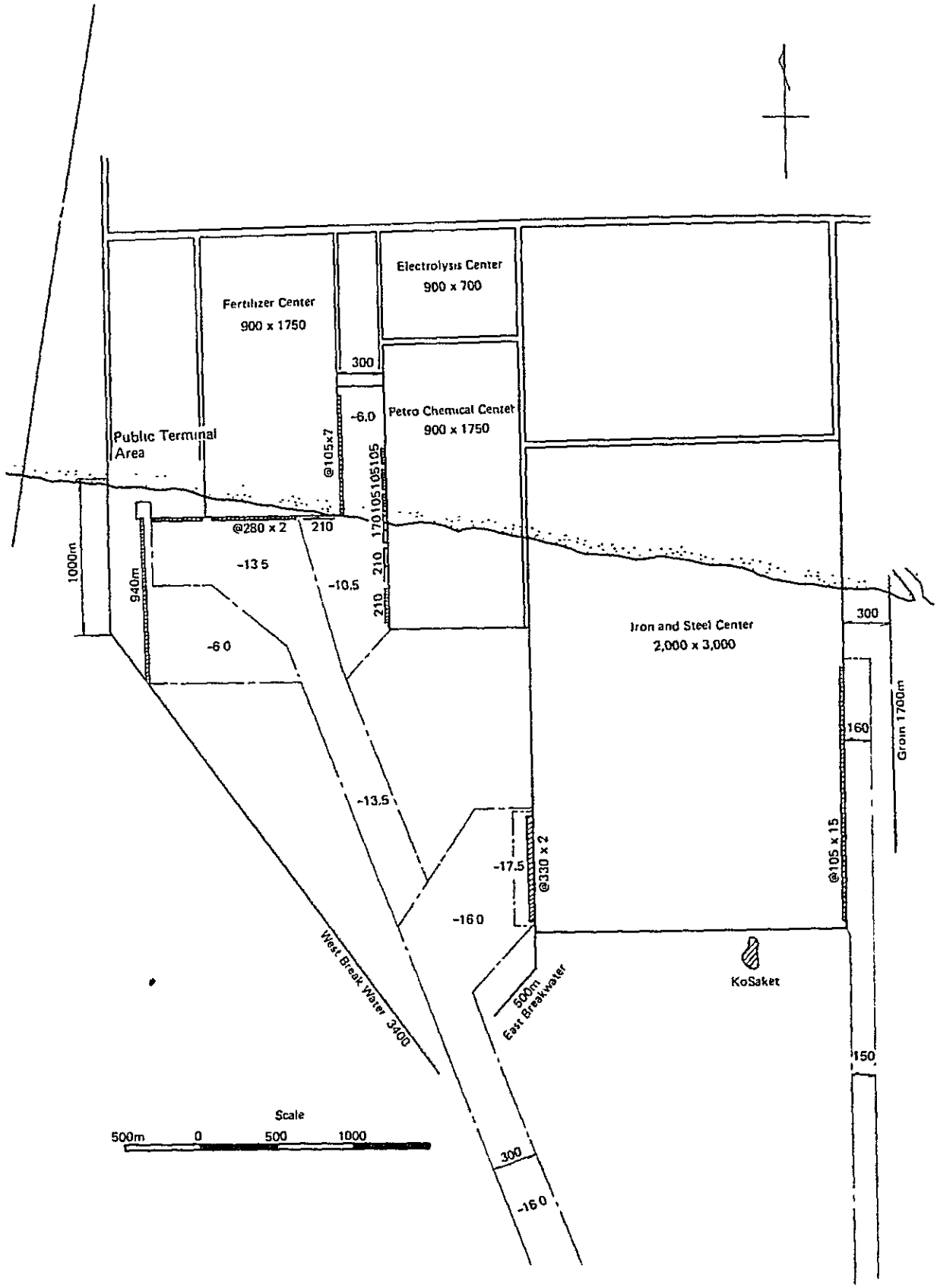


Fig. 1-2 Berth Arrangement [Excavated Type]

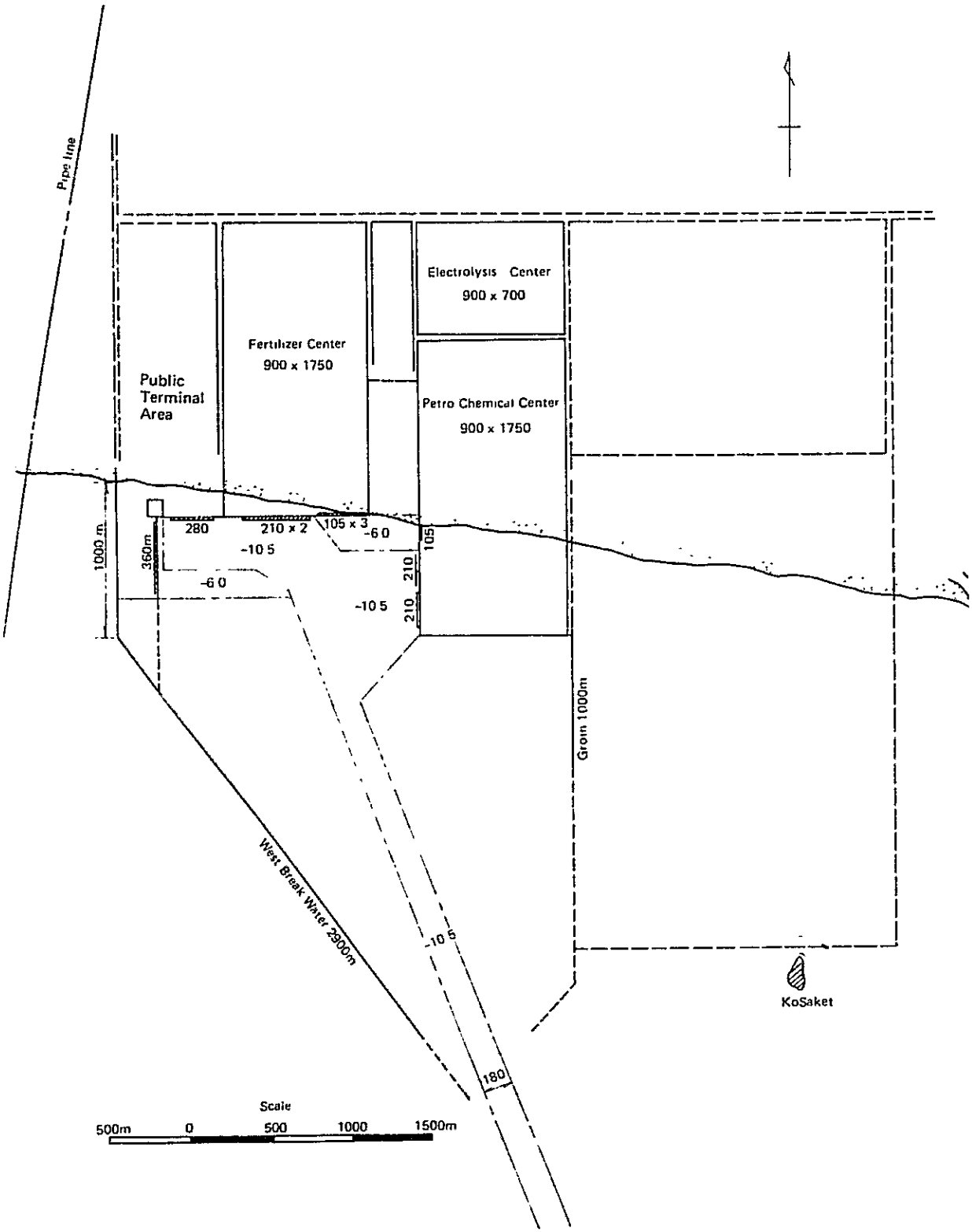


Fig. 1-3 Berth Arrangement [Excavated Type] –(1)
(The Short Term Development Plan)

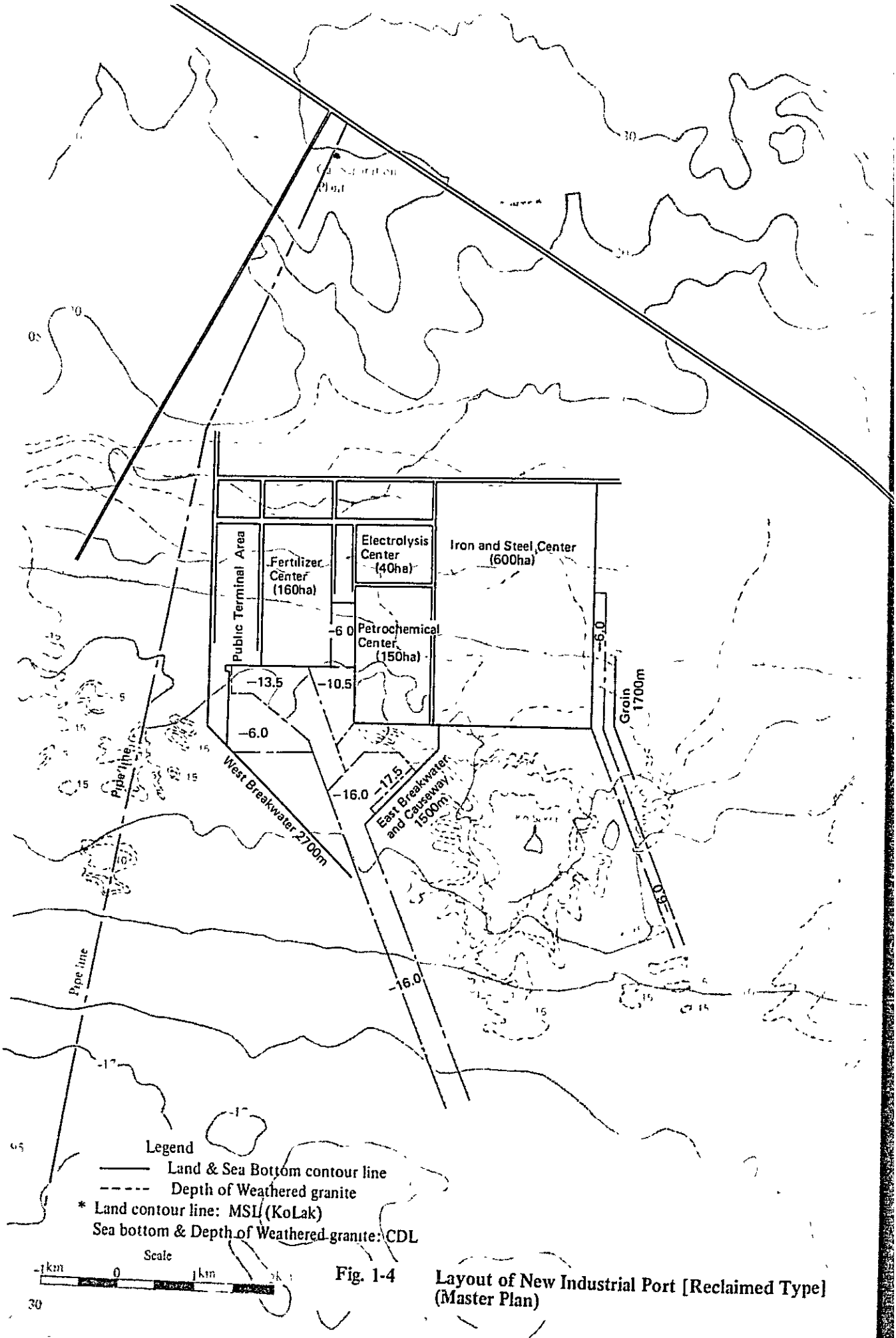


Fig. 1-4 Layout of New Industrial Port [Reclaimed Type] (Master Plan)

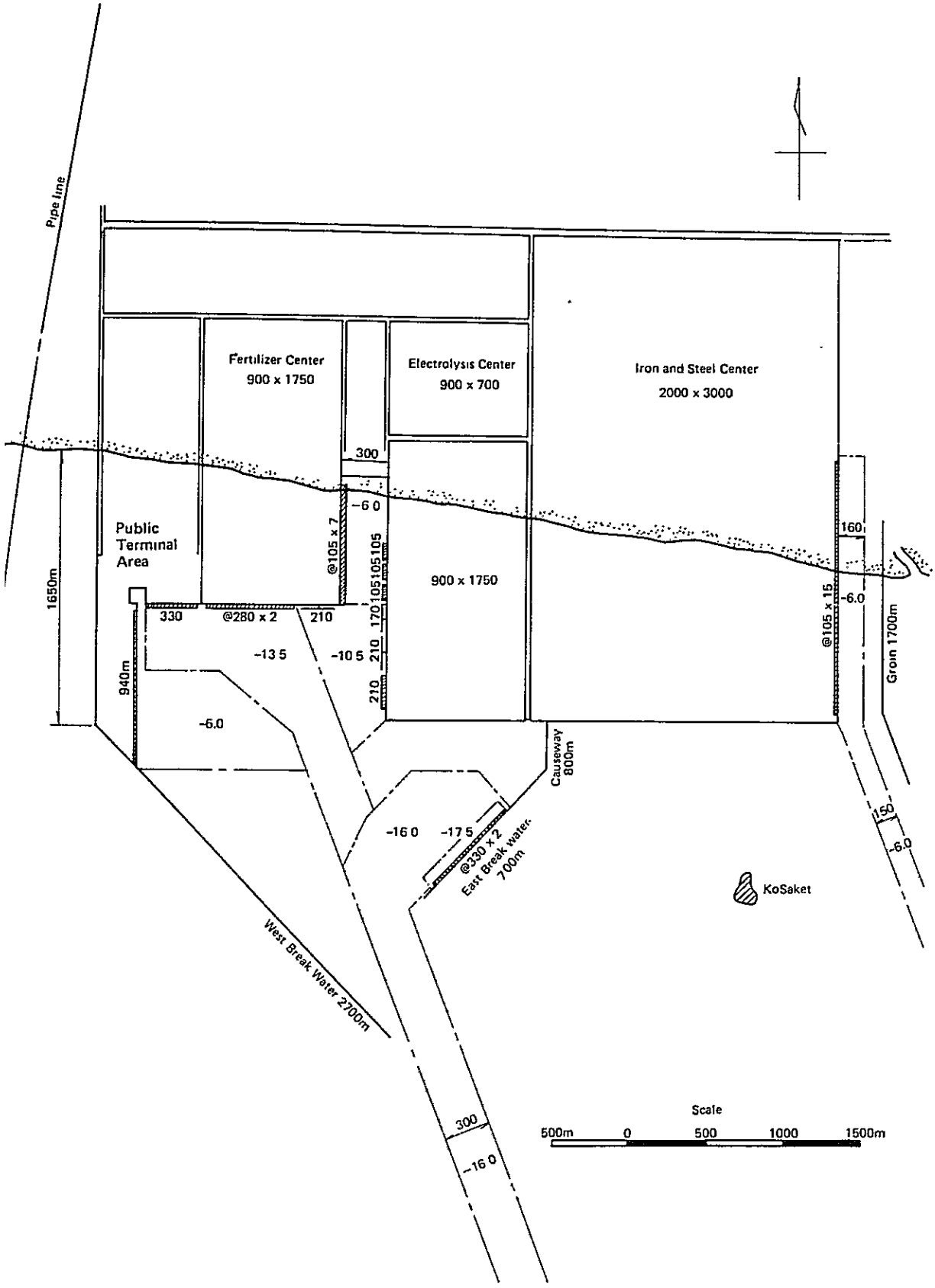


Fig. 1-5 Berth Arrangement [Reclaimed Type]
(Master Plan)

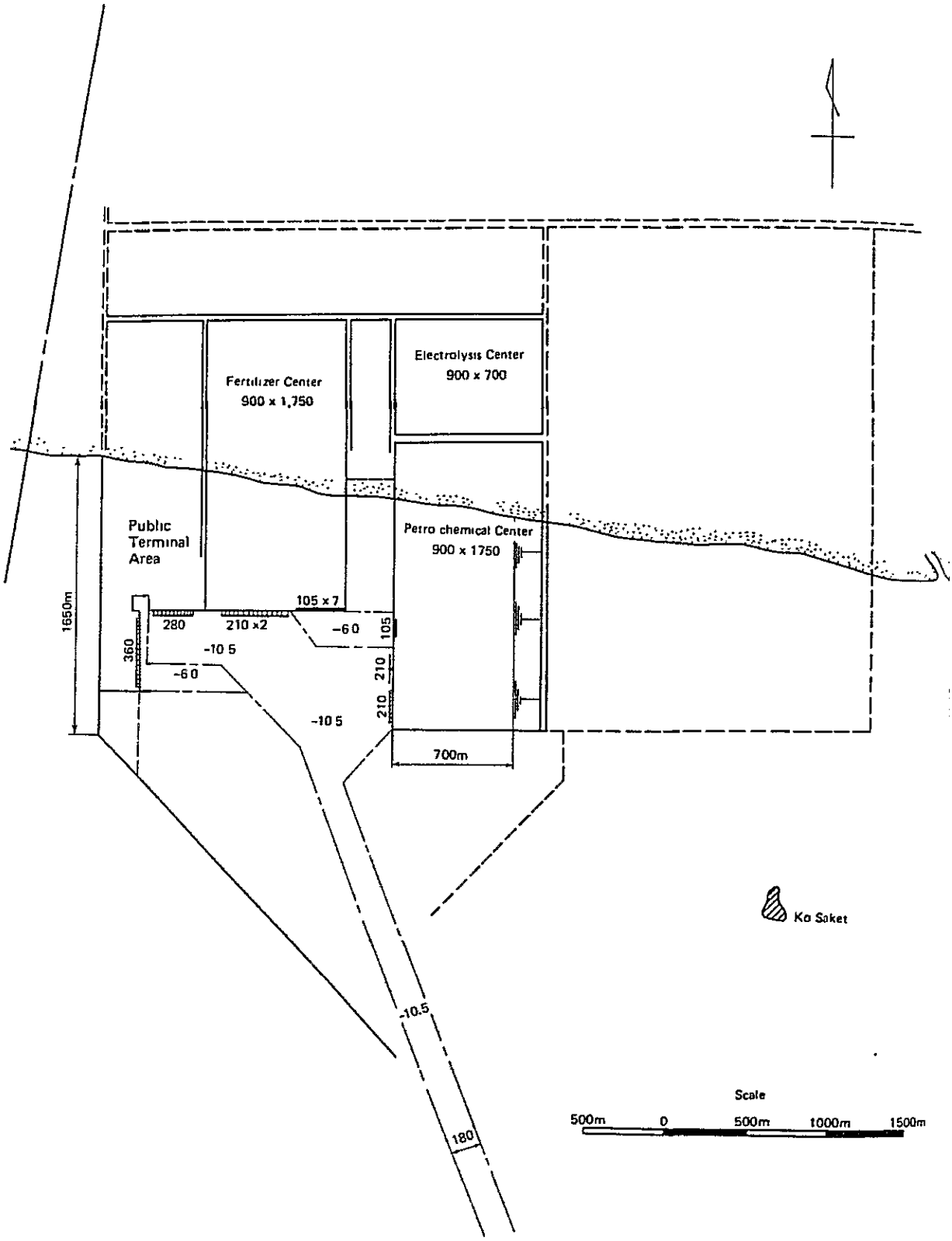
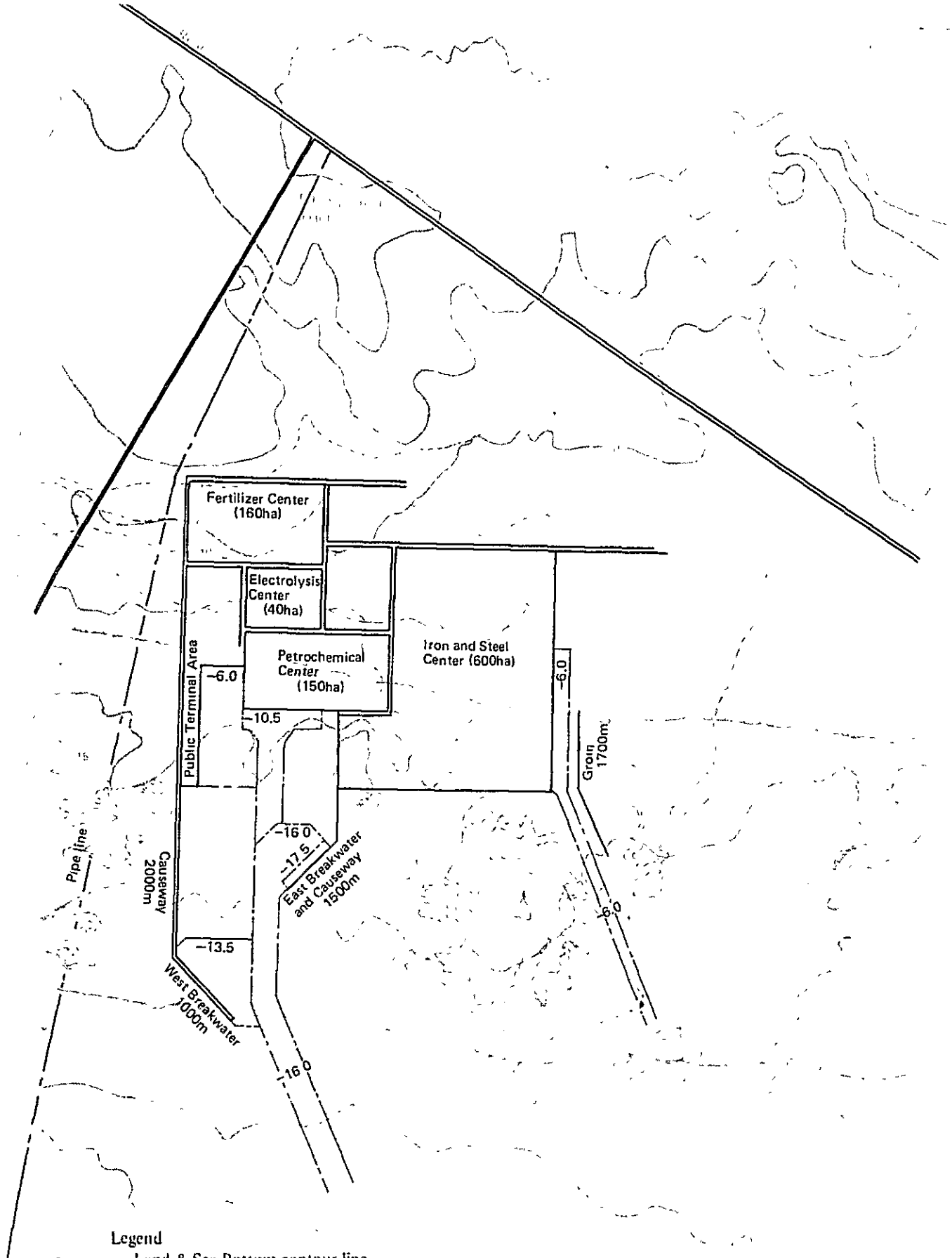


Fig. 1-6 Berth Arrangement [Reclaimed Type]
(The Short Term Development Plan)



Legend

——— Land & Sea Bottom contour line

- - - - Depth of Weathered granite

* Land contour line: MSL (KoLak)

Sea bottom & Depth of Weathered granite: CDL

Fig. 1-7 Layout of New Industrial Port [Jetty Type] (Master Plan)

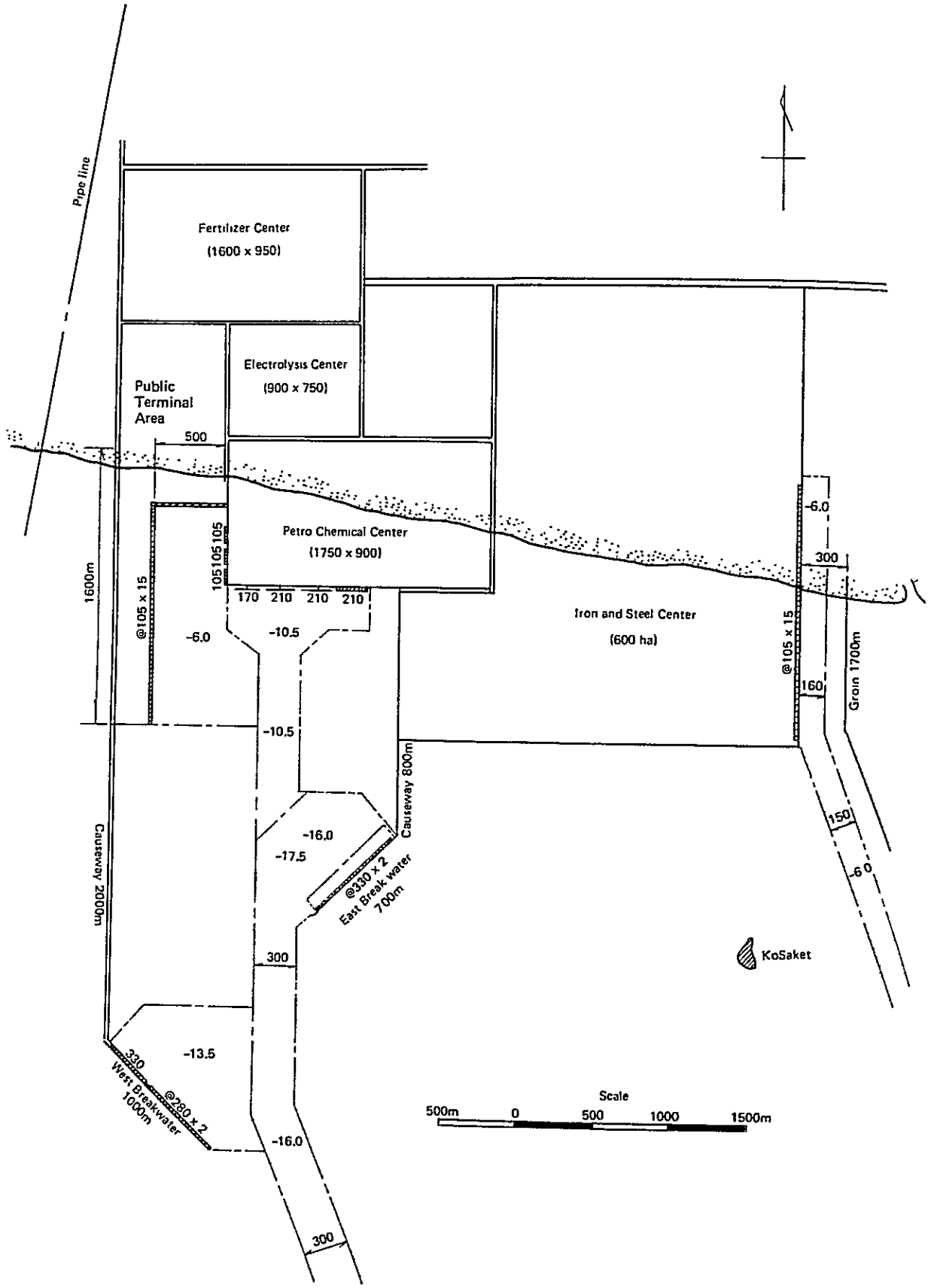
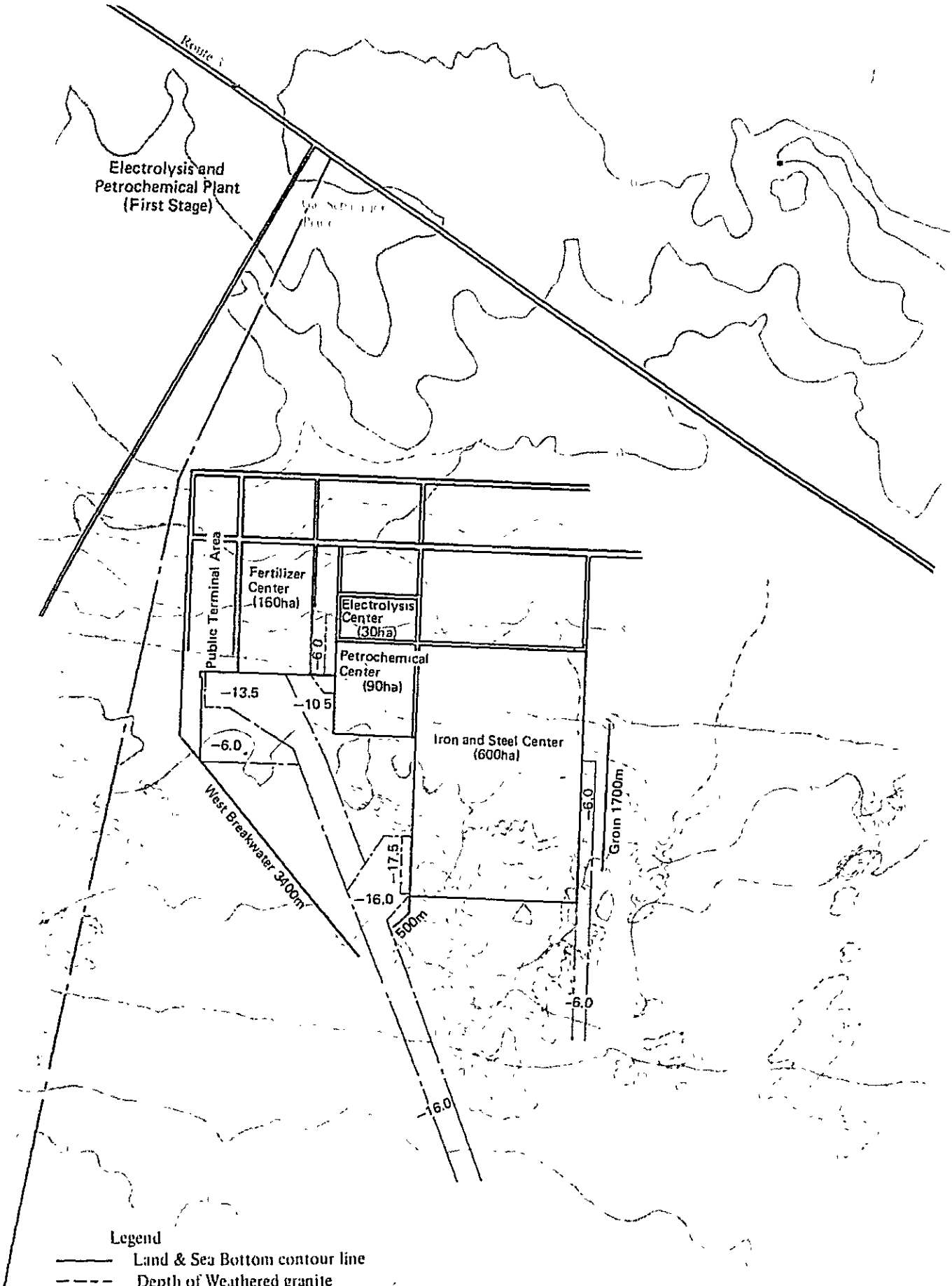


Fig. 1-8 Berth Arrangement [Jetty Type] (Master Plan)



Legend

——— Land & Sea Bottom contour line

– – – – Depth of Weathered granite

* Land contour line: MSL (KoLak)

Sea bottom & Depth of Weathered granite: CDL

Fig. 1-9 Layout of New Industrial Port [Excavated Type] –(2) (Master Plan)

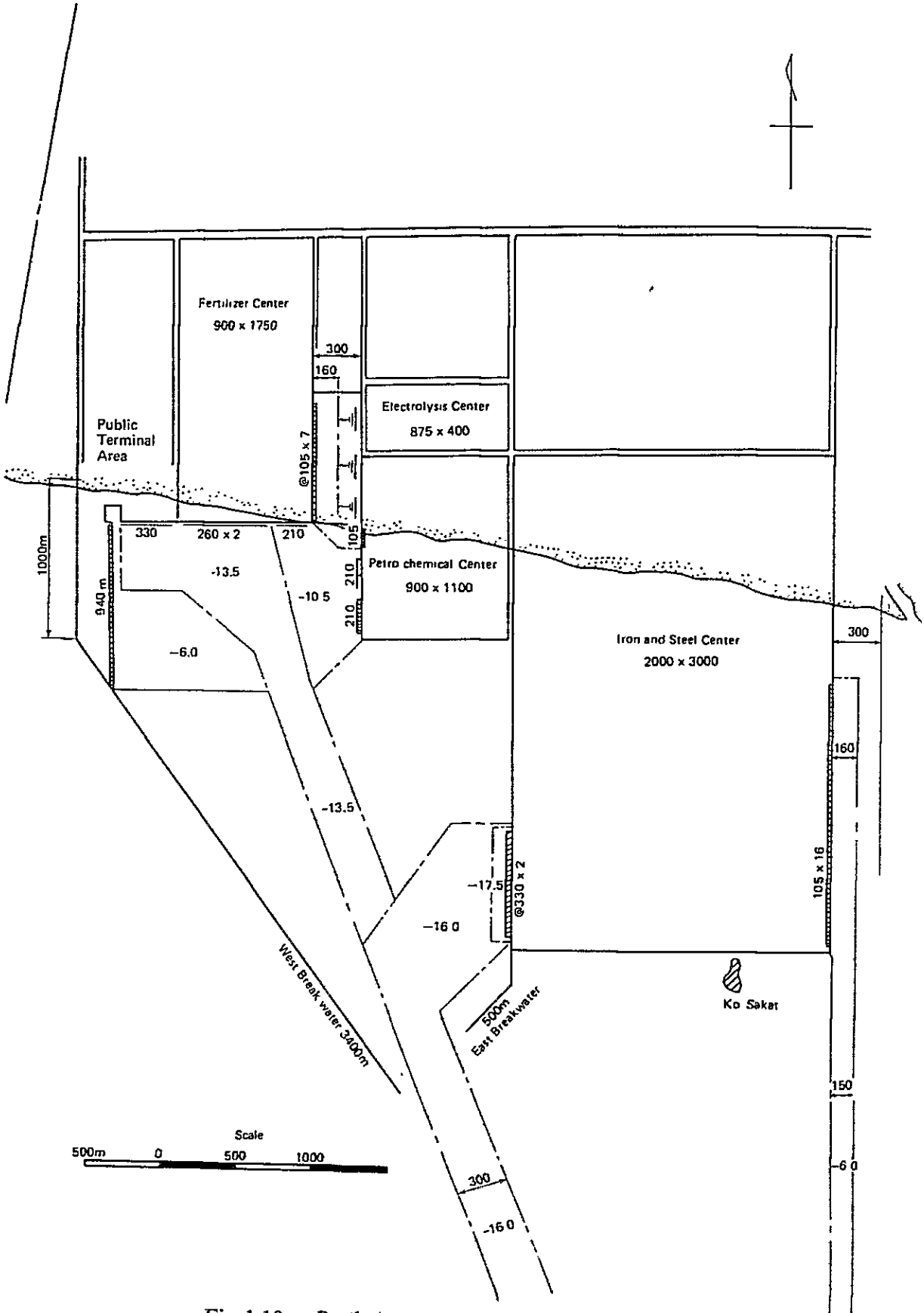


Fig. 1-10 Berth Arrangement [Excavated Type]–(2) (Master Plan)

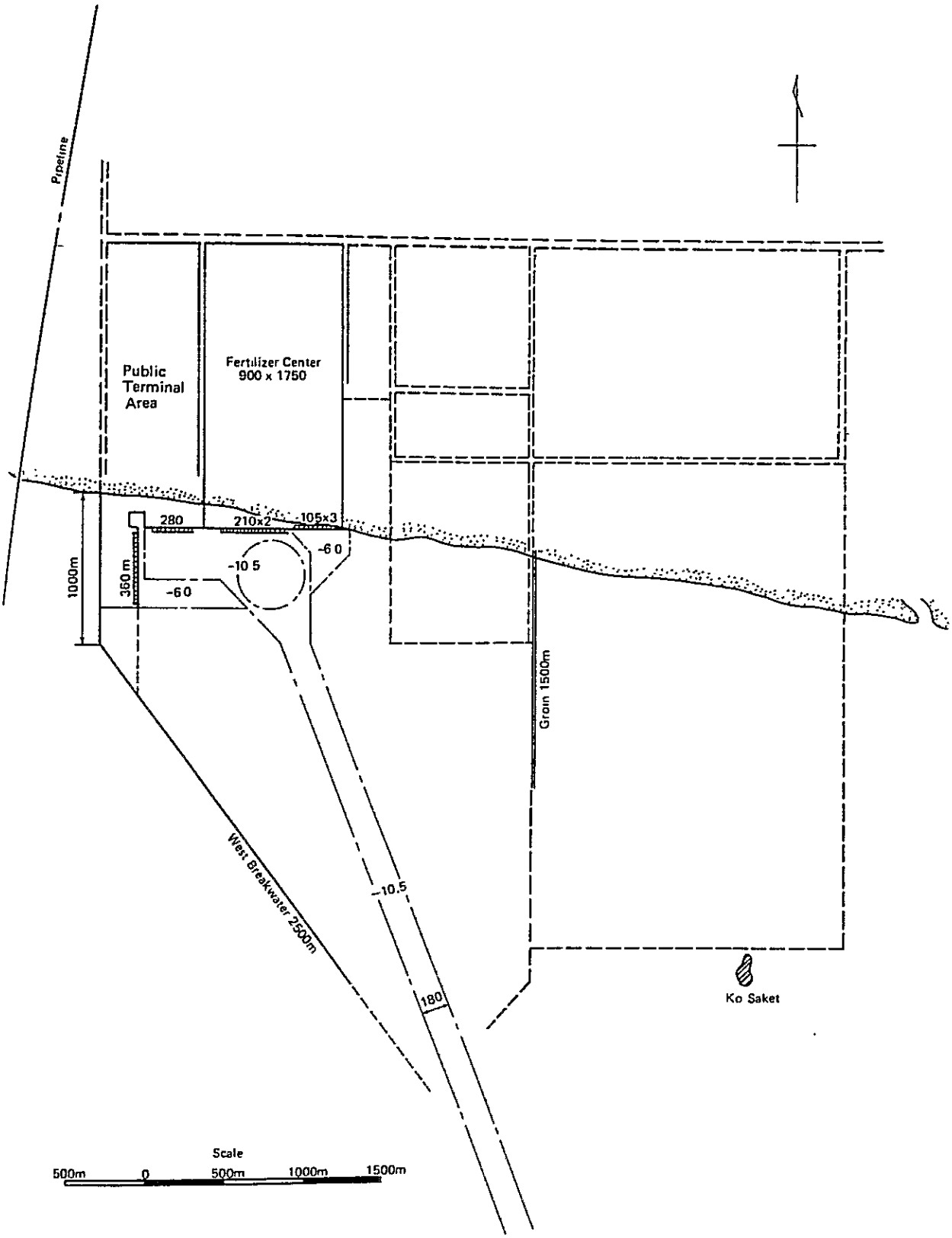


Fig. 1-11 Berth Arrangement [Excavated Type]—(2)
(The Short Term Development Plan)

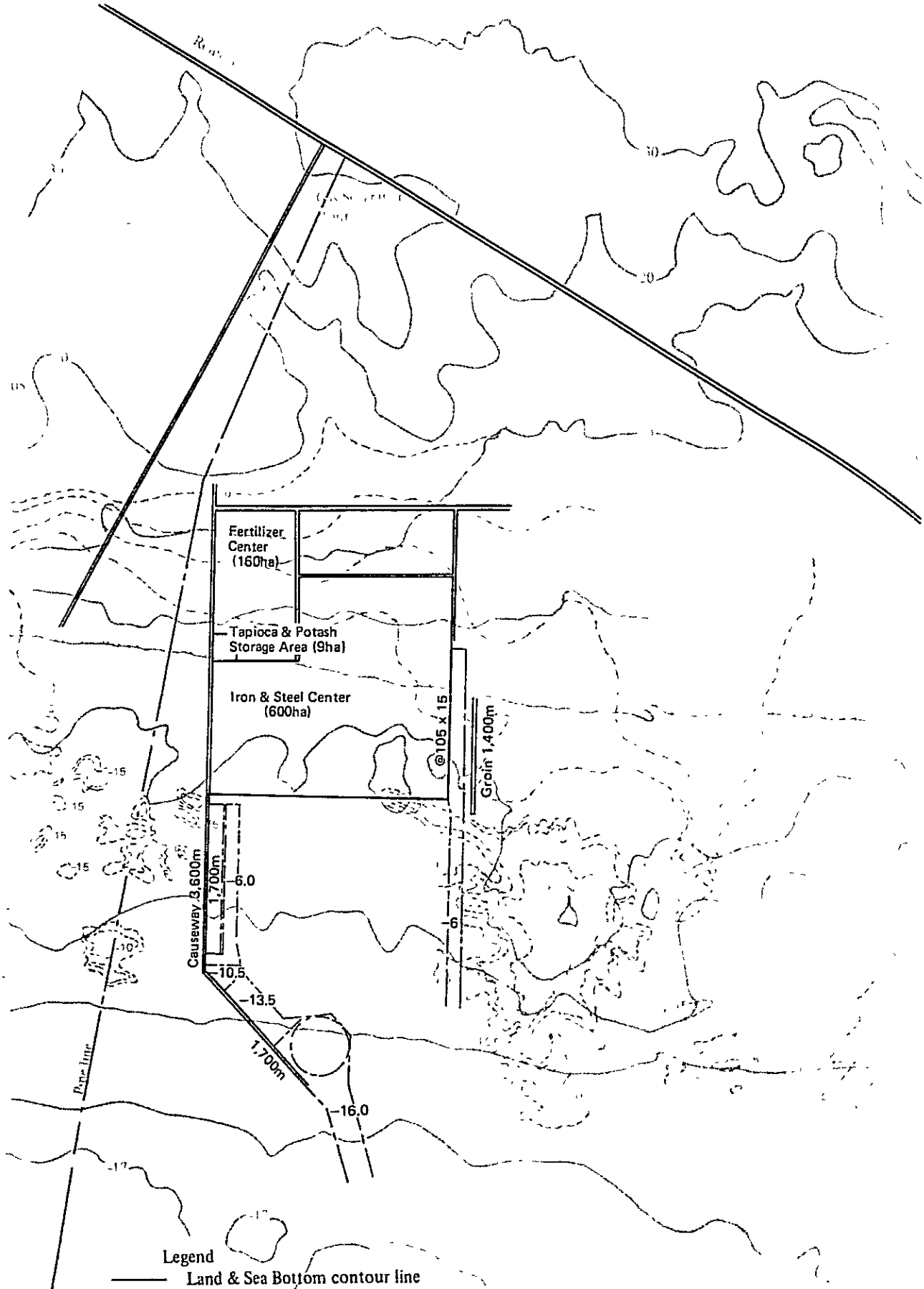


Fig. 1-12 The Layout of New Industrial Port (Master Plan, Jetty Type (2))

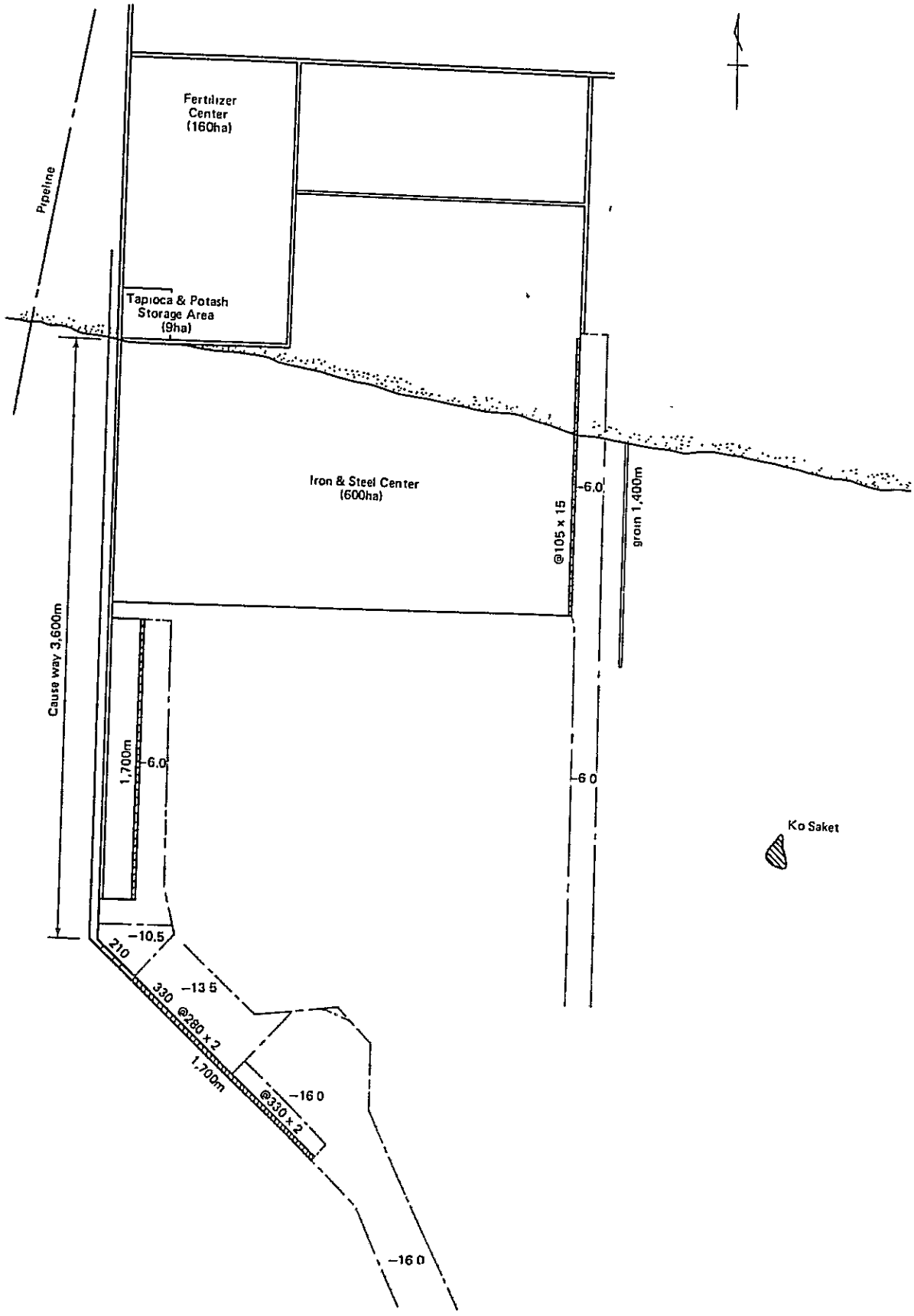


Fig. 1-13 Berth Arrangement
(Master Plan, Jetty Type (2))

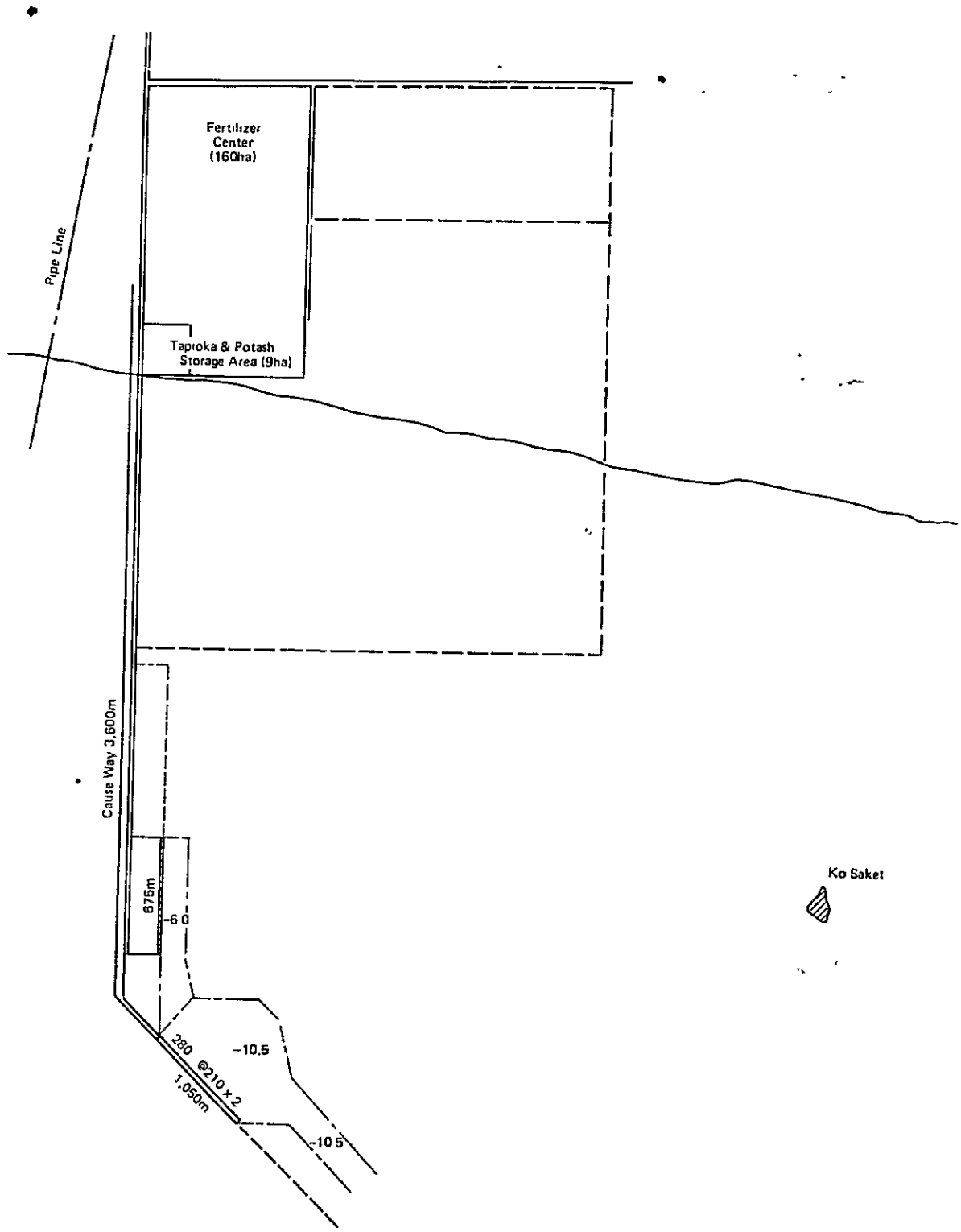


Fig. 1-14 Berth Arrangement
(Short Term Plan, Jetty Type (2))

Appendix 2 Urban Facilities

(1) Housing Scheme

(2) Water Supply

(3) Sewerage and Treatment of Effluent

(4) Drainage System

(5) Solid Waste Disposal

Table 2-1 Income Distribution – 1981

Percentile	Bangkok	Other Municipalities	Rayong	Municipalities* and sanitary districts in Central Thailand	Assumed Distribution ESS (urban)
20	4,000	2,400	1,800	na	2,100
30	4,800	3,000	2,250	na	2,650
40	5,500	3,500	2,750	na	3,150
50	6,500	4,250	3,300	3,800	3,800
70	8,600	6,200	4,800	na	5,500

Baht per month

*Excluding Bangkok

Sources: National Housing Authority, Housing Development Programme 1981–1986
National Housing Authority, Rayong Housing Demand Study 1981
National Statistical Office, Socio Economic Survey: Central Region 1976 (updated)
Eastern Seaboard Study

Table 2-2 Future Household Income Levels in the Eastern Seaboard Development Planning Areas (by ESS)

Percentile	1981	1986	1991	1996	2001
20	2,100	2,850	4,150	5,600	7,650
30	2,650	3,550	5,000	6,500	8,650
40	3,150	4,150	5,700	7,300	9,800
50	3,800	4,950	6,500	8,500	11,100
70	5,500	7,000	8,950	10,600	13,100

Baht per month (1981 prices)

Table 2-3 Average Daily Supplied Water per Capita in Cities of North-East Thailand

Year	Name of City	Chai Yaphum	Burilum	Ubon-Ratcha-thani	Roi-et	Khon-Kaen	Mahasa-Lakarm	Udon-thani	Nong-Kai	Suein	Total and Average
1972	(1)	66.51	50.50	58.30	43.55	43.55	33.87	46.80	60.93	44.41	47.85
	(2)	10,724	9,964	29,458	9,869	26,355	8,787	32,813	15,014	12,414	155,398
	(3)	1,080	1,839	5,362	1,041	4,225	1,426	3,791	2,274	1,898	22,936
(366)	(4)	101	185	182	105	160	162	116	151	153	148
16	(1)	70.46	53.16	62.95	47.39	48.35	37.69	49.44	61.05	47.20	-
	(2)	11,362	10,943	33,173	11,515	31,006	9,973	34,904	15,147	13,550	171,573
1973	(3)	1,187	2,246	5,899	1,281	6,405	2,010	3,852	3,137	2,185	28,202
	(4)	104	205	178	111	207	202	110	207	161	164
17	(1)	74.90	61.18	62.32	50.65	45.96	43.37	49.35	63.17	43.48	-
	(2)	13,932	13,032	34,378	12,663	31,074	11,622	39,034	16,172	12,889	184,796
1974	(3)	1,509	2,327	5,721	1,323	6,982	2,099	3,271	2,018	2,027	27,277
	(4)	108	179	166	104	225	181	84	125	157	148
18	(1)	78.88	53.94	63.50	46.46	42.93	40.08	55.83	67.81	44.26	-
	(2)	13,641	12,170	33,198	12,006	30,173	11,066	41,718	16,992	13,408	184,912
1975	(3)	1,698	2,004	5,727	1,472	8,342	2,194	4,151	2,708	2,205	30,501
	(4)	124	164	173	123	272	198	99	159	164	165
19	(1)	80.14	52.82	65.52	47.04	57.05	46.11	61.77	66.02	47.63	-
	(2)	14,179	12,058	34,177	12,600	43,000	13,230	46,391	16,290	14,747	206,672
1976	(3)	1,888	1,753	5,753	1,445	8,694	2,126	3,944	2,143	2,776	30,422
(366)	(4)	133	145	168	115	200	161	85	132	188	147
20	(1)	84.64	54.09	67.50	48.88	46.51	47.58	57.35	70.88	49.61	-
	(2)	15,444	12,771	33,690	13,958	37,268	14,011	43,665	17,376	15,824	204,007
1977	(3)	2,302	1,914	5,795	2,058	8,868	2,611	6,566	2,162	3,368	35,644
	(4)	149	150	172	147	238	186	150	124	213	175
21	(1)	88.52	56.99	68.50	49.79	49.73	52.11	67.43	73.48	53.17	-
	(2)	16,923	13,899	33,037	14,641	42,020	15,646	52,021	18,148	17,194	233,484
1978	(3)	2,502	2,708	6,059	1,647	9,060	3,492	8,461	2,203	3,934	36,159
	(4)	148	195	183	113	216	223	163	121	229	162
22	(1)	-	58.00	66.88	50.16	43.98	55.98	51.03	77.77	55.19	-
	(2)	18,835	14,386	51,153	15,153	39,552	17,974	40,550	19,210	18,240	235,657
1979	(3)	3,034	3,686	12,567	1,735	9,472	3,658	10,083	3,464	4,587	52,290
	(4)	161	256	243	114	239	203	249	180	251	222
23	(1)	-	60.11	70.84	51.67	49.61	57.44	(54.34)	81.48	57.15	-
	(2)	21,298	15,568	55,346	16,134	46,640	18,951	(44.045)	20,394	19,282	257,658
1980	(3)	3,380	2,852	10,066	2,061	10,073	3,659	8,999	2,780	5,364	49,234
(366)	(4)	159	183	189	128	216	193	204	136	278	191
24	(1)	-	62.12	72.74	52.46	51.18	58.18	(55.50)	83.35	58.32	60.17
	(2)	-	16,416	56,914	16,744	51,315	19,795	(45,350)	21,138	20,013	247,685
1981	(3)	4,840	3,572	13,545	3,147	13,146	3,959	10,253	3,474	5,549	56,645
	(4)	-	218	238	188	256	200	226	164	277	229

Reference (1) Earned ratio (2) Population served (3) Daily average water consumption (m^3/d)
(4) Supplied water per capita (l/c.d)

Source: (PWWA) investigation by Mr. Hayashi, expert from JICA.

Table 2-4 Standard of Drinking Water

Physical Characteristic	Act of the Food and Drug Administration	Department of Medical Science Health Ministry	Department of Science Ministry of Industry	Thai Industrial Standards Institute		Department of Mineral Resource Ministry of Industry		MWA	DWA (WHO 1963)			Recommend Limit of Environment Health Division Health Ministry		U.S. Water Quality Criteria 1972	Japan Drinking Water Quality Std. (1974)	WHO (1971) International Standard for Drinking Water	
Criterion / Parameters				Max. Acceptable ppm.	Max. Allowable ppm.	Max. Acceptable ppm.	Max. Allowable ppm.		Recommended Limit	Acceptable Limit	Tolerance Limit	Max. Acceptable ppm.	Max. Allowable ppm.	Maximum		Highest desirable level	Max. Permissible level
1. Color	20	20.0	20.0	5.0	15.0	5.0	25.0	20.0	5.0	50.0	-	5.0		75.0	less than 5.0	5.0	50.0
2. Odor	-	Odorless	-	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	-	-	Unobjectionable		-	none	Unobjectionable	Unobjectionable
3. Taste	-	-	-	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	-	-	Unobjectionable		-	none	Unobjectionable	Unobjectionable
4. Turbidity	5.0	5.0	5.0	5.0	20.0	5.0	20.0	5.0	5.0	20.0	-	5.0		-	less than 2 ppm	5.0	25.0

Chemical Characteristic	Act of the Food and Drug Administration.	Department of Medical Science Health Ministry	Department of Science Ministry of Industry	Thai Industrial Standards Institute		Department of Mineral Resource Ministry of Industry		MWWA	PWWA (WHO 1963)			Recommend Limit of Environment Health Division Health Ministry		U.S. Water Quality Criteria 1972	Japan Drinking Water Quality Std. (1974)	WHO (1971) International Standard for Drinking Water	
Criterion / Parameters				Max. Acceptable ppm.	Max. Allowable ppm.	Max. Acceptable ppm.	Max. Allowable ppm.		Recommended Limit	Acceptable Limit	Tolerance Limit	Max. Acceptable ppm.	Max. Allowable ppm.	Maximum		Highest desirable level	Max. Permissible level
1. Alkyl benzene sulfonate (ABS)	-	-	-	0.5	1.0				0.5	1.0	-	0.5				-	
2. Ammonia (NH_3-N)	0.005	0.05	-	-	-			0.05	-	-	-	0.05		0.5	none	-	-
3. Arsenic (As)	0.05	0.05	0.05	0.05	-	-	0.05	0.01	-	-	0.05	0.01		0.1	0.05	-	0.05
4. Barium (Ba)	-	-	-	1.0	-	-	1.0		-	-	1.0	0.5	1.0	1.0		-	-
5. Cadmium (Cd)	-	-	-	0.01	-	-	0.01		-	-	0.01	0.01		0.01		-	0.01
6. Calcium (Ca)	-	-	-	75	200	75	200		75	200	-	75		-		75	200
7. Chloride (Cl)	200 asCl	330asCl 550as NaCl	550 as NaCl	250	600	200 as Cl	500 as Cl	250	200	600	-	250		250	200 as Cl	200	600
8. Chromium (Cr^{+6})	-	3.0	-	0.05		-	0.05	0.05	-	-	0.05	0.05		0.05	0.05	-	-
9. Copper (Cu)	-	-	-	1.0	11.5	1.0	1.5	1.0-3.0	1.0	1.5	-	1.0		1.0	1.0	0.05	1.5
10. Cyanide (CN)	-	-	-	0.2	-	-	0.2	0.01-0.2	-	-	0.2	0.01		0.2	none	-	0.05
11. Fluoride (F)	1.5	1.5	-	< 0.5 > 0.7	1.0	1.0	1.5	1.2 accept 1.5 allow.	-	1.0-1.5	-			less than 0.2		Lower 0.6	Upper 0.8

Chemical Characteristic	Act of the Food and Drug Administration.	Department of Medical Science Health Ministry	Department of Science Ministry of Industry	Thai Industrial Standards Institute		Department of Mineral Resource Ministry of Industry		MWA	DWA (WHO 1963)			Recommend Limit of Environment Health Division Health Ministry		U.S. Water Quality Criteria 1972	Japan Drinking Water Quality Std. (1974)	WHO (1971) International Standard for Drinking Water	
Criterion / Parameters				Max. Acceptable ppm.	Max. Allowable ppm.	Max. Acceptable ppm.	Max. Allowable ppm.		Recommended Limit	Acceptable Limit	Tolerance Limit	Max. Acceptable ppm.	Max. Allowable ppm.	Maximum		Highest desirable level	Max Permissible level
12. Hardness (as $CaCO_3$)	300	300	300	300	-	-	-	300	-	-	-	300.		-	300	100	500
13. pH	6.5-8.0	6.5-8.5	6.5-8.5	6.5-8.5	9.2	7.0-8.5	6.5-8.5	6.8-8.2	7.0-8.5	6.5-9.2	-	6.5-8.5		5.0-9.0	5.8-8.6	7.0-8.5	6.5-9.2
14. Iron (Fe)	0.5	0.5	0.5	0.5	1.0	0.5	1.0	0.5	0.3	1.0	-	0.5		0.3	0.3	0.1	1.0
15. Lead (Pb)	0.1	0.1	0.1	0.05	-	-	0.05	0.5	-	-	0.05	0.05		0.05	0.1	-	0.1
16. Magnesium (Mg)	-	125	-	50	150	50	150	125	50	150	-	50		-	-	30	150
17. Manganese (Mn)	-	-	-	0.3	0.5	0.2	0.5	0.3	0.1	0.5	-	0.1		0.05	0.3	0.05	0.5
18. Nitrate (NO_3)	4.0	4.0	4.0	45	45	-	45	1.5	-	45	-	45* 10**		10	10	-	45
19. Nitrite (NO_2-N)	0.001	0.002	0.001	-	-	-	-	<0.001	-	-	-	0.001		1.0		-	-
20. Phenolic compound (as Phenol)	-	-	-	0.001	0.002	-	-		0.001	0.002	-	0.001		1.0ug/l	0.005	0.001	0.002
21. Selenium (Se)	-	-	-	0.01	-	-	0.01	0.01	-	-	0.01	non	0.01	0.01		-	0.01
22. Silver (Ag)	-	-	-	-	-	-	-		-	-	-	0.001		-		-	-

Chemical Characteristic	Act of the Food and Drug Administration.	Department of Medical Science Health Ministry	Department of Science Ministry of Industry	Thai Industrial Standards Institute		Department of Mineral Resource Ministry of Industry		MWWA	DWWA (WHO 1963)			Recommend Limit of Environment Health Division Health Ministry		U.S. Water Quality Criteria 1972	Japan Drinking Water Quality Std. (1974)	WHO (1971) International Standard for Drinking Water	
Criterion / Parameters				Max. Acceptable ppm.	Max. Allowable ppm.	Max. Acceptable ppm.	Max. Allowable ppm.		Recommended Limit	Acceptable Limit	Tolerance Limit	Max. Acceptable ppm.	Max. Allowable ppm.	Maximum		Highest desirable level	Max. Permissible level
23. Sulfate (SO_4)	-	250 as Na_2SO_4	-	200	250	200	200	250	200	400	-	200		250	-	200	400
24. Total Solides	1000	-	1000	500	1500	500	1000	1000	-	-	-	500		-	500	500	1500
25. Zinc (Zn)	-	15.0	-	5.0	15.0	5.0	15.0	15.0	5.0	15.0	-	5.0		5.0	-	5.0	15.0
26. Oil & Grease	-	-	-	-	-	-	-	-	-	-	-	non			-	-	-
27. Organic Matter (Consumption of $KMnO_4$)	-	-	-	-	-	-	-	-	-	-	10	-		-	-	-	-
28. Organic Phosphate	-	-	-	-	-	-	-	-	-	-	none	-		-	-	-	-
29. Anion Active Agent		-	-	-	-	-	-	-	-	-	0.5	-		-	-	0.2	1.0
30. Mercury		-	-	-	-	-	-	-	-	-	none	-		-	-	0.	0.001
31. Mineral Oil		-	-	-	-	-	-	-	-	-		-		-	-	0.01	0.30

Biological Characteristic	Act of the Food and Drug Administration.	Department of Medical Sciences Health Ministry	Department of Science Ministry of Industry	Thai Industrial Standards Institute	Department of Mineral Resource Ministry of Industry	MWWA	PWWA (WHO 1963)	Recommend Limit of Environment Health Division Health Ministry	U.S. Water Quality Criteria 1972	Japan Drinking Quality Std. (1974)	WHO (1971) Internation Standard for Drinking Water
1. M.P.N.	2.2 coliform org/100ml	2.2 Coliform org/100ml	2.2 Coliform org/100ml	2.2Coliform org/100ml			2.2Coliform org/100ml	2.2 Coliform org/100ml		none	2.2Coliform org/100ml
2. Total plate count	500Colonies /ml	500 Colonies / ml	500 Colonies /ml	500Colonies /ml			500 Colonies / ml			100 Colonies / ml	500 Colonies / ml
3. E. Coli	none	none	none	none			none	none		---	none
4. Fecal Coliform	---	---	---	---						---	none
5. Salmonella										---	
6. Shigella										---	
7. Vibrio Cholera										---	
8. Vibrio Parahemolyticus											

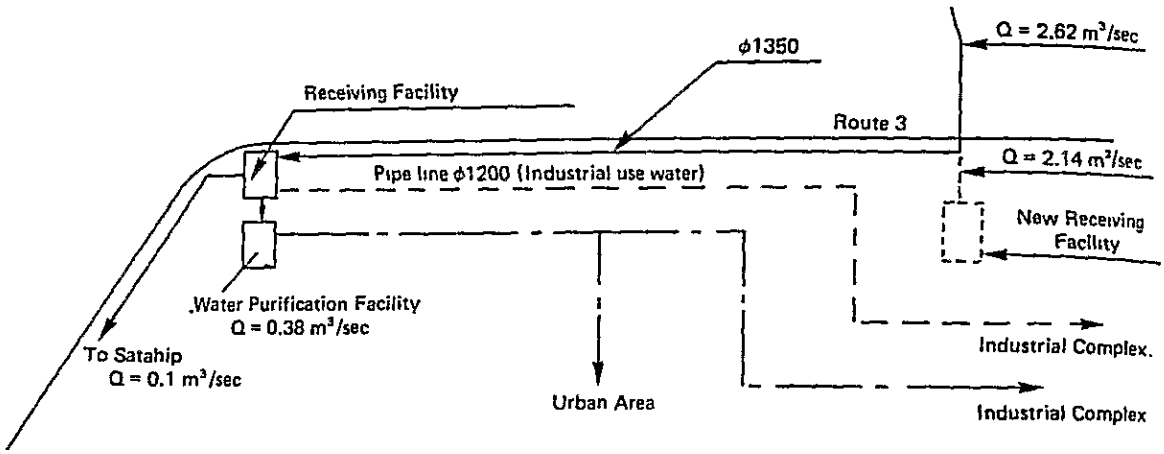
Table 2-5 Calculation for Purification Facilities

Items	Planning conditions	1st phase (1987)	2nd phase (2000)
1. Receiving Well	Retention period: 2 min.	$Q = 9200\ m^3/d$ $V = \frac{9200}{24 \times 60} \times 2$ $= 12.8\ m^3$ (1.8 mW x 3.0 mL x 2.5 mD) x 1 unit $= 13.5\ m^3$	$Q = 24800\ m^3/d$ $V = \frac{24800}{24 \times 60} \times 2$ $= 34.4\ m^3$ (3.5 mW x 3.5 mL x 3 mD) x 1 unit $= 36.8\ m^3$
2. High Rate Coagulosedimentation Basin	Retention period: 2 hrs. Rising velocity : 40-50 mm/min.	$Q = 9200\ m^3/d$ Provide 2 units For 1 unit $Q = \frac{9200}{2} = 4600\ m^3/d$ $V = \frac{4600}{24} \times 2 = 383.3\ m^3$ (ø11 m x 4.5 mD) x 2 units $= 855.3\ m^3$ As the diameter of center well is ø4 m Rising velocity: v $V = \frac{4600}{\frac{\pi}{4}(11^2-4^2)} \times \frac{1}{24 \times 60} \times 1000$ $= 38.7$ mm/min.	$Q = 24800\ m^3/d$ Provide 4 units For 1 unit $Q = \frac{24800}{4} = 6200\ m^3/d$ $V = \frac{6200}{24} \times 2 = 516.7\ m^3$ (ø12 m x 5.0 mD) x 4 units $= 2262.0\ m^3$ As the diameter of center well is ø4 m Rising velocity: v $V = \frac{6200}{\frac{\pi}{4}(12^2-4^2)} \times \frac{1}{24 \times 60} \times 1000$ $= 42.8$ mm/min.
	Discharged sludge volume Operation time is 5 seconds per 30 minutes	Pipe diameter is ø200 m/m for sludge drawing. As velocity of sludge drawing is 1.5 m/sec. Discharged sludge volume per day $q = \frac{\pi}{4} \times (0.2)^2 \times 1.5 \times 2 \times 5 \times 24$ $= 11.3\ m^3/d$	Pipe diameter is ø250 m/m for sludge drawing. As velocity of sludge drawing is 1.5 m/sec. Discharged sludge volume per day $q = \frac{\pi}{4} \times (0.25)^2 \times 1.5 \times 2 \times 5 \times 24$ $= 17.7\ m^3/d$

Items	Planning conditions	1st phase (1987)	2nd phase (2000)
3. Rapid Sand Filter	Filtration velocity: 120 m/d	$Q = 9200\ m^3/d$ Three units will be provided For 1 unit $Q = \frac{9200}{3} = 3066.7\ m^3/d$ $A = \frac{3066.7}{120} = 25.6\ m^2$ (4 mW x 8 mL) x 3 units = $96\ m^2$	$Q = 24800\ m^3/d$ Six units will be provided For 1 unit $Q = \frac{24800}{6} = 4133.3\ m^3/d$ $A = \frac{4133.3}{120} = 34.4\ m^2$ (5 mW x 8 mL) x 6 units = $240\ m^2$
	Washing: Using fixed type surface washing and back washing	As 1 time a day washing Duration time: 5 min. Amount of washing	As 1 time a day washing Duration time: 5 min. Amount of washing
	Surface jet amount: $0.20\ m^3/m^2 min.$	(0.2 + 0.9) x 96 x 5 = $528.0\ m^3/d$	(0.2 + 0.9) x 240 x 5 = $1320.0\ m^3/d$
	Backwashing amount: $0.9\ m^3/m^2 min.$		

Items	Planning conditions	1st phase (1987)	2nd phase (2000)
4. Chlorination Tank	Retention period: 20 min.	$Q = 9200\ m^3/d$ $V = \frac{9200}{24x60} \times 20 = 127.8\ m^3$ (4 mW x 15 mL x 2.5 mD) x 1 unit $= 150.0\ m^3$	$Q = 24800\ m^3/d$ $V = \frac{24800}{24x60} \times 20 = 344.4\ m^3$ (8 mW x 16 mL x 3 mD) x 1 unit $= 384.0\ m^3$
5. Sludge Lagoon	Capacity is average discharged sludge volume for 3 days.	From 1 and 3 Sludge volume: q $q = 11.3 + 528.0 = 539.3\ m^3/d$ $V = 539.3 \times 3 = 1617.9\ m^3$ (35 mW x 35 mL x 1.5 mD) x 1 unit $= 1837.5\ m^3$	From 1 and 3 Sludge volume: q $q = 17.7 + 1320.0 = 1337.7\ m^3/d$ $V = 1337.7 \times 3 = 4013.1\ m^3$ (35 mW x 80 mL x 1.5 mD) x 1 unit $= 4200.0\ m^3$
6. Distribution Facilities 1) Distribution Basin	Capacity is 10-12 hrs supply of daily maximum.	$Q = 9200\ m^3/d$ $V = \frac{9200}{24} \times 12 = 4600\ m^3$ (30 mW x 30 mL x 5.5 mD) x 1 unit $= 4950\ m^3$	$Q = 24800\ m^3/d$ $V = \frac{24800}{24} \times 10 = 10333.3\ m^3$ (30 mW x 35 mL x 5.5 mD) x 2 unit $= 11550.0\ m^3$
2) Distribution Tower	Capacity is 2 hrs supply of daily maximum.	Unnecessary	As one thirds of 24800 m^3/d is used in high service system. $Q = \frac{24800}{3} = 8266.7\ m^3/d$ $V = \frac{8266.7}{24} \times 2 = 688.9\ m^3$ (ø13 m x 6 mD) x 1 unit = 796.6 m^3

*1 Outline of the Comparative Study for Construction Costs of Cases ⓐ and ⓑ



Explanation of Alternatives

The demand of industrial water (excluding that from sea water) in the master plan is estimated at 3.65 m^3/sec as shown in Table 8.2-5 of the Final Report. The presently planned water pipeline has a flow rate of 2.62 m^3/sec. Of this rate, 2.14 m^3/sec can be used for industrial water.

The presently planned receiving reservoir has a net capacity of about 28,000 m^3. If retention period of the industrial water of 2.14 m^3/sec is taken as 3 hours as in the original plan,

$$2.14 \times 60 \times 60 \times 3 = 23{,}112\ m^3$$

Thus, the receiving reservoir for the industrial water in Case ⓑ will require the same capacity as that in the original plan.

Where the industrial water is taken from the presently planned receiving reservoir, it is necessary to lay a 1200 ϕ pipeline.

1. Conditions for Comparative Study

(1) The diameter (1350 ϕ) of the presently planned water pipeline is not changed.

(2) The capacity of the presently planned receiving reservoir is not changed.

(3) The newly planned receiving reservoir has the same capacity as that of the presently planned one.

Table 2-6 Comparative Study for Alternatives

	Case ⓐ	Case ⓑ
Pipeline	Steel Pipe, ϕ 1200 4600 m X 6855 ฿ = 31,530,000 ฿	Disuse
Receiving Facilities	Disuse	26,360,000 ฿ (Incl. Receiving Well)
Land Acquisition	Disuse	37,500 m^2/1600 X 50,000 ฿/Lay = 1,170,000 ฿
Total Cost	31,530,000 ฿	27,530,000 ฿

Table 2-7 Industrial Wastewater Standards

		Ministry of Industry Notification (1982)
(1)	pH	Between 5.0 and 9.0
(2)	Permanganate Value	60 mg/l
(3)	Dissolved Solids:	
	3.1 Discharge into watercourses:	2,000 mg/l or more but not exceeding 5,000 mg/l, depending upon discharging point
	3.2 Discharge into sea or estuaries (Salinity higher than 2,000 mg/l)	5,000 mg/l higher than dissolved solids content in sea or estuary waters
(4)	Sulfide as H_2S	1.0 mg/l
(5)	Cyanide as HCN	0.2 mg/l
(6)	Heavy metals:	
	6.1 Zinc	5.0 mg/l
	6.2 Chromium	0.5 mg/l
	6.3 Arsenec	0.25 mg/l
	6.4 Copper	1.0 mg/l
	6.5 Mercury	0.005 mg/l
	6.6 Cadmium	0.03 mg/l
	6.7 Barium	1.0 mg/l
	6.8 Selenium	0.02 mg/l
	6.9 Lead	0.2 mg/l
	6.10 Nickel	0.2 mg/l
	6.11 Manganese	5.0 mg/l
(7)	Tar	Nil
(8)	Oil & Grease	5.0 mg/l (Except for crude oil refinery and lubuicant blending plant, less than 15 mg/l)
(9)	Formaldehyde	1.0 mg/l
(10)	Phenols & Cresols	1.0 mg/l
(11)	Free chlorine	1.0 mg/l
(12)	Insecticides and radioactive substances	Nil
(13)	Suspended solids	30 mg/l or more depending on dilution ratio as shown below
	Dilution Ratio	Allowable Suspended solids
	8–150	30 mg/l
	151–300	60 mg/l
	301–500	150 mg/l
(14)	BOD, 5 days, 20°C	20 mg/l or more but not exceeding 60 mg/l, depending upon discharging point, except for industries as shown below
(15)	Temperature	Less than 40°C
(16)	Color and Odor	Not objectionable when mixed in receiving water

Table 2-8 Calculation for Sewage Treatment Plant

Items	Planning conditions	1st phase (1987)	2nd phase (2000)
1. Grit Chamber	Retention period: 30-60 sec Flow rate : 0.3 m/sec	$Q = \frac{500}{60 \times 60} = 0.1389\ m^3/sec$ $V = 0.1389 \times 60 = 8.3333\ m^3$ $A = \frac{0.1389}{0.3} = 0.46\ m^2$ (0.8 mW x 6 mL x 1 mD) x 2 units $= 9.6\ m^3$	$Q = \frac{1500}{60 \times 60} = 0.4167\ m^3/sec$ $V = 0.4167 \times 60 = 25.0\ m^3$ $A = \frac{0.4167}{0.3} = 1.39\ m^2$ (1.5 mW x 9 mL x 1 mD) x 2 units $= 27.0\ m^3$
2. Primary Sedimentation Tank	Surface load: 30 m^3/m^2d Retention period: 1.5 hrs	$Q = 8300\ m^3/d$ Two units will be provided For 1 unit $Q = \frac{8300}{2} = 4150\ m^3/d$ $A = \frac{4150}{30} = 138.3\ m^2$ $V = \frac{4150}{24} \times 1.5 = 259.4\ m^3$ (ø14 m x 2.5 mD) x 2 units $= 307.9\ m^2$	$Q = 24200\ m^3/d$ Two units will be provided For 1 unit $Q = \frac{24200}{2} = 12100\ m^3/d$ $A = \frac{12100}{30} = 403.3\ m^2$ $V = \frac{12100}{24} \times 1.5 = 756.3\ m^3$ (ø23 m x 2.5 mD) x 2 units $= 831.0\ m^2$
3. Aerated Lagoon	Bod loading: 0.15 $kg/m^3/d$	$Q = 8300\ m^3/d$ $V = \frac{8300 \times 140 \times 10^{-3}}{0.15}$ $= 7746.7\ m^3$ Average water depth = 2.5 mD $A = \frac{7746.7}{2.5} = 3098.7\ m^2$ (30 mW x 55 mL) x 2 units $= 3300\ m^2$	$Q = 24200\ m^3/d$ $V = \frac{24200 \times 140 \times 10^{-3}}{0.15}$ $= 22586.7\ m^3$ Average water depth = 2.5 mD $A = \frac{22586.7}{2.5} = 9034.7\ m^2$ (50 mW x 100 mL) x 2 units $= 10000\ m^2$

Items	Planning conditions	1st phase (1987)	2nd phase (2000)
4. Final Sedimentation Tank	Surface load: 20 m^3/m^2d Retention period: 2.5 hrs	Q = 8300 m^3/d Two units will be provided For 1 unit $Q = \frac{8300}{2} = 4150\ m^3/d$ $A = \frac{4150}{20} = 207.5\ m^2$ $V = \frac{4150}{24} \times 2.5 = 432.3\ m^3$ (ø17 m x 2.5 mD) x 2 units = 454.0 m^2	Q = 24200 m^3/d Two units will be provided For 1 unit $Q = \frac{24200}{2} = 12100\ m^3/d$ $A = \frac{12100}{20} = 605\ m^2$ $V = \frac{12100}{24} \times 2.5 = 1260.4\ m^3$ (ø28 m x 2.5 mD) x 2 units = 1231.5 m^2
5. Chlorination Tank	Retention period: 20 min.	Q = 8300 m^3/d $V = \frac{8300}{24x60} \times 20 = 115.3\ m^3$ (3 mW x 9 mL x 2.5 mD) x 2 units = 135 m^3	Q = 24200 m^3/d $V = \frac{24200}{24x60} \times 20 = 336.1\ m^3$ (3 mW x 24 mL x 2.5 mD) x 2 units = 360 m^3
6. Sludge Digestion Tank	Retention period: 10 days	Sludge volume: (at 98 % sludge moisture) Q = 8300 m^3/d $V = \frac{8300x(250-30)x10^{-6}x100}{100-98}$ = 91.3 m^3/d V = 91.3 x 10 = 913 m^3 (5 mW x 24 mL x 4.5 mD) x 2 units = 1080 m^3	Sludge volume: (at 98 % sludge moisture) Q = 24200 m^2/d $V = \frac{24200x(250-30)x10^{-6}x100}{100-98}$ = 266.2 m^3/d V = 266.2 x 10 = 2662 m^3 (7 mW x 40 mL x 5 mD) x 2 units = 2800 m^3

Items	Planning conditions	1st phase (1987)	2nd phase (2000)
7. Sludge Thickner	Solid load: 60 kg/m^2d Assumed that 50 % of sludge will be digested in sludge digestion tank.	Q = 8300 m^3/d Sludge volume: $\frac{8300 \times (250-30) \times 10^{-3} \times 50}{100}$ = 913 kg/d A = $\frac{913}{60}$ = 15.2 m^2 Two units will be provided (ø3.5 m x 2.5 mD) x 2 units = 19.2 m^2	Q = 24200 m^3/d Sludge volume: $\frac{24200 \times (250-30) \times 10^{-3} \times 50}{100}$ = 2662 kg/d A = $\frac{2662}{60}$ = 44.4 m^2 Two units will be provided (ø6 m x 2.5 mD) x 2 units = 56.6 m^2
8. Sludge Storage Tank	Capacity is average discharged sludge volume for 7 days.	Sludge volume: (at 96 % sludge moisture) 913 x $\frac{100 \times 10^{-3}}{100-96}$ = 22.8 m^3/d V = 22.8 x 7 = 159.6 m^3 Two units will be provided (5 mW x 5 mL x 4 mD) x 2 units = 200 m^3	Sludge volume: (at 96 % sludge moisture) 2662 x $\frac{100 \times 10^{-3}}{100-96}$ = 66.6 m^3/d V = 66.6 x 7 = 466.2 m^3 Two units will be provided (7 mW x 7 mL x 5 mD) x 2 units = 490 m^3

Table 2-9 Calculation of Drainage Size 1

Drainage area (ha)	Run-off (m^3/sec)	Drainage size (mm X mm)	Grade (%)	Velocity (m/sec)	Capacity (m^3/sec)
0.5	0.097	300 X 400	5.0	1,331	0.120
1.0	0.194	400 X 500	5.0	1,612	0.258
2.0	0.389	500 X 600	5.0	1,871	0.468
4.0	0.778	700 X 900	5.0	2,341	1,147
6.0	1,167	800 X 1000	5.0	2,559	1,638
8.0	1,556	800 X 1000	5.0	2,559	1,638
10.0	1,944	900 X 1100	4.5	2,626	2,127
15.0	2,917	1100 X 1400	4.5	3,000	3,630
20.0	3,889	1200 X 1500	4.0	3,000	4,320
25.0	4,861	1300 X 1600	4.0	3,164	5,347
30.0	5,833	1400 X 1700	4.0	3,324	6,515
40.0	7,778	1600 X 1900	3.0	3,147	8,056
50.0	9,722	1800 X 2100	3.0	3,404	11,029
75.0	14,583	2000 X 2300	3.0	3,651	14,604
100.0	19,444	2400 X 2700	2.5	3,764	21,681
150.0	29,167	2800 X 3100	2.0	3,731	29,251

$$Q = \frac{1}{360} C \cdot i \cdot A \cdot = \frac{1}{360} \times 0.5 \times 140 \cdot A$$

Table 2-10 Calculation of Drainage Size 2

Drainage Area (ha)	Run-off (m^3/sec)	Drainage Size (mm X mm X mm)	Grade (%)	Velocity (m/sec)	Capacity (m^3/sec)
0.5	0.097	900 x 300 x 300	5.0	1.118	0.112
1.0	0.194	1100 x 300 x 400	5.0	1.370	0.247
2.0	0.389	1300 x 300 x 500	4.5	1.507	0.422
4.0	0.778	1700 x 300 x 700	4.5	1.870	1.010
6.0	1.167	1900 x 300 x 800	4.5	2.035	1.425
8.0	1.556	2100 x 300 x 900	4.5	2.193	1.930
10.0	1.944	2300 x 300 x 1000	4.5	2.344	2.532
15.0	2.917	2700 x 300 x 1200	4.0	2.348	3.052
20.0	3.889	3100 x 300 x 1400	4.0	2.611	4.700
25.0	4.861	3300 x 300 x 1500	4.0	2.737	5.693
30.0	5.833	3500 x 300 x 1600	4.0	2.860	6.807
40.0	7.778	3900 x 300 x 1800	3.5	2.898	8.811
50.0	9.722	4100 x 300 x 1900	3.5	3.007	10.223
75.0	14.583	4900 x 300 x 2300	3.0	3.167	15.962
100.0	19.444	5300 x 300 x 2500	3.0	3.350	20.033
150.0	29.167	6000 x 300 x 3000	2.5	3.457	30.004

(width X 300 X depth)

$$Q = \frac{1}{360} \cdot C \cdot A = \frac{1}{360} \times 0.5 \times 140 \times A$$

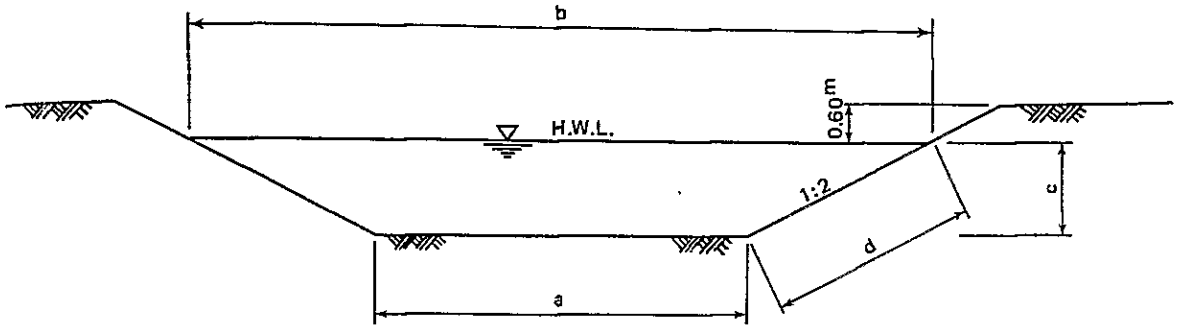
Table 2-11 Run-off and Planned Flood Discharge

No.	A	ΣA	C	T	i	Qo		Q
6	N 481 D 83	N 481 D 83	0.15 0.5	127	80	16.0 9.2	25.2	26
5	N 688 D 92	N 688 D 92	0.15 0.5	115	80	22.9 10.2	33.1	34
4	N 60 D 260	N 1229 D 435	0.15 0.5	159	60	30.7 36.2	66.9	67
3	N 76 D 24	N 1305 D 459	0.15 0.5	172	55	29.9 35.1	65.0	67
2	N 67 D 113	N 67 D 113	0.15 0.5	35	140	3.9 22.0	25.9	26
1	N 176 D 0	N 1548 D 572	0.15 0.5	190	55	35.5 43.7	79.2	80
8	N 620 D 290	N 620 D 290	0.15 0.5	110	80	20.7 32.2	52.9	55*
7	N 120 D 370	N 740 D 660	0.15 0.5	140	60	18.5 55.0	73.5	·74

A : Catchment area (ha)
ΣA : Sum (ha)
C : Run-off coefficient
T : Time of concentration (min.)
i : Rainfall intensity (mm/hr)
Qo : Run-off (m^3/sec)
Q : Planned flood discharge (m^3/sec)
N : Undeveloped area
D : Developed area

Remarks: * Denotes planned flood discharge applied to short term plan.

Table 2-12 Section of Rivers



No.	a	b	c	d	A	S	R	I	V	Qc	Q
6	7.5	13.5	1.5	3.354	15.75	14.208	1.109	3	1.683	26.5	26
5	10.5	16.5	1.5	3.354	20.25	17.208	1.177	3	1.752	35.5	34
4	10.5	19.7	2.3	5.143	34.73	20.786	1.671	2.5	2.011	69.8	67
3	10.5	19.7	2.3	5.143	34.73	20.786	1.671	2.5	2.011	69.8	67
2	7.5	13.5	1.5	3.354	15.75	14.208	1.109	3	1.683	26.5	26
1	10.5	20.5	2.5	5.590	38.75	21.680	1.787	2.5	2.104	81.5	80
8	9.0	19.0	2.5	5.590	35.00	20.180	1.734	1.5	1.608	56.3	55
7	11.0	21.8	2.7	6.037	44.28	23.074	1.919	1.5	1.720	76.2	74

A : Sectional area (m^2)
S : Wetted perimeter (m)
R : Hydraulic radius (m)
Qc : Capacity of flow (m^3/sec)
I : Slope (%)
V : Velocity (m/sec)
Q : Planned flood discharge (m^3/sec)

Table 2-13 Solid Waste Chemical and Physical Composition

Chemical Composition	Year	
	1980 (wt %)	2000 (wt %)
Moisture content	57.1	55.4
Ash content	15.7	15.7
Combustibles content	27.2	28.9
Total	100.0	100.0
Lower calorific value (Kcal/kg, wet basis)	1130.0	1280.0

Physical Composition	Year	
	1980 (wt % on wet basis)	2000 (wt % on wet basis)
Combustibles	83.9	83.9
Paper	18.3	22.1
Textile	3.6	4.4
Garbage	29.9	27.6
Grass and Wood	23.2	19.4
Plastics	7.5	9.2
Rubber and Leather	1.4	1.2
Incombustibles	10.3	10.0
Ferrous metal	2.0	2.2
Non-ferrous metal	0.1	0.1
Glass	2.4	2.6
Stones and Ceramics	2.4	2.0
Bones, Shells and Crusts	3.2	3.0
Dry cells	0.2	0.1
Miscellaneous	5.8	6.1
Total	100.0	100.0
Moisture content (wt %)	57.1	55.4
Bulk density (in reception pit)	0.29	0.28

Appendix 3 Telecommunication System

(1) Status Quo of Telephone Service

(2) Telex and Telegraph Service

(3) Macroscopic Demand Forecast for Telephone Service

(4) Telephone Demand Forecast and Capacity of Facilities for the Proposed Area

(5) Demand Prospect for Non-telephone Services and Traffic

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(1) Status Quo of Telephone Service

(a) General

During the 5-year period from 1975 to 1980, automatic telephone facilities in the Kingdom of Thailand increased at the rate of approximately 13% annually. As a result, automatic telephone facilities which numbered not more than 270,840 in 1975 increased to as many as 496,558 units in 1980.

At the same time, the telephone automatization ratio which was 96% in 1975 reached 100% in 1980.

At present, the Telephone Organization of Thailand (TOT) is in charge of a fully automatic telephone system providing about 900,000 local exchange lines connected about 270 local telephone exchanges.

It is now implementing a large project aimed at increasing the total number of exchange lines to approximately 1,800,000 by the year 1987.

This project is formally called the "Economic Development Plan 1982–1986 of TOT" which is based on and constitutes an integral part of the "Fifth National Economic Development Plan 1982–1987 for the whole Kingdom".

As of 1987, the number of main telephone stations per 100 inhabitants can be expected as approximately 3.36 or more.

(b) Structure of the National Telephone Network

The Kingdom of Thailand is divided into the five telecommunication areas as follows:

Metropolitan area	–	02
Central area	–	03
North-Eastern area	–	04
Northern area	–	05
Southern area	–	07

Each telecommunication area mentioned above is called a tertiary area.

A tertiary area, excluding the Metropolitan area, is divided into serveral secondary areas.

The area codes are shown in Fig. 3–1 and the names of the centers of the secondary and teriary areas are as follows:

032 – Petchaburi	Secondary Center
034 – Nakhon Pathom	Secondary Center
035 – Ayutthaya	Secondary Center
036 – Saraburi	Secondary Center
037 – Prachinburi	Secondary Center
038 – Chonburi	Secondary Center
039 – Chantaburi	Secondary Center
042 – Udon Thani	Secondary Center
043 – Khon Kaen	Secondary Center
044 – Korat	Tertiary Center
045 – Ubol	Secondary Center
053 – Chiang Mai	Secondary Center
054 – Lam Pang	Secondary Center

055	– Phitsanulok	Tertiary Center
056	– Nakhon Sawan	Secondary Center
073	– Yala	Secondary Center
074	– Haad Yai	Secondary Center
075	– Thungsong	Secondary Center
076	– Phuket	Secondary Center
077	– Phun Phin	Tertiary Center

The names of centers of the primary areas in the "038" area code are Chonburi, Chachoengsao and Rayong.

(c) Special Service Codes

100 – International Trunk Operator
101 – National Trunk Operator
13 – Directory Assistance (for Number Changed or New Installed) for BKK
17 – Repair Service
181 – Time (Recorded Service)
183 – Directory Assistance for Provinces
185 – Ship to Shore
188 – Revertive call for two-party line
199 – Emergency (Fire)
123 – Mobile Patrol
191 – Metropolitan Mobile Police

Note: 102–109, 11X, 12X (excluding 123), 14X–16X 182, 184, 186–187, 189–180, 192–198 and 190 are spare.

(d) Dialling Procedures

(i) Local call: For local calls and calls within a secondary area subscriber directory number is to be dialled. This will be 7 digits in Bangkok and 6 digits in other areas.

(ii) Long Distance: For a call outside one's secondary area, the 9 digit number including trunk pre-fix "0" is to be dialled. This number consists of the area code + subsdriber directory number.

(e) Numbering assignment in the Rayong Primary Center

Area code	Subscriber directory number	Name of exchange	Capacity
038	61 xxxx – 66 xxxx	Rayong	60,000 lines
038	67 xxxx	Klaeng	10,000 lines
038	68 xxxx	Band Khai	10,000 lines
038	69 xxxx	Ban Plauk Dang	10,000 lines
038	60 xxxx	Ban Chang	10,000 lines

Some of the subscriber directory numbers for the Rayong primary center will be used for the new telephone exchange in the proposed area.

(f) Existing telephone service in the Rayong Area

The existing telephone service in the Rayong Primary Center Area is as follows:

Item \ Ex.		Rayong	Ban Chang	Klaeng
First Opening		1974	1978	1978
Type of Switching Eg.		ARF102	ARF102	ARF102
Line Capacity (line)		1000	400	200
Building Capacity (line)		2000–3000	1000	1000
No. of Main Telephones	1983	999	285	185
"	1980	999	185	184
"	1979	997	177	169
"	1978	994	26	–
"	1977	891	–	–
"	1976	377	–	–
Signalling		MFC-R2	MFC-R2	MFC-R2
Numbering		61 xxxx	60 xxxx	67 xxxx
Emergency Engine		30 kVA	20 kVA	20 kVA

(g) Long-distance telephone transmission system

All telephone exchanges in the Rayong Primary Center Area now have long distance subscriber trunk dialling (S.T.D).

The existing long-distance telephone transmission system is shown in Fig. 3–2.

(2) Telex and Telegraph Service

(a) Telex network configuration

The Kingdom of Tahiland is divided into four telex service parts, the Central, North-Eastern, Northern and Southern parts.

Fig. 3-3 shows the telex network configuration for the whole of Thailand.

(b) Telex service

The existing telex service operated by the Communications Authority of Thailand (C.A.T) has approximately 3,500 subscribers throughout the Kingdom.

Telex subscribers are accommodated in the telex network that interconnects main cities in the country. Among those subscribers, automatic connections are possible.

During the 4-year period from 1979 to 1982, the number of telex terminals, total domestic service minutes per year and total international service minutes per year in the Kingdom of Tahiland increased at the rates of approx. 21%, 19% and 26% respectively. Refer to Table 3–1.

The density is approximately 0.052 per 1000 inhabitants. The existing exchanges within the Eastern Seabroad are the Pattaya zone exchange with 250 lines, and the Chachoengsao,

Chonburi, Rayong, Siracha, Chanthaburi, Prachinburi, Trat, and Nakon Nayok concentrator exchanges.

Fig. 3–4 shows "TELEX NETWORK IN PATTAYA ZONE EXCHANGE". Generally, each exchange is able to serve the subscriber's area within a 10–15 km radius.

Under the Fifth Plan, telex services will be extended to all provinces in Thailand.

(c) Telegraph service

Telegraph offices in the main cities are connected to the telex network so that, among those telegraph offices, message sending and receiving by dialling are possible.

The statistics of domestic and international telegraph services are shown in Table 3–2.

The number of international telgrams continued to decrease in and after 1979 by about 15% annually. The number in 1982 has fallen to about 60% of the number in 1979.

Fig. 3–5 shows the concept of C.A.T. organization.

(d) National numbering plan for telex

	Name of Part	Number	
1.	Central Part		
	Bangkok	8 xxxx,	72 xxx
	Banpong		782xx
	Chachoengsao		742xx
	Chanthaburi		762xx
	Chon Buri		818xx
	Hua Hin		783xx
	Nakhonpathom		772xx
	Pattaya	819xx,	759xx
	Ratchaburi		785xx
	Saraburi		734xx
2.	Northern Part		
	Chiang Mai		43xx
	Lampang		42xx
	Nakhon Sawan		452xx
	Tak		482xx
3.	Northeastern Part		
	Khon Kaen		53xx
	Nakhon Ratchasima		52xx
	Roiet		572xx
	Surin		534xx
	Ubon Ratchathani		51xx
	Udon Thani		562xx
4.	Southern Part		
	Hat Yai Songkhla		62xx
	Phattalung		633xx
	Phuket		65xx
	Trang		632xx
	Yala		612xx

(3) Macroscopic Demand Forecast for Telephone Service

(a) Base years of forecast

The years 1987, 1992, 1997 and 2000 are used as the base years of demand forecast.

(b) Telephone density

For the macroscopic demand forecast for telephone service, the strong correlation between G.D.P (Gross Domestic Product) per capita and telephone density (main telephone stations per 100 inhabitants) is utilized.

The regression line formula that indicates the relationship between telephone density and G.D.P per capita can be obtained as follows:

$$Y = 0.00036191 \cdot X^{1.2758}$$

where

Y: Telephone density

X: G.D.P per capita (in U.S. dollars)

This is the regression line formula with correlation data for telephone density and G.D.P per capita in 21 countries, graphically plotted.

Refer to Fig. 3–6

For such correlation data, refer to Table 3–3.

However, the average telephone density in Tahiland will reach 3.36 in 1987 under the Fifth "Economic Development Plan 1982– 1986 of T.O.T".

Therefore, when the correlation formula quoted above is corrected accordingly, the regression line formula for this project can be obtained as follows:

$$Y = 0.0004985 \cdot X^{1.2758}$$

Refer to Fig. 3–7.

(c) Population forecast

Based on the data of the "World Bank" (an average increase ratio 1.9, 1980–2000), a forecast is made for the population in each base year. The forecast results appear in Table 3–4.

(d) Growth outlook of G.D.P per capita

According to the data of the "World Bank", G.D.P per capita during the period from 1970 to 1980 recorded a growth of about 7.2% per year.

On the other hand, the annual growth rate of G.D.P per capita is calculated by the "National Economic Social Development Board" to be 6.6% during the period from 1981 to 1986.

The rate of population increase during the period from 1980 to 2000 is estimated at 1.9% annually by the "World Development Report 1980 (The World Bank)".

Thus the calculated growth rate of G.D.P per capita during Fifth Plan stands at 4.6% annually.

Granting that during and after the Fifth Plan a comfortable G.D.P growth will continue as at present, the annual growth of G.D.P per capita can be expected as almost 5%.

Table 3–5 present G.D.P per capita estimates for the base years of forecast, on the assumption that growth will be at the rate of 5% annually.

(e) Main telephone station (M.T.S)

In Thailand, during the 5–year period from 1976 to 1980, the ratio of main telephone stations to the total number of telephones reached 74% or thereabouts.

The main telephone station ratio in other countries also is in the neighborhood of this percentage.

Therefore, in this forecast also, a main telephone station ratio of 75% ~ 80% is used.

(f) Calculation of forecast values

The total number of main telephone stations (M.T.S) and the number of telephones in each base year are calculated as follows:

$$\text{M.T.S} = \text{Forecasted population} \times \text{Telephone density} \div 100$$

$$\text{Total number of telephones} = \frac{\text{M.T.S}}{0.75 \sim 0.80}$$

The demand forecast for telephone service by G.D.P per capita growth estimate at annual growth rate of 5% is given in Table 3–5.

Fig. 3–8 shows the demand trends for the number of M.T.S., the number of telephones and the telephone density.

(4) Telephone Demand Forecase and Capacity of Favilities for the Proposed Area

The proposed area will be divided into three different regions, that is the New town, Industrial complex and Port including Port related area.

In this project, generally, the basic design for public telephone facilities will be prepared under the following conditions.

For telephone exchange equipment:

- Commencement of service: 1987
- Equipment capacity:

To meet with the telephone demand up to the 3rd year (1990) after commencement of service.

For local cable network facilities in the proposed area;

- Commencement of service: 1987
- Primary cable:

To meet with the demand up to 5 years (1992) after commencement of service.

- Secondary cable and Capacity of terminals:

To meet with the demand up to 10 years (1997) after commencement of service.

- Capacity of underground facilities:

To meet with the demand in 20 years or more after commencement of service.

(a) New town area

The number of main telephone stations (M.T.S) required for New town area will be assumed as follows;

(i) Based on 1990 demand

Categories of Housing	No. of Household	No. of M.T.S.	Remarks
Detached	740	740	100% fulfilment
Semidetached	1,470	500	Density 4.05 x 2
Town house	2,940	500	Density 4.05
Flat	2,200	60	one tel/40 household
Total	7,350	1,800	

Note: No. of M.T.S. for Town house

$2,940 \times 4.2 \times 4.05 \div 100 = 500$

(ii) Based on 2000 demand

Categories of Housing	No. of Household	No. of M.T.S	Remakrs
Detached	1,730	1,730	100% fulfilment
Semidetached	3,470	2,150	Density 7.55 X 2
Town house	6,940	2,150	Density 7.55
Flat	5,200	260	one tel/40 household
Total	17,340	6,290	

Note: No. of M.T.S. for Town house

$6,940 \times 4.1 \times 7.55 \div 100 = 2,150$

(b) Town center

At the end of the 1st phase and the end of the 2nd, the number of jobs, allowing for the multiplier effect, are estimated as 6,490 and 17,980 respectively. Refer to "Table of Population Projection".

Approximately 80% of above population will be concentrated in the town center.

Therefore, the telephone demand of the town center will be considered as follows;

No. of jobs (multiplier effect) x 0.8 x Telephone density x 2

Consequently, the number of main telephone stations required in the town center will be assumed as follows:

	1990	2000
No. of M.T.S	600	2,170

Note:

$$\text{No. of M.T.S (1990)} = \left\{\frac{(17{,}980 - 6{,}490)}{13}\right\} \times 3 + 6{,}490 \quad \times$$

$$0.8 \times \frac{4.05}{100} \times 2 \fallingdotseq 600$$

(c) Industrial complex area

According to the total manpower requirement in each plant at 1st phase and 2nd phase, the number of P.A.B.X extension telephones and main telephone stations will be estimated.

The total manpower requirement and the categories in each plant are as follows;

Plant & Phase \ Category		GM & AGM	M	S.C	G.A	CP, CL & W	TOTAL
Soda	1st Phase	1	6	25	242	*559	833
	2nd Phase	1	4	17	170	*391	583
	Sub total	2	10	42	412	*950	1,416
Petch	1st Phase	6	24	72	387	*1,055	1,544
	2nd Phase	4	16	48	270	*743	1,081
	Sub total	10	40	120	657	*1,798	2,625
Fert.	1st Phase	1	4	16	240	*780	1,041
	2nd Phase	1	3	12	168	*544	728
	Sub total	2	7	28	408	*1,324	1,769
Iron	1st Phase	–	–	–	–	–	–
	2nd Phase	10	42	489	1,058	*5,422	7,010
	Sub total	10	42	489	1,058	*5,411	7,010
Total	1st Phase	8	34	113	869	*2,394	3,418
	2nd Phase	16	65	566	1,666	*7,089	9,402
	Sub total	24	99	679	2,535	*9,483	12,820

Note: Abbreviation

G.M – General Manager
A.G.M. – Assistant G.M
M – Department Manager
S.C – Section Chief
G.L – Group Leader
O.P – Operator
C.L – Clerk
W – Worker

* : without P.A.B.X extension telephone

Therefore, the number of P.A.B.X extension telephones and main telephone stations installed are as follows;

Year / Plant	1990		2000	
	M.T.S	P.A.B.X Tel.	M.T.S	P.A.B.X Tel.
Soda Ash Plant	50 (=35+15)	300	80 (=50+30)	500
Petrochemical Plant	80 (=50+30)	500	130 (=85+45)	850
Fertilizer Plant	50 (=35+15)	300	80 (=50+30)	500
Steel Plant	–	–	250 (=170+80)	1,700
Total	180 (=120+60)	1,100	540 (=355+185)	3,550

A + B

A: Central Office Line for P.A.B.X

B: Individual Line

(d) Port and related area

The number of telephone demands for port areas and port related areas will be considered as follows;

No. of employment x Telephone density x 2

Therefore, the telephone demand in 1990 and 2000 are estimated as follows;

	1990	2000
No. of M.T.S	50	150

(e) Other industrial areas

The number of telephone needed for other industrial areas such as, Supporting industries and Down-stream Industries will be estimated in the same way as the above item (4)-(d).

	1990	2000
No. of M.T.S	170	620

(f) Number of public booths

In general, the number of public booths required will be estimated as follows;

No. of M.T.S x 0.02

$$\left(\text{As of 1980: } \frac{\text{No. of public booth}}{\text{No. of M.T.S}} = \frac{5{,}758}{365{,}894} = 0.016\right)$$

(g) Total M.T.S. and the number of lines installed

Total M.T.S and public booths are estimated as follows;

		1990	2000
(i)	New town area	1,800	6,290
(ii)	Town center	600	2,170
(iii)	Industrial comples	180	540
		(120 + 60)	(355 + 185)
(iv)	Port and related area	50	150
(v)	Other industrial area	170	620
(vi)	Sub-total	2,800	9,770
(vii)	Public booth	60	200
	Total M.T.S (vi + vii)	2,860	9,970
	The number of lines installed	3,000	10,000

(h) Map Ta Phut area and Ban Chang area

The number of lines required for the existing Map Ta Phut area and the Ban Chang area will be estimated as follows;

	1990	2000
Map Ta Phut	700	1,500
Ban Chang	1,500	3,000

(i) T.O.T's Plan as of 1983

The TOT forecasts for the Rayong provincial area are summerized as follows;

Exchange	1977 – 1984		1982 – 1986		Total	
	Line	Primary cable pairs	Line	Primary cable pairs	Line pairs	Primary cable pairs
Rayong	3,000	4,500	1,536	2,300	4,536	6,800
Ban Chang	600	1,000	936	1,300	1,536	2,300
Klaeng	800	900	736	1,400	1,536	2,300
Ban Khai	*	–	1,024	1,500	1,024	1,500
Pluak Daeng	*	–	128	200	128	200
Wang Chan	*	–	128	200	256	400
Thung Khwai Kim	–	–	256	400	256	400
Map Ta Phut	–	–	1,024	1,500	1,024	1,500
Ban Phe	–	–	1,024	1,500	1,024	1,500

Source: TOT

* Public Long Distance Service

(j) Traffic

The number of units of switching equipment and trunk circuits to be provided are determined on the basis of the traffic to be handled at peak load, as well as the number of subscribers to be connected.

Generally, the calling rate varies with subscribers' categories approximately as follows;

Category	Subscribers' calling rate
Residence sub.	0.01 – 0.04 Erlangs
Business sub.	0.03 – 0.06 Erlangs
P.A.B.X	0.10 – 0.60 Erlangs
Public booth	0.07 Erlangs

It is very difficult to estimate the said value with high accuracy, and there are unknown factors affecting the traffic estimate, e.g., traffic variations, which derive from daily weekly, seasonal and annual variations, and subscribers' habits.

As a result of the above study, the subscribers' calling rate for the new telephone exchange is assumed as follows;

Residence sub. ..... 0.04 Erlangs
Business sub. ..... 0.06 Erlangs
P.A.B.X ..... 0.2 Erlangs
Public booth ..... 0.07 Erlangs

The number of subscribers in the new telephone exchange is shown below by stage;

	Initial	2000
Residence sub.	1,800	6,290
Business sub.	880	3,125
P.A.B.X	120	355
Public booth	60	200
Total	2,860	9,970

Multiply the above figures by the calling rate corresponding to each subscriber's category, and the total traffic capacity required is obtained as follows;

	Initial	2000
Residence sub.	72.0	251.6
Business sub.	52.8	187.5
P.A.B.X	24.0	71.0
Public booth	4.2	14.0
Total (in Erlangs)	153.0	524.1

These traffic data are used for calculation of the amount of equipment and number of trunk circuits, etc., after the traffic volumes are distributed between each of the considered routes.

Fig. 3–11 shows the traffic flow diagram assumed.

(5) Demand Prospect for Non-Telephone Services and Traffic

(a) Domestic Telegrams

From the short-range viewpoint, it can be assumed that the demand for domestic telegram service will continue at a constant value as shown in Table 3–2.

However, hereafter, from the long-term viewpoint, the demand will gradually decrease.

The proliferation of telex system among business organizations and governmental offices is bound to shift demand to the telex service and away from the domestic telegram service.

(b) International Telegrams

In and after 1979, the demand for international telgram service continues to decrease by about 15% annually.

For the time being, this downtrend will continue and, ultimately, the demand is anticipated to come down to a minimum level of 100,000 telegrams per year or thereabouts.

(c) Telex

The short-term prospect is that the demand will continue to grow at the current average annual growth rate of 20%.

From the long-term viewpoint, the demand for telex service will indisputably be replaced with the demand for such new services as data communication and facsimile services. This trend is already taking shape in the developed countries.

However, at the initial stage of proliferation of such new services, the demand for telex service will continue to make steady growth.

The future proliferation rate of telex is forecast to be around 0.6 per 1000 persons.

(d) New services, such as data communication and facsimile

Judging from the situation in the developed countries, the initial growth of demand for new services will be by 20% or more annually.

Main users of data communication and facsimile services are business organizations and governmental offices so that the size of demand depends upon the type of information that the users deal with and also upon the user distribution by business category.

Although it is difficult to forecast demand at present, it is assumed that the combined demand for telex data communication and facsimile services mainly used by business organizations and governmental offices will continue to grow at a 10% annual rate.

(e) Number of telex and telegram terminals etc.

The number of telex terminals, telegram terminals and other nontelephone service facilities required in the industrial complexes will be assumed as follows;

Area	As of 1987			As of 2000		
	Telex	Tele-gram	Fax. etc.	Telex	Tele-gram	Fax. etc.
Soda ash	1	–	1	2	–	1
Petrochemical	6	–	2	10	–	5
Fertilizer	1	–	1	2	–	1
Iron	–	–	–	3	–	2
Port & Related area	1	–	–	3	–	1
Other industries	2	–	1	4	–	2
Town Center	4	2	6	28	2	14
Total	15	2	6	28	2	14
Leased circuits		23			44	

(f) Traffic

(i) Telegram traffic, A(tg), calculation is done by the following formula;

A(tg) = Annual total of outgoing telegrams x 1/12 x 1/25 (1/Average monthly working days) x 1/8 (busy-hour concentration factor) x 125 (Average handling time of messages; sec) x 1/3600

Unit: in Erlang

(ii) Telex traffic, A(tx), calculation is done by the following formula;

A(tx) = (Number of demand) x 0.05

Unit: in Erlang

Provided that the originating calling rate per subscriber is 0.05 Erlangs.

(iii) New service traffic, A(dt), calculation is done by the following formula;

A(dt) = (Number of demand) x0.1

Unit: in Erlang

Provided that the originating calling rate per subscriber is 0.1 Erlangs.

(6) Automatic Telephone Switching System

Telephone Organization of Thailand (TOT) realizes that electronic exchanges controlled by stored program, the digital type (SPC Digital), is internationally accepted as the most modern system.

Most countries adopted this SPC Digital system instead of the Cross Bar System and other systems because it facilitates telephone network utilization and system flexibility for future extensions of services and network.

Accordingly, T.O.T. will introduce this SPC Ditigal system to supply the telephone service for the proposed industrial complexes under the following conditions;

(a) Numbering plan for new telephone exchange

Area code: 38

Subscriber number: 6x-xxxx

(b) Number of lines

Initial capacity (to meet with the telephone demand of 1990):	3,000 lines
Capacity as of 2000:	10,000 lines
Ultimate capacity:	Approximately 20,000 lines

(c) Signalling system

Multi-Frequency Code (MFC) or Common Channel Signalling (CS) system will be applied between the exchanges.

(d) Charging system

The following charging system will be adopted.

For local calls and calls in the same area code;

Periodic Pulse Metering (P.P.M) system will be applied.

To call outside the area code:

Centralized Automatic Message Accounting (CAMA) system will be applied.

(e) Subscriber line resistance

D.C loop resistance:	1,500 ohms (excluding telephone resistance)

(f) Telephone set

Dial type telephones (10 PPS, 20 PPS) and Push-phones will be used.

(g) Loss probability for each trunk (grade of service)

Outgoing trunk:	$P \leq 0.01$
Incoming trunk:	$P \leq 0.01$
Intra-office trunk:	$P \leq 0.02$
Other trunk:	$P \leq 0.01$

(7) Telex Exchange System

The present telex network of C.A.T is shown Fig. 3–3. Automatic connection can be established between any two lines terminating at 5 telex exchanges, i.e., Bangkok, Pattaya, Lampang, Nakhon Ratchasima and Hat Yai.

A double 16 line telex concentrator exchange will be installed by C.A.T. in new Post Office in the town center of the industrial complexes 1987.

And this concentrator exchange will depend upon the existing Pattaya zone exchange as well as the existing Rayong, Chonburi, Siracha and other concentrator exchanges, and the existing signalling system will be applied.

(a) Signalling system

The existing signalling system is as follows;

(i) Operating mode:	Half duplex
(ii) Transmission speed:	50 bauds
(iii) Character:	International Alphabet No. 2
(iv) Code:	6 units (Thai and Roman) or 5 units (Roman)
(v) Signalling type:	Type A signalling, Keyboard selection
(vi) Operating voltage:	±60 V
(vii) Circuit distortion:	30%

(b) Numbering plan

The numbers 819xx or 759xx will be used for the numbering plan of this concentrator exchange.

(8) Subscriber's Cable System

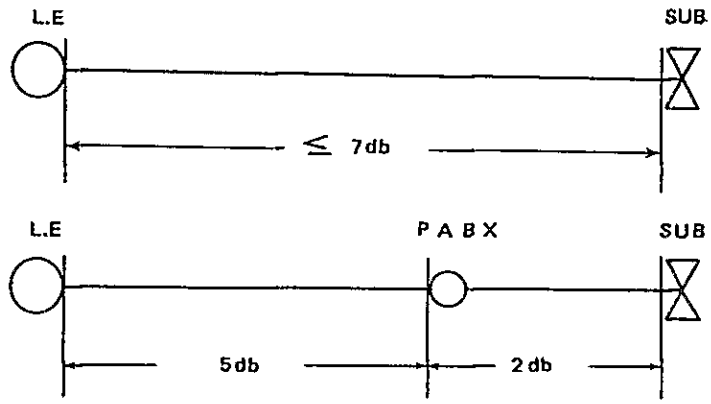
The engineering and installation work of subscriber's cable system for the industrial complexes, Map Ta Phut area and Ban Chang area will be carried out by T.O.T based on the following T.O.T technical criteria for local cable systems.

(a) Transmission requirement

The subscriber's line in the local network will be designed under the below stipulations as economically as possible.

(i) Attenation loss

The attenation loss value between local exchange (L.E) and subscriber will be less than 7 db at 1 kHz.



(ii) Subscriber's line resistance

The D.C loop resistance value for subscriber's line will be less than 1,500 ohms excluding telephone set resistance.

(b) Provisional period

The provisional period for each facility will be the following;

(i) Primary calbe

For demand in five (5) years from the first year in service.

(ii) Secondary cable

For demand in ten (10) years from the first year in service.

(iii) Capacity of terminal

For demand in ten (10) years from the first year in service.

(iv) Capacity of underground facilities

For demand in twenty (20) or more years from the first year in service.

(c) Underground cable system

In case the cable facilities correspond to any of the following, the underground cable system will be adopted in general.

(i) In case cable pairs exceed the following limits:

0.4 mm cable	600 pairs
0.5 mm cable	400 pairs
0.65 mm cable	400 pairs
0.9 mm cable	300 pairs

(ii) Places where construction of aerial cables will be difficult due to highways, buildings, and other topographical hindrances.

In general, in Thailand, the conduit system for underground calbe system will be applied.

(d) Cable

The following cables will be used for the subscriber line cable network.

(i) CCP-JF ..... Color Corded Polyethylene – Jelly Filled: to be used for primary cable

(ii) CCP-AP ..... CCP-Aluminum Polyethylene: to be used for secondary cable.

(iii) CCP-AP (SS) ..... CCP-AP (Self Support): to be used for secondary cable.

(e) Cross-connection cabinet

The capacity of the cross-connection cabinet to be used for the distributing the subscriber line cables will be designed to be 900 pairs.

(9) Exchange Location Plan

The exchange location will be determined within the town center based upon the following conditions;

(a) The exchange building should be located within the industrial complexes.

(b) The exchange building should face both the existing roads and new roads within the industrial complexes.

(c) The exchange building should be located near the new town.

The following land areas for the telephone exchange and the post office will be prepared in the town center by IEAT.

For telephone exchange:	*3,200 m^2 (2.0 Rai)
For post office:	16,000 m^2 (10.0 Rai) required by C.A.T.

Note: *1,600 m^2 required by TOT

(10) Scope of Works and Responsibilities for Telecommunication Facilities

In general, the construction work outside of the industrial complexes is carried out by the relevant authorities.

The infrastructure within the battery limits will be planned and constructed by each factory to be compatible with his own production plant.

The scope of works and responsibilities for this project are shown in Table 3–6.

(11) Recommendations

According to TOT's New town telephone exchange plan for the proposed industrial complexes in Rayong province, the line capacity of New town telephone exchange is approximately 1,000 lines, and a remote switching system controlled by Rayong's new host digital exchange is schedule in TOT's fifth plan.

However, as the result of this study, JICA would like to recommend to IEAT that the initial capacity of New town telephone exchange for the proposed area be about 3,000 lines and that each switching system applied be operated independently by its own central processor.

The remote switching exchanges controlled by the New town host digital exchange will be installed by TOT for the Ban Chang and Map Ta Phut areas respectively.

Fig. 3-1 TELEPHONE AREA CODE NUMBERING PLAN