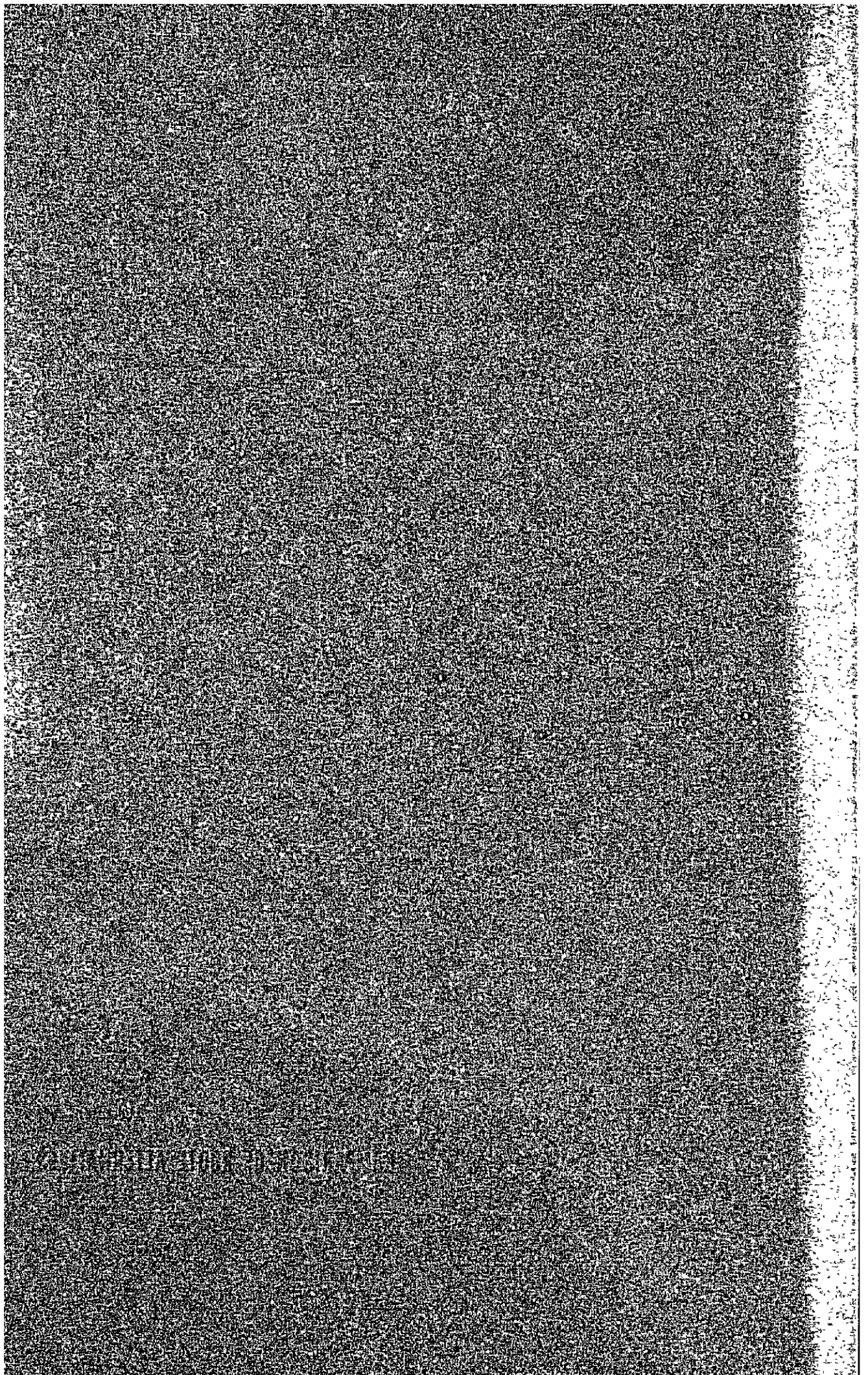


Chapter VIII

COMPARISON OF ROUTE ALTERNATIVES



Chapter VIII

COMPARISON OF ROUTE ALTERNATIVES**8-1 COMPARISON AMONG ROUTE ALTERNATIVE-I, -II and -III****8-1-1 General**

In this section, three route alternatives formulated in Chapter V, are compared. As again summarized in Table 8-1, they have different characteristics each other in principle of route formulation, construction cost and impacts accrued from the investment. Their comparison was made based on an economic analysis.

The following criteria and conditions were applied in the analysis.

- a) The analysis is made under the usual practice of "with and without project" concept.
- b) The project costs are composed of construction cost and maintenance cost.
- c) The project benefits are composed of road users' benefit and agricultural benefit.
- d) The period of quantification of costs and benefits is taken for 15 years after opening of road, and consequently the total period of analysis was taken for 19 years.

- e) Valuation of costs and benefits is made at the economic component of prices based on the constant prices of 1978.
- f) Evaluation is made under the criterion of Benefit Cost Ratio, Net Present Value and Internal Rate of Return.
- g) Present values of costs and benefits are calculated with a discount rate of 12 percent per annum to the present values in 1979, the year when the detailed design of the Project will start.
- h) The project is judged economically justifiable, if it has a positive net present value.

8-1-2 Project Costs

1) Construction Cost

Economic construction cost, including physical contingency, engineering and administration and land acquisition, was estimated by deducting transfer items especially taxes from the financial construction cost as shown in Table 7-9.

Construction was assumed to start in mid-1980 for a period of two and a half years, after the detailed design in 1979 and land acquisition in the first half of 1980. Yearly disbursement was assumed that half of engineering and administration cost would be expensed for detailed design in 1979, land acquisition cost in 1980, and 20 percent of the remaining cost in 1980 and 40 percent in each year of 1981 and 1982.

Yearly disbursement of each route alternative is shown below:

Yearly Disbursement of Economic Construction Cost

<u>Year</u>	<u>(million Baht)</u>		
	<u>Route Alternative</u>		
	<u>I</u>	<u>II</u>	<u>III</u>
1979	8.2	7.5	8.9
1980	50.0	54.8	57.1
1981	97.6	88.7	106.3
1982	97.6	88.7	106.3
Total	253.4	239.7	278.6

No salvage value of the Project was considered in this study.

2) Road Maintenance Cost

a) Annual Routine Maintenance Cost

Little information was available of a correlation between maintenance cost and level of traffic volume by surface type. It was assumed that the same formulae as given in the Louis Berger's previous study^{/1} were applicable to the proposed road.

For soil aggregate surface road (F5 Standard)

$$8,000 + 27 \times \text{ADT (Baht/km)}$$

For SBST road (F4 Standard)

$$14,000 + 22 \times \text{ADT (Baht/km)}$$

For asphalt concrete road (after overlay)

$$14,000 + 16 \times \text{ADT (Baht/km)}$$

Annual routine maintenance costs of each route alternative are shown below:

	<u>Annual Routine Maintenance Cost</u>		
	(million Baht)		
	<u>Route Alternative</u>		
	<u>I</u>	<u>II</u>	<u>III</u>
1983	2.9	1.8	2.3
1989	3.2	2.1	2.5
1990	2.9	2.0	2.2
1997	3.0	2.1	2.3

b) Overlay Cost for SBST Road

Overlay will be necessary in the 7th years after opening to traffic. Cost of a 5 centimeters asphaltic concrete overlay was counted for each route alternative as shown below:

^{/1} "Feasibility Study for Provincial Road Improvements", April, 1978.

<u>Overlay Cost</u>	
	(million Baht)
Alternative-I	39.5
Alternative-II	9.6
Alternative-III	35.2

8-1-3 Project Benefits

The benefits attributable to the Project comprise road users' benefit and agricultural development benefit.

1) Road Users' Benefit

Road users' benefits in 1983, 1989 and 1997 for each route alternative were computed in 6-7 of Chapter VI. Benefits of the intermediate years were calculated by a simple linear interpolation.

2) Agricultural Development Benefit

The benefit derived from the agricultural development attributable to the proposed road is the increment of net added value of production, that is the difference in net added value between with and without the Project, as discussed in 5-4 of Chapter V. Benefits are given in 1983, 1989 and 1997 for each route alternative. Those of the intermediate years were calculated by a simple linear interpolation.

8-1-4 Economic Comparison

Based on the cost and benefit stream developed from 1979 through the year of 1997, Benefit Cost Ratio, Net Present Value and Internal Rate of Return were calculated for Route Alternative-I, -II and -III as shown in Table 8-2, 8-3 and 8-4, respectively. They are summarized below.

Economic Comparison

Description	Route Alternative		
	I	II	III
Discounted Costs (mil. Baht)			
Construction Cost	200.1	190.3	220.3
Road Maintenance Cost	27.4	12.7	22.7
Total	227.5	203.0	243.0
Discounted Benefits (mil. Baht)			
Agricultural Benefit	156.5	202.4	109.8
Road Users' Benefit	236.8	126.4	231.7
Total	393.3	328.8	341.5
Net Present Value (mil. Baht)	165.8	125.8	98.5
Benefit Cost Ratio	1.73	1.62	1.41
Internal Rate of Return (%)	20.6	18.5	17.1

Among three route alternatives, Route Alternative-I has the highest economic indicators, and Route Alternative-III the lowest, though all of three are economically justifiable. In other words, the north-south route is more advantageous, from the economic viewpoint, than the east-west route.

Furthermore, from the viewpoint of road network improvement, Route Alternative-I or -II in north-south direction is also preferable. Even if Route Alternative-III is constructed, the all-weather road network in the Project Area is incomplete, while both Route Alternative-I and -II can be the arteries of all-weather road, connecting the Project Area with Route 21 at Phetchabun and Wichian Buri and with Route 205 at Tha Maduk.

It was concluded, therefore, that the optimum route should be selected in north-south direction.

8-2 THE OPTIMUM ROUTE

In the economic comparison made in the preceding section, Route Alternative-I has higher economic indicators than Route Alternative-II. However, it is probable that a route in combination of sections of Route Alternative-I and -II is more preferable than Route Alternative-I. In order to select the optimum route in combination of two alternatives, sectional comparison was made for the following three parts.

Southern Part :	Alt.-I :	Link No. 6, 11 and 16 (63.0 km)
	Alt.-II:	Link No. 7, 12 and 17 (55.5 km)
Central Part :	Alt.-I :	Link No. 18 and 22 (19.3 km)
	Alt.-II:	Link No. 19 (14.2 km)
Northern Part :	Alt.-I :	Link No. 27, 30 and 33(21.0 km)
	Alt.-II:	Link No. 28 (15.5 km)

The remaining links, Link No. 3, 23, 25, 35, 37 and 40, are common between two alternatives.

For the sake of the sectional comparison of the above three parts, the following 8 cases were prepared in combination of sections of two alternatives:

Cases to be Compared

Case	Southern Part	Central Part	Northern Part	Remarks
1	Alt.-I	Alt.-I	Alt.-I	Route Alternative-I
2	Alt.-I	Alt.-I	Alt.-II	
3	Alt.-I	Alt.-II	Alt.-I	
4	Alt.-I	Alt.-II	Alt.-II	
5	Alt.-II	Alt.-I	Alt.-I	Route Alternative-II
6	Alt.-II	Alt.-I	Alt.-II	
7	Alt.-II	Alt.-II	Alt.-I	
8	Alt.-II	Alt.-II	Alt.-II	

For six cases of the above, excluding case 1 (Route Alternative-I) and case 8 (Route Alternative-II), traffic volumes were forecasted, and costs and benefits were estimated in the same line with the study of Route Alternative-I, -II. and -III. The economic indicators calculated for each case are compared in Table 8-5.

The economic comparison in southern part was made assuming both central and northern parts are common, that is the comparisons between case 1 and 5, between case 2 and 6, between case 3 and 7 and between case 4 and 8. All comparisons suggest that Route Alternative-I is preferable than Route Alternative-II in southern part. Similarly, Route Alternative-I was selected in central part and Route Alternative-II in northern part, although there is no substantial difference between two alternatives in both parts. However, for the central part, it is also possible to select Route Alternative-II if the great importance is placed on the better alignment.

As a conclusion, the optimum route will be a combination of major part of Route Alternative-I and minor part of Route Alternative-II, which consists of Road Link No. 3, 6, 11, 16, 18, 22, 23, 25, 28, 35, 27 and 40. (refer to Figure 8-1)

The main features of the optimum route (from Tha Maduk to Phetchabun) are summarized below:

a) Road Length

Improvement of the existing road	136.4 km
New road construction	15.5 km
Total	151.9 km

b) Pavement

SBST road	91.8 km
Soil aggregate surfaced road	60.1 km
Total	151.9 km

TABLE 8-1

Table 8-1 MAIN FEATURES OF ROUTE ALTERNATIVES

DESCRIPTION	ROUTE ALTERNATIVE		
	I	II	III
Principle :	Improvement of local communications on the east side of the Pasak	Maximum development of agricultural field on the east side of the Pasak	Simple follow of present pattern of freight and passenger movement
Length (km):			
Improvement of existing road	147.4 (94%)	57.1 (41%)	79.5 (72%)
New construction	10.0 (6%)	82.2 (59%)	30.8 (28%)
Total	157.4	139.3	110.3
Pavement (km):			
SBST	96.3 (61%)	23.5 (17%)	85.8 (78%)
Soil aggregate surface	61.1 (39%)	115.8 (83%)	24.5 (22%)
Total	157.4	139.3	110.3
Construction cost (million Baht):			
Total	279.4	264.7	307.7
Per km	1.8	1.9	2.8
Agricultural Field in Influence Area in 1978 (1,000 Rai)			
Existing	516	390	354
Newly cultivable	130	321	87
Total	646	711	441

Table 8-2 COSTS AND BENEFITS STATEMENT
(ROUTE ALTERNATIVE-I)

(million Baht)								
Year	COSTS			BENEFITS			DISCOUNTED AT 12%	
	Const. Cost	RMC	Total	Agricultural Benefit	Road Users' Benefit	Total	Costs	Benefits
1979	8.2		8.2				8.2	
1980	50.0		50.0				44.6	
1981	97.6		97.6				77.8	
1982	97.6		97.6				69.5	
1983		2.9	2.9	15.7	48.8	64.5	1.8	36.6
1984		3.0	3.0	21.0	50.1	71.1	1.7	36.0
1985		3.0	3.0	26.3	51.4	77.7	1.5	35.2
1986		3.1	3.1	31.6	52.6	84.2	1.4	34.0
1987		3.1	3.1	37.0	53.9	90.9	1.3	32.8
1988		3.2	3.2	42.4	55.2	97.6	1.2	31.4
1989		42.7	42.7	51.8	56.5	108.3	13.8	31.1
1990		2.9	2.9	51.2	57.4	108.6	0.8	27.9
1991		2.9	2.9	50.5	58.3	108.8	0.7	24.9
1992		2.9	2.9	49.9	59.2	109.1	0.7	22.3
1993		3.0	3.0	49.3	60.2	109.5	0.6	20.0
1994		3.0	3.0	48.6	61.1	109.7	0.6	17.9
1995		3.0	3.0	48.1	62.0	110.1	0.5	16.0
1896		3.0	3.0	47.4	62.9	110.3	0.4	14.4
1997		3.0	3.0	46.6	63.8	110.4	0.4	12.8
Total	253.4	84.7	338.1	617.4	853.4	1,470.8	227.5	393.3

Discounted Economic Costs (mil. B) :

Construction Cost	200.1
RMC	27.4
Total	227.5

Discounted Economic Benefits (mil. B) :

Agricultural Benefit	156.5
Road Users' Benefit	236.8
Total	393.3

Net Present Value (mil. B): 165.8

Benefit Cost Ratio: 1.73

IRR (%): 20.6

Table 8-3 COSTS AND BENEFITS STATEMENT
(ROUTE ALTERNATIVE-II)

(million Baht)								
Year	COSTS			BENEFITS			DISCOUNTED AT 12%	
	Const. Cost	RMC	Total	Agricultural Benefit	Road Users' Benefit	Total	Costs	Benefits
1979	7.5		7.5				7.5	
1980	54.8		54.8				48.9	
1981	88.7		88.7				70.7	
1982	88.7		88.7				63.2	
1883		1.8	1.8	7.3	26.2	33.5	1.1	19.0
1984		1.9	1.9	17.1	26.9	44.0	1.1	22.3
1985		1.9	1.9	26.9	27.5	54.4	1.0	24.6
1986		2.0	2.0	36.7	28.2	64.9	0.9	26.2
1987		2.0	2.0	46.5	28.8	75.3	0.8	27.2
1988		2.1	2.1	56.3	29.5	85.8	0.7	27.6
1989		11.7	11.7	75.8	30.1	105.9	3.8	30.4
1990		2.0	2.0	75.4	30.6	106.0	0.6	27.2
1991		2.0	2.0	75.0	31.0	106.0	0.5	24.3
1992		2.0	2.0	74.6	31.5	106.1	0.5	21.7
1993		2.1	2.1	74.2	31.9	106.1	0.4	19.4
1994		2.1	2.1	73.8	32.4	106.2	0.4	17.3
1995		2.1	2.1	73.4	32.8	106.2	0.3	15.5
1996		2.1	2.1	73.0	33.3	106.3	0.3	13.8
1997		2.1	2.1	72.1	33.7	105.8	0.3	12.3
Total	239.7	39.9	279.6	858.1	454.4	1,312.5	203.0	328.8

Discounted Economic Costs (mil. B) :

Construction Cost	190.3
RMC	12.7
Total	203.0

Discounted Economic Benefits (mil. B) :

Agricultural Benefit	202.4
Road Users' Benefit	126.4
Total	328.8

Net Present Value (mil. B): 125.8

Benefit Cost Ratio: 1.62

IRR (%): 18.5

Table 8-4 COSTS AND BENEFITS STATEMENT
(ROUTE ALTERNATIVE-III)

(million Baht)								
Year	COSTS			BENEFITS			DISCOUNTED AT 12%	
	Const. Cost	RMC	Total	Agricultural Benefit	Road Users' Benefit	Total	Costs	Benefits
1979	8.9		8.9				8.9	
1980	57.1		57.1				51.0	
1981	106.3		106.3				84.7	
1982	106.3		106.3				75.7	
1983		2.3	2.3	11.3	49.5	60.8	1.5	34.5
1984		2.3	2.3	15.0	50.3	65.3	1.3	33.1
1985		2.4	2.4	18.6	51.1	69.7	1.2	31.5
1986		2.4	2.4	22.3	51.9	74.2	1.1	30.0
1987		2.4	2.4	26.0	52.8	78.8	1.0	28.4
1988		2.5	2.5	29.6	53.6	83.2	0.9	26.8
1989		37.7	37.7	36.0	54.4	90.4	12.1	26.0
1990		2.2	2.2	35.6	55.2	90.8	0.6	23.3
1991		2.2	2.2	35.2	56.0	91.2	0.6	20.9
1992		2.2	2.2	34.7	56.8	91.5	0.5	18.7
1993		2.3	2.3	34.3	57.6	91.9	0.5	16.8
1994		2.3	2.3	33.9	58.4	92.3	0.4	15.1
1995		2.3	2.3	33.5	59.2	92.7	0.4	13.5
1996		2.3	2.3	33.0	60.0	93.0	0.3	12.1
1997		2.3	2.3	32.6	60.8	93.4	0.3	10.8
Total	278.6	70.1	348.7	431.6	827.6	1,259.2	243.0	341.5

Discounted Economic Costs (mil. B):

Construction Cost	220.3
RMC	22.7
Total	243.0

Discounted Economic Benefits (mil. B) :

Agricultural Benefit	109.8
Road Users' Benefit	231.7
Total	341.5

Net Present Value (mil. B):	98.5
Benefit Cost Ratio:	1.41
IRR (%):	17.1

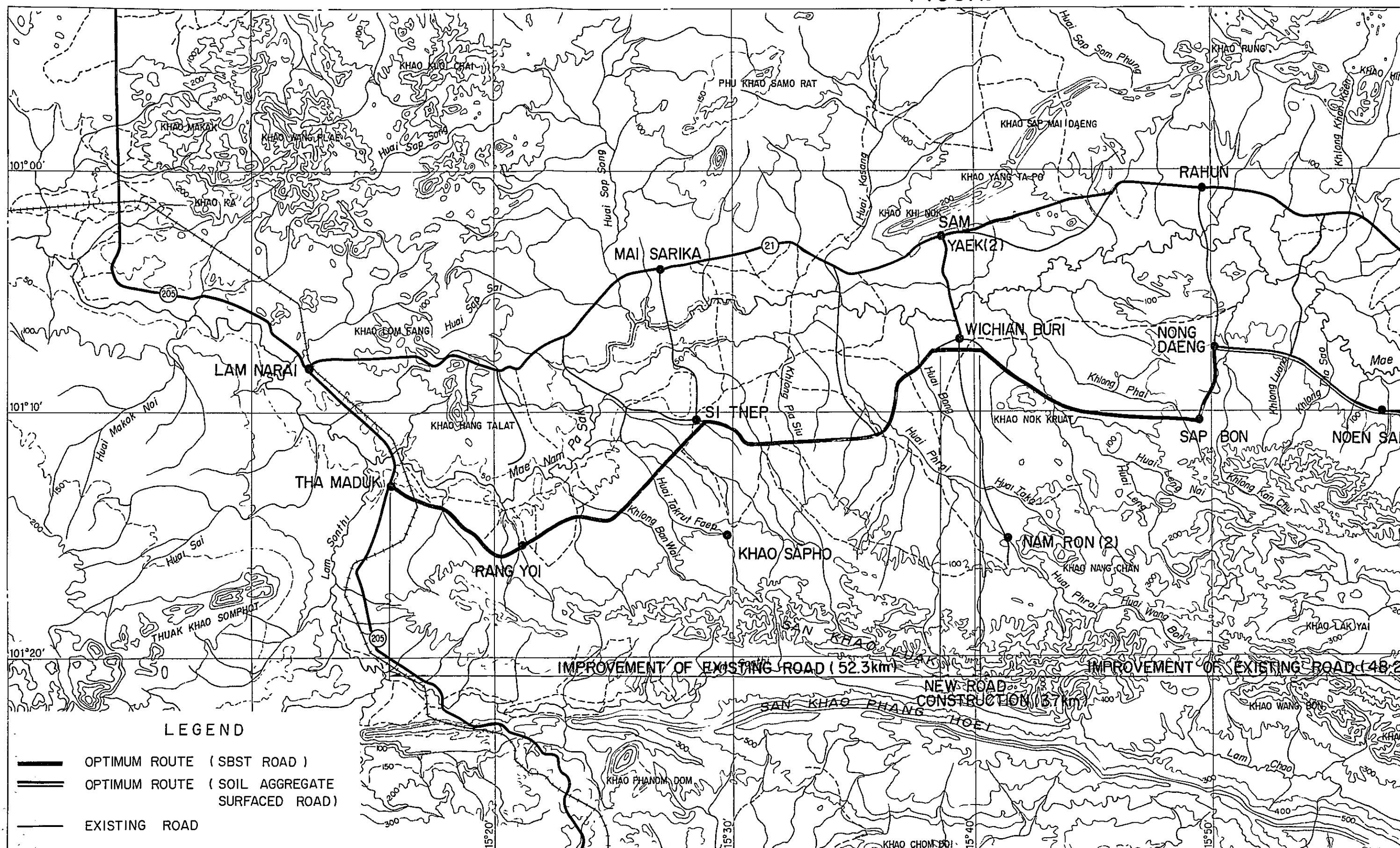
TABLE 8-5

Table 8-5 SECTIONAL COMPARISON

SECTION	DESCRIPTION	CASE							
		1 (Alt.-I)	2	3	4	5	6	7	8 (Alt.-II)
SOUTHERN part	Southern part	I	I	I	I	II	II	II	II
	Central part	I	I	II	II	I	I	II	II
	Northern part	I	II	I	II	I	II	I	II
ECONOMIC COSTS									
	Construction cost	200.1	194.0	207.5	198.4	195.1	185.9	200.1	190.3
	Road maintenance cost	27.4	25.9	26.3	24.3	16.3	14.1	14.7	12.7
	Total	227.5	219.9	233.8	222.7	211.4	200.0	214.8	203.0
ECONOMIC BENEFITS									
	Agricultural benefit	156.5	154.0	149.9	147.2	211.9	209.4	205.1	202.4
	Road users' benefit	236.8	231.9	224.2	220.9	134.4	132.7	127.9	126.4
	Total	393.3	385.9	374.1	368.1	346.3	342.1	333.0	328.8
	NET PRESENT VALUE	165.8	166.0	140.3	145.4	134.9	142.1	118.2	125.8
	BENEFIT COST RATIO	1.73	1.75	1.60	1.65	1.64	1.71	1.55	1.62
	INTERNAL RATE OF RETURN (%)	20.6	20.8	19.2	19.7	18.8	19.4	17.9	18.5

Remarks: Costs and benefits in million Bahts, discounted at 12%.

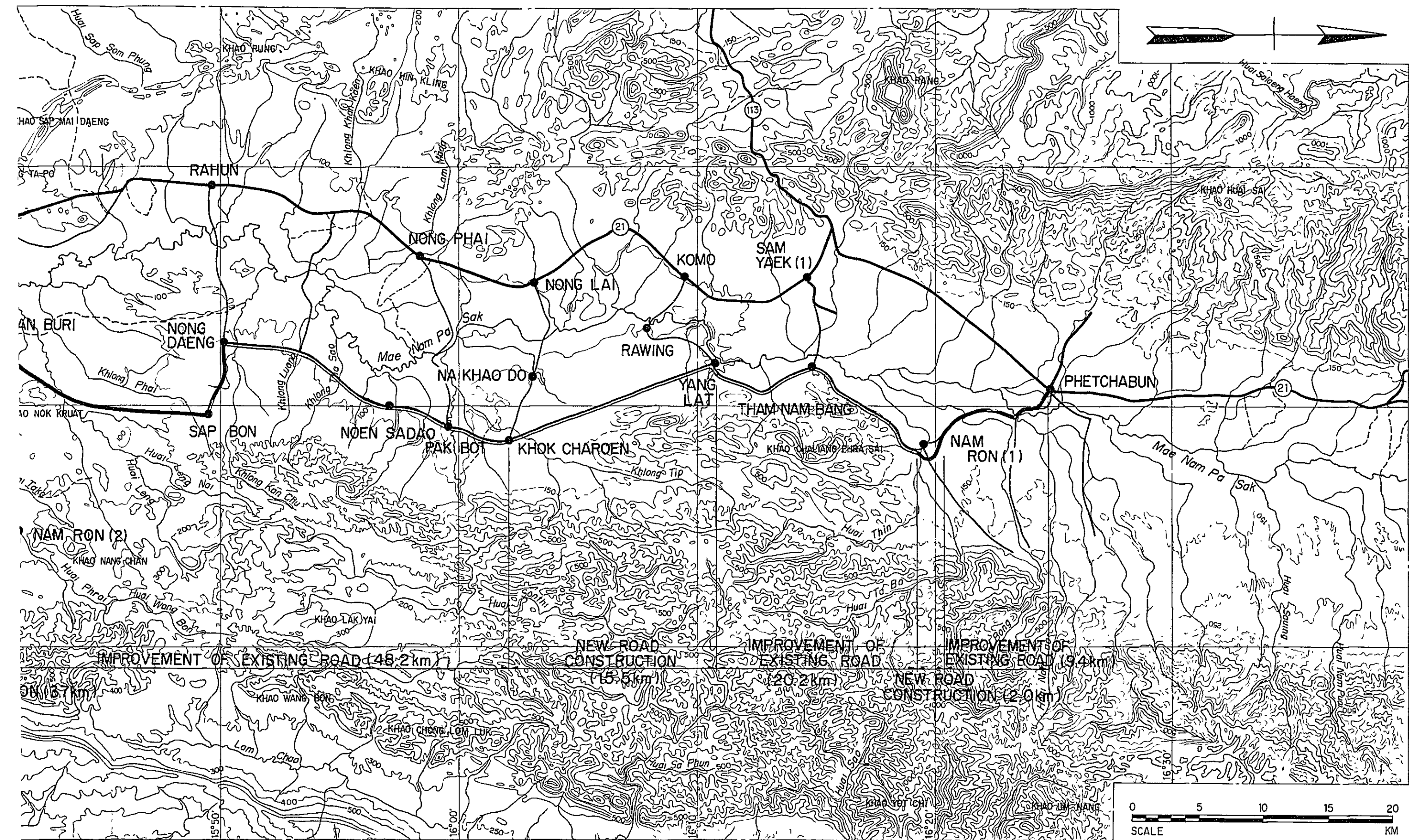
FIGURE 8-1 OPTIMUM ROUTE



8-1 OPTIMUM ROUTE

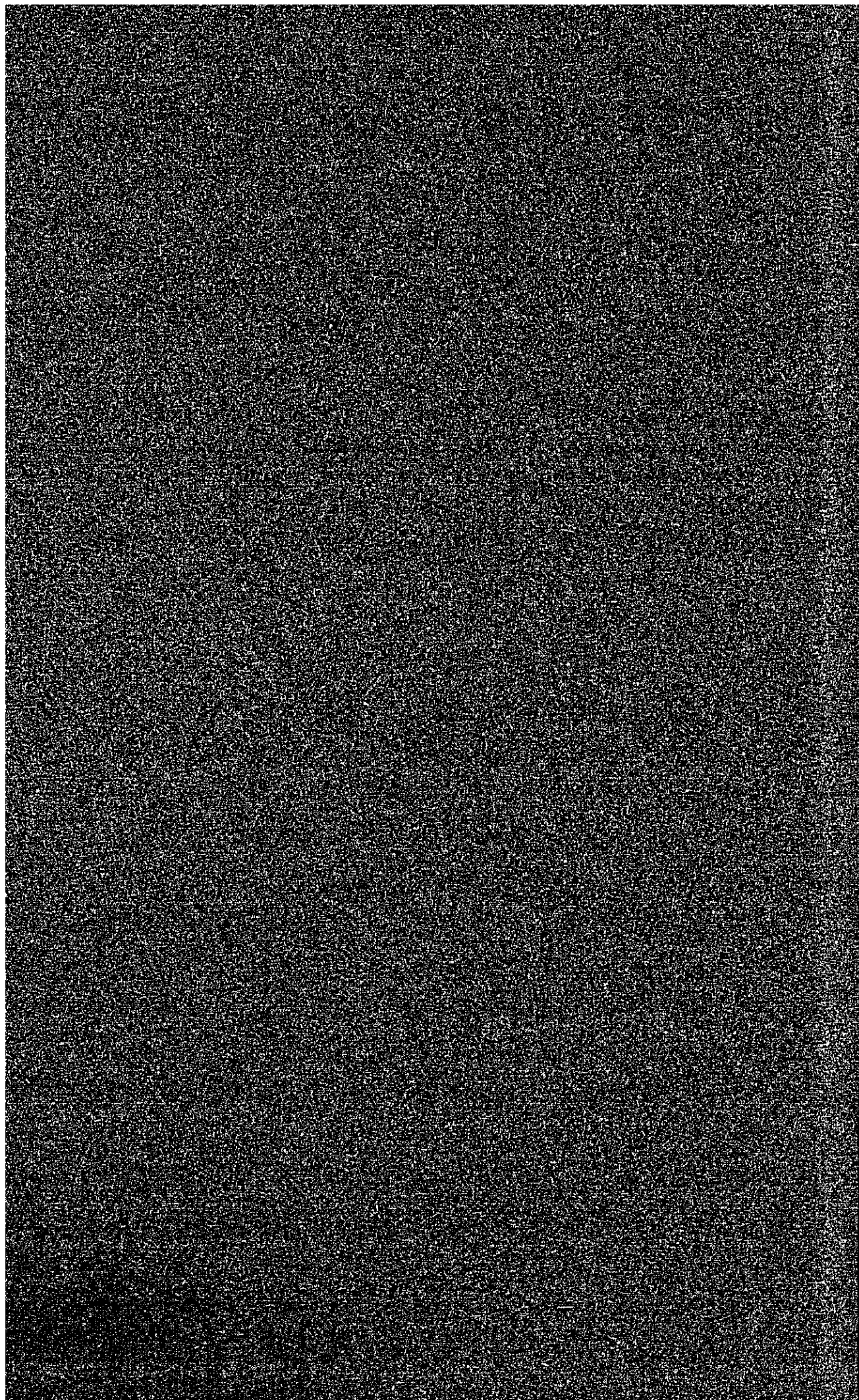
OPTIMUM ROUTE

FIGURE 8-1



PART III

DETAILED STUDY ON OPTIMUM ROUTE

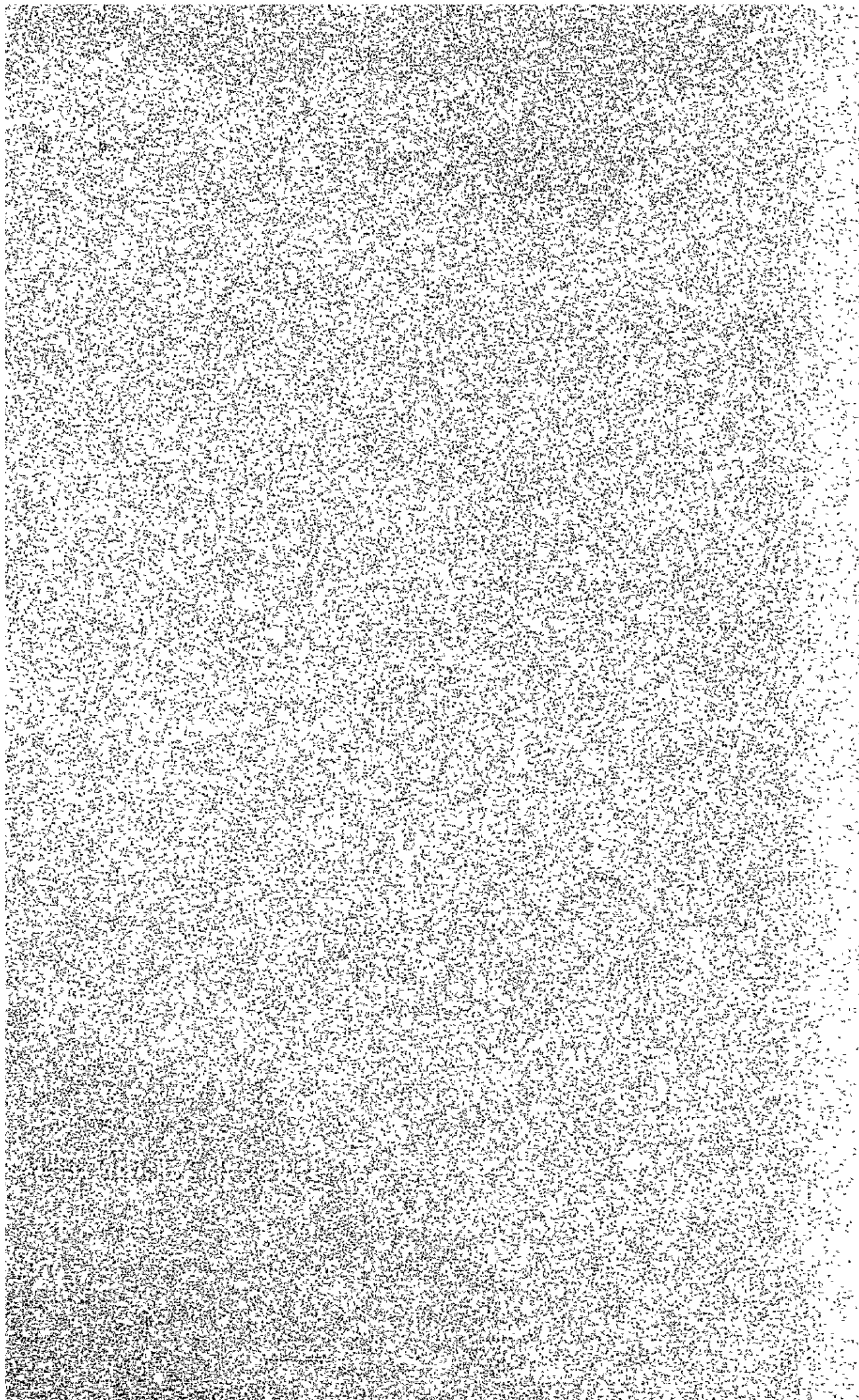


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Chapter IX

REFINEMENT OF TRAFFIC STUDY



Chapter IX

REFINEMENT OF TRAFFIC STUDY

Traffic on the optimum route was forecasted using the same model discussed in Chapter VI. The same conditions and inputs were maintained as those in Chapter VI, except for route search. While the route searching in Chapter VI was made under the uniform condition of road class of F5 Standard for every road link, the route search for optimum route was based on the respective freight charges and passenger fares on each link corresponded to the road classes of F5 or F4 Standard. F4 Standard was assigned to the road links having ADT more than 300 and F5 Standard to those having ADT below 300 in 7th year after opening, according to the traffic volume forecasted in Chapter VI.

The projected ADT is shown in Table 9-1 and ADT in 1989 is illustrated in Figure 9-1. Based on the results of this traffic forecast, the standard to be applied was determined finally for each road link as follows:

- F4 Standard: Road Link 3, 6, 11, 16, 18 and 40
- F5 Standard: Road Link 22, 23, 25, 28, 35 and 37

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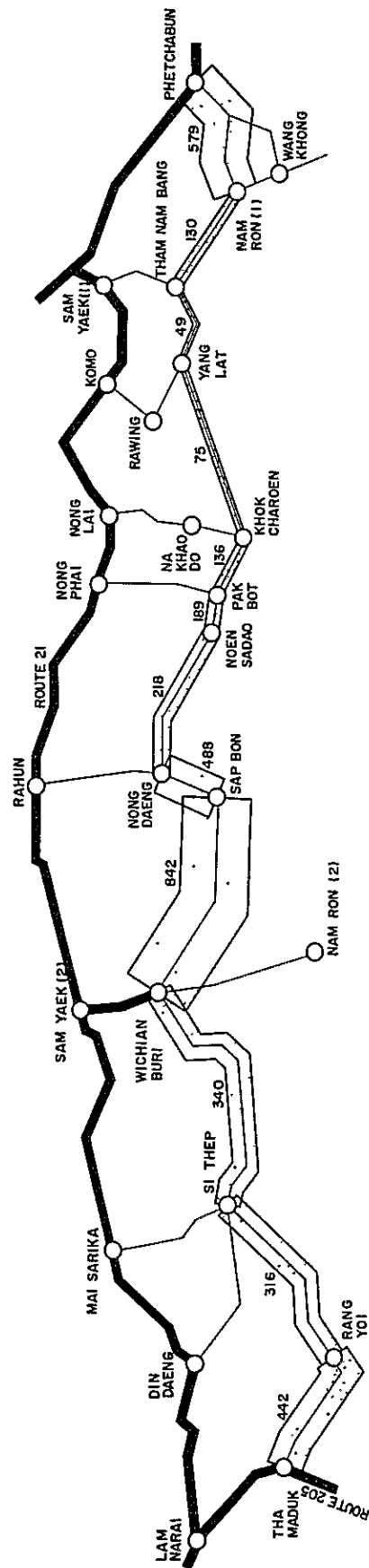
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Table 9-1 TRAFFIC PROJECTION (OPTIMUM ROUTE)

ROAD LINK NO.		TYPE OF TRAFFIC	(vehicles per day)																				
			1 9 8 3							1 9 8 9							1 9 9 7						
			P/C	L/B	H/B	L/T	M/T	H/T	TOTAL	P/C	L/B	H/B	L/T	M/T	H/T	TOTAL	P/C	L/B	H/B	L/T	M/T	H/T	TOTAL
3	Normal	29	171	53	28	9	5	295	32	189	59	41	14	8	343	36	214	66	59	20	11	406	
	Developed+Induced	3	15	5	0	0	0	24	10	56	18	10	3	2	99	10	56	18	10	3	2	99	
	Total	32	187	58	28	9	5	319	42	245	77	51	17	10	442	46	270	84	69	23	13	505	
6	Normal	24	140	43	8	3	2	220	27	155	48	14	5	2	251	30	176	55	20	7	4	292	
	Developed+Induced	2	14	5	0	0	0	21	7	40	13	3	1	1	65	7	40	13	3	1	1	65	
	Total	26	154	48	8	3	2	241	34	195	61	17	6	3	316	37	216	68	23	8	5	357	
11	Normal	24	140	44	32	11	6	257	29	171	54	45	15	8	322	32	191	60	61	20	11	375	
	Developed+Induced	0	1	0	0	0	0	1	1	4	1	7	3	2	18	1	4	1	7	3	2	18	
	Total	24	141	44	32	11	6	258	30	175	55	52	18	10	340	33	195	61	68	23	13	393	
16	Normal	58	339	106	68	23	13	607	70	401	126	82	28	17	724	78	454	141	100	34	20	827	
	Developed+Induced	6	35	11	0	0	0	52	11	68	21	12	4	2	118	12	69	22	12	4	2	121	
	Total	64	374	117	68	23	13	659	81	469	147	94	32	19	842	90	523	163	112	38	22	948	
18	Normal	35	205	65	28	10	6	349	44	254	80	37	12	8	435	49	286	89	47	16	10	497	
	Developed+Induced	2	11	3	0	0	0	16	5	28	9	7	3	1	53	5	29	9	7	3	1	54	
	Total	37	216	68	28	10	6	365	49	282	89	44	15	9	488	54	315	98	54	19	11	551	
22	Normal	16	92	29	14	5	3	159	18	102	32	18	6	3	179	20	117	36	22	7	4	206	
	Developed+Induced	2	12	4	0	0	0	18	4	23	7	3	1	1	39	4	24	8	3	1	1	41	
	Total	18	104	33	14	5	3	177	22	125	39	21	7	4	218	24	141	44	25	8	5	247	
23	Normal	15	91	29	8	3	2	148	18	102	32	9	3	2	166	20	117	36	9	4	2	188	
	Developed+Induced	2	10	3	0	0	0	15	2	15	5	1	0	0	23	3	16	5	1	0	0	25	
	Total	17	101	32	8	3	2	163	20	117	37	10	3	2	189	23	133	41	10	4	2	213	
25	Normal	9	55	17	17	6	3	107	10	62	19	18	6	4	119	12	70	22	20	6	4	134	
	Developed+Induced	1	6	2	0	0	0	9	2	9	3	2	1	0	17	2	10	3	2	1	0	18	
	Total	10	61	19	17	6	3	116	12	71	22	20	7	4	136	14	80	25	22	7	4	152	
28	Normal	4	31	9	0	0	0	44	5	34	11	0	0	0	50	6	38	12	0	0	0	56	
	Developed+Induced	1	2	1	11	4	2	21	1	4	1	13	4	2	25	1	4	1	13	5	3	27	
	Total	5	33	10	11	4	2	65	6	38	12	13	4	2	75	7	42	13	13	5	3	83	
35	Normal	4	24	8	4	1	1	42	5	27	9	4	1	1	47	6	30	10	4	1	1	52	
	Developed+Induced	0	1	0	0	0	0	1	0	2	0	0	0	0	2	0	2	0	0	0	0	2	
	Total	4	25	8	4	1	1	43	5	29	9	4	1	1	49	6	32	10	4	1	1	54	
37	Normal	10	58	18	16	6	3	111	11	65	20	17	6	3	122	13	73	23	18	6	3	136	
	Developed+Induced	1	4	1	0	0	0	6	1	5	2	0	0	0	8	1	5	2	0	0	0	8	
	Total	11	62	19	16	6	3	117	12	70	22	17	6	3	130	14	78	25	18	6	3	144	
40	Normal	45	263	82	72	25	14	501	50	293	91	75	25	15	549	56	330	104	77	26	16	609	
	Developed+Induced	3	16	5	0	0	0	24	3	18	6	2	1	0	30	4	21	6	2	1	0	34	
	Total	48	279	87	72	25	14	525	53	311	97	77	26	15	579	60	351	110	79	27	16	643	

Remarks: P/C: Passenger Car, L/B: Light Bus, H/B: Heavy Bus, L/T: Light Truck, M/T: Medium Truck, H/T: Heavy Truck

Figure 9-1 ADT IN 1989 (Optimum Route)



1871

My dear Mr. [Name]
I have just received your letter of the 10th inst. and am
glad to hear that you are well. I am also well and hope
these few lines will find you the same. I have not much news
to write at present. The weather here is very pleasant and
the crops are doing well. I have not much time to write
at present but will write again soon. I am, dear Sir,
Very respectfully,
[Signature]