

From Tha Rua, around 90 percent of maize is sent by barges on the river to Bangkok, and remaining 10 percent is transported by trucks.

2) Marketing of Rice

a) Local Mills

Paddy after threshing is sent by farmers or village rice merchant to local rice mills. Rice mills exist in each center of rice growing areas. Major rice growing zones in the Area are mostly in the lowland nearer to the paved highway along which major assembling markets exist. Hence, intervention of village middlemen is seldom.

b) Assembly Markets and Terminal Markets

Milled rice is distributed by mills to local markets, assembly markets and terminal markets. Assembly markets for rice are located at major towns along highways. About 25 percent of total production in the Area is sold at the markets in the surrounding districts or cities in the northward of Bangkok. Hillside zones in the Area have shortage of paddy field and are supplied milled rice from local assembly markets or mills in lowland.

3) Marketing of Cassava

a) Assembling, Chipping and Drying

Promptly after harvesting cassava roots, within a few days at the latest, farmers bring them to the nearest cassava chipping factories. There exist no special middlemen like in the case of maize. Main assembling season of cassava roots extends from June through October. After chipping and drying, cassava chips are sent to either cassava pellet factories or cassava flour factories for materials of tapioca products.

b) Pelleting and Exporting

Cassava chips are sent to several pelleting factories in the vicinity of Chaiphum city and Chaturat. Cassava pellets produced in those factories are sent to the several port cities such as Sattahip, Chon Buri, Sracha and Bangkok for export to Europe mainly.

Tapioca flour factories are mostly in coastal area and collect materials directly from the production area.

4) Marketing of Kenaf**a) Grading and Baling**

After drying and retting stems, farmers or middlemen send kenaf raw materials to primary factories in Chaiphum city and in the towns along Route 201. In the factories, raw materials are graded into six grades by quality and then baled to be sent to textile mills. Main assembling season of raw kenaf is from October to February.

b) Jute Textile Mills

Kenaf bales produced in Chaiphum area are sent mainly to the jute mills in Nakhon Ratchasima area. In the mills, gunny bags and industrial yarns are produced from kenaf with other kind of jute materials. Products are sent to Bangkok area for exportation and domestic consumption.

5) Marketing of Beans and Other Crops

Marketing system for mung beans and soy beans are mostly same as the case of maize. Shipping times of beans from farms to local markets are both rainy and dry seasons. The unit amount of shipment of beans is not large comparing with maize and rice, and accordingly handling charges of middlemen for beans are rather high. Furthermore, purchase prices of beans from farmers are quite flexible according to the market conditions in each production season.

Other minor second crops, vegetables and fruits are mainly produced for self-consumption of farmers or sold to neighbouring local markets, directly by farmers or by village merchants except the fruits productions in big orchards.

3-9 SURROUNDING HIGHWAYS AND TRAFFIC

Due to the dominant position of Bangkok in the Thai economy, majority of goods and passengers moves to and from the Bangkok area. Primary and agricultural products are carried to Bangkok and the Central Region for export or processing, while imported or domestically manufactured products flow in the opposite direction. Reflecting the above traffic demands, radial type road network centering in Bangkok have been evolved. And, road network connecting rural centers in an east-west direction is less dense especially in the surroundings of the Area.

National Highway Route 1 or 32 connects the North Region with the Central Region and Bangkok, and the Northeast Region is connected with the latter by Route 2. The North and the Northeast Region are only linked by Route 12 which runs in an east-west direction between Tak on Route 1 and Khon Kaen on Route 2, through Phitsanulok and Lom Sak. About 160 km down to the south of Route 12, another shorter east-west road, Route 205, connects partly the Northeast Region and the Central Region. In the area widely surrounded by the above-mentioned four highways, i.e., Route 1 in the west, Route 2 in the east, Route 12 in the north and Route 205 in the south, no

other east-west road exist, while road network in north-south is relatively dense. There exist Route 21 in the center of the area, Route 201 in the east and Route 11, of which section between Kao Sai and Tak Fa is under construction, in the west. In addition, two proposed provincial roads, Nakhon Sawan - Phitsanulok Road (Route 1142) and Phetchabun - Chai Badan Road (Route 2260), will complete the road network in a north-south direction. On the other hand in an east-west direction, only short Route 113, which connect Route 11 and 21, exists.

Such being the situation, traffic flow is scarce in an east-west direction at present. For instance, traffic volumes of the existing Route 12 and 205 are 393 - 3,782 and 384 - 2,388 in ADT in 1977, respectively. Scarcity of traffic in an east-west direction is reflected by the present characteristics of economic movement. As major industries and large terminal markets are concentrated in the Central Region and Bangkok areas, there are few economic exchanges between rural areas especially in an east-west direction. However, the present pattern should be changed in the future due to the national policy to disperse the industries away from Bangkok. To accomodate the potential demand of economic exchanges between the North Region and the Northeast Region in an east-west direction, the Project road is one of the most substantial requirements in the Area. The Northeast Region has ample potential for industries such as kenaf textile, kenaf pulp and paper, potash, and ranch industries which are able to attract demands in the North and the Central Regions. On the other hand, the North Region, especially Nakhon Sawan Region, will be a supply source to the Northeast Region of its particular products such as ceramic, agricultural equipment and rice, in case of shortage in the Northeast.

3-10 PRESENT ROAD CONDITION

Figure 3-2 shows the existing road network in and surrounding the Area which give not a little influence to the planning of the proposed highway.

According to the DOH's classification, the existing roads which form the said road network are classified into i) national highways, ii) provincial

highways (hereinafter referred to as DOH road, as commonly called so), iii) Accelerated Rural Development Office roads (hereinafter referred to as ARD road), iv) rural roads and v) others such as Royal Irrigation Department (hereinafter referred to as RID) road and private road. Except national highways, the present conditions of these existing roads are summarized in Table 3-1.

As seen in this table, most of DOH roads are of 6 to 8 m in width between edge to edge, of soil aggregate surfaced and with wooden bridges. Rural roads are generally in poor conditions, such as narrow width of less than 5 m, earth surfaces without any treatment, no drainage system and lacking of river bridge.

Moreover, most of these roads, except national highways, suffer damages more or less from the floods of the rivers in rainy season. Therefore, the road network formed by these imperfect roads is difficult to be called as perfect road network or all-weather road network. This is one of the important factors which necessitate the construction of new highway in an east-west direction in the Area.

As already mentioned, there are no inter-regional highway in an east-west direction in the Area. Only local roads are used mainly for the short range traffic within the limited area. However, a fairly long trip is possible by linking these local roads. For the trip from Nakhon Sawan on Route 1 to Sap Sano Thot on Route 21, through Nong Bua, the following routes can be used:

Nakhon Sawan - Nong Bua	DOH road Routes 1118 and 1119 (or Routes 3004 and 1119)	67.0 km (84.1)
Nong Bua - Khao Haike	Private road of gypsum mine	21.4
Khao Haike - Nong Ngu Luan	Rural road	13.6
Nong Ngu Luan - Hin Dat Yai	Rural road	13.3
Hin Dat Yai - Sap Sano Thot	Rural road	11.4
	Total	126.7 km (143.8)

There exists no distant bus service operated throughout the whole length of the above-mentioned route. The present bus services are those of short range operated between adjoining villages, for example, between Nong Bua and Nong Ngu Luam and between Nong Ngu Luam and Sap Samo Thot. Such a pattern of bus services are seen likewise over the whole Area. Despite the very poor condition in the rural road between Khao Maikae and Nong Ngu Luam, a bus service is offered. This suggests that this route is the shortest one in the existing road network for the trips between Nong Bua and Nong Ngu Luam. If this route does not exist, the traffic between two villages would be required to take long distance detour as the following route:

Nong Bua - Tha Tako	DOH road Route 1119	39.0 km
Tha Tako - Phai Sali	DOH road Route 3004	20.5
Phai Sali - Wang Phikun	Rural road	25.9
Wang Phikun - Nong Ngu Luam	Rural road	14.6
	Total	100.0 km

From Nakhon Sawan to Sap Samo Thot, the following alternative route, not through Nong Bua, can also be taken:

Nakhon Sawan - Tha Tako	Highway Route 1 and DOH road Route 3004	45.1 km
Tha Tako - Phai Sali	DOH road Route 3004	20.5
Phai Sali - Wang Phikun	Rural road	25.9
Wang Phikun - Sap Samo Thot	ARD road	19.6
	Total	111.1 km

Route 3004 between Nakhon Sawan and Tha Tako is a paved road maintained in good conditions and the rest of the section from Tha Tako to Sap Samo Thot is planning to be improved. This route is expected to be an important trunk route between Nakhon Sawan and Sap Samo Thot after completion of the improvement.

For the trip from Sap Samo Thot to the east bank area of the Pasak River, for example, to Naa Ron located at the foot of the Luak Range, the following two routes are to be taken, since there is no road which runs to the east directly from Sap Samo Thot and traverses the Pasak River.

Sap Samo Thot - Rahun	Highway Route 21	5.5 km
Rahun - Sap Bon	ARD road	18.1
Sap Bon - Wichian Buri	ARD road	21.0
Wichian Buri - Nam Ron	ARD road	18.0
	Total	<u>62.6 km</u>

and

Sap Samo Thot - Sam Yaek	Highway Route 21	15.4 km
Sam Yaek - Wichian Buri	DOH road Route 2012	7.4
Wichian Buri - Nam Ron	ARD road	18.0
	Total	<u>40.8 km</u>

The former is located apart away from the center of Sap Samo Thot by about 5.5 km to the north and the latter by 15 km to the south, respectively. Of the sections crossing over the Pasak River in these two routes, DOH road Route 2012 between Sam Yaek and Wichian Buri of the latter is an all-weather paved road with many concrete bridges, while ARD Road between Rahun and Sap Bon of the former suffer much damage from the floods of the Pasak River in every rainy season due to lack of enough openings for cross drainage and low embankment height. The traffic on this road is usually cut to pieces.

On the east side of Nam Ron, the road network for the traffic in an east-west direction is cut completely. Between Nam Ron and Na Raya, the section crossing the Luak Range, there is no road which allows vehicle traffic to pass. It is connected by a small track which is passable only by farm tractors.

Na Raya, which is located in the area sandwiched by two mountain ranges, the Luak Range and the Phang Hoi Range, is connected with Chaiyaphum through the following route:

Na Raya - Nong Bua Daeng	Rural road	70.0 km
Nong Bua Daeng - Chaiyaphum	DOH road Route 2159	45.0
	Total	<u>115.0 km</u>

Of this route, DOH road Route 2159 is a newly paved road in good conditions. On the other hand the rural road between Na Raya and Nong Bua Daeng is in poor conditions and the traffic is often cut in rainy season. This rural road is to be improved by ARD budget in five years from 1979. After the improvement, the condition of this route is expected to be fairly good over the whole length in near future. However, this route is too long as the route to connect Na Raya with Chaiyaphum. This route runs up to the north and down to the south, as if it runs along two sides of a regular triangle formed by three top points of Na Raya, Nong Bua Daeng and Chaiyaphum.

There is no road, even a foot path, crossing over Phang Iloei Range between Na Raya and Tha Pong. The escarpment of this mountain range has obstructed the construction of traversing road so far. However, if the road which traverses this mountain range is constructed, the travelling distance between Na Raya and Chaiyaphum is greatly shortened, linking this new road with the existing road network in the east of Tha Pong.

There are many existing roads in the area between Tha Pong and Chaiyaphum. They are mainly DOH and ARD roads. The traffic from Tha Pong to Chaiyaphum takes generally the following route:

Tha Pong - Wang Katha	Small track	9.0 km
Wang Katha - Nong Bua Raxe	ARD road Route 11010	25.0
Nong Bua Raxe - Chaturat	DOH road Route 2170	27.0
Chaturat - Chaiyaphum	Highway Route 201	39.0
	Total	<u>100.0 km</u>

Among them the road between Tha Pong and Wang Katha is in poor conditions of a narrow width and a bad earth surface. Moreover, no bridge exists at the river sites. The other roads, DOH road and ARD road are constructed according to the DOH's F5 or F6 Standard and are maintained in fairly good conditions. The present traffic using the above mentioned route to connect Tha Pong with Chaiyaphum will be changed in the section between Nong Bua Raxe and Chaiyaphum in near future. A permanent concrete bridge, 100 m long, is going to be constructed over the Chi River in rural road

section between Nong Bua Rawe and Lup Pho where no bridge exists at present. Therefore, the future route will be:

Tha Pong - Wang Katha	Small track	9.0 km
Wang Katha - Nong Bua Rawe	ARD road Route 11010	25.0
Nong Bua Rawe - Lup Pho	Rural road	14.0
Lup Pho - Chaiphum	DOH road Route 2053	19.5
	Total	<u>67.5 km</u>

Of this route, the rural road is poor in condition, but DOH road Route 2053 has been paved in the section between Ban Khwao and Chaiphum and the remained section is under improvement by the DOH.

Besides the existing roads, mainly in an east-west direction, described hereinabove, there are many other roads, which are connected to these east-west roads, such as ARD road running through Hin Dat Yai in parallel with Highway Route 21, and RID road intersecting with DOH road Route 2053 near Ban Khwao. The present conditions of these roads are described briefly also in Table 3-1.

3-11 TRANSPORTATION

Main transportation system in the Area is land transportation by vehicles, and there is no water and railway transportation. Based on the field survey information, the characteristics of present transportation in the Area are summarized as follows:

1) Passenger Traffic

- Bus is the most popular transportation mode of passenger traffic. Few movement by passenger car are seen. Type of buses in the Area varies according to the road conditions and locality in bus operation. In Nakhon Sawan/Phetchabun side, the main type is light bus of seat capacity of 10 persons, while heavy bus occupies a large portion in Chaiphum side.

- There are about 40 bus lines in the Area. Some of them change their route in rainy season from that in dry season due to the deteriorated condition of road surface. Number of bus operations in each line ranges from 1 to 50 buses per day. Total number of operations in the Area amounts about 530 buses per day in dry season and 400 in rainy season. Details of the network of the major bus routes are shown in Table 4A-1 and Figure 4A-1 of Appendix - 4.
- The bus fare ranges from 0.2 Baht per person per km on better conditioned roads to 1.0 Baht on bad roads.
- The trip purpose of passenger traffic is divided roughly into three categories, i) to and from farm, office, school, etc., ii) business, shopping, transportation of agricultural products, etc. and iii) others such as personal business. According to the roadside interview survey, their average shares in whole trips were 39, 52 and 9 percent, respectively.
- The length of trips to and from farm, office, school, etc. is mostly within 30 minute drive or 15 Baht in passenger fare. That of trips for business, shopping, transport of products, etc. is mostly within 60 minutes or 30 Baht. Trips for other purposes such as entertainment, visiting friends, has a long trip length regardless of trip time and fare.
- Although destinations of passenger traffic depend on the trip purpose, the destinations of trips in the Area are concentrated mainly to Nong Bua, Sap Samo Thot, Wichian Buri, Chatturat and Chaiyaphum.

2) Freight Traffic

- Agricultural products are collected primarily to village centers by carts or tractors. Average distance of primary transportation ranges from 1 to 3 km.

- Agricultural products are transported secondarily to the assembly markets. The destinations are different by crops. The major assembly markets for paddy are the places where big rice mills exist, such as Nong Bua, Wang Phikun, Sap Samo Thot, Wichian Buri, Chatturat and Chaiyaphum. The secondary destinations of maize transportation are Nong Bua, Sap Samo Thot, Wichian Buri, Wata Bag and Chaiyaphum. Especially, Sap Samo Thot and Wichian Buri have predominant influences among the assembling markets of maize.
- The freight charge of secondary transportation of agricultural products ranges from around 2 Baht per ton per km on better conditioned roads to around 7 Baht on bad roads.
- Tradable agricultural products are transported thirdly to such terminal markets outside of the Area as Bangkok, Tha Rua or Sara Buri, by heavy trucks on paved national highways such as Route 21, Route 205 and Route 201.
- The freight charge of third transportation of agricultural products is about 0.4 Baht per ton per km. It is about 1/10 of that of secondary transportation.
- Daily necessities for the inhabitants in the Area are transported by trucks and buses from the local centers. The products such as pig, chicken, charcoal, firewood are being transported mainly by the passengers in the same buses.

Table 3-1 PRESENT CONDITION OF THE EXISTING ROADS

SECTION		CATEGORY	LENGTH (km)	WIDTH (m)	ALIGNMENT	SURFACE		MAJORITY TYPE OF BRIDGES
FROM	TO					TYPE 1/	CONDITION	
Nakhon Sawan	- Chum Saeng	DOH (1118)	35.0	7.0 - 8.0	Fair	SA	Poor	Concrete
Chum Saeng	- Nong Bua	DOH (1119)	32.0	7.0 - 8.0	Fair	SA	Poor	Concrete
Nong Bua	- Tha Tako	DOH (1119)	39.0	7.0 - 8.0	Fair	SA	Poor	Concrete
Nakhon Sawan	- Tha Tako	DOH (3004)	41.5	11.0 - 12.0	Good	SBST	Good	Concrete
Tha Tako	- Phai Sali	DOH (3004)	20.5	11.0 - 12.0	Good	SBST	Fair	Concrete
Nong Bua	- Khao Maike	Private Road of Mine 2/	21.4	7.0 - 8.5	Fair	SA	Poor	Timber
Khao Maike	- Nong Ngu Luam	Rural	13.6	6.5 - 8.0	Bad	SA/E	Bad	Timber
Phai Sali	- Yang Phikun	Rural	25.9	7.0 - 8.0	Poor	SA	Poor	Timber
Yang Phikun	- Sap Samo Thot	ARD	19.6	6.5 - 8.0	Fair	SA	Fair	Timber
Nong Ngu Luam	- Sap Samo Thot	Rural	22.9	4.5 - 5.5	Poor	SA	Bad	No Bridge
Rahun	- Sap Bon	ARD	18.1	6.0 - 10.0	Good	SA	Fair	Timber 3/
Sam Yaek	- Wichan Buri	DOH (2012)	7.4	8.0 - 9.0	Good	DBST	Good	Concrete
Wichan Buri	- Nam Ron	ARD	18.0	8.0 - 9.0	Good	SA	Bad	Timber
Tha Pong	- Yang Katha	Small Track	8.0	4.0 - 5.5	Bad	E	Bad	No Bridge
Yang Katha	- Nong Bua Rave	ARD	25.0	5.5 - 7.5	Poor	SA	Fair	Timber 4/
Nong Bua Rave	- Nong Bua Ban	DOH (2170)	15.0	8.0 - 9.0	Poor	SA	Fair	Concrete
Nong Bua Rave	- Lup Pho	Rural	14.0	3.0 - 4.5	Bad	SA/E	Bad	No Bridge 5/
Lup Pho	- Chaiyaphum	DOH (2053)	19.5	8.0 - 9.0	Good	DBST	Good	Concrete
Chaiyaphum	- Nong Bua Daeng	DOH (2159)	45.0	8.0 - 9.0	Good	DBST	Good	Concrete
Huai Nam Dam	- Ban Khwao	RID	33.0	7.0 - 8.5	Fair	SA	Fair	Concrete
Hin Dat Yai	- Sap Mai Daeng	ARD	6.0	7.0 - 8.5	Fair	SA	Fair	Timber

Note : 1/ DBST --- Double Bituminous Surface Treatment
 SBST --- Single Bituminous Surface Treatment
 SA --- Soil Aggregate
 E --- Earth

- 2/ 6 km. near Khao Maike is narrow (5 m.) and bad surface condition.
 3/ Permanent concrete bridge exists at Pasak River.
 4/ Permanent concrete bridge exists at Lam Chang Tha River.
 5/ Permanent concrete bridge is under construction at Lam Chi River.

FIGURE 3-1 GEOGRAPHIC PROFILE (NONG BUA - CHAIYAPHUM)

GEOGRAPHIC PROFILE

FIGURE 3-1

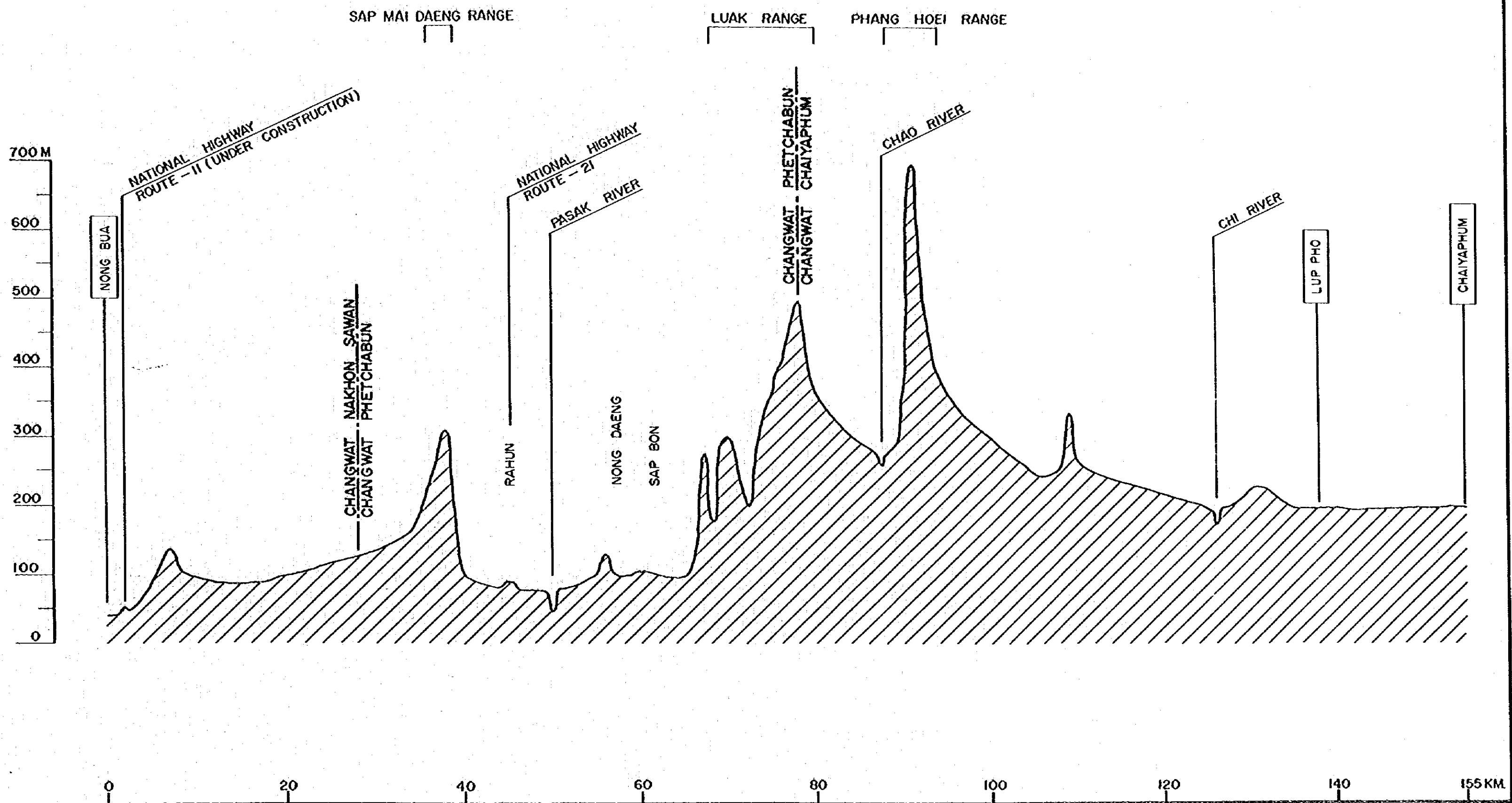
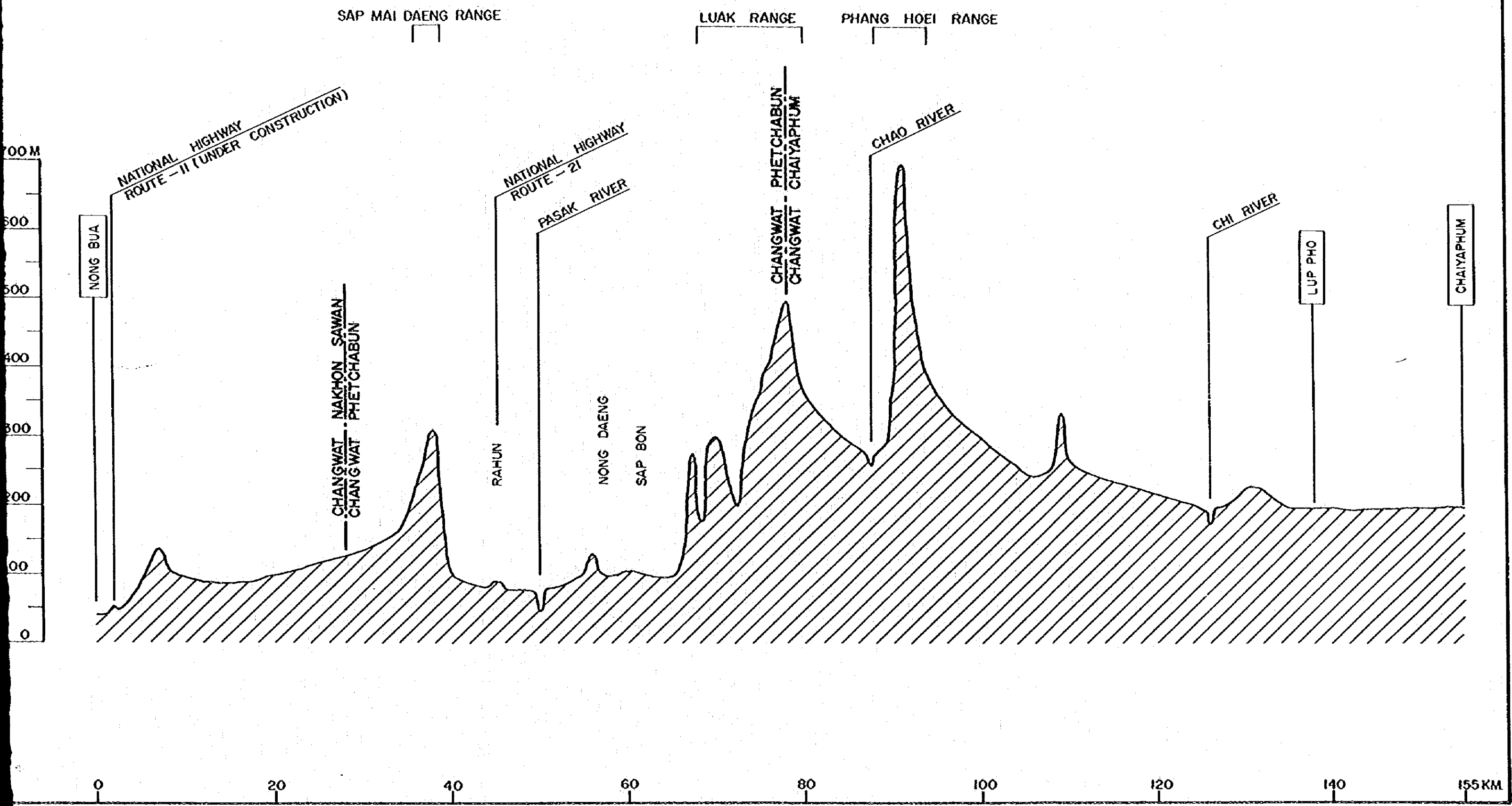








FIGURE 3-1 GEOGRAPHIC PROFILE (NONG BUA - CHAIYAPHUM)

GEOGRAPHIC PROFILE

FIGURE 3-1



LEGEND

-  NATIONAL ROAD UNDER RESPONSIBILITY OF DEPARTMENT OF HIGHWAYS
-  PROVINCIAL ROAD UNDER RESPONSIBILITY OF DEPARTMENT OF HIGHWAYS
-  ACCELERATED RURAL DEVELOPMENT ROAD
-  RURAL ROAD
-  SMALL TRACK
-  OTHERS

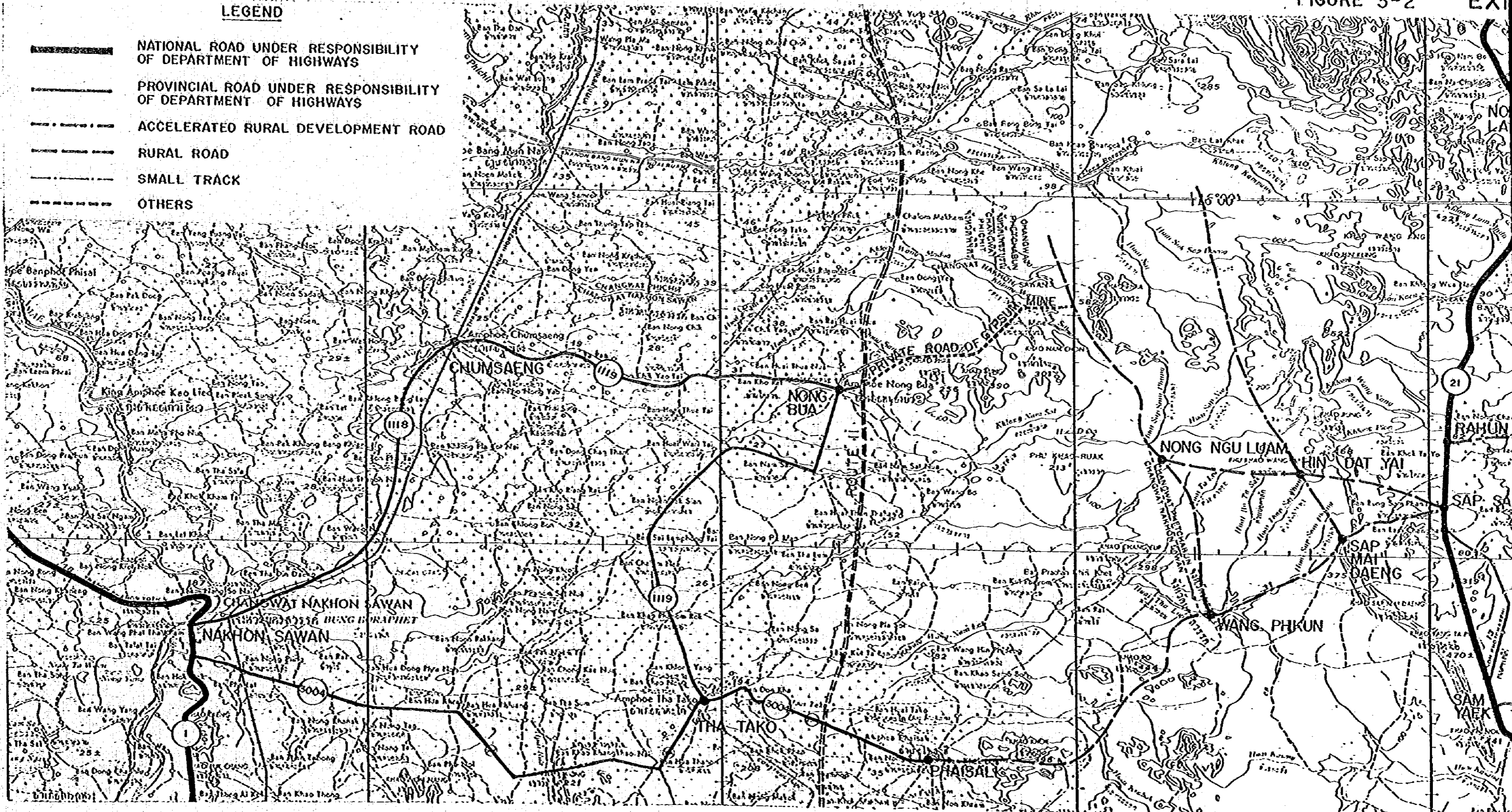
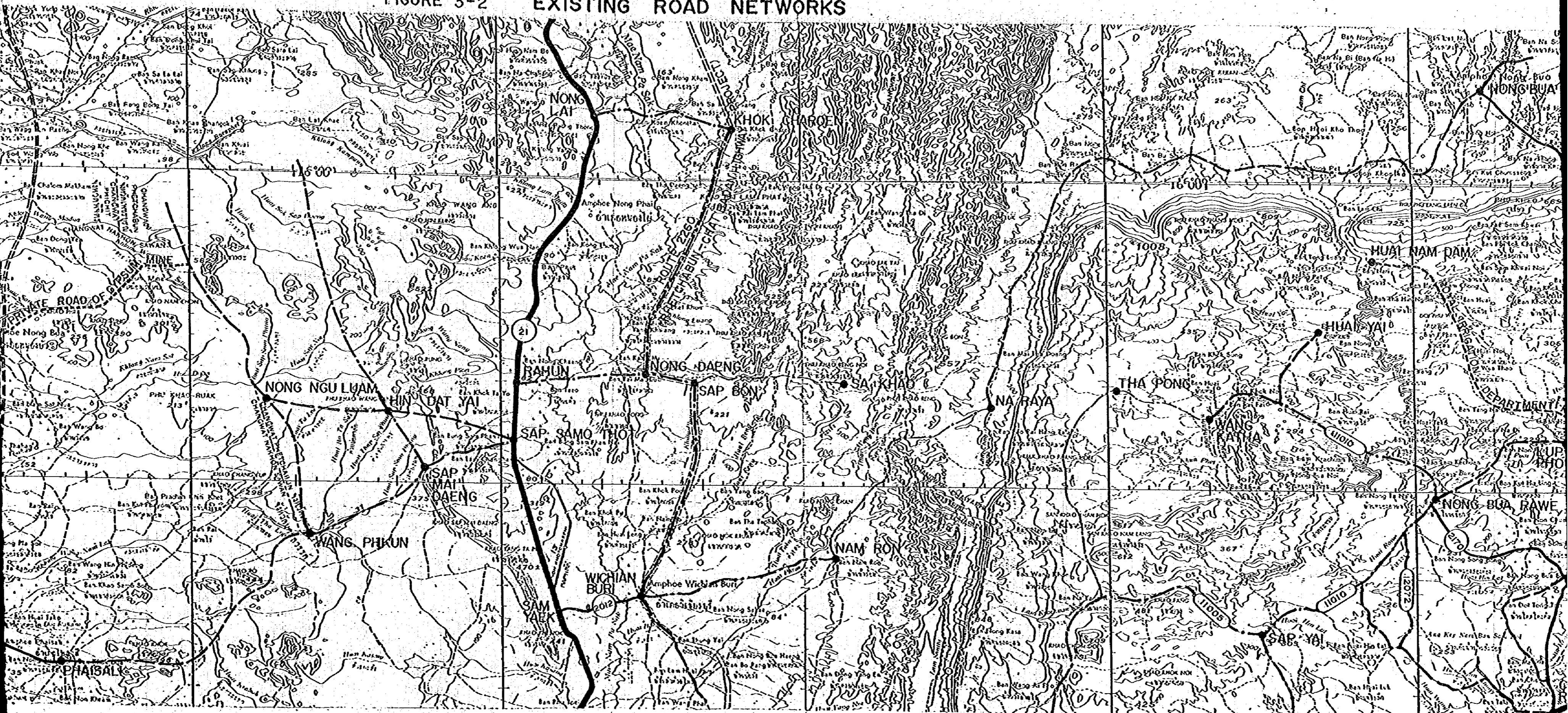
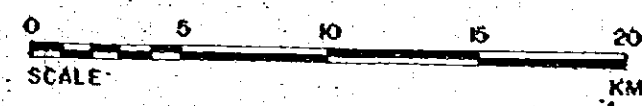
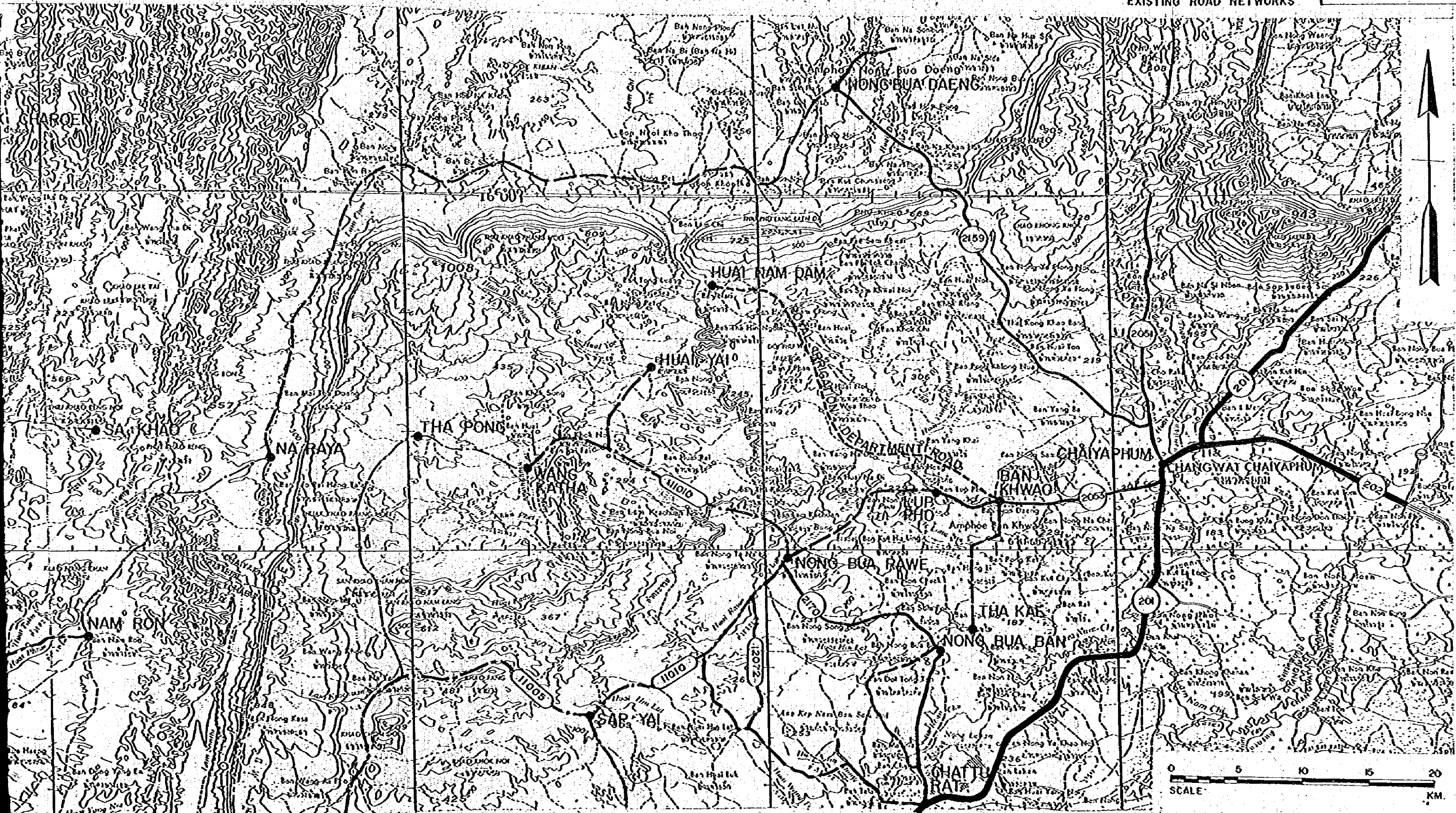


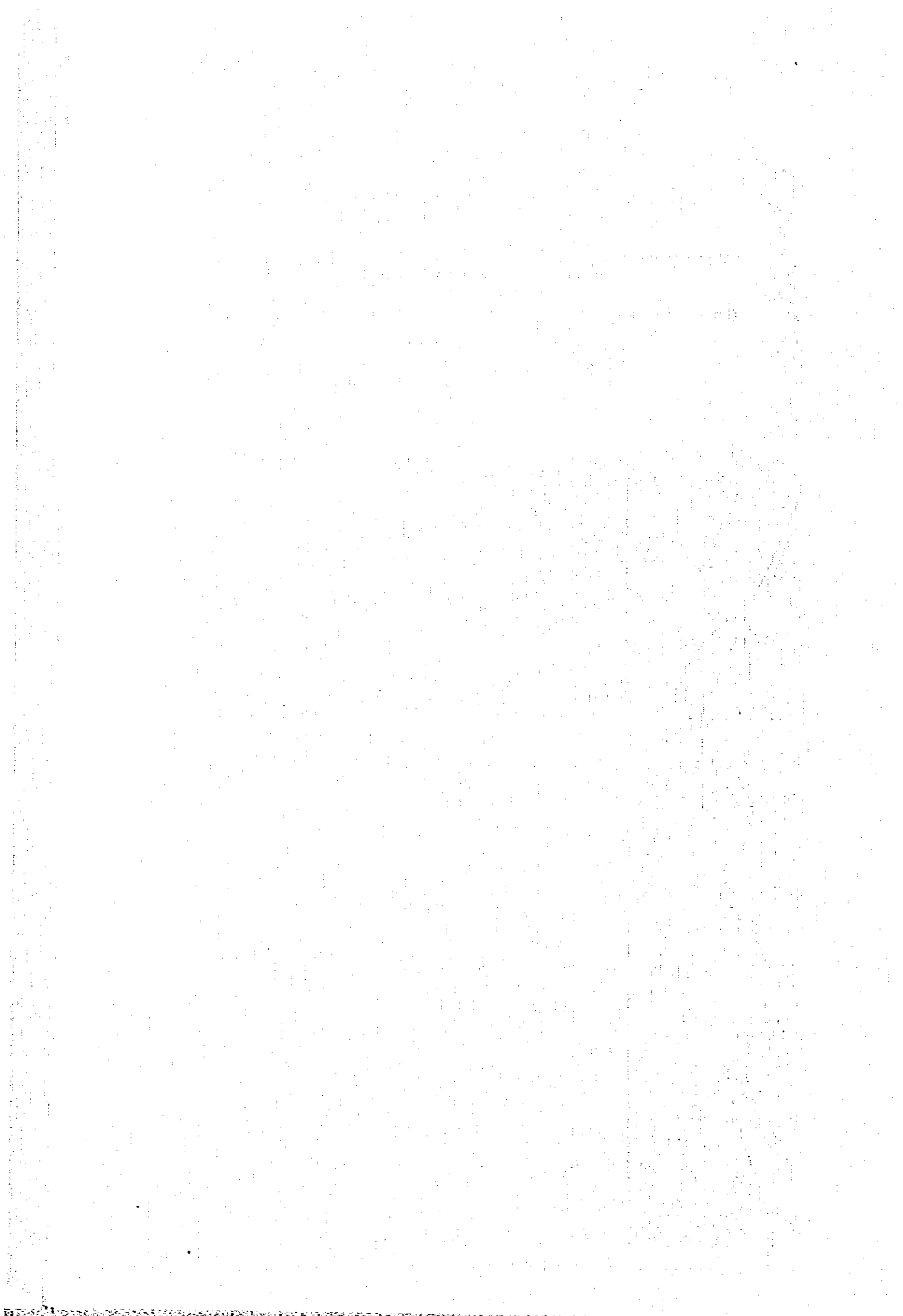
FIGURE 3-2 EXISTING ROAD NETWORKS



EXISTING ROAD NETWORKS

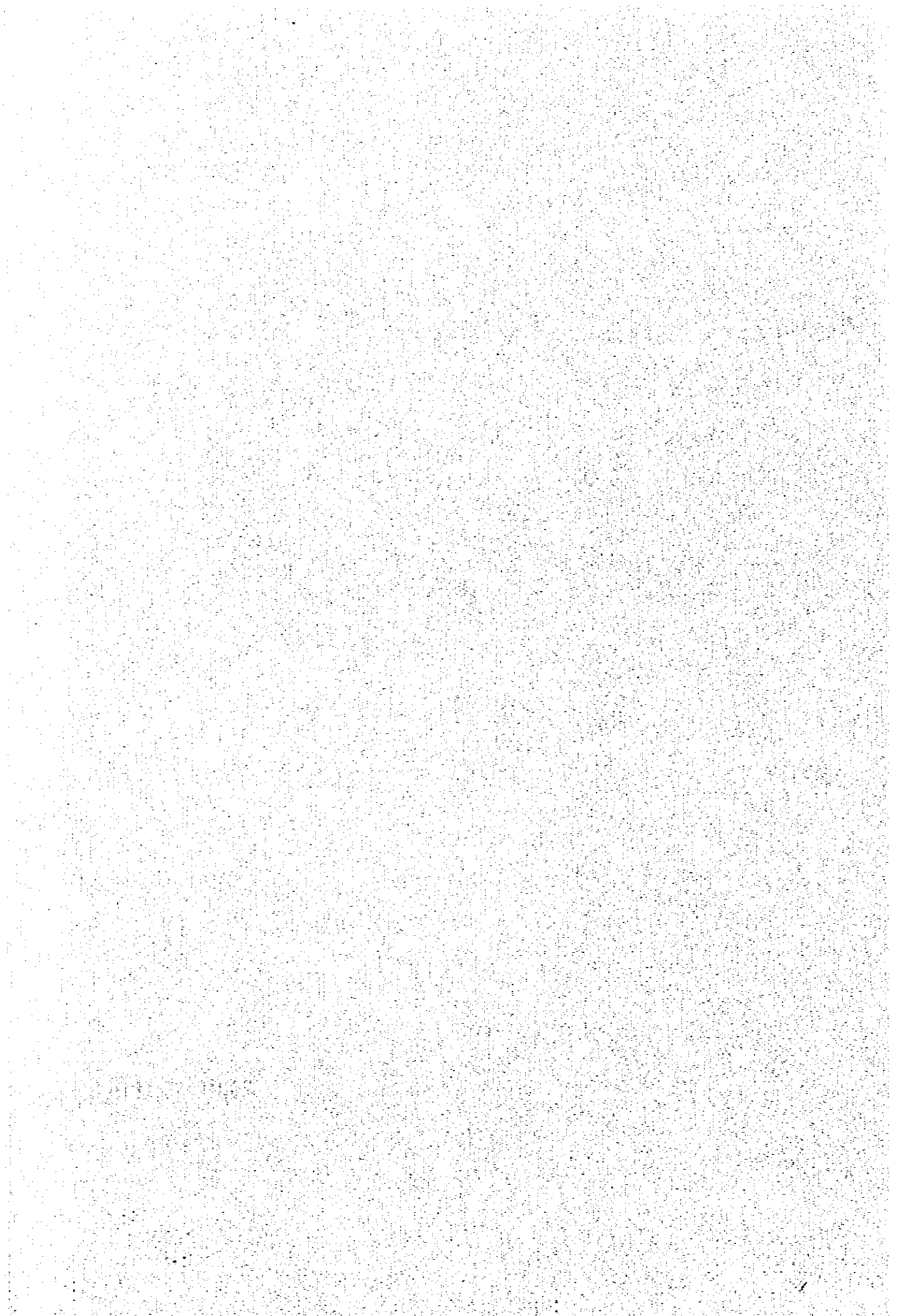
FIGURE 3-2





Chapter IV

ROUTE SELECTION



Chapter IV

ROUTE SELECTION

4-1 PROJECT LOCATION

One of the main objectives of the Project is to construct an east-west highway connecting three Changwats of Nakhon Sawan, Phetchabun and Chaiyaphum in the area between the existing two east-west trunk highways of Route 12 and Route 205, since there is no east-west highway between these two highways, more than 160 km apart each other.

The original project name is "Nong Bua - Sap Samo Thot - Lam Chi Bon Dam Highway" according to the DOH's "Plans for Provincial Road Construction and Improvement (1977-1981)". The background of the original plan, on which Nong Bua, Sap Samo Thot and Lam Chi Bon Dam were included in the Project, is understood as follows:

Nong Bua is connected with Nakhon Sawan by Route 1119 via Chum Saeng and by Route 3004 via Tha Iako. Furthermore, it is an Amphoe center and is located near Route 11, now under construction.

Sap Samo Thot is one of the biggest towns along the Route 21 between Route 12 and Route 205, and the center of King Amphoe Bung Sam Phan.

Lam Chi Bon Dam is the dam site of the Upper Chi Dam, one of the dam sites of the Chi Irrigation Project proposed by the RID. The dam site is connected with Chaiyaphum by a RID road, which would be improved in the said irrigation project, and Route 2055 via Ban Khwao. In

addition, the dam crest would be utilized for the crossing over the Chi River without any bridge construction in the proposed highway project, in case that the timing would match.

However, a slight modification of the project location was required considering that the actual situation has been changed. As in the original idea, Sap Samo Thot is to be considered as an intersection point with Route 21. In addition, Rahun, 5 km north of Sap Samo Thot, is also well positioned for an alternative point of intersection with Route 21, since the existing road is available eastward from Rahun. According to the discussion with the DOH, it was decided that an alternative route through Rahun be also considered. On the other hand, the Upper Chi Dam Site has no right reason as the terminus of the Project at present, as the long delay of the Chi Irrigation Scheme is expected according to the RID. Even if new bridge construction over the Chi River is included in the Project, the east-west highway can not be completed unless the existing RID road is improved, as its vertical alignment is very poor at present. Hence, Lup Pho, a village on Route 2053 near the intersection point with the RID road was selected as the terminus on Chaiyaphum side after the discussion with the DOH. Lup Pho is connected with Chaiyaphum by Route 2053 having been paved partially, of which Lup Pho - Ban Khwao is now under improvement.

Consequently, the project location is summarized as shown below:

- | | |
|---------------------------------|--------------------------|
| i) Starting point | : Nong Bua |
| ii) Ending point | : Lup Pho |
| iii) Intersection with Route 21 | : Sap Samo Thot or Rahun |

4-2 FORMULATION OF ROUTE ALTERNATIVES

4-2-1 Controlling factors in Locating Alignment

The pre-study and field reconnaissance revealed the following absolute controlling factors in locating the alignment of the proposed highway.

1) Avoidance of Reservoir Areas of the Chi Irrigation Project

As mentioned in 4-1, the implementation of the Chi Irrigation Project has been delayed, but not cancelled. Therefore, the alignment of the proposed highway should be selected so as to avoid passing the reservoir areas of the plan. Out of five dams proposed in the Chi Irrigation Project, three dams are located in the Area, they are the Chi Diversion Dam on the main stream of the Chi River near the village of Tha Kadon, the Kachuan Dam on a tributary of the Chi River near the village of Lam Kachuan, and the Prong Khun Phet Dam also on a tributary of the Chi River near the village of Nong Bua Noi. The location of the reservoirs of these dams are shown in Figure 4-1.

In relation with the above, the possible crossing of the Chi River is limited at the following two sites:

- i) Near the proposed Upper Chi Dam Site.
- ii) South of the proposed Chi Diversion Dam, near Nong Bua Rawe.

It should be noted that if the crossing point is selected on the south of the proposed Chi Diversion Dam near Nong Bua Rawe, the 100 m long bridge over the main stream of the Chi River, now under construction and the existing 105 m long bridge over the Chiang Tha River, a tributary of the Chi River, both are the permanent concrete bridges of 7 m wide, can be availed.

2) Selection of the Easiest Crossing of Mountain Ranges

The project road has to cross three mountain ranges which lie in a north-south direction. They are:

- The Rung - Sap Mai Daeng Range on the west of Route 21,
- The Luak Range between the Pasak River and the Chao River, and
- The Phang Hoi Range on the east of the Chao River.

The most difficult one is the crossing of the Phang Hoi Range, the mountain range of sandstone, with an altitude of 550 to 900 m. Since its western side is a very steep precipice, the alignment has to climb on the mountainside along the ridge, for a long length. Therefore,

the route should be located to pass through low portion of the range to save the construction cost. The lowest ridge is located on the east of Na Raya, which is 550 m in altitude. Judging from the profile of the mountains ridge, it was concluded that this lowest ridge is the only portion to be passed.

The Luak Range is also difficult to pass. The easiest terrain of it is the col located between two mountains of the Reng and the Sap Yang, with an altitude of 350 to 700 m. As the north and south sides of the terrace are high and steep mountains and difficult to pass, this col was also selected as one of the controlling points in route locating.

The Rung - Sap Mai Daeng Range has many cols of low elevation along its ridge, therefore, needs no special consideration.

Besides the above, the following should be taken into account in locating route alignment.

- i) To set out a straight connection as possible.
- ii) To utilize the existing road alignment and permanent concrete bridges as much as possible.
- iii) To pass the potential areas for agricultural development as much as possible.
- iv) To connect the villages as many as possible to improve local communications.

4-2-2 Route Alternatives

The possible routes were examined using 1/50,000 scale topographic maps, 1/15,000 scale aerial photos and information obtained through field reconnaissance and inventory survey.

The route alternatives to be further compared were selected based on the above examination, dividing the whole project into three parts, namely, Part I between Nong Bua and Wang Nat, Part II between Wang Nat and Iha Pong and Part III between Iha Pong and Lup Pho. Alternative routes are described below, and are illustrated in Figure 4-1.

Part I: Nong Bua - Wang Wat

This part has two conceivable routes in broad sense, namely, Route Alternative I-1 and Route Alternative I-2.

Route Alternative I-1 is the route via Nong Ngu Luam, which is one of the terminals of the local bus operations, situated on the existing road in the middle between Nong Bua and Sap Samo That.

Route Alternative I-2 is the route via Wang Phikun, which is one of the biggest village in Part I area, aiming at the expansion of economic and social exchanges among big villages of Nong Bua, Wang Phikun and Sap Samo That.

Route Alternative I-1 was further divided into two sections, Section A (Nong Bua- Nong Ngu Luam) and Section B (Nong Ngu Luam - Wang Wat), both having sectional alternatives as follows:

Section A: Nong Bua - Nong Ngu Luam

Sectional Alternative A-1 is selected taking into the maximum utilization of the existing road alignment and passes near the Gypsum mine, north of Khlong Kumlang.

Sectional Alternative A-2 is selected aiming at the short connection by new road construction between Nong Bua and Nong Ngu Luam.

Section B: Nong Ngu Luam - Wang Wat

Sectional Alternative B-1 is selected aiming at the shortest and direct east-west alignment. B-1 constructs new road between Nong Ngu Luam and Rahun on Route 21, and follows the existing road between Rahun and Sap Bon which has permanent concrete bridge over the Pasak River (7 m wide, 75 m long), passes 5.3 km long section between Nong Daeng and Sap Bon which will be improved by the Phetchabun - Chal Badan Highway Project, and then constructs new road between Sap Bon and Wang Wat.

Sectional Alternative B-2 is selected aiming at maximum utilization of the existing road alignment. So, the route follows the existing rural road between Nong Ngu Luam and Rahun. The alignment of the remaining part, east of Rahun, is common to that of B-1.

Sectional Alternative B-3 is selected to pass the north of Sap Samo Thot. The route follows the alignment of the existing rural road between Nong Ngu Luam and Sap Samo Thot. From Sap Samo Thot to Wang Wat, the route constructs new road including new bridges over the Pasak River and its tributaries.

Sectional Alternative B-4 is the modification of B-3. The route separates from that of B-3 at Hin Dat Yai, and then follows the alignment of the existing ARD road which is the best conditioned road in Section B area. After intersecting with Route 21 on the south of Sap Samo Thot town, the route joins B-3 route. From Sap Mai Daeng to Wang Wat, the alignment of B-4 is common to that of Route Alternative I-2.

Part II: Wang Wat - Tha Pong

There is no alternative route in this part, since the alignment is severely limited by the possible crossing of two mountain ranges, the Phang Hoi Range and the Luak Range, as described in 4-2-1. From Wang Wat, the route passes through the col of the Luak Range and reach Na Raya. Then, after crossing the Chao River, it climbs the Phang Hoi Range with the maximum grade of 5 percent and hairpin curves. After the ridge, it descends in rolling terrain to reach Tha Pong. This part is all of new construction. The total length is 41.7 Km.

Part III: Tha Pong - Lup Pho

This part has two route alternatives, they are Route Alternatives III-1 and III-2, depending on the crossing point of the Chi River.

Route Alternative III-1 is the route passing the Chi River at the proposed Upper Chi Dam Site. From Tha Pong, it runs in a northeastern direction to the dam site by new road construction. Then, the route follows the alignment of the existing RID road, running in a southeastern direction, and reaches Lup Pho.

Route Alternative III-2 is the route passing the Chi River at the new bridge site near Nong Bua Rawe. For the most length, it follows the existing road alignment, linking tambon centers of Wang Takhe and Nong Bua Rawe.

4-3 SELECTION OF OPTIMUM ROUTE

As mentioned above, Parts I and III has route alternatives, respectively. However, from the viewpoint to construct an east-west highway, all of them can be included within a corridor connecting Nakhon Sawan and Chaiyaphum. This means that there would be no great difference in future traffic volume among alternatives. Therefore, route comparison was made in comparatively simple way, without calculating economic indicators such as Benefit Cost Ratio and Internal Rate of Return.

4-3-1 Method of Comparison

The components of the Project costs are construction cost and road maintenance cost. The route alternative which has lower construction cost is firstly advantageous in order to raise up the feasibility of the Project. As for the road maintenance cost, as it is proportional to the route length, it can be translated to that shorter route is advantageous.

On the other hand, the quantifiable benefits which are expected to be attained by the Project are agricultural development benefits and road users' benefits. As the agricultural development benefits are measured by the net added value of production, its size depends mainly on the acreage of newly cultivable land within the area which will have the influence of accelerated agricultural development by road construction. The band area of 5 Km wide on both sides of the route was defined as such area, as described in Chapter V. Therefore, the route alternative which has more newly cultivable land in such band area is advantageous. While, since the road users' costs are proportional to the route length, road users' benefits, which is the saving of road users' costs, can be considered to be inversely proportional to the route length. Therefore, shorter route is again advantageous.

Taking the above into consideration, the criteria adopted in selecting the best route was the combination of the following:

- i) The route of lower construction cost is advantageous.
- ii) The route of shorter length is advantageous.

- iii) The route having more newly cultivable land within a band area of 5 Km wide on both sides of the route is advantageous.

Based on the 1/50,000 scale map and the information obtained by the inventory survey and field reconnaissance, preliminary design was carried out. Direct construction cost together with land acquisition cost were estimated by route alternative, assuming the construction of soil aggregate road in accordance with the DOH's F5 Standard, which is described in detail in Chapter VIII: Their details are shown in tables of Appendix 5. While the acreage of newly cultivable land was estimated based on the land capability maps described in 4-5-2.

4-3-2 Comparison of Route Alternatives

1) Part I: Nong Bua - Wang Wat

Route comparison was made taking two steps as follows:

Step 1: Selection of the alignment of Route Alternative I-1 in combination of the best routes selected in both Section A and Section B.

Step 2: Comparison of Route Alternatives I-1 and I-2.

The sectional comparison is shown in tables 4-1 and 4-2 for Sections A and B, respectively.

In Section A, A-2 is advantageous in every respects, lower construction cost, shorter route length and more newly cultivable area than A-1.

In Section B, B-1 is the most advantageous in respect of construction costs and route length, while the acreage of newly cultivable land is the smallest among four sectional alternatives. However, after the following consideration, B-1 was judged as the best route in this section.

The comparison between B-1 and B-4, for example, shows that the construction cost of B-4 is 15 percent higher than that of B-1, while the acreage of newly cultivable land of B-4 is 17 percent

larger than that of B-1. However, as for the agricultural development benefits, referring to the other studies on the same type of roads as the proposed project, they do not exceed the amount of road users' benefits. Therefore, even though agricultural development benefit is assumed to share a half of total benefits, the 17 percent up of acreage raise up the total benefits by 8.5 percent at the highest, while the construction cost of B-4 is 15 percent higher than that of B-1.

The comparison between Route Alternative I-1, which is the combination of Sectional Alternatives A-2 and B-1, and Route Alternative I-2 is shown in Table 4-3. I-1 is advantageous in respect of construction cost and route length, while the acreage of newly cultivable land of I-2 is 19 percent larger than that of I-1. In this comparison, the same consideration was made as described for the comparison of Section B, and I-1 was selected as the best one.

2) Part II: Wang Kat - Tha Pong

The comparative studies were not made as no alternative route was formulated in this Part.

3) Part III: The Pong - Lup Pho

Route Alternatives III-1 and III-2 are compared in Table 4-4. As shown in the table, the acreage of newly cultivable land is almost same between two alternatives, but in respect of construction cost and route length, III-2 is far preferable to III-1.

4-3-3 Optimum Route

The optimum route determined through the above procedures is illustrated in Figure 4-1. Its main features are shown below:

Route: Nong Bua - Nong Ngu Luam - Rahun -
Sap Bon - Wang Wat - Tha Pong -
Nong Bua Rawe - Lup Pho

Length ^{/1}

Part I:	70.3 km	^{/2}	Improvement	54.8 km
Part II:	41.7 km		New Construction:	100.9 km
Part III:	43.7 km			
Total	155.7 km		Total	155.7 km

Note: ^{/1} The lengths are tentatively defined in the stage of the comparative study of route alternatives.
^{/2} Excluding the length of 5.3 km which is overlapped with the Phetchabun - Chai Badan Highway Project.

For the above optimum route, agricultural development forecast, traffic forecast, and preliminary design were made and the project viability was evaluated in the succeeding chapters.

TABLE 4-1

Table 4-1 SECTIONAL COMPARISON (1)
 Section A : Nong Bua - Nong Ngu Luam

ITEM	SECTIONAL ALTERNATIVE	
	A-1	A-2
Route :	Nong Bua - Gypsum Mine - Nong Ngu Luam	Nong Bua - Nong Ngu Luam
Principle :	Utilization of existing road alignment	Short connection by new road construction
Length (km):		
Improvement :	35.0	3.0
New construction :	-	21.4
Total :	35.0	24.4
Construction Costs ^{1/} (million Baht)	38.1	28.5
Newly Cultivable Area: (rai)		
Suited for paddy :	2,100	4,200
Suited for upland crops :	17,800	43,400
Total :	19,900	47,600

Note: ^{1/} Composed of direct construction cost and land acquisition cost.

Conclusion: ALTERNATIVE A-2 IS ADVANTAGEOUS.

A-2 has the following characteristics:

- The horizontal alignment is better and match the objective of the Project to construct east-west highway.
- A-2 connects some big villages along the route which are served with only poor tracks at present, and improves their local communication.
- No contribution to gypsum ore transport.

Table 4-2 SECTIONAL COMPARISON (2)
Section B : Nong Ngu Luam - Wang Wat

ITEM	SECTIONAL ALTERNATIVE			
	B-1	B-2	B-3	B-4
Route :	Nong Ngu Luam - Rahun - Sap Bon - Wang Wat	Nong Ngu Luam - Hin Dat Yai - Rahun - Sap Bon - Wang Wat	Nong Ngu Luam - Hin Dat Yai - Sap Samo Thot (north) - Wang Wat	Nong Ngu Luam - Hin Dat Yai - Sap Samo Thot (south) - Wang Wat
Principle :	Direct connection by new construction between Nong Ngu Luam and Rahun in western part and utilization of the existing Rahun - Sap Bon road alignment	Maximum utilization of the existing road alignment in both western and eastern parts	Utilization of the existing rural road in western part and new construction in eastern part	Utilization of existing rural road (Nong Ngu Luam - Hin Dat Yai) and ARD road (Hin Dat Yai - Sap Samo Thot north) in western part and new construction in eastern part
Length (km) :				
Improvement :	12.8	30.8	24.7	26.6
New construction :	33.1	17.5	27.2	26.0
Total :	45.9	48.3	51.9	52.6
Construction Costs ^{1/} : (million Baht)	84.2	92.7	111.5	96.7
Newly Cultivable Area : (rai)				
Suited for paddy :	4,100	5,700	4,600	4,600
Suited for upland crops :	47,500	50,100	55,800	55,800
Total :	51,600	55,800	60,400	60,400

Note : ^{1/} Composed of direct construction cost and land acquisition cost.

Conclusion : ALTERNATIVE B-1 IS MOST ADVANTAGEOUS.

B-1 has the following characteristics :

- Shortest and most smooth horizontal alignment in east-west direction.
- Vertical alignment crossing the Rung - Sap Mai Daeng Range is the best among alternatives.
- No need to construct the bridge over the Pasak River because the existing bridge (7 m wide, 75 m long) is available.
- A section between Nong Daeng and Sap Bon (5.3 km long) would be improved by the Phetchabun - Chai Badan Highway Project.
- Intersect with Route 21 at Rahun, about 5 km north of Sap Samo Thot.

Table 4-3 ROUTE COMPARISON IN PART I
 Nong Bua - Sap Samo Thot (or Rahun) - Wang Wat

ITEM	ROUTE ALTERNATIVE	
	I-1	I-2
Route :	Nong Bua - Nong Ngu Luam - Rahun - Sap Bon - Wang Wat	Nong Bua - Wang Phikun - Sap Samo Thot (south) - Wang Wat
Principle :	Combination of Sectional Alternatives of A-2 and B-1	Passing through Wang Phikun, one of the biggest villages in Part I area
Length (km)		
Improvement :	15.8	22.6
New construction :	54.5	57.7
Total :	70.3	80.3
Construction Costs ^{1/} : (million Baht)	112.7	128.9
Newly Cultivable Area: (rai)		
Suited for paddy :	8,300	8,200
Suited for upland crops :	89,000	108,000
Total :	97,300	116,200

Note: ^{1/} Composed of direct construction cost and land acquisition cost.

Conclusion: ALTERNATIVE I-1 IS ADVANTAGEOUS

I-1 has the following characteristics:

- Better alignment as the east-west highway than I-2.
- Intersect with Route 21 at Rahun.

TABLE 4-4

Table 4-4 ROUTE COMPARISON IN PART III
Tha Pong - Lup Pho

ITEM	ROUTE ALTERNATIVE	
	III-1	III-2
Route :	Tha Pong - Upper Chi Dam Site - Lup Pho	Tha Pong - Nong Bua Reve - Lup Pho
Principle :	New construction between Tha Pong and the Upper Chi Dam Site and utilization of the existing RID road	Maximum utilization of the existing ARD road alignment and proposed bridge over the Chi River
Length (km):		
Improvement :	33.0	39.0
New construction :	23.0	4.7
Total :	56.0	43.7
Construction Costs ^{1/} (million Baht)	77.0	47.3
Newly Cultivable Area : (rai)		
Suited for paddy :	900	700
Suited for upland crops :	93,000	93,400
Total :	93,900	94,100

Note: ^{1/} Composed of direct construction cost and land acquisition cost.

Conclusion: ALTERNATIVE III-2 IS ADVANTAGEOUS.

III-2 has the following characteristics:

- Better alignment as the east-west highway than III-1.
- No need to construct bridges over the Chi River and Chiang Tha River.
- Improve local communication greatly because most of villages are situated along III-2, not along III-1.

FIGURE 4 - 1

PART	ROUTE ALTERNATIVE	SECTION	LENGTH(km)	SEGMENT ²
I	A	A-1	35.0	1 4
		A-2	(24.4)	1 2 3 5
	B	B-1	(45.9)	7 12 18 21
		B-2	48.3	8 11 13 18 21
		B-3	51.9	8 11 14 17 20
I-2	B-4	52.6	8 10 15 16 20	
I-2			80.3	1 2 6 9 15 16 20
II			(41.7)	22 23 24
III	III-1		56.0	26 28
	III-2		(43.7)	25 27 29 30

Note : 1. The length in parentheses are for the optimum route
 2. The length of segments are indicated in Figure 8-1

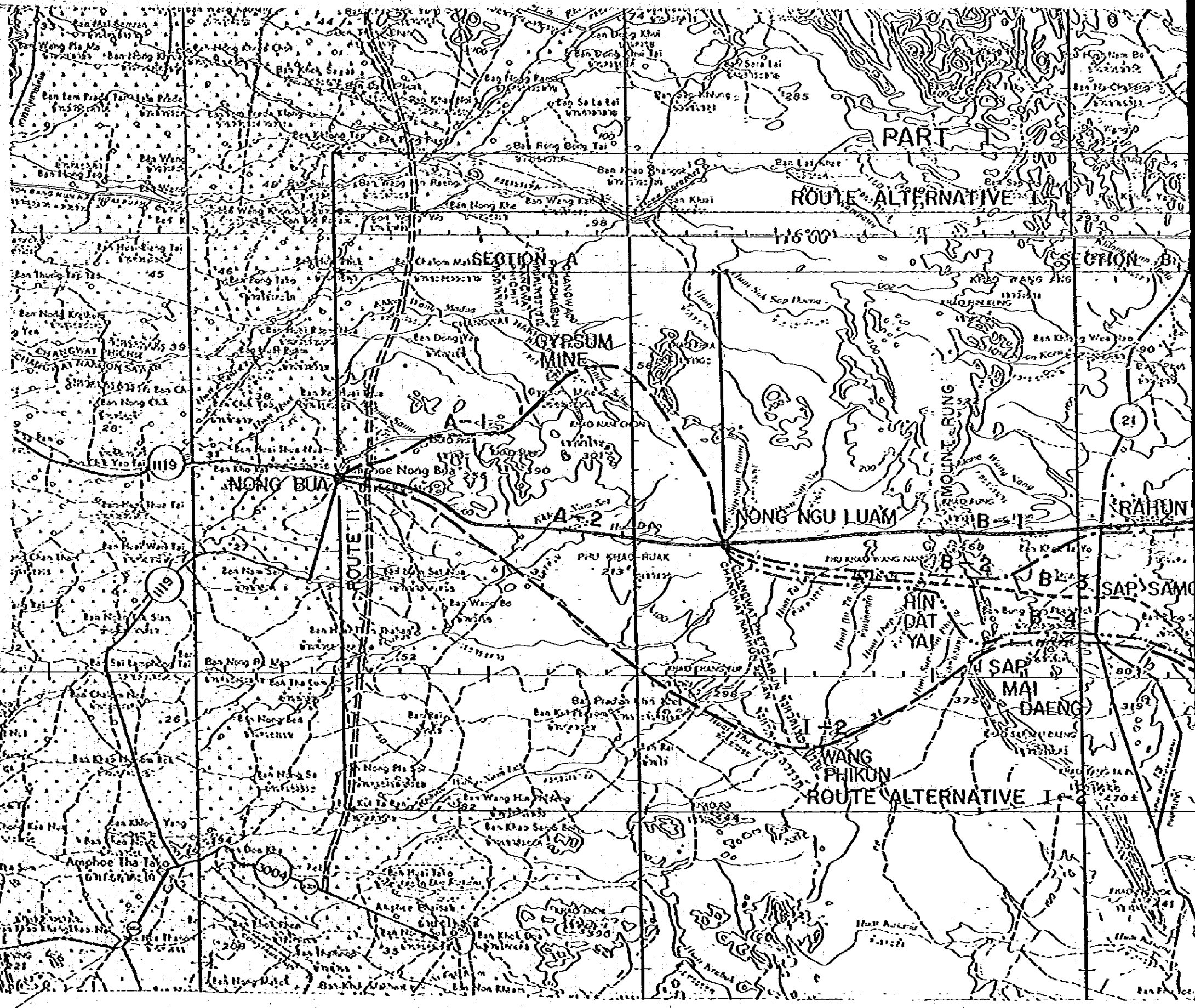
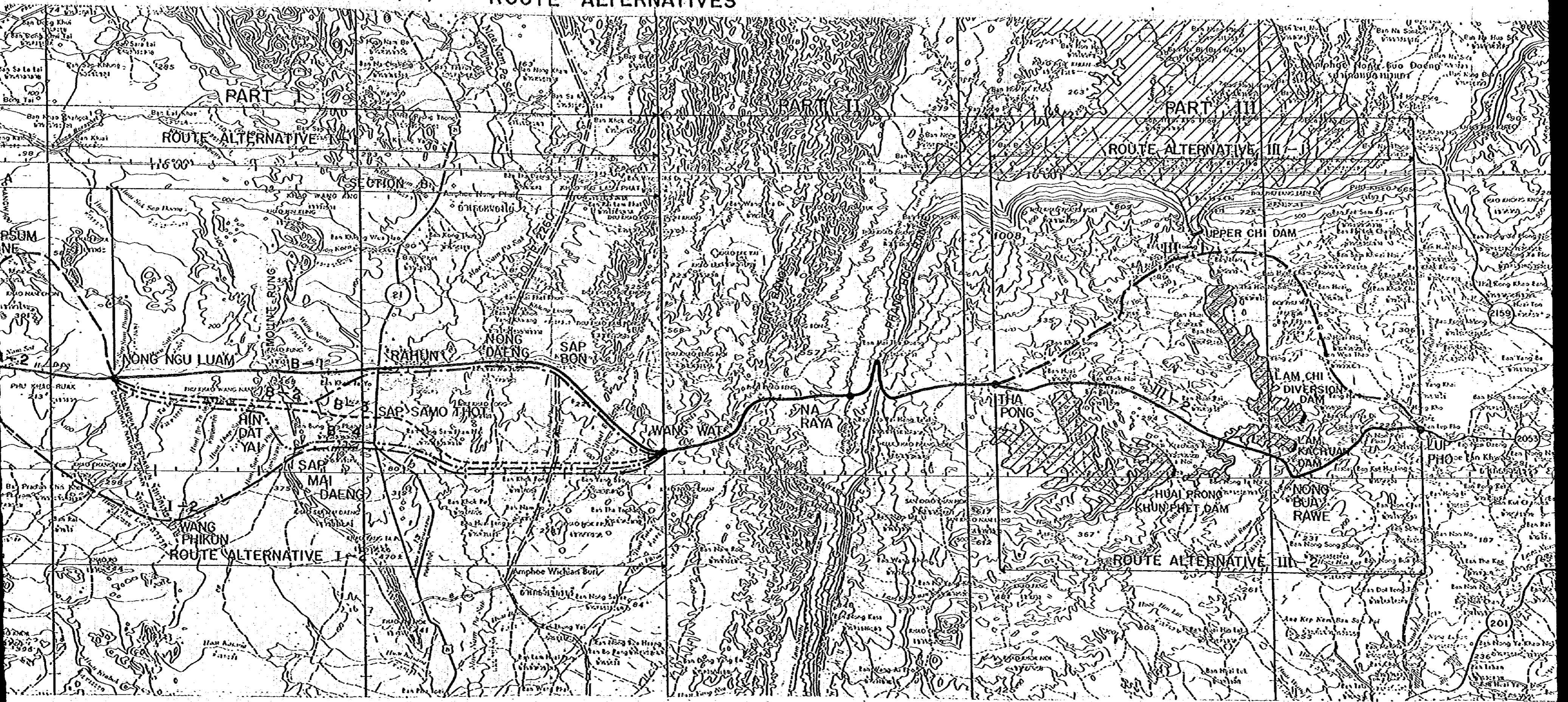
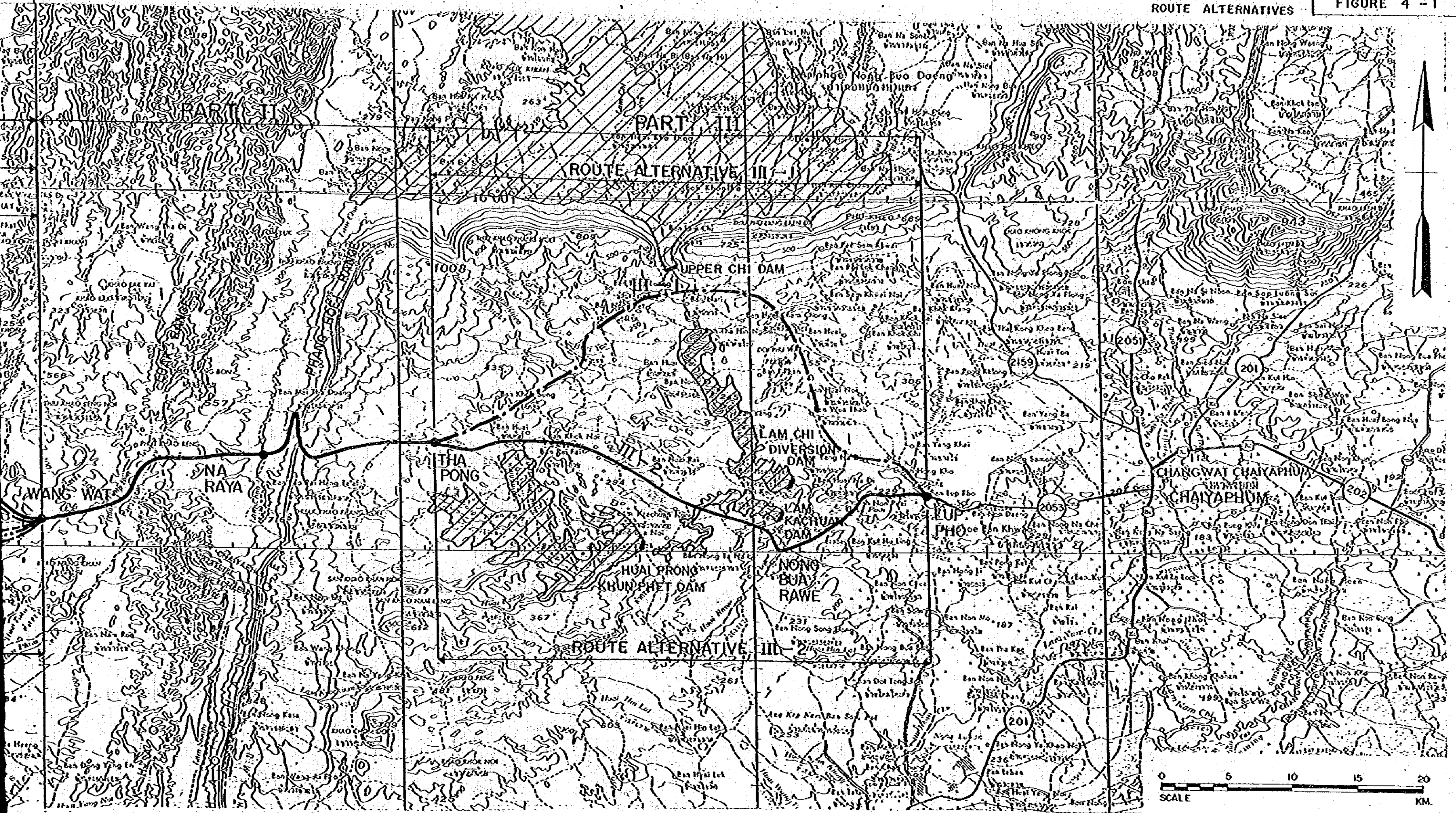


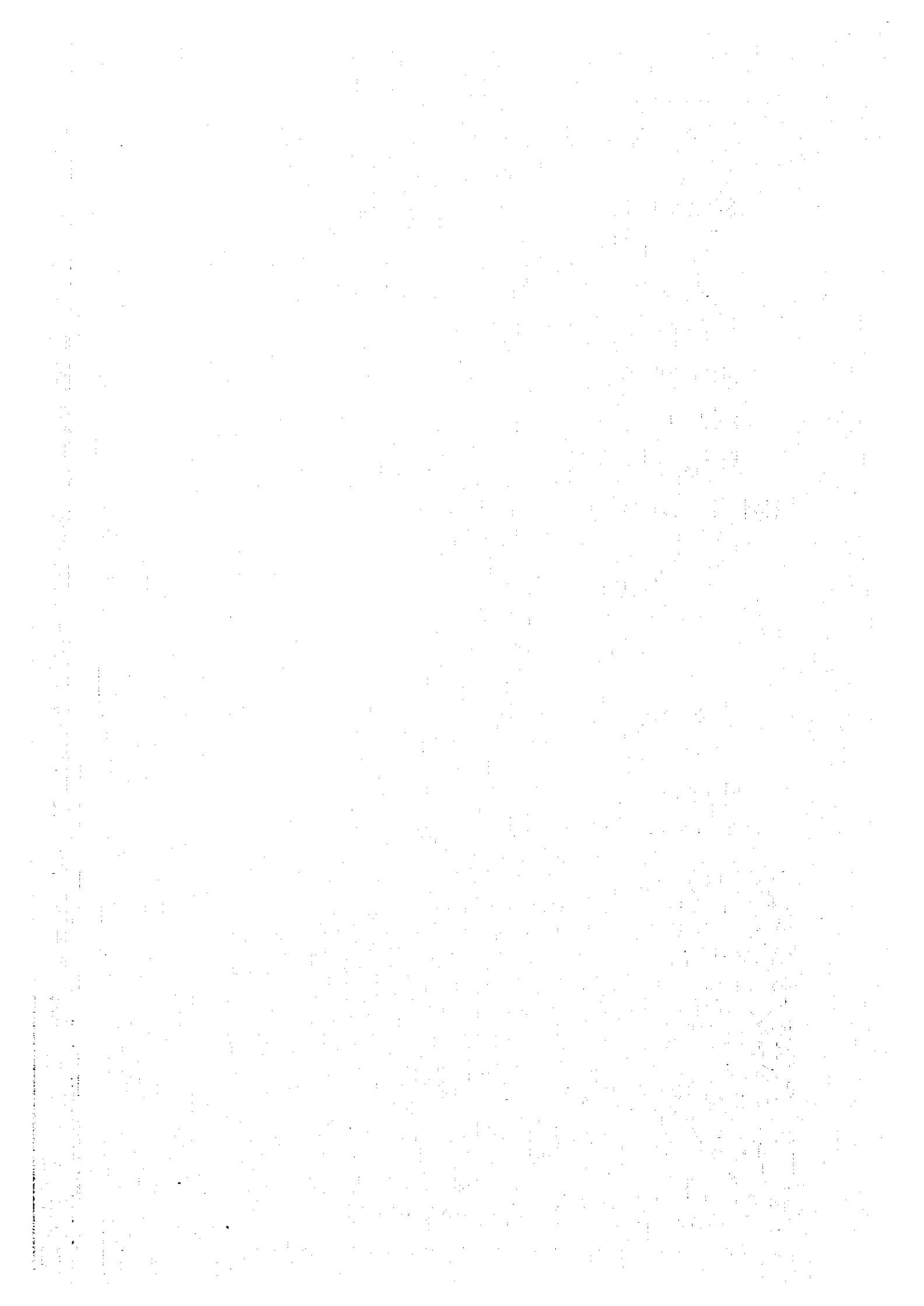
FIGURE 4 - 1 ROUTE ALTERNATIVES



ROUTE ALTERNATIVES

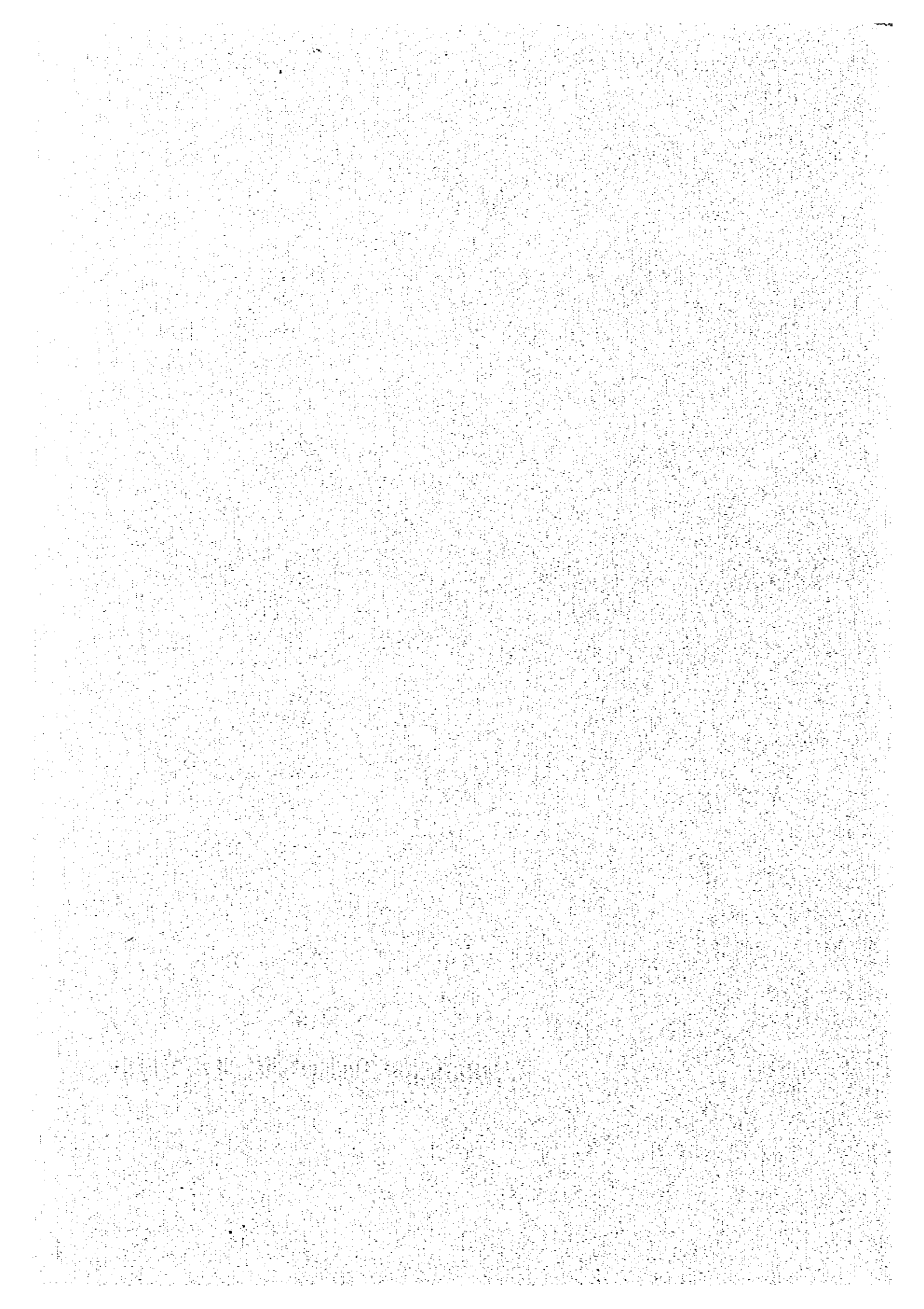
FIGURE 4 - 1





Chapter V

PROJECTION OF AGRICULTURAL DEVELOPMENT



Chapter V

PROJECTION OF AGRICULTURAL DEVELOPMENT

5-1 GENERAL

The Project will bring about multiple effects to the agricultural development in the Area. It will accelerate the opening of new lands for cultivation and consequently accelerate the augmentation of production. The Project will result in reduction of transportation costs, saving of handling and marketing charges, and consequent increase of farmgate prices. All-weather road will enable to adopt the more efficient cropping pattern and help accelerate double cropping. Furthermore, the proposed road will enhance the agricultural extension services and help more intensive use of agricultural inputs. These factors will also result in production increase.

Taking the above effects into consideration, the projection of the agricultural development in the future with the Project was made as discussed in the following sections.

5-2 AREA OF ACCELERATED DEVELOPMENT

Historical studies on the impacts of roads to the agricultural development suggest that the area adjacent to a good road within 5 km has quite high intensity of land use, 75 to 100 percent, while the intensity of the distant area in 15 km falls to 40 percent. For this project, it is also

plausible to presume that the accelerated new land development extends over the area adjacent to a proposed road within about 5 km on an average (hereinafter referred to as the Development Area). Present land use in the Development Area was estimated based on the available land use map, aerial photos and field survey information. The area of 343,940 rai or 41 percent is already cultivated out of the total area of the Development Area, 833,980 rai, as shown below. Land capability of the remaining uncultivated area of 490,000 rai was examined in preliminary evaluation of the soils, topography, climate, availability of water, forest reserve, etc. It was judged that 285,730 rai of cultivable land for paddy and upland crops still remains for future development. And provided that 30 percent of the above newly cultivable lands will be opened in 20 years linearly, it was estimated that the land use in the Development Area in 1983, one year before the year of opening to traffic, will be as follows:

Land Use in Development Area

(1,000 rai)

	<u>1979</u>	<u>1983</u>
Cultivated Area		
Paddy	89.9	94.9
Maize	149.2	157.0
Cassava	26.1	27.4
Kenaf	29.7	31.4
Other Upland Crops	49.0	54.3
Sub-total	343.9	365.0
Arable land	285.7	264.6
Non-arable land	204.4	204.4
Total	834.0	834.0

Considering the land capability, lower initial investment costs and future marketability of crops, it was anticipated that the main crop to be cultivated in the new land would be maize on the Nakhon Sawan/Phetchabun side and cassava and kenaf for the Chaiyaphum side. Even in Chaiyaphum district, mountainous areas in King Amphoe Nong Bua Rak and King Amphoe Thep Sathit are expected to be covered by maize field as the Project will

provide these area the easy access to the established markets located on the Phetchabun side.

5-3 MAJOR DEVELOPMENT EFFECTS

5-3-1 Effects on New Land Development

Improvement of roads will accelerate the degree of opening the uncultivated land. The proposed road will stimulate the opening of new land and will enable all of the newly cultivable land be converted to the crop land within 15 years after the opening of the proposed road. Furthermore, speed of opening of new land will be rapid in the former period. It was estimated that three fourth of the new land available will be opened within five years after completion of the road. On the other hand, without good road, opening of new land proceed with slow speed. Judging from past studies and field survey information, it was estimated that 30 percent of available land would be opened by 1998, in the case of without Project.

5-3-2 Effects on Farmgate Price

Price effects of the improvement of the proposed road will be brought greatly to the crops to be produced in remote mountainous areas and to be shipped in rainy season such as maize, cassava, many beans and groundnuts. Farmgate prices will be raised up due to the reduction of transportation costs, savings of unnecessary handling and marketing charges, and avoidance of long and hard trips for assembling and the consequent deterioration of crop quality.

Field survey information indicates that the average differences are more than 10 Baht per 100 kg for maize and 5 Baht for cassava between farmgate prices in areas of better access to markets and those in remote areas that are isolated in rainy season. This information suggests that the effects of the proposed all-weather road will result in raising up of average farmgate prices of maize and cassava at the above rates for the crops in the remote areas.

As it is estimated that 60 to 70 percent of the total production will benefit by the above-mentioned higher farmgate prices, the overall average rates of price increase in the Development Area in case of with project will be about 6 Baht per 100 kg for maize and 4 Baht for cassava.

Other crops to be shipped partly in rainy season such as mung beans, soy beans and groundnuts will also benefit, proportionally to the shipping rate in rainy season, by the high farmgate prices due to the Project.

Price effects will not be accrued to the other crops to be shipped in dry season such as paddy, kenaf, cotton. As the existing roads in the Area are fairly good enough to provide easy access to markets in dry season, the improvement by the proposed road will give no remarkable impact on farmgate prices.

5-3-3 Effects on Production Increase

Owing to the road improvement, crop production will increase reflecting the following effects:

1) Acceleration of Double Cropping

In the Development Area, intensity of double cropping is relatively low especially for maize field, mainly because of delay of harvesting of the first crop due to the worst road condition in the shipping season. The proposed all-weather road will enable earlier and timely harvesting of maize and consequently make possible to catch rains for second crops such as beans. It was estimated that 5 to 15 percent, deferring by zone, of maize fields and 5 percent of some parts of paddy fields would become to be used for second crops by the full development year.

2) Improvement of Farming Practice

Improvement of land communication by the proposed road will enhance the agricultural extension services and make easy to extend information on new farming techniques. These effects together with the reduction of transportation costs will enable farmers to adopt more agricultural inputs such as fertilizer and chemicals and to improve farming practice. Direct effect to the production increase will be brought by the application of fertilizer for paddy and cassava and agro-chemicals for maize and mung beans.