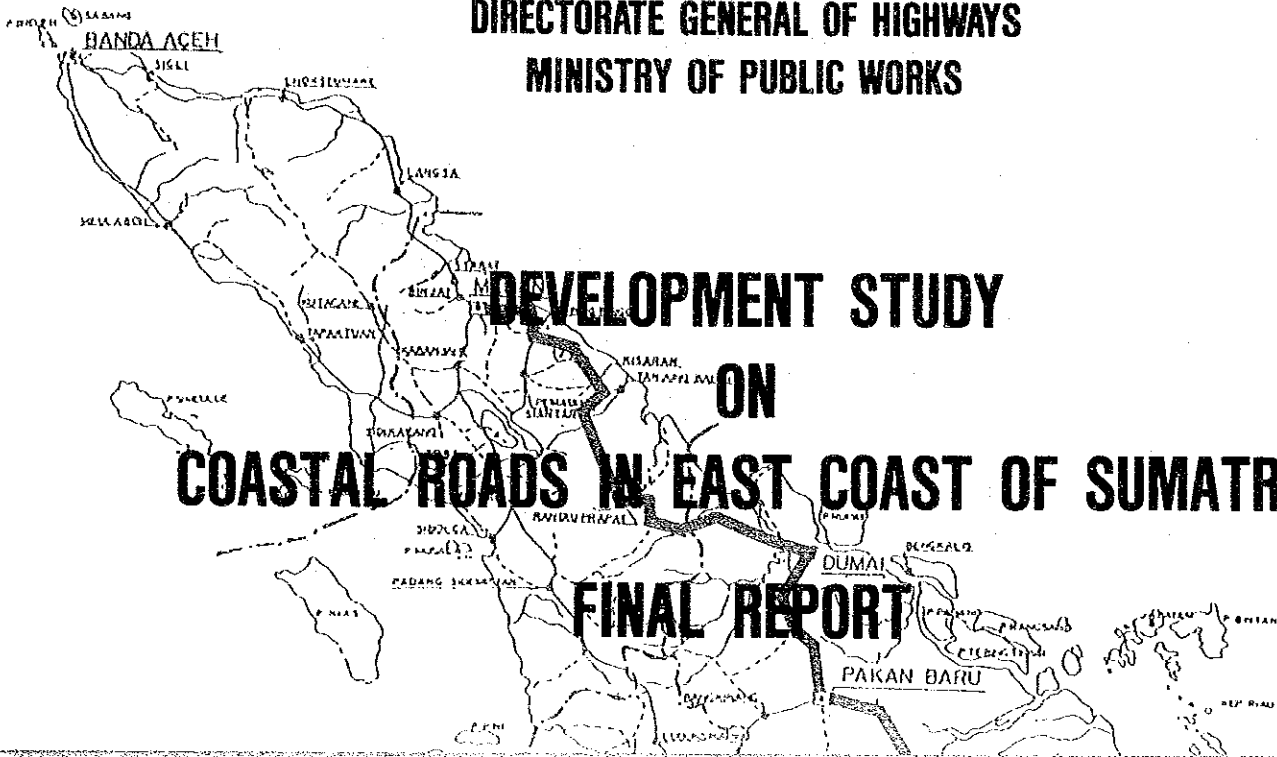


THE REPUBLIC OF INDONESIA
DIRECTORATE GENERAL OF HIGHWAYS
MINISTRY OF PUBLIC WORKS



**DEVELOPMENT STUDY
ON
COASTAL ROADS IN EAST COAST OF SUMATRA
FINAL REPORT**

EXECUTIVE SUMMARY

DECEMBER 1962

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to a request from the Government of the Republic of Indonesia, the Government of Japan decided to conduct a development study on Coastal Roads in East Coast of Sumatra and entrusted the study to the Japan International Cooperation Agency (JICA).

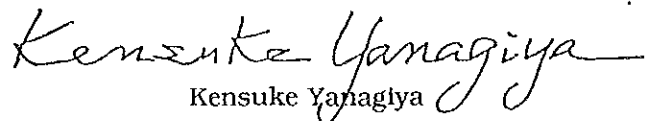
JICA sent to Indonesia a study team headed by Mr. Satoshi WATABE, Pacific Consultants International, three times between October 1991 and October 1992.

The team held discussions with the officials concerned of the Government of Indonesia, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

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

December 1992

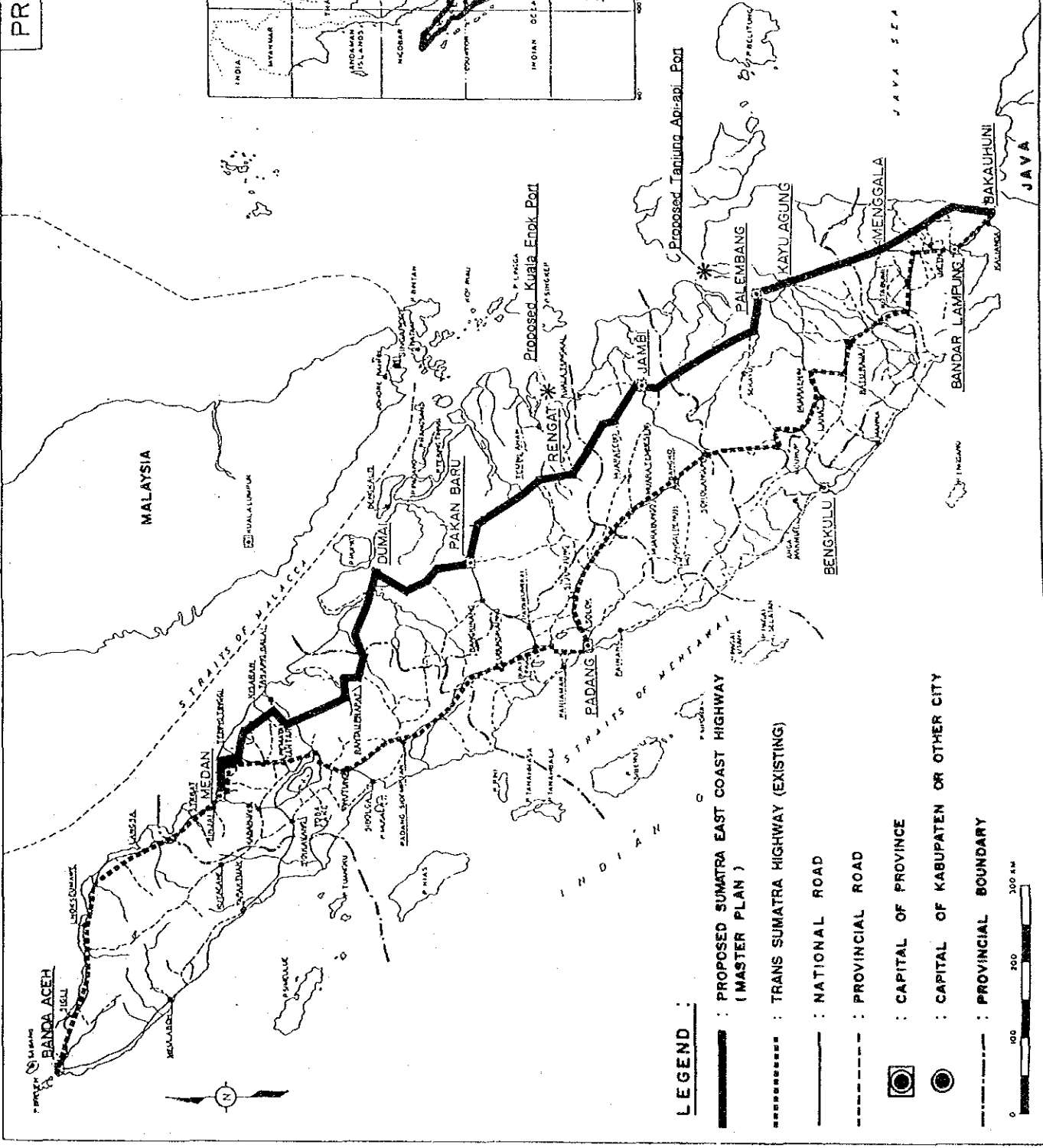
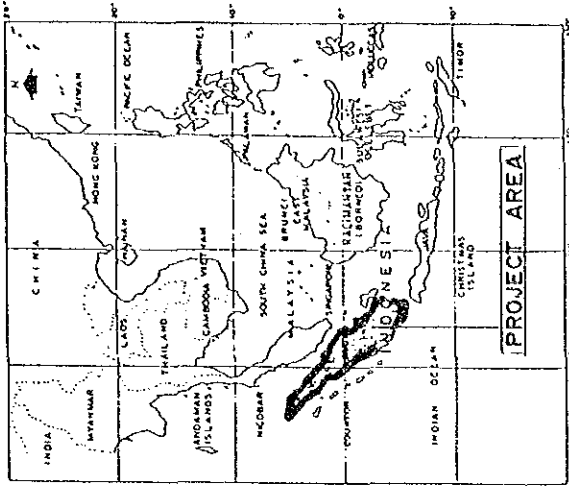


Kensuke Yanagiya

President

Japan International Cooperation Agency

PROJECT LOCATION MAP



- LEGEND :**
- : PROPOSED SUMATRA EAST COAST HIGHWAY (MASTER PLAN)
 - : TRANS SUMATRA HIGHWAY (EXISTING)
 - : NATIONAL ROAD
 - : PROVINCIAL ROAD
 - : CAPITAL OF PROVINCE
 - : CAPITAL OF KABUPATEN OR OTHER CITY
 - : PROVINCIAL BOUNDARY

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1 Introduction

This Report is the result of the investigation for the "Development Study on Coastal Roads in East Coast of Sumatra in the Republic of Indonesia" which has been conducted from October 1991 to December 1992.

1.1 Background of the Study

In the Five-Year National Development Plan (Repelita V), the Government of Indonesia has cited to promote the development of Sumatra island with rich natural resources such as oil, gas, agricultural and water resources.

In 1984, as a part of the Asia Highway, the Trans Sumatra Highway was completed. This was constructed with a view to developing the rural areas and improving and contributing to the raising of the living condition of the people residing along the road. The highway extends from Banda Aceh in the north to Bakauhuni at the southern tip of the island covering a distance of 2,600 km. However, the highway travels along the western mountain ranges and does not pass through Pekanbaru, Jambi, Palembang, which are large core cities.

In the "Northern Sumatra Integrated Regional Development Plan (JICA)", the Coastal Roads in the East Coast of Sumatra (hereinafter called the "Sumatra East Coast Highway") has been recommended as a top priority project.

Together with the various development plans, the construction of the highway, which will traverse the east coast of Sumatra including new seaport developments of Tanjung Api-api, South Sumatra and Kuala Enok, Riau, will contribute to regional development, agricultural production, industrial production, and relocation of population. It will also enhance travel to Java from the east coast cities of Sumatra. These projects will conform with the policies of Repelita V and will help realize fulfillment of the national road network. This has given rise to the preparation of a Sumatra East Coast Highway Plan.

1.2 Objectives of the Study

The objectives of the study are as follows:

- 1) To prepare a basic plan for a regional trunk road network which will interconnect the principal cities on the East Coast of Sumatra (design year is 2010).

Subject road sector : Medan to Bandar Lampung to Bakauhuni; total distance approximately 1,900 km.

2) Pre-Feasibility Study:

Preparation of a Pre-Feasibility Study for the basic plan for the road network described in paragraph 1) above, especially for road sectors with a high degree of importance (design year is 1997).

Subject road sector : Rengat - Jambi, Palembang - Menggala - Bakauhuni; total distance approximately 600 km assumed.

3) Feasibility Study:

Preparation of a Feasibility Study for the road sectors of high importance described in paragraph 2) above (design year; 1997).

Subject road sector : Kayuagung - Menggala; total distance approximately 180 km.

1.3 Study Area

The study area (see Project Location Map) is located on the east coast of Sumatra, and will include the five provinces of North Sumatra, Riau, Jambi, South Sumatra, and Lampung, which will be directly involved, and the three provinces of Aceh, West Sumatra and Bengkulu which will be indirectly affected. The traffic demand forecast, which will be taken into account concerning socio-economic matters, will include in the study that of Java Island.

2. Present Condition of Sumatra Island

- The population of the island of Sumatra was 36,500,000 in 1990, and in the last 10 years the annual growth was 3.1 % for the first 5 years, however, annual growth was lower at 2.3 % in the last 5 years.
- The regional GRDP for the island of Sumatra was 20 % of the total of Indonesia in 1989. The annual growth for Sumatra for the period 1983 - 1989 was 7.5 %. For the same period, Provincial growth was largest for Lampung, with North Sumatra, Bengkulu and Riau Provinces following with growth in excess of 8 %.
- The provinces where forest lands covered more than 50 % of the entire area were West Sumatra, Riau, Bengkulu and Aceh in that order. Forest lands on Sumatra average 50 %, of the area, Lampung Province has the least area with 32 %, the main reason being due to the development of the Transmigration Projects.
- The provinces with swamplands are South Sumatra and Riau Provinces, the ratio to the total province being 11 % and 5 % respectively.
- Provinces with large scale agricultural plantations are North Sumatra (18 %), Jambi (14 %), Lampung (14 %), with South Sumatra (9 %) and Riau (9 %) following. The extent of development of agricultural estates on Sumatra Island in the last 10 years amounted to 59,870 km², and is approximately one-half of the whole of Indonesia which amounted to 117,200 km².
- The provinces with comparatively large areas of paddy fields are North Sumatra, Lampung and Aceh.
- Sumatra has the largest number of registered vehicles next to Java. The proportions of vehicle registered in 1989 were Trucks 46 %, Passenger Cars 38 % and Buses 16 %. The provinces of North Sumatra and South Sumatra have a larger number of vehicles than the other provinces since industries are well developed. The number of vehicles registered in 1989 was 183,000 and 123,000 respectively. The total number of vehicles registered in the two provinces was approximately 60 % of the total (8 provinces).

3. Framework for the Future Development of Sumatra

The 5th Five Year National Development Plan has the objective of fairness and growth, and proposes regional development for the island of Sumatra by utilizing the existing potential (agriculture, agricultural produces, industry, tourism) by activating the industries to enhance the economic development of the island.

The economic growth of Sumatra from here on will be based on the linkage of Jakarta, Medan and the Singapore-Johore-Riau Islands (SIJORI) which will form the base for its future growth.

There is a Provincial Spatial Structure Plans (RSTRP) for Sumatra Island, based on all the provinces of the island, which takes into consideration the distribution of the population, land use plan, and the transportation network. Future development will use the development centres as growth axes.

Fig. 1 shows the development concept for the island of Sumatra. Table 1 and Table 2 give the future development framework for the island. At the present time BAPPENAS is planning the Second 25 Year Long Term Programme (1994/95 - 2019/20), and the latest social-economic framework has not yet been announced. According to information from BAPPENAS the most reliable forecast values from the framework has been prepared by JICA for the Integrated Regional Development Project for Northern and Southern Sumatra.

The Future Traffic Demand Forecast was prepared based on the National OD Survey conducted in 1991, incorporating the forecast values given in the above development plan. Future traffic volume forecasts for 1997 and 2010 are given in Fig. 2 and Fig. 3.

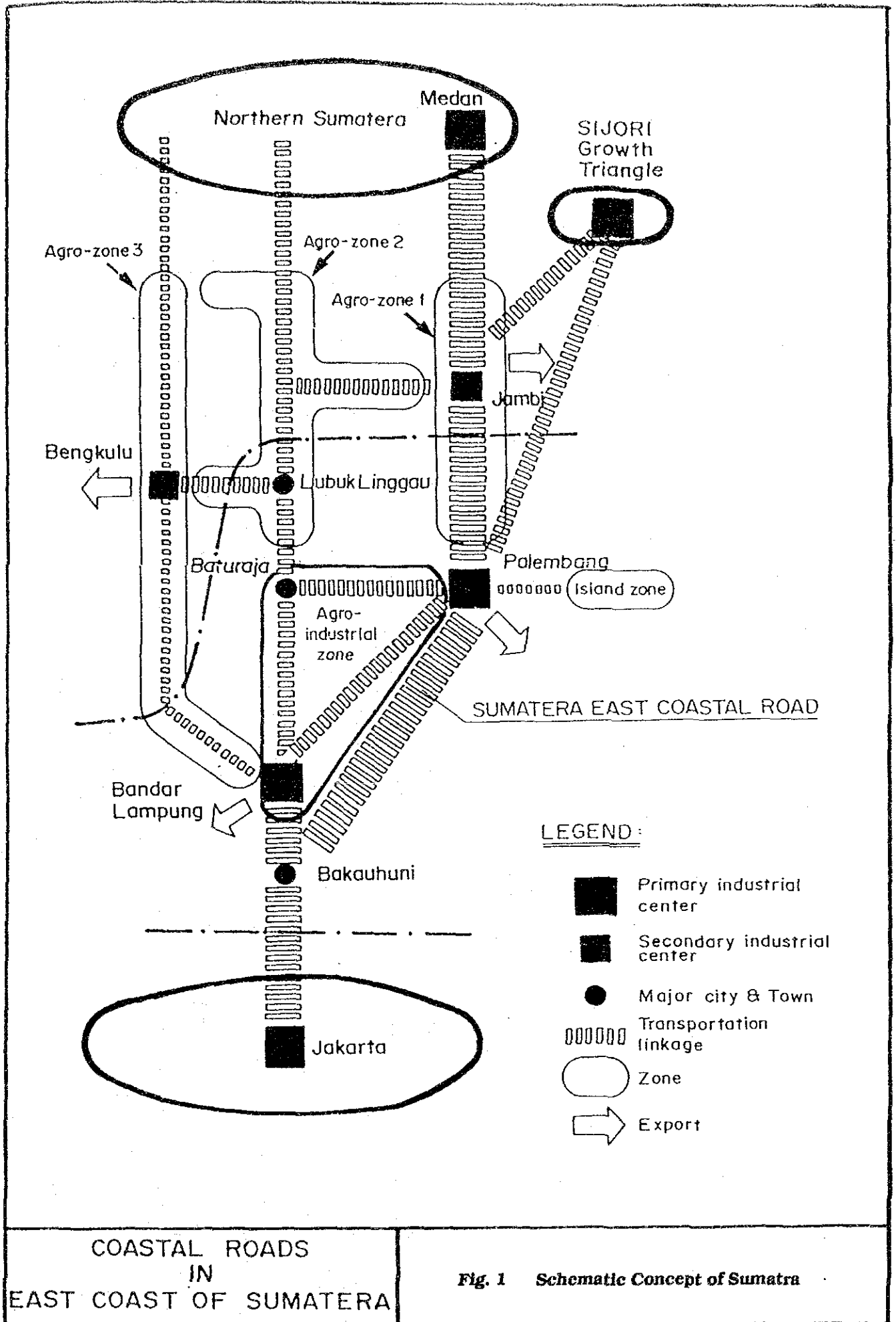
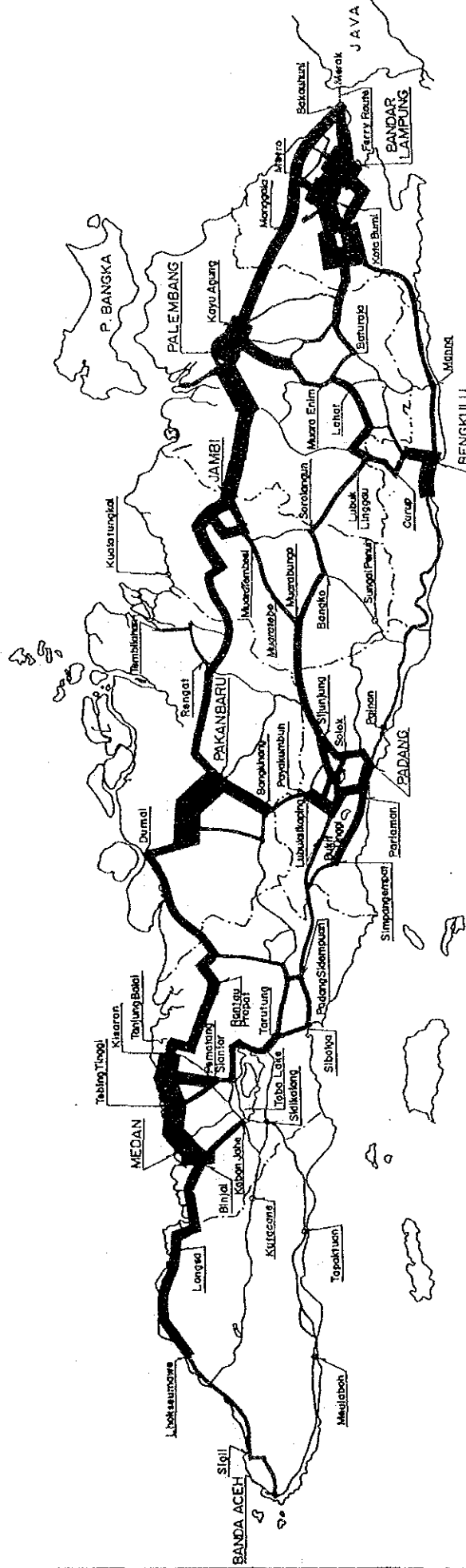


Table 1 Future Population Forecast by Province for Sumatra

Province	Land Area (Km sq.)	Population (thousand)					Population Density (Km sq.)		
		1990	1995	2000	2005	2010	1990	2000	2010
Aceh	55,392	3,415	3,919	4,440	4,955	5,471	62	80	99
North Sumatra	70,787	10,252	11,588	12,987	14,445	16,027	145	183	226
West Sumatra	49,778	3,999	4,265	4,508	4,721	4,902	80	91	98
Riau	94,561	3,281	3,871	4,515	5,197	5,905	35	48	62
Jambi	44,800	2,014	2,367	2,724	3,077	3,432	45	61	77
South Sumatra	103,688	6,276	7,293	8,310	9,289	10,255	61	80	99
Bengkulu	21,168	1,179	1,410	1,618	1,818	2,018	56	76	95
Lampung	33,307	6,004	6,823	7,613	8,411	9,253	180	229	278
Sumatra -total	473,481	36,420	41,536	46,715	51,913	57,263	77	99	121
Indonesia	1,919,317	179,322	194,516	208,823	221,552	233,315	93	109	122

Table 2 Future GRDP Forecast by Province for Sumatra

Province	GRDP (billion Rp.)			Per Capita GRDP (thousand Rp.)		
	1990	1995	2000	1990	1995	2000
Aceh	1,737	2,350	3,251	509	600	732
North Sumatra	5,744	7,745	10,877	560	668	838
West Sumatra	1,804	2,388	3,231	451	560	717
Riau	1,653	2,155	2,876	504	557	637
Jambi	756	1,122	1,679	375	474	616
South Sumatra	3,906	5,433	7,657	622	745	921
Bengkulu	457	679	993	388	482	614
Lampung	1,934	2,938	4,480	322	431	588
Sumatra -total	17,991	24,810	35,044	494	597	750
Indonesia	94,346	123,904	164,416	526	637	787

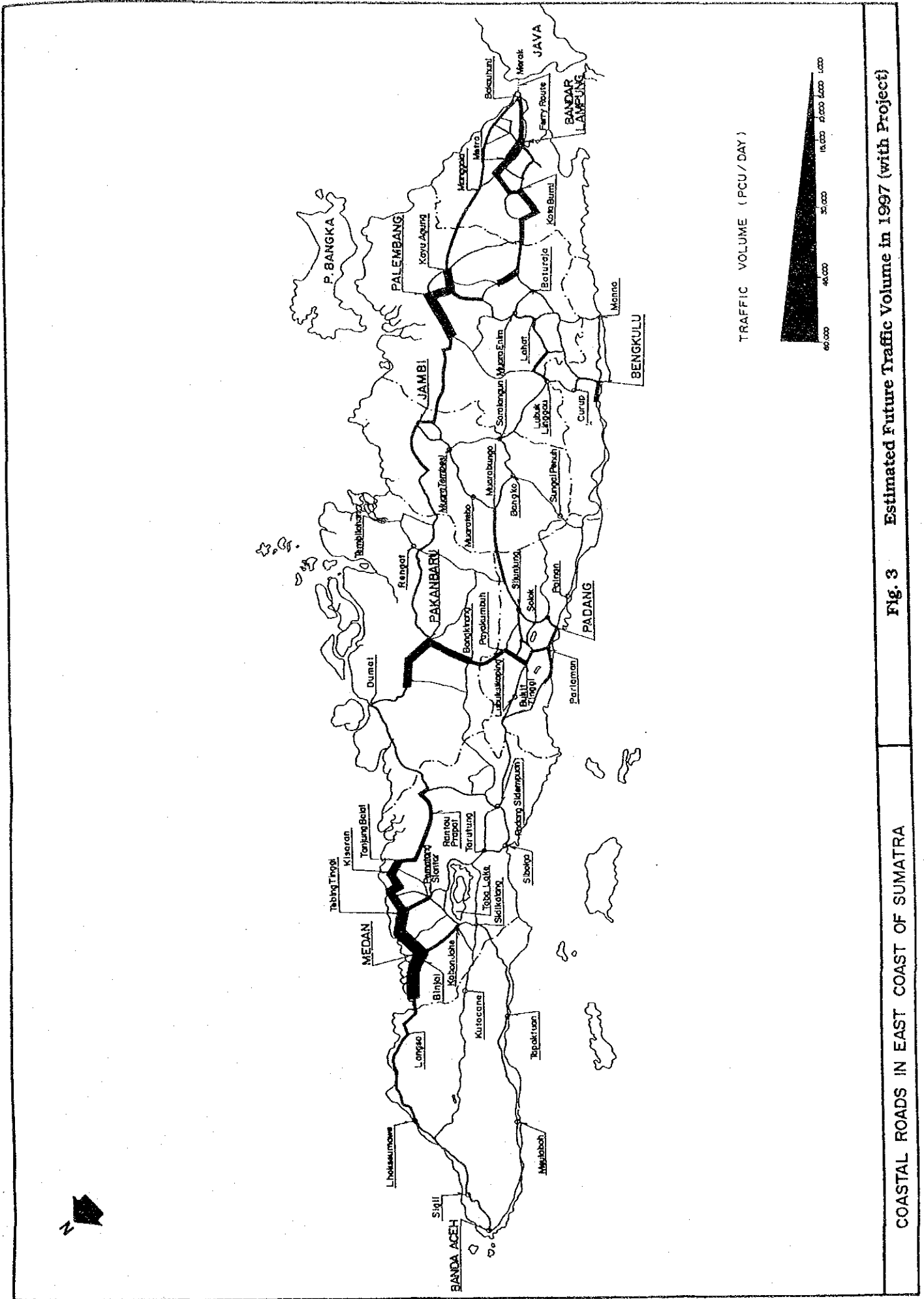


TRAFFIC VOLUME (PCU/DAY)



Fig. 2 Estimated Future Traffic Volume in 2010 (with Project)

COASTAL ROADS IN EAST COAST OF SUMATRA



4. The East Coast Highway Masterplan

4.1 Characteristics of the East Coast Region and Inherent Problems

Sumatra is a long and slender island approximately 1,700 km long in the north-south direction, and 300 km wide. The Barisan Mountain Range is on the west coast side, and an alluvial plain formed by the many large and small rivers which have their sources in the mountains, together with swamplands, stretch towards the east coast. The east coast is rich in natural resources due to the geographical makeup of the island, however, on account of the swampland/flood areas, road construction has been very slow and there are many undeveloped areas.

(1) Resources of the East Coast Region

The east coast region has many developed agricultural plantations, rice paddies and energy developments due to the rich natural conditions and resources, and together with the marine transport bases (ports) development has taken place at suitable areas.

(2) Economic Structure

The east coast region has been constrained by the numerous rivers and the economic development centres are confined to their own restricted areas due to delay in road development. There are great differences between the various growth centres, based on the degree of development of the resources.

(3) Movement of Goods

The movement and import of goods are largely confined to the three provinces of North Sumatra, Riau and South Sumatra, and they constituted 80 % of the total for the island of Sumatra. The three provinces all have industrially developed areas, with refining centres for petroleum, natural gas, plantations and productive growth areas in their hinterlands.

(4) Degree of Road Development

In general it can be said that Sumatra has basically well developed trunk road systems suitably laid out. The west coast and the main cities on the east coast region are interconnected with a trunk road system running north and south, and they are well interconnected with crossroads in the east-west direction.

However, the degree of road development in the east coast region leaves much to be desired. There are sections of roads missing, non-paved roads, roads requiring widening and in general the roads do not function properly as a road network system.

(5) Trend of Regional Development

There are many development plans for the east coast region, such as large scale agricultural plantations, port development projects as centres for the movement of goods, irrigation projects for the delta and swampland areas. Furthermore there is now a tendency for the development of Sumatra to move towards the east coast whereas in the past development has been centered on the west coast. Across the Strait of Malacca there is the SIJORI Project which aims to develop an international market for the Singapore - Johore - Riau areas, and will involve the island of Sumatra in its development.

4.2 The Need for the East Coast Highway

The island of Sumatra is situated in a strategic location second in Indonesia to the island of Java. On the other hand, development of the east coast of Sumatra has just recently started, and there are still large expanses of undeveloped land and vast natural resources which have not been effectively utilized. To realize the development potential it has been recognized that a trunk road network is urgently required.

In particular the rich natural resources together with the geographically located marine transport system must be utilized, and each province must put to good use its economic centres. Furthermore it has become more important for the provinces to combine their efforts for future economic development. In order to realize these objectives, the following must be implemented:

- coordination of the economic activities of the city centres.
- improvement of the coordination between the production centres and the consuming areas.
- improvement of the coordination between the hinterlands and the port facilities which are the bases for marine transportation.

In order to realize the above it is essential to develop the trunk road systems.

Development of the Sumatra East Coast Highway will provide two Trunk Traffic Axes in Sumatra including the Trans-Sumatra Highway System. By providing a system of highways to connect the two main highways in the east-west direction, the road system will form an integral highway network connecting all parts of the island. (See Fig. 4).

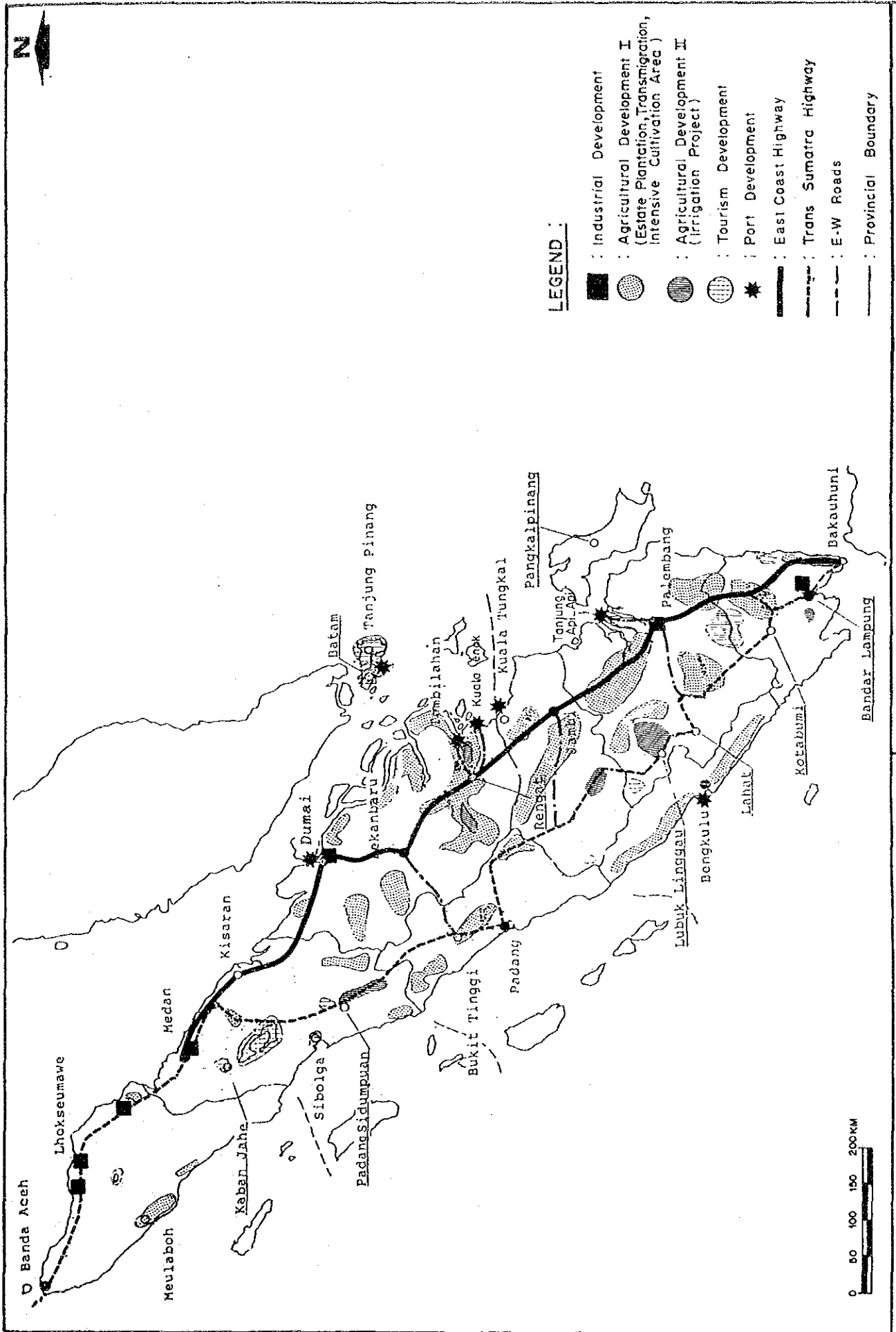
Furthermore, the interconnection of Sumatra area as a whole due to infrastructure developments such as the Sumatra East Coast Highway and seaports, will contribute to economic developments not only in Sumatra area but also in Indonesia.

4.3 Establishment of Masterplan for the East Coast Highway

4.3.1 Basic Policy for the East Coast Highway Project

The basic policy for the Sumatra East Coast Highway will be as follows:

- (1) Interconnection of the main cities of each Province:
Bakauhuni - Bandar Lampung - Menggala - Palembang - Jambi - Pekanbaru
- Rantau Purapat - Dumai - Medan
- (2) In order to accomplish early completion of the project highway, and also to keep the construction costs low, as a general rule the existing roadway (National and Provincial) will be rehabilitated.
- (3) The road construction standards will be, keeping in mind development of the roads along the route, public roads with unlimited access.
- (4) The number of lanes will be basically determined by the traffic demand. When the traffic demand cannot be met, the existing roadway will be widened or a bypass road will be constructed giving consideration to other roads in the area.
- (5) When the existing National or Provincial roads make a circuitous route, a new bypass route will be provided to increase the benefits of the road.
- (6) Where necessary, the present horizontal and vertical alignment will be improved.



LEGEND :

- : Industrial Development
- : Agricultural Development I (Estate Plantation, Transmigration, Intensive Cultivation Area)
- ◐ : Agricultural Development II (Irrigation Project)
- ◑ : Tourism Development
- ★ : Port Development
- : East Coast Highway
- : Trans Sumatra Highway
- - - : E-W Roads
- : Provincial Boundary

Fig. 4 Conceptual Trunk Traffic Axes in Sumatra

COASTAL ROADS IN EAST COAST OF SUMATRA

- (7) Road sectors in swamplands will be rehabilitated to maintain their annual traffic volume.
- (8) Any adverse effects caused by the road development works to the natural and social environment will be kept to a minimum.

4.3.2 Comparison of the Routes in Lampung Province

(1) Alternative Routes

The following three alternative routes can be proposed. (See Fig. 5).

7-A: Utilization of the Existing National Road

This route proposes to utilize the existing National Road to strengthen the utility and function of the City of Lampung.

7-B: Road Route Utilizing the Center of the Hilly Plains

This route proposes to promote the inland portion between the Trans-Sumatra Highway and the east coast, and to route the highway away from the city limits of Bandar Lampung where future traffic congestion is expected.

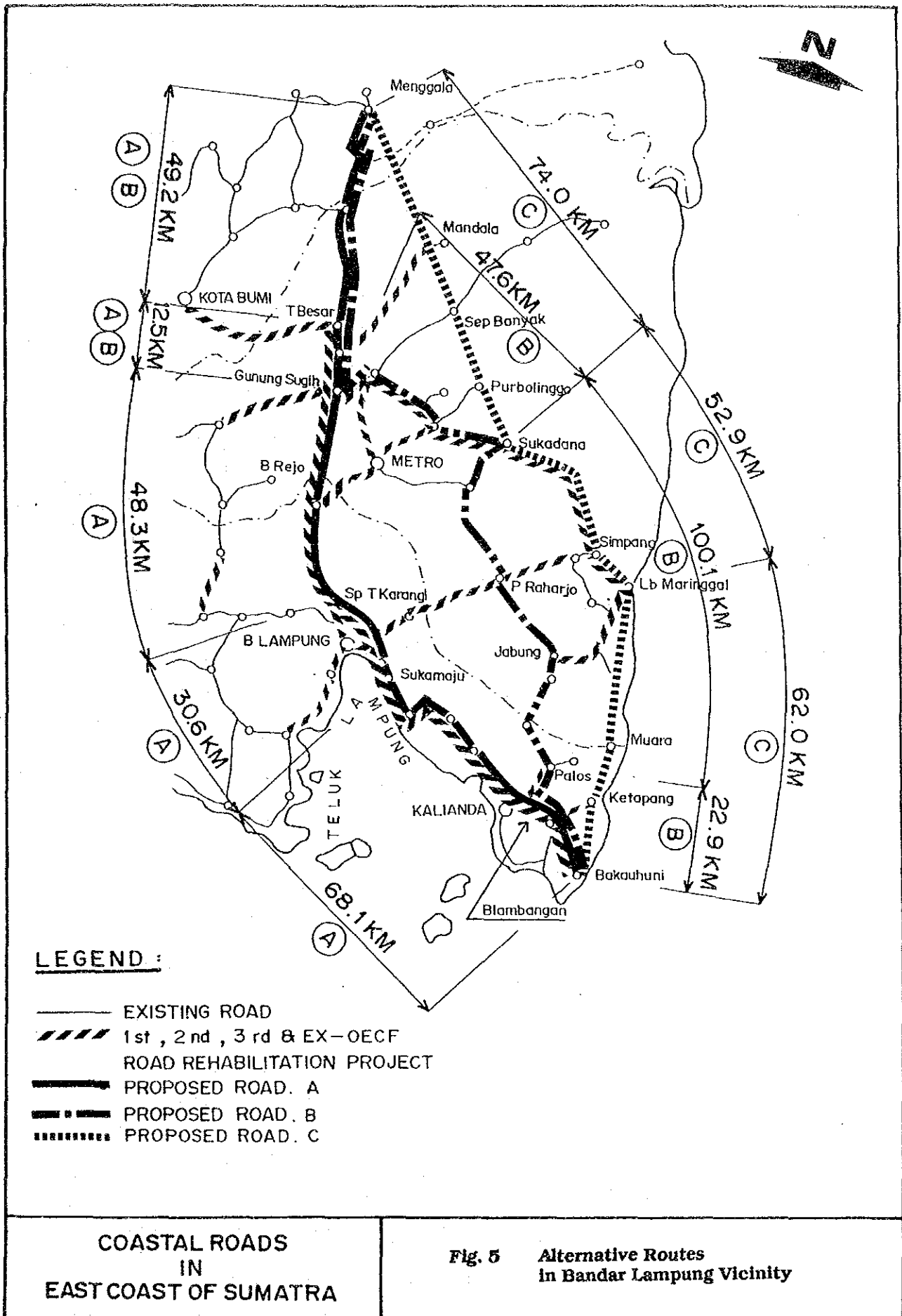
7-C: Road Route Along the East Cost

This route promotes regional development along the east coast and improves access to the villages and towns in the area. It has a shorter road length and will divert traffic away from the city limits of Bandar Lampung.

(2) Optimum Route

From a review of the following four aspects, Route 7-C is recommended as the optimum choice. Route 7-A which follows the existing road connects with the center of Lampung City which is one of the principal cities in Sumatra, and it may be necessary to develop this road along with the recommended Route 7-C.

- 1) Economic Aspect (Refer to (3) Economic Analysis for Route Comparison)
- 2) Difficulty in Widening Existing Road (Route 7-A)
- 3) Road Network Aspect
- 4) Development Trend in Lampung Province



(3) Economic Analysis for Route Comparison

A preliminary economic analysis was conducted for comparison of the route alternatives, assuming individual development for each related route. (See Table 3).

Table 3 Summary of Economic Comparison on Route 7-A, 7-B and 7-C

	Route 7-A	Route 7-B	Route 7-C
Road Length (Km)	209	232	189
Project Cost (initial) (Economic price) (Mil. Rp.)	100,501	107,478	113,500

Related to Direct Benefit (Savings on Vehicle Operating Cost and Vehicle Time Cost)			
EIRR	18.8%	18.3%	18.4%
NPV (Mil. Rp.)	32,700	30,400	33,200
B/C	1.4	1.3	1.3

Related to Indirect Benefit (Development Benefits)			
EIRR	8.5%	11.3%	12.5%
NPV (Mil. Rp.)	-37,600	-24,400	-18,100
B/C	0.5	0.8	0.8

Related to Total of Direct Benefit and Indirect Benefit			
EIRR	23.0%	25.1%	25.4%
NPV (Mil. Rp.)	74,600	104,200	114,800
B/C	1.9	2.1	2.1

Note : EIRR : Economic Internal Rate of Return
 NPV : Net Present Value (at discount rate of 15%)
 B/C : Benefit Cost Ratio (at discount rate of 15%)

The comparison results indicate the following:

- From the direct benefit viewpoint, Route 7-A has an advantage, followed by Routes 7-C and 7-B. However, differences of the efficiency measures among these three alternative routes are very slight.
- From the indirect benefit viewpoint, Route 7-C is favorable, followed by Routes 7-B and 7-A.

(4) Consideration of Development Trend in Lampung Province

According to the Future Development Concept prepared by a hearing conducted to the Provincial Development Planning Board (BAPPEDA) and the road Authority of Lampung Province, the potential for future development of the Province will be high in the east coast area, and will require a solution for the areas with poor traffic facilities.

In order to accelerate regional development it is necessary to complete the trunk road network, and Route 7-C is considered the best solution for this purpose.

(5) Conclusion

The Study Team recommended Route 7-C as the optimum choice from the long-term viewpoint. However, it can be said that the investment effects will be enhanced by utilization and/or improvement of existing road networks at the first stage in accordance with the staged road development of Route 7-C.

4.4 General Description of the Sumatra East Coast Highway

4.4.1 Road Sections and the Planned Traffic Volumes

The total length of the Sumatra East Coast Highway is approximately 1,900 km and for the development project, the roadway will be divided into seven sections using the principal cities as the points of demarcation. The planned traffic volume in 2010 of each section is indicated in Fig. 6.

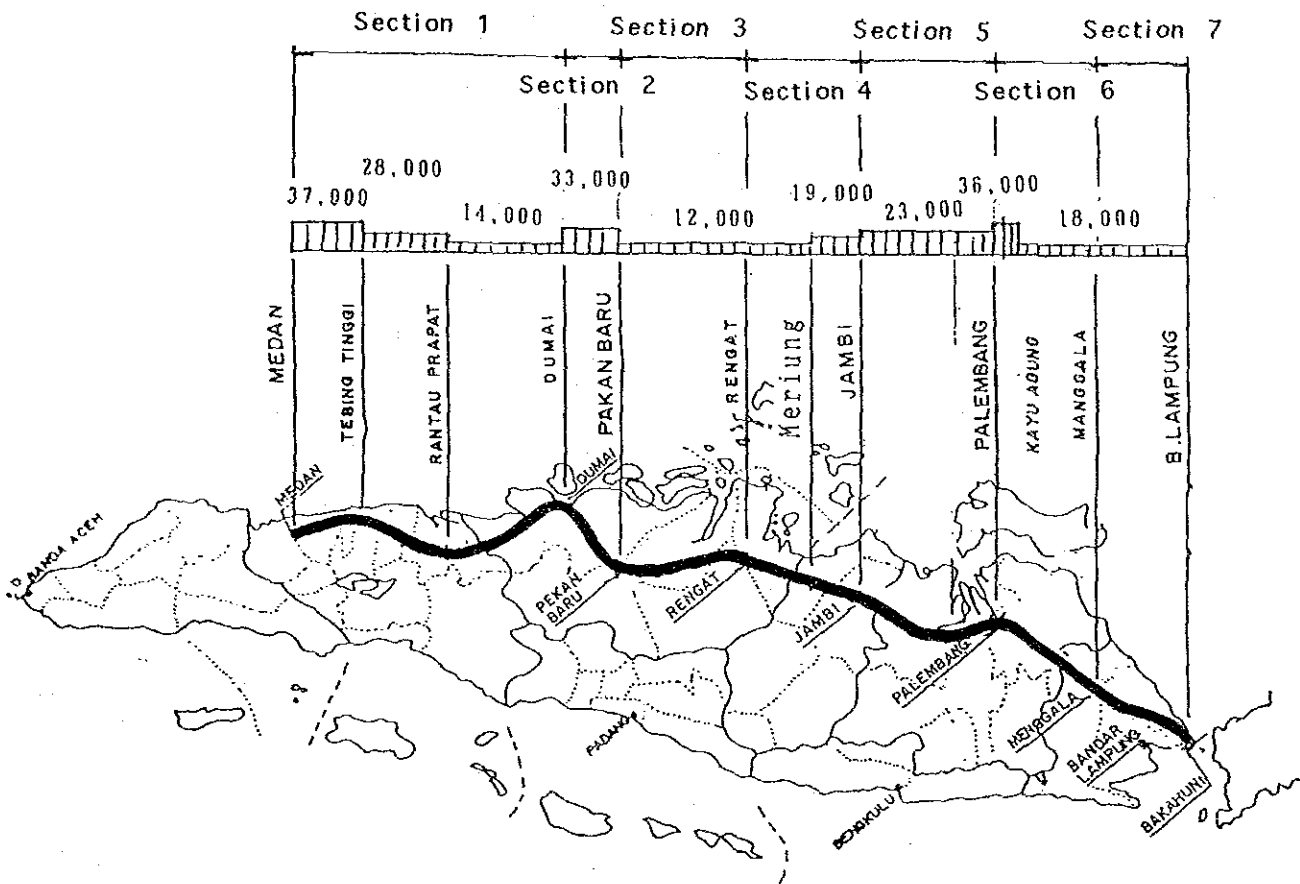


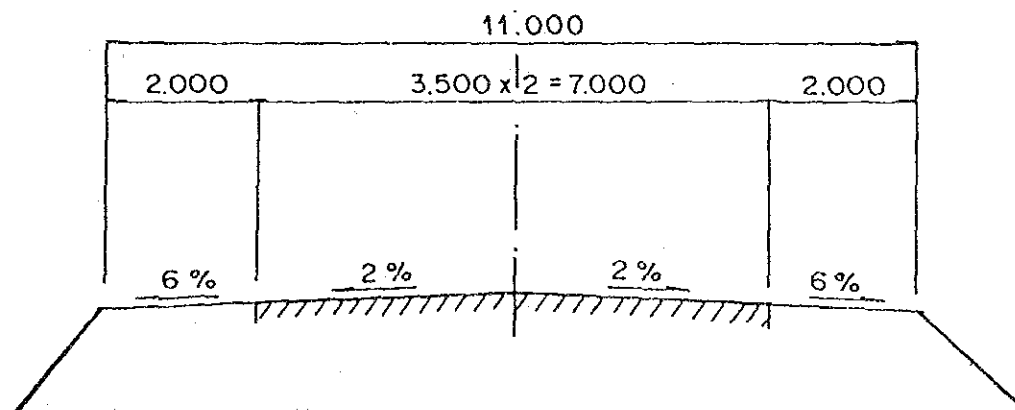
Fig. 6 Designed Traffic Volume in 2010 (pcu/day)

4.4.2 Road Design Standard, Geometric Structural Standard and Standard Road Cross Section

(1) The Road Design Standard and the Geometric Structural Standard are as follows:

Item	Unit	Standard
Road Class		Class II B
Terrain		Flat, Rolling and Mountain
Design Traffic Volume	pcu/day	1,500 ~ 8,000
Design Speed	km/hr	60
R.O.W. Width	m	30
Lane Width	m	2 x 3.5 m
Shoulder Width	m	2.0
Median Width	m	na
Crossfall of Pavement	%	2
Crossfall of Shoulder	%	6
Max. Superelevation	%	10
Min. Radius Curve	m	115
Max. Gradient	%	5
Min. Clearance	m	5

(2) The Standard Road Cross Section is as shown below:



4.4.3 Road Length and Construction Cost

The length of the Sumatra East Coast Highway by section and the construction costs are given in Table 4. The total construction cost for the Sumatra East Coast Highway for the length L = 1,906 km is estimated to be Rp. 851,775 million (at 1992 costs).

Table 4 Road Length and Construction Cost

Section	Length (km)	Financial Total Cost (mil.Rp.)	Financial Unit Cost (mil.Rp./km)
1. Medan - Dumai	522	213,805	409.5
2. Dumai - Pekanbaru	205	77,120	376.2
3. Pekanbaru - Rengat	201	85,121	423.5
4. Rengat - Jambi	264	131,876	499.5
5. Jambi - Palembang	276	108,843	394.3
6. Palembang - Menggala	249	113,971	457.7
7. Menggala - Bakauhuni	189	121,039	640.4
	1,906	851,775	446.9

4.5 Effect of the Sumatra East Coast Highway Development

Completion of the Sumatra East Coast Highway will give EIRR of 24.6 % in terms of a direct benefit and 32.5 % in terms of an indirect benefit, and 44.3 % in terms of the aggregate of the two. (See Table 5)

These analysis results indicate that the development project of the East Coast Highway is economically feasible.

Table 5 Economic Analysis

Description	In terms of Direct Benefit	In terms of Indirect Benefit	In terms of Aggregate
EIRR (Economic Internal Rate of Return)	24.6 %	32.5 %	44.3 %
NPV (Net Present Value) at Discount Rate of 15 % (Million Rp.)	406,800	681,700	1,461,700
B/C (Benefit Cost Ratio) at Discount Rate of 15 %	2.1	2.8	4.9

5. Pre-Feasibility Study and Feasibility Study

The roadway sections which are required to be completed by 1997 as the 1st Phase of the Sumatra East Coast Highway Masterplan for 2010 have been selected for their physical and strategic needs. The road sections and their evaluation are given in Table 6. The road sections with high priority are as follows:

- Section 4: Rengat - Jambi, Total Road Length 255 km.
- Section 6: Kayuagung - Menggala, Total Road Length 183 km.
- Section 7: Menggala - Bakahuni, Total Road Length 189 km.

5.1 Pre-Feasibility Study

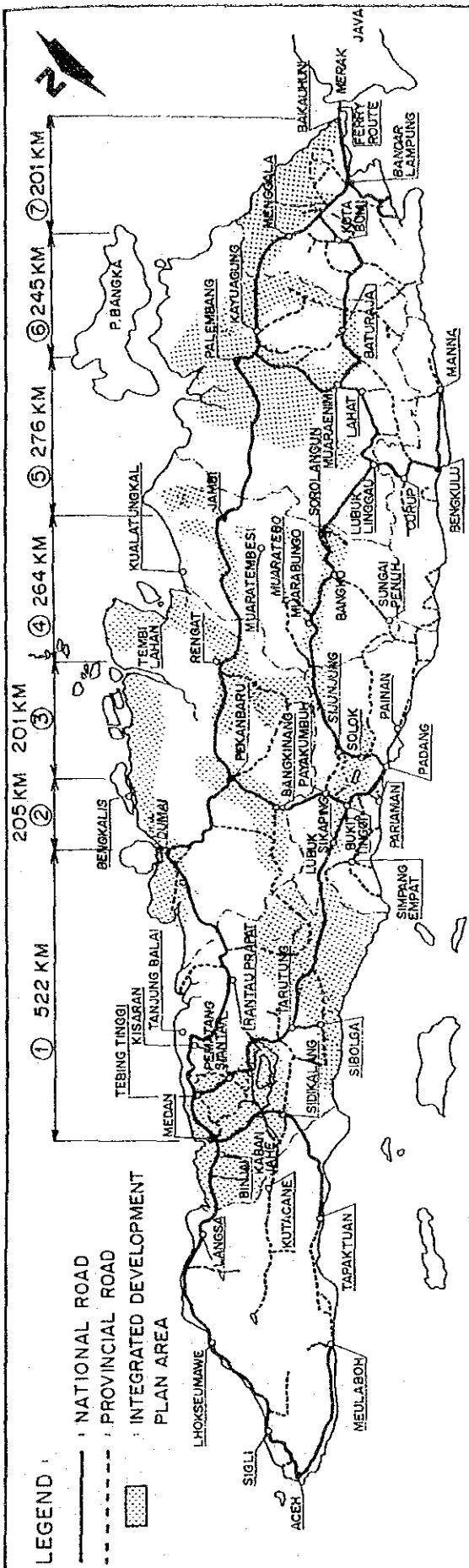
The relative priority for the three sections to be implemented is determined in the Pre-Feasibility Study. Table 7 gives the construction costs of the road sections in the Pre-Feasibility Study and the calculated EIRR.

**Table 7 Project Costs and Economic Analysis Results
for Sections 4, 6 and 7 in Pre-feasibility Study Stage**

(Million Rp. at 1992 price)

	Section 4	Section 6	Section 7
(Financial Costs)			
a) Initial Costs			
Construction, Engineering, etc.	106,754	76,525	87,129
Land Acquisition	20,008	13,746	38,066
Total	126,762	90,271	125,195
b) Whole Costs including Maintenance			
	Section 4	Section 6	Section 7
EIRR	12.5 %	20.9 %	18.0 %
NPV (Million Rp.)	-20,300	41,600	30,300
B/C	0.8	1.6	1.3

Note) EIRR ----- Economic Internal Rate of Return
 NPV ----- Net Present Value at discount rate of 15 %
 B/C ----- Benefit Cost Ratio at discount rate of 15 %



ITEMS OF EVALUATION	1. MEDAN - DUMAI		2. DUMAI - PEKANBARU		3. PEKANBARU - RENGAT		4. RENGAT - JAMBI		5. JAMBI - PALEMBANG		6. PALEMBANG - MENGGALA		7. MENGGALA - BAKAUHUNI	
	○	△	○	△	○	△	○	△	○	△	○	△	○	△
1. MISSING LINK OF NATIONAL ROAD					X	X	X							X
2. UNSUITABLE ROAD CONDITION		△	X	X	X	○	○	○	○	○	○	○	○	X
3. SHORTENING OF VEHICLE TRIP		△	X	○	○	○	○	○	○	○	○	○	○	△
4. TRAFFIC DEMAND		△	△	△	○	○	○	○	○	○	○	○	○	○
5. COMBINED WITH HEAVY LOADED IMPROVEMENT PROJECT		○	○	○	○	○	○	○	○	○	○	○	○	○
6. PRIORITY COASTAL ROAD LINKS IN VIEW OF INVESTMENT EFFECT		○	○	○	○	○	○	○	○	○	○	○	○	○
7. SUPPORTING OF DEVELOPMENT PLAN		○	○	○	○	○	○	○	○	○	○	○	○	○
8. ROLL OF ACCESS TO THE HINTERLAND OF PORT		△	○	○	○	○	○	○	○	○	○	○	○	○
9. PROMOTION OF LOW DEVELOPMENT AREA LINKAGE WITH JKT ECONOMIC ZONE		X	X	X	X	X	X	X	X	X	X	X	X	X
TOTAL OF EVALUATION	○	△	○	△	○	△	○	△	○	△	○	△	○	△
LEGEND: ○ MOST EFFECTIVE		△		△		△		△		△		△		△
△ MEDIUM EFFECTIVE		X		X		X		X		X		X		X
X LESS EFFECTIVE														

Table 6 Selection of Priority Sections

COASTAL ROADS IN EAST COAST OF SUMATRA

5.2 Feasibility Study

From the results of the Pre-Feasibility Study, the road section from Kayuagung to Menggala (Section 6) has been selected for the Feasibility Study. The location of the subject road section is given in Fig. 7.

5.2.1 Items to be Rehabilitated

Rehabilitation of the road sections will be performed where the following conditions pertain:

- A) Road sections with a horizontal curve radius less than $R = 115$ m.
- B) Road sections with vertical gradients of more than 5 %.
- C) Road sections that are over-topped by flood waters (raise road bed).
- D) Bridge approach sections where bridges have been replaced.
- E) Road sections that have been widened or the pavement strengthened (all road sections).

The road rehabilitation works are described in Table 8 and will be divided into the following two classifications. Horizontal alignment will be rehabilitated for about 8 % of the total road section length, $L = 183$ km, while rehabilitation of road widening and pavement strengthening will be for the entire road section.

Table 8 Items to be Rehabilitated

Reason	No. of Sites	Length (km)
Rehabilitation of horizontal alignment	40	6.4
Rehabilitation of vertical alignment	5	3.0
Raising of road bed	7	4.8
Rehabilitation of Bridges, and other rehabilitation	2	0.8
Widening of road and pavement strengthening	-	183.0

Of the bridges for the road section described in the Feasibility Study, the following two bridges will require rehabilitation work:

- a) Tulang Bawang Bridge
- b) Pedada Bridge

The bridges will generally be widened to 7.0 m as determined by the Government of Indonesia.

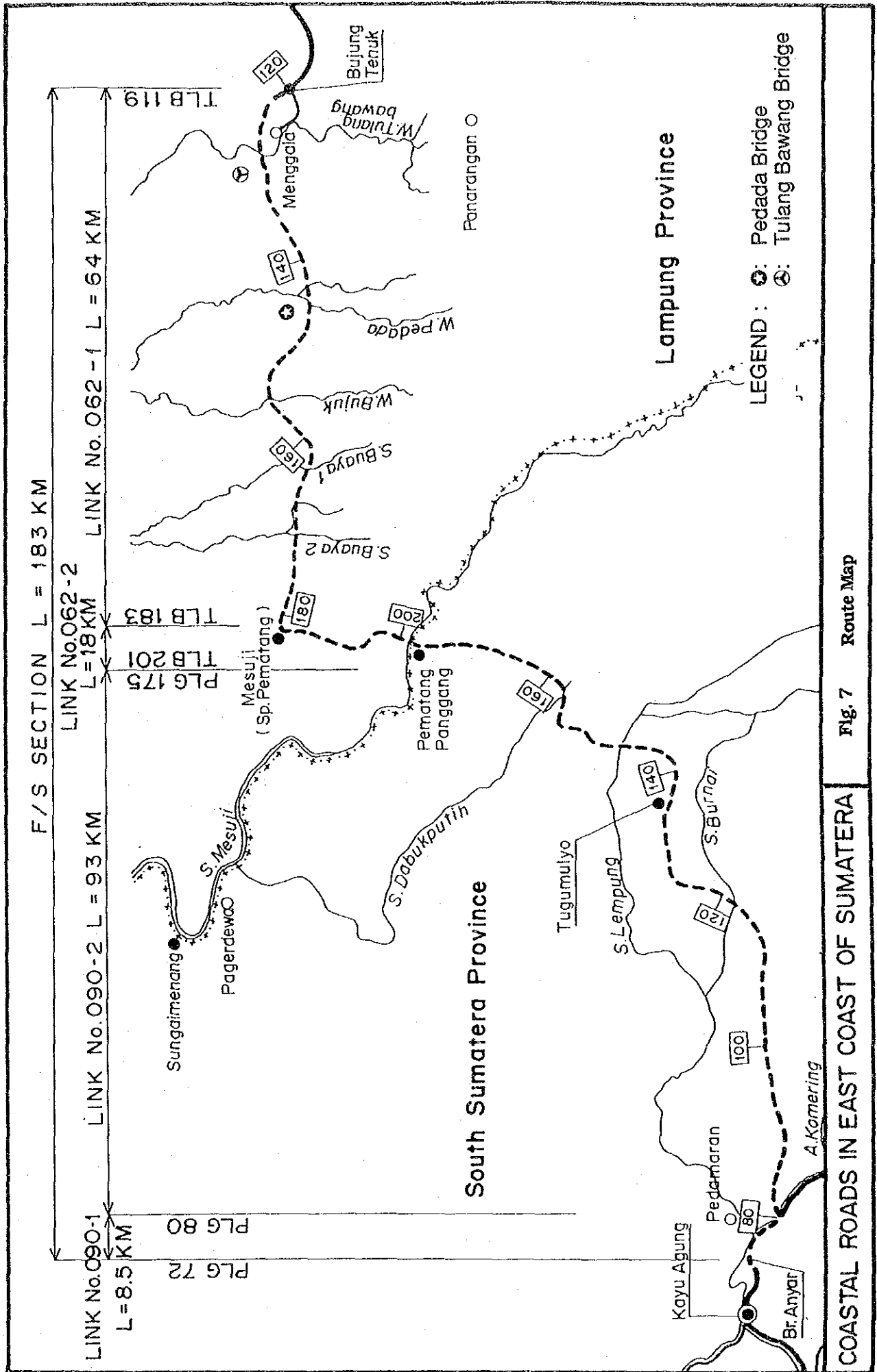


Fig. 7 Route Map

5.2.2 Required Number of Lanes

Based on the planned traffic volume in 1997 and 2010 and the assumed traffic capacity, the required number of lanes are determined.

- in 1997, it will be necessary to change the present single lane road to a 2-lane road;
- the proposed 2-lane road section is considered to be able to handle the traffic volume efficiently in 2010. Otherwise, the future traffic demand (18,000 PCU vehicles /day) to the present bridge capacity (6.0 meter width) ratio will be assumed to be 0.78.

5.2.3 Design of the Road Pavement

a) Method of Design

The AASHTO Design Guide for Pavement Structure, 1986, will be used as a design reference.

b) Design CBR

A design CBR of 3.0 % will be used based on the results of the CBR Test conducted for soil samples obtained from the borrow areas.

c) Design Life Period

The design life period will be 10 years.

d) Designed Traffic Volume for Pavement Design

Designed traffic volume for the pavement design will be for the period from 1997 to 2007, a period of 10 years. (The highway will be opened to the public in 1997)

The pavement structure and thickness for new and overlay pavement are given in Fig. 8

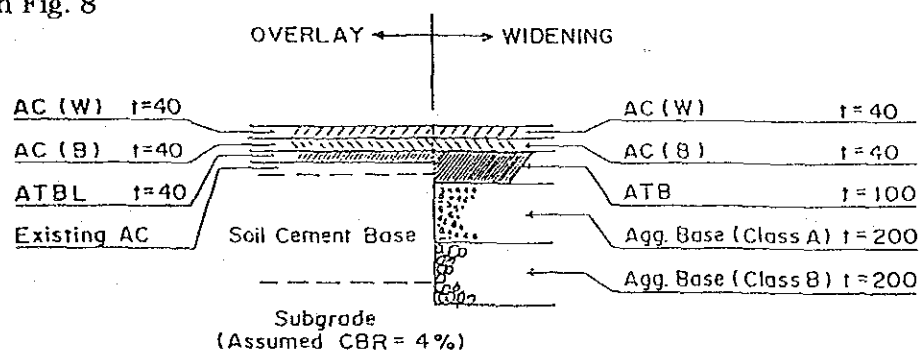


Fig. 8 Pavement Structure

5.2.4 General Description of Construction Works

The construction works consist of rehabilitation of the road from Kayuagung to Menggala, a distance of 183 km, and the replacement of two bridges. The detailed description is as follows:

1) Road Rehabilitation Works

- Total Length: 183 km (101 km within South Sumatra Province and 82 km within Lampung Province)
- Number of Lanes: Before Reconstruction: 1-lane, 4.5 m width
and Width (partially 2-lane, 2x3.0= 6.0m)
After Reconstruction: 2-lane, 2 x 3.5 = 7.0 m
- Shoulder Width: Before Reconstruction: 1.0 m
(partially 1.5 m or 2.0 m)
After Reconstruction: 2.0 m
- Pavement: Asphalt Pavement:
 - Existing paved road with overlay pavement.
 - Widened road sections and road sections with improved horizontal and vertical alignment with new pavement.

2) Bridge Replacement Works

Tulang Bawang:

- Location: Lampung Province, 8.5 km north of Menggala (TLB 127.5 km)
- Length: 3 x 40 m = 120 m
- Number of Lanes and Width: 2-lanes, 2 x 3.5 = 7.0 m
- Bridge Structure: Super Structure ----- Trussed Bridge
Sub Structure ----- Reinf. Concrete
Inverted T-Beam Abutment, Pile-Bent Bridge Pier
Foundation ----- Steel Pipe Pile
- Detour Bridge: Use existing bridge (W = 4.5 m)

Pedada Bridge:

- Location: Lampung Province, 24.3 km north of Menggala, (TLB 143.3 km)
- Length: 45 m
- Number of Lanes and Width: 2-lanes, 2 x 3.5 = 7.0 m
- Bridge Structure: Super Structure ----- Trussed Bridge
Sub Structure ----- Reinf. Concrete
Inverted T-Beam Abutment
Foundation ----- Steel Pipe Pile
- Detour Bridge: Use existing bridge (W = 3.8 m)

5.2.5 Project Implementation Schedule and Project Cost

On the assumption of commencement of the Detailed Design works from the beginning of 1994, the opening of the project to the public will be early 1997. The project implementation period will be 3 years (see the following figure).

	1994	1995	1996	1997
Detailed Design	■			
Land Acquisition	■	■		
Construction		■	■	■
Opening to Traffic				▼

Table 9 shows the project cost for the Feasibility Study section.

Table 9 Project Cost

(Million Rp. at 1992 price)

	Financial Costs
Construction Costs	89,906
Land Acquisition	14,883
Engineering Services	8,645
Grand Total	113,434

5.2.6 Economic Analysis

The results of the economic analysis for the Feasibility Study section are given in Table 10. The EIRR for the Kayuagung - Menggala section is 18.2 %, and this indicates that the road development project for this section is economically feasible.

Table 10 Economic Project Analysis

Efficiency Measures	
EIRR	18.2 %
NPV (Million Rp.)	26,200
B/C	1.3

Note) EIRR----- Economic Internal Rate of Return

NPV----- Net Present Value at discount rate of 15 %

B/C ----- Benefit Cost Ratio at discount rate of 15 %

6. Evaluation of the Environmental Impact Study

An Environmental Impact Study (EIS) was conducted for the Feasibility Study covering road section 6 (Kayuagung - Menggala, L = 183 km). The study was made to check whether the implementation of the road section could cause any major impacts to the environment. Table 11 gives the results of the EIS evaluation. Some undesirable effects to the environment are expected, but it is judged that there is no any serious adverse impact on the environment through the discussion with Bina Marga.

(1) During the Construction Period:

It is expected that there will be some adverse effects of air pollution from exhaust emissions and dust generated by the construction equipment during the dry season which would affect plant life in the vicinity of the project site.

(2) After Opening of the Road to the Public:

It is expected that there will be some adverse effects to the health and movements of wild life and to plants.

There are elephants and monkeys living in the vicinity of the project site in Way Buaya and Way Sungkay preserves that are protected by Law. In particular, it has been observed that the elephants cross the roadway in herds of 5 to 25. The exact numbers of the elephants and their behaviour are not fully known. It will be necessary to obtain in the future further information on their behaviour.

Table 11 Environment Impact Assessment

Environmental Component	Implementing Activities								
	Pre-Construction		Construction					Operation	
	A	B	C	D	E	F	G	H	I
I. Physical Chemistry									
- Climate				-1/a				-1/a	
- Air Quality			-1/a	-1/a	-1/b	-1/a		-1/b	
- Rainfall									
- Soil/Land				-1/a	-1/a		-2/b	-1/a	
- Hydrology				-1/b			-2/b	-2/b	
- Space System		-1/a					-1/a	+3/c	
II. Biology									
- Vegetation		-1/a			-1/a				
- Wild Species			-1/a	-2/b	-1/b	-1/a		-3/c	-1/a
- Aquatic Biota			-1/a		-1/a	-1/a		-1/b	-1/a
III. Socio-Economy & Socio-Culture									
- Demography								+2/b	
- Education								+1/a	
- Health			-1/a	-1/b	-1/a	-1/a	-1/a	+1/a	
- Culture								+1/a	
- Income			+1/c	+1/c	+1/a	+1/c	-1/b	+2/c	+1/a
- Social Perception	+1/a	-1/a		-1/a				+2/b	+1/a

Explanation:

- A. Preparation
- B. Land Acquisition
- C. Covering
- D. Earth Work
- E. Installing Batching Plant
- F. Bridge Work
- G. Making Drainage Channel
- H. Using/Operating Road
- I. Road Maintenance

Magnitude

- 1. Very Small
- 2. Small
- 3. Medium
- 4. Big
- 5. Very Big

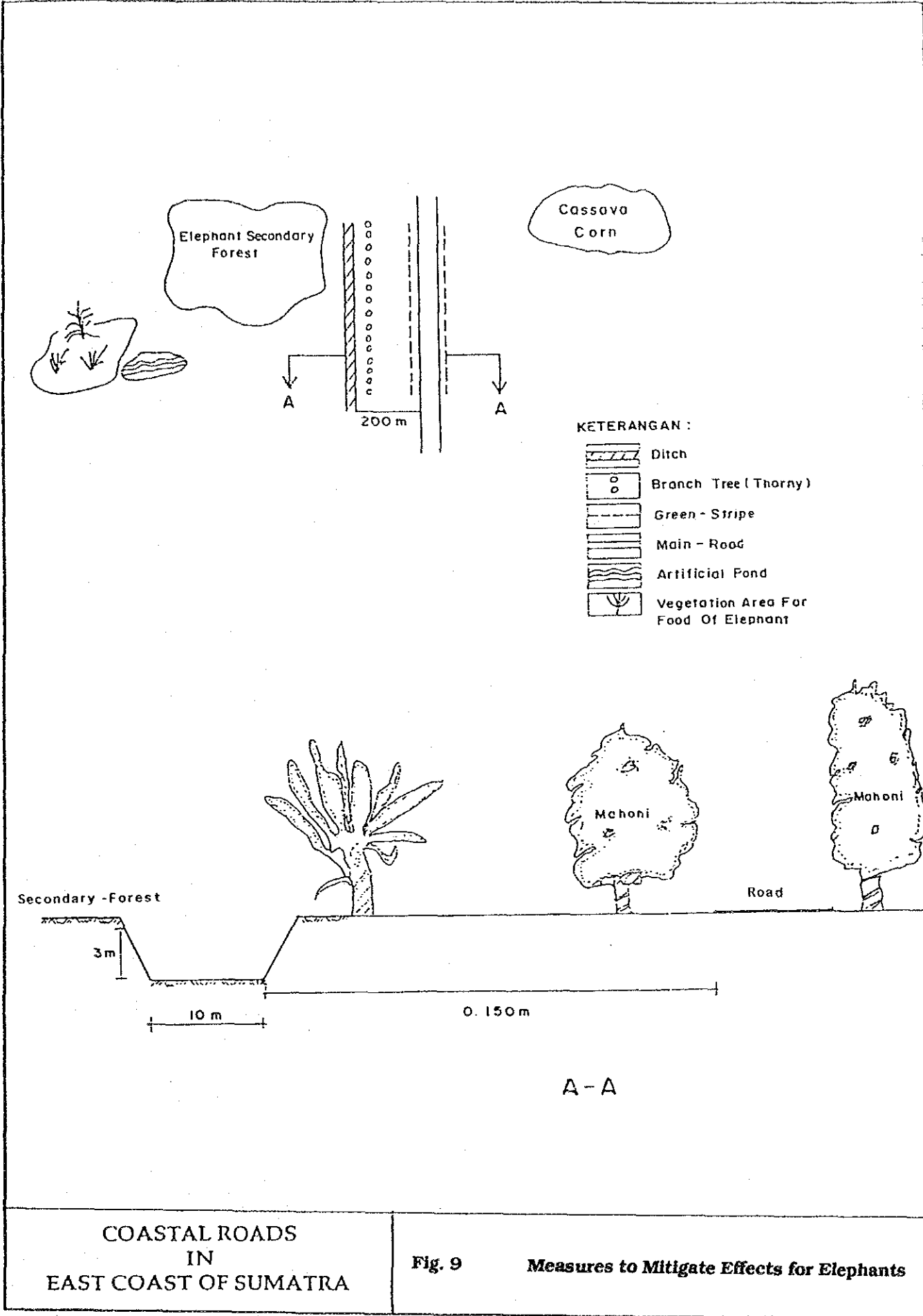
Importance

- a. Negligible
- b. Slight
- c. Moderate
- d. Significant
- e. Major

- + = Positive Impact
- = Negative Impact
- Blank = No Impact

With the implementation of the project there will be some adverse effects to the environment, for which the following protective measures will be taken:

- The impact to the environment can be mitigated by planting Mahoni along the project route to lessen the effects of air pollution and noise (see Fig. 9). The plants are expected to prevent the elephants from freely crossing the project road.
- Measures to prevent elephants from crossing the project road are given in Fig. 8. Basically ditches will be constructed along the road to prevent the elephants from freely crossing. Also watering holes and feeding areas will be provided for the elephants, and methods adopted to mitigate the impact to wild life and plants. Moreover, in the detailed design stage, construction of animal crossing is to be studied for the location where they are known to cross for their safety (by constructing flyover or other means).



7. Conclusion

The development plan for the whole Sumatra East Coast Highway (Masterplan) was established for the section of Medan - Bakauhuni (approximately 1,900 km in length) with the target year of 2010.

The development of Sumatra East Coast Highway is expected to perform the following important roles for the welfare of the island:

- Together with the existing Trans Sumatra Highway it will form the trunk road network on the Island of Sumatra.
- It will contribute to the development of road traffic on the east coast where road construction programmes have not been well developed.
- The East Coast Highway is expected to inter-connect the major core cities (Palembang, Jambi, Pekanbaru, etc.) on the east coast area.
- The highway will back-up the SIJORI Development Programme.

In summary, construction of the East Coast Highway will greatly contribute to the regional development, enhance the movement of agricultural and industrial products of the neighboring areas, and facilitate transportation to and from the island of Java.

The implementation of the Masterplan is to be performed on the basis of the staged-construction program. Out of the seven road sections defined in the Masterplan, the road section of Kayuagung - Menggala (183 km in length) was selected as a most high priority section, and the Feasibility Study was conducted for the road development of this section with the target year of 1997.

The study results of the Masterplan indicate that the implementation of Sumatra Coast Highway is technically feasible, and from the national economic viewpoint high feasibility is indicated. It can be expected that the direct benefits will be high, and there will be a large indirect benefit to the related regions.

Also for the Feasibility Study section, high feasibility is indicated. It is therefore that the road development of the Feasibility Study section should be implemented as soon as practically possible.

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