10.2.6 Project Benefits

As a result of the development of coastal shipping facilities in Songkhla Port, some cargo will be transported by coastal vessel as a conversion from road transportation (truck) since the transport cost per cargo ton will be reduced. In addition to the direct effect of saving in transport costs, savings in road maintenance costs is expected from the decrease of road (truck) traffics, compared to the existing condition without sea transportation.

Moreover, improvements of road traffic conditions such as a decrease of traffic accidents and mitigation of road traffic congestions can be expected. Such decrease of road traffic will result in a positive environmental impact such as mitigation of air pollution by reducing emission from trucks. In this regard, ships also exhaust emission gases, however, its impact is limited to the sea area, thereby not affecting roadside communities. Furthermore, the development of the Songkhla port will facilitate an economically effective inter-modal transport system by becoming one of the major gateway ports in the southern region of Thailand and contribute to the regional economic development in the hinterland area.

In this economic analysis, effects of savings for transport costs and savings for road maintenance costs are treated as quantitative economic benefits.

10.2.7 Economic and Financial Analysis

(1) Economic Analysis

In this section, economic analysis is carried out based on the above-mentioned benefits.

1) Estimation of economic benefits

(a) Benefit of savings for transport cost

i) Estimation of benefit of savings for transport cost

The benefit of savings for transport cost is estimated by multiplying the demand volume by the difference of unit transport cost between road and sea transportation.

ii) Demand volume

The demand volume for the general cargo at the proposed berth is estimated at 350,000 tons

in 2018 when the handling volume will reach the capacity level, compared to 124,000 tons in 2010, the operation starting year, as shown in Table 10.2.7-1.

Table 10.2.7-1 Demand Volume for Proposed Berth (General Cargo)

(tons/year)

	2010	2015	2018
Total Demand (a)	474,300	608,300	703,489
Capacity of Existing Berth (b)	350,000	350,000	350,000
(a) – (b)	124,300	258,300	353,489
Capacity of Proposed Berth	350,000	350,000	350,000
Demand for Proposed Berth	124,300	238,600	350,000

Source: Estimated by JICA Study Team

Note: In the short-term plan, it is forecast that the cargo handling volume will reach the capacity in 2018, and maintain the same level subsequently.

Out of the demand for general cargo, 10% is assumed to be diverted to container cargo. For the rest of the demand, each one third is shared with the routes of Songkhla-Bangkok, Songkhla-Laem Chabang and Songkhla – Map Ta Phut, respectively.

The demand volume for the proposed berth for Ro/Ro cargo is forecast to be 150,000 tons/year in total in 2011, as shown in Table 10.2.7-2.

Table 10.2.7-2 Demand Volume for Proposed Berth (Ro/Ro Cargo)

(ton/year)

	2010	2011	2015
Total Demand (a)	296,600	310,262	371,500
Diverted Demand	148,300	155,131	185,750
Capacity of Proposed Berth	150,000	150,000	150,000
Demand for Proposed Berth	148,300	150,000	150,000

Source: Estimated by JICA Study Team

Note: In the short-term plan, it is forecast that the handling cargo volume will reach the capacity in 2011, then after that year, the same volume is maintained.

The share by route of Ro/Ro cargo is assumed to be as follows: 50% is assumed for Songkhla – Laem Chabang and the other 50% for Songkhla – Map Ta Phut..

In this economic analysis, the above demand volume for the proposed berth is assumed to be transported by road transport in the case of “without the proposed berth”.

iii) Unit transport cost of vessels and trucks

Based on the categories shown in the demand forecast, the unit transport costs of vessel and truck with respect to the three cargo categories ("general cargo", "container cargo" and "Ro/Ro vessel cargo") were estimated for the three routes (Songkhla – Bangkok, Songkhla – Laem Chabang and Songkhla – Map Ta Phut).

The unit transport costs for vessels and trucks are estimated based on the study results of "Coastal Transport Development Project Study, 2001", OMPC (Office of the Maritime Promotion Commission), and the results of the interview survey of several shipping operators in Bangkok. The details of the estimation are described below:

General cargo

Both cost components, operator (shipping or trucking) cost and user cost (including handling, storage and other costs) were considered. General cargo vessels of 3,000 DWT and trucks with 13 tons payload were assumed as representative sizes in this economic analysis. (Refer to Table 10.2.7-3.)

Table 10.2.7-3 Summary of Transport Cost of "By Sea" and "By Road" for General Cargo

	Songkhla - Bangkok	Songkhla – Laem Chabang	Songkhla – Map Ta Phut
Distance by Road (km)	950 km	1,088 km	1,250 km
Distance by Sea (km)	730 km	670 km	610 km
General cargo vessel (3,000 DWT)			(Unit: Baht/ton)
Operator cost	49	45	41
User (handling etc.) cost	361	361	361
(Total)	410	406	401
Truck (13 tons)			(Unit: Baht/ton)
Operator cost	741	849	975
User (handling etc.) cost	84	84	84
(Total)	825	933	1,059

Source: Estimated by JICA Study Team

Note: "Songkhla – Bangkok" is based on the study results of "Coastal Transport Development Project Study, 2001", OMPC. "Songkhla – Laem Chabang" and "Songkhla – Map Ta Phut" are estimated based on the result of "Songkhla – Bangkok" and data of shipping operator cost per (Baht/ton/1,000km) shown in the above study results.

Container cargo

Since the unit cost data of container cargo by road were not available directly in the above study results, the operator cost was substituted for the information about fare obtained by the interview survey of a shipping operator in Bangkok. Thus, the road (per km) fare of transport of container trailer was obtained. Using the user cost (such as handling cost) data per ton related to truck (with a payload of 13 tons) based on the results of the above study and the assumed payload of container (26 tons for 40'), the user cost of container trailer was estimated.

For container cargo by sea, the fare data of "Songkhla – Laem Chabang" obtained from the shipping company (private coastal operator) was used as the base of the unit value per km for estimating the fares for "Songkhla – Bangkok" and "Songkhla – Map Ta Phut". For user costs, such as handling cost, the results of the above study were incorporated. Using the user cost data (per ton) related to vessel of 3,000 DWT and the assumed payload of container (26 tons for 40'), the user cost of container vessel was estimated. The comparison of "container cargo" was based on these fares. (Refer to Table 10.2.7-4.)

Table 10.2.7-4 Summary of Transport Cost of "By Sea" and "By Road" for Container Cargo

	Songkhla - Bangkok	Songkhla – Laem Chabang	Songkhla – Map Ta Phut
Distance by Road (km)	950 km	1,088 km	1,250 km
Distance by Sea (km)	730 km	670 km	610 km
Container vessel			(Unit: Baht/40')
Operator cost	12,257	11,250	10,243
User (handling etc.) cost	9,377	9.377	9,377
(Total)	21,634	20,627	19,619
Trailer			(Unit: Baht/40')
Operator cost	19,000	21,760	25,000
User (handling etc.) cost	2,178	2,178	2,178
(Total)	21,178	23,938	27,178

Source: Estimated by JICA Study Team

Note: Operator costs are estimated based on the interview survey to shipping operators in Bangkok. User cost are estimated based on the study results of "Coastal Transport Development Project Study, 2001", OMPC, and the assumed payload of each mode.

Ro/Ro cargo

For Ro/Ro cargo, the method of cost estimation is similar to the case of container cargo. The fare of road (per km) transport of container trailer was also estimated by the similar method as in the case of container cargo.

Through the interview survey of a shipping operator in Bangkok, which is intending to commence Ro/Ro ferry operation, the unit value per km for shipping cost of Ro/Ro vessel was obtained. Using this value, the shipping costs for the three routes were estimated. For user costs, such as handling cost, the results of the above study were incorporated. Using the user cost data (per ton) related to truck (with a payload of 13 tons) and the assumed payload of container (26 tons for 40'), the user cost of container vessel was estimated. The comparison with Ro/Ro cargo was based on these fares. (Refer to Table 10.2.7-5.)

Table 10.2.7-5 Summary of Transport Cost of "By Sea" and "By Road" for Ro/Ro Cargo

	Songkhla - Bangkok	Songkhla – Laem Chabang	Songkhla – Map Ta Phut
Distance by Road (km)	950 km	1,088 km	1,250 km
Distance by Sea (km)	730 km	670 km	610 km
Ro/Ro vessel			(Unit: Baht/40')
Operator cost	22,462	20,615	18,769
User (handling etc.) cost	2,178	2,178	2,178
(Total)	24,639	22,793	20,947
Trailer			(Unit: Baht/40')
Operator cost	19,000	21,760	25,000
User (handling etc.) cost	2,178	2,178	2,178
(Total)	21,178	23,938	27,178

Source: Estimated by JICA Study Team

Note: Operator costs are estimated based on the interview survey to shipping operators in Bangkok. User cost are estimated based on the study results of "Coastal Transport Development Project Study, 2001", OMPC, and the assumed payload of each mode.

Table 10.2.7-6 shows the summary of unit transport costs.

Table 10.2.7-6 Summary of Unit Transport Costs

	Songkhla - Bangkok	Songkhla – Laem Chabang	Songkhla – Map Ta Phut
Distance by Road (km)	950 km	1,088 km	1,250 km
Distance by Sea (km)	730 km	670 km	610 km
(1) General cargo			
General cargo vessel (3,000 DWT) (Baht/ton)	410	406	401
Truck (13 tons) (Baht/ton)	825	933	1,059
(2) Container cargo			
Container vessel (Baht/40')	21,634	20,627	19,619
Trailer (Baht/trip (40'))	21,178	23,938	27,178
(3) Ro/Ro cargo			
Ro/Ro vessel (Baht/vehicle(40'))	24,639	22,793	20,947
Trailer (Baht/trip (40'))	21,178	23,938	27,178

Source: Estimated by JICA Study Team

Note: 40' means 40 feet container

iv) Estimation of benefit of savings for transport cost

Using the above-estimated demand volume and the assumed unit transport cost by each mode, the benefit of savings for transport costs were estimated at 80.630 million Baht in 2010 and 189.858 million Baht in 2018. The estimation results are summarized in Table 10.2.7-7.

Table 10.2.7-7 Summary of Estimated Benefit of Savings for Transport Costs

(Baht 1,000 / year)

	2010	2015	2018
Savings for Transport Costs			
1) For General cargo	58,467	121,513	164,640
2) For Container cargo	1,548	3,219	4,367
3) For Ro/Ro cargo	20,615	20,851	20,851
Total	80,630	145,583	189,858

Source: Estimated by JICA Study Team

(b) Estimation of benefit of savings for road maintenance cost

According to the feasibility study report on "Development of Waterway Transportation for Export Promotion in Mae Klong and Tha Chin Rivers" (Harbor Department), the road maintenance cost of 10-wheel truck is 0.53 Baht per km, which is equivalent to 0.04 Baht per ton-km. Using the total ton-kilometer which was obtained from the results of demand forecast, the saving in road maintenance cost was calculated. The estimated results are summarized in Table 10.2.7-8.

Table 10.2.7-8 Summary of Estimated Benefit of Savings for Road Maintenance Cost

(Baht 1,000 / year)

	2010	2015	2018
Saving in Road Maintenance Cost			
1) Related to General cargo	4,904	10,192	13,810
2) Related to Container cargo	540	1,123	1,523
3) Related to Ro/Ro cargo	6,935	7,014	7,014
Total	12,379	18,329	22,347

Source: Estimated by JICA Study Team

2) Project costs

For the economic analysis, the project costs in financial prices need to be converted to economic prices. The details of the conversion process are mentioned below:

(a) Estimation of Economic Price of Project Costs

1) Application of Conversion Factors

i) Conversion factors

All the costs were classified as: 1) trade goods, 2) non-trade goods, 3) skilled labor, 4) unskilled labor and 5) transfer items.

In this economic analysis, it was assumed that trade goods are equivalent to the foreign currency portion, and aggregation of non-trade goods, skilled labor and unskilled labor composes the local currency portion. Transfer items covers taxes.

The economic prices of the non-trade goods were obtained by applying the standard conversion factor. The economic prices of skilled labor and unskilled labor costs were obtained by applying the skilled and unskilled labor conversion factors respectively.

ii) Standard conversion factor (SCF)

Items such as import duties cause a price differential between the domestic market and international market. The standard conversion factor is an index which converts domestic prices to the border prices by adjustment of the distortion of domestic prices.

The standard conversion factor is estimated based on the following equation:

$$SCF = \frac{I + E}{(I + Di) + (E - De)}$$

where;

I : Total value of import

E : Total value of export

Di : Total value of import duty

De : Total value of export duty

According to the statistical data about foreign trade and governmental revenues, SCF is estimated as shown in Appendix Table 10.2.7-9.

The standard conversion factor is estimated to be 0.98.

Table 10.2.7-9 Estimation of SCF

(Million Baht)

	1997	1998	1999	1997 - 1999
Import	1,924,958	1,778,564	1,910,302	5,613,824
Export	1,811,763	2,248,813	2,215,181	6,275,757
Import duties	103,116	66,168	65,971	235,255
Export duties	9	21	59	89
SCF (no unit)	0.97	0.98	0.98	0.98

Source: Estimated by JICA Study Team based on Statistical Yearbook Thailand, 2000

iii) Consumption conversion factor (CCF)

The consumption conversion factor is an index which converts domestic prices of consumption goods to border prices, and is applied for conversion of domestic prices labor cost to border prices.

The consumption conversion factor was estimated based on a similar equation to that of the standard conversion factor mentioned above, by limiting the items of goods of import/export to major consumption goods.

However, the statistical data applicable to the estimation of CCF was not available.

Consequently, in this economic analysis, the value of CCF was assumed to be the same as that of SCF.

iv) Skilled labor conversion factor

For skilled labor, the opportunity cost is judged to be the same as wages, since the market mechanism functions well. Wages can be evaluated by the purchasing power of consumption goods.

The skilled labor conversion factor is estimated below:

(Skilled labor opportunity cost / Skilled labor wage) x CCF = 1.0 x 0.98 = 0.98

v) Unskilled labor conversion factor

For unskilled labor, the potential number of laborers is considered generally high, and the market mechanism generally does not function well. Since most of the unskilled laborers are considered to flow in from the agricultural sector where the income level is relatively low, the opportunity cost of unskilled labor is considered to be equivalent to the income level of laborers in the agricultural sector.

The unskilled labor conversion factor is estimated below:

(Unskilled labor opportunity cost / Unskilled labor wage) x CCF

= (Per capita GRDP in agricultural sector / Unskilled labor wage) x CCF

Based on the statistical data of Gross Regional Development Products (GRDP) in agricultural sector and the number of employed person in the sector, per capita GRDP in agricultural sector is obtained. Per capita GRDP in agricultural sector is estimated to be Baht 126 per day at 1998 current prices.

Table 10.2.7-10 Estimation of Per Capita GRDP in The Agricultural Sector

	1997	1998
GRDP in the Agricultural Sector (Million Baht, current prices)	541,864	620,182
Number of Employed Person in Agricultural Sector (thousand)	16,691	16,472
Per Capita GRDP in Agricultural Sector (Baht/year)	32,464	37,651
Per Capita GRDP in Agricultural Sector (Baht/day)	108	126

Source: Estimated by JICA Study Team based on Statistical Yearbook Thailand, 1999 and 2000.

Note: Annual working day is assumed to be 300 days.

The data of wage paid for unskilled labor in this Project is Baht 175 per day. While the data of unskilled labor wage is as of 2001, per capita GRDP in agricultural sector is as of 1998. However, assuming that the value per capita GRDP in the agricultural sector remains at the same level, the above estimated value is adopted in this economic analysis. As a result, the unskilled labor conversion factor is estimated to be 0.71 ((126 / 175) x 0.98 = 0.71).

2) Economic Price of Project Costs

i) Construction cost

The portion of foreign currency was directly adopted. For the portion of non-trade goods, the standard conversion factor was applied. The labor cost was divided into two portions (skilled labor and unskilled labor), and the skilled and unskilled labor conversion factors were applied to the above portions respectively.

ii) Operation cost

The operation cost was estimated by deducting the transfer items portion from the financial prices and by applying the skilled labor conversion factor.

iii) Maintenance cost

Since the maintenance cost was assumed to be 1.0% of the construction cost, the results of adjustment were the same as those of construction cost.

(b) Project costs

As a result, the initial investment cost accounts for 386.382 million Baht in terms of economic prices, compared to 419.920 million Baht in financial prices at 2001 prices, as shown in Table 10.2.7-11.

The maintenance cost was assumed to be 1% of the investment cost. The additional

operation cost for Songkhla Port was Baht 30 million per annum in financial prices and Baht 29.4 million in economic prices per annum. These operation cost were estimated for full scale operation in 2018, and the annual cost was estimated in proportion with the cargo volume handled in each year.

Table 10.2.7-11 Project Costs (Initial Investment) for the Songkhla Project

(Baht 1,000)

	Financial Prices	Economic Prices
2004	6,998	6,488
2005	1,749	1,622
2006	37,093	34,202
2007	180,568	166,036
2008	152,775	140,479
2009	38,988	35,933
2010	1,749	1,622
Total	419,920	386,382

Source: Estimated by JICA Study Team

Note: Excluding costs for sand bypass.

3) Cost benefit analysis

Using the estimated economic benefits and costs, EIRR (economic internal rate of return) was calculated. Also, assuming the discount rate of 12% [1], B/C Ratio (benefit/cost ratio) and NPV (net present value) were calculated. The project life was assumed to be 25 years after the starting year (2010) of port operation service. The calculation results are summarized in Table 10.2.7-12, where it is revealed that the EIRR of the Project is 22.0% and the B/C ratio is 1.87. The details of calculation of EIRR are shown in Table 10.2.7-13.

[1] World Bank and ADB generally apply 12% for the transport infrastructure project. For example, this rate was applied for “Songkhla and Phuket Ports Development Project, 1995”in Thailand. Therefore, the team assumes 12% for the economic evaluation.

Table 10.2.7-12 Summary of Cost/Benefit Analysis for the Songkhla Project

Indicators	Values
EIRR	22.0 %
B/C Ratio (at discounted rate of 12%)	1.87
NPV (Baht 1,000) (at discounted rate of 12%)	240,270

Source: Estimated by JICA Study Team

4) Sensitivity test

Altering the amount of the costs by +10% and the benefits by –10% to the base case, the sensitivity test was carried for changes in the EIRR value. The results of the sensitivity test are summarized in Table 10.2.7-14. As seen in this table, even given a 10% increase in the cost or a 10% reduction of the benefit, the EIRR can still remain above the level of 18.6% that is much higher than 12% the discount rate, or the opportunity cost of the capital.

Table 10.2.7-14 Summary of Sensitivity Test for the Songkhla Project

	Costs	
Benefits	Base Case	+10%
Base Case	22.0%	20.3%
-10%	20.2%	18.6%

Source: Estimated by JICA Study Team

5) Evaluation

The result of economic analysis shows that the value of EIRR is over 12%, which is conceived as the evaluation criterion of the EIRR for infrastructure project in Thailand. Therefore, it can be safely concluded that the Project is economically feasible.

Table 10.2.7-13 EIRR for Songkhla Project

EIRR =	22.0%	
B/C Ratio=	1.87	(at Discount Rate of 12%)
NPV (Baht 1,000) =	240,270	(at Discount Rate of 12%)

(Baht 1,000)

		Year	Benefits			Costs				Net Cash Flow for EIRR
			Saving in Transport Cost	Saving in Road Maint. Cost	Total	Invest-ment	Operation Cost	Maint. Cost	Total	
1		2004			0	6,488			6,488	-6,488
2		2005			0	1,622			1,622	-1,622
3		2006			0	34,202			34,202	-34,202
4		2007			0	166,036			166,036	-166,036
5		2008			0	140,479			140,479	-140,479
6		2009			0	35,933			35,933	-35,933
7	1	2010	80,630	12,378	93,008	1,622	16,027	3,864	21,512	71,496
8	2	2011	92,810	13,542	106,352		17,582	3,864	21,446	84,906
9	3	2012	106,014	14,739	120,753		19,189	3,864	23,052	97,701
10	4	2013	119,179	15,936	135,114		20,795	3,864	24,659	110,456
11	5	2014	132,379	17,132	149,512		22,401	3,864	26,265	123,247
12	6	2015	145,583	18,329	163,912		24,007	3,864	27,871	136,041
13	7	2016	158,748	19,526	178,274		25,614	3,864	29,477	148,796
14	8	2017	175,137	21,013	196,149		27,609	3,864	31,473	164,676
15	9	2018	189,859	22,347	212,206		29,400	3,864	33,264	178,942
16	10	2019	189,859	22,347	212,206		29,400	3,864	33,264	178,942
17	11	2020	189,859	22,347	212,206		29,400	3,864	33,264	178,942
18	12	2021	189,859	22,347	212,206		29,400	3,864	33,264	178,942
19	13	2022	189,859	22,347	212,206		29,400	3,864	33,264	178,942
20	14	2023	189,859	22,347	212,206		29,400	3,864	33,264	178,942
21	15	2024	189,859	22,347	212,206		29,400	3,864	33,264	178,942
22	16	2025	189,859	22,347	212,206		29,400	3,864	33,264	178,942
23	17	2026	189,859	22,347	212,206		29,400	3,864	33,264	178,942
24	18	2027	189,859	22,347	212,206		29,400	3,864	33,264	178,942
25	19	2028	189,859	22,347	212,206		29,400	3,864	33,264	178,942
26	20	2029	189,859	22,347	212,206		29,400	3,864	33,264	178,942
27	21	2030	189,859	22,347	212,206		29,400	3,864	33,264	178,942
28	22	2031	189,859	22,347	212,206		29,400	3,864	33,264	178,942
29	23	2032	189,859	22,347	212,206		29,400	3,864	33,264	178,942
30	24	2033	189,859	22,347	212,206		29,400	3,864	33,264	178,942
31	25	2034	189,859	22,347	212,206		29,400	3,864	33,264	178,942
			4,238,081	512,490	4,750,572	386,382	673,024	96,595	1,156,001	

Source: Estimated by JICA Study Team

(2) Financial analysis

1) General

For the financial evaluation, a vital factor is the revenue reflecting the available tariff structure. Currently, there is no officially regulated port tariff for the coastal shipping in Thailand, but the tariff for "local Ro/Ro ferry service" in the Laem Chabang port has been stipulated. However, for general cargo and container cargo services, no port tariffs have been charged. According to the interview survey with the Port Authority of Thailand (PAT), they are currently considering a port tariff for coastal shipping. Therefore, an estimation of the revenue based on an official tariff scale by types of cargo or service is hard to make. Hence, in this financial analysis, the following procedure was assumed:

2) FIRR value and service fee assumptions

Some current concession projects such as BOT projects for infrastructure development have sought an FIRR of 15% as a guaranteed level for concessionaire. Therefore, in this financial analysis, 15% is set as the target value of FIRR.

The project cost of the Songkhla Port development is already outlined in the previous Economic Analysis section.

According to the interview survey to PAT, the level of service fee proposed for coastal shipping by PAT was about Baht 60 per ton for the berth usage for coastal shipping in the Laem Chabang port. However, this is not an officially regulated tariff scale as mentioned above, but applied only for coastal shipping at the Laem Chabang port. According to PAT, different tariff scales can be proposed for other coastal shipping ports, depending upon their port facilities and transport conditions.

The service fees at the Songkhla port is estimated by a comparison between sea and road transport costs as shown in the Table 10.2.7-6. Hence, the economic competitive prices are estimated for each cargo type, based on the Songkhla-Laem Chabang route.

Table 10.2.7-15 Service Fee Estimation

Unit: Baht/ton

		Road Transport (1)	Coastal Transport (2)	Coastal Benefit (1)-(2)	Service Fee
General Cargo	SKL-BKK	825	410	415	120
	SKL-LCB	933	406	527	
	SKL-MTP	1,059	401	658	
Container Cargo	SKL-LCB	921	793	127	120
	SKL-MTP	1,046	755	291	
Ro/Ro Cargo	SKL-LCB	921	877	44	40
	SKL-MTP	1,045	806	239	

Source: Estimated by JICA Study Team

Note: SKL: Songkhla, BKK: Bangkok, LCB: Laem Chabang, MTP: MTP

3) FIRR

Revenues were calculated based on the estimated cargo demand and service fee per ton. Then comparing project costs, Project FIRR (financial internal rate of return) was examined.The project life was assumed to be 25 years after the start of service of the port operation (2010).

However, for this case without subsidy, the FIRR was a negative value as shown in Table 10.2.7-16. The details of calculation of FIRR are shown in Table 10.2.7-17.

Table 10.2.7-16 FIRR without Government Subsidy for Songkhla Project

Indicators	Values
FIRR	-2.3 %

Source: Estimated by JICA Study Team

The above result of the financial analysis shows that the Project will not be financially feasible. In other words, the investment for the Project will be recovered only with revenues in the long-term.

Table 10.2.7-17 FIRR for Songkhla Project (Without Subsidy)

FIRR = -2.3%

(Baht 1,000)

		Year	Revenues (Financial Revenues)				Costs (Financial Costs)				Net Cash Flow for FIRR
			General Cargo	Container Cargo	Ro/Ro Cargo	Total	Invest-ment	Additional Operation Cost	Maint. Cost	Total	
1		2004				0	6,998			6,998	-6,998
2		2005				0	1,749			1,749	-1,749
3		2006				0	37,093			37,093	-37,093
4		2007				0	180,568			180,568	-180,568
5		2008				0	152,775			152,775	-152,775
6		2009				0	38,988			38,988	-38,988
7	1	2010	13,424	1,488	5,932	20,844	1,749	16,354	4,199	22,302	-1,458
8	2	2011	16,094	1,788	6,000	23,882		17,941	4,199	22,140	1,742
9	3	2012	19,048	2,112	6,000	27,160		19,580	4,199	23,779	3,381
10	4	2013	21,990	2,448	6,000	30,438		21,219	4,199	25,418	5,020
11	5	2014	24,944	2,772	6,000	33,716		22,858	4,199	27,057	6,659
12	6	2015	27,898	3,096	6,000	36,994		24,497	4,199	28,696	8,298
13	7	2016	30,840	3,432	6,000	40,272		26,136	4,199	30,335	9,937
14	8	2017	34,506	3,840	6,000	44,346		28,173	4,199	32,372	11,974
15	9	2018	37,800	4,200	6,000	48,000		30,000	4,199	34,199	13,801
16	10	2019	37,800	4,200	6,000	48,000		30,000	4,199	34,199	13,801
17	11	2020	37,800	4,200	6,000	48,000		30,000	4,199	34,199	13,801
18	12	2021	37,800	4,200	6,000	48,000		30,000	4,199	34,199	13,801
19	13	2022	37,800	4,200	6,000	48,000		30,000	4,199	34,199	13,801
20	14	2023	37,800	4,200	6,000	48,000		30,000	4,199	34,199	13,801
21	15	2024	37,800	4,200	6,000	48,000		30,000	4,199	34,199	13,801
22	16	2025	37,800	4,200	6,000	48,000		30,000	4,199	34,199	13,801
23	17	2026	37,800	4,200	6,000	48,000		30,000	4,199	34,199	13,801
24	18	2027	37,800	4,200	6,000	48,000		30,000	4,199	34,199	13,801
25	19	2028	37,800	4,200	6,000	48,000		30,000	4,199	34,199	13,801
26	20	2029	37,800	4,200	6,000	48,000		30,000	4,199	34,199	13,801
27	21	2030	37,800	4,200	6,000	48,000		30,000	4,199	34,199	13,801
28	22	2031	37,800	4,200	6,000	48,000		30,000	4,199	34,199	13,801
29	23	2032	37,800	4,200	6,000	48,000		30,000	4,199	34,199	13,801
30	24	2033	37,800	4,200	6,000	48,000		30,000	4,199	34,199	13,801
31	25	2034	37,800	4,200	6,000	48,000		30,000	4,199	34,199	13,801
						1,073,653	419,920	686,759	104,980	793,488	

Source: Estimated by JICA Study Team

4) Sensitivity test for FIRR

The financial sensitivity of the Project was examined for different cases by changes in the costs and the revenues. For this examination, the costs are reduced by 10% through 50%, while the revenues increased by 10% through 30%. Table 10.2.7-18 shows the outcomes as a cost-revenue matrix. As seen in this matrix, a positive FIRR can be obtained only with a 10% reduction of the cost and a 10% increase of the revenue. However, since more than 12% FIRR is the criterion to judge investment feasibility, 50% reduction of the cost and 30% increase of the revenue is required. However, this extremely condition seems to be impractical, when considered a trade-off relation between the demand and the port service

fee as well as the necessity of reliable construction of the port facilities. Thus, it is assessed that the Project cannot be managed on a self-paying basis. Therefore, another financial scheme, involving a government subsidy is recommended for the project implementation.

Table 10.2.7-18 Sensitivity Test for FIRR

		Cost Reduction					
		Base	**-10%**	**-20%**	**-30%**	**-40%**	**-50%**
Revenue	**Base**	-2.3%	-0.3%	1.7%	3.8%	6.0%	8.6%
UP	**+10%**	-0.5%	1.4%	3.2%	5.2%	7.4%	10.0%
	+20%	1.0%	2.7%	4.5%	6.4%	8.6%	11.2%
	+30%	2.3%	4.0%	5.7%	7.6%	9.8%	12.4%

Source: Estimated by JICA Study Team

5) Proposed PPP (Public and Private Partnership) Scheme

In the case of Songkhla and Phuket ports, private port operators are in charge of operation and management of the ports under lease agreement with the Ministry of Finance. This scheme is conducted under the policy of "privatization" to promote more competitive and efficient port operation.

In the line with this policy, a Public and Private Partnership scheme (PPP) is proposed for this Project. Based on the implementation scheme of the Songkhla Port Project and on consideration of the outcomes of the financial evaluation as discussed in the preceding section, the following assumptions are made:

i) The construction is to be carried out by the government sector (Harbor Department).

ii) After the construction, operation and maintenance of the port facilities shall be the responsibility of a private operator which shall run the port service from revenues of the service fees, paying a certain portion of the revenues to the port management entity, or the HD, as a concession royalty or a facility user cost.

iii) In such a revenue sharing scheme, a facility usage cost scale shall be set in accordance with the revenue amount so that the private operator is able to perform the services in a financially and operationally sustainable manner over the long-term.

iv) For the determination of the amount of revenue sharing to be paid, the FIRR value of 15% is assumed in order to produce a financial return of 15% for the private operator. This 15% return is

thought to be a guideline for the private sector to take part in a privatization scheme in Thailand. An optimal rate for the revenue sharing will be examined in order to achieve the FIRR value of 15% for the private operator.

v) For HD, the shared revenue collected from the private operator will be used to recover the investment cost. However, because only levied revenues would not allow recovery of the investment, it is assumed that the construction cost will be covered by the government subsidy as well as the levied charge from the private operator.

vi) The current prime rates in Thailand are reported to be 7-8% per annum. Hence, the necessary amount of the government subsidy will be calculated to achieve the FIRR value of 7% for HD.

Based on the PPP scheme as assumed above, it is computed that 80% of the construction cost, or about 335.9 million Baht needs to be covered by a government subsidy to make the Project financially viable. This will allow the private operator to run the port service operation at a feasible level and pay 21% of the total revenue to HD as a facility charge. The results of the above examination are summarized in Table 10.2.7-19. The details of calculations of FIRR are shown in Tables 10.2.7-20 and -21.

Table 10.2.7-19 FIRR for Songkhla Project with PPP Implementation Scheme

Government (HD)	FIRR	7.2%
	Government Subsidy Rate for Construction Cost	80%
	(Amount of Subsidy)	(335.936 million Baht)
Private Operator	FIRR	15.6%
	Rate of Revenue Sharing to be Paid as a Facility Charge	21% for Each Year (in 2020, 10.08 million Baht)
	Maintenance Cost	(4.199 million Baht/year)
	Operation Cost	(30. million Baht in 2020)

Source: Estimated by JICA Study Team

6) Sensitivity test

Although the criterion of the 15% FIRR value is assumed for the determination of an optimal revenue sharing scheme involving the private sector in the above examination, according to the interview of commercial banks in Bangkok, the current level of interest rates for long-term loans has tended to decrease. Thus, the cases of 12 % and 10% as FIRR criteria for the private sector are tested. When a lower FIRR level is applied for the private sector's participation, less government subsidy is required.

The results of the above examination are summarized in Table 10.2.7-22. As seen in this table, given a 12% financial return for the private operator, the government subsidy ratio to the total construction cost will decrease to 79%, and HD can receive 22% of the total revenue. Compared to the base case (a 15% FIRR), the reduction of the subsidy ratio is only 1%. Even if a 10% FIRR is assumed, the subsidy ratio will be 78%. As a result, it can be observed that a small change in the government subsidy is likely to significantly affect the financial condition of the private operator.

Table 10.2.7-20 FIRR for Songkhla Project (Private Operator side)

FIRR = 15.6%

(Baht 1,000)

		Year	Revenues (Financial Revenues)				Costs (Financial Costs)					Net Cash Flow for FIRR
			General Cargo	Container Cargo	Ro/Ro Cargo	Total	Invest-ment	Revenue Sharing Paid 21%	Additional Operation Cost	Maint. Cost	Total	
1		2004				0					0	0
2		2005				0					0	0
3		2006				0					0	0
4		2007				0					0	0
5		2008				0					0	0
6		2009				0					0	0
7	1	2010	13,424	1,488	5,932	20,844		4,377	16,354	4,199	24,930	-4,087
8	2	2011	16,094	1,788	6,000	23,882		5,015	17,941	4,199	27,156	-3,273
9	3	2012	19,048	2,112	6,000	27,160		5,704	19,580	4,199	29,483	-2,323
10	4	2013	21,990	2,448	6,000	30,438		6,392	21,219	4,199	31,810	-1,372
11	5	2014	24,944	2,772	6,000	33,716		7,080	22,858	4,199	34,138	-421
12	6	2015	27,898	3,096	6,000	36,994		7,769	24,497	4,199	36,465	529
13	7	2016	30,840	3,432	6,000	40,272		8,457	26,136	4,199	38,793	1,480
14	8	2017	34,506	3,840	6,000	44,346		9,313	28,173	4,199	41,685	2,661
15	9	2018	37,800	4,200	6,000	48,000		10,080	30,000	4,199	44,279	3,721
16	10	2019	37,800	4,200	6,000	48,000		10,080	30,000	4,199	44,279	3,721
17	11	2020	37,800	4,200	6,000	48,000		10,080	30,000	4,199	44,279	3,721
18	12	2021	37,800	4,200	6,000	48,000		10,080	30,000	4,199	44,279	3,721
19	13	2022	37,800	4,200	6,000	48,000		10,080	30,000	4,199	44,279	3,721
20	14	2023	37,800	4,200	6,000	48,000		10,080	30,000	4,199	44,279	3,721
21	15	2024	37,800	4,200	6,000	48,000		10,080	30,000	4,199	44,279	3,721
22	16	2025	37,800	4,200	6,000	48,000		10,080	30,000	4,199	44,279	3,721
23	17	2026	37,800	4,200	6,000	48,000		10,080	30,000	4,199	44,279	3,721
24	18	2027	37,800	4,200	6,000	48,000		10,080	30,000	4,199	44,279	3,721
25	19	2028	37,800	4,200	6,000	48,000		10,080	30,000	4,199	44,279	3,721
26	20	2029	37,800	4,200	6,000	48,000		10,080	30,000	4,199	44,279	3,721
27	21	2030	37,800	4,200	6,000	48,000		10,080	30,000	4,199	44,279	3,721
28	22	2031	37,800	4,200	6,000	48,000		10,080	30,000	4,199	44,279	3,721
29	23	2032	37,800	4,200	6,000	48,000		10,080	30,000	4,199	44,279	3,721
30	24	2033	37,800	4,200	6,000	48,000		10,080	30,000	4,199	44,279	3,721
31	25	2034	37,800	4,200	6,000	48,000		10,080	30,000	4,199	44,279	3,721
						1,073,653		225,467	686,759	104,980	1,017,206	

Source: Estimated by JICA Study Team

Table 10.2.7-21 FIRR for Songkhla Project (HD side)

FIRR = 7.2%

(Baht 1,000)

	Year	Revenues (Financial Revenues)			Costs (Financial Costs)		Net Cash Flow for FIRR
		Revenue Sharing Received	Subsidy 80%	Total	Invest-ment	Total	
1	2004		5,598	5,598	6,998	6,998	-1,400
2	2005		1,399	1,399	1,749	1,749	-350
3	2006		29,674	29,674	37,093	37,093	-7,419
4	2007		144,454	144,454	180,568	180,568	-36,114
5	2008		122,220	122,220	152,775	152,775	-30,555
6	2009		31,190	31,190	38,988	38,988	-7,798
7 1	2010	4,377	1,399	5,776	1,749	1,749	4,027
8 2	2011	5,015		5,015		0	5,015
9 3	2012	5,704		5,704		0	5,704
10 4	2013	6,392		6,392		0	6,392
11 5	2014	7,080		7,080		0	7,080
12 6	2015	7,769		7,769		0	7,769
13 7	2016	8,457		8,457		0	8,457
14 8	2017	9,313		9,313		0	9,313
15 9	2018	10,080		10,080		0	10,080
16 10	2019	10,080		10,080		0	10,080
17 11	2020	10,080		10,080		0	10,080
18 12	2021	10,080		10,080		0	10,080
19 13	2022	10,080		10,080		0	10,080
20 14	2023	10,080		10,080		0	10,080
21 15	2024	10,080		10,080		0	10,080
22 16	2025	10,080		10,080		0	10,080
23 17	2026	10,080		10,080		0	10,080
24 18	2027	10,080		10,080		0	10,080
25 19	2028	10,080		10,080		0	10,080
26 20	2029	10,080		10,080		0	10,080
27 21	2030	10,080		10,080		0	10,080
28 22	2031	10,080		10,080		0	10,080
29 23	2032	10,080		10,080		0	10,080
30 24	2033	10,080		10,080		0	10,080
31 25	2034	10,080		10,080		0	10,080
		225,467	335,936		419,920	419,920	

Source: Estimated by JICA Study Team

Table 10.2.7-22 Sensitivity Test of FIRR for Songkhla Project

Test Case		Target FIRR for the Private Operator	Target FIRR for the Private Operator
		12%	10%
The Government (HD) Side	FIRR	7.2%	7.2%
	Government Subsidy Rate for the Construction Cost	**79%**	**78%**
	(Amount of Subsidy)	(331.737 million Baht)	(327.538 million Baht)
The Private Operator Side	Computed FIRR	12.8%	10.3%
	Rate of Revenue Sharing to be Paid (Amount in 2020)	**22%** for each year, or (10.56 million Baht)	**23%** for each year, or (11.04 million Baht)
	Maintenance Cost in 2020	4.199 million Baht/year	4.199 million Baht/year
	Operation Cost in 2020	30. million Baht	30. million Baht

Source: Estimated by JICA Study Team

7) Cashflow Analysis for the Implementing Agency

Although 80% of the total investment is to be provided by government subsidy, the implementing agency (HD) needs to procure the fund for the remaining 20% of the investment cost from other financial sources. Therefore, it was examined whether or not the 20% investment will be financially manageable in the cashflow for the government. For this analysis, the following assumptions were made:

i) The implementing agency (HD) can obtain a government bank long-term loan or a concessional long-term loan from any external resource with a special low interest rate to procure the initial investment fund.

ii) The implementing agency can also access short-term loans at a commercial bank to finance any shortfall in the cashflow so that the annual balance is always zero or positive.

iii) These loans will be paid back from the HD share of revenues.

Three cases were examined for different interest rate conditions for both long-term and short-term loans based on the current financial situation in Thailand: Case 1 assumes a 7% interest long-term loan and a 7% short-term loan; Case 2: a 7% long-term loan and a 3.0% short-term loan; and Case 3: a 3% long-term loan and a 3% short-term loan. Case 3 is

conceivable only if an international aid agency such as Japan Bank for International Cooperation (JBIC) would provide the long-term loan with such a low interest rate.

The results of the analysis are tabulated in Table 10.2.7-23. (The cashflow for Case 2 is shown in Table 10.2.7-24.) It is concluded that the implementing agency will be able to manage the debt services for both the long-term initial investment and the short-term loans for annual deficits within the 25 year planning time horizon. Differences among the cases appear in the years of annual surplus and the accumulated net cashflow in the 25th year after starting operation. Obviously, Case 3 brings the most favorable condition since the annual surplus will appear in the 8th year after starting operation, and a total of about 103.2 million Baht will be accumulated in the 25th year.

Table 10.2.7-23 Cash-flow Analysis for the Implementing Agency

	Case 1	Case 2	Case 3
Loan Interest Rates:			
Long-term	7.0%	7.0%	3.0%
Short-term	7.0%	3.0%	3.0%
First Year of Surplus in Net Cash Flow (from the operation start year)	Year 2034 (25^{th} year)	Year 2027 (18^{th} year)	Year 2017 (8^{th} year)
Year of Maximum Short-term Loan (million Baht)	Year 2017 (41.404)	Year 2016 (31.721)	Year 2012 (8.077)
Accumulated Net Cash Flow in the 25th year (million Baht)	3.311	43.883	103.221

Source: Estimated by JICA Study Team

8) Conclusion

Based on the results of the economic analysis, the Project is considered to be feasible from the viewpoint of the national economy because the computed EIRR of 22.0% is much higher than the opportunity cost of capital (12%) in the current Thai economy. The Project will yield a great economic savings in transportation costs, and also bring qualitative benefits from reduced road traffic congestions, a decrease of road traffic accidents and improvement of road environmental conditions. It can also be said that the Project will improve the coastal shipping system in the region, thereby contributing to the improvement of an economically effective inter-modal transport system for the Kingdom.

However, from the financial point of view, the Project is evaluated to be difficult to be self-sustaining (i.e., for the capital investment for the Project to be recovered on a commercial basis) without substantial involvement of the government sector through provision of a subsidy. At least 80% of the investment costs need to be covered with the subsidy or another form of funding such as a grant aid for local economy stabilization purpose.

For operation and maintenance, an optimal PPP (Public and Private Partnership) scheme can be explored, introducing the revenue sharing system in such a way that the private operator can gain a 15% return on its investment in the long-term, paying the government sector 20% of the total revenue collected from the port service fees. This scheme should be attractive enough for the private sector to take part in the Project, considering the current financial situation of the Thai economy.

While the government should provide a subsidy equivalent to 80% of the total investment cost, the implementing agency should seek long-term loans with at less than 7% interest rate for the remaining 20% of the initial investment funds. The Project will be manageable for the debt services within the 25 years planning time horizon.

It is consequently recommended that the Project should be implemented with strong support of the government sector to facilitate the local economy, as it can be justified from the standpoint of the national economy. Furthermore, the optimal PPP scheme examined here, should be pursued for the commercial operation and maintenance, to sustain the financial condition of the project.

Table 10.2.7-24 Cash Flow Table for Case 2 (Government (HD)

(Baht 1,000)

		Year	Financial Cash Flow (In)				Financial Cash Flow (Out)								Net Cash Flow	Accum. Net Cash Flow
			Revenue Sharing Received	Subsidy (80%)	Loan (Long-term) (20%)	In-flow Total	Invest-ment	Loan Repay (Long)	Loan Interest (Long) 7.0%	Loan Repay (Short)	Loan Interest (Short) 3.0%	Out-flow Total	In-flow minus Out-flow	Loan (Short-term)		
1		2004		5,598	1,400	6,998	6,998		49	0	0	7,047	-49	49	0	0
2		2005		1,399	350	1,749	1,749		110	49	1	1,910	-161	161	0	0
3		2006		29,674	7,419	37,093	37,093		382	161	5	37,641	-548	548	0	0
4		2007		144,454	36,114	180,568	180,568		1,906	548	16	183,038	-2,470	2,470	0	0
5		2008		122,220	30,555	152,775	152,775		4,239	2,470	74	159,558	-6,783	6,783	0	0
6		2009		31,190	7,798	38,988	38,988		5,581	6,783	203	51,556	-12,568	12,568	0	0
7	1	2010	4,377	1,399	350	6,126	1,749	3,359	5,749	12,568	377	23,802	-17,676	17,676	0	0
8	2	2011	5,015			5,015		3,359	5,526	17,676	530	27,092	-22,077	22,077	0	0
9	3	2012	5,704			5,704		3,359	5,291	22,077	662	31,389	-25,686	25,686	0	0
10	4	2013	6,392			6,392		3,359	5,056	25,686	771	34,872	-28,479	28,479	0	0
11	5	2014	7,080			7,080		3,359	4,821	28,479	854	37,514	-30,433	30,433	0	0
12	6	2015	7,769			7,769		3,359	4,586	30,433	913	39,291	-31,523	31,523	0	0
13	7	2016	8,457			8,457		3,359	4,350	31,523	946	40,178	-31,721	31,721	0	0
14	8	2017	9,313			9,313		3,359	4,115	31,721	952	40,147	-30,834	30,834	0	0
15	9	2018	10,080			10,080		3,359	3,880	30,834	925	38,999	-28,919	28,919	0	0
16	10	2019	10,080			10,080		3,359	3,645	28,919	868	36,791	-26,711	26,711	0	0
17	11	2020	10,080			10,080		3,359	3,410	26,711	801	34,281	-24,201	24,201	0	0
18	12	2021	10,080			10,080		3,359	3,175	24,201	726	31,461	-21,381	21,381	0	0
19	13	2022	10,080			10,080		3,359	2,939	21,381	641	28,321	-18,241	18,241	0	0
20	14	2023	10,080			10,080		3,359	2,704	18,241	547	24,852	-14,772	14,772	0	0
21	15	2024	10,080			10,080		3,359	2,469	14,772	443	21,044	-10,964	10,964	0	0
22	16	2025	10,080			10,080		3,359	2,234	10,964	329	16,886	-6,806	6,806	0	0
23	17	2026	10,080			10,080		3,359	1,999	6,806	204	12,368	-2,288	2,288	0	0
24	18	2027	10,080			10,080		3,359	1,764	2,288	69	7,480	2,600	0	2,600	2,600
25	19	2028	10,080			10,080		3,359	1,529	0	0	4,888	5,192	0	5,192	7,792
26	20	2029	10,080			10,080		3,359	1,293	0	0	4,653	5,427	0	5,427	13,219
27	21	2030	10,080			10,080		3,359	1,058	0	0	4,418	5,662	0	5,662	18,882
28	22	2031	10,080			10,080		3,359	823	0	0	4,182	5,898	0	5,898	24,779
29	23	2032	10,080			10,080		3,359	588	0	0	3,947	6,133	0	6,133	30,912
30	24	2033	10,080			10,080		3,359	353	0	0	3,712	6,368	0	6,368	37,280
31	25	2034	10,080			10,080		3,359	118	0	0	3,477	6,603	0	6,603	43,883
			225,467	335,936	83,984	645,387	419,920	83,984	85,741	395,290	11,859			395,290		

Source: Estimated by JICA Study Team

10.2.8 Preliminary EIA

Prior to the implementation of the proposed project by this study, the preparation of detailed EIA is required in accordance with the Office of Environmental Policy and Planning (OEPP), Ministry of Science, Technology and Environment in Thailand.

The environmental impact assessment (EIA) was conducted in accordance with the guidelines of Japan International Cooperation Agency (JICA) for the additional reclamation of about 35,350 m^2 at Songkhla port.

This EIA study was undertaken on the assumption that Songkhla port expansion (phase 1) will be completed prior to the project proposed in this study. Therefore, the assessment will focus only on the additional reclamation.

Based on the initial environmental examination (IEE) described in Section 5.4, the potentially significant environmental impacts were identified. Therefore, the content of this EIA will primarily concentrate on the issues mentioned below:

1. Coastal Zone
2. Fauna and Flora
3. Water Pollution
4. Resettlement
5. Economic Activities
6. Traffic and Public Facilities
7. Common Use Rights
8. Cultural Property
9. Air Pollution and Offensive Odor
10. Soil Contamination
11. Noise and Vibration

(1) Project Description

The summary of project description is shown in Table 10.2.8-1 and Figure 10.2.8-1 for the short-term development plan in Songkhla Port.

Table 10.2.8-1 Summary of Project Description

Description	Unit	Quantity	Remarks
1. Port Facilities			
1) General Civil Works			
Dredging	m^3	105,400	
Reclamation	m^3	195,600	35,350 m^2
Access Road	m^2	15,680	L= 980m, W= 16m
Access Bridge	m^2	640	L= 40m, W= 16m
Yard Pavement	m^2	18,900	
Entrance Gate & Checking Post	m^2	40	L= 8m, W= 5m
Utility	L/S	1	
2) Coastal Berth			
Coastal Berth	m	130	
Transit Shed	m^2	3,000	L= 100m, W= 30m
3) Ro/Ro Berth			
Ro/Ro Berth	m	150	
Movable Bridge	L/S	1	
4) Others			
Traffic Volume (Construction)	No	3,600/2 years	99/day
Traffic Volume (Operation)	No	71,500/year	196/day
2. Shoreline Protection			
1) Groins	m	1,000	
2) Detached Breakwaters	m	600	
3. Construction Period	year	4	

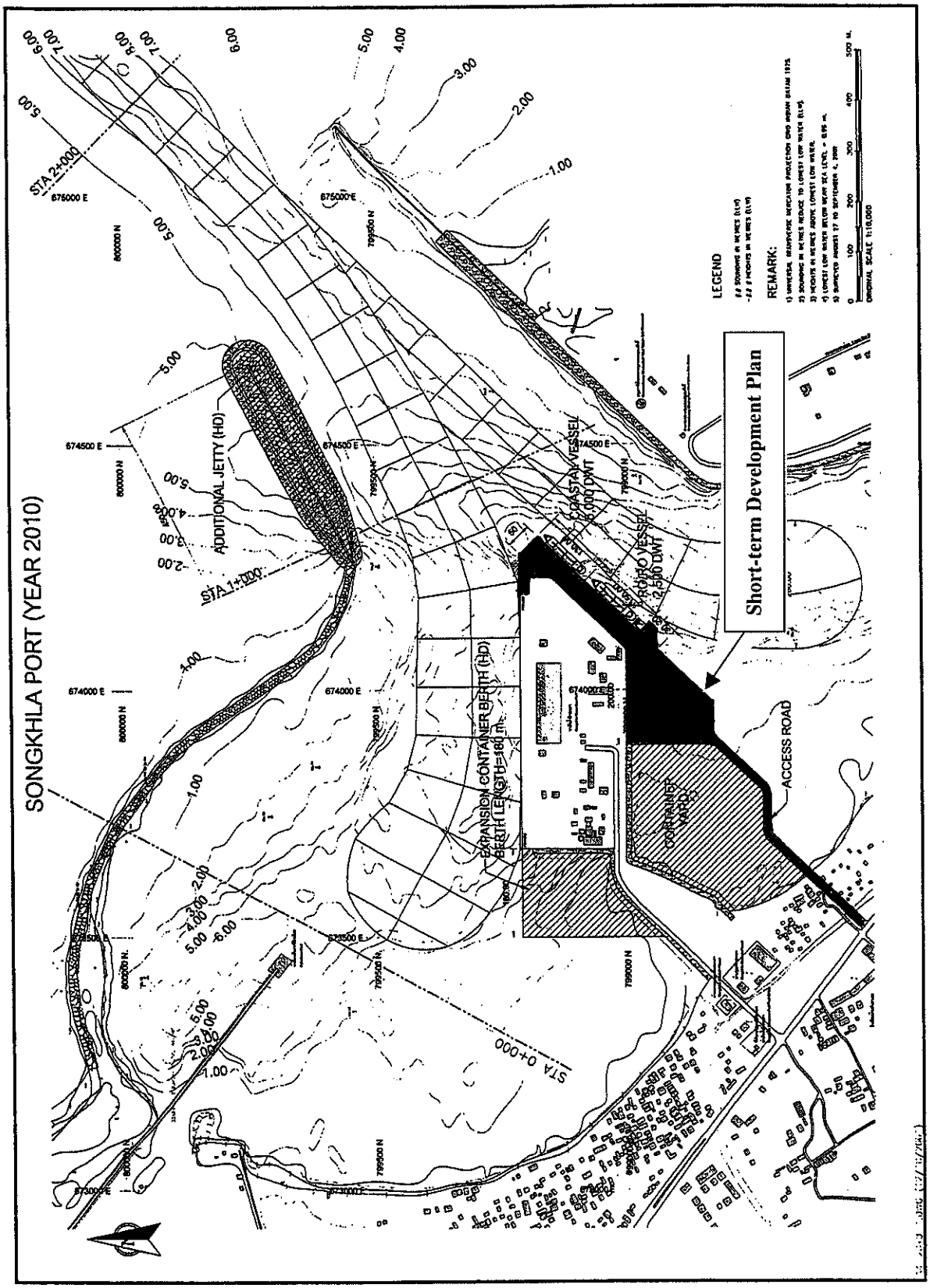


Figure 10.2.8-1 Short-term Development Plan of Songkhla Port

(2) Existing Environmental Conditions

a) Coastal Zone

The west and east sides of Songkhla deep sea port are protected by the breakwater and jetty. The shoreline erosion around the port is seen in the north of Had Sai Kaeo due to the construction of a jetty east of the Lake entrance.

The sediment transport along the shoreline is headed to the north during the northeastern monsoon and to the south during the southwestern monsoon.

b) Fauna and Flora

It was stated that the dominant phytoplanktons were diatom in genus *Coscinodiscus*, *Chaetoceros* and *Nitzchia*. The species diversity was relatively low at the Lake entrance area due to high water velocity.

Concerning the benthic species, the dominant group was *Polychaete* collected mostly near Ban Khao Daeng area with the density about 355 individuals/m^2.

The information from National Coastal Aquaculture Institute (1982) indicated that there were 134 fish species in Songkhla Lake (freshwater:37. brackish water:97; herbivore:22, carnivore:112).

Not so many species of wildlife were found in Songkhla Lake entrance area because most of land uses are community and agricultural, and human activities always disturb animal habitats and living conditions. Most of wildlife found in the study area were only well-adaptive animals such as amphibians of Black-spined Toad, Rugosed Frog and Ornate Chorus Frog, reptiles of Spiny-tailed House Gecko, Common Sun Skink, Indochinese Rat Snake and Forest Crested Lizard, birds of Little Egret, Zebra Dove, Great Egret, Common Kingfishers and Black Drongo, and mammal of House Rat and Common Tree Shrew.

All 15 species of rarely-seen wildlife were less abundant, the existence of which was only verified by interviews. They were: one species of amphibian (Dark-sided Chorus Frog), three species of reptile (Malayan Box Turtle, Reticulated Python), eight species of birds (Cattle-egret, Wood

Sandpiper, Lesser Coucal), and three species of mammal (Crab-eating Mongoose, Common Palm Civer).

White-chested Babbles was the only one species of animals found in this study which was defined as near-threatened species.

High density mangrove forest can be found in two sites: the mangrove forest conservation area at Hua Khao sub-district and the Tinnasulanonda Fishery College in Songkhla Lake entrance area.

The mangrove forest at Hua Khao has a tree density of 6,800/ha, sapling density of 700/ha, seedling density of 1,550/ha and average wood volume (fuel wood) of 213 m^3/ha.

On the other hand, the mangrove forest at Tinnasulanonda Fishery College has the average tree density of 3,700/ha, average sapling density of 450/ha, average seedling density of 650/ha and average wood volume (fuel wood) of 34 m^3/ha.

c) Water Pollution

It was indicated that the surface water around the project area was contaminated mainly with human wastes and the discharges from the surrounding communities. A good indicator of this aspect, fecal coliform bacteria, was very high (1,100 to >24,000 MPN/100ml) and exceeded the water quality standard class 4 for aquaculture.

In addition, the concentration of suspended solid was also very high, especially along the lake entrance and existing jetty near Samila beach.

Based on the water quality analysis (November 1997 by HD) for deep sea port expansion area, heavy metals of iron and mercury were detected at the port area with significantly high concentration (Fe: 1.360ml Fe/l, Hg: 0.001mg/l) exceeding the water quality standard class 4 for aquaculture.

d) Resettlement

Although the project area is situated entirely within the Department of Harbor's premises, such area is currently occupied by about 600 families which need to be resettled prior to the port expansion (see Figure 10.2.8-2). This area is primarily within Ban Le community, Hua Kao sub-district, Singha Nakhon district. This community covers Moo 1 and 7 (partly) of Hua Kao sub-district.

The decree for land acquisition was issued in 1976. The affected families totaled 363 (land compensation: 165, building compensation: 363) and the compensation was paid to 331 families with remaining unpaid compensation for 32 families. The most updated survey on November 1999 indicated that there were 594 families with about 4,000 residents living in this area.

HD expedited the resettlement program to try to meet the target completion date on 1 July 1991 with the assistance from National Housing Authority, Provincial Electricity Authority and Songkhla Provincial Administration Organization. The resettlement site of 40 rai was located close to the shoreline at Ban Nam Rob, Moo 7, Wat Kanun sub-district, Singha Nakhon district. This allocated area can serve 209 families, with 120 m^2 per family.

In addition, a boat docking area is provided within an area of 0.3 rai. The total budget for the resettlement program is approximately 14.124 million Baht. Up to now, the infrastructure in the resettlement site has been developed, but the actual relocation has not been conducted.

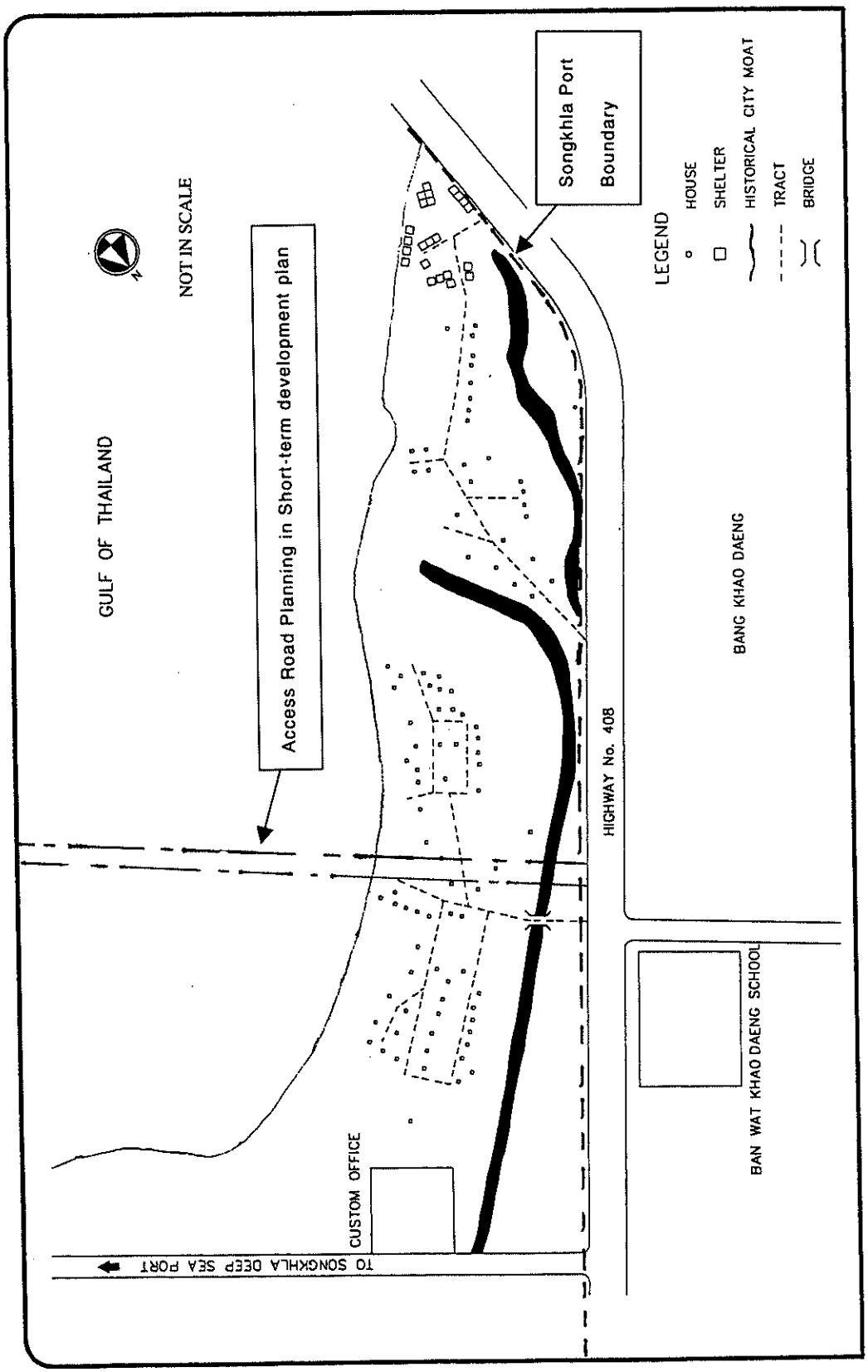


Figure 10.2.8-2 Houses Affected by Port Expansion

e) Economic Activities

In Songkhla province, the major industry is agriculture with 52.0 % of the area utilized for agricultural purposes. The dominant cash crops are para-rubber, rice, oil palm, coconut and durian.

Fisheries are also an important major income source for the province. There are coastal and in-land (Songkhla Lake) fisheries. The coastal and in-land fishing grounds cover about 660 and 1,086 km^2, respectively. Songkhla is a central market for fisheries in the southern part of Thailand.

Coastal fisheries are mostly small domestic industries with small boats less than 10 meters long and 30 horsepower. The fishing grounds are about 5 km from the shoreline. The amount of fish caught in 1999 was 244,507 tons which was a 5.2 % reduction from 1998.

Aquaculture is also frequently observed along the shoreline and within Songkhla Lake. Dominant fish species are white sea bass, tiger prawn and cod.

Fishing activities are mostly found around Ko Nu, Ko Mao and outer Songkhla Lake area (see Figure 10.2.8-3). The fishing equipment is mostly floating seine, trawl, fishing hook and marine trap, etc. The dominant economic species in the area are mullet, sea perch, tassel fish, king mackerel, black tiger prawn, squid and crab.

Around the project area, especially at Ban Le community, Hua Kao sub-district, major occupation is fishery related: i.e., fishing, fish culture, fish processing and fish buying/selling (36 %). Other occupations are small business and work in factories.

f) Traffic and Public Facilities

The major traffic route to the project site is highway No.408. Traffic volume on this highway was 8,914 vehicles/day in 1993 and 20,515 vehicles/day in 1997. The increasing trend continues year by year because this highway crossing the lake is the major link between highways No.42 and 43.

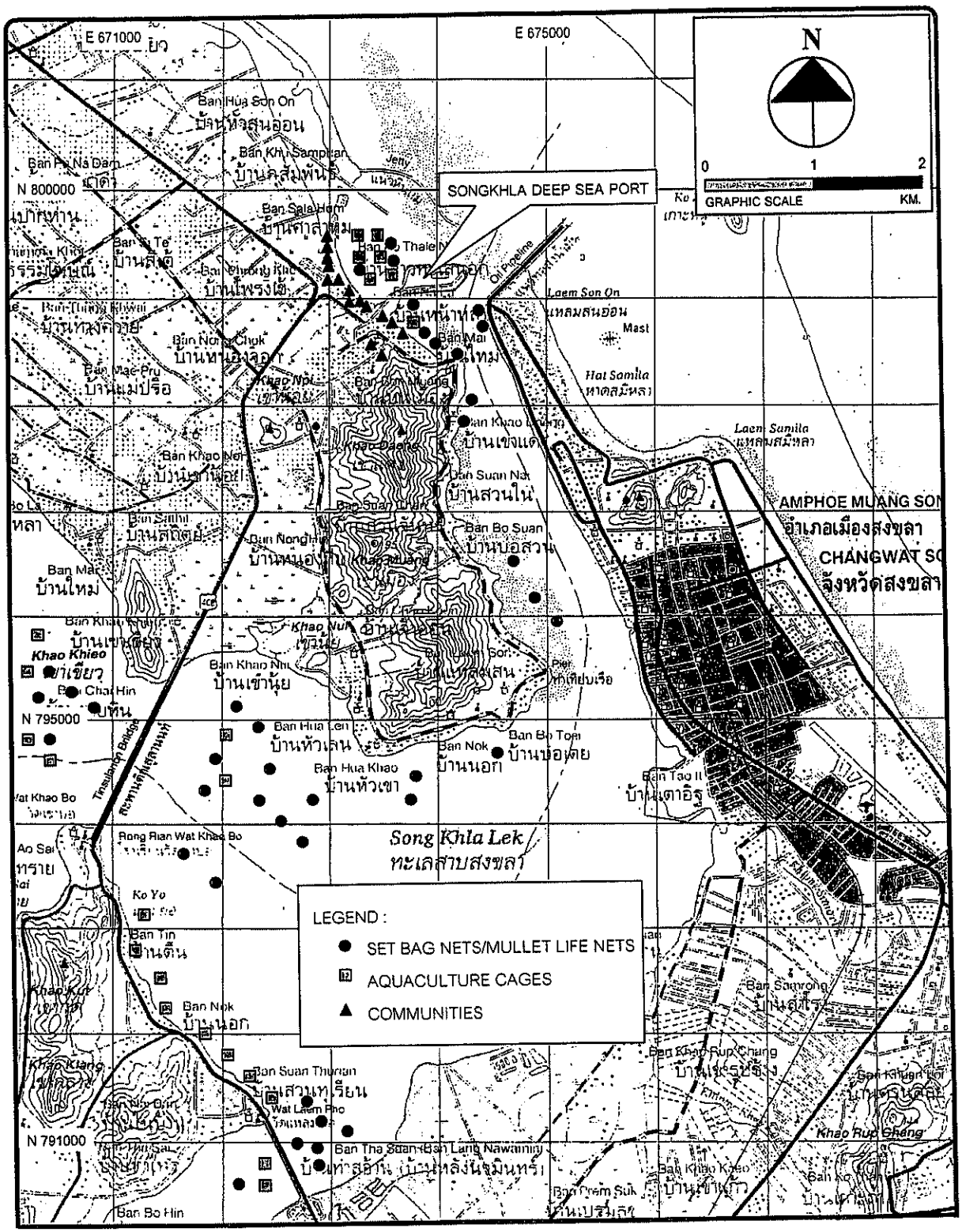


Figure 10.2.8-3 Fishing Activities in Songkhla Lake Entrance

In addition, large-sized vehicles were also recorded in large number on highway No.408.

The number of ships docked at Songkhla port was 569 in 2000 which 398 ships were container carriers and 83 were general cargo ships.

g) Common Use Rights

The coastal area and waterways are common area for public utilization. Within Songkhla lake and lake entrance, however, the areas are illegally occupied with about 1,063 set bag nets and mullet life nets. Most of these fishermen are Muslim. This issue is very sensitive which may lead to a conflict of public, religious, economical and political concerns.

The Office of Regional Harbor Section 4 in Songkhla is directly responsible for common use areas. The representatives of fishermen were invited to negotiate about bag net removal from the waterway. The negotiations were not successful and the operation of set bag nets and mullet life nets seriously impairs the navigation in the port and inner lake area.

Therefore, the Office of Regional Harbor Section 4 took a case to Singha Nakhon police station on 23 May 2000 for ten convicted operators. Even after pressing charges, bag net operation is still on going around the project area.

h) Cultural Property

There are numerous evidences of ancient human settlements around Songkhla Lake. Two significant sites, according to several documents, are Hua Khao Daeng historical city and Bo Yang historical city.

Hua Khao Daeng historical city is located at the foothill of Khao Daeng mountain in Singha Nakhon district opposite Songkhla port. The physical appearance of the city is rectangular measuring 800 m in width and 1,330 m in length; the total area is 665 rai with forts and moats on three sides and Khao Daeng hill on the back side as shown in Figure 10.2.8-4.

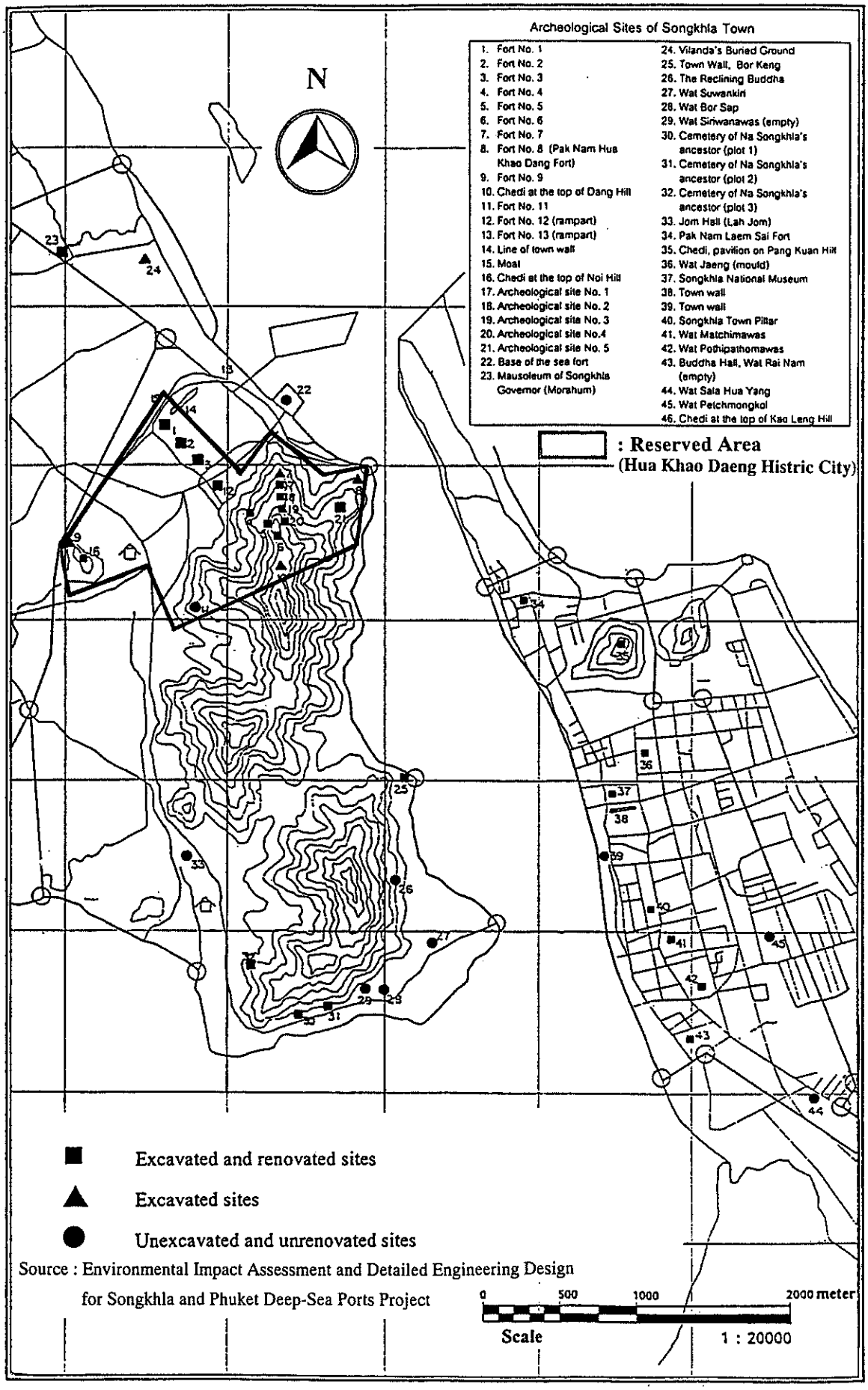


Figure 10.2.8-4 Archeological Sites of Songkhla City

Ancient monuments are building basement, pagoda, city wall and forts. At present, Hua Khao Daeng is declared as a part of Songkhla historical city. City wall, forts and moat are under excavation and restoration by the Department of Fine Arts. Ancient evidences in Hua Khao Daeng site have already been destroyed and altered by the current community of Ban Bon Muang.

Bo Yang historic city located in the southern bank on mouth of the Songkhla Lake is considered as one of the important cultural centers of the southern Thailand. At present, it is the center of Songkhla administrative offices.

Songkhla area has abundant historical monuments and cultural heritage sites. It also serves as a transportation hub between the lower and upper southern regions of South China Sea as well as the center for Songkhla tourism attractions such as Ko Yoh, Hua Khao Daeng and Songkhla Lake.

According to research documents, there are at least 12 historical and archaeological sites in Singha Nakhon district and ten of them are in the study area. Most of the sites are in Khao Daeng, Khao Muang and Khao Noi. Two of the historical sites are near the project site.

The nearest archaeological sites to the port are city wall, forts and city moat which are located outside the project site, opposite the port. These sites are under excavation and restoration by the Department of Fine Arts. However, some sections of the city wall are obstructed by the current structures. Several archaeological sites which are located near the project site such as Wat Khao Noi, Wat Suwankiri, the cemetery of Phraya Kaek are under restoration by the Department of Fine Arts.

Khao Daeng historic city located in Moo 7, Ban Bon Muang and a part of Moo 1, Ban Khao Daeng, Hua Khao sub-district of Singha Nakhon district with total area of 2,460 rais have been proclaimed as archaeological sites in Royal Decree (volume 102, section 180, November 29, 1985 – special edition) and Zoning Proclamation in Royal Decree (volume 109, section 119, September 17, 1992).

The important monuments in Khao Daeng historic city are as follows:

1) Fortress

There are thirteen forts on land and one at seafront (Fort No.14) according to the preservation and development report on historic city of Songkhla by the Department of Fine Arts (1992). All those forts are made of stone and plaster. Later another fort (Fort No.15) was found at the foot of Kaay Muang hill.

2) City Wall

Only the northern wall is visible with the length of 150 meters. It was made of stone and plaster like the forts.

3) City Moat

The moat lies only on the north and east sides of the city with total length of 2,000 meters. The eastern moat is not in good condition, but the northern moat is still good shape with the widest part 30 meters.

4) Religious Monuments

Two religious monuments are found: one chedi (jeti) at the top of Khao Daeng mountain and one at the top of Khao Noi hill.

i) Air Pollution

Air quality measurements were conducted around the Songkhla port area at three stations in October 1995 and at five stations in April 1998 for the following parameters: Total Suspended Particulate (TSP), Sulphur Dioxide (SO_2), Nitrogen Dioxide (NO_2) and Carbon Monoxide (CO).

The maximum values of the measurements were 0.153 mg/m^3 for TSP, 0.033 mg/m^3 for SO_2, 0.060 mg/m^3 for NO_2 and 1.56 ppm for CO. These values are within the standard of Pollution Control Department in Thailand (1995).

j) Soil Contamination

Existing results of soil analyses for heavy metals performed around Songkhla port in 1996 show that the maximum values were 54.13 ppm for Lead (Pb), 1.72 ppm for Cadmium (Cd), 1.37 ppm for Mercury (Hg) and 6.80 ppm for Arsenic (As).

The soil contamination of heavy metals is low except for Lead.

k) Noise

The project area is mainly allocated to industrial purposes. However, there are communities close to the port, especially Ban Khao Daeng and Ban Ao Thale Nog. Noise was measured in April 1998 at five stations around the port.

It was found that the noise levels were Leq (Equivalent Sound Level): 60.8 – 70.3 dBA and Ldn (Day-night Average Sound Level): 62.8 – 73.0 dBA: i.e., around the standard of 70 dBA of the National Environmental Board.

(3) Preliminary Environmental Impact Assessment

a) Coastal Zone

The proposed reclaimed area of about 35,350 m^2 is in the inner part of the port facing the lake entrance. Currently, such area is a shallow bay which dries up during the ebb tide. Thus, the reclamation area will not have any structure to block the current or sand particles.

Therefore, it is not expected to cause significant impact to the coastal zone both in construction and operation periods.

b) Fauna and Flora

In the area around the proposed reclamation, there is no mangrove or forest community. Thus, there will be no impact on the terrestrial ecological resources from the project implementation. However, the direct impact from reclamation activities on aquatic life is expected in two areas: the reclaimed site and the influenced area of turbid water discharged.

The identified species around the area are common benthos. Therefore, the impact is not a serious issue. Concerning the impact from turbid water from construction activities, the dispersion of suspended solid can impact fish net and cage culture facilities by clogging the nets. In addition, silt containing water can be carried into Songkhla Lake during the flood tide which may impact the aquatic life in the lake area and cage culture.

Detailed analysis by a dispersion modeling needs to be undertaken to scope out the potentially impacted area.

The port operation will generate a certain amount of oily and human waste contaminated wastewater. If not properly treated, the seawater in the nearby area can become polluted which will directly impact the aquatic life in terms of species diversity, richness and density.

c) Water Pollution

During land reclamation activities, silt laden water will be discharged from a silt pond to the

surroundings. The dispersion of sediment can be transported into the inner lake area during the flood tide and can cause adverse effect on the recreational activities near Lam Son On and in the lake itself.

In addition, domestic wastewater from site office and construction camp can lead to low dissolved oxygen and high BOD level in the nearby area which can have indirect impact on fisheries and recreation in the area.

During the port operation, there will be two major types of wastewater generated by the project: domestic wastewater and oil contaminated wastewater.

d) Resettlement

Prior to the development of Songkhla Deep Sea Port expansion (Phase 1), about 594 families with close to 4,000 members need to be resettled from Ban Le community of Hua Khao sub-district to the allocated site at Ban Nam Rob of Wat Kanun sub-district.

This activity is very sensitive from religious, social and political viewpoints. Currently, these affected families have resisted moving, even though some groups have already received the compensation money since 1986.

e) Economic Activities

The resettlement of 594 families in Ban Le community from Songkhla Deep Sea Port expansion (Phase 1) will have direct impact on their income. Most of these families have a relatively low income of about 5,000 Baht per month. Therefore, the relocation process will lead to partial impairment of their earnings.

For the approximately 200 operators of cage culture and nets, they also will be directly impacted by the proposed project on this study.

On the other hand, the operation of Songkhla port will bring in revenue to the area and country, and can attract investors to operate additional coastal shipping and Ro/Ro vessels. These investments can offer direct benefit to Songkhla in terms of job opportunities and related services such as restaurants, car rental, housing and groceries, etc.

f) Traffic and Public Facilities

The project related vehicles will total about 99 cars and trucks per day (about 13 vehicles/ working hour). These vehicles will use highways No.408 and 4222. These two highways are two-lane highways with asphalt paved surface and the capacity is 2,000 cars/hour.

Current traffic volume is about 1,000 and 520 cars/hour on highways No.408 and 4222, respectively. Therefore, the additional 13 vehicles/hour should not have any impact on the transportation network in the area.

During the operation of the port, it is expected that 196 vehicles/day (25 vehicles/hour) will be generated from such activities. This additional volume will make traffic on highways No.408 and 4222 total about 1,025 and 550 cars/hour, respectively, while the road capacity is 2,000 cars/hour. Therefore, the potential impact on traffic aspect is considered as minor.

g) Rights of Common Use Areas

The proposed project will be located entirely within the area under the authority of Harbor Department. Therefore, no violation of common use rights will occur.

However, Songkhla Deep Sea Port expansion (Phase 1) needs to relocate about 100 cage cultures, 90 set bag nets and 10 mullet life nets from the construction area. Harbor Department has unsuccessfully approached the operators and finally submitted the case to the Singha Police Station on 23 May 2000.

h) Cultural Property

Land reclaimed area is in about 500 m from the historic city moat. The shallow moat has been abandoned for a long time, which caused the diverted watercourse. Some sections are dry and the new community drainage trenches have also caused the diverted watercourse. Therefore, the proposed project will not physically damage the city moat.

According to research on environmental impact, there is a historic fort (No.14) built at the seafront which might conflict with the expansion project. Also, some experts have suggested that

there are three forts within the project compound.

In conclusion, there might be three to four forts at the seafront. However, most of them had been destroyed by nature and only one fort is still evident. It can be seen during the low tide at approximately 30 m from the beach having Latitude 100° 34′ 23″ E and Longitude 7° 13′ 24″ N. This fort is about 300 m from the project site. Therefore, there will be no impact on such structure (see Figure 10.2.8-5).

i) Air Pollution

During the four-year construction period, there will be some air pollution: namely, dust particles from the reclamation area and exhaust gas from project vehicles and machinery.

The dust particles from the reclamation area is not expected to be large due to the high moisture in reclaimed materials and the distance between the construction area and Ban Khao Daeng (about 500 m). In addition, the dry season in Songkhla is only six months per year. The impact on air quality will be relatively minor with the proper practice of mitigation measures.

The impact on air quality during the port operation will be mainly from the coastal vessels, Ro/Ro vessels and project related vehicles which will total about 196 vehicles/day. It is expected that the pollution concentration around the project area will be increased to a minor level due to relatively low traffic volume increase.

j) Soil Contamination

There will be no dredging in the nearby waterways. Therefore, the dispersion of contaminated soil is not expected. Reclaimed materials will be purchased from other sources which will be analyzed for heavy metal contents prior to utilization for the project.

During the port operation, oily or chemical contaminated waste can be generated. It is necessary to segregate such waste and to temporarily store it in designated containers for further specialized treatment by a registered firm.

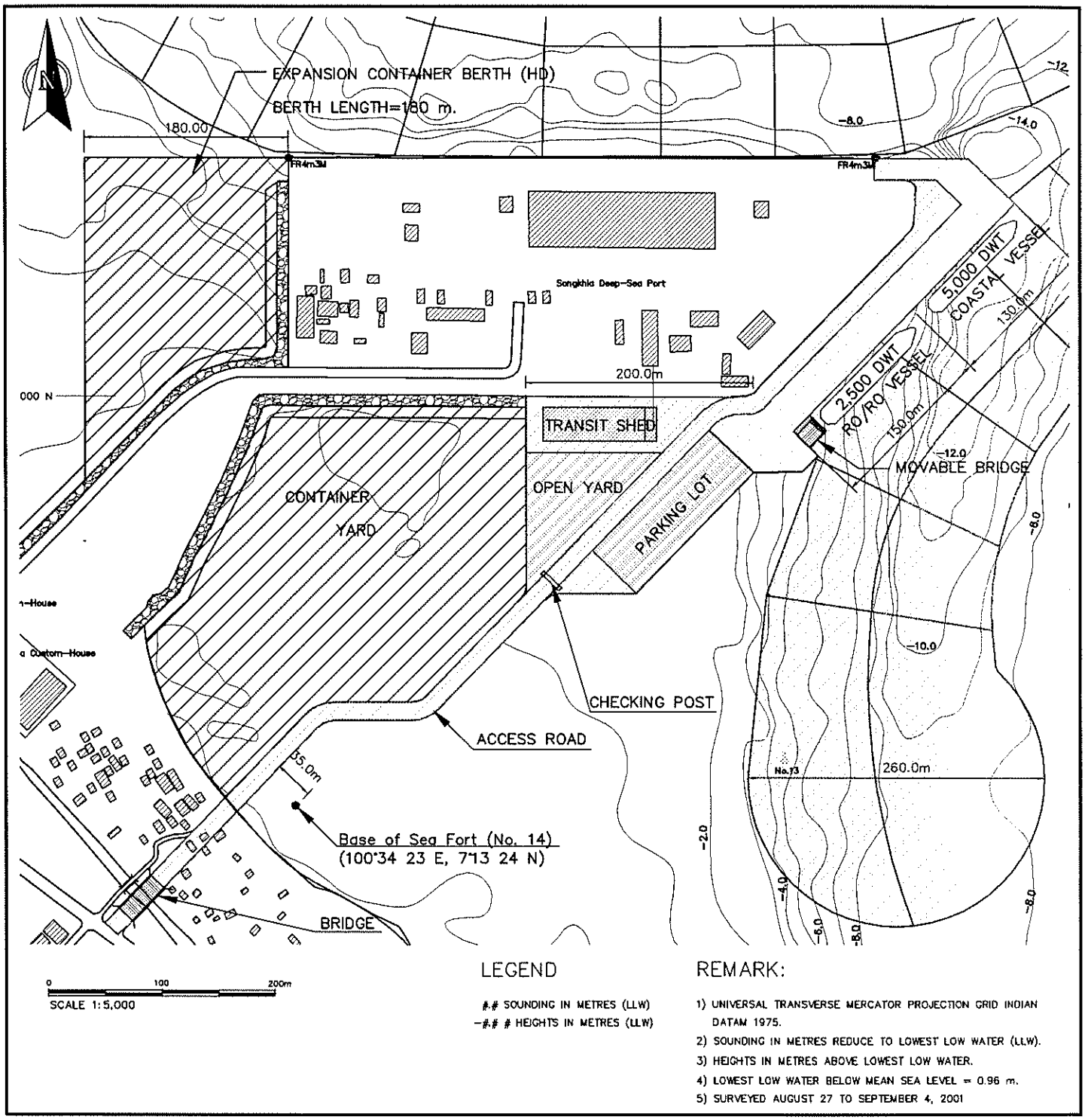


Figure 10.2.8-5 Location of Archeological Sites Near Songkhla Port

k) Noise

The construction activities will increase the noise level in the vicinity. However, the closest receptor at Ban Khao Daeng school is about 500 m from the reclaimed area. Therefore, the potential impact on the concerned receptor due to noise generated from construction activities will be relatively minor.

Project related traffic will also increase the noise level in the nearby highways, especially highways No.408 and 4222. Hence, a suitable transportation schedule needs to be planned and enforced to reduce potential impact.

The operation of coastal and Ro/Ro vessels will generate some noise during the berthing period. In addition, increased traffic noise on highway No.408 can create some impact on the school at Ban Khao Daeng. Therefore, careful planning on daily traffic distribution is essential to minimize the above impacts.

Conclusions

From the above examinations, it can be concluded that the proposed project including additional reclamation of about 35,350 m^2 in Songkhla port is not expected to cause major impact. The potential impacts are summarized in Table 10.2.8-2.

The environmental impact assessment presented in this study is based on JICA's guidelines. Therefore, detailed EIA according to Office of Environmental Policy and Planning, Ministry of Science, Technology and Environment is needed to fulfill the requirements of the Environmental Enhancement and Conservation of National Environmental Quality Act of 1992 prior to any actual construction activities.

Table 10.2.8-2 Summary of Environmental Impact Assessment

Items	Environmental Impact	
	Construction Period	Operation Period
Social Environment		
1. Resettlement	B	X
2. Economic Activities	C	X
3. Traffic and Public Facilities	C	C
4. Rights of Common Use Areas	C	X
5. Cultural Property	X	X
Natural Environment		
6. Coastal Zone	X	X
7. Fauna and Flora	C	X
Pollutant		
8. Water Pollution	C	X
9. Air Pollution and Offensive Odor	C	X
10. Soil Contamination	X	X
11. Noise and Vibration	C	X

Note : Level of Environmental Impact

A : Relatively high magnitude of impact is expected.

B : Medium magnitude of impact is expected.

C : Relatively low magnitude of impact is expected.

X : No effect is expected.

10.3 Sichon Channel

10.3.1 Requirements of Training Jetty

As a result of simulation analysis as described in Chapter 8, the navigation channel of Sichon is expected to be affected by the sedimentation of sand drift. The same type of training jetty is planned as the existing one.

10.3.2 Recommended Channel Layout

The recommended channel layout was designed to secure the existing channel route and prevent the wave intrusion. In addition, the navigational aid devices shall be installed for the safety of ship maneuverings.

Basic criteria of channel layout are as follows:

- Not to disturb the fishing or navigation activities in the existing channel.
- Minimize the dredging construction cost for channel.
- To add the navigation aid system for the safety vessel navigation

Following the above criteria, the short-term development plan is illustrated in the following Figure 10.3.2-1.

10.3.3 Development Program

Sichon area does not have heavy sand sedimentation by sand drift. Therefore, only a little dredging maintenance for soil sedimentation in the channel is necessary in the future. Construction schedules for tentative implementation program are shown in the following Figure 10.3.3-1.

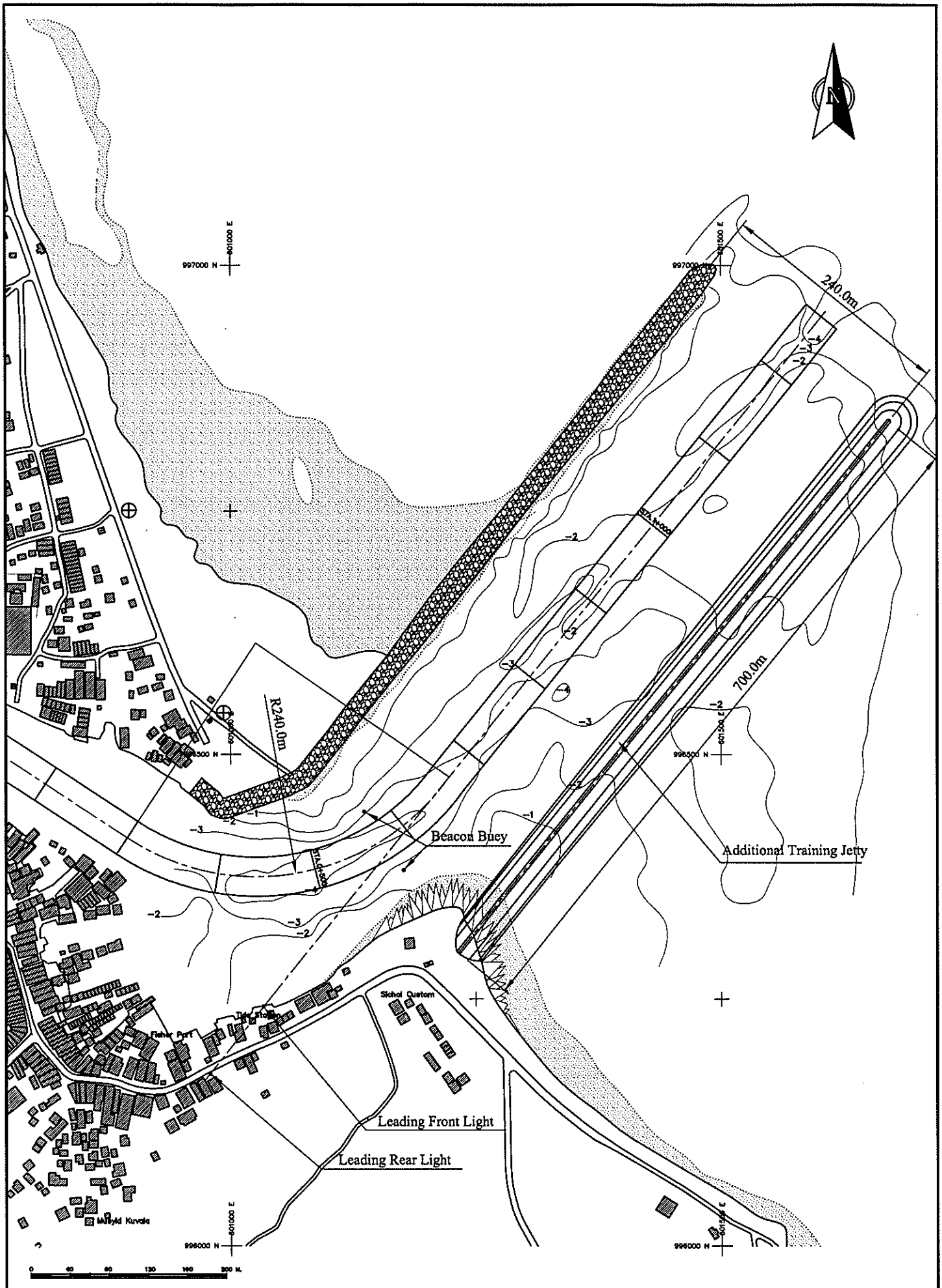


Figure 10.3.2-1 General Layout of Additional Training Jetty in Sichon

Item	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Remarks
1. Selection of the Consultant											
2. Engineering Service											
- Detailed Design											
- Tender Assistance											
- Construction Supervision											
- Maintenance Period											
3. Selection of the Contractor											
a. P/Q											
b. Tender											
c. Evaluation											
d. Negotiation											
e. Contract											
4. Construction Works											
- Construction of Training Jetty											L=700m
- Installation of Light Beacon											2 units
5. Maintenance Period											

Figure 10.3.3-1 Tentative Implementation Program of Sichon Channel (Short-term Development Program)

10.3.4 Project Cost

(1) Construction of Training Jetty

In Sichon channel, the construction of a training jetty was planned at the opposite side of the existing training jetty to assure the depth of channel and to prevent sedimentation caused by littoral drift sand.

The detailed dimensions of additional training jetty designed are as follows.

- Crown Height +4.0
- Crown Width 4.0m
- Slope Gradient 1:3 for Seaward, 1:2.5 for Harbor Side
- Max. Weight of Cover Layer 2,500kg
- Max. Water Depth -3.0 MSL
- Total Length 700m

A typical section is shown in Fig. 10.3.4-1.

(2) Navigation Aids

In order to assure the safe navigation of vessels, several light beacons shall be installed to show the center of channel and the boundary of shoals. The number of planned light beacons are as follows:

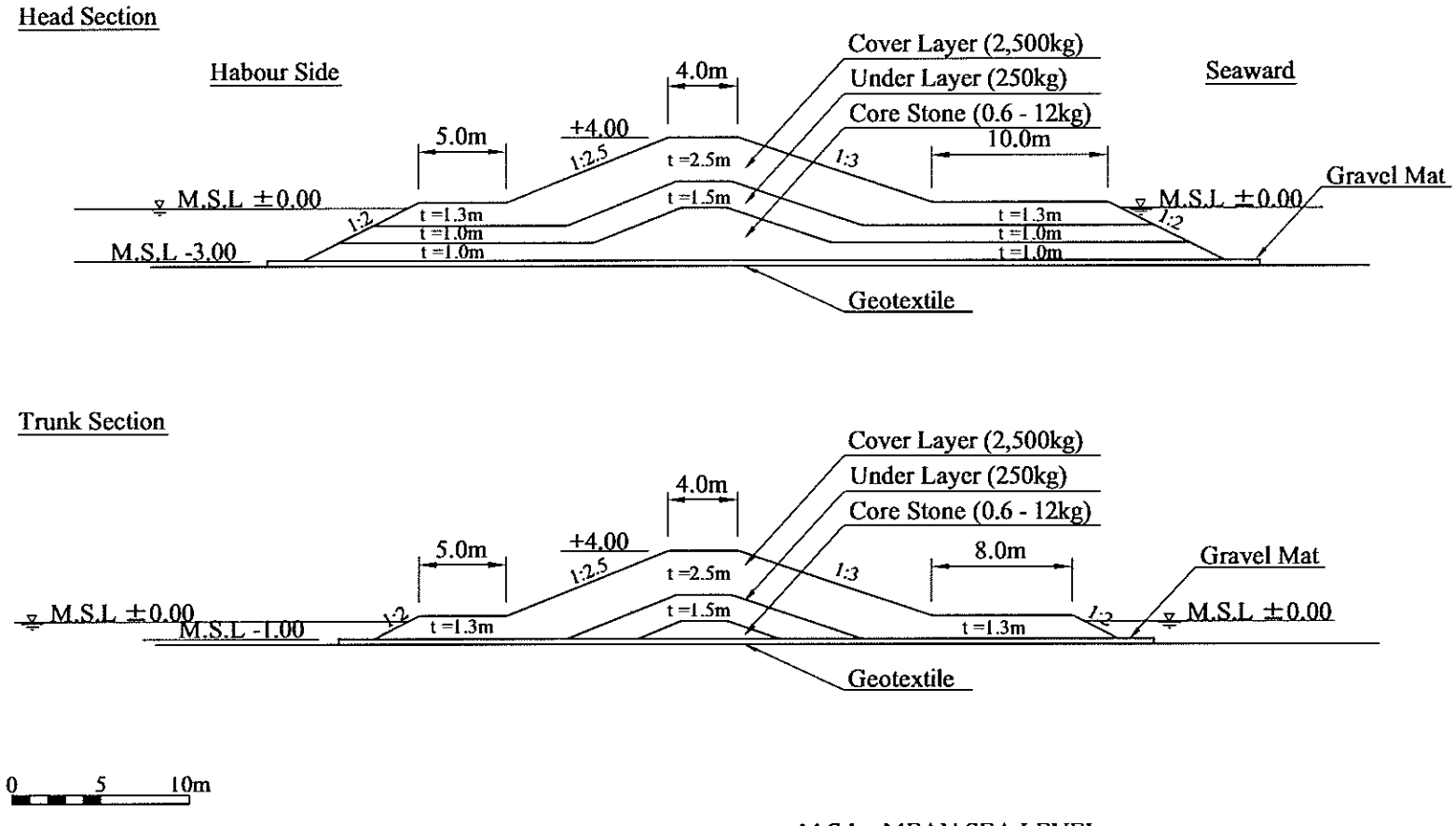
1) To indicate the center of channel : 2 units
2) To indicate the boundary of shallow part : 2 units

(3) Cost Estimate of the Project

Table 10.3.4-1 shows the estimated project cost for Sichon Channel.

Table 10.3.4-1 Sichon Channel Project Cost

Project Items	Remarks (Quantity)	Project Cost (Baht)
A. Direct Cost		
1.Construction of Single Jetty		
1) Seabed E.L –3.0 to – 1.0	L=560m	57,428,000
2) Seabed E.L –1.0 to ±0.0	L=140m	8,141,000
2. Installation of Light Beacons	4 units	1,400,000
Total of Direct Cost		66,969,000
B. Indirect Cost	L/S	
1. Engineering Fee	L/S	6,697,000
2. Physical Contingency		6,697,000
Total of Indirect Cost		13,394,000
C. Total of Project Cost (excluding VAT)		80,363,000
D. VAT	7%	5,625,000
Total Project Cost (2001 – 2010)		85,988,000



M.S.L : MEAN SEA LEVEL
LOWEST LOW WATER (L.L.W) BELOW MEAN SEA LEVEL = 1.00m

Fig. 10.3.4-1 Typical Cross Section of Training Jetty, Sichon Port (2001 - 2010)

10.3.5 Project Benefits

(1) Background of the Project

For the following description and the several units used for benefit estimation, information was obtained through the site survey carried out by the sub-contracted local consultants as well as the site reconnaissance by the Study Team. Also the information in the previous study reports on Sichon and other channels was referred.

The population of Sichon is about 8,000 persons in 1,900 households in the fishing community along Sichon channel. Accordingly, Sichon has many fishery processing factories. The estimated total number of fishing boats using the channel is 1,327, of which 595 are smaller-sized boats and 732 are medium- and large-sized boats.

The major fishing grounds cover the area of 2 - 60 km from the shoreline, among which the area of 20-30 km from the shoreline is the most productive. The fishing period is almost the whole year. The major marine catches are crab, shrimp, fish and squid.

(2) Project benefits

The construction of a single training jetty in Sichon was completed in February 1996. The objective of the project was to secure the navigation channel for the fishing boats in Sichon channel. Since completion, the training jetty has served fishermen for navigating through Sichon channel. This facility has contributed to save the cost of fishing activities as a whole, and produced a positive effect on the socio-economic situation of the related area.

Since completion, however, the sediment deposition has occurred in the sea area near the jetty. This is considered to be caused by the wave-induced current, which is blocked by the single jetty. In addition, in 2000, some fishing boats were stranded nearby several times. Without a proper mitigation measure, the sediments will soon congest the mouth of channel blocking the path of fishing boat so that fishing boats will need to wait for high tide to pass the channel. Hence, the construction of another jetty should provide a solution of this situation.

In this context, quantitative economic benefits of the construction of the second jetty are as follows:

a) Savings in fuel consumption of fishing boats from shorter waiting time for high tide.

The improvement of navigation problem should liberate the fishing boats from waiting for the high tide. This will save the fuel consumption by those boats during the waiting time.

b) Savings by reducing loss of value of marine catches

The shorter the waiting time, the higher the total catch is expected. The benefit of channel improvement is also qualified in terms of the increased fishery production.

c) Savings in cost of channel dredging

The channel improvement by constructing another jetty will save dredging of accumulated sediment, which is estimated to be approximately 30,000 m^3 per dredging.

Other than the above, the following benefits are expected as qualitative benefits:

- The creation of job opportunity during the construction period
- Positive effect for local economy by the promotion of such industrial activities as fish processing industries
- Overall social stability in the related area through income generation by promoted fishing activities
- Prevention of wave intrusion to wharf and processing factory areas of the port.

10.3.6 Economic Analysis

(1) Estimation of Benefits

Economic benefits to be derived from the channel improvement are as follows:

(a) Savings in Fuel consumption

Due to the anticipated shallowness of Sichon channel, fishermen will have to waste about 1 to 3 hours in waiting for high tide. This will require more fuel consumption. The benefits of fuel savings is estimated as below:

Total Number of trip involved by hindrance x Unit fuel consumption x Fuel price

Table 10.3.6-1 shows the estimation results of total number of trips involved by hindrance (waiting for high tide).

Here, among fishing boats, the medium and large sized boats are the focus. The average number

of trip per boat is estimated to be 16 per annum based on the site survey carried out by the sub-contracted local consultants for the JICA study. The ratio of trips involved by hindrance is assumed to be 20% of total trips, based on the site reconnaissance results regarding tide conditions.

Table 10.3.6-1 Estimation of Total Number of Trips Involved by Hindrance

Number of Fishing Boats (Medium and Large size)	Average Number of Trips per Boat per Annum	Total Number of Trips	Assumed Ratio of Involved by Hindrance	Total Number of Trips Involved by Hindrance
732	16	11,712	20%	2,342

Source: Estimated by JICA Study Team

Table 10.3.6-2 shows the estimation of savings in fuel consumption. The extra fuel required per involved trip by hindrance is assumed based on the study results of "F/S Report for Construction of Sakom Training Jetty, 1994". The fuel price excluding tax is assumed based on the site interview and the fuel tax information of NEPO (National Energy Policy Office).

Table 10.3.6-2 Estimation of Savings in Fuel Consumption

	Unit	Amount
Total Number of Involved Trips		2,342
Fuel Waste per Involved Trips	liter	30
Fuel Price excluding Tax	Baht per liter	10
Savings in Fuel Consumption Cost	Baht/year	702,600

Source: Estimated by JICA Study Team

b) Savings in Loss of Marine Catch

The longer the waiting time in the shallow channel of Sichon, the more deterioration in the quality of marine catch. This will spoil the value of marine catch. In case of improved channel depth, the benefits of savings by reducing loss of marine catch is estimated as below:

Total number of trips involved by hindrance x Unit volume of marine catch per trip x Unit lost value per kilogram

The number of trips involved by hindrance is already shown in Table 10.3.6-1. The unit volume of average marine catch and the average price per kilogram by kind of marine catch are estimated

based on the site survey carried out by the sub-contracted local consultants for this study. The unit loss was estimated based on the loss ratio of 3%, which is used in the previous study report of "F/S Report for Construction of Sakom Training Jetty, 1994". The calculation results are shown in Table 10.3.6-3.

Table 10.3.6-3 Estimation of Saving in Loss of Marine Catch

Total No. of Trips Involved by Hindrance	Average Marine Catch per Trips (kg)	Marine Catch for Involved Trip (kg)	Average Price of Marine Catch (Baht/kg)	Unit Loss Value (Baht per kg) (Ratio:3%)	Amount of Loss of Marine Catch (Baht 1,000 per annum)
2,342	812	1,902,029	70	2.1	3,994

Source: Estimated by JICA Study Team

Note: Average marine catch per trip and average price per kg are estimated based on the site survey carried out by the sub-contracted local consultants for the JICA study.

c) Savings in dredging cost

By construction of another training jetty, the required dredging volume will be reduced. The expected volume of dredging is estimated to be 30,000 m^3. Assuming the unit cost of dredging of Baht 70 per m^3, the savings in dredging cost is estimated to be Baht 2.1 million.

(2) Project costs

In this economic analysis, the project costs in terms of financial price are converted into terms of economic price. The details of conversion process were mentioned in the previous section of 10.2.7 (1) 2). As a result, the project costs are shown in Table 10.3.6-4. The maintenance cost was assumed to be 1% of the investment cost.

Table 10.3.6-4 Project Costs (Initial Investment) for Sichon Project

(Baht 1,000)

Year	Financial Price	Economic Price
2003	1,434	1,329
2004	358	332
2005	24,160	22,290
2006	59,678	55,002
2007	358	332
Total	85,988	79,286

Source: Estimated by JICA Study Team

(3) Cost benefit analysis

Based on the estimated economic benefits and costs, EIRR (economic internal rate of return) was calculated. Also, assuming the discount rate of 12%, B/C Ratio (benefit/ cost ratio) and NPV (net present value) were calculated. The project life was assumed to be 25 years after the starting year (2007) of the service of improved channel. The calculation results are summarized in Table 10.3.6-5. The details of calculation are shown in Table 10.3.6-6.

Table 10.3.6-5 Summary of Cost/Benefit Analysis for the Sichon Project

Indicators	Values
EIRR	5.6%
B/C Ratio (at discounted rate of 12%)	0.61
NPV (Baht 1,000) (at discounted rate of 12%)	-19,718

Source: Estimated by JICA Study Team

(4) Sensitivity test

Altering the amount of the costs by +10% and the benefits by –10% to the base case, the sensitivity test regarding the changes of EIRR value was made. The results of sensitivity testing are summarized in Table 10.3.6.7. In the worst case of combination of costs: +10% and benefits: –10%, the value of EIRR was 3.4%.

Table 10.3.6.7 Summary of Sensitivity Test for Sichon Project

	Costs	
Benefits	Base Case	+10%
Base Case	5.6%	4.5%
-10%	4.4%	3.4%

Source: Estimated by JICA Study Team

(5) Evaluation

The value of EIRR did not reach the level of 12%, which is the criteria of EIRR for infrastructure projects in Thailand. From the results of economic analysis, the Project is not economically feasible.

However, the overall improvement in social stability in the community through job creation and income generation by promoted fishing activities may be an additional incentive to implement the project.

Table 10.3.6-6 EIRR for Sichon Project

EIRR =	5.6%		
B/C Ratio=	0.61	(at Discount Rate of	12%)
NPV (Baht 1,000) =	-19,718	(at Discount Rate of	12%)

(Baht 1,000)

	Year	Benefits				Costs			Net Cash Flow for EIRR
		Saving in Fuel Cost	Saving in Loss of Marine Catch	Saving in Dredging Cost	Total	Invest-ment	Maint. Cost	Total	
1		2003			0	1,329		1,329	-1,329
2		2004			0	332		332	-332
3		2005			0	22,290		22,290	-22,290
4		2006			0	55,002		55,002	-55,002
5	1	2007	703	3,994	2,100	6,797	332	332	6,465
6	2	2008	703	3,994	2,100	6,797	793	793	6,004
7	3	2009	703	3,994	2,100	6,797	793	793	6,004
8	4	2010	703	3,994	2,100	6,797	793	793	6,004
9	5	2011	703	3,994	2,100	6,797	793	793	6,004
10	6	2012	703	3,994	2,100	6,797	793	793	6,004
11	7	2013	703	3,994	2,100	6,797	793	793	6,004
12	8	2014	703	3,994	2,100	6,797	793	793	6,004
13	9	2015	703	3,994	2,100	6,797	793	793	6,004
14	10	2016	703	3,994	2,100	6,797	793	793	6,004
15	11	2017	703	3,994	2,100	6,797	793	793	6,004
16	12	2018	703	3,994	2,100	6,797	793	793	6,004
17	13	2019	703	3,994	2,100	6,797	793	793	6,004
18	14	2020	703	3,994	2,100	6,797	793	793	6,004
19	15	2021	703	3,994	2,100	6,797	793	793	6,004
20	16	2022	703	3,994	2,100	6,797	793	793	6,004
21	17	2023	703	3,994	2,100	6,797	793	793	6,004
22	18	2024	703	3,994	2,100	6,797	793	793	6,004
23	19	2025	703	3,994	2,100	6,797	793	793	6,004
24	20	2026	703	3,994	2,100	6,797	793	793	6,004
25	21	2027	703	3,994	2,100	6,797	793	793	6,004
26	22	2028	703	3,994	2,100	6,797	793	793	6,004
27	23	2029	703	3,994	2,100	6,797	793	793	6,004
28	24	2030	703	3,994	2,100	6,797	793	793	6,004
29	25	2031	703	3,994	2,100	6,797	793	793	6,004

Source: Estimated by JICA Study Team

10.4 Bang Ra Pha Channel

10.4.1 Requirements of Shore Protection and Sand Bypassing System

As a result of simulation analysis described in Chapter 8, the navigation channel of Bang Ra Pha is expected to be affected by the sedimentation of sand drift. However, once the jetties are expanded, an additional erosion problem will occur immediately. Moreover, in several years, similar sedimentation condition will recur because of the continuous sand accumulation.

In this regard, especially in an area of large sand drift, a sand-bypassing system is highly effective against sand sedimentation and erosion. Sand bypassing is better solution than the expansion of jetties in case of Bang Ra Pha Channel as shown in the following Table 10.4.5.

Table 10.4.5 Comparison Sand Bypassing System and Expansion of Jetties

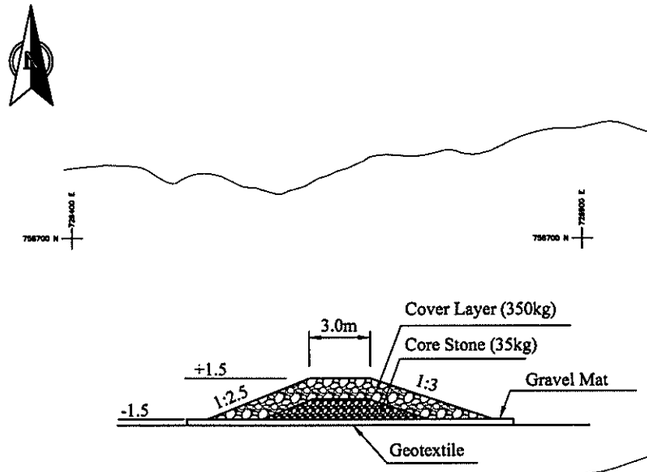
	Sand Bypassing System	Expansion of Jetties
Dimension	Sand Bypassing Volume: 50,000m^3/year from sand sedimentation area to erosion area	Expansion Jetties Length: 250m x 2 jetties=500m
Additional Civil Works	4 Detached Breakwater Total length=400m Erosion distance is estimated 1,500m, but sand filling by sand bypassing will reduce 50% of total erosion distances. Therefore, 4 detached breakwaters are required for protection of erosion.	16 Detached Breakwater Total length=1,600m Due to expansion jetties as twice distances, the erosion distance will expand to 3,000m. Therefore, 16 detached breakwaters are required for protection of erosion.
Construction Direct Cost 5 years	22,452,000 Baht	66,983,000 Baht
Construction after 5 years	Every year constant sand bypassing necessary	Based on the estimated sand sedimentation volume per year, sand sedimentation reach to end of expanded eastern side jetty in 5 years. Therefore, additional expansion of jetties will be necessary after 5 years.

10.4.2 Recommended Channel Layout

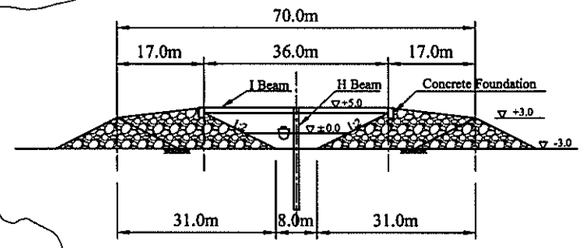
Land transport in sand bypass method is the most reasonable method against sand sedimentation and erosion around the existing training jetties. However, firstly, four detached breakwaters will be installed against rapid and drastic erosion. And then sand bypassing shall be operated at 50,000 m^2/year. (See Figure 10.4.2-1)

10.4.3 Development Program

This project is considered urgent and necessary for channel management. Otherwise, the channel will be close soon by sand sedimentation. Construction schedule for tentative implementation program is shown in Figure 10.4.3-1.



Detached Breakwater



Temporary Bridge Section

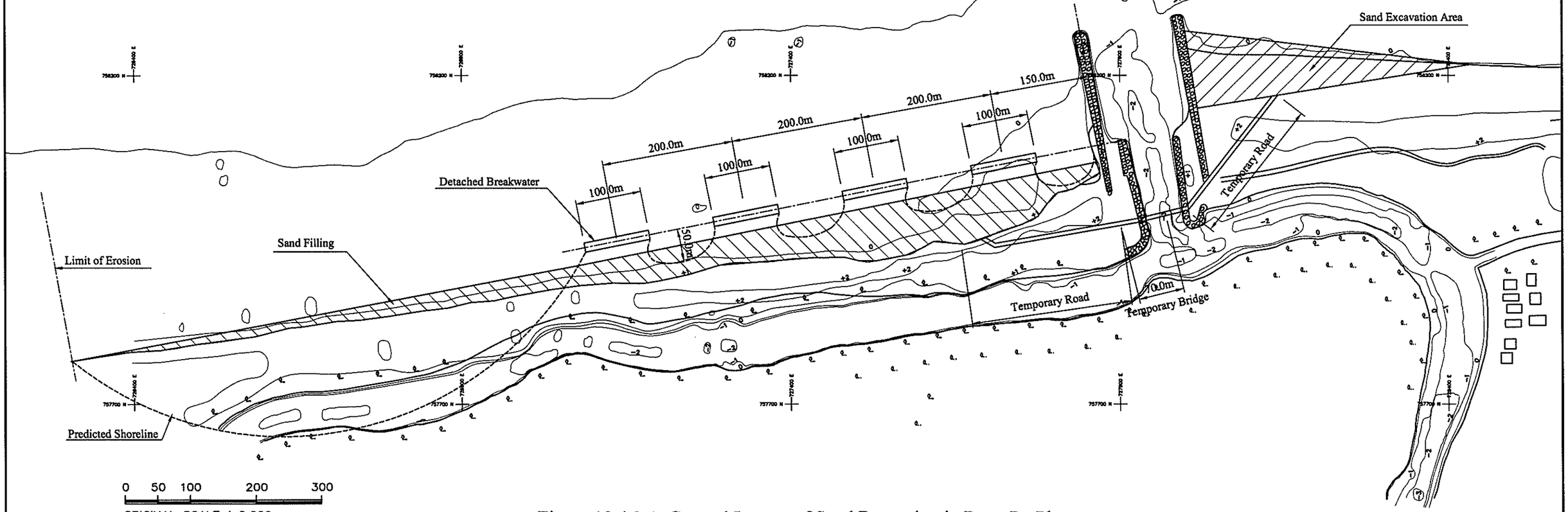


Figure 10.4.2-1 General Layout of Sand Bypassing in Bang Ra Pha

Item	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Remarks
1. Selection of the Consultant											
2. Engineering Service											
- Detailed Design											
- Tender Assistance											
- Construction Supervision											
- Maintenance Period											
3. Selection of the Contractor											
a. P/Q											
b. Tender											
c. Evaluation											
d. Negotiation											
e. Contract											
4. Construction Works											
- Construction of Detached B/W											400m
- Execution of Sand Bypass						100	100	100	100	100	100,000m^3/year
5. Maintenance Period											

Figure 10.4.3-1 Tentative Implementation Program of Bang Ra Pha Channel (Short-term Development Program)

10.4.4 Project Cost

(1) Construction of Detached Breakwater

The detached breakwater is proposed to prevent erosion of the shoreline. The designed breakwater consists of four units with the total length of 400 m with the following dimensions.

- Crown Height	+1.5**m**
- Crown Width	3.0m
- Slope Gradient	1:3 for Seaward, 1:2.5 for Harbour Side
- Max. Weight of Cover Layer	350kg
- Max. Water Depth	-1.5**m**
- Total Length	400m

A typical cross section of the detached breakwater is shown in Figure 10.4.2-1.

(2) Execution of Sand Bypass

In order to maintain the depth inside of the channel, sand bypass method should be adopted together with the detached breakwater as mentioned above.

A planned sand bypass is estimated to move sediment of approx. 100,000m^3 per year during the period 2006 to 2010. To ensure the transportation route of the sediment, a temporary bridge is designed to cross over the channel as shown in Figure 10.4.2-1.

(3) Cost Estimate of the Project

Table 10.4.4-1 shows an estimated project cost for Bang Ra Pha Channel.

Table 10.4.4-1 Bang Ra Pha Channel Project Cost

Project Items	Remarks (Quantity)	Project Cost (Baht)
A. Direct Cost		
1. Construction of Detached Breakwater	L=400m	6,452,000
2. Sand Bypass		
- Construction of Temporary Access Bridge	L/S	1,000,000
- Execution of Sand Bypass	V=100,000m^3/year	30,000,000
Total of Direct Cost		37,452,000
B. Indirect Cost		
1. Engineering Fee	L/S	3,745,000
2. Physical Contingency	L/S	3,745,000
Total of Indirect Cost		7,490,000
C. Total of Project Cost (excluding VAT)		44,942,000
D. VAT	7%	3,146,000
Total Project Cost (2001 – 2010)		48,088,000

10.4.5 Project Benefits

(1) Background of the Project

For the following description and the several units used for benefit estimation, information was obtained through the site survey carried out by the sub-contracted local consultants as well as the site reconnaissance by the Study Team. Also the information in the previous study reports on Bang Ra Pha channel and other channels were referred to.

The population of Bang Ra Pha village is about 700 persons or 130 households. About 90% of the total households in the village make up the community of local shoreline fishermen.

The total number of fishing boats was assumed to be 110, on the assumption that the number of fishing boat owner is equivalent to the number of fishermen households (i.e., the number of above-mentioned total households x 90%). This number was adopted for economic analysis.

All of boats are small size of 6 - 9 m in length. The major fishing grounds are at the river mouth and in the nearby sea at a distance of about 2 - 4 km from shoreline which permit one trip in a day. The number of fishing trips ranges between 10 - 24 times per month. The major marine catches are crab and shrimp because there are small factories purchasing those catches from local fishermen in the village. The fishing periods are in general from April to August for crab and from August to March for shrimp.

(2) Project Benefits

The construction of the training jetty in Bang Ra Pha was completed in June 1999. The objective of the training jetty is to secure the navigation route for fishing boats in the nearby community. Since completion, the training jetty has helped fishermen in navigating through the Bang Ra Pha channel. This facility has contributed to savings in the cost of fishing activities as a whole, and produced a positive effect on the socio-economic situation of the related community.

Since completion, however, deposition of littoral drift has been continued on one side of the jetty resulting in the accretion of land. On the other hand, erosion has occurred on another side of jetty. According to the engineering study results, the channel will soon be congested by littoral drift resulting in a shallow water depth at the mouth of channel. Without a proper mitigation measure, the channel mouth might be completely clogged. Accordingly, the passage of fishing boats will generally become difficult and will be blocked in the near future. Hence, the fishing boats will need to shift their mooring points from their original points nearby fishermen’s residences to an

area along the seashore outside the channel.

In order to prevent the further sedimentation and erosion, a method of sand bypass is planned for Bang Ra Pha channel. By the application of this method, it is expected that the obstruction of channel will be prevented and the passage route secured. This is one resolution to the problem of shallow passage in the near future from which negative economic impacts are anticipated.

The quantitative economic benefits expected by the channel improvement are as follows:

a) Savings in incremental transport costs for marine catches
Under the condition of a closed channel, fishing boats will have to moor not at their original points nearby fishermen's residences but at an area along the seashore outside the channel. Then, incremental transportation for marine catches will be necessary from seashore to the community area (estimated distance of road is about 1- 2 km). With proper mitigation measures, such costs will be prevented.

b) Savings in incremental cost related to fishing boats by mooring at seashore
Under the condition where fishing boats moor at the area along the seashore outside the channel, some extra expenses will be required; for example, costs for watching boats, extra handling costs, etc. With proper mitigation measures, such costs will be prevented.

c) Savings in loss of value of marine catches
The above condition will result in a reduced value of marine catches during the time of handling at seashore and transportation. With proper mitigation measure, such a loss of value will be prevented.

Among the above, the costs of items a) and b) were considered to be negligible. Therefore, the cost of item c) was actually calculated as quantitative benefit in this economic analysis.

Other than the above, the following benefits are expected as qualitative benefits:
- Job opportunities created during the construction period
- Improved social stability in the community through income generation by fishery activities

10.4.6 Economic Analysis

(1) Estimation of Benefits

Economic benefits of savings in preventing loss of marine catch to be derived from channel improvement are as follows:

Due to the anticipated closure of Bang Ra Pha channel, the quality of marine catch will become worse. This will cause a decrease in the value of marine catch. The benefits of savings in preventing loss of marine catch is estimated as below:

Number of fishing boats x Number of trips involved by hindrance x Unit volume of marine catch per trip x Unit lost value per kg.

The number of trips involved by hindrance (waiting for high tide) per boat was estimated as shown in Table 10.4.6-1. The average number of trips per boat was assumed to be 20 per month.

Table 10.4.6-1 Estimation of Total Number of Trips Involved by Hindrance

Kind of Marine Catch	Average Number of Months for fishing Period	Average Number of Trip a Month per Boat	Total Number of Trips per Annum per Boat	Assumed Ratio of Involved by Hindrance	Total Number of Trips Involved by Hindrance
Crab	5	20	100	100%	100
Shrimp	7	20	140	100%	140
Total			240		240

Source: Estimated by JICA Study Team

Note: Average number of trip a month per boat is assumed to be 20 based on site survey carried out by the sub-contracted local consultants for the JICA study

The unit volume of marine catch and the price per kilogram were estimated based on the site survey carried out by the sub-contracted local consultants for the study. The unit loss value was estimated based on the loss ratio of 3%, which was used in the previous study report on Bang Ra Pha channel and other similar study report on similar channel improvement project. The calculation results are shown in Table 10.4.6-2.

Table 10.4.6-2 Estimation of Savings in Preventing Loss of Marine Catch

No. of Boat	Kind of Marine Catch	Total No. of Trips Involved by Hindrance per Boat	Total No. of Trips Involved by Hindrance	Marine Catch per Trip (Kg)	Marine Catch for Involved Trips (Kg)	Price per Kg (Baht)	Unit Loss Value (Baht per kg) (Ratio: 3%)	Amount of Loss of Marine Catch (Baht 1,000 per annum)
110	Crab	100	11,000	18	198,000	87	2.61	517
	Shrimp	140	15,400	7	107,800	196	5.88	634
Total								1,151

Source: Estimated by JICA Study Team

Note: Marine catch per trip and price per kg are estimated based on the site survey carried out by the sub-contracted local consultants for the JICA study.

(2) Project Costs

In this economic analysis, the project costs in terms of financial price were converted into terms of economic price. The details of conversion process were mentioned in the previous section of 10.2.7 (1) 2). As a result, the project costs are shown in Table 10.4.6-3. The maintenance cost is assumed to be 1% of the investment cost. The costs for sand bypass are Baht 7.297 million in financial price and Baht 6.720 million in economic price during 2006 - 2010, and Baht 3.531 million in financial price and Baht 3.251 million in economic price after 2011.

Table 10.4.6-3 Project Costs (Initial Investment) for Bang Ra Pha Project

(Baht 1,000)

	Financial Price	Economic Price
2003	801	742
2004	200	186
2005	2,579	2,370
2006	8,672	8,072
Total	12,252	11,370

Source: Estimated by JICA Study Team

Note: Excluding cost for sand bypass

(3) Cost Benefit Analysis

Using the estimated economic benefits and costs, EIRR (economic internal rate of return) was calculated. Also, assuming the discount rate of 12%, B/C Ratio (benefit/ cost ratio) and NPV (net

present value) were calculated. The project life was assumed to be 25 years after the starting year (2007) of service of the improved channel improvement. The calculation results are summarized in Table 10.4.6-4. The details of calculation are shown in Table 10.4.6-5.

Table 10.4.6-4 Summary of Cost/Benefit Analysis for Bang Ra Pha Project

Indicators	Values
EIRR	- (not calculated)
B/C Ratio (at discounted rate of 12%)	0.16
NPV (Baht 1,000) (at discounted rate of 12%)	-26,457

Source: Estimated by JICA Study Team

Due to the negative value in net cashflow for every year in the calculation period, EIRR could not be calculated. This was because the amount of benefits was small compared to the total amount of costs for each year.

(4) Evaluation

The value of EIRR is far from the level of 12%, which is conceived as criteria of EIRR for an infrastructure project in Thailand. From the results of economic analysis, the Project is not economically feasible. However, the project may deserve to be implemented after considering such qualitative benefits as social stability, job creation, income generation and promotion of fishing industry of the local community.

Table 10.4.6-5 EIRR for Bang Ra Pha Project

EIRR =	-(not calculated)		
B/C Ratio=	0.16	(at Discount Rate of	12%)
NPV (Baht 1,000) =	-26,457	(at Discount Rate of	12%)

(Baht 1,000)

	Year	Benefits		Costs				Net Cash Flow for EIRR
		Saving in Loss of Marine Catch	Total	Invest-ment	Sand Bypass	Maint. Cost	Total	
1	2003		0	742			742	-742
2	2004		0	186			186	-186
3	2005		0	2,370			2,370	-2,370
4	2006		0	8,072	6,720		14,793	-14,793
5	1 2007	1,151	1,151	0	6,720	114	6,834	-5,683
6	2 2008	1,151	1,151		6,720	114	6,834	-5,683
7	3 2009	1,151	1,151		6,720	114	6,834	-5,683
8	4 2010	1,151	1,151		6,720	114	6,834	-5,683
9	5 2011	1,151	1,151		3,251	114	3,365	-2,214
10	6 2012	1,151	1,151		3,251	114	3,365	-2,214
11	7 2013	1,151	1,151		3,251	114	3,365	-2,214
12	8 2014	1,151	1,151		3,251	114	3,365	-2,214
13	9 2015	1,151	1,151		3,251	114	3,365	-2,214
14	10 2016	1,151	1,151		3,251	114	3,365	-2,214
15	11 2017	1,151	1,151		3,251	114	3,365	-2,214
16	12 2018	1,151	1,151		3,251	114	3,365	-2,214
17	13 2019	1,151	1,151		3,251	114	3,365	-2,214
18	14 2020	1,151	1,151		3,251	114	3,365	-2,214
19	15 2021	1,151	1,151		3,251	114	3,365	-2,214
20	16 2022	1,151	1,151		3,251	114	3,365	-2,214
21	17 2023	1,151	1,151		3,251	114	3,365	-2,214
22	18 2024	1,151	1,151		3,251	114	3,365	-2,214
23	19 2025	1,151	1,151		3,251	114	3,365	-2,214
24	20 2026	1,151	1,151		3,251	114	3,365	-2,214
25	21 2027	1,151	1,151		3,251	114	3,365	-2,214
26	22 2028	1,151	1,151		3,251	114	3,365	-2,214
27	23 2029	1,151	1,151		3,251	114	3,365	-2,214
28	24 2030	1,151	1,151		3,251	114	3,365	-2,214
29	25 2031	1,151	1,151		3,251	114	3,365	-2,214

Source: Estimated by JICA Study Team