BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR BRIDGE CONSTRUCTION
IN RURAL REGION
IN
NORTHEAST THAILAND

MAY 1989

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request of the Government of the Kingdom of Thailand, the Government of Japan has decided to conduct a Basic Design Study on the Project for Bridge Construction in Rural Region in Northeast Thailand and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Thailand a survey team headed by Mr. Hiroyuki Nakajima, Deputy Managing Director, Higashi-Kobe Construction Office, Kobe Construction Division, Hanshin Expressway Public Corporation from January 18 to March 3, 1989.

The team exchanged views with the concerned officials of the Government of Thailand and conducted a field surveys in the Northeast Thailand area.

After the team returned to Japan, further studies were made. Then, a mission was sent to Thailand in order to discuss a draft report and the present report has prepared.

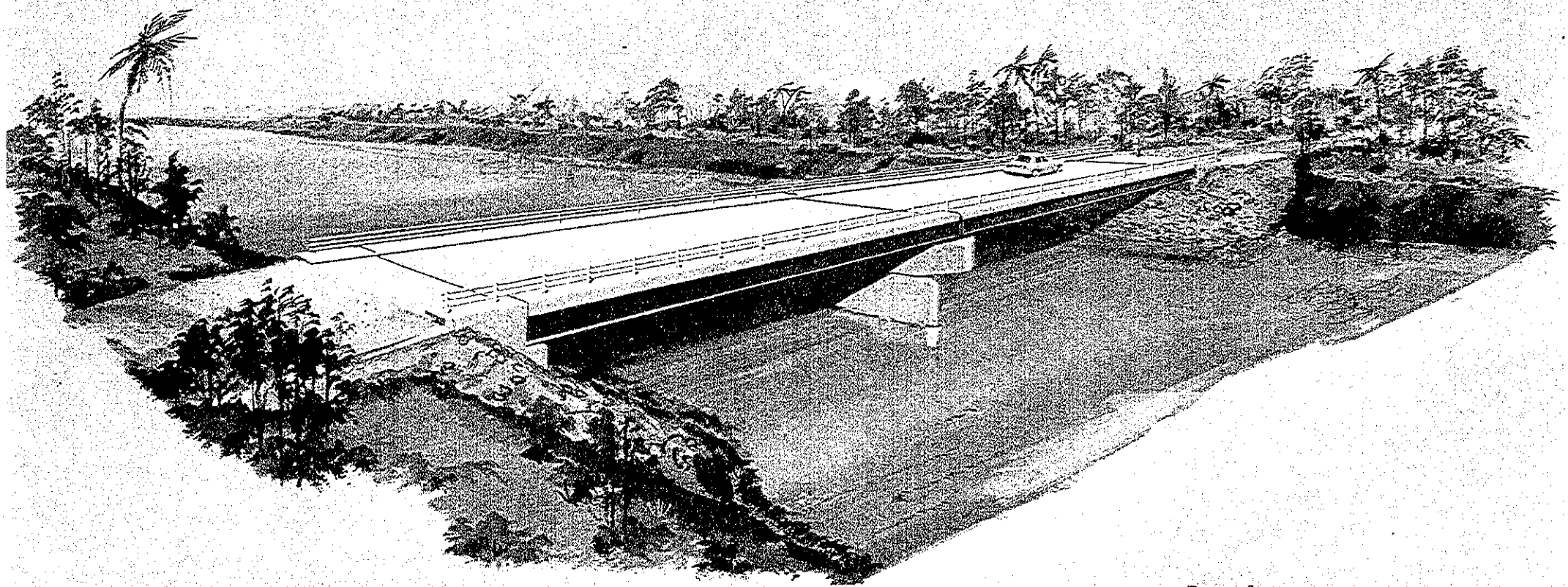
I hope that this report will serve for the development of the Project and will contribute to the promotion of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Kingdom of Thailand for their close cooperation extended to the team.

May, 1989

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

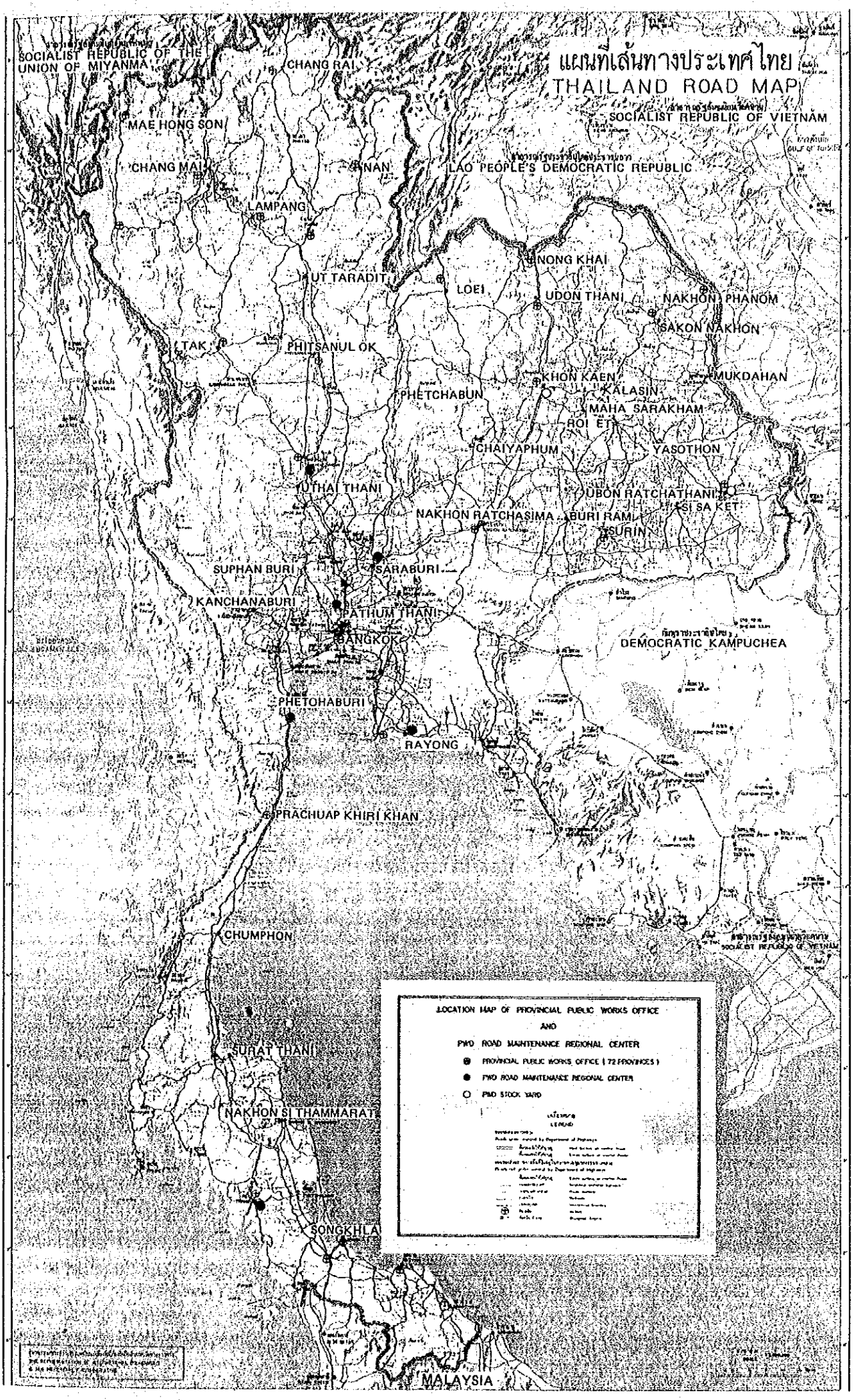


Example

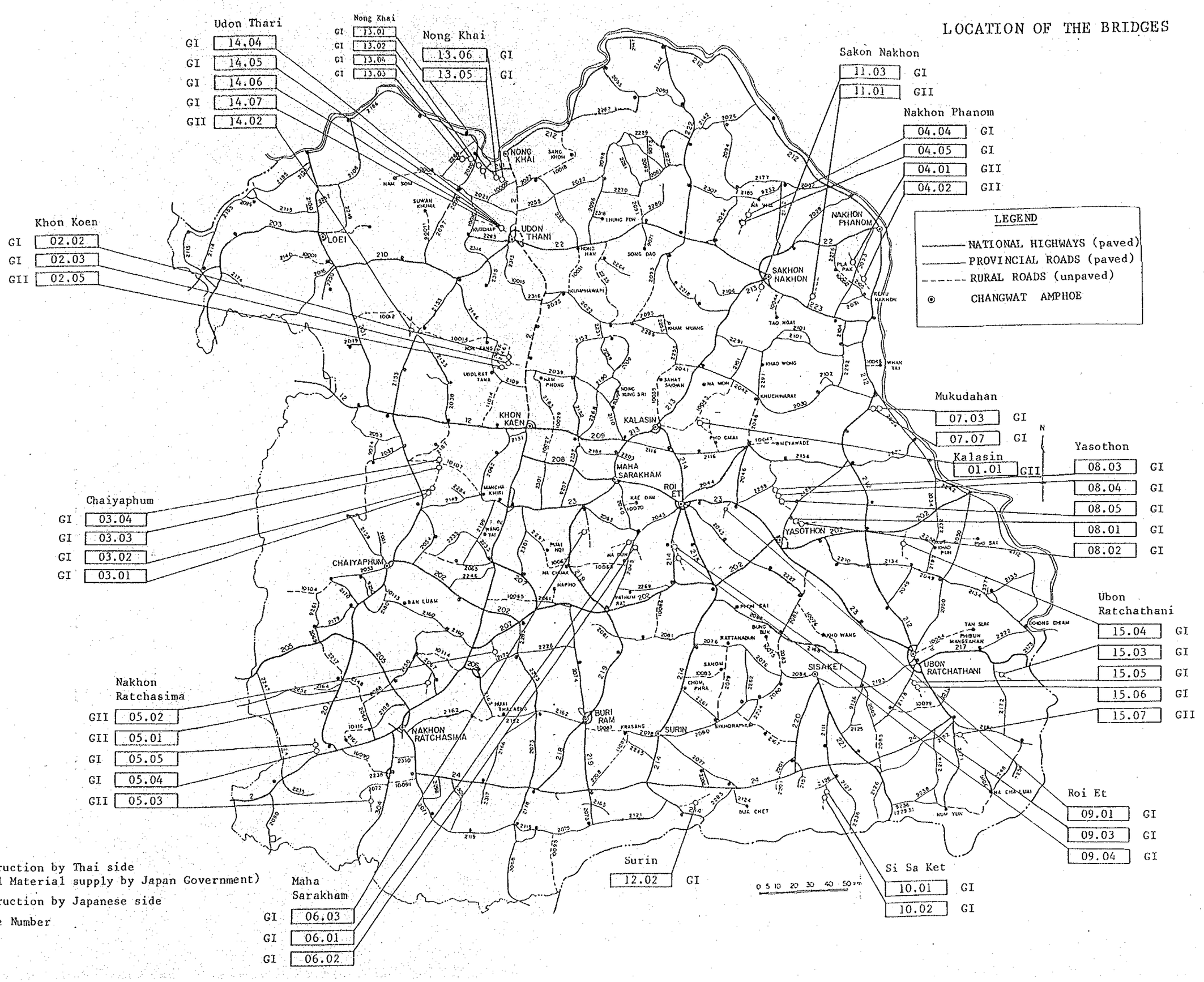
Bridge Length	40 m
Span Arrangement	20^{m} x
Carriageway	7.0 m

(01.01 Huai Kae)

PERSPECTIVE


แผนที่เส้นทางประเทศไทย
THAILAND ROAD MAP
SOCIALIST REPUBLIC OF THE UNION OF MIYANMA
CHANG RAI
MAE HONG SON
CHANG MAI
NAN
LAO PEOPLE'S DEMOCRATIC REPUBLIC
SOCIALIST REPUBLIC OF VIETNAM
LAMPANG
NONG KHAI
UT TARADIT
LOEI
UDON THANI
NAKHON PHANOM
SAKON NAKHON
TAK
PHITSANUL OK
KHON KAEN
MUKDAHAN
KALASIN
PHETCHABUN
MAHA SARAKHAM
ROI ET
CHAIYAPHUM
YASOTHON
UTHAI THANI
UBON RATCHATHANI
SI SA KET
NAKHON RATCHASIMA
BURI RAM
SURIN
SUPHAN BURI
SARABURI
KANCHANABURI
PATHUM THANI
BANGKOK
DEMOCRATIC KAMPUCHEA
PHETCHABURI
RAYONG
PRACHUAP KHIRI KHAN
CHUMPHON
SURAT THANI
NAKHON SI THAMMARAT
SONGKHLA
MALAYSIA
LOCATION MAP OF PROVINCIAL PUBLIC WORKS OFFICE
AND
PWD ROAD MAINTENANCE REGIONAL CENTER
PROVINCIAL PUBLIC WORKS OFFICE (72 PROVINCES)
PWD ROAD MAINTENANCE REGIONAL CENTER
PWD STOCK YARD
LEGEND

LOCATION OF THE BRIDGES



G-I, Construction by Thai side
(Steel Material supply by Japan Government)

G-II, Construction by Japanese side

[ ], Bridge Number

SUMMARY

Summary

1. Background of the Project

In the 5th Economic and Social Development Plan (1982 to 1986), the Thai government placed top priority on the development of rural areas.

Like the 5th Development Plan, priority had also been placed on the development of rural areas in the 6th Development Plan (1987 to 1991) to eradicate poverty, improve the quality of life, and distribute wealth and prosperity equally to all regions as much as possible.

The three aims of the 6th Development Plan are to:

1. Increase the efficiency of national development.
2. Improve the production system and marketing and raise the quality of the economic factors.
3. Increase the distribution of income and prosperity into provincial regions and rural areas.

Based on these three guidelines, 10 major program have been specified. To achieve a greater distribution of income and prosperity into provincial regions and rural areas, the following two programs have been specified.

a) Development of Urban and Specific Areas
b) Rural Development

As one part of these development programs, the Thai government initiated a development plan for the northeast region (the poorest in Thailand) called the "Green E-sarn Project." Improving economic/social infrastructures is one of the main goals of this plan.

Most national and provincial highways in northeast Thailand have been improved, but the rural roads used for transporting agricultural products have not yet been improved. The Thai government is attaching great importance to the development of rural areas including the construction of bridges in this region.

The major modes of transportation in the northeast region of Thailand are roads, railways and aircraft. Each mode of transportation uses two main routes (Bangkok-Udon Thani and Bangkok-Ubon Ratchatani) that connect the northeast region and Bangkok.

The road network is well distributed and accommodates 92% of all domestic passengers and 88% of all cargo. The arterial road network in northeast Thailand is formed by five primary national highways and 23 secondary national highways. Primary National Highway Route-2 separates from Route-1, which originates in Bangkok at Saraburi and extends up to Nong Khai via Nakhon Ratchatani, Khon Kaen and Udon Thani. Route-24 connects Nakhon Ratchasima with Ubon Ratchatani via the southern part of northeast Thailand.

These two primary national highways are the most important main routes in the northeast region. Primary National Highway Route-12 and the 23 secondary national highways separate from Route-2 and they form a rural arterial road network extending to the east and west areas. The secondary national highways (interlinked with the above primary national highways) play a key role in highway transportation in the region, and form a rural road network with the various provincial highways and rural roads.

In the northeast region 1,600 km of primary national highways, 3,200 km of secondary national highways, and 7,800 km of provincial highways have been extended. Of the total length, only 7,600 km are paved.

The total length of roads in Thailand is about 166,000 km; the length of national highways and provincial highways is 50,000 km, most of which are paved. Conversely, the total length of rural roads is about 108,000 km, most of which are unpaved.

In accordance with the 6th Economic and Social Development Plan, the Ministry of the Interior has set up a master plan (1987 to 1991) that emphasizes road construction and improvement in rural areas. In this plan, all existing roads are to be improved.

According to the 4th master plan set up by the Ministry of the Interior, the Public Works Department (PWD) has started to improve

3,000 km of roads under their control. This improvement plan calls for the replacement of 234 bridges in northeast Thailand. Of these bridges, 68 were to be replaced immediately under Grant Aid from Japan.

2. Requested Bridges and Study

After studying and evaluating the 68 bridges requested by the Thai government 51 bridges have been selected to be studied for basic design, based on discussions with the representatives of each province, placing importance on connecting to main cities, benefits, future improvement plans, and including bridges added newly at the request of the Thai government.

Considering the conditions of existing timber bridges, lack of load capacity and width, deterioration, the Thai government requested the Government of Japan to construct such bridges with steel girders.

According to the result of a study by the study team, steel-bridge construction in Thailand has been rare, but the Thai government intends to construct steel bridges from now on, and seeks a transfer of technology for this purpose. From the urgency in the replacement of timber bridges, steel bridges are required. Considering these situation, the study team has reached to the conclusion that the replacement of timber bridges by steel bridges is appropriate.

2.1 Grouping of the Bridges

51 bridges have been selected for the study of the basic design. After considering the experience of steel-bridge construction in Thailand and the urgency in the replacement of timber bridges, it has been recommended that some bridges be constructed by Japan side. Accordingly, it has been decided that easy-to-construct short bridges (under 40m) will be constructed by the authority of Thailand as Group I under the supply of steel materials by Japanese government, longer bridges requiring higher-level technology of construction, for example, requiring temporary stages and large construction machinery, will be constructed by Japan side as Group II. Thus 41 bridges are to be constructed as Group I, and ten bridges as Group II.

2.2 Phasing

Bridge construction stage has been divided into two phases: the first year and second year. To determine the time at which to construct the bridges, the socioeconomic impact in the region has been considered. Accordingly, the phases have been classified as Phase I for the northern part of northeast Thailand (20 bridges in the first year, Group I - 15 bridges, Group II - 5 bridges), and Phase II for the southern part (31 bridges in the second year, Group I - 26 bridges, Group II - 5 bridges).

The selected 51 bridges are classified as follows:

List of Phase I Bridges

Group I				Group II			
No.	Bridge No.	Name of Bridge	Bridge Length (m)	No.	Bridge No.	Name of Bridge	Bridge Length (m)
1.	02.02	Huai Nong Ben	26.0	1.	02.05	Huai Khum Mum	46.0
2.	02.03	Huai Yang	30.0	2.	04.01	Huai Soeng No.1	40.0
3.	04.04	Huai Na Khoi	20.0	3.	04.02	Huai Soeng No.2	40.0
4.	04.05	Huai Na Krathum	20.0	4.	11.01	Lam Nam Kam	55.0
5.	11.03	Ban Na Kae	31.0	5.	14.02	Lam Nam Phuai	110.0
6.	13.01	Huai Sieo No.1	25.0				
7.	13.02	Huai Sieo No.2	20.0				
8.	13.03	Huai Ban Mui	31.0				
9.	13.04	Huai Ran	23.0				
10.	13.05	Huai Bang Phuan No.1	20.0				
11.	13.06	Huai Bang Phuan No.2	20.0				
12.	14.04	Nong Bung Mo No.1	18.0				
13.	14.05	Nong Bung Mo No.2	18.0				
14.	14.06	Nong Bung Mo No.3	26.0				
15.	14.07	Nong Bung Mo No.4	20.0				

List of Phase II Bridges

Group I				Group II			
No.	Bridge No.	Name of Bridge	Bridge Length (m)	No.	Bridge No.	Name of Bridge	Bridge Length (m)
1.	03.01	Huai Khon Tha	20.0	1.	01.01	Huai Kae	40.0
2.	03.02	Huai Yai	30.0	2.	05.01	Lam Klang	50.0
3.	03.03	Huai Phai No.1	20.0	3.	05.02	Lam Nam Mum	80.0
4.	03.04	Huai Phai No.2	20.0	4.	05.03	Lam Phra Phloeng	60.0
5.	05.04	Lam Ta Khong No.1	20.0	5.	15.07	Lam Som No.1	50.0
6.	05.05	Lam Ta Khong No.2	31.0				
7.	06.01	Huai Sieo	34.0				
8.	06.03	Huai Lom Khom No.2	20.0				
9.	06.04	Huai Na	16.0				
10.	07.07	Huai Po	20.0				
11.	07.08	Huai Ngui	31.0				
12.	08.01	Huai Wang Pla sium	26.0				
13.	08.02	Huai Na Pong	20.0				
14.	08.03	Huai Khaen	20.0				
15.	08.04	Huai Khaen Long No.1	20.0				
16.	08.05	Huai Khaen Long No.2	24.0				
17.	09.01	Huai Pla Pong	26.0				
18.	09.03	Huai Siao No.1	35.0				
19.	09.04	Huai Siao No.2	26.0				
20.	10.01	Huai Palan Muong	26.0				
21.	10.02	Huai Kantruat	20.0				
22.	12.02	Huai Thamo	20.0				
23.	15.03	Huai Sa Do	31.0				
24.	15.04	Huai So Phra	28.0				
25.	15.05	Huai Choek	31.0				
26.	15.08	Huai Khaen	33.0				

2.3 Implementation Agency

The organization responsible for project design and implementation, construction management, and maintenance is the Rural Road Division.

PWD has 72 rural offices to which the necessary engineers will be dispatched from the Rural Road Division to manage the construction and, which perform maintenance. The rural offices in the northeast region involved in the project are located in 15 provinces. The number of PWD officers (as of 1989) is 2,295 including 460 officers of the Rural Road Division.

The fiscal budget of PWD in 1989 is 1,739.8 million baht (equivalent to ¥8.7 billion). Of the fiscal budget, 1,513.8 million baht (equivalent to ¥7.5 billion), or 87%, is allocated to construction works. The fiscal budget in 1988 was 1,030.6 million baht (equivalent to ¥5.2 billion), and the budget for construction works was 972.7 million baht (equivalent to ¥4.9 billion). The increase rate for the fiscal budget in 1989 is 69%, and 56% for construction works. According to previous year the Rural Road Division, which is directly responsible for the project, the total length of roads constructed in 1988 was 340 km at a cost of 156 million baht (equivalent to ¥7.8 billion), with a total length of 1,084 m for bridge construction at a cost of 44 million baht (equivalent to ¥220 million). These figures have not changed much over the past five years. The reason is that the Rural Road Division did not have a special project during this period. For PWD, however, the total budget and the allocated budget for construction works are both showing high growth. From this point, it can be judged that PWD is capable of implementing and managing the project.

The total land area of the northeast region is 168,900 km^2, which is 33% of Thailand. The regional population is 18,884,000 (equivalent to 35% of Thailand's population). Some 580,000 people are expected to have benefit from the projected.

3. Description of Bridges

After considering the weather conditions of Thailand (dry and rainy seasons) and the one-year period required to complete the construction of the bridges, construction works have been divided into two stages: construction of substructure in the dry season, and construction of superstructure in the rainy season. To shorten the construction period, steel girder bridges have been adopted as the superstructure. In addition, it has been decided that simple girder bridges will be construction with non-composite girders for easy handling and transportaiton. For maintenance-free, weathering steel has been also selected. Bridges are assigned by group and phase as follows.

	Phase I	Phase II	Total
Group I	350m	649m	999m
Group II	298m	287m	585m

(1) Bridges in Group I

Bridges in Group I are as follows:

Total bridges : 41 bridges (Phase I: 15 bridges, Phase II: 26 bridges)

Total bridge length : 999m

Width : 2 lanes — Total width 8.6m, Roadway width 7.0m

1 lane — Total width 5.6m (for 05.04, 05.05, 13.05, 13.06), Roadway width 4.0m

Superstructure: Simple non-composite H-shaped steel plate girders

Substructure : Abutment ... Inverted-T seat type or pile bent type

Pier ... 15.03, 15.04 Wall type (15.03, 15.04 spread foundation) pile bent type for others

Pile foundation ... RC pile □ -350x350, □ -400x400

□ : indicates square section.

(2) **Bridges in Group II**

Bridges in Group II are as follows:

Total bridges : 10 bridges (Phase I: 5 bridges,
Phase II: 5 bridges)

Total bridge length : 585m

Span arrangement:

Phase I		Phase II	
02.05	2 x 23m	01.01	2 x 20m
04.01	2 x 20m	05.01	15 + 20 + 15
04.02	2 x 20m	05.02	4 x 20m
11.01	15 + 25 + 15	05.03	3 x 20
14.02	2x20+30+2x20	15.07	15 + 20 + 15

Width : 2 lanes Total width 8.6m
Roadway width 7.0m

1 lane Total width 7.0m (for 05.02, 14.02)
Roadway width 6.0m

Superstructure: Span length under 20m
Simple non-composite H-shaped steel girders

Span length over 20m
Simple non-composite built-up steel girders

Substructure : Abutment ... Pile bent type

Pier ... 04.01, 02.05, 14.02, 15.07, Wall type
04.02, 05.02, Piller type
11.01, 06.01, 05.03, 01.01 Pile bent type

Pile foundation ... RC pile □ -400x400

□ : indicates square section.

4. Undertaking of Both Governments

4.1 Japan's Grant Aid Program

(1) **The scope of Japan's Grant Aid is supply of materials/tools for the construction of bridges and related works.**

Supply of materials and tools (Group I)

Superstructure members (main girders, cross beams, etc.)

Bearings

Railings and Posts on the bridges

Torque wrenches etc.

(2) **Bridge construction (Group II)**

Construction of superstructure
Construction of substructure
Approaching roads
Protection of slope surfaces

4.2 Thai Side

The arrangement of tax exemption and customs clearance for materials and tools supplied by Japan

Acquisition of land necessary for the project

Removal of obstacles (including houses) within the right of way

Provision of roads to transport materials and construction machinery

Maintenance of bridges

Preparation of stockyards

Construction of bridges in Group I (including protective embankments)

Construction of approaching roads

5. Construction Costs

Thai government

Group I	Construction of superstructure/substructure and approaching roads, others	
	Preparation of stockyards	
	Vehicles (1 micro-bus, 4 pick-ups)	
	Amount	¥400,000,000.- (approximately)
Group II	Road construction	
	Land acquisition	
	Removal of obstacles	
	Amount	¥100,000,000.- (approximately)
Total Construction cost		¥500,000,000.- (approximately)

6. Conclusion and Recommendations

Conclusion

The 6th National Economic and Social Development Plan (1987 to 1991) intends to improve agricultural production and increase the income of local residents through the implementation of a development program in rural areas and alleviate poverty as a result.

The Green E-Sarn Project has been planned as one part of this program, and the Thai government is placing top priority on road construction.

The construction of 51 bridges to be undertaken under Japanese Grant Aid is recommended.

The project will provide transportation for agricultural products, and enable 580,000 residents to travel safely through the year.

Accordingly, the project complies with the development program specified by the Thai government, and it is expected that the development in rural areas will be promoted, employment opportunities will increase, and as a result, it will contribute to rural economic growth.

Consequently, implementing the project under Japan's Grant Aid is recommended.

Recommendations

On the present situation in Thailand, rural development and increase of employment opportunities are urgently required, and it is recommended that the project is implemented as quickly as possible.

In order to implement the project effectively and efficiently and achieve the expected objectives, sufficient measures must be taken by the Thai government. The following measures are recommended:

(1) **Arrangement of implementation budget and formation for the project**

Preparation of implementating formation and reservation of necessary budget which are essential to carry out the detailed design of substructure and work execution of super and sub-structure of the group I Bridges.

(2) **Required Terms to be arranged by Thai side in advance of the execution.**

- Removal of obstacles for construction
- Acquisition of land for construction

- Provision of roads to transport materials and construction machinery.
- Preparation of stockyards for steel materials in Group I

(3) **Implementation of related programs**

- To improve access roads connecting from the main roads to the bridges constructed under the project within a few years.

TABLE OF CONTENTS

CHAPTER 1 INTRODUCTION

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In response to a request made by the Government of the Kingdom of Thailand, the Government of Japan decided to conduct a basic design study related to the project for constructing bridges along rural roads in the northeast region of Thailand. In response to this decision, the Japan International Cooperation Agency (JICA) dispatched a basic design study mission to Thailand to conduct a survey at the sites from January 18 to March 3, then to prepare a basic design study report by April 1989.

After a series of discussion with Thai government, JICA's mission selected 51 of 84 bridges proposed for improvement as the bridges appropriate to the Grant Aid, after carefully examining the necessity, importance and urgency of bridge construction, the construction period, population of project areas, the connective function between rural roads and main roads and with main cities, the availability of alternate and socio-economic impact.

In addition, field, topographical and geological surveys have been conducted at the construction sites of the proposed bridges in cooperation with the Thai government.

The purpose of the project is to construction newly or replace timber bridges with permanent bridges in the northeast region of Thailand. The project is divided into two phases: Phase I for the first year of construction (20 bridges), and Phase II for the second year of construction (31 bridges).

In addition, based on technical and engineering study, the bridges are also classified into two groups: Group I (41 bridges) whose construction is to be carried by Thailand, and Group II (10 bridges) by Japan. 15 bridges in Group I and five bridges in Group II are included in Phase I. 26 bridges in Group I and five bridges in Group II are included in Phase II.

JICA assumes that all bridges in Group I will be constructed by Thailand independently with steel materials supplied by the Japan's Grant Aid. The ease of construction will permit Thailand to design and construct the bridges (including the erection of steel materials).

On the other hand, all bridges in Group II, whose bridge length is more than 40m, are comparatively difficult to construct, and will be designed and constructed by Japan (including the construction of superstructures and substructures).

Surveys have been conducted on the 51 existing bridges. All information, measurements, and survey results have been further investigated and analyzed by the basic design study team after returning to Japan.

Based on these surveys and analysis, the team has completed the final report on basic design.

CHAPTER 2
BACKGROUND OF THE PROJECT

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2.1 Situation of Roads and Bridges

The main transportation system in Thailand (before modern railways and existing roads were constructed after World War II) had been water transportation supported by rivers and canals.

Existing roads have been constructed since 1860 (Rama IV era). However, traffic on roads had been relatively light until the 1950s. National Highway Route No. 2 was constructed under U.S. Aid in 1958 to connect Saraburi and Nakhon Ratchasima and the investment to social capital after the First Five-Year National Economic and Social Development Plan (1962 to 1966) has been concentrated on roads. Since then modern road construction has been promoted to beginning the age moterization.

Concerning the passengers and freight cargoes in Thailand, road transport occupies respective shares of 92% and 88%. Compared with the situation in Japan where passenger transportation accounts for 57% and freight cargo accounts for 47%, the share of road transportation in Thailand is very high.

Table 2.1-1 Share of Road Transportation in Thailand (1984)

Transport-ation	Passenger (Million persons·km)	(%)	Freight (Million tons·km)	(%)	JAPAN (1985) Passenger (%)	Freight (%)
Road	113,606	91.8	18,920	87.8	57.0	47.4
Railway	9,643	7.8	2,618	12.2	38.5	5.1
Water, Coast	N.A.	-	N.A.	-	0.7	47.4
Inland Air	548	0.4	2	0.0	3.8	0.1
Total	123,795	100.0	21,540	100.0	100.0	100.0

Source: Annual Transport Statistics (Ministry of Communications)

2.1-1 Roads

As listed in Table 2.1-2, the roads in Thailand are classified into eight.

1) **Special Highways**

Special highways are the high standard national roads to which access roads are restricted. Four heavy-traffic main routes around Bangkok are especially assigned to this road standard.

2) **National Highways**

National highways are important from the viewpoint of economic development and administration. In general, they are in good condition in accordance with high design standards, and they enable driving at high speed because of few intersections. National highways are classified into two groups: primary highways connect main cities, and secondary highways that connect primary highways passing through provincial cities. Primary highways have one/two-digit route numbers while secondary highways have three-digit route numbers. For reference, the first digit of a route number indicates the local region (i.e., 1 = northern region, 2 = north region, 3 = center region, 4 = south region).

3) **Provincial Highways**

Provincial highways are the routes that complement national highways and connect provincial cities, and county cities. Recently, these roads are being upgrade. These roads have 4-digit route numbers.

Roads described in 1), 2) and 3) above are managed under control of DOH.

4) **Rural Roads**

Rural roads are under the municipalities (outside the sanitary districts) and are closely related to local production and daily life. Such roads are constructed by many government authorities, and provincial offices are responsible for these roads. After road construction, the maintenance of these roads is mostly transferred to other organizations.

5) **Municipal Roads**

Municipal roads are located in municipalities and construction and maintenance are carried out by major municipalities. However, some roads in other municipalities are constructed by the Ministry of Interior (PWD) and the maintenance of these roads is transferred to the municipalities.

6) **Sanitary Roads**

Sanitary roads are located in sanitary districts and constructed by PWD.

7) **Concession Highways**

Concession highways are constructed by the private sector under agreement with DOH. User tolls are collected.

After the agreement with DOH, these roads are transferred to DOH for use as public roads (open to the public and free of charge).

8) **Expressways**

Expressways are the roads that are constructed and managed by the Expressway & Rapid Transit Authority of Thailand (ETA), which was established in 1972 by the Ministry of Interior. Currently, 27.1 km of expressways are in service and a plan for further extension to 46 km is being prepared through private concessions.

TABLE 2.1-2 ROAD LENGTH PER TYPE OF ROAD (1987)

Type of Road	Organization in Charge	Length (Km)
Special Highways	(1) DOH	Assigned only (251)
National Highways	(1) DOH	16,698
Provincial Highways	(1) DOH	33,170
Rural Roads	(2) PWD	2,914
	(2) ARD	18,556
	(3) MOD	577
	(4) CAO & PWD	4,746
	(5) PAU, PWD & others	81,074
	TOTAL	107,867
Municipal Roads	(6) BMA	1,173
	(7) Other Municipalities	7,389
	TOTAL	8,562
Sanitary Roads	(2) Sanitary district (PWD)	-
Concession Highways	(1) DOH	0
Expressways	(8) ETA	27
GRAND TOTAL		166,324

Source: Ministry of Communications

Notes:
(1) Department of Highway (DOH)
(2) Public Works Department (PWD)
(3) Ministry of Defense
(4) Changwat Authority Organization
(5) Provincial Administration Union
(6) Bangkok Metropolitan Authority
(7) Other Municipalities
(8) Expressway & Rapid Transit Authority of Thailand

2.1.2 Bridges

As mentioned in Table 2.1-2 above, the bridge administrators in the northeast region of Thailand are DOH for national and provincial highways, and PWD, ARD, MDU and CAO for rural roads.

The number and total length of bridges under control of PWD are listed in Table 2.1-3. There still remains many timber bridges. They are so old that the traffic causes danger. They are closed during the rainy season. Such conditions present an obstacle to the development of the northeast region.

In the northeast region of Thailand, "ratio" is expressed as "Seven to ten", does it mean that 70% of bridges under PWD administration are timber bridges. The longest total length of bridges is found in Ubon Ratchathani province. The provinces which timber bridges than concrete bridges are Nakhon Phanom (95%), Udon Thani (95%), Yasothon (100%), and Surin (100%).

TABLE 2.1-3 LENGTH OF CONCRETE AND TIMBER BRIDGES UNDER CONTROL OF PWD

	Provinces	Concrete Bridges Numbers	(m)	Timber Bridges Numbers	(m)	Total Numbers	(m)
1	Kalasin	5	330	6	236	11	616
2	Khon Kaen	4	175	19	719	23	894
3	Chaiya Phum	5	201	18	704	23	905
4	Nakhon Phanom	1	26	15	501	16	527
5	Nakhon Ratchasima	2	110	10	304	12	414
6	Maha Sarakham	2	45	7	157	9	202
7	Mukdahan	2	155	34	1259	36	1414
8	Yasothon	-	-	19	610	19	610
9	Roi-et	4	385	4	285	8	670
10	Sisaket	4	660	8	685	12	1345
11	Sakon Nakhon	5	233	24	496	29	729
12	Surin	3	460	4	100	7	560
13	Nong Khai	-	-	11	170	11	170
14	Udon Thani	2	62	35	1090	37	1152
15	Ubon Ratchathani	10	1180	20	1468	30	2576
	Total	48	3950	234	8834	283	12784

The current situation of bridges in the northeast region of Thailand is described as follows:

- During flooding, timber bridges are frequently damaged or washed away and require repair and replacement.
- Such work requires a great amount of expences.
- Maintenance and repair are mostly done by local farmers.
- The lack of load capacities of bridges has forced road users to take detour routes. Consequently, it causes inconvenience to people moving or transporting their harvests to market.
- The safe passage of heavy machinery or trucks is almost impossible.

2.2 Related Development Plans

The principal goods of the Six Five-year National Economic and Social Development Plan (1987 to 1991) are to raise national development to a level that will enable the country to progress and prosper in the future and to solve the economic and social problems that have accumulated over the past.

In June 1988 (second year of the plan), and supported by smooth economic growth after establishing the plan (as listed in TABLE 2.2.1), economic growth during relevant term exceeded 5%. This met the initial target to a great deal (approaching 7%) and indicates progress in transforming Thailand into a newly industrialized nation, as well as developing agriculture and industry-supported services.

TABLE 2-2-1 MAIN ECONOMIC INDECES

Unit: %

Item \ Term	4th Plan (1977-81)	5th Plan (1982-86)	6th Plan Target	(1987-91) Expected
Economic Growth (Yearly)	6.6	5.3	Over 5.0	7.0
Agricultural Production Increase Rate (Yearly)	3.9	4.1	2.9	1.9
Manufactural Production Increase (Yearly)	8.0	5.2	6.6	9.2
Saving Rate (to GDP)	21.7	20.5	23.7	-
Investment Rate (to GDP)	26.9	24.1	24.9	-
Inflation rate (yearly)	11.6	2.9	2.3	3.7
Normal Income/Expense (to GDP)	6.2	3.6	0.9	2.8
Financial Balance (to GDP)	3.3	3.6	2.6	-

(1) *Target of Economic and Social Development*

The 6th Plan seeks to ensure the economic growth necessary to expand employment and increase income for improving the quality, peace and security of life. Three targets (increase of the efficiency of national development, improvement of the production system and marketing, increase of the distribution of income and prosperity into rural areas) are being pursued.

As a macro-economic policy, the 6th Plan purposes to solve the problems of foreign trade and national budget deficits, diversify the production structure, develop natural resources while protecting the natural environment, create employment opportunities, increase income and minimize regional difference.

1) **Targets:**

(a) Economic: Maintain an average rate of growth at a level not below 5 percent in order to absorb the minimum of 3.9 million persons who will be entering the labour market. Growth should be accomplished in such a way that economic stability is strengthened and the economic problems that arose during the Fifth Plan period are solved.

(b) Social: Develop the quality of the population so that social development can progress, peace and justice be attained and development of the country as a whole supported. The national identity, culture and system of values will be maintained and the quality of life of the Thai people will be raised in both rural and urban areas.

(2) **Plan**

(a) Improving the efficiency of development

(i) Overall Economic Development;

(ii) Population, Social and Cultural Development;

(iii) Development of Natural Resources and the Environment;

(iv) Development of Science and Technology;

(v) Improving the Administration and Reviewing the Role of the Government in National Development; and

(vi) Development of State Enterprises.

(b) Restructuring production and improving the quality of infrastructure services

(vii) Development of the Production System, Marketing and Employment; and

(viii) Development of Infrastructure Services.

(c) Distributing prosperity and creating justice

(ix) Development of Urban and Specific Areas; and

(x) Rural Development.

(3) **Thailand Northern Region Development Plan**

The 5th Five-Year National Economic and Social Development Plan placed priority on rural development. The 6th plan also places priority on rural issues, such as alleviating poverty in rural areas. Improving the quality of life and distributing wealth and prosperty into rural areas are also targets.

The target areas are divided into backward rural area, middle-level rural area and progressive rural area. Most efforts are concentrated on backward development and middle development areas, while the northeast region of Thailand is in the category of a backward development area.

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CHAPTER 3
OUTLINE OF THE NORTHEAST REGION

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3.1 Socio-economic Situation

Thailand occupies 513,000 square km of land. The northeast region accounts for 33% (equivalent to 168,900 square km) of this total land area. Except for the western part and the southern mountain range area around the Cambodian border, this region is a plain with an average height of 120 to 180 m above sea level.

The average annual rainfall in the northeast region of Thailand is about 1,100 mm (from 858 mm in Buri Ram Ratchasima to 2,177 mm in Nakhon Phanom located on the banks of Mekong River). Rainfall is concentrated from May to October, during which 85% to 90% of the annual rainfall is recorded.

In Thailand, the temperature is lowest during December and January, and highest during April and May. The cold season (22°C) is in January while the hot season (32°C) is in April.

The population of Thailand in 1987 was 53,873,000, with an estimated population density of 105 persons per square km. The average rate of population growth from 1980 to 1985 was 2.0%. The population of the northeast region (18,884,000 with a population density of 112 persons per square km) accounts for 35% of total Thailand. The population density in this region ranks second after the central part as follows:

Table 3.1-1 Regional Population (1987)

Region	Population (1,000 persons)		Percent Distribution	Annual Growth Rate 1980-1985 (%)
Thailand	58,873	(105)	100	2.0
Northeast	18,884	(112)	35	2.0
Central (excluding Bangkok)	9,333	(498)	17	1.8
Bangkok	5,609	(3,584)	10	3.4
Northern	10,585	(62)	20	1.5
Southern	6,715	(95)	12	1.9

Figures in parentheses indicate population density (persons/square km)
Source: National Statistics Office

GNP in 1986 was 1,055,000 million bahts and 19,580 bahts for a per capita income. The yearly average growth from 1983 to 1986 was 17.4%.

For the categories of GNP in 1980, agriculture ranks second (after construction and services) and accounts for 25% of the total GNP. (Table 3.1-2)

The population in the northeast region accounts for 35% of total Thailand, while the GRP (Gross Regional Product) of this region occupies only 14% of the total. Agriculture holds a relatively large share of 44% of the total GRP, while manufacturing accounts for a low share of the total GRP.

Table 3.1-2 Relative Position of Northeast Region in National Economy (1980)

	Share of Northeast Region (%)	Regional Distribution	
		Northeast Region	Thailand
Gross Regional Product	14	100	100
Agriculture	24	44	25
Crops	26	35	19
Livestock	30	7	3
Fisheries	9	1	2
Forestry	9	1	1
Mining	6	1	2
Manufacturing	5	6	20
Trade	16	21	19
Construction & Services	11	28	34
Construction	14	6	6
Electricity & Water Supply	6	1	1
Transportation & Communications	8	4	7
Banking, Insurance & Real Estate	5	2	6
Ownership of Dwellings	12	1	1
Public Administration & Defence	14	4	4
Services	15	10	9

Source: NESDB

3.2 Main Industry (Agriculture) of Project Area

3.2.1 Agricultural Workers and Land

Like other regions of Thailand, the main industry in the northeast is agriculture.

In 1983, there were 14 million workers engaged in agricultural production. This accounted for 82% of all workers in this region, while workers engaged in agricultural production in the whole country accounted for 68% of all workers. The average growth rate of the number of agricultural workers over the past three years (1981 to 1983) maintained a level of 1.5%, which is lower than 2.0% for all Thai workers. The low agricultural productivity in this region has resulted in movement of workers to other regions or cities looking for employment opportunities.

Table 3.2-1 FARM AND NON-FARM WORKERS

	Farm (thousand) (%)	Non-Farm (thousand) (%)	Total (thousand) (%)
Northeast Region			
1981	13,680 (84)	2,713 (16)	16,393 (100)
1982	13,883 (83)	2,835 (17)	16,720 (100)
1983	14,093 (82)	3,126 (18)	17,219 (100)
Growth, 81-83	1.5% p.a.	2.5% p.a.	
Thailand			
1981	32,500 (68)	15,375 (32)	47,875 (100)
1982	33,085 (68)	15,375 (32)	48,847 (100)
1983	33,681 (68)	15,834 (32)	49,515 (100)
Growth, 81-83	1.8% p.a.		1.7% p.a.

Source: Office of Agricultural Economics (OAB), Ministry of Agriculture and Cooperatives (MAC)

Table 3.2-2 AGRICULTURAL LAND USE

(Unit: thousand rai)

	Forest Land A	Farm Land			
		Total B	Paddy C	Upland Crops D	Tree Crops, Vegetables, and Flowers E
Northeastern Region (1)					
Total Land: 105,534					
(T_1) (100)	(A/T_1)	(B/T_1)	(C/B)	(D/B)	(E/B)
1975	28,824 (27)	47,497 (45)	34,090 (72)	7,527 (16)	548 (1)
1978	19,513	49,301	35,555	9,257	542
1981	16,941 (16)	51,708 (49)	36,183 (70)	10,736 (21)	623 (1)
Growth 75 - 78	-12.2%	1.3%	1.4%	7.1%	-0.4%
75 - 81	- 8.5%	1.4%	1.0%	6.1%	2.2%
Thailand (2)					
Total Land: 320,697					
(T_2) (100)	(A/T_2)	(B/T_2)	(C/B)	(D/B)	(E/B)
1975	130,762 (41)	112,211 (35)	71,239 (63)	19,953 (18)	10,771 (10)
1978	109,315	116,441	73,270	23,759	10,772
1981	100,582 (31)	121,294 (38)	73,523 (61)	27,385 (23)	11,712 (10)
Growth 75 - 78	- 5.7%	1.2%	0.9%	6.0%	0%
75 - 81	- 4.3%	1.3%	0.5%	5.4%	1.5%
Ratio (T_1) / (T_2) 1981		42.6%	49.2%	39.2%	5.3%

Source: OAE, MAC

3.2.2 Agriculture-Related Industries and Markets

According to a survey conducted on agriculture-related industries, the collection of agricultural products and their transport to processing plants are as follows:

Table 3.2-2 TRANSPORTATION OF AGRICULTURAL PRODUCTS

Crop	Transport by (%)		
	Farmer	Factory	Middleman
Sugar-cane	100	-	-
Cassava	82	5	13
Rice	37	13	50
Kenaf	13	69	18

Most sugar-cane and more than 80% of the cassava crop are transported by the farmers themselves or by trucks of processing plants. On the other hand, most rice is transported by merchants, while kenaf is collected and transported mainly by the factories.

The number of agricultural processing plants is as follows:-

Table 3.2-3 NUMBER OF PROCESSING PLANTS

Rice mills (capacity: more than 30t/day)	132
Cassava plants (chips, pellets, flour)	297
Kenaf plants (textile)	95
Sugar plants (brown, refinery sugar)	13

Large and medium-size rice mills are concentrated in provincial centers or cities.

Most cassava processing plants are scattered and isolated along National Highways Nos. 2, 24, and 204 in Nakhon Ratchasima and Khon Kaen. Small chip processing plants and large cassava processing plants are found along with provincial highways in areas where cassava is grown. The processed products are transported directly to the plants of exporters, Chon Buri or Chacheongsao through National Highways Nos. 2 and 304. A small portion of them is occasionally transported by railways.

Kenaf processing plants are concentrated in central cities of such provinces as Udon Thai, Khon Kaen, Ubon Ratchathani, and Nakhon Ratchatsima.

Many sugar processing plants capable of processing more than 2,000 tons sugarcane a day are located in such provinces as Udon Thai, Khon Kaen and Buri Ram. The Kumphawapi sugar plant in Udon Thani province and the Nam Phong sugar plant in Khon Kaen are both capable of processing more than 5,000 tons of sugar-cane a day. During the seven months from November, 1982, to May, 1983, sugar production reached 7 million tons. As the sugar content ratio of harvested sugarcane fell by 5% to 10% a day, it is important to assure accessibility by roads between the sugarcane fields and the sugar processing plants.

3.2.3 Transporting Agricultural Products over Bridges

Most agricultural products grown in the northeast region of Thailand are transported from rural villages to neighboring cities by road. Thus, a complete and efficient road network plays a vital role in regional development. In this area, national highways and provincial highways are almost completed, but roads to the highways require urgent improvement. Most bridges on such roads are made of timber and are only one-lane wide, thus imposing restrictions on the smooth traffic flow of heavy vehicles. Consequently, the transportation of agricultural products is very difficult. Though the Thai government has been working to improve road conditions and bridges, such work has just reached to 30% of required by PWD administration. After constructing the 51 bridges involved in this investigation, 580,000 residents of this region will enjoy the benefits.

CHAPTER 4 DETAILS OF PROJECT

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4.1 Objectives of the Project

As pointed out in Chapter 2, rural roads in the northeast region of Thailand have many timber bridges with inadequate load capacities. This situation causes a bottleneck for vehicles, residents, and the distribution of goods.

The replacement or renewal of such timber bridges will enable a smooth traffic flow for people and goods and help promote socio-economic development in the region.

Thailand's road improvement plan places top priority on replacing such timber bridges.

According to this improvement plan, the project will be implemented to achieve the followings:

(a) To ensure reliable transportation in rural areas
(b) To contribute to socio-economic development and accelerate rural development.

4.2 Study of Requested Bridges

4.2.1 Proposed Bridges

The number of bridges proposed to the Japanese government by the Thai government in the initial request for this project was 68 as stated concept paper drafted in 1988 by the Thai government. (See Appendix 3.)

After the basic design study mission arrived in Thailand, the first conference was held with PWD on Jan. 19, 1989. The explanation from PWD is as follows. There are 234 bridges under the authority of PWD in the northeast region of Thailand; top priority for urgent replacement is given to 84 bridges, of which 68 bridges are initially proposed and 16 bridges are newly proposed.

The Thai government proposed that 84 bridges be the subject of Japan's Grant Aid. Thus, the survey mission obtained a basic understanding that it would promote a survey based on the proposed 84 bridges.

TABLE 4.2-1 LIST OF INITIALLY PROPOSED BRIDGES

No.	Province	Numbers	Group I	Group II
1	Kalasin	3	(1)	(2)
2	Khon Kaen	4	(4)	(-)
3	Chiya Phum	4	(8)	(1)
4	Nakhon Phanom	6	(5)	(1)
5	Nakhon Ratchasima	6	(2)	(3)
6	Maha Sarakhan	4	(4)	(-)
7	Mukdahan	6	(4)	(2)
8	Yasothon	4	(4)	(-)
9	Roi-et	4	(3)	(1)
10	Sisaket	3	(2)	(1)
11	Sakon Nakhon	3	(2)	(1)
12	Surin	4	(4)	(-)
13	Nong Khai	6	(8)	(-)
14	Udon Thani	6	(4)	(2)
15	Ubon Ratchatani	6	(4)	(2)
	Total	68	(52)	(16)

4.2.2 Selection and Classification of Bridges

(1) Selection of Bridges

The necessity and urgency of replacing the 84 bridges (proposed by the Thai government) under the Grant Aid Program were fully investigated. By considering the survey results of existing bridges and the detailed views of each province representative at the meeting in Bangkok, 51 bridges have been selected from the viewpoints of necessity, urgency, importance and socio-economic impact.

For selection of the bridges, the following items were checked;

a) Existing Bridge Conditions

- Bridge location
- Width and length of bridges
- Damaged condition
- Presence of bridges

b) Condition of Related Roads

- Existing condition of access roads (pavement, damaged condition, linearity)
- Access road width
- Connection to main roads
- Connection to main cities
- Existence of alternate roads
- Future improvement plan

c) Socioeconomic relationships

- Population in impact area
- Main industries
- Development plan

d) Site Photo

After examining the proposed 84 bridges by the Thai government, 51 bridges have been selected to be surveyed. (See Appendix 1 on the Minutes of Discussion for the bridges to be surveyed.)

(2) Grouping of the Bridges

51 bridges have been selected for further study and investigation. After considering the experience of steel-bridge construction in Thailand and the urgency in the replacement of timber bridges, it has been recommended that some bridges be constructed by Japan side. Accordingly, it has been decided that easy-to-construct short bridges (under 40m) will be constructed by the authority of Thailand as Group I under the supply of steel materials by Japanese government, and longer bridges requiring a higher-level of construction technology, for example, requiring temporary stages and large construciton machinery, will be constructed by Japan side as Group II. Thus 41 bridges are to be constructed as Group I, and ten bridges as Group II.

(3) Phasing

Bridge construction stage has been divided into two phases: the first year and second year. To determine the time at which to

construct the bridges, the socio-economic impact in the region has been considered. Accordingly, the phases have been classified as Phase I for the northern part of northeast Thailand (20 bridges in the first year, Group I - 15 bridges, Group II - 5 bridges), and Phase II for the southern part (31 bridges in the second year, Group I - 26 bridges, Group II - 5 bridges).

The selected 51 bridges are classified as follows:

List of Phase I Bridges

Group I				Group II			
No.	Bridge No.	Name of Bridge	Bridge Length (m)	No.	Bridge No.	Name of Bridge	Bridge Length (m)
1.	02.02	Huai Nong Ben	26.0	1.	02.05	Huai Khum Mum	46.0
2.	02.03	Huai Yang	30.0	2.	04.01	Huai Soeng No.1	40.0
3.	04.04	Huai Na Khoi	20.0	3.	04.02	Huai Soeng No.2	40.0
4.	04.05	Huai Na Krathum	20.0	4.	11.01	Lam Nam Kam	55.0
5.	11.03	Ban Na Kae	31.0	5.	14.02	Lam Nam Phuai	110.0
6.	13.01	Huai Sieo No.1	25.0				
7.	13.02	Huai Sieo No.2	20.0				
8.	13.03	Huai Ban Mui	31.0				
9.	13.04	Huai Ran	23.0				
10.	13.05	Huai Bang Phuan No.1	20.0				
11.	13.06	Huai Bang Phuan No.2	20.0				
12.	14.04	Nong Bung Mo No.1	18.0				
13.	14.05	Nong Bung Mo No.2	18.0				
14.	14.06	Nong Bung Mo No.3	26.0				
15.	14.07	Nong Bung Mo No.4	20.0				

List of Phase II Bridges

Group I				Group II			
No.	Bridge No.	Name of Bridge	Bridge Length (m)	No.	Bridge No.	Name of Bridge	Bridge Length (m)
1.	03.01	Huai Khon Tha	20.0	1.	01.01	Huai Kae	40.0
2.	03.02	Huai Yai	30.0	2.	05.01	Lam Klang	50.0
3.	03.03	Huai Phai No.1	20.0	3.	05.02	Lam Nam Mum	80.0
4.	03.04	Huai Phai No.2	20.0	4.	05.03	Lam Phra Phloeng	60.0
5.	05.04	Lam Ta Khong No.1	20.0	5.	15.07	Lam Som No.1	50.0
6.	05.05	Lam Ta Khong No.2	31.0				
7.	06.01	Huai Sieo	34.0				
8.	06.03	Huai Lom Khom No.2	20.0				
9.	06.04	Huai Na	16.0				
10.	07.07	Huai Po	20.0				
11.	07.08	Huai Ngui	31.0				
12.	08.01	Huai Wang Pla sium	26.0				
13.	08.02	Huai Na Pong	20.0				
14.	08.03	Huai Khaen	20.0				
15.	08.04	Huai Khaen Long No.1	20.0				
16.	08.05	Huai Khaen Long No.2	24.0				
17.	09.01	Huai Pla Pong	26.0				
18.	09.03	Huai Siao No.1	35.0				
19.	09.04	Huai Siao No.2	26.0				
20.	10.01	Huai Palan Muong	26.0				
21.	10.02	Huai Kantruat	20.0				
22.	12.02	Huai Thamo	20.0				
23.	15.03	Huai Sa Do	31.0				
24.	15.04	Huai So Phra	28.0				
25.	15.05	Huai Choek	31.0				
26.	15.08	Huai Khaen	33.0				

4.3 Scope of Japan's Grant Aid

The scope of Japan's Grant Aid for the project is as follows:

For Group I (41 Bridges)

Supply of materials and tools

- Superstructure members (main girders, cross beams, etc.)
- Bearings
- Railings and posts on the bridges
- Torque wrenches/calibrators

The Japan's Grant Aid for Group II includes the supply of materials for the superstructures of 10 bridges as described above, and the following construction work for the 10 bridges:

For Group II (10 Bridges)

- All construction work for ten bridges
- Construction of approaching embankments
- Construction of embankment protection
- Demolition of existing bridges

Table 4.2.1 lists the bridges that were initially proposed.