หอสมุดกลาง สถาบันวิทยบริการ จุฬาลงกรณ์มหาวิทยาลัย

CHAPTER V

INPUT DATA REQUIRED DESCRIPTION AND PREPARATION

5.1 Links on the Study Road

Based on the reason that the link is the basic element of organization in the model and link has a constant traffic, terrain and surface condition, therefore the Tha Maduk-SriThep provincial roal studied was divided into two links in accordance with the above reasons. The first link started at Tha Maduk (chainage 0 + 000 km) and ran to chainage 12 + 500 at Rang Yoi, the second link started from Rang Yoi and ended at SriThep (chainage 30 + 500), as shown in Figure 5.1.

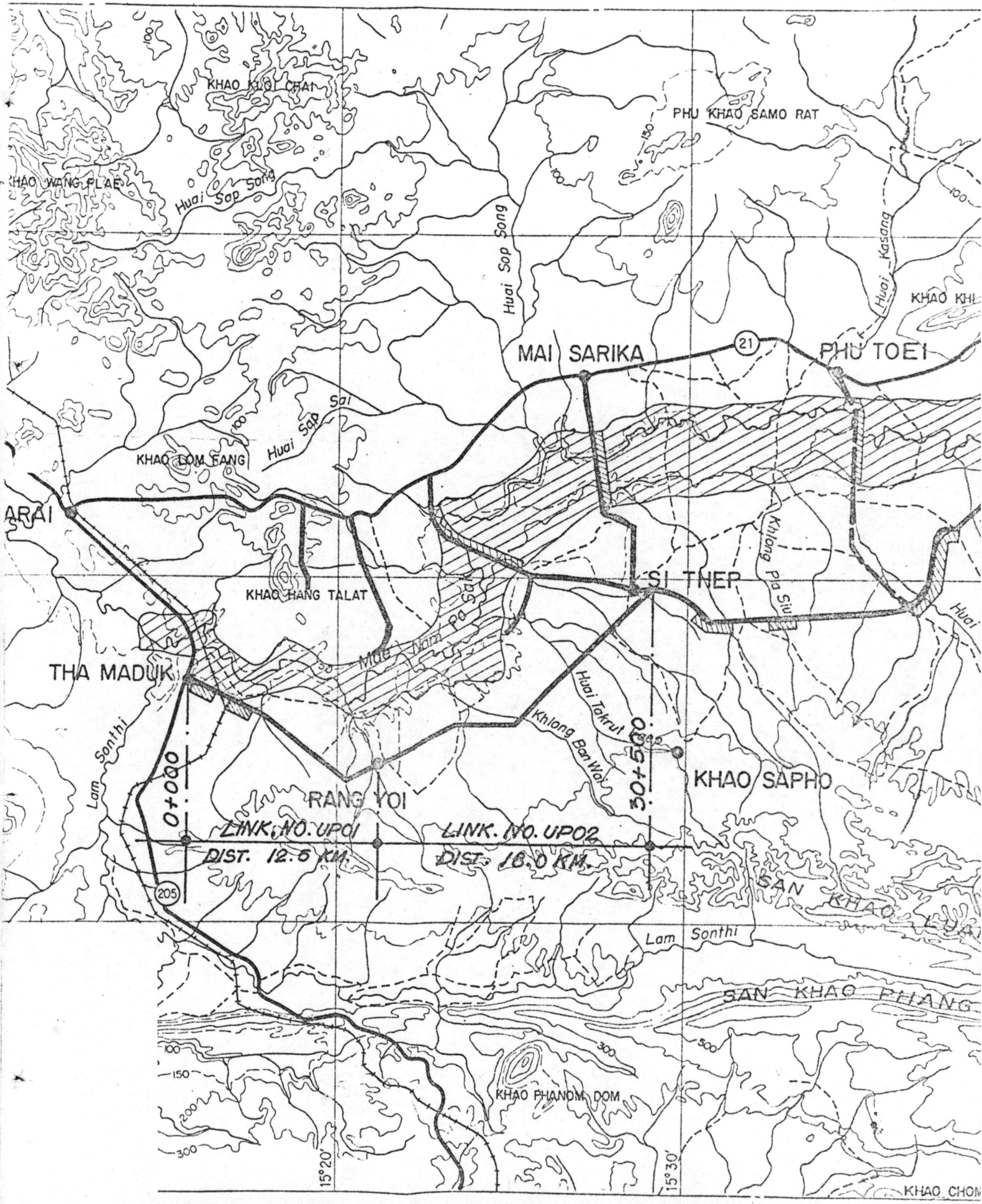
5.2 Existing Link Characteristics Data:

Within a link, sections are divided according to constant terrain, climate, road geometrics, subgrade, surface type, and condition. Because the study road has already been constructed, therefore these characteristics can be calculated from the plans which were designed by Location and Design Division, Department of Highways. The method of calculating these data are described in section 4.10.1.

5.3 Construction Options Data

Two construction options or "projects" are formulated to road links for economic analysis to compare which project is most

FIGURE 5.1 ROAD LINKS



economic or appropriate to the study road.

The formulated projects are stated as follows:

i) Pavement widening without geometric changing (project identification code is PRJ. 1 and project type code is 4).

ii) Pavement widening and reconstructing without geometric changing (project identification code is PRJ. 2 and project type code is 5).

Both of projects are specified to both links to determine optimum project and assumed to take only one year for completion. The construction costs incurred for them are one hundred percent in the construction year. For both of them, economic costs are estimated about 90 percent of financial construction costs and foreign exchange costs are 50 percent of economic construction costs. The salvage value of each project is assumed to be 10 percent.

As two projects are expected to give rise to some induced traffic, so that induced traffic will be introduced in the year after effective completion, in the second year.

5.4 Maintenance Standards and Costs:

Unit costs for maintenance operations are input in Thai Baht, which are the input currency units in this computer run; for all three cost types, financial, economic and foreign exchange.

The maintenance unit costs which used in this study are assumed to be 15 percent increased from the value shown in Table 2.3. This assumption

are made reasonably based on the inflation after 1977.

Because one objective of this study is to determine the most economic road improvement type, hence to obtained this propose the most appropriate maintenance standard, which produced lowest total investment costs, must be searched out. Therefore both schedule and responsive maintenance are specified for economic evaluation. These maintenance standards are taken from Department of Highways and suggested by LOUIS BERGER INTERNATIONAL, INC., and summarized below:

Maintenance Standard for Unpaved Road

Activity	AADT Up to 149	AADT 150 and over
Gradings (passes/KM/Year)	3	12
Spot Gravelling (m^3/KM/Year)	20	50
Gravel Resurfacing (100 mm)	every 5 years	every 3 years
Routine Maintenance	every year	every year

Scheduled Maintenance Standards for DBST

Activity	Standard from Dept. of Hwy.	Standard from LOUIS BERGER
Surface Patching (M^2/KM/Year)	313	313
Surface Dressing	every 5 years	every 5 years
Overlays	-	30 mm every 7 years
Routine Maintenance	every year	every year

Responsive Maintenance Standards for DBST

(suggested by LOUIS BERGER INTERNATIONAL, INC.)

Activity	Responsive Maintenance Standard
Surface Patching	Patch 100% of unpatched crack but not more than 313 m^2/KM/Year.
Surface Dressing	When cracking + patching exceed 25% but not less than 5 years per dressing, and not more than 3 years per dressing.
Overlays	When roughness exceed 5,500 mm/km but not less than 4 years/overlay, and not more than 2 years/overlay, using asphaltic concrete paving 50 mm.
Routine Maintenance	every year

5.5 Vehicle Characteristics and Costs:

The present traffic in Study Area was classified by JICA into six (6) types of vehicle (or "Vehicle groups") as listed below:

a) Passenger Car

b) Light Bus (4-wheel light bus, pick up bus)

c) Heavy Bus

d) Light Truck (4-wheel truck, pick up truck)

e) Medium Truck (6-wheel double axle truck)

f) Heavy Truck (10-wheel triple axle truck)

The input data required for the vehicle operating cost submodel includes road geometric and environmental characteristics, surface type and condition, and vehicle characteristics and costs, as listed in Table 5.1. Vehicle characteristics and costs are required for different "vehicle groups" which constitute the road traffic volume; each vehicle group can be of any of the five types of vehicle in Table 5.2.

The vehicle characteristics and costs data, those necessary for use in this study, were available from several recent reports of vehicle operating costs study done by various consultant firms, such as VALLENTINE, LAURIE & DAVIES, R.O.P., LOUIS BERGER INTERNATIONAL, INCO., JAPAN INTERNATIONAL COOPERATION AGENCY, and listed in Table 5.3.

For investigation of road deterioration by the model, it is necessary to supply not only the total number of commercial vehicles that will use the road but also the axle loads of these vehicles. Then, from the equivalency factor as described in paragraph 2.2.2, the damaging power

TABLE 5.1

DATA REQUIREMENTS FOR VEHICLE OPERATING COST SUBMODEL

		Remarks
Road Geometry		
1.	Road Rise	meters per kilometer
2.	Road Fall	meters per kilometer
3.	Curvature	degrees for kilometer
4.	Road Width	meters
Environment		
5.	Elevation	meters
Surface Type and Condition		
6.	Surface Type	paved, gravel or earth
7.	Roughness	millimeters per kilometer
8.	Rut Depth	millimeters
9.	Looseness	millimeters
10.	Moisture Content	percent
Vehicle Characteristics and Costs		
11.	Vehicle Classification	five vehicle types
12.	Fuel Type	petrol or diesel
13.	Brake Horsepower	BHP
14.	Gross weight	metric tons
15.	Equivalent Standard Load Factor	(used in road deterioration relationships only)
16.	Cost of New Vehicle	per vehicle
17.	Tire Cost	per tire
18.	Fuel Cost	per liter
19.	Oil Cost	per liter
20.	Maintenance Labor Wage	per mechanic-hour
21.	Crew Cost	per crew-hour
22.	Value of Passenger Time	per passenger hour delayed
23.	Overhead Costs	annual or percent of operating costs
24.	Interest Rate	percent
25.	Cargo Holding Costs	per truck hour delayed
26.	Average Number of Passengers	integer or real number
27.	Annual Operating Hours	hours per year
28.	Annual Kilometers Driven	kilometers per year
29.	Average Vehicle Life	years
30.	Age Distribution	percentages
31.	Annual Fleet Growth Rates	percent per year

TABLE 5.2

VEHICLE TYPES IN RESOURCE CONSUMPTION RELATIONSHIPS

Type of Vehicle	Description
1. Passenger Cars	This class includes passenger vehicles seating not more than nine persons (including the driver). Estate cars, taxis, and hire cars are generally included but not "Land Rover" type vehicles or mini-buses.
2. Light Goods	This class includes goods vehicles of less than 1,500 kg. Unladen weight or vehicles with a payload capacity of less than 760 kg. This class specifically includes "Land Rover" type vehicles and mini-buses.
3. Buses	This class includes all regular passenger service vehicles and coaches; excludes very large buses with gross weights greater than 8.5 tons.
4. Medium Goods	This class includes all 2-axle goods vehicles of more than 1,500 kg. unladen weight or vehicles with a payload capacity greater than 750 kg. In general, medium goods vehicles differ from light goods vehicles in that they have more than one tire at each end of the rear axle, i.e. twin tires. The maximum gross vehicle is 8.5 metric tons.
5. Heavy Goods	This class includes all goods vehicles with more than two axles and is often sub-divided into groups with specific axle configurations. Also involved are the two-axle vehicles, including very large buses, with gross vehicle weights over 8.5 metric tons.

TABLE 5.3

VEHICLE CHARACTERISTICS AND COST

Economic Cost Item	Passenger Car (฿)	Light Bus (฿)	Heavy Bus (฿)	Light Truck (฿)	Medium Truck (฿)	Heavy Truck (฿)
New Vehicle (2)	80,920	96,410	597,480	93,210	288,360	338,950
Tyre (2)	415	817	3,088	817	2,077	2,077
Maintenance/Labor hr. (2)	45	45	45	45	45	45
Crew/hour (1)	-	18.19	23.07	8.34	18.75	23.67
Passenger Time Value/ (2,3) hr.	17.68	6.20	5.25	9.46	9.71	-
Standing(% of VOC)(2)	-	-	7.3	-	5	5
Fuel/Liter (1)	3.978	3.978	2.672	2.672	2.672	2.672
Oil/Liter (2)	22.196	22.196	22.196	22.196	22.196	22.196
Financial Cost Item	**Passenger Car (฿)**	**Light Bus (฿)**	**Heavy Bus (฿)**	**Light Truck (฿)**	**Medium Truck (฿)**	**Heavy Truck (฿)**
New Vehicle (2)	178,000	116,250	700,000	112,250	359,400	430,000
Tyre (2)	455	896	3,387	896	2,278	2,278
Maintenance/Labor hr. (2)	45	45	45	45	45	45
Crew/hour (1)	-	18.91	23.07	8.34	18.75	23.67
Passenger Time Value/ hour(2,3)	17.68	6.20	5.25	9.46	9.71	-
Standing(% of V.O.C.) (2)	-	-	7.3	-	5	5
Fuel/Liter (1)	5.36	5.36	3.03	3.03	3.03	3.03
Oil/Liter (2)	25	25	25	25	25	25

TABLE 5.3 (Continued)

Vehicle Characteristic & Utilization	Passenger Car	Light Bus	Heavy Bus	Light Truck	Medium Truck	Heavy Truck
Fuel Type (1)	Petrol	Petrol	Diesel	Diesel	Diesel	Diesel
Brake Horsepower (BHP) (1)	90	70	133	77	133	133
Average Gross (1,2)	1.00*	2.00*	12.23*	2.00*	13.71*	20.83*
Vehicle Weight (tons)	-	-	-	-	4.04**	6.73**
Average Passenger (1)	2	9	33	2	2	-
Annual Operating Hours (1)	322	625	1,429	446	661	840
Annual Kilometer (3)	18,000	35,000	80,000	25,000	37,000	47,000
Average Service Life (year) (3)	10	7	9	10	13	12

Note : * : Loading Vehicle

** : Unloaded Vehicle

SOURCE: (1) LOUIS BERGER INTERNATIONAL, INC., VOL. 2.1979. TABLE C-8, C-9, D-1, D-2, & E-4

(2) JAPAN INTERNATIONAL COOPERATION AGENCY, VOL. 1. 1980. PP. 120-126

(3) VALLENTINE, LAURIE & DAVIES, R.O.P. 1977 TABLE 7.2.

of axles of different magnitudes can be expressed in terms of an equivalent number of standard, 8,200 kg., axle loads.

The determination of average equivalence factors for heavy trucks, medium trucks and heavy buses is shown in Table 5.4. Passenger cars, light buses and light trucks do not contribute significantly to the total equivalent standard axle load, and have therefore been disregarded in the assessment of pavement loading.

The proportion of gross vehicle weight on each axle is shown below.

Axle Weight for Buses and Trucks

Vehicle Type	Type of axle and percentage of total weight on axle		
	1	2	3
Heavy Bus	single (40)	single (60)	—
Medium Truck (6-wheel truck)	single (25)	single (75)	—
Heavy Truck (10-wheel truck)	single (18)	single (41)	single (41)

TABLE 5.4 STANDARD AXLE EQUIVALENCE FACTORS

VEHICLE TYPE	CARGO TYPE	AVERAGE GROSS VEHICLE WEIGHT (Tons)	AXLE LOAD (TONS)			EQUIVALENCE FACTOR			PERCENT of VEHICLE (d)	PERCENT d(a+b+c)
			1st Axle	2nd Axle	3rd Axle	1st Axle (a)	2nd Axle (b)	3rd Axle (c)		
HEAVY TRUCK	Other Material	20.83	3.75	8.54	8.54	0.03	1.20	1.20	58.0	140.94
	Empty	6.73	1.21	2.76	2.76	-	0.007	0.007	42.0	0.59
									TOTAL	141.53
MEDIUM TRUCK	Other Material	13.71	3.43	10.28	-	0.02	2.766	-	49.0	136.51
	Empty	4.04	1.01	3.03	-	-	0.011	-	51.0	0.56
									TOTAL	137.07
HEAVY BUS	38 Passengers	12.23	4.89	7.34	-	0.098	0.607		100.0	70.50
									TOTAL	70.50

VEHICLE EQUIVALENCY FACTORS: HEAVY BUS - 0.70
MEDIUM TRUCK - 1.37
HEAVY TRUCK - 1.41

NOTES:
1. Assume average weight passenger including luggage = 60 kg/person
2. Axle Equivalence Factor = $\left\{\frac{\text{LOAD}}{8.2}\right\}^{4.5}$
3. Axle load percentage distribution (From DOH Survey)
   - 3.1 Heavy Truck, Front - 18%, Rear - 41 & 41%
   - 3.2 Medium Truck, Front - 25%, Rear - 75%
   - 3.3 Heavy Bus, Front - 40%, Rear - 60%

5.6 Traffic Characteristics

5.6.1 General

Because the road studies is divided into two links, therefore traffic forcasting was made for individual link. Traffic forecast on the subject road was undertaken dividing into two types of traffic, according to traffic classification of the HDM model, as follows.

a) Normal traffic

b) Generated traffic

The analysis period is 17 years, range from 1981 (scheduled construction year) to 1997 (last analysis year).

Traffic forecast was made based mainly on the forecasted agricultural production in the Study Area for freigh traffic, and on the forecasted population and trip rates obtained by home interview survey for passenger traffic.

5.6.2 Results from Traffic Forecast

The base year (1978) traffic, forecasted traffics and growth rate for both links are summarized in Table 5.5 and 5.6.

TABLE 5.5

BASE YEAR (1978) TRAFFIC, FORECASTS AND GROWTH RATES

LINK NO. UPO 1 (THA MADUK - RANGYOI)

TRAFFIC	YEAR	TRAFFIC VOLUME (AADT)						TOTAL
		P/C	L/B	H/B	L/T	M/T	H/T	
NORMAL TRAFFIC	1978	25	162	47	22	4	2	262
		3.0	1.1	2.4	4.9	17.6	20.1	
	1983	29	171	53	28	9	5	295
		1.6	1.7	1.8	6.6	7.6	8.1	
	1989	32	189	59	41	14	8	343
		1.5	1.6	1.4	4.6	4.6	4.1	
	1997	36	214	66	59	20	11	406
GENERATED TRAFFIC	1978	-	-	-	-	-	-	-
	1983	3	16	5	0	0	0	24
	1989	10	56	18	10	3	2	99
	1997	10	56	18	10	3	2	99
TOTAL	1978	25	162	47	22	4	2	262
	1983	32	187	58	28	9	5	319
	1989	42	245	77	51	17	10	442
	1997	46	270	84	69	23	13	505

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

SOURCE: JAPAN INTERNATIONAL COOPERATION AGENCY.

VOL. 1. 1979.

TABLE 5.6

BASE YEAR (1978) TRAFFIC, FORECOASTS AND GROWTH RATES

LINK NO. UPO 2 (RANGYOI - SRITHEP)

TRAFFIC	YEAR	TRAFFIC VOLUME (AADT)						TOTAL
		P/C	L/B	H/B	L/T	M/T	H/T	
NORMAL TRAFFIC	1978	21	135	40	5	1	1	203
		2.7	0.7	1.5	9.8	24.6	14.9	
	1983	24	140	43	8	3	2	220
		2.0	1.7	1.8	9.8	8.9	0.0	
	1989	27	155	48	14	5	2	251
		1.3	1.6	1.7	4.6	4.3	9.1	
	1997	30	176	55	20	7	4	292
GENERATED TRAFFIC	1978	-	-	-	-	-	-	-
	1983	2	14	5	0	0	0	21
	1989	7	40	13	3	1	1	65
	1997	7	40	13	3	1	1	65
TOTAL	1978	21	135	40	5	1	1	203
	1983	26	154	48	8	3	2	241
	1989	34	195	61	17	6	3	316
	1997	37	216	68	23	8	5	357

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

SOURCE : JAPAN INTERNATIONAL COOPERATION AGENCY,

VOL. 1. 1979.

5.7 Other Costs/Benefits:

5.7.1 General

Because the main purpose of this road construction is to raise up farm production in the adjacent area to the road, therefore in economic evaluation must be consider about value added benefit or agricultural benefit caused by provision of a good road. Although the HDM model does not itself calculate the regional income or value added benefits of feeder roads, nor accident costs, but it does provide a facility for these items to be fed in from separate estimates.

5.7.2 Estimation of Value Added Benefit:

The main agricultural benefit attributable to the road is the net added value of production which is derived from the various effects such as effects on farmgate price, effect on production increase. Main elements which produce the net added value consist of increment of unit value of crops and increment of quantity of production of crops. Net value added should be obtained after deducting necessary costs for opening new land and for increasing crop yield and costs of production inputs. Balance after deducting the net value added without project from that in a situation with project is to be net incremental value of production attributable to the road.

5.7.3 Conditions for Estimation of Benefit

1. Cropping Area

From the studies on the impacts of Route 21 and Route 12 suggest that the high intensity of land use extends over adjacent areas to good roads within 5 kilometers on an average. As the same condition will be applicable in the project area, the influence of the proposed road was presumed as the band areas with 10 kilometers width along the road. Cropping areas in the influence area are estimated in consideration of the following assumptions:

a) Development Speed

The full development year was set at 17th year after completion of the road. However, in case of without project only 50 percent of newly cultivable area will be opened at 7th year, while 100 percent will be opened with project. In the with project situation, 75 percent of the full development target will be attained by 9th year, while development speed in the without project situation will be linear to the 17th year.

b) Allocation of Cropping Area

Area allocation by crop at full development year was dicided under the following conditions:

- Share of maize field in the newly cultivated

area will be 80 to 100 percent.

- In the existing area, 5 percent of maize area will be converted to paddy field.
- Second crop area of beans will became about 32 percent at full development year with project.

Thus, cropping areas by each link by major crops in the future both with and with out project were estimated and summarized below.

TABLE 5.7

Cropping Area for Link UPOI

(1,000 rai)

Crop	1982		1989		1997	
	W	W/O	W	W/O	W	W/O
Maize	22.1 (60.5 %)	22.1 (60.5 %)	32.1 (61.5%)	26.6 (60.4 %)	37.5 (62.8%)	32.7 (61.6 %)
Paddy	7.1 (19.5 %)	7.1 (19.5 %)	8.6 (16.9%)	7.8 (17.7 %)	9.1 (15.2%)	8.8 (16.6 %)
Beans	3.8 (10.4 %)	3.8 (10.4 %)	6.4 (12.5%)	5.5 (12.5 %)	7.5 (12.6%)	6.6 (12.4 %)
Others	3.5 (9.6 %)	3.5 (9.6 %)	4.8 (9.4%)	4.1 (9.5 %)	5.6 (9.4%)	5.0 (9.4 %)

Cropping Area for Link UPO2

(1,000 rai)

Crop	1982		1989		1997	
	W	W/O	W	W/O	W	W/O
Maize	21.5 (35.2%)	21.5 (35.2%)	49.6 (44.8%)	38.3 (42.2%)	71.5 (48.0%)	60.7 (46.5%)
Paddy	17.9 (29.3%)	17.9 (29.3%)	21.9 (19.8%)	20.2 (22.3%)	24.6 (16.5%)	23.4 (17.9%)
Beans	16.9 (27.7%)	16.9 (27.2%)	30.7 (27.7%)	25.2 (27.8%)	41.3 (27.2%)	36.2 (27.8%)
Others	4.7 (7.8%)	4.7 (7.8%)	8.6 (7.8%)	7.0 (7.7%)	11.5 (7.8%)	10.1 (7.8%)

2. Crop Yield

Crop yield will be raised up owing to the improvement of agricultural inputs or introduction of high yielding variety, which will be accelerated by the road. Unit crop yields were estimated as follow:

TABLE 5.8

Average Unit Yield

(Kg/rai)

Crop	With the project			Without the project		
	1st year	9th year	last year	1st year	9th year	last year
Maize	344	368	384	344	346	384
Paddy	350	370	370	350	350	350
Beans	135	140	140	135	135	135

3. Farmgate Price

For economic valuation, unit prices of crops are to reflect the real value of products from the viewpoint of national economy. As export prices, FOB prices of maize, rice and beans, reflect mostly the real value of products to the national economy, the real value of farmgate prices can be estimated at net value of FOB prices after deducting marketing and processing costs and transfer items from FOB prices. Base prices for estimation of unit value to be used in economic evaluation were decided referring to the past trend of FOB prices and IBRD's forecast of world prices. Farmgate prices with project were estimated by adding 100 Bahts per ton to the prices in case of without project in consideration of the price effects of the road. Unit prices in 1978 constant price were estimated as follows:

TABLE 5.9

Average Farmgate Prices

(Baht/ton)

	With Project	Without Project
Maize	1,800	1,700
Paddy	2,300	2,200
Beans	5,600	5,500

4. Production Cost

Production Costs required to attain certain yield of crops are estimated as follows:

TABLE 5.10

Average Production Costs

(Baht/rai)

	With Project			Without Project		
	1st Year	9th Year	Last Year	1st Year	9th Year	Last Year
Maize	449	458	464	449	450	464
Paddy	485	520	520	485	485	485
Beans	540	550	550	540	540	540

5. Land Preparation Cost

To convert new lands to farm land a certain amount of initial investment is required for clearing of forest. As no sophisticated work is necessary for preparation of upland crop field, costs for opening of new land is relatively small. It was estimated that the average cost for land preparation of new land, weighted by shared of maize field and paddy field, was 400 Bahts per rai. In estimation of this average cost, some consideration was paid for values of by-products such as timber and charcoal which might be produced during the clearing works.

5.7.4 Agricultural Benefit

1. Benefit to the National Economy

Increment of net added value estimated under the conditions given in 5.7.3 is the agricultural benefit, from the viewpoint of national economy, attributable to the road. Formular to calculate the increment of net added value for each year are as follows:

Increment of Net Added Value = Net Added Value with Project - Net Added Value without Project

Net Added Value = Net Value of Production - Land Preparation Cost

Net Value of Production = (GVP - PC) CA

where:

GVP = Gross Value of Production per Rai

= Unit Crop Yield per Rai x Unit Farmgate Price per Ton

PC = Production Cost per Rai

CA = Cropping Area in Rai

Increments of net added values of each link were estimated and shown below.

TABLE 5.11

Increment of Net Added Value

(Baht)

Year	Road Link	
	No. UPO 1	No. UPO 2
1982	1,060,040	1,594,250
1989	3,266,210	6,842,280
1997	3,284,440	8,740,740

2. Benefit to The Farmer

The improvement of the road will contribute to raise up the farmer's income. Saving of transportation costs and handling costs will directly reflect the raising up of

selling prices of farmers. Development of farming practice owing to the improvement of land communication will bring about the increase of crop production. Average holding of cultivation land by one household with six (6) persons in the study area is 25 rai, based on this condition, the annual farm incomes of typical maize farm and rice farm were estimated and shown below.

TABLE 5.12

Annual Farm Incomes of Typical Farms

(Baht)

	1978	1982		1997	
		W	W/O	W	W/O
Maize Farm	4,159	5,500	4,355	7,098	5,624
Rice Farm	5,935	7,071	5,935	7,291	5,935

Note: a) W : With the Project

b) W/O : Without the Project

SOURCE : Japan International Cooperation Agency. Vol. 1. 1979.

5.7.5 Excluded Benefits and Costs

5.7.5.1 The excluded benefits were:

a) Increases in the value of land and property.

b) Indirect and diffused benefits such as the spending

of saving accruing from the project.

c) Non-quantifiable benefits.

d) Environmental benefits.

5.7.5.2 The excluded costs were:

a) Non-quantifiable and environmental dis-benefits.

b) Accident costs

5.8 Sensitivity Analysis

In order to test the sensitivity of project viability to possible changes in costs and benefits, the following parameters were made the subject of separate sensitivity testing.

1) Costs at + 15% and - 15%
2) Cost at - 15% and benefit at + 20% the most optimistic solution.
3) Cost at + 15% and benefit at - 20% the most pessimistic solution.
4) Discount rate of at 8%, 10%, 12%, 14% and 16%.