CHAPTER 1

INTRODUCTION

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1-1 BACKGROUND OF THE STUDY

Under the basis of technical cooperation between Thailand and Japan, the study on the road development in the Northern Region of Thailand has been carried out since June 1980. The study comprised two phases: Phase 1 (Master Planning) and Phase 2 (Feasibility Study). The Phase 1 Study was completed in June 1981 by issuing a Final Report (Phase 1). Major objectives of the Phase 1 Study was (i) identification of further road development needs in the Northern Region, (ii) establishment of a priority order for the projects identified and (iii) selection of priority projects for further feasibility study in the Phase 2.

In response to the recommendation of the Phase 1 Study, the Phase 2 commenced in June 1981 to carry out feasibility studies of the selected 14 routes.

1-2 SCOPE AND FRAME OF THE STUDY

The objective of the Phase 2 Study is to evaluate the technical and economic feasibility of the proposed roads. The routes to be studied in the Phase 2 are shown in Figure 1-1. Prior to the commencement of the Phase 2 Study, a request by DOH was presented for replacement of some routes in the project package proposed in the Phase 1 Study. Among 16 routes of 409.3 km in total recommended in the Phase 1, Study Route No. 9, 16, 21 and 22 were requested to be deleted, and, instead, study Route No. 6 and 19 were included in the project list for the Phase 2 Study. As the result, the routes for the Phase 2 were decided to be 14 routes of 410.5 km in total.

Feasibility studies for the proposed roads were carried out in an usual practice. Flow of the study, putting a focus on the evaluation process, is illustrated in Figure 1-2. While the evaluation in the Phase 1 Study was made at pre-feasibility level, the present study has been carried out based on the field surveys of more detailed nature than the Phase 1. Preliminary design is made fully incorporating the results of topographic survey, soil tests and detailed inventory survey. Construction costs were estimated using the latest unit cost data as of mid-1981. For traffic study, O-D survey and traffic counts were conducted at 18 places which were carefully selected on or near the proposed roads. Furthermore, a home interview survey was performed to collect information required to estimate income elasticity of transportation demand. The estimated elasticity was used as one of the factors to determine the traffic growth rate. To up-date the vehicle operationg costs, the latest data on components of VOC was collected.

For the re-estimation of the agricultural development benefit, basic data such as planted area, crop yields, farmgate prices, production costs were also up-dated. Based on the economic costs and benefits estimated at mid-1981 price, assuming project life at 15 years after 1987, internal rate of return was calculated for each proposed road in order to judge the economic viability of them.

The report, which presents the results of the Phase 2 Study, consists of the following volumes:

Volume 1	:	Summary Report
Volume 2	:	Route Report

Description on the area characteristics of the Northern Region as a whole was omitted from the Phase 2 Report in order to avoid duplication with the description in Chapter 2 of the Volume 1 of the Phase 1 Report.

1-3 ORGANIZATION FOR THE STUDY

For the Phase 2 Study, Japan International Cooperation Agency (JICA), the official agency for the technical cooperation programs of the Japanese Government, organized a study team headed by Mr. M. Tohi and composed of experts of Nippon Koei Co., Ltd. and Katahira & Engineers Inc.. The study team has carried out the study under the supervision of the Steering Committee, directed by Mr. T. Nakano and consisted of Japanese Government officials, also organized by JICA. In the course of the Study, the study team has kept close collaboration with the counterpart team organized by DOH. The organization for the Study is illustrated in Figure 1-3.

Figure 1-1 LOCATION OF STUDY ROUTE

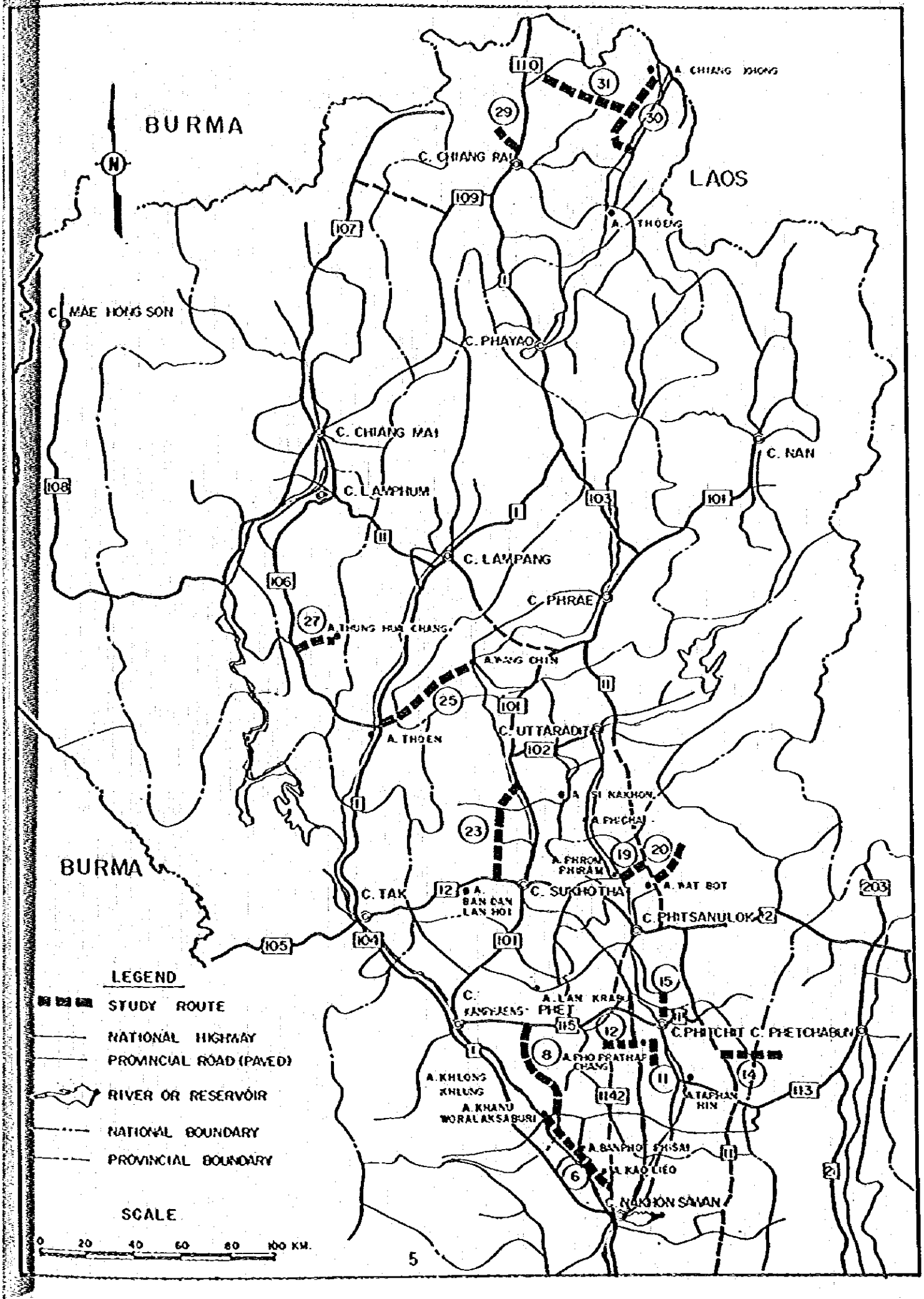


Figure 1-2

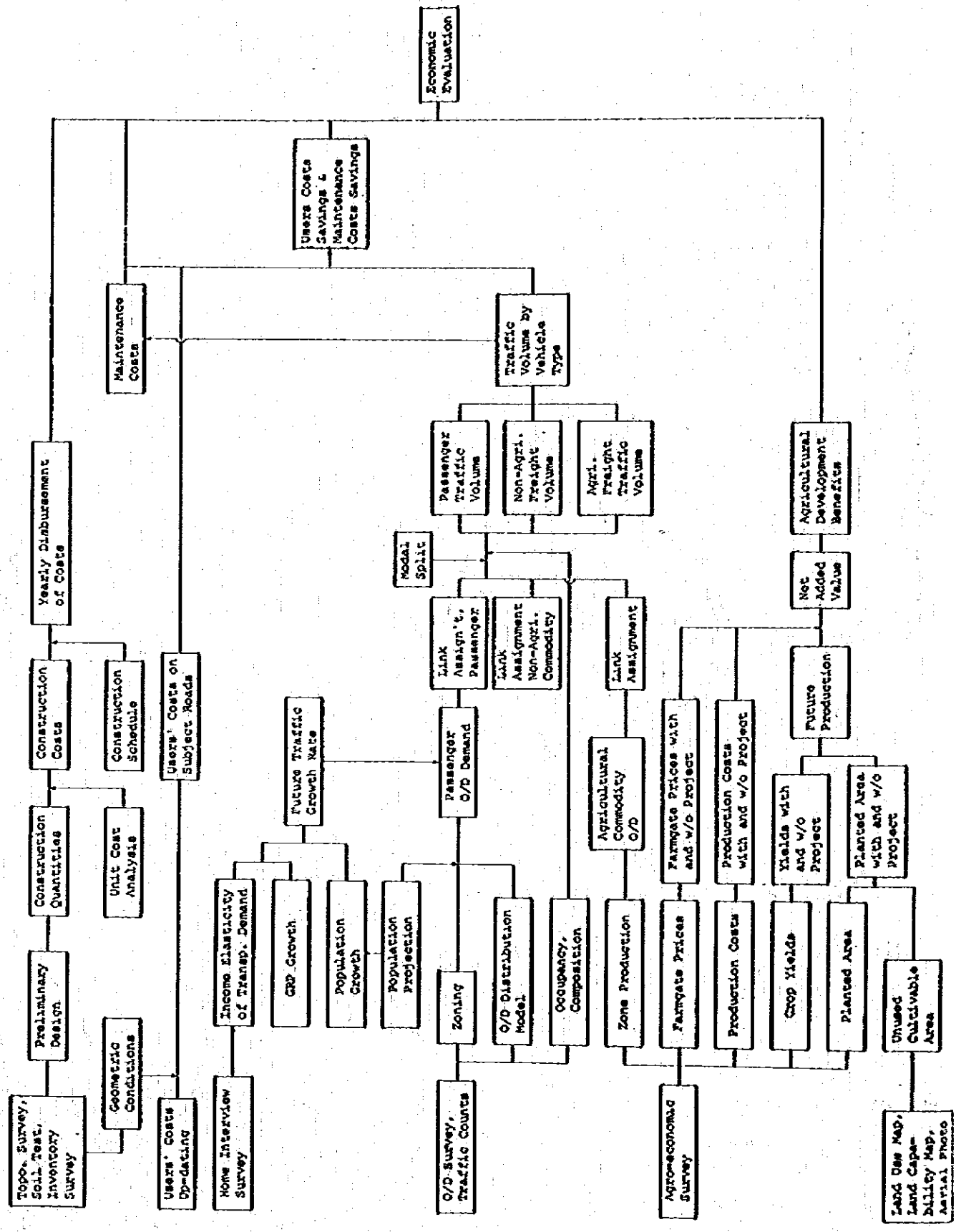
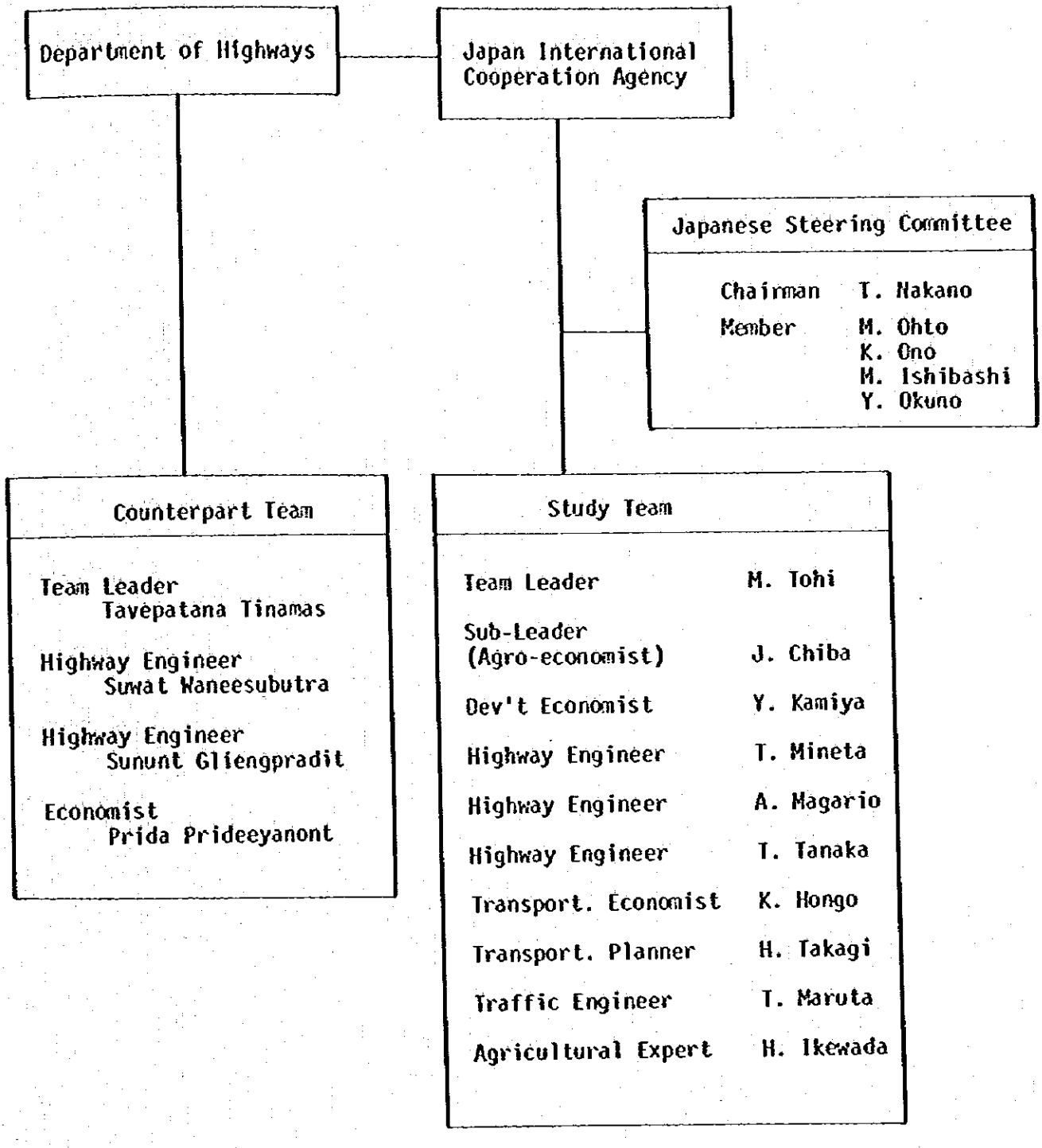


Figure 1-2 STUDY FLOW
Economic Evaluation
Users Costs Savings & Maintenance Costs Savings
Maintenance Costs
Traffic Volume by Vehicle Type
Passenger Traffic Volume
Non-Agri. Freight Volume
Agri. Freight Traffic Volume
Agricultural Development Benefits
Modal Split
Net Added Value
Link Assign't, Passenger
Link Assignment Non-Agri. Commodity
Link Assignment
Yearly Disbursement of Costs
Construction Costs
Construction Schedule
Users' Costs on Subject Roads
Future Traffic Growth Rate
Passenger O/D Demand
Agricultural Commodity O/D
Farmgate Prices with and w/o Project
Production Costs with and w/o Project
Future Production
Yields with and w/o Project
Planted Area with and w/o Project
Construction Quantities
Unit Cost Analysis
Income Elasticity of Transp. Demand
GRP Growth
Population Growth
Population Projection
Zoning
O/D Distribution Model
Occupancy, Composition
Zone Production
Farmgate Prices
Production Costs
Crop Yields
Planted Area
Unused Cultivable Area
Preliminary Design
Geometric Conditions
Topo. Survey, Soil Test, Inventory Survey
Users' Costs Up-dating
Home Interview Survey
O/D Survey, Traffic Counts
Agroeconomic Survey
Land Use Map, Land Capability Map, Aerial Photo

Figure 1-3 ORGANIZATION FOR THE STUDY



CHAPTER 2

AREA OF INFLUENCE

CHAPTER 2

AREA OF INFLUENCE

2-1 DEFINITION OF AREA OF INFLUENCE

As shown in the project location given in Figure 1-1, the proposed roads are scattered over in the Northern Region, Ten Changwat and 30 Amphoe are concerned with the proposed roads. The area of influence was defined for each proposed roads, for the sake of projection of population and crop production which generate traffic.

An underlying premise in delineation of the area of influence is that the intensive influence of improved roads extends over ragnes of about 5 km either side of the roads. The actual area of influence is, however, to be defined taking into account topographic features such as rivers, mountains, existing roads and other transport modes. It is plausible that the area of influence may not extend beyond big rivers and mountains. A portion of the area of influence of proposed road which is duplicated with that of existing roads is to be shared mutually by the proposed road and the existing roads concerned. It is considered that the area thus defined is a spacial range where the influence of a proposed road may extend to its socio-economic activities such as agricultural development. The area of influence for each proposed road is shown in land use and capability map in Volume 2 Route Report.

In the zoning for traffic study, zones are sometimes confined so as to extend beyond the above-mentioned area of influence. All the area, to where the influence of a proposed road in terms of traffic generation may reach, were included into the traffic zones.

2-2 SOCIO-ECONOMIC GROWTH

2-2-1 Population

The population of the area of influence of each proposed road was estimated by zone allocating Tambon population, referring to the aerial photographs and land use. Population projections were elaborated taking into account past trends of Tambon population, the regional growth target in the current 5-year plan, and the long range national goal. In the current 5-year plan, population growth of the Northern Region is estimated at 2% p.a. and targeted at 1.7% p.a. in 1986. In a long run, population growth of areas outside Bangkok is assumed to approach to the national target of 1.1% p.a. Further details of population projection in the area of influence are discussed in Chapter 3 and individually in Route Report.

2-2-2 Per Capita GRP

For the projection of future economic growth in the areas of influence, one of the ways may be to apply ratio method in relation with the regional and national growth target. The target growth rate of Gross Regional Product (GRP) of the Northern Region during the current five-year-plan perion (1982-86) is set at 6% p.a., while that of national level is 6.6% p.a. Assuming the same relationship between Kingdom and the North may continue, the long range growth targets of GRP are estimated, in ratio with the national level, at 6.6% p.a. for 1987-90 and 5.9% p.a. for 1990 onward. In the same manner the target growth of per capita GRP are estimated at 5.2% p.a. for 1987-90 and 5.0% p.a. for 1990 onward.

As no target is set for economic growth at Changwat level and the past trends of Changwat growth are too fluctuated to be used for future projection, ratios between regional average growth and Changwat's growth are applied to estimate the future growth of Changwat level. Trends in 1973-79 show that growth rates of Changwat concerned with the proposed roads are higher than the regional average. Assuming this relative position may not alter in future, the future growth rates at Changwat level are estimated in proportion to the regional growth target applying the ratios of

past growth of Changwat against the regional average. Past trend of gross provincial product and index of growth rates of Changwat group against the regional average are shown in Appendix 2-1 and further discussed in Chapter 3.

CHAPTER 3

TRAFFIC SURVEY AND FORECAST

CHAPTER 3

TRAFFIC SURVEY AND FORECAST

3-1 GENERAL

3-1-1 Traffic Forecast Procedure

The process and method of traffic forecasts used in this study are illustrated in Figure 3-1 and briefly explained below.

Forecasting works were divided broadly into three steps. The first step is to estimate the transportaiton demands for passenger and freight by origin - destination pair in the opening year of the project, 1987, as a base year.

In order to estimate the transportation demands, traffic zoning was worked out so as to confine the unit of traffic generation within the area of influence of the project and to define the area of destination of traffic flows originated from the influential area.

Transportation demands between zones were forecasted using the models developed in this study for three cases of passenger, agricultural freight and non-agricultural freight.

The second step is to forecast the transportation demands in the years after opening of the project, using demands growth rates derived from the future growth of socio-economic activities in the area of influence such as population, agricultural productions and income.

The last step is to convert the transportation demands between zones thus forecasted for the first, 7th and 15th years after opening the project into traffic volumes by vehicle type on the project roads.

The probable route for the demands by origin - destination pair was searched taking minimum travelling time as a sole yardstick. The volumes on the road links in terms of passenger trips or freight tonnage thus assigned were converted into the numbers by vehicle type depending on the estimated traffic composition, occupancy and loading ratio.

Traffic surveys were carried out in order to obtain the supporting data required for forecasting. The surveys were composed of origin/destination survey, home interview survey and traffic counts. In addition, the other relevant data such as past traffic records, vehicle registration, population, etc. were collected from the possible sources.

3-1-2 Type of Traffic

For the purpose of estimation of road users' benefits, whole traffic was classified into four types of traffic, i.e., normal, diverted, induced and developed traffic. Their definitions are described below:

Normal Traffic is defined as the traffic which takes place on the existing road, arising from the natural increase of population and economic activities independent of the road improvement.

Diverted Traffic is defined as the traffic which may change its routes due to the improvement or new construction of road.

Induced Traffic is defined as the extra traffic which is newly generated as a result of improvement of transport condition such as decrease of travelling time and cost. In the estimation of induced traffic, only population with natural growth would be considered as a source of traffic, in other words, population increase by migration would be disregarded.

Developed Traffic is defined as the traffic which occurs in excess of natural growth of population and economic activities due to the agricultural development attributable to the road development.

3-1-3 Vehicle Classification

According to the result of traffic surveys in the study area, the present traffic can be classified into ten types of vehicle in views of trip purpose, shape of vehicle and public/private use. They are motorcycle, passenger car, pickup (passenger use), light bus, medium bus and heavy bus for passenger traffic and pickup (truck use), 4-wheel truck, 6-wheel truck and 10-wheel truck for freight traffic.

Since no significant change is predicted, the future traffic was also forecasted with these ten types of vehicles.

Standard type of vehicles and characteristics of each class were recognized as below:

a) Motorcycle (M/C)

Motorcycle is 2-wheel vehicle with engine such as SUZUKI A100 and HONDA DT100. The engine capacity ranges from 50 to 150 cc and the major is 100 cc.

b) Passenger Car (P/C)

Standard models are TOYOTA Corolla and DUTSAN 160J with a 1600 cc petrol engine. The 4-wheel-drived vehicles such as Land Rover and Taxis, purchased of second-hand vehicles with installing a diesel engine, are also classified in this category but they belong to the minority in the rural area.

c) Pickup for Passenger Use (P/P)

A shape of vehicle is same as so-called "pickup truck" such as TOYOTA HILUX and ISUZU FASTER but it is mainly used for passenger

trip as a substitute of passenger car. Some of P/Ps are rigged by canopy of canvas with lower roof than that of light bus.

d) Light Bus (L/B)

Light bus is a simple adoption of pickup truck with longitudinal bench seats and canopy of canvas. Seat capacity is 10 in average.

e) Medium Bus (M/B)

Medium bus is also a modified truck of medium size with longitudinal bench seats and canopy of canvas. Standard model is TOYOTA DYNA with diesel engine and seat capacity is 16 in average.

f) Heavy Bus (H/B)

Heavy bus is represented by HINO BX321. Seat capacity is 38 in average.

g) Pickup for Truck Use (P/T)

Standard model is TOYOTA HILUX with 4-wheel. Main purpose of use is for freight transport. Loading capacity is 1 ton.

h) 4-Wheel Truck (4/T)

4/T is a truck, such as TOYOTA DYNA, bigger than pickup with loading capacity up to 4 tons.

i) 6-Wheel Truck (6/T)

6/T is double axle truck such as ISUZU KS22R with loading capacity up to 6 tons.

j) 10-Wheel Truck (10/T)

10/T is triple axle truck such as ISUZU JCM490Y, with loading capacity up to 13 tons.

3-2 TRAFFIC SURVEY

3-2-1 O/D Survey and Traffic Counts

Roadside interviews to drivers and interviews to bus passengers together with automatic traffic counts and classified manual counts were conducted at 18 stations in mid-June 1981.

a) Roadside Interview to Drivers

The roadside interviews aimed mainly to obtain the O/D patterns between traffic zones in each project area. In addition, other information useful for the traffic forecast were also colledcted

The survey items are as follows:

- Origin and destination of vehicle trip
- Purpose of trip
- Kinds of commodity and average freight volume of freight vehicle
- Average number of passengers in passenger vehicle
- Traffic composition
- Route of trip
- Travel time and fare
- Vacancy rate of vehicle

The survey form of roadside interview is shown in Figure 3-2, and the location of the survey points are illustrated in Figure 3-3 and also shown in Route Report.

b) Interview to Bus Passengers

To obtain O/D pattern in terms of person-unit of passenger traffic, interview survey to bus passengers was carried out. This survey was conducted by interview to bus passengers on the representative bus routes around the proposed route.

c) Traffic Counts

Manual traffic counts by vehicle type and 24-hour automatic counts were conducted at each site of roadside interview. The data were used for the estimation of Expansion Factor to be employed in obtaining average daily traffic volume.

d) Survey Time

Above-mentioned traffic surveys were conducted in the following time:

Survey	Survey Point	Survey Time
Roadside Interview	18 places	6.00 a.m. - 2.00 p.m. (8 hrs.)
Traffic Counts	18 places	6.00 a.m. - 6.00 p.m. (12 hrs. manual)
		24 hrs. - 2 days (Automatic)
Bus Passenger Interview	18 routes	

The results of the surveys are summarized in Table 3-1.

3-2-2 Home Interview Survey

The home interview survey aimed mainly to obtain the supporting data for the estimation of income elasticity coefficient which should be the basis of projection of future growth rate of passenger transportation demands.

The survey was conducted at three representative villages along the projects roads of Route 6, 8, 14, 20, 23, 25, 29 and 31 in mid-September 1981. It was planned to interview 20 samples in each village. The number of data collected is 446 in total. The villages where the survey was conducted are shown in Table 3-2.

The survey items are as follows:

- Household income
- Number of household members
- Number of person trips by vehicle type
- Fare per public transport
- Cost of unit trip by private vehicle
- Car ownership

The form of the home interview survey is shown in Figure 3-4, and the results of data compilation of the survey are shown in Table 3-3.

3-3 TRAFFIC FORECAST

3-3-1 Zoning and Road Links

1) Zoning

The area of influence was divided into several traffic zones. Zoning for the area of influence was made taking into consideration the road networks, constraints of physical features such as rivers and mountains, and Tambon boundaries. Population and agricultural products by traffic zone were estimated rearranging Tambon statistics or allocating total figure of the area of influence obtained from aerial photos and topographic maps. On the other hand, the boundary of external zones outside the influence area was determined referring to the information in the O/D survey results. The unit of such traffic zone was chosen among the units of Tambon, Amphoe or Changwat in accordance with the magnitude of attraction as the destination of traffic. The zone node was set at the place being most predominant in terms of socio-economic activities.

2) Road Links

The existing and proposed roads in the area of influence, together with surrounding roads connected with external zones of influential area, were divided into several road links which were assumed to be uniform throughout the link in its characteristics on traffic composition and traffic volume. Assuming the opening year of the project at 1987, the related roads which are committed to be improved or constructed by 1987 under the Government programs were regarded as improved ones in both cases of with and without project. Dummy nodes were placed at the intersections of the road link and other roads, in addition to the zone node. The specific road characteristics, i.e., distance, surface condition by season, average travelling speed, improvement plan under the Government program were surveyed through the field reconnaissance,

road inventory survey and data available in the DOH. For the sake of simplification, the road links were classified into one of the 16 road grades considering surface condition, alignment and travelling speed as shown below:

Road Grade

Grade	Surface Condition	Alignment	Season	Travelling Speed by Vehicle Type(km/h)			
				Average	Type A	Type B	Type C
1	AC	Good	All	78	85	78	70
2	AC	Fair	All	68	75	68	60
3	AC	Bad	All	58	65	58	50
4	SBST	Good	All	70	78	70	62
5	SBST	Fair	All	60	68	60	52
6	SBST	Bad	All	50	58	50	42
7	SA	Good	Dry	53	60	53	45
8	SA	Fair	Dry	43	50	43	35
9	SA	Bad	Dry	33	40	33	25
10	SA	Good	Rainy	45	53	45	38
11	SA	Fair	Rainy	35	43	35	28
12	SA	Bad	Rainy	25	33	25	18
13	Earth	Fair	Dry	23	23	23	23
14	Earth	Bad	Dry	18	18	18	18
15	Earth	Fair	Rainy	16	16	16	16
16	Earth	Bad	Rainy	11	11	11	11

Note: AC : Asphaltic Concrete
SBST : Single Bituminous Surface Treatment
SA : Soil Aggregate
Type A : P/C
Type B : L/B, M/B, H/B, P/P, P/T and 4/T
Type C : M/C, 6/T and 10/T

The road links of the proposed route were classified in one of the grades of 4, 5 and 6, which corresponds to F4 class in the DOH Standard.

3-3-2 Passenger Traffic in Base Year

1) Estimation of Passenger Transportation Demands

In accordance with the traffic zoning, transportation demands of passenger by origin and destination pair was estimated for three cases of transportation demands, i.e., normal, induced and developed in the opening year of the project at 1987.

a) Passenger O/D Model

A mathematical model of gravity type, of which variables are population size in traffic zone and travelling time between zones was developed for the estimation of passenger traffic demands. The model formula is as follows:

$$Vij = Qi \cdot k \cdot \frac{Qj^a}{tij^b}$$

where, Vij : transportation demands of passenger between zone i and zone j (trip/day)

Qi : population size in origin zone i

Qj : population size in destination zone j

tij : travelling time between zone i and zone j

a, b, k : model parameter

The model parameters, a, b and k, were determined by a least square method. The regression analysis were made on the correlation of the data on number of trips by O/D pair obtained from the results of roadside interview survey, present population size of corresponding traffic zones and actual travelling time between the zones under existing road network condition. In general, O/D survey by roadside

interview can not catch all of the transportation demands to be generated in a zone, because some of traffic may move on the other routes without passing the O/D stations. Furthermore, a pattern of traffic observed through O/D survey is characterized depending on the specific functions and conditions of the road on which the station is located. Therefore, the data of actual transportation demand of passenger were carefully checked to obtain the inputs for the estimation of model parameters. Then 43 data were selected among the results of O/D survey. The estimated parameters together with the correlation coefficient between the actual transportation demands and that estimated by the model are shown below:

Estimated Model Parameters

Parameter			Correlation Coefficient
a	b	k	
0.239	1.305	590.5	0.85

In case of the estimation of passenger transportation demands in base year at 1987, projected population by traffic zone and travelling time between zones which is calculated by searching minimum pass for O/D pair concerned based on the road link data, were given as the inputs for the calculation.

b) Growth of Trip Rate

In addition to the estimation derived from the passenger O/D model, the change in trip rate per head during 1981 to base year of 1987 was examined and then adjusted the estimation figure. Growth of passenger traffic depends not only on population increase but also on growth of trip rate per head which is caused by the growth of economic activities.

Observing past trend of traffic growth of passenger obtained from DOH records, it was judged that annual growth rate of passenger traffic in the Northern Region was about 8.5 percent as shown in the following table:

Past Traffic Growth

Road Type	Traffic	Annual Growth Rate (%)	Source
North Region Provincial	Passenger	7.7	SRNT, Vol. 1, 1980 Period: 1972-1978
	Freight	10.7	
	Total	8.7	
North Region Provincial	Total	8.6	data: DOH traffic records 1973-1978, 60 links, calculated by JICA team

Assuming that the annual rate of traffic growth for the period of 1981 - 1987 follows 8.5 percent of past trend, the annual growth of trip rate per head can be estimated at 6.8 percent as the annual increase of population has been projected at 1.7 percent for the same period.

Based on the above average rate of growth of trip rate in Northern Region, specific growth rates were assigned to each project route classified into area groups as shown below:

Growth of Trip Rate

Area	Index of Economic Growth[5/]	Growth of Trip Rate (%)	γ[6/]
North (average)	100	6.8	1.48
Nakhon Sawan Area[1/] (Route 6, 8, 11, 12, 14, 15)	112	7.6	1.55
Phitsanulok Area[2/] (Route 19, 20, 23)	102	6.9	1.49
Lampang Area[3/] (Route 25, 27)	127	8.7	1.65
Chiang Rai Area[4/] (Route 29, 30, 31)	110	7.5	1.54

Note: 1/ : Changwat Nakhon Sawan, Phichit and Kamphaeng Phet

2/ : Changwat Phitsanulok and Sukothai

3/ : Changwat Lampang, Phrae and Lamphun

4/ : Changwat Chiang Rai and Phayao

5/ : Based on annual growth rate of per capita GRP, 1973-1979, NESDB

6/ : Coefficient of expansion to estimate transportation demands by passenger O/D model. It is calculated by the following formula:

$$\gamma = (1 + \alpha)^6 \qquad \alpha : \text{annual growth rate of trip rate}$$

The transportation demand of passenger by O/D pair calculated by the passenger O/D model were adjusted basing on the coefficient of expansion, γ, denoted in the table.

c) Passenger Transportation Demand by Type

For the sake of VOC benefit calculation, the estimation was made for the transportation demands of passenger corresponding to each type of traffic normal, induced and developed applying the model formula denoted above.

The transportation demand for passenger by type together with its description and calculation formula is expressed in the following table:

Transportation Demand by Type
(Passenger Traffic)

Type	Description	Calculation Formulae 1/
Normal	Corresponds to the population with natural growth	$V_{ij}^{(N)} = \bar{Q}_i \cdot k \cdot \frac{\bar{Q}_j^a}{t_{ij}^b}$
Induced	Corresponds to the difference in the travelling time between with and without project	$V_{ij}^{(I)} = \bar{Q}_i \cdot k \cdot \frac{\bar{Q}_j^a}{t_{ij}^b} - \bar{Q}_i \cdot k \cdot \frac{\bar{Q}_j^a}{t_j^b}$
Developed	Corresponds to the migrated population due to the accelerated agricultural land development by road improvement	$V_{ij}^{(DV)} = Q_i \cdot k \cdot \frac{Q_j^a}{t_{ij}^b} - \bar{Q}_i \cdot k \cdot \frac{\bar{Q}_j^a}{t_{ij}^b}$

Note: 1/ $V_{ij}^{(N)}$: Normal transportation demand between zone i and zone j

$V_{ij}^{(I)}$: Induced transportation demand between zone i and zone j

$V_{ij}^{(OV)}$: Developed transportation demand between zone i and zone j

$\bar{Q}_i$: Population in zone i of without project

Q_i : Population in zone i of with project

$\bar{t}_{ij}$: Minimum travelling time between zone i and zone j of without project

t_{ij} : Minimum travelling time between zone i and zone j of with project

a, b, k : Model parameter

2) Link Assignment of Passenger

Assignment of the transportation demands by type to road links was carried out searching the most probable route by O/D pair under the all or nothing method taking minimum travelling time as a sole yardstick.

In order to clarify the traffic types of normal, diverted, induced and developed, five cases of combination of transportation demands and road network were set up for link assignment as shown below:

Case of Link Assignment

Case	Transportation Demand	Road Network[2/]	Type of Traffic on Road Link
1.	$V_{ij}^{(N)}$	$\bar{W}$	Normal
2.	$V_{ij}^{(N)}$	W	Normal + Diverted
3.	$V_{ij}^{(I)}$	W	Induced
4.	$V_{ij}^{(DV)}$	W	Developed
5.[1/]	$V_{ij}^{(I)}$	$\bar{W}$	-

Note: 1/ Hypothetical case for use of benefit calculation
2/ $\bar{W}$: without project case
W : with project case

3) Traffic Composition and Occupancy

The conversion from a term of number of passengers to traffic volume by vehicle type was based on traffic composition and occupancy rate of passenger vehicles.

The present traffic compositions on the proposed road and other roads located nearby the project area were surveyed through the manual classified counts. In addition, DOH traffic records in 1979 related in the project area were referred. Based on these data, passenger traffic composition under the existing road condition was estimated in each project road.

For the future composition in both cases of with and without projects, it was assumed that factors of road surface condition and economic growth especially growth of per capita income are related to future composition. The relation between the proportion of public to total traffic and level of per capita income was analized basing on the data from home interview survey as shown in Figure 3-5.

The results of the analysis indicated that the proportion of public vehicles to total traffic would decrease with the growth of per capita income. Thus future proportion of public vehicles was estimated based on the projected growth of per capita income, as in the following table:

Proportion of Passenger Traffic

Year	Per Capita Income		Proportion	
	Annual Growth[1/]	Index	Public[2/]	Private[3/]
1981		100	.68	.32
1987	)4.2%	128	.62	.38
1993	)5.2%	174	.56	.44
2001	)5.0%	256	.50	.50

Note: 1/ : refer to Chapter 2-2
2/ : L/B, M/B and H/B
3/ : P/C and P/P

The traffic composition of passenger was estimated by breaking down the proportions of public and private vehicles into proportions by vehicle type referring to present traffic composition on provincial roads.

The passenger traffic compositions on the provincial road in the Northern Region in both cases of paved and unpaved condition are thus estimated as follows:

Passenger Traffic Composition

Vehicle Type		Condition Unpaved			Paved Condition		
		1987	1993	2001	1987	1993	2001
Private	P/C	11	12	14	12	16	20
	P/P	27	32	36	26	28	30
	(Sub-T)	(38)	(44)	(50)	(38)	(44)	(50)
Public	L/B	31	28	25	32	30	27
	M/B	27	25	22	24	19	14
	H/B	4	3	3	6	7	9
	(Sub-T)	(62)	(56)	(50)	(62)	(56)	(50)
	Total	100	100	100	100	100	100

For the traffic composition in each project which was actually used for the traffic forecast, some modifications was made taking into consideration present composition on each proposed road and road network condition as shown in the Route Report.

On the other hand, average occupancy by vehicle type was determined basing on the information obtained in the roadside interview survey mentioned in 3-2-1. The occupancy rates were assumed not to be changed in both cases of with and without projects.

3-3-3 Freight Traffic in Base Year

Freight traffic was forecasted dividing into agricultural freight traffic and non-agricultural freight traffic.

1) Agricultural Freight Traffic

a) Estimation of Agricultural Transportation Demands

The agricultural development in the area of influence was forecasted by crop for both cases of with and without projects. The crop production volume was estimated by traffic zone.

Major destination of agricultural products by crop was determined from the results of the agro-economic survey on the flow of agricultural products. The agricultural transport demands by origin and destination pair were thus estimated.

b) Agricultural Transportation Demand by Type

The transportation demands of agricultural freight were estimated for normal traffic and developed traffic. The normal traffic demand corresponds to the production volume in case of without project. The demand for developed traffic is to be derived from the excess production volume attributable to the projects, that is the difference of production between with project case and without project case.

It was judged that no induced traffic would be appeared for agricultural transportation.

c) Link Assignment of Agricultural Freight

The agricultural transportation demands were assigned to road links in the same way based on the route search by minimum travelling time as explained in previous section of 3-3-2.

The conversion from a term of tonnage to traffic volume by vehicle type was based on the traffic composition and average load of freight vehicles. The present freight composition on the existing roads was estimated referring to the data obtained from the manual classified counts in this study and the traffic records available in the DOH.

The traffic composition in case of with project was determined referring to the composition on the paved provincial roads located in the project area.

Average load by vehicle type was determined according to the results of roadside interview survey.

2) Non-agricultural Freight Traffic

The freight traffic other than agricultural freight was estimated on the basis of the relationship between passenger movement and tonnage of general freight on a road link. A model of exponential type was assumed to the relationship as shown in the following formula:

$$Zi = a \cdot Yi^{b}$$

where, Zi : tonnage of non-agricultural freight carried on road link i
Yi : passenger movement on road link i
a, b : model parameter

The actual data of Yi and Zi, which were obtained from the roadside interview surveys in the Phase 1 and Phase 2 studies, were used for the estimation of the parameters. Details of supporting data are shown in Table 3-4, and estimated parameters are shown in the following table:

Estimated Parameters

a	b	Corr. Coefficient
0.0156	1.19	0.86

The transportation demands of non-agricultural freight by traffic type, i.e. normal, induced and developed traffic, were also estimated basing on the above equation applying corresponding figures of passenger transportation demand by type.

The tonnage derived from the above equation was then converted into traffic volume, applying the freight composition and the average load.

3-3-4 Estimation of Motorcycle Traffic

Motorcycle traffic is not counted in ADT but it is necessary to be forecasted for the sake of calculation of VOC savings.

According to the observation of traffic records, the motorcycle percentage, the ratio of motorcycle traffic volume to ADT, showed generally higher value with low average ADT and lower with high average ADT. And a relation was also found that the motorcycle volume was higher in case of higher volume in light bus traffic. Hence, the following model was developed for estimating motorcycle volumes:

$$\frac{M/C}{ADT} = a - b \cdot \log ADT + c \cdot \frac{L/B}{ADT}$$

The parameters, a, b and c, were estimated based on the actual data obtained from the traffic surveys, as shown below:

Estimated Parameters

Parameter			Corr. Coefficient
a	b	c	
1.756	0.220	4.051	0.89

Table 3-5 shows the basis of the development of the above model.

The method on estimaiton for motorcycle traffic by type is as follows:

Normal

$$M/C^{(N)} = ADT^{(N)} \cdot \{ a - b \log ADT^{(N)} + c \cdot \frac{L/B^{(N)}}{ADT^{(N)}} \}$$

Induced

$$M/C^{(I)} = M/C^{(N+I)} - M/C^{(N)}$$

$$= ADT^{(N+I)} \cdot \{ a - b \log ADT^{(N+I)} + c \cdot \frac{L/B^{(N+I)}}{ADT^{(N+I)}} \}$$

$$- ADT^{(N)} \cdot \{ a - b \log ADT^{(N)} + c \cdot \frac{L/B^{(N)}}{ADT^{(N)}} \}$$

Developed

$$M/C^{(DV)} = M/C^{(T)} - M/C^{(N+I)}$$

$$= ADT^{(T)} \cdot \{ a - b \log ADT^{(T)} + c \cdot \frac{L/B^{(T)}}{ADT^{(T)}} \}$$

$$- ADT^{(N+I)} \cdot \{ a - b \log ADT^{(N+I)} + c \cdot \frac{L/B^{(N+I)}}{ADT^{(N+I)}} \}$$

where, T : total traffic
N : normal traffic (including diverted traffic)
I : induced traffic
DV : developed traffic

3-3-5 Growth Rate of Transportation Demands

Future transportation demands in 7th and 15th years after opening the project roads were forecasted applying demands in base year at 1987 with the growth rates set for three types of transportation demands, passenger, agricultural freight and non-agricultural freight.

The future transportation demands thus forecasted were then converted into traffic volumes by vehicle type in the same way as described in 3-3-2 and 3-3-3.

1) Growth Rate of Passenger Transportation Demands

Changes in per capita income, relative transportation price and population were chosen as factors which would affect the growth rate of passenger transportation demands corresponding to the normal traffic.

a) Elasticity Coefficient of Transport Demands

The income elasticity coefficient for the project areas was derived from the average per capita income and number of trips per head by income class obtained from the Home Interview Survey. The basis for calculation of income elasticity are shown in Figure 3-6.

The other elasticities, relative transportation price elasticity and population elasticity of transport demands, were determined referring to the past studies concerned. The coefficient of the elasticities are as follows:

Elasticity

Indicator	Elasticity Coefficient
Per capita income	1.08
Transportation price	-0.24
Population	1.00

b) Projection of Changes in Indicators

The growth rates of passenger transport demands during the periods of 1987-1993 and 1993-2001 were calculated depending on the changes in per capita income, relative transportation price and population during the same periods, and applying the elasticities concerned.

The future changes in per capita income were estimated by area group of aggregated Changwat, based on the target growth rates of per capita GDP and GRP and changwat index of GPP per capita given in Chapter 2. The estimated growth rates of per capita income by area group are as follows:

Growth of Per Capita Income

Area Group	Annual Growth Rate (%)	
	1987 - 1993	1993 - 2001
Nakhon Sawan Area 1/ (Route 6,8,11,12,14 and 15)	5.8	5.6
Phitsanulok Area 2/ (Route 19, 20 and 23)	5.3	5.1
Lampang Area 3/ (Route 25 and 27)	6.6	6.4
Chiang Rai Area 4/ (Route 29, 30 and 31)	5.7	5.5
Northern Region	5.2	5.0
Thailand	5.7	5.5

Note: 1/ : Changwat Nakhon Sawan, Phichit and Khamphaeng Phet
2/ : Changwat Phitsanulok and Sukothai
3/ : Changwat Lampang, Phrae and Lamphun
4/ : Changwat Chiang Rai and Phayao

For the increase of relative transport price, it was assumed that future increase rate would follow the past trend during the period of 1976-1980 in the Northern Region, 3.6 percent per annum, since

it is not usually possible to project long term price changes.

The supporting data for the past trend of relative transportation price are shown in the following table:

Transportation Price Increase

Item	Index as 1976 = 100				1980/1976		Annual Rate of Increase(%)
	1977	1978	1979	1980	Current	Real	
Transportation	105.5	114.4	135.6	167.7	1.677	1.153	3.6
All Items	106.7	115.0	124.1	145.5	1.455	1.000	-

Source: Consumer Price Index for Northern Region annual average 1977-1980, Ministry of Commerce

The annual rates of population increase were determined referring to the past trends in the area of influence in each project road and projected average growth rates for the Northern Region available in the NSO, 1.4 percent for the period of 1987-1993 and 1.1 percent for the period of 1993-2001. The results are shown in the Route Report.

2) Grwoth Rate of Freight Transportation Demands

a) Agricultural Freight

The growth rates of agricultural transportation demands were determined by the growth of the forecasted crop productions in the area of influence in 1993 and 2001.

b) Non-agricultural Freight

According to the non-agricultural freight model described in the previous section, it was judged that the derived model parameter, 1.19, should be passenger transport demand elasticity of non-

agricultural transportation demand. Therefore, the growth rates of non-agricultural transportation demands were calculated by multiplying those of passenger transportation demands by 1.19.

The projected growth rates of transportation demands by project are summarized in Table 3-6.

3-3-6 Forecasted ADT

The forecasted ADTs of each proposed road in 1987, 1993 and 2001 are summarized in Table 3-7.

The traffic volumes by vehicle type by traffic type are shown in the Route Report.

Figure 3-1 PROCESS OF TRAFFIC FORECASTING

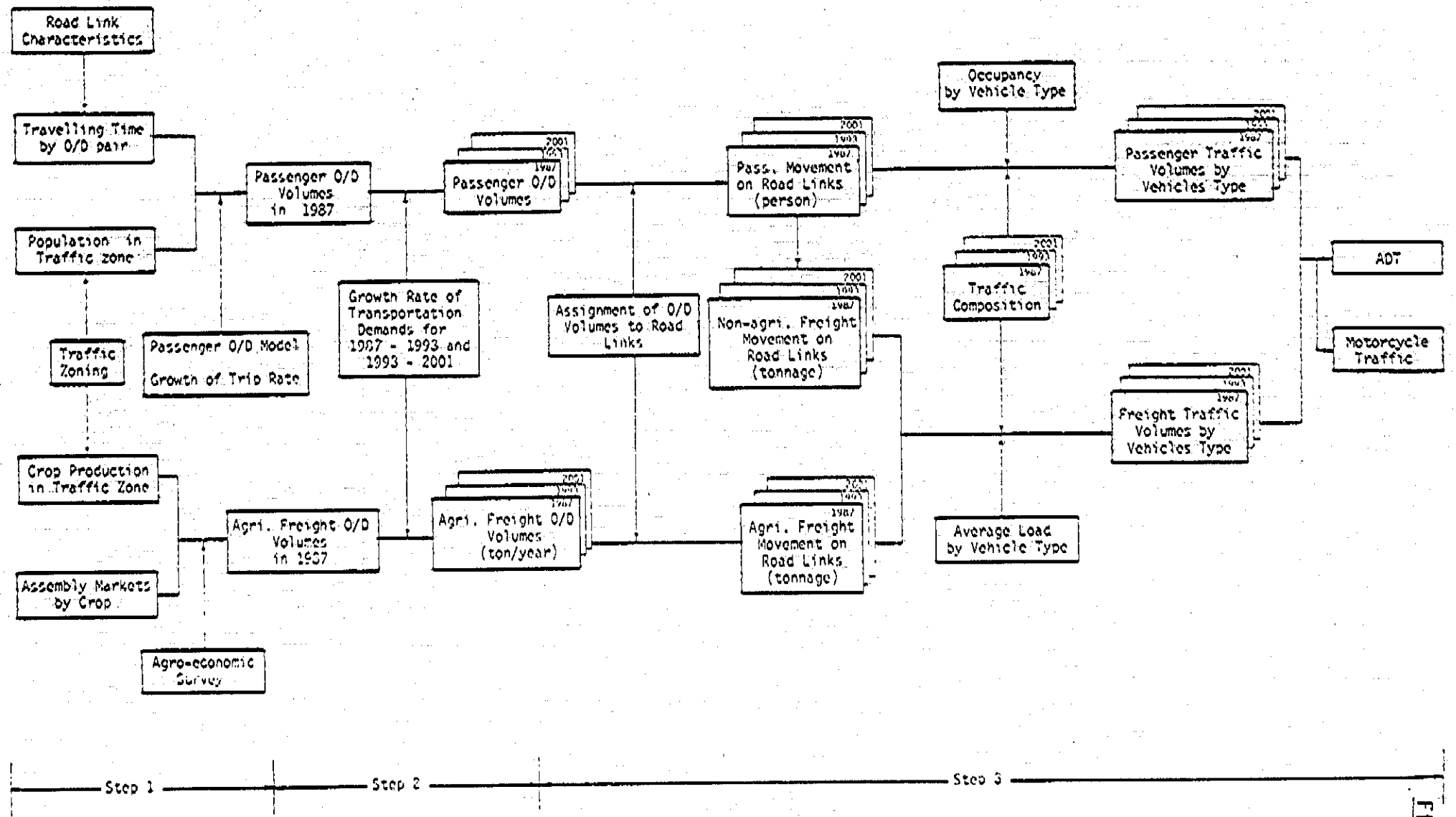


Figure 3-1

Figure 3-2

FIGURE 3-2 O/D SURVEY FORM

THE ROADS DEVELOPMENT STUDY IN THE NORTH REGION PHASE II

O/D QUESTIONNAIRE FOR PASSENGER CAR AND TRUCK

Station _____ Date _____ Time _____ Direction _____

Type of Vehicles		Question	General
Passenger Car and Taxi	Pan Car Taxi	For All Vehicles	1. Mark _____ Model _____ Engine Size _____ C.C. or H.P. 2. Type of Fuel A. Diesel B. L. Benzene C. H. Benzene D. Gas 3. Origin of This Trip (Ban, Tambon, Amphoe, Changwat) _____ 4. Destination of This Trip (Ban, Tambon, Amphoe, Changwat) _____ 5. Number of Trips on This Road Per Day/Week/Month _____ 6. Number of Occupants in the Vehicle (Including driver) _____
Truck	Pick Up or Smaller 4 Wheel Truck Bigger than Pick Up 6 Wheel Truck 10 Wheel Truck and Trailer	For Truck and Other Vehicles Carrying Capacity	Particular 7. It is Registered as Passenger Car/Bus/Truck 8. Empty Weight _____ Ton; Load Carrying Capacity _____ Ton; Gross Weight _____ Ton 9. Weight of Cargo _____ Ton 10. Volume of Cargo _____ Cu.M. ☐ Empty ☐ 1/4 Truck ☐ 1/2 Truck ☐ 3/4 Truck ☐ Full ☐ 1/4 over capacity 11. Type of Commodities 1981 ☐ Rice ☐ Maize ☐ Sugar Cane ☐ Cassava ☐ Bean ☐ Seed Cotton ☐ Tobacco Leaves ☐ Forest Products ☐ Livestock ☐ Other Agr. Prod. ☐ Fishery Prod. ☐ Other Ind. Products ☐ Mining Product ☐ Mineral and Oil ☐ Groceries ☐ Household Implements ☐ Person ☐ Other

THE ROADS DEVELOPMENT STUDY IN THE NORTH REGION PHASE II

O/D QUESTIONNAIRE FOR BUS ONLY

Type of Buses	General
Light Bus Medium Bus Heavy Bus	Station _____ Direction _____ Date _____ Time _____ Mark _____ Model _____ Engine Size _____ C.C. or H.P. Type of Fuel Diesel L. Benzene H. Benzene Gas

Bus Information

Origin (Ban, Tambon, Amphoe, Changwat) _____

Destination (Ban, Tambon, Amphoe, Changwat) _____

Maximum Capacity _____

Number of Occupants (Including driver) _____

Passenger Information

Number	Origin (Ban, Tambon, Amphoe, Changwat)	Destination (Ban, Tambon, Amphoe, Changwat)
1.		
2.		
3.		
4.		

Figure 3-3 O/D SURVEY POINTS

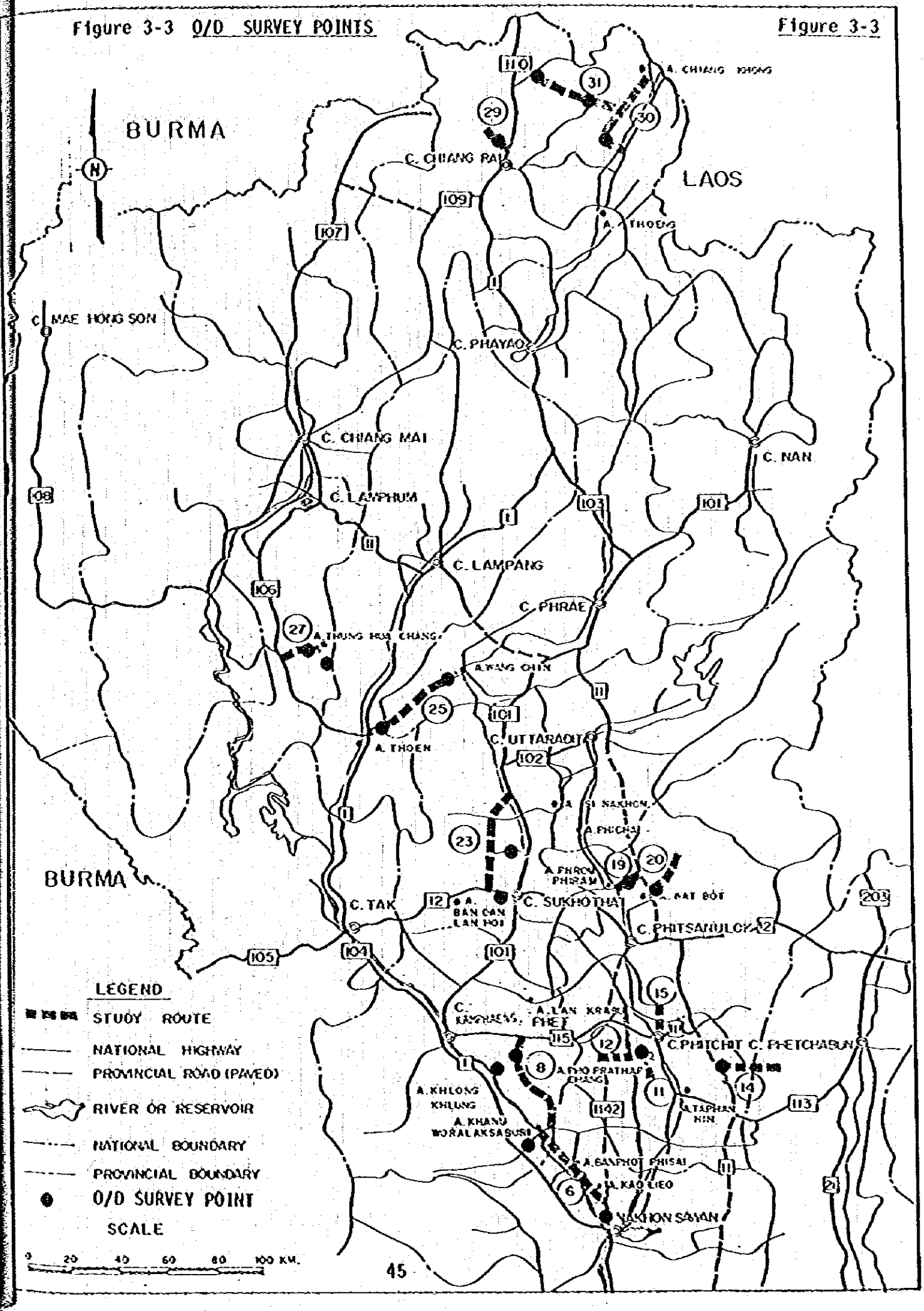


FIGURE 3-4 HOME INTERVIEW SURVEY FORM

ROAD DEVELOPMENT STUDY IN THE NORTHERN REGION (PHASE II)

HOME INTERVIEW SURVEY

NO.

☑ Sample Indentification

Name of Village	Ban: Tambon : Amphoe:	Project Road	
Date & Survey Time	th Sep. 1981 (AM/PM : ~ AM/PM :)	Recorded by	

☑ Household Income and Trip Characteristics

Number of Household Members..... ____ persons

Household Members		Sex	Age (Years)	Occupation						Income		Number of Person Trips														Cost per Trip	
												Light Bus			Heavy Bus			Motorcycle			Pickup (passenger)			Passenger Car, Taxi			L/B	H/B
				Farmer	Self-employed	Employee	Gov. officer	Others	None	Monthly (B/m)	Yearly (B/Y)	per day	per week	per month	per day	per week	per month	per day	per week	per month	per day	per week	per month	per day	per week	per month	(B)	(B)
Head of Household	(1)	M F																									
Member of Household	(2)	M F																									
	(3)	M F																									
	(4)	M F																									
	(5)	M F																									
	(6)	M F																									
	(7)	M F																									
	(8)	M F																									
	(9)	M F																									
	(10)	M F																									
	(11)	M F																									
	(12)	M F																									
Total																											

☑ Car Ownership ☑ Office Work

1. Owned 2. Not Owned

Vehicle Type	Model of Vehicle	Engine Capacity	Vehicle Purchase: Price (¥)	Purchase Year	New Car	Second Hand (Years)	Running Km (Km/Month)	Fuel Cost (¥/Month)	Other Running Cost (¥/Month)
Motorcycle		cc			n	S( )			
		cc			n	S( )			
		cc			n	S( )			
Pickup Truck (passenger use)		cc			n	S( )			
		cc			n	S( )			
Passenger Car		cc			n	S( )			
		cc			n	S( )			
					n	S( )			

Household Income	¥/Y
Per Capita Income	¥/Y
Total Household Trips	tr/Y
Trips per person	tr/Y
Cost for Local Travel	¥/Y
Cost for Long Dist. Travel	¥/Y
Vehicle Operation Cost	¥/Y
Vehicle Purchase	¥/Y

Figure 3-4

FIGURE 3-5 PROPORTION OF PUBLIC VEHICLES TO PASSENGER TRAFFIC

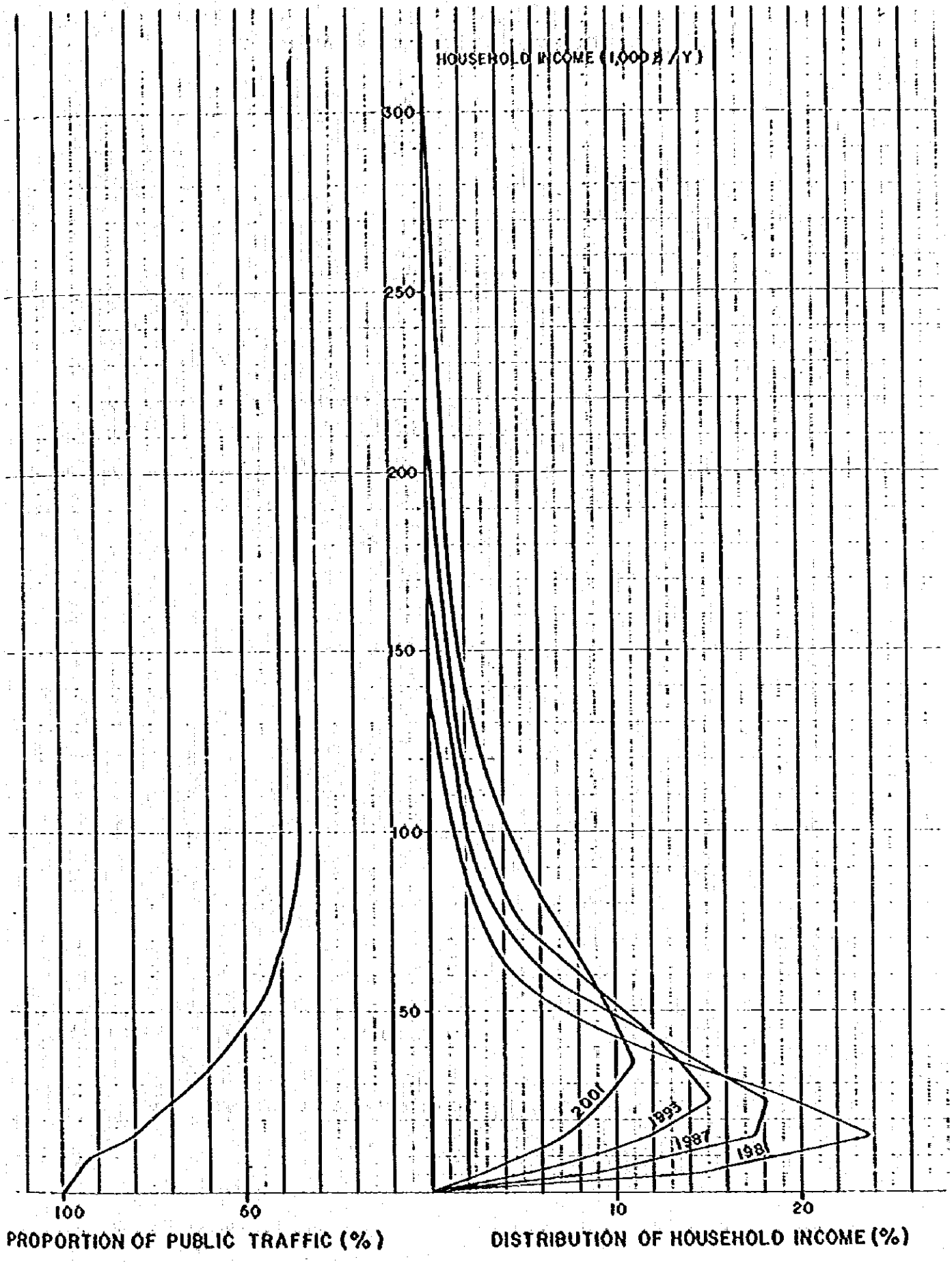
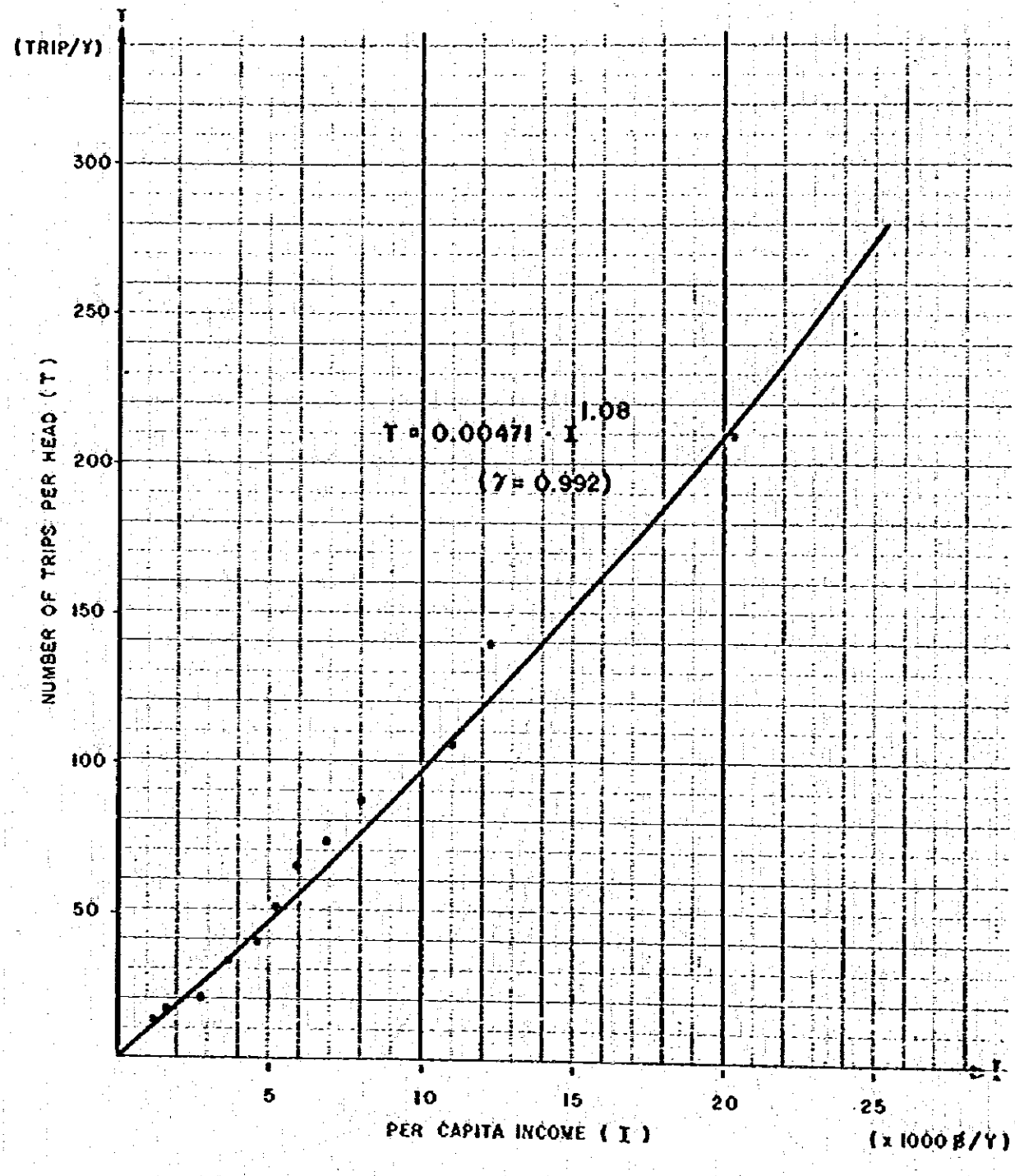


Figure 3-6

FIGURE 3-6 INCOME ELASTICITY



Note: Income elasticity is calculated as follows:

$$e = \frac{dT/T}{dI/I} = 1.08$$

Table 3-1 RESULTS OF ROADSIDE INTERVIEW

1) Traffic Composition

Passenger Traffic

Road Class	Traffic Composition (%)				
	P/C	P/P	L/B	M/B	H/B
National Highway (Primary)	30.9	24.4	6.8	22.0	15.9
National Highway (Secondary)	40.6	24.6	6.9	22.4	5.5
Provincial Road (Paved)	18.7	28.5	28.5	15.3	9.0
Provincial Road (Un-paved)	8.8	23.5	34.0	29.9	3.8

Freight Traffic

Road Class	Traffic Composition (%)			
	P/T	4/T	6/T	10/T
National Highway (Primary)	24.7	11.4	37.6	29.3
National Highway (Secondary)	37.3	17.2	24.1	21.4
Provincial Road (Paved)	45.6	2.6	37.6	14.2
Provincial Road (Un-paved)	42.1	15.3	29.9	12.7

Table 3-1 RESULTS OF ROADSIDE INTERVIEW (Cont'd)

2) Average Occupancy, Loading Ratio

Occupancy

Type of Vehicle	Occupancy (person/vehicle)
P/C	3.1
P/P	4.4
L/B	10.9
M/B	16.2
H/B	38.3

Loading Ratio

Type of Vehicle	Ave. Load (ton/vehicle)
P/T	0.65
4/T	2.00
6/T	4.10
10/T	12.61

Rate of Empty Truck

Type of Vehicle	Empty Truck	Loaded Truck
P/T	66.3	33.7
4/T	52.0	48.0
6/T	60.4	39.6
10/T	47.5	52.5

Table 3-2 VILLAGES SURVEYED FOR HOME INTERVIEWS

Study Route	Ban	Tambon	Amphoe
6	Kao Lieo	Kao Lieo	Kao Lieo
	Dongpachan	Tasang	Banphot Phisai
	Yangane	Maklua	M.Nakhon Sawan
8	Tungsai	Tungsai	Klongklung
	Tungsanoon	Rahan	Kanu Woralak Buri
	Donchan	Tungsai	Klongklung
14	Wang Cha Nang	Tai Dong	Chon Daen
	Wang Kradat	Tai Dong	Chon Daen
	Khao Din	Khaojedlook	Thaphan Hin
20	Pa Khai	Ban Yang	Wat Bote
	Nam Hak	Ban Yang	Wat Bote
	Na Kham	Ban Yang	Wat Bote
23	Pak Klong	Muang Kao	M. Sukhothai
	Wang Thong Daeng	Wang Thong Daeng	M. Sukhothai
	Nhong Tachot	Wang Thong Daeng	M. Sukhothai
25	Thapha	Mae Pa	Thoen
	Huathung	Mae Pa	Thoen
	Muang Kham	Saroy	Wang Chin
29	Ban Pa Yang	Mae Yao	M. Chiang Rai
	Bai Mun	Mae Yao	M. Chiang Rai
	Thung Luang	Mae Yao	M. Chiang Rai
31	Khew Phao	Chantawa	Mae Chan
	Mae Ha	Takhaoploek	Mae Chan
	Takhaoploek	Takhaoploek	Mae Chan

Table 3-3 RESULTS OF HOME INTERVIEW SURVEY

Class No.	Household Income Class (₱/Y)	No. of Sample	Ave. of Household Income (₱/Y)	Transport Expenditure (₱/Y)				Per Capita Income (₱/Y)	Per Capita Expenditure for Transport (₱/Y)	Number Trips per Head (Trip/Y)
				Local Travel	Out of zone	Vehicle Operation	Vehicle Purchase			
1	less than 5,000	13	4,392	304	19	-	-	1,098	81	10.5
2	5,000~10,000	48	7,192	420	74	11	31	1,598	118	15.1
3	10,000~15,000	64	12,666	563	110	83	206	2,711	206	18.9
4	15,000~20,000	53	17,904	973	187	184	436	3,663	364	33.2
5	20,000~25,000	38	22,592	863	452	559	685	4,591	520	39.1
6	25,000~30,000	54	28,290	1,186	134	723	1,077	5,305	585	48.8
7	30,000~35,000	31	33,003	1,057	793	786	1,098	5,880	666	64.5
8	35,000~40,000	39	37,944	1,441	734	1,013	1,265	6,757	793	72.2
9	40,000~50,000	33	45,527	2,100	113	1,498	2,325	8,034	1,065	86.1
10	50,000~60,000	24	55,195	1,683	181	1,688	3,318	10,682	1,330	106.3
11	60,000~80,000	28	70,732	1,766	429	4,046	3,022	12,076	1,581	140.0
12	more than 80,000	21	123,022	2,538	1,289	8,999	8,063	20,183	3,427	209.1

Note: Average of Per Capita Income ----- 6,287 (₱/Y)

Table 3-4 BASE DATA FOR ESTIMATION OF PARAMETERS OF NON-AGRICULTURAL FREIGHT MODEL

Survey Point		Pass. Movement (person/day)	Freight Movement (ton/day)	
			Actual	Predicted
Phase 2	No.1	5,428	360	434
	No.2A	1,038	192	61
	No.2B	585	43	31
	No.3	1,583	290	100
	No.4	567	15	30
	No.5	6,567	1,408	544
	No.7	1,069	299	63
	No.10	586	18	31
	No.11	487	7	25
	No.12	953	136	55
	No.14	1,175	26	70
Phase 1	OD-1	4,991	189	393
	OD-2	1,017	77	59
	OD-3	6,114	456	500
	OD-4	3,469	88	255
	OD-5	15,026	2,001	1,458
	OD-6	2,488	137	171
	OD-7	4,153	456	315
	OD-8	8,986	455	790
	OD-9	9,336	756	827
	OD-21	6,550	631	543

Table 3-5 BASE DATA FOR ESTIMATION OF PARAMETERS OF MOTORCYCLE TRAFFIC MODEL

Traffic Count Station	ADT	L/B	M/C	
			Actual	Predicted
No.11	50	14	69	101
No.98	64	3	40	66
No.4	92	16	148	135
No.10	98	37	362	223
No.13	101	37	218	225
No.14	112	19	150	157
No.15	119	2	165	92
No.8	121	3	132	97
No.9A	121	2	116	93
No.2A	143	2	45	103
No.7	155	43	171	274
No.12	225	61	214	374
No.6	313	47	371	344
OD-2	360	40	519	328
OD-6	400	54	408	394
OD-1	710	52	384	432
OD-7	850	34	271	369
No.1	956	221	1,114	1,131
No.5	1,033	38	224	391
OD-21	1,350	160	665	878
OD-8	1,730	56	792	427
OD-9	1,730	19	304	277
OD-22	1,900	103	621	598

Table 3-6 GROWTH RATES OF TRANSPORTATION DEMANDS

Project Road	Passenger		Agri. Freight		Non-Agri. Freight	
	1987-1993	1993-2001	1987-1993	1993-2001	1987-1993	1993-2001
6	6.4	6.3	0.1	0.1	7.6	7.5
8	6.8	6.3	1.9	1.6	8.1	7.5
11	7.2	6.3	0.7	0.3	8.6	7.5
12	6.3	6.3	0.5	0.4	7.5	7.5
14	7.2	6.3	0.4	0.4	8.6	7.5
15	5.9	6.3	0.5	0.5	7.0	7.5
19	6.3	5.7	0.5	0.4	7.5	6.8
20	6.7	5.7	0.8	0.2	8.0	6.8
23	7.4	5.7	1.7	1.4	7.5	6.8
25	7.7	7.1	0.4	0.3	8.8	8.4
27	6.7	7.1	1.3	0.7	9.2	8.4
29	6.7	6.2	0.1	0.1	8.0	7.4
30	6.7	6.2	0.1	0.1	8.0	7.4
31	6.2	6.2	0.6	0.5	7.4	7.4

Table 3-7 FORECASTED ADTs ON PROPOSED ROUTE

Study Road No.	Changwat	Origin - Destination	ADT 1987	ADT 1993	ADT 2001
6	Kamphaeng Phet/ Nakhon Sawan	Khanu Woralaksa Buri - Kao Lieo - Rt. 117	617	887	1435
8	Kamphaeng Phet	Rt.115 (B. Thung Mahachai) - B. Nong Takhian	361	527	855
11	Phichit	Rt. 1068 - Pho Prathap Chang	159	244	419
12	Phichit	B. Wang Chik - Rt. 117 (B. Pa Daeng)	411	598	1026
14	Phichit/ Phetchabun	Rt. 11 (B. Nong Khanak) - B. Wang Pong	312	493	849
15	Phichit/ Phitsanulok	B. Wang Tham - Rt. 1114 (B. Tha Makham)	342	483	828
19	Phitsanulok	Phrom Phiram - Rt. 11 (B. Nong Makhang)	165	242	380
20 1/	Phitsanulok	Wat Bot - B. Makham	138	213	361
23	Shukhothai	Rt. 12 (Muang Kao Sukhothai) - Si Satchanalei	233	345	546
25	Lampang/Phrae	Toen - Wang Chin	270	404	700
27 2/	Lamphun	Rt. 106 (B. Mae Thoei) - Thung Hau Chang	67	90	136
29	Chiang Rai	Rt. 110 (B. Rong Sua Ten) - B. Hauai Khom	269	391	637
30	Chiang Rai	Rt. 1020 (B. Thung Ngiu) - Rt. 1020 (B. Chumphu)	291	414	642
31	Chiang Rai	Rt. 1016 (B. Kiu Phrao) - Rt. 1174 (B. Kaen Tai)	239	324	495

Note: 1/ : F5 Standard
2/ : F6 Standard