

10.2.5 Cost Benefit Analysis

In order to investigate the economic justification for the study routes, economic project costs and economic benefits were compared based on the conventional discounted cash flow method.

1. Conditions for Economic Analysis

The following conditions were assumed for the analysis:

1) The opening years of the L/D Route and B/C Route are scheduled to be at the beginning of the year 2002 and 2001 respectively in accordance with the implementation plans of each study route.

2) Benefit streams between each benchmark years (2000, 2010 and 2020) are estimated by means of interpolation. Benefits after 2020 are assumed to be the same benefits as in the year 2020 considering the situations of traffic saturation over the road capacity and to avoid the difficulty of accurate traffic forecasts beyond the foreseeable time horizon longer than 25 years.

3) Land acquisition costs were included in the economic costs. As explained in the section of Methodology, all inputs for the project implementation should be evaluated at, in principle, real resource values. This means that the evaluations must be based on the opportunity costs such as "opportunity cost of capital", "opportunity cost of labor". If a land area occupied for the Right of Ways (ROW), that area may be eliminated from opportunities for other uses (agricultural, residential, commercial, industrial purposes, e.t.c) during the long project life. Although the estimation of exact opportunity costs of land will be a difficult operation itself and, in addition, a market land price reflects many factors, those can not be reasons to exclude land costs from the economic costs. In this analysis, prices of lands were adopted as proxy values of land costs.

4) The evaluation period of the project motorways was assumed as 30 years after opening year.

5) No residual values except for the lands were assumed for the project routes. As a land is not depreciable and will remain as it is even after a long project life, those values were recorded as minus (negative) costs at the end of the evaluation period. This treatment for lands means that no land costs are included in the economic cost streams before discounting because the initial land costs are offset by the same amount of (minus) residual land values. However, in the discounted cash flows, land costs are included based on the opportunity cost of capital (= discount rate at 12 % p.a.).

2. Results of Economic Evaluation

Results of the economic evaluations are summarized in Table 10.2-12 for the L/D and B/C Routes. These results indicate that the both project routes are economically feasible with the Economic Internal Rate of Return (EIRR) of 14.08% and 23.02%

respectively. The cost benefit cash flows are presented in Table10.2-13 and Table10.2-14.

TABLE 10.2-12 SUMMARY OF ECONOMIC EVALUATION

Indicator \ Route	L/D Route	B/C Route
EIRR (%)	14.08 %	23.02 %
NPV (Million Baht)	4,412	30,286
B/C Ratio	1.31	2.98

Note: Opportunity Cost of Capital = 12 %

3. Economic Sensitivity Analysis

The sensitivity tests for the project routes were conducted changing the following factors:

- (1) Changing both costs and benefits in total
- (2) Effects of changing toll rates

The results of test (1) are shown in Table10.2-15. The L/D Route may be feasible within the changing area of cost-up by 20% alone, and benefit-down by 20% alone. This route will not be feasible in the case of changing together both costs and benefits more than 15% up/down.

On the other hand, the B/C Route shows robustness of feasibility in all tested cases. Even if the project costs go up by 20% and benefits go down by 20% simultaneously, an EIRR of more than 18% is still maintained for the B/C Route.

TABLE 10.2-15 ECONOMIC SENSITIVITY ANALYSIS FOR EIRR(%)

(Lampang - Doi Saket Route)

	Base Case 14.08%	Cost : +10 %	Cost : +15 %	Cost : +20 %
Benefit : -10 %	13.25%	12.51%	12.18%	11.86%
Benefit : -15 %	12.80%	12.08%	11.76%	11.44%
Benefit : -20 %	12.34%	11.64%	11.31%	11.01%

(Ban pong - Cha Am Route)

	Base Case 23.02%	Cost : + 10 %	Cost : + 15 %	Cost : + 20 %
Benefit : -10 %	21.73%	20.61%	20.10%	19.63%
Benefit : -15 %	21.05%	19.96%	19.46%	19.00%
Benefit : -20 %	20.35%	19.29%	18.80%	18.35%

TABLE 10.2-14 COST BENEFIT CASH FLOWS
(S-Route:Ban Pong - Cha Am Route)

(Million Baht)						
No.	YEAR	INVESTMENT COSTS	O & M COSTS	TOTAL COSTS	TOTAL BENEFITS	BALANCE (B-C)
1	1995	198.0		198.0	0.0	-198.0
2	1996	288.1		288.1	0.0	-288.1
3	1997	962.9		962.9	0.0	-962.9
4	1998	9,942.6		9,942.6	0.0	-9,942.6
5	1999	8,248.0		8,248.0	0.0	-8,248.0
6	2000	5,461.9		5,461.9	0.0	-5,461.9
1	7		119.3	119.3	2,775.5	2,656.2
2	8		119.3	119.3	3,984.7	3,865.4
3	9		119.3	119.3	5,194.0	5,074.7
4	10		119.3	119.3	6,403.2	6,283.9
5	11		119.3	119.3	7,612.5	7,493.2
6	12		119.3	119.3	8,821.7	8,702.4
7	13		119.3	119.3	10,031.0	9,911.7
8	14		119.3	119.3	11,240.2	11,120.9
9	15		119.3	119.3	12,449.5	12,330.2
10	16		119.3	119.3	13,658.7	13,539.4
11	17		119.3	119.3	14,856.2	14,736.9
12	18		119.3	119.3	16,053.6	15,934.3
13	19		119.3	119.3	17,251.1	17,131.8
14	20		119.3	119.3	18,448.6	18,329.3
15	21		119.3	119.3	19,646.1	19,526.8
16	22		119.3	119.3	20,843.5	20,724.2
17	23		119.3	119.3	22,041.0	21,921.7
18	24		119.3	119.3	23,238.5	23,119.2
19	25		119.3	119.3	24,435.9	24,316.6
20	26		119.3	119.3	25,633.4	25,514.1
21	27		119.3	119.3	25,633.4	25,514.1
22	28		119.3	119.3	25,633.4	25,514.1
23	29		119.3	119.3	25,633.4	25,514.1
24	30		119.3	119.3	25,633.4	25,514.1
25	31		119.3	119.3	25,633.4	25,514.1
26	32		119.3	119.3	25,633.4	25,514.1
27	33		119.3	119.3	25,633.4	25,514.1
28	34		119.3	119.3	25,633.4	25,514.1
29	35		119.3	119.3	25,633.4	25,514.1
30	36	-1,247.0	119.3	-1,127.7	25,633.4	26,761.1
TOTAL		23,854.5	3,579.0	27,433.5	540,952.6	513,519.1

Note : Opportunity Cost of Capital = 12 %

EIRR	23.02%
NPV (Mill'Bht)	30,286
B/C	2.98

The base case explained above is under the situation of constant toll rates up to the year 2020 (i.e. 1.0 Baht/km for light vehicles and 2.0 Baht/km for medium and heavy vehicles). The toll rates may be revised corresponding to the future increase of income level of users of toll motorways and with other cost push factors such as inflation effect. In the sensitivity test (2), periodically revised toll rates (increase rate of 3% p.a.) were assumed and the following 3 cases were tested for the comparison:

Case 1 : Toll rate = 0.75 Baht/km for light vehicles (1.50 Baht/km for medium and heavy vehicles which were fixed up to 2020.

Case 2 : The above toll rates were revised with an increase rate of 3.0% p.a. at every 5-year interval which were shown as below:

<u>Year</u>	<u>Light Vehicle</u>	<u>Medium & Heavy Vehicle</u>
(1995)	0.75 Baht/km	1.50 Baht/km
2000	0.87	1.74
2005	1.01	2.02
2010	1.17	2.34
2015	1.36	2.72
2020	1.58	3.16

Case 3 : The toll rates applied in the base case(1.0 Baht/km, 2.0 Baht/km) were raised at every 5-year interval with a 3.0 % of increase rate p.a. as shown below:

<u>Year</u>	<u>Light Vehicle</u>	<u>Medium & Heavy Vehicle</u>
(1995)	1.00 Baht/km	2.00 Baht/km
2000	1.16	2.32
2005	1.34	2.68
2010	1.55	3.10
2015	1.80	3.60
2020	2.09	4.18

The increase rate of toll rate (average annual rate of 3.0%) was assumed at the level lower than general consumer price index and set within the range of the future growth of per capita GDP.

The results of sensitivity tests by changing toll rates are given in Table 10.2-16.

Usually, an increase (decrease) in toll rates tends to increase (reduce) the users transport costs (VOC and time costs) and hence results in a lower (higher) economic return. In this evaluation, however, the revised toll rates were applied not only to the study routes but also to other motorway sections at the same time in both "With" and "Without" cases. The effects of changing toll rates on the study routes are, therefore, not substantial and still economically feasible in all cases.

It should be pointed out again that a lower toll rate will reduce the VOC and time costs even in the "Without" project case. Therefore, benefits under lower toll rates

which are defined as differences of VOC and time costs between "Without" and "With" project cases are not necessary higher than the benefits under higher toll rates. This is a reason why the EIRR and other evaluation indicators for L/D Route in case 1 are lower than the base case.

TABLE 10.2-16 SENSITIVITY TEST BY REVISED TOLL RATES

Case		(*) Toll Rate	Route Indicator	L/D Route	B/C Route
Base Case		1.0 Baht/km (2.0 Baht/km) Fixed	EIRR (%)	14.08 %	23.02 %
			NPV (Million Baht)	4,412	30,286
			B/C Ratio	1.31	2.98
Revised Toll Rate	Case 1	0.75 Baht/km (1.50 Baht/km) Fixed	EIRR (%)	12.25%	23.77%
			NPV (Million Baht)	509	32,623
			B/C Ratio	1.04	3.13
	Case 2	0.75 Baht/km (1.50 Baht/km) Raised	EIRR (%)	13.76	24.59
			NPV (Million Baht)	3,527	34,927
			B/C Ratio	1.25	3.28
	Case 3	1.0 Baht/km (2.0 Baht/km) Raised	EIRR (%)	12.68 %	22.40 %
			NPV (Million Baht)	1,381	29,022
			B/C Ratio	1.10	2.89

Note : (*) Upper : Light Vehicles

(Middle) : Medium & Heavy Vehicles

Bottom : Fixed = Fixed rates were applied during the project life.

Raised = Toll rates were raised at every 5-year interval (3.0 % p.a.).

4. Conclusions

The study routes, Lampang - Doi Saket and Ban Pong - Cha Am routes are economically feasible and the implementation of the both routes are justified from the view point of national economy.

Regarding the Lampang - Doi Saket route, even though it is economically feasible, an Internal Rate of Return (IRR) and other evaluation indicators are not so high because of comparatively higher construction costs for the tunnels and viaduct. It must be pointed out, however, that the regional development effects by the Lampang - Doi Saket route (as explained in the section of 10.2.4) are expected to generate the new traffic and those traffic will push up the value of EIRR to higher side.

10.3 FINANCIAL ANALYSIS

10.3.1 Objective

The financial analysis is usually conducted for the projects which accompany the revenues or income generated from the operation of the projects. The project roads are planned and proposed as toll motorways considering its functions/roles and characteristics different from the toll-free highways and due to the huge amounts of project costs. Unlike the economic analysis, the purpose of the financial analysis is to investigate whether and how the each project route can stand by its own toll revenues. Instead of the economic and social benefits explained in the previous section, not only the financial costs but the toll revenues will be a main component which will affect to the results.

10.3.2 Financial Costs

1. Financial Investment Costs

The financial investment costs including Detailed Engineering and Design for the project routes were presented in the previous section and summarized here as shown below:

At the same time, a cost escalation rate of 5.0% p.a. was assumed for the financial analysis so as to make the study results be on the realistic bases. The 5.0% of annual cost escalation rate was adopted referring to the statistical data and a recent study ("Preparation of an Investment Programme for The Department of Highways":ADB, April 1992).

All the costs are evaluated at market prices including taxes and duties.

TABLE 10.3-1 FINANCIAL COSTS

FINANCIAL COSTS (L/D ROUTE)

		(Million Baht)						
Constant Prices	TOTAL (1994 prices)	1995	1996	1997	1998	1999	2000	2001
F.C.	16,735.7	120.2	177.9	57.7	2,254.9	6,053.8	5,320.7	2,750.6
L.C.	10,827.9	180.3	266.8	1,221.1	1,518.3	3,317.4	2,823.0	1,501.0
TOTAL	27,563.6	300.5	444.7	1,278.7	3,773.3	9,371.2	8,143.6	4,251.6
Cost Escalation (5.0 % p.a.)								
F.C.	21,856.8	126.2	196.1	66.7	2,740.9	7,726.4	7,130.2	3,870.3
L.C.	13,871.6	189.3	294.1	1,413.5	1,845.6	4,233.9	3,783.1	2,112.1
TOTAL	35,728.4	315.5	490.2	1,480.3	4,586.4	11,960.3	10,913.2	5,982.4

FINANCIAL COSTS (B/C ROUTE)

		(Million Baht)					
	TOTAL (1994 prices)	1995	1996	1997	1998	1999	2000
F.C.	12,923.6	88.0	128.0	40.0	4,898.9	4,625.8	3,142.8
L.C.	14,828.3	132.0	192.0	932.9	6,106.8	4,538.6	2,925.9
TOTAL	27,751.9	220.0	320.1	972.9	11,005.7	9,164.4	6,068.8
Cost Escalation (5.0 % p.a.)							
F.C.	16,350.1	92.4	141.1	46.3	5,954.7	5,903.8	4,211.7
L.C.	18,566.7	138.6	211.7	1,079.9	7,422.9	5,792.5	3,921.0
TOTAL	34,916.8	231.0	352.9	1,126.2	13,377.5	11,696.4	8,132.7

Note : F.C. : Foreign Currency Portion
L.C. : Local Currency Portion

The percentage shares of Foreign Currency Portion (F.C) and Local Currency Portion (L.C) for the both study routes are as follows:

L/D Route:
(F.C) 61.0% (L.C) 39.0%
B/C Route:
(F.C) 47.0% (L.C) 53.0%

2. Financial Operation and Maintenance Costs

The annual financial operation and maintenance costs are estimated at 0.5% of total investment costs (excluding land acquisition cost) and summarized below:

L/D Route : 129.7 (Million Baht/Year, 1994 prices)
B/C Route : 132.5 (Million Baht/Year, 1994 prices)

Effects of cost escalation on these costs are also taken into account assuming the same increase rate of 5.0% per annum.

10.3.3 Toll Revenue

Toll revenues were calculated for the base case (1.00 Baht/km) and the toll case 3 (Raised case) and summarized in Table 10.3-2. As the future per capita GDP will grow with a rate more than 3.0% p.a. and due to the future traffic congestion on highways, toll revenues will increase even if the toll rates are raised.

TABLE 10.3-2 TOLL REVENUE BY ROUTE

Route	Toll Revenue (Million Baht/Year)			
L/D Route	Year	2000	2010	2020
	Fixed Rate	(1.0 Baht/km)	(1.0 Baht/km)	(1.0 Baht/km)
		76.8	635.5	2122.4
	(*) Revised Rate	(1.16 Baht/km)	(1.55 Baht/km)	(2.09 Baht/km)
		78.9	875.5	4275.1
B/C Route	Toll Revenue (Million Baht/Year)			
	Year	2000	2010	2020
	Fixed Rate	(1.0 Baht/km)	(1.0 Baht/km)	(1.0 Baht/km)
		1122.3	3438.7	6418.9
	(*) Revised Rate	(1.16 Baht/km)	(1.55 Baht/km)	(2.09 Baht/km)
		1230.3	4848.8	11843.8

Note : Periodical Toll Revision = Every 5-year interval (3.0% p.a.)

10.3.4 Financial Return

Given the above financial costs and toll revenues, Financial Internal Rates of Return (FIRRs) were calculated by each study route as shown in Table 10.3-3. In addition to individual route, combined effects of the two routes are also examined. This is a kind of pool system. The financial cash flows are presented in Table 10.3-4 to Table 10.3-6.

Table 10.3-3 shows that the financial return of the L/D route is low with a 2.57% of FIRR in the case of cost escalation. This means that the L/D route alone may be difficult to maintain the financial viability unless the Government funds or unburden loans are available.

TABLE 10.3-3 SUMMARY OF CALCULATION OF FIRR (%)

Route	Costs (Financial)	Toll Rate	
		Fixed (1.0 Baht/km)	Periodically Revised
L/D Route	1994 Constant Prices	1.45%	4.45%
	Cost up (5.0 % p.a.)	-0.96%	2.57%
B/C Route	1994 Constant Prices	9.54%	12.32%
	Cost up (5.0 % p.a.)	7.51%	10.37%
Combined Pool System (L/D + B/C)	1994 Constant Prices	6.30%	9.13%
	Cost up (5.0 % p.a.)	4.25%	7.25%

TABLE 10.3-4 FINANCIAL CASH FLOWS (L/D ROUTE)

Toll Rate : = Periodically Revised (1.0 Baht/km Base)

Cost Escalation : 5 % p.a.

(Lampang - Doi Saket Route)

(Million Baht)

No.	YEAR	INVESTMENT COSTS	O & M COSTS	TOTAL COSTS	TOLL REVENUES	R-C
1	1995	315.5		315.5	0.0	-315.5
2	1996	490.3		490.3	0.0	-490.3
3	1997	1,480.3		1,480.3	0.0	-1,480.3
4	1998	4,586.5		4,586.5	0.0	-4,586.5
5	1999	11,960.3		11,960.3	0.0	-11,960.3
6	2000	10,913.2		10,913.2	0.0	-10,913.2
7	2001	5,982.4		5,982.4	0.0	-5,982.4
8	2002		191.6	191.6	194.2	2.6
9	2003		201.2	201.2	251.8	50.6
10	2004		211.3	211.3	309.5	98.2
11	2005		221.8	221.8	424.0	202.2
12	2006		232.9	232.9	490.6	257.7
13	2007		244.6	244.6	557.2	312.6
14	2008		256.8	256.8	623.8	367.0
15	2009		269.6	269.6	690.3	420.7
16	2010		283.1	283.1	875.5	592.4
17	2011		297.3	297.3	1,105.0	807.7
18	2012		312.1	312.1	1,334.5	1,022.4
19	2013		327.7	327.7	1,564.1	1,236.4
20	2014		344.1	344.1	1,793.6	1,449.5
21	2015		361.3	361.3	2,349.4	1,988.1
22	2016		379.4	379.4	2,615.9	2,236.5
23	2017		398.4	398.4	2,882.4	2,484.0
24	2018		418.3	418.3	3,148.9	2,730.6
25	2019		439.2	439.2	3,415.4	2,976.2
26	2020		461.2	461.2	4,275.1	3,813.9
27	2021		484.2	484.2	4,275.1	3,790.9
28	2022		508.4	508.4	4,275.1	3,766.7
29	2023		533.9	533.9	4,275.1	3,741.2
30	2024		560.6	560.6	4,275.1	3,714.5
31	2025		588.6	588.6	4,275.1	3,686.5
32	2026		618.0	618.0	4,275.1	3,657.1
33	2027		648.9	648.9	4,275.1	3,626.2
34	2028		681.4	681.4	4,275.1	3,593.7
35	2029		715.4	715.4	4,275.1	3,559.7
36	2030		751.2	751.2	4,275.1	3,523.9
37	2031		788.8	788.8	4,275.1	3,486.3
TOTAL		35,728.5	12,731.4	48,459.9	75,927.3	27,467.4

FIRR	2.57%
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TABLE 10.3-5 FINANCIAL CASH FLOWS (B/C ROUTE)

Toll Rate := Periodically Revised (1.0 Baht/km Base)

Cost Escalation := 5 % p.a.

(Ban Pong - Cha Am Route)

(Million Baht)

No.	YEAR	INVESTMENT COSTS	O & M COSTS	TOTAL COSTS	TOLL REVENUES	BALANCE (R - C)
1	1995	231.0		231.0	0.0	-231.0
2	1996	352.9		352.9	0.0	-352.9
3	1997	1,126.3		1,126.3	0.0	-1,126.3
4	1998	13,377.5		13,377.5	0.0	-13,377.5
5	1999	11,696.4		11,696.4	0.0	-11,696.4
6	2000	8,132.8		8,132.8	0.0	-8,132.8
7	2001		186.4	186.4	1,470.1	1,283.7
8	2002		195.8	195.8	1,710.0	1,514.2
9	2003		205.6	205.6	1,949.8	1,744.2
10	2004		215.8	215.8	2,189.7	1,973.9
11	2005		226.6	226.6	2,806.5	2,579.9
12	2006		238.0	238.0	3,083.6	2,845.6
13	2007		249.8	249.8	3,360.6	3,110.8
14	2008		262.3	262.3	3,637.7	3,375.4
15	2009		275.5	275.5	3,941.8	3,666.3
16	2010		289.2	289.2	4,848.8	4,559.6
17	2011		303.7	303.7	5,242.3	4,938.6
18	2012		318.9	318.9	5,635.8	5,316.9
19	2013		334.8	334.8	6,029.3	5,694.5
20	2014		351.6	351.6	6,422.7	6,071.1
21	2015		369.1	369.1	7,915.6	7,546.5
22	2016		387.6	387.6	8,372.6	7,985.0
23	2017		407.0	407.0	8,829.5	8,422.5
24	2018		427.3	427.3	9,286.5	8,859.2
25	2019		448.7	448.7	9,743.5	9,294.8
26	2020		471.1	471.1	11,843.8	11,372.7
27	2021		494.7	494.7	11,843.8	11,349.1
28	2022		519.4	519.4	11,843.8	11,324.4
29	2023		545.4	545.4	11,843.8	11,298.4
30	2024		572.7	572.7	11,843.8	11,271.1
31	2025		601.3	601.3	11,843.8	11,242.5
32	2026		631.4	631.4	11,843.8	11,212.4
33	2027		662.9	662.9	11,843.8	11,180.9
34	2028		696.1	696.1	11,843.8	11,147.7
35	2029		730.9	730.9	11,843.8	11,112.9
36	2030		767.4	767.4	11,843.8	11,076.4
	TOTAL	34,916.8	12,386.9	47,303.7	226,758.2	179,454.5

FIRR	10.37%
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TABLE 10.3-6 FINANCIAL CASH FLOWS (COMBINED L/D & B/C ROUTES)

Toll Rate := Periodically Revised (1.0 Baht/km Base)
 Cost Escalation := 5 % p.a.

(Combined L/D and B/C Routes)		(Million Baht)				
No.	YEAR	INVESTMENT COSTS	O & M COSTS	TOTAL COSTS	TOLL REVENUES	BALANCE (R - C)
1	1995	546.5		546.5	0.0	-546.5
2	1996	843.2		843.2	0.0	-843.2
3	1997	2,606.5		2,606.5	0.0	-2,606.5
4	1998	17,964.0		17,964.0	0.0	-17,964.0
5	1999	23,656.6		23,656.6	0.0	-23,656.6
6	2000	19,046.0		19,046.0	0.0	-19,046.0
7	2001	5,982.4	186.4	6,168.9	1,470.1	-4,698.8
8	2002		387.4	387.4	1,904.2	1,516.8
9	2003		406.8	406.8	2,201.6	1,794.8
10	2004		427.1	427.1	2,499.2	2,072.1
11	2005		448.5	448.5	3,230.5	2,782.0
12	2006		470.9	470.9	3,574.2	3,103.3
13	2007		494.4	494.4	3,917.8	3,423.4
14	2008		519.1	519.1	4,261.5	3,742.4
15	2009		545.1	545.1	4,632.1	4,087.0
16	2010		572.3	572.3	5,724.3	5,152.0
17	2011		601.0	601.0	6,347.3	5,746.3
18	2012		631.0	631.0	6,970.3	6,339.3
19	2013		662.6	662.6	7,593.4	6,930.8
20	2014		695.7	695.7	8,216.3	7,520.6
21	2015		730.5	730.5	10,265.0	9,534.5
22	2016		767.0	767.0	10,988.5	10,221.5
23	2017		805.4	805.4	11,711.9	10,906.5
24	2018		845.6	845.6	12,435.4	11,589.8
25	2019		887.9	887.9	13,158.9	12,271.0
26	2020		932.3	932.3	16,118.9	15,186.6
27	2021		978.9	978.9	16,118.9	15,140.0
28	2022		1,027.9	1,027.9	16,118.9	15,091.0
29	2023		1,079.3	1,079.3	16,118.9	15,039.6
30	2024		1,133.2	1,133.2	16,118.9	14,985.7
31	2025		1,189.9	1,189.9	16,118.9	14,929.0
32	2026		1,249.4	1,249.4	16,118.9	14,869.5
33	2027		1,311.8	1,311.8	16,118.9	14,807.1
34	2028		1,377.4	1,377.4	16,118.9	14,741.5
35	2029		1,446.3	1,446.3	16,118.9	14,672.6
36	2030		1,518.6	1,518.6	16,118.9	14,600.3
37	2031		788.8	788.8	4,275.1	3,486.3
TOTAL		70,645.2	25,118.3	95,763.6	302,685.5	206,921.9

FIRR	7.25%
------	-------

In order to compare the above FIRR's with average interest rates of various loan combinations, Table 10.3-7 was prepared referring to the recent actual loan conditions:

The L/D route alone may be financially viable by the fund resources of Case 2 with an average interest rate of 1.83 that is lower than FIRR of 2.57 % as far as the assumed fund resources concerned. On the other hand, B/C route will be financially viable with a FIRR higher than the average rates of interest of the candidate loan resources. The case of combined pool system with L/D route and B/C route indicates a recommendable result to maintain a financial base for the both routes.

TABLE 10.3-7 COMBINATIONS OF FUND RESOURCES

Case No.	Fund Resources				L/D Route	B/C Route	(L/D) + (B/C)
	Local Portion		Foreign Portion		FIRR = 2.57%	FIRR = 10.37%	FIRR = 7.25%
	GOT (DOH)	Local Loans	Source A	Source B	Average Interest Rate	Average Interest Rate	Average Interest Rate
Case 1	●	-	●	-	4.91%	3.78%	4.35%
Case 2	●	-	-	●	1.83	1.41	1.62
Case 3	-	●	●	-	9.40	9.88	9.64
Case 4	-	●	-	●	6.32	7.51	6.91
			Composition Ratio	Local	0.39	0.53	0.46
				Foreign	0.61	0.47	0.54

Loan Conditions:

Source A : Interest Rate 7.30 % p.a., Repayment Period 20 years (including 5- year Grace Period. Commission of 0.75 % p.a. on outstanding amount.

Source B : Interest Rate 3.00 % p.a., Repayment Period 25 years (including 7- year Grace Period.

Local Loans : Interest Rate 11.5 % p.a., Repayment Period 10 years with no Grace Period.

● Combination of Funds

10.3.5 Repayment Program

The tables of repayment programs for the prepared options by each route and for the combined pool system are shown in Appendix 10.3-1 and the summarized results are presented in Table 10.3-8.

TABLE 10.3-8 THE FIRST YEAR GENERATING NET SURPLUS

Case No.	Fund Resources				First Year Generating Net Surplus		
	Local Portion		Foreign Portion		Upper: First Year of Net Surplus		
	GOT (DOH)	Local Loans	Source A	Source B	L/D Route	B/C Route	(L/D) + (B/C)
Case 1	●	-	●	-	2019	2001	2012
Case 2	●	-	-	●	2015	2001	2018
Case 3	-	●	●	-	2026	2001	2001
Case 4	-	●	-	●	2019	2009	2012
					Divergence	2020	2029
					2015	2008	2010
					-	2016	2023

The annual accumulated net surplus and the first year generating net positive surplus are illustrated in Fig.10.3-1 to Fig.10.3-3.

The B/C route and the pool system of two routes may be financially feasible and can cover the loan portion within the project life (30 years after opening: up to the year 2031) by their own revenues if the fund resources are available and the periodical revision of toll rates is realized. The L/D route alone will generate the accumulated net positive surplus 24 years after opening only if the most unburden fund combination in assumed options is applied (fund case 2). The combined pool system with L/D and B/C routes will generate the accumulated net positive surplus from the year 2029 that is 28 years after opening even if the most burden fund combination in all options is adopted.

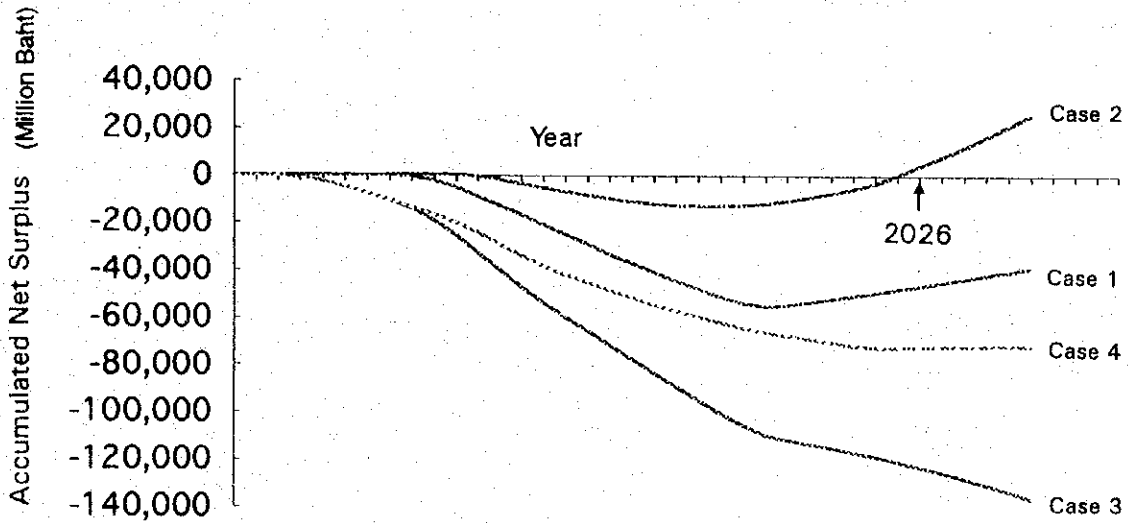


FIGURE 10.3-1 REPAYMENT PROGRAM AND ACCUMULATED NET SURPLUS (L/D ROUTE)

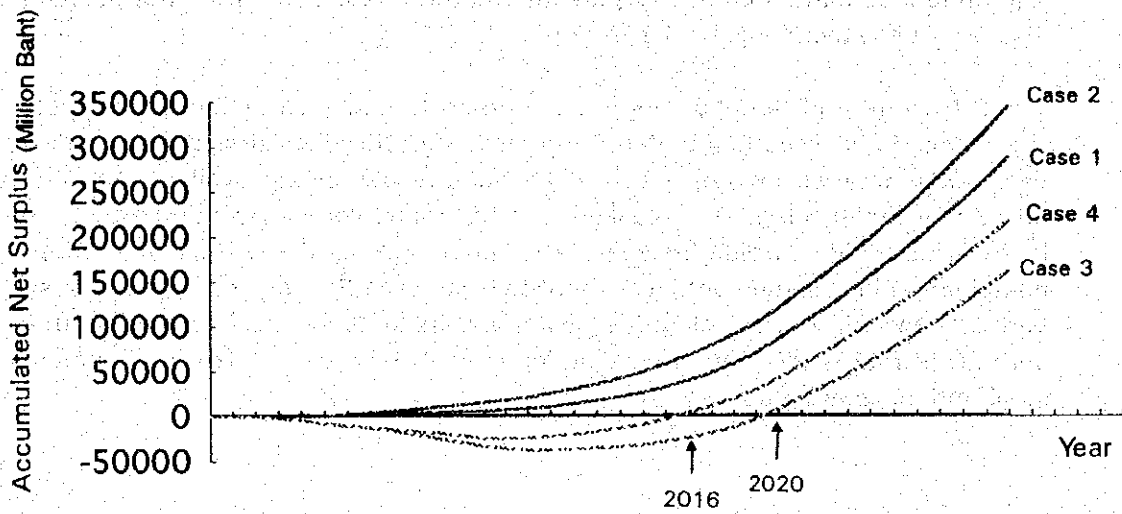


FIGURE 10.3-2 REPAYMENT PROGRAM AND ACCUMULATED NET SURPLUS (B/C ROUTE)

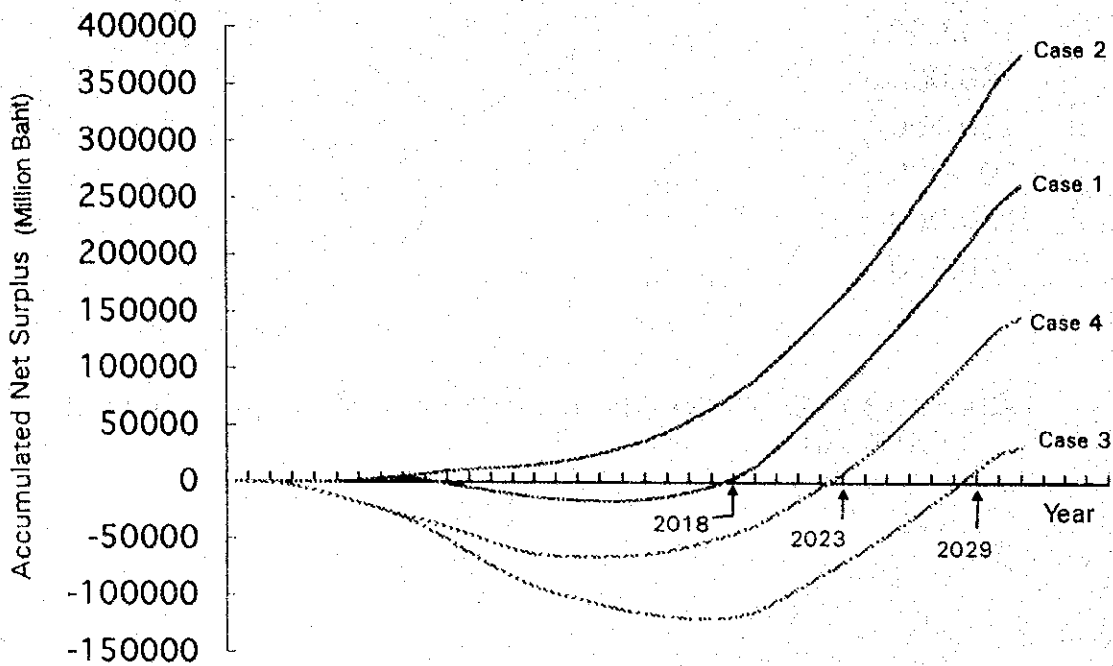


FIGURE 10.3-3 REPAYMENT PROGRAM AND ACCUMULATED NET SURPLUS (COMBINED L/D AND B/C ROUTES)

10.3.6 Financial Sensitivity Tests by Changing Toll Rates

(1) Toll Rates, Traffic Volume and Toll Revenues

Financial sensitivity tests were carried out by changing the toll rates from the original cases. Based on the additional two cases as adopted in Table 10.2-16 in the previous section (toll case 1 and 2), traffic volume (Vehicle-km) were calculated as shown in Table 10.3-9.

The Table 10.3-9 indicates the inelastic demand situation and toll revenues will increase (decrease) if toll rates are raised (go down) as given in Table 10.3-10.

TABLE 10.3-9 TOLL RATES AND TRAFFIC VOLUME (VEHICLE-KM)

Route	Fixed or Raised	Base Toll Rate	Case No.	Traffic Volume (1000 Vehicle-km/day) on the Route		
				2000	2010	2020
L/D Route	Fixed Rate	0.75 Baht/km	Case 1	235.5	1,516.5	4,747.4
		1.00 Baht/km	Base Case	189.4	1,431.4	4,731.1
	(*) Raised Rate	0.75 Baht/km	Case 2	(0.87 Baht/km)	(1.17 Baht/km)	(1.58 Baht/km)
		1.00 Baht/km	Case 3	(1.16 Baht/km)	(1.55 Baht/km)	(2.09 Baht/km)
				210.9	1,378.3	4,743.1
				168.6	1,282.6	4,610.4
B/C Route	Fixed Rate	0.75 Baht/km	Case 1	2,566.1	7,213.6	13,379.0
		1.00 Baht/km	Base Case	2,367.5	7,071.4	12,770.9
(*) Raised Rate	0.75 Baht/km	Case 2	(0.87 Baht/km)	(1.17 Baht/km)	(1.58 Baht/km)	
	1.00 Baht/km	Case 3	(1.16 Baht/km)	(1.55 Baht/km)	(2.09 Baht/km)	
			2,465.6	6,910.3	12,031.9	
			2,257.1	6,548.3	11,524.4	

Note : (*) : Periodical Toll Revision = Every 5-year interval (3.0% p.a.)

TABLE 10.3-10 TOLL RATES AND TOLL REVENUE

Route	Fixed or Raised	Base Toll Rate	Case No.	Toll Revenue (Million Baht/Year)		
				2000	2010	2020
L/D Route	Fixed Rate	0.75 Baht/km	Case 1	72.1	507.1	1,605.5
		1.00 Baht/km	Base Case	76.8	635.5	2,122.4
	(*) Raised Rate	0.75 Baht/km	Case 2	(0.87 Baht/km)	(1.17 Baht/km)	(1.58 Baht/km)
		1.00 Baht/km	Case 3	(1.16 Baht/km)	(1.55 Baht/km)	(2.09 Baht/km)
				74.7	715.3	3,337.0
				78.9	875.5	4,275.1
B/C Route	Fixed Rate	0.75 Baht/km	Case 1	925.6	2,657.2	5,093.4
		1.00 Baht/km	Base Case	1,122.3	3,438.7	6,418.9
(*) Raised Rate	0.75 Baht/km	Case 2	(0.87 Baht/km)	(1.17 Baht/km)	(1.58 Baht/km)	
	1.00 Baht/km	Case 3	(1.16 Baht/km)	(1.55 Baht/km)	(2.09 Baht/km)	
			1,024.3	3,910.8	9,406.7	
			1,230.3	4,848.8	11,843.8	

Note : (*) : Periodical Toll Revision = Every 5-year interval (3.0% p.a.)

(2) Financial Return by Toll Rate

Table 10.3-11 shows FIRR by each toll rate case. In the case of cost escalation with a rate of 5.0% p.a. and the raised toll rate from 0.75 Baht/km, L/D route alone will not be financially viable as FIRR was estimated at 1.20%. The combined pool system may be viable in the case of fund combination case 1 and case 2 (in raised 0.75 Baht/km toll case).

TABLE 10.3-11 SUMMARY OF FIRR BY TOLL RATE

Route	Costs (Financial)	Toll Rate			
		Fixed (0.75 Baht/km)	Fixed (1.00 Baht/km)	Raised (0.75 Baht Base)	Raised (1.00 Baht Base)
L/D Route	1994 Constant Prices	-0.13%	1.45%	3.20%	4.45%
	Cost up (5.0 % p.a.)	-2.98%	-0.96%	1.20%	2.57%
B/C Route	1994 Constant Prices	7.74%	9.54%	10.62%	12.32%
	Cost up (5.0 % p.a.)	5.75%	7.51%	8.74%	10.37%
Combined Pool System (L/D + B/C)	1994 Constant Prices	4.72%	6.30%	7.64%	9.13%
	Cost up (5.0 % p.a.)	2.61%	4.25%	5.76%	7.25%

10.3.7 Validity of the Level of Toll Rate

The traffic forecasting was based on the toll rates at 1.0 Baht/km for light vehicles and 2.0 Baht/km for medium and heavy vehicles which were judged as reasonable levels in the Master Plan Study. It is necessary, however, to re-examine again the validity of the toll levels above because the benefits are different between L/D route and B/C route.

The level of toll rate under the condition of (Benefits > Toll Charge) will be justified and will be too high if (Benefits < Toll Charge).

In order to investigate the situations of the both routes, comparisons of benefits and charged toll were carried out for a trip by a passenger car via motorways and via highways by each route assuming the conditions given in Table 10.3-12.

The average benefit per trip may exceed toll charges as shown in Table 10.3-13 and, therefore, the toll rate of 1.0 Baht/km can be judged as reasonable.

TABLE 10.3-12 ASSUMED CONDITIONS

Tested vehicle type : Passenger Car

Road Conditions :	Average Running Speed
	Highways (R11 & R4) = 60 Km/h Motorways =100 km/h
Unit VOC(Financial) :	Motorways (RC1: Good) = 5.4118 Baht/km Highways (RC2 : Good/Fair) = 6.4579 Baht/km
Average Time Value	= 35 Baht/hr. (= 0.5833 Baht/min.)

TABLE 10.3-13 COMPARISON OF TRAVEL COSTS

L/D Route (Origin : Lampang - Destination : Chiang Mai)
=via. [Lampang I/C - Lamphun I/C]

Travel Costs	via via. Highways(R11)	via. Motorways	
Distance (km)			
Highway sections	95.5 km	35.5 km	
Motorway sections	-	60.1 km	
Travel Time (minute)			
Highway sections	95.5 minu.	35.5 minu.	
Motorway sections	-	36.1 minu.	
Travel Costs (Baht/trip)			
VOC	616.7	554.5	
TIME COST	55.7	41.8	Toll Charge
Total	672.4	596.3	(1.0 Baht/km)
Benefit/trip (=672.4 - 596.3)		76.2	> 60.1 Baht

B/C Route (Origin : Ban Pong - Destination : Cha Am)
= via [Ban Pong I/C - Cha Am I/C]

Travel Costs	via via. Highways(R04)	via. Motorways	
Distance (km)			
Highway sections	139.9 km	1.5 km	
Motorway sections	-	125.2 km	
Travel Time (minute)			
Highway sections	139.9 minu.	1.5 minu.	
Motorway sections	-	75.1 minu.	
Travel Costs (Baht/trip)			
VOC	903.5	687.2	
TIME COST	81.6	44.7	Toll Charge
Total	985.1	731.9	(1.0 Baht/km)
Benefit/trip (=985.1 - 731.9)		253.1	> 125.2 Baht

10.3.8 Conclusions

The Ban Pong - Cha Am route can be financially viable with its guaranteed traffic demands. In the case of Lampang - Doi Saket route, the Government funds will be essential for the implementation. Although the estimated FIRR of the L/D route seems not so high, the regional development effects along the route will generate new traffic and will push up the value of FIRR.

In order to maintain the financial soundness, it will be necessary to revise the toll rates periodically by referring to the actual economic growth and other cost push factors. The pool system may be recommendable in order to expand the motorway network to cover the low traffic demands and hence low profitable areas/regions where the BOT by private sectors have no incentives to investments in the toll motorways.

10.4 ENVIRONMENTAL IMPACT

Existing conditions and predicted impacts on major environmental parameters are studied in depth, assessment of these impacts are made, and feasible mitigation measures and recommendations, as well as monitoring programs, are proposed.

It is studied from the entire analysis that the magnitude of adverse impact on the environment is mixed. Some environmental parameters will be severely affected, while others have minor impacts. For example, some areas on motorway routes need to be expropriated, causing severe human relocation problems, while impact on air quality has been found minimal. All the environmental parameters will be adversely affected in some degree by the project implementation. However, these negative impacts can be mitigated by the provision of appropriate counter measures. Unfortunately, it is an unavoidable fact that a total area of 75 hectares, 48 hectares of teak plantation and 26 hectares of natural forest, need to be cut down, although the density of the forests is not very high and total economic loss of these tree cutting is evaluated relatively low, about Baht 34.1 million. This is only environmental parameter which mitigation measures can not relieve the vanishing resources. Alteration of wildlife habitats caused by tree cutting is also anticipated; however, thanks to surrounding huge protected areas, it is considered that wildlife could easily find shelters or alternative habitats in the surrounding areas. Adverse impacts on any other environmental parameters can most likely be mitigated by the proposed counter measures and monitoring programs, and no serious environmental problems are expected in the future.

Consequently, overall environmental impact caused by the motorway project is evaluated to be minimal only if all the proposed mitigation measures and monitoring programs are properly implemented.

Apart from negative impact on the environment, on balance, it is expected that the motorway will actually enhance economic development through the provision of smooth and time-saving transport systems. Economic evaluation of the project is studied in Section 10.2 in this report, concluding that the motorway project is economically viable. The economic viability and overall environmental impact discussed above will promise vital outcome from the project implementation.

As a final remark, it is proposed that mitigation measures during construction be clearly stated in construction contract and qualified environmental inspectors be hired to oversee implementation of the mitigation measures during construction. Reports on the mitigation measures should be prepared by inspectors and submitted to relevant agencies regularly.

CHAPTER 11

PROJECT IMPLEMENTATION AND RECOMMENDATIONS

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PROJECT IMPLEMENTATION AND RECOMMENDATIONS

This chapter presents the implementation strategy and plan of two routes focusing on financial and structural arrangements. Outcomes of this chapter are the ideal project implementation schedule based on economic evaluation and the financial requirement including annual investments estimated according to the proposed ideal schedule. Finally several recommendations to implement inter-city toll motorway construction are presented.

11.1 IMPLEMENTATION SCHEDULE

11.1.1 Outline of Projects

1. Corridor

Lampang - Doi Saket Route starts at intersection with Rt. 1 at southwest of Muang Lampang, runs through Amphoe Hang Chat in Changwat Lampang, Amphoe Mae Tha and Muang Lamphun in Changwat Lamphun, Amphoe Saraphi and San Kamphaeng in Changwat Chiang Mai, and ends at Amphoe Doi Saket in Chanwat Chiang Mai. Design speeds of 4-lane 2-way motorway with the length of 98.72 km are 120 km/h for flat and/or rolling terrain in rural area and 100 km/h for mountainous terrain and urban/suburban areas.

Ban Pong - Cha Am Route starts at the cross point of TM-32 (an other proposed motorway) in Ban Pong city, runs through Amphoe Photharam, Muang Ratchaburi and Amphoe Pak Tho in Changwat Ratchaburi, Amphoe Khao Yoi, Muang Phetchaburi, Amphoe Ban Lat and Amphoe Tha Yang in Changwat Phetchaburi, and ends at Amphoe Cha Am in Changwat Phetchaburi. Design speeds of 6-lane 2-way motorway with the length of 133.74 km are 120 km/h for flat terrain in rural areas and 100 km/h for urban/suburban areas.

2. Structures and Facilities

Main structures and facilities designed along two routes are listed in Table 11.1-1.

TABLE 11.1-1 FACILITY AND STRUCTURE OUTLINE OF ROUTES

Item and Description		Lampang - Doi Saket 4-lane L = 98.72km	Ban Pong - Cha Am 6-lane L = 133.74km
Interchange	Interchange	5	7
	Junction	0	1
Other Facility	Rest Area	6	7
	Bus Stop	8	10
Bridge	$l < 30m$	11/196m	55/652m
	$30m \leq l < 100m$	18/406m	56/682m
	$100m \leq l < 500m$	1/100m	-
Overbridge	Flat area	26	42
	Mountainous area	7	-
Viaduct	Urban/Suburban	21/6,915m	21/14,585m
	Mountainous area	14/6,450m	-
Crossing Structure	Box culvert	291	400
	Pipe culvert	26,599	51,423
Tunnel	Tunnel	2 (3,800m,750m)	0

Other structures and facilities characterized by this projects are; boundary fence and toll booth necessary for toll motorway, and buffer zone, noise barrier and various slope protection structures designed as environmental mitigation measures.

3. Overall Project Cost

Table 11.1-2 summarizes the project costs necessary to the implementation of two projects.

TABLE 11.1-2 PROJECT COST

Portion	Unit: Million Baht	
	Lampang - Doi Saket Route	Ban Pong - Cha Am Route
Local Currency	10,828 (39.3%)	14,828 (53.4%)
Foreign Currency	16,736 (60.7%)	12,924 (46.6%)
Total	27,564	27,752

11.1.2 Implementation Schedule

Project implementation is divided into two main activities, pre-construction activity and construction activity. Pre-construction activity includes detail design, bidding and land acquisition. Figure 11.1-1 presents the schedule of each activity by route and year.

Route	Items	Duration (Months)	1995	1996	1997	1998	1999	2000	2001	2002
N-Route (Lampang- Doi Saket)	Detailed Design	18	[Bar]							
	Land Acquisition	24			[Bar]					
	Bidding	7			[Bar]					
	Construction	48				[Bar]				
	Opening									[Bar]
	Annual budget (%)	(%)	1	2	5	14	34	29	15	
	Accumulative Budget (%)	(%)	1	3	8	22	56	85	100	
S-Route (Ban Pong- Cha Am)	Detailed Design	18	[Bar]							
	Land Acquisition	24			[Bar]					
	Bidding	7			[Bar]					
	Construction	36				[Bar]				
	Opening								[Bar]	
	Annual budget (%)	(%)	1	1	3	40	33	22		
	Accumulative Budget (%)	(%)	1	2	5	45	78	100		

FIGURE 11.1-1 GENERAL IMPLEMENTATION SCHEDULE

4 years construction period of Lampang - Doi Saket Route is depending on No. 1 tunnel (3,800 m) and high pier viaduct construction periods, while 3 years construction periods of other sections along both routes including interchanges are estimated based on the experiences of national highway construction.

Proposed implementation schedule shows that Lampang - Doi Saket Route will open in 2002 and Ban Pong - Cha Am Route will open in 2001.

11.2 INVESTMENT PROGRAM

Table 11.2-1 shows the investment program by currency and year. The peak demand for implementation of the projects are 9.4 Billion Baht in 1999 for Lampang - Doi Saket Route and 11.0 Billion Baht in 1998 for Ban Pong - Cha Am Route.

TABLE 11.2-1 INVESTMENT PROGRAM

Lampang - Doi Saket Route											
Item	Year	Total	1995	1996	1997	1998	1999	2000	2001	Total	(baht)
Direct Cost		14,428,111,560	0	0	0	2,019,828,668	5,394,179,951	4,675,281,840	2,338,841,101	14,428,111,560	
Physical Contingency		1,442,811,156	0	0	0	201,982,867	539,417,995	467,526,184	233,894,110	1,442,811,156	
Sub-Total		15,870,922,716	0	0	0	2,221,811,535	5,933,597,946	5,142,788,024	2,572,725,211	15,870,922,716	
F/C		578,504,624	120,207,068	177,857,531	57,650,462	33,119,745	62,556,606	62,556,606	62,556,606	578,504,624	
Administration		288,252,312	0	0	0	57,650,462	57,650,462	57,650,462	57,650,462	288,252,312	
Sub-Total		864,756,936	120,207,068	177,857,531	57,650,462	33,119,745	120,207,068	120,207,068	120,207,068	864,756,936	
Total		16,735,679,652	120,207,068	177,857,531	57,650,462	2,254,931,280	6,053,805,014	5,220,645,555	2,790,582,742	16,735,679,652	
Direct Cost		7,409,194,814	0	0	0	893,100,649	2,895,548,970	2,411,157,486	1,206,377,709	7,409,194,814	
Physical Contingency		740,918,482	0	0	0	89,310,085	289,554,897	241,115,749	120,997,771	740,918,482	
Sub-Total		8,150,103,296	0	0	0	982,410,734	3,185,103,867	2,652,273,235	1,330,315,480	8,150,103,296	
L/C		864,756,937	180,310,602	266,786,296	86,475,694	49,679,618	93,834,909	93,834,909	93,834,909	864,756,937	
Administration		192,168,208	0	0	0	0	39,433,642	78,867,283	78,867,283	192,168,208	
Land Acquisition		1,620,819,400	0	0	1,134,573,590	486,245,820	0	0	0	1,620,819,400	
Sub-Total		2,677,744,545	180,310,602	266,786,296	1,221,049,274	535,925,438	132,268,551	170,702,192	170,702,192	2,677,744,545	
Tax											
Total		10,827,847,841	180,310,602	266,786,296	1,221,049,274	1,519,336,152	3,317,372,418	2,822,975,427	1,501,017,672	10,827,847,841	
GRAND TOTAL		27,563,527,493	300,517,670	444,643,827	1,278,699,736	3,779,267,432	9,371,177,432	8,143,620,942	4,251,600,414	27,563,527,493	100.00%
			1.09%	1.61%	4.64%	13.69%	34.00%	29.54%	15.42%		

Ban Pong - Cha Am Route											
Item	Year	Total	1995	1996	1997	1998	1999	2000	2001	Total	(baht)
Direct Cost		11,112,255,920	0	0	0	4,355,358,043	4,052,533,239	2,704,383,637		11,112,255,920	
Physical Contingency		1,111,225,592	0	0	0	435,535,904	405,253,324	270,436,364		1,111,225,592	
Sub-Total		12,223,481,512	0	0	0	4,790,894,948	4,457,786,563	2,974,800,001		12,223,481,512	
F/C		400,074,710	88,016,436	128,023,907	40,007,471	48,008,965	48,008,965	48,008,965		400,074,710	
Administration		300,056,032	0	0	0	60,011,206	120,022,413	120,022,413		300,056,032	
Sub-Total		700,130,742	88,016,436	128,023,907	40,007,471	108,020,172	168,031,378	168,031,378		700,130,742	
Total		12,923,612,254	88,016,436	128,023,907	40,007,471	4,908,915,119	4,625,817,941	3,142,831,379		12,923,612,254	
Direct Cost		11,619,261,651	0	0	0	5,106,738,342	3,987,787,058	2,521,736,251		11,619,261,651	
Physical Contingency		1,161,926,165	0	0	0	510,973,834	398,778,706	262,173,625		1,161,926,165	
Sub-Total		12,781,187,816	0	0	0	5,620,712,176	4,386,565,764	2,773,909,876		12,781,187,816	
L/C		600,112,065	132,024,654	192,035,861	60,011,207	72,013,448	72,013,448	72,013,448		600,112,065	
Administration		200,037,355	0	0	0	40,007,471	80,014,942	80,014,942		200,037,355	
Land Acquisition		1,246,959,000	0	0	872,871,300	374,087,700	0	0		1,246,959,000	
Sub-Total		2,047,108,420	132,024,654	192,035,861	932,882,507	486,106,619	152,028,390	152,028,390		2,047,108,420	
Tax											
Total		14,828,296,235	132,024,654	192,035,861	932,882,507	5,108,820,795	4,538,594,154	2,925,938,265		14,828,296,235	
GRAND TOTAL		27,751,908,489	220,041,091	320,059,768	972,889,978	11,005,735,914	9,164,412,095	6,068,769,644		27,751,908,489	100.00%
			0.79%	1.15%	3.51%	39.66%	33.02%	21.87%			

11.3 RECOMMENDATIONS

- Long-term Vision of Motorways in Thailand:

The nation wide toll motorway network, with a total length of 4,300 km, was established in the "Master Plan Study" to support the rapid growth in socioeconomic development and to create a multi-polar decentralized nation by bringing the benefits of motorways to everywhere in Thailand. As the construction of the motorways requires a huge amount of investment, a long-term stage-construction implementation strategy should be recognized emphasizing the need of motorways in a parallel momentum to the development of national and provincial highways. The concept of this long-term vision strategy should contain specific programs integrating management, construction, maintenance and operation systems for this vital motorway network.

The two motorway routes under this feasibility study provide basic policies and specific targets in many of the aspects contributing in the development and implementation of the motorway network.

- Design Standards for Smooth and Safe Mobility:

Providing higher service to motorists on motorways require the selection of higher design speeds for the different motorway sections. The adopted design speed of 120 km/hr for sections in rural flat areas gives the basic criteria which controls all other geometric design elements.

To handle the future traffic demand, a carriage way of 2 or 3 lanes for each direction is provided. The lane width of 3.75 m is required to provide smooth and safe mobility on the motorways. The carriageway contains shoulders on both sides and a depressed median with 13.50 m width for efficient drainage. Barriers for traffic and glare-prevention are provided for control access and safety in addition to buffer zones for the protection of roadside environment. The same concept for the design standards is also applied on all the facilities of the motorways.

- Harmony and Conservation of Environment:

Appropriate mitigating measures should be applied to alleviate negative environmental impacts of the project implementation based on the preliminary design on the 10 studied items of; air quality, noise, vibration, water resources and aquatic ecology, soil conditions, terrestrial ecology, transportation network, land-use pattern socioeconomic conditions and cultural/aesthetic/archaeological values. Environmental conservation targets are established quantitatively from scientific aspects; however, some environmental parameters are difficult to be evaluated quantitatively, in which a qualitative way of evaluation targets is considered.

- Effective Operation and Management System:

The Study proposes that the construction and operation of some sections of the motorway network should be executed by the DOH until a new state enterprise is

created. In the mean time, it is urgently required to establish a motorway organizing committee to develop policy and strategy and to study the required legal, economic and engineering issues. The inter-city motorway enterprise should be under the supervision of the Ministry of Transport and Communications with the specific objectives of financing, constructing and operating the 4,300 km motorway network.

Funds for implementation can be acquired through public investments, government subsidy and private financing. As the network is connecting all major regions and cities, the applicable toll system should be a closed-system with a toll based on the traveled distance. For the operation and maintenance of the whole network, an approximate number of 11 division offices and 90 district offices are required. In addition, a traffic control system and traffic safety facilities are required to ensure the safe operation of the motorway network.

▪ Unburdened Financial Investment Program:

The study routes, Lampang - Doi Saket and Ban Pong - Cha Am routes are economically feasible and the implementation of the both routes are justified from the view point of national economy.

Regarding the Lampang - Doi Saket route, even though it is economically feasible, an Internal Rate of Return (IRR) and other evaluation indicators are not so high because of comparatively higher construction costs for the tunnels and viaduct. It must be pointed out, however, that the regional development effects by the Lampang - Doi Saket route are neglected from the benefit calculation. The roles of motorways are not only to handle many long distance trips but also to contribute greatly to the growth of the region so as to realize an inter-regional balanced growth.

The Ban Pong - Cha Am route can be financially viable with its guaranteed traffic demands. In the case of Lampang - Doi Saket route, the Government funds will be essential for the implementation.

In order to maintain the financial soundness, it will be necessary to revise the toll rates periodically by referring to the actual economic growth and other cost push factors. The pool system may be recommendable in order to expand the motorway network to cover the low traffic demands and hence low profitable areas/regions where the BOT by private sectors have no incentives to investments in the toll motorways.

JICA