Table 6.10 Forecast 2010 Zonal O-D Trip Ends

Zone	Trip Attractions by Mode					
	Sedans	Light Trucks	Heavy Trucks	Small Bus	Large Bus	Total
1	358	696	6	149	100	1309
2	131	275	2	10	44	462
3	962	2041	20	391	251	3665
4	56	256	2	11	40	366
5	427	894	10	181	117	1630
6	593	1057	86	182	239	2157
7	214	536	5	99	147	1002
8	1834	3113	180	1127	613	6866
9	1868	2460	194	608	357	5488
10	1942	1808	212	42	348	4351
11	970	1097	240	235	176	2719
12	1618	1974	311	106	299	4307
13	3646	4013	826	878	549	9912
14	3187	2785	776	745	469	7961
15	372	592	322	101	85	1473
16	930	1456	61	245	214	2905
17	8711	10355	1652	5586	1478	27784
18	3803	4526	447	6975	576	16327
19	775	825	6	81	254	1943
20	1782	1451	9	3575	256	7074
21	1106	1482	40	1727	153	4508
22	2013	1433	69	2733	266	6514
23	5354	4713	359	1893	1498	13817
24	2386	1503	64	2707	433	7093
25	1885	1753	279	1963	335	6214
26	1151	1003	13	328	319	2814
27	439	765	41	202	129	1577
28	661	944	12	86	178	1881
29	1628	4833	1144	1536	530	9670
30	2569	5596	1015	1457	705	11342
31	155	516	3	68	147	889
32	427	846	10	491	255	2029
33	1983	2909	174	3065	1174	9305
34	616	934	12	967	369	2899
35	458	811	14	1004	185	2471
36	747	1813	18	1145	392	4116
37	6243	9892	298	5160	2483	24077
38	768	1633	86	772	382	3642
39	566	1175	59	767	229	2797
40	659	1295	15	2110	236	4315
41	2641	4683	88	4308	920	12640
42	662	1268	58	2097	170	4256
43	1058	1868	29	2657	252	5864
44	1368	2671	172	3817	445	8473
45	7349	14454	1369	5519	2193	30883
46	3971	7332	908	2969	943	16124
47	2711	7852	437	4837	925	16761
Total	85755	128187	12153	77715	22860	326669

6.5.3 1997/2010 OD Matrices

Forecasted 1997 and 2010 matrices of internal study area travel demand were prepared using the calibrated gravity models and the respective zonal trip ends as discussed in section 6.5.2.

A single trip matrix was forecast for each of the two design years, with input road network travel impedances being based on assumed upgrading of all sections of the East Coast Highway. This assumption was reasonable, in that in the longer term all road sections will be upgraded, and new business and residential developments will locate to gain maximum benefit from the entire upgraded road; differential construction phasing is not likely to have any significant impacts on long term travel patterns. It was not considered appropriate to explicitly model trip distribution for each individual road improvement section, as a single section upgrading is an unrealistic long term development scenario; the differences in trip distribution patterns likely to result from modelling each section are considered minor in any case.

Following completion of the internal trip distribution phase, the separately modelled external trips (refer section 6.5.2) were added to the internal trips to create total 1997 and 2010 vehicle trip matrices.

6.5.4 Lampung Sub-Area Model Development

The East Coast Highway section between Bakauhuni and Menggala includes three alternative road alignments as follows: The work flow of Lampung sub-area analysis is illustrated in Fig. 6.6.

- Route A - widening /upgrading of the existing alignment;
- Route B - construction of a new road through the central hilly area of Lampung;
- Route C - construction of a new road along the east coast.

The zone system in Lampung which comprises three Kabupaten zones was considered to be too coarse for proper evaluation of the alignment alternatives. Smaller zones were deemed necessary in order to have a more reasonable spread of trips around the network. Accordingly, the three traffic zones were subdivided into 67 Kecamatan zones.

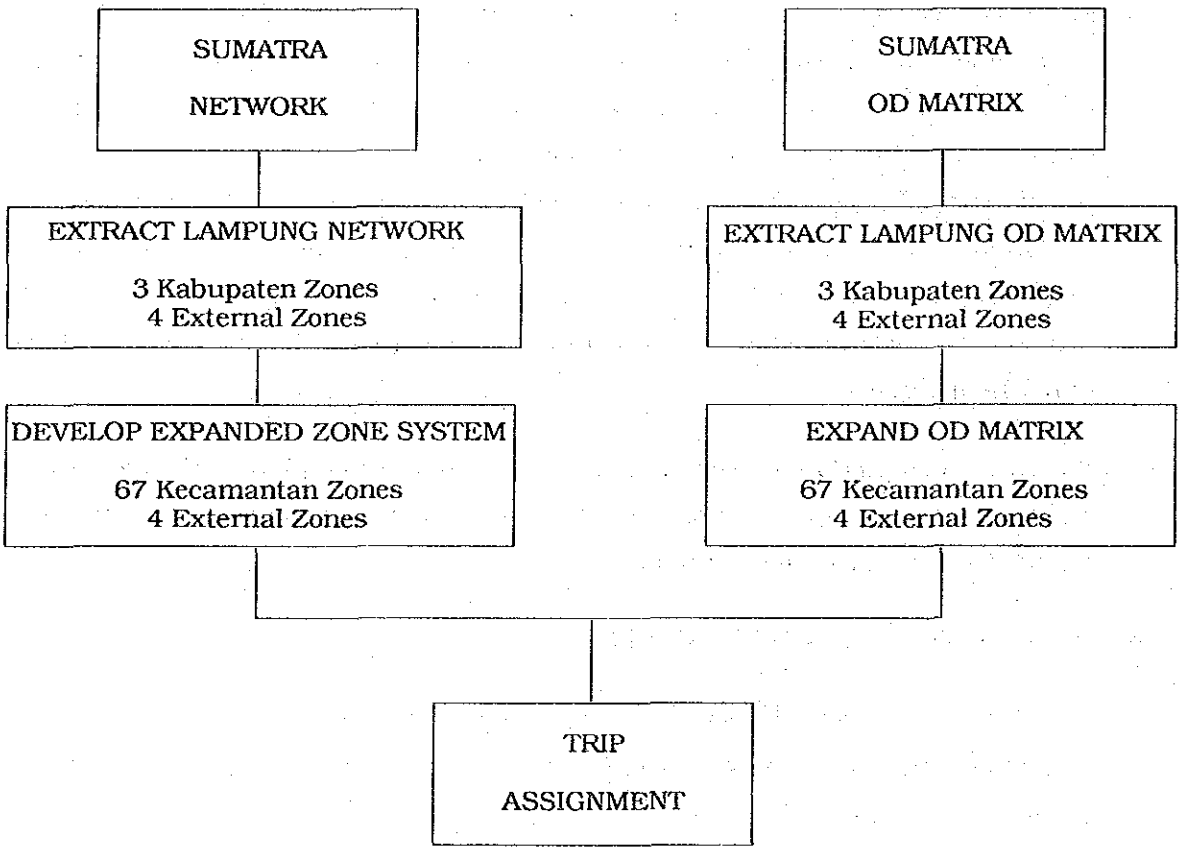


Fig. 6.6 Work Flow of Lampung Sub-Area Analysis

There was no inter-Kecamatan trip data available for this study. The 1991 National OD Survey, due to the nature of the study which located survey stations on Kabupaten boundaries, only provide inter-Kabupaten trip movement. To obtain inter-Kecamatan trip data, while at the same time preserving the regional (i.e. inter-Kabupaten) trip characteristics, a sub-matrix containing trips within Lampung province (including external trips to/from Lampung) was extracted from the Sumatra OD matrix. The extracted matrix is an inter-Kabupaten trip table which consists of 3 internal zones (i.e. the three Kabupatens in Lampung) and 4 external zones (representing four exit/entrance links from/to Lampung). This Kabupaten-based OD matrix was then expanded to 67 Kecamatan zones according to population distribution to simulate inter-Kecamatan movement. Population was used for this purpose because it was the only data available on Kecamatan level. Trips from external stations remained as they were.

Similar to the OD matrix, the road network in Lampung area was also extracted from the Sumatra network. The inter-Kecamatan trip was assigned to the extracted network and then compared to ground counts from the 1991 National OD Survey and to a factored 1990 Bina Marga count. Along Kabupaten boundaries, where National OD count stations are located, the synthesized traffic compares well with the traffic count. (This is the result of matrix calibration procedures set forth in section 6.4.2 sub 2) Intra-Provincial Matrix Adjustment). However, inside a Kabupaten, modeled traffic is generally less than the ground count because of the exclusion of local traffic. It was decided for this study that local traffic (i.e. traffic in/around a city, and between cities within a Kabupaten) be excluded from the trip table to ensure a comparable level of analysis throughout Sumatra island.

6.5.5 Future Traffic Assignment Results

The future traffic volumes for 1997 and 2010 were estimated by assigning the future OD traffic matrix to the future road network.

The network scenario was composed of the road network development in the planning years of 1997 and 2010, and "with" and "without" the East Coast Highway options. The traffic assignment results are shown from Fig. 6.7 to Fig. 6.10.

According to the results, upgrading of the East Coast Highway (in isolation of other improvements) will lead to diversion of other road users to take advantage of the improvements in travel time and capacity. (This is evidenced by the increases in pcu-km for the improvement options relative to the base cases.) This implies that the upgrading options will lead to significant benefits to both existing and diverted users. A further benefit of diversion of these other users will be to lessen traffic demand on other (non East Coast Highway) sections of the Sumatra road network.

Table 6.11 Summary of East Coast Highway Load Statistics

Network Option	East Coast Highway (PCU-km)	Other Roads (PCT-km)
1997		
Section 7C Improvement	18,289,700	20,950,300
Without Improvement	13,980,500	25,466,500
2010		
All Improvement	48,853,800	60,331,600
Without Improvement	37,222,000	73,848,000

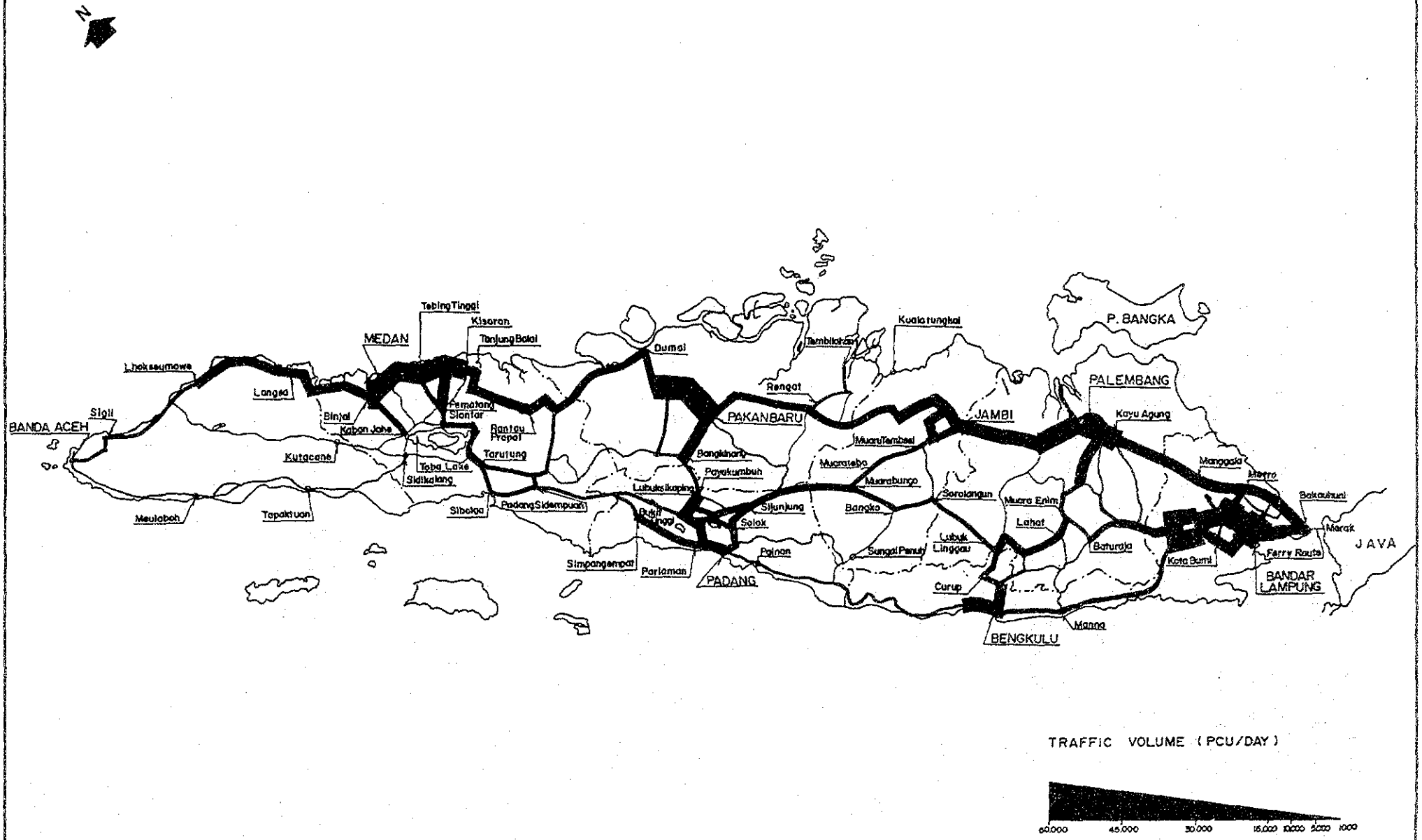
Source : Assignment results by the Study Team

6.5.6 Lampung Sub-Area Analysis

A separate distribution of future Kecamatan population was prepared corresponding to each route alternative (Route A, B, or C), to reflect the expected differential growth in socio-economic condition which would likely result from the improved levels of accessibility from each respective option. These alternative population scenarios were input to the travel model (refer to section 6.4.7) to forecast inter-Kecamatan traffic distribution in Lampung area for each route alignment option. Several assignment runs were then carried out to the respective route options.

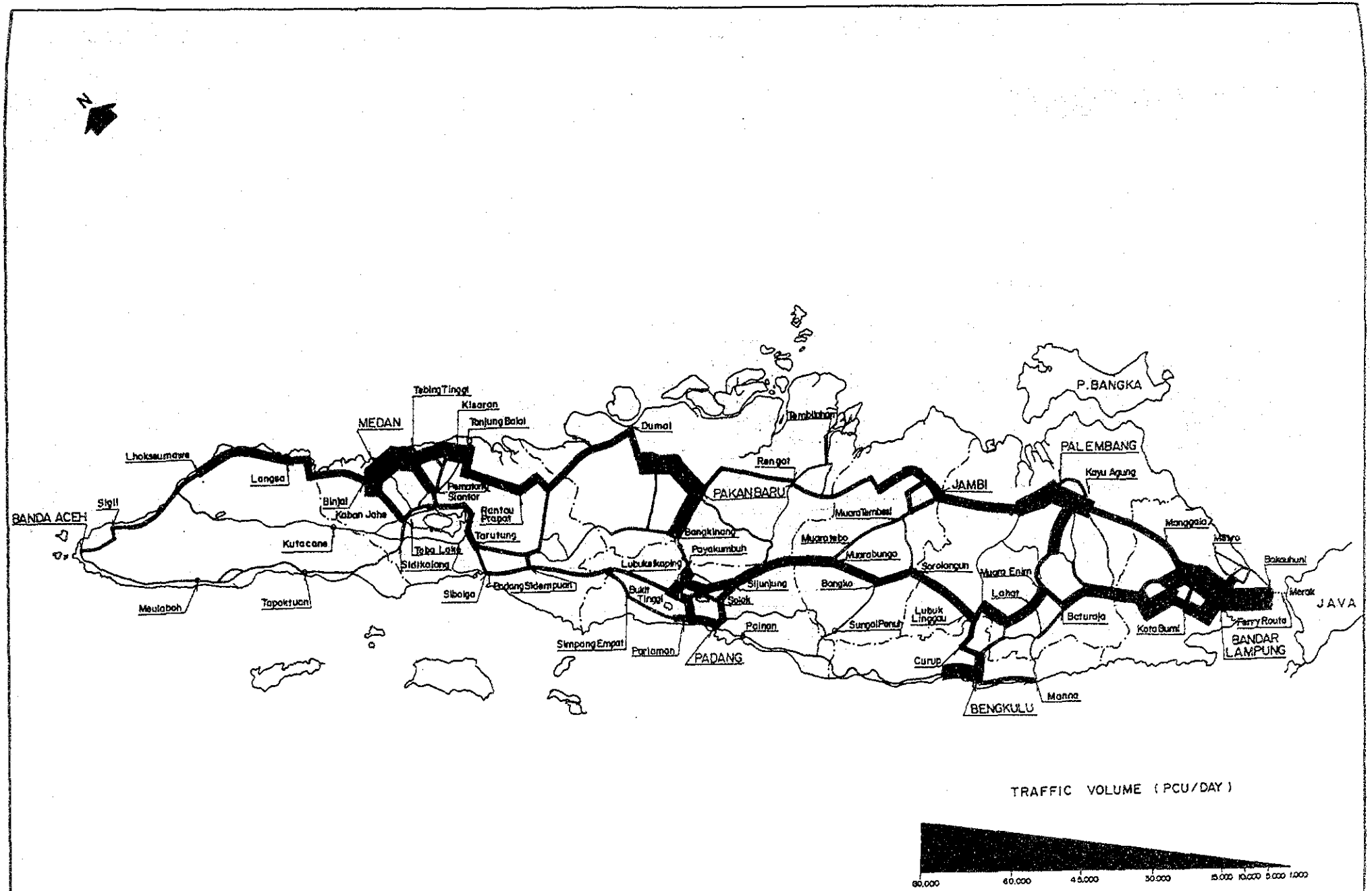
Results from initial traffic assignment runs for all options indicated a common, heavily congested section of (existing) road north of Bandar Lampung, with traffic volumes forecast to considerably exceed capacity by 2010. (This is a critical section of road, being the sole road connecting Bandar Lampung with Tegineneng and the Metro transmigration centre.) Analysis of the assignment results indicated that road improvements over this section of road, additional to what might be included in any of the three route options, will be required by 2010.

Taking the local traffic and proposed tollway project between Bakauhuni and Tegineneng into consideration, further detailed study will be required for expansion to 4-lane of the section.



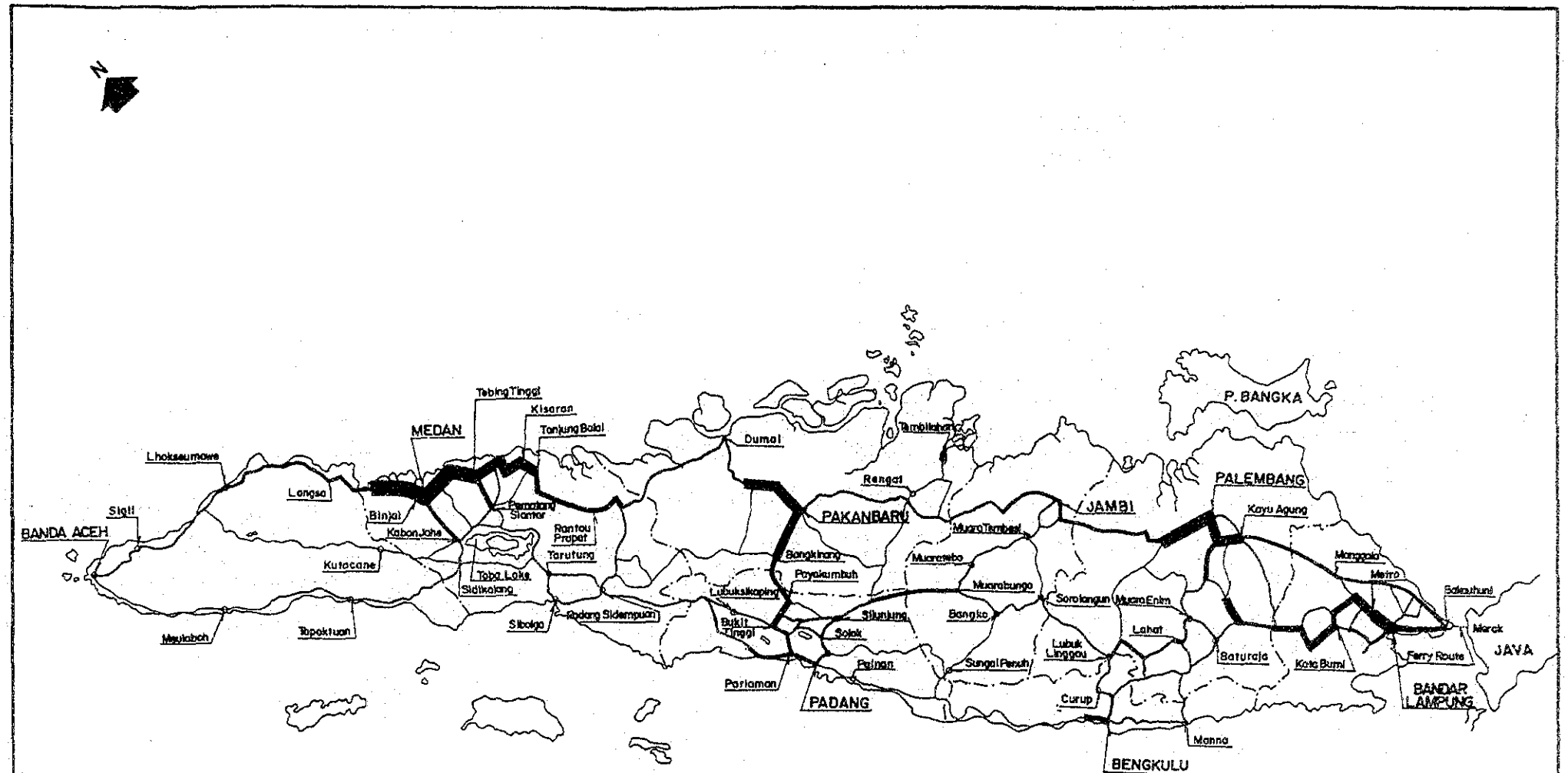
COASTAL ROADS IN EAST COAST OF SUMATRA

Fig. 6.7 Estimated Future Traffic Volume in 2010 (With Project)



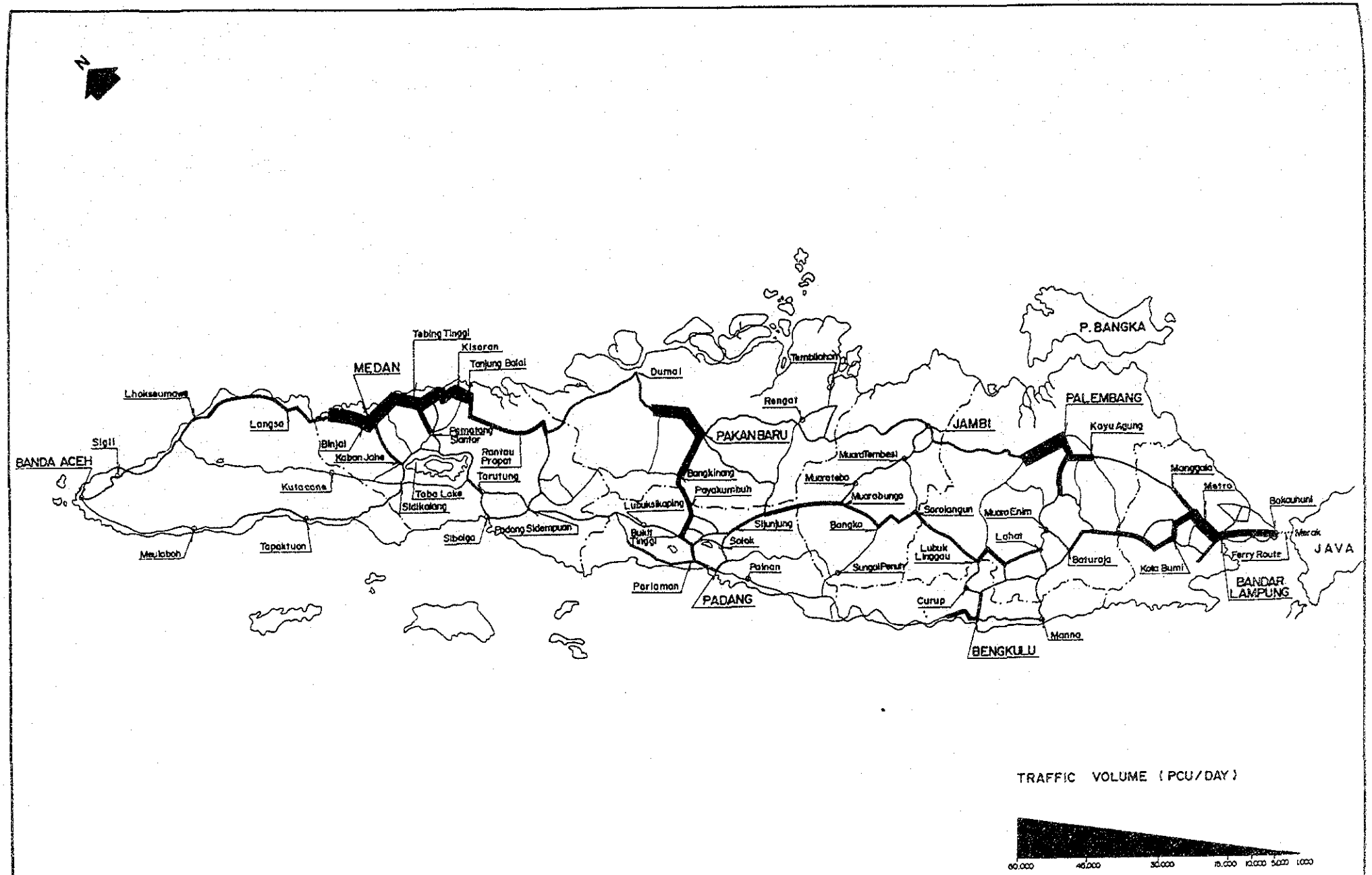
COASTAL ROADS IN EAST COAST OF SUMATRA

Fig. 6.8 Estimated Future Traffic Volume in 2010 (Without Project)



COASTAL ROADS IN EAST COAST OF SUMATRA

Fig. 6.9 **Estimated Future Traffic Volume in 1997 (With Project)**



COASTAL ROADS IN EAST COAST OF SUMATRA

Fig. 6.10 Estimated Future Traffic Volume in 1997 (Without Project)

Chapter 7

THE PREPARATION OF A MASTER PLAN FOR SUMATRA EAST COAST HIGHWAY

CHAPTER 7

THE PREPARATION OF A MASTER PLAN FOR SUMATRA EAST COAST HIGHWAY

7.1 The Position of Sumatra in Indonesia

The island of Sumatra contributes its share of 28 % of the total GRDP (including petroleum oil and natural gas) of Indonesia, and its total regional production was second to that of Java Island. In addition, the island has other natural resources of plantations with agricultural development, wetland paddy development, and energy source development, and is expected to contribute greatly to their development.

In addition to the above resources, the island of Sumatra is considered the top candidate for absorbing the excess in population of Java island, and is expected to play a central role in the transmigration policy of Indonesia. The island has other potential development possibilities in comparison with the island of Java which has been developed much earlier, due to its geographical location, and there are plans for a large scale international development plan (the SIJORI Development Project) for the island. With this backup, there are projects which involve industrial factory construction which are giving rise to industrial production, and with its future growth Sumatra is expected to become one of the growth centers of Indonesia.

However with such a bright future expected of Sumatra in the future development of Indonesia, the island does have its problems. The characteristics of the East Coast Area and the problems related thereto are described in the following paragraphs.

7.2 Characteristics and Problems of the East Coast Area

(1) Geography

The island of Sumatra is a long and narrow island with a length of approximately 1,700 km running north to south, and approximately 300 km wide in the east to west direction. The Barisan Mountain Ranges, with an elevation of 2,000 to 3,000 m, runs along the west side of the island. Towards the east coast, there is a

wide alluvial plain where the rivers from the mountain range flow towards the east coast.

Due to its geography, there are many rivers of all sizes flowing to the east together with vast wetlands (swamplands) on the east side of the island. Since construction of roads has been slow vast areas of this side of the island have not been developed

(2) The Economy

There is a large imbalance in the economy where Medan, Palembang and Riau, with their energy resources, are put to good use and reflect the benefits derived therefrom, when compared with the other areas within the region. The overall economic activity is not well developed on account of the many rivers which cut across the fertile plains and the lack of roads in the north-south direction which has limited the regional economy to certain focal points.

(3) Flow of Goods

The movement and import of goods are largely confined to the three provinces of North Sumatra, Riau, and South Sumatra which handle more than 80 % of the total goods. The principal ports are Belawan (North Sumatra), Dumai (Riau), Palembang (South Sumatra), which are all located on the east coast of Sumatra.

Industrialization is well developed in the area of the three ports where the oil producing areas are found. Furthermore they all have hinterlands with plantations where fresh produces are grown, and will continue to serve the future increase in the handling of goods.

(4) Level of Road Construction

The trunk road network on the island of Sumatra is fairly well developed and interconnects the principal cities with a few exceptions.

However, the roads classified as trunk highways, especially in the East Sumatra Coastal Region, do not function satisfactorily as trunk highways. The road widths are narrow, the roads are deficient in their horizontal and vertical alignment, and are not satisfactory as link roads, having been poorly maintained.

(5) Development Trend

Indonesia has cited a policy of increased exports as its development policy, and includes a balanced national development, increase in employment, and increase in non-petroleum products, etc.

Within the above basis, Indonesia has planned the SIJORI Development Projects (including Bantam Island in Riau Province) with the international market as its objective. There are also projects underway to develop plantations along the east coast with construction of the new ports of Tanjung Apia-api and Kuala Enok to function as their distribution centers, and large irrigation projects in order to increase the agricultural productivity along the river valleys. All of the above development are in the east coast area and conform that development projects on the island of Sumatra are changing from the west coastal areas to the east coastal areas.

7.3 Necessity for the East Coast Highway

As described above, the role of the island of Sumatra has become very important for Indonesia as a whole. However, the vast land areas and natural resources of Sumatra have not been put to use in an efficient manner, and the roads, which play an important role in the utilization of the land and resources, cannot be said to be satisfactory.

In particular, in the east coast region the rich resources and the geographical merits of coastal marine transportation have not been utilized to their fullness. Each province must develop its own characteristics and strengthen the regional structure by coordinative efforts between the provinces.

In order to implement this concept, the following measures are recommended:

- coordination of the economic activities of the large cities as the focus of their efforts
- improvement in the relationship between the producing regions and the consumption centers (cities)
- improvement of the port facilities.

Main trunk highway systems need to be constructed in order to accelerate the development of the east coastal regions.

In particular it is important to accelerate development of the trunk highway transport system in the north-south direction along the east coast areas which have not been developed in keeping with the changes of the times.

By establishing a traffic route in the north-south direction (Sumatra East Coast Highway), the road network on the island of Sumatra will have two Trunk Traffic Axes, which would include the Trans-Sumatra Highway. These Trunk Traffic Axes can be further strengthened by the construction of a tie-line system of cross-linking highways, and a comprehensive system of roadways can be established for interconnecting of the regional development centers. (See Fig. 7.1).

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.

7.4 Basic Criteria for the Sumatra East Coast Highway Project

The basic policy of the Sumatra East Coast Highway Project are as follows:

(1) Connection of the Main Cities of the Provinces

Bakauhuni - Bandar Lampung - Menggala - Palembang - Jambi - Pakanbaru - Dumai - Medan

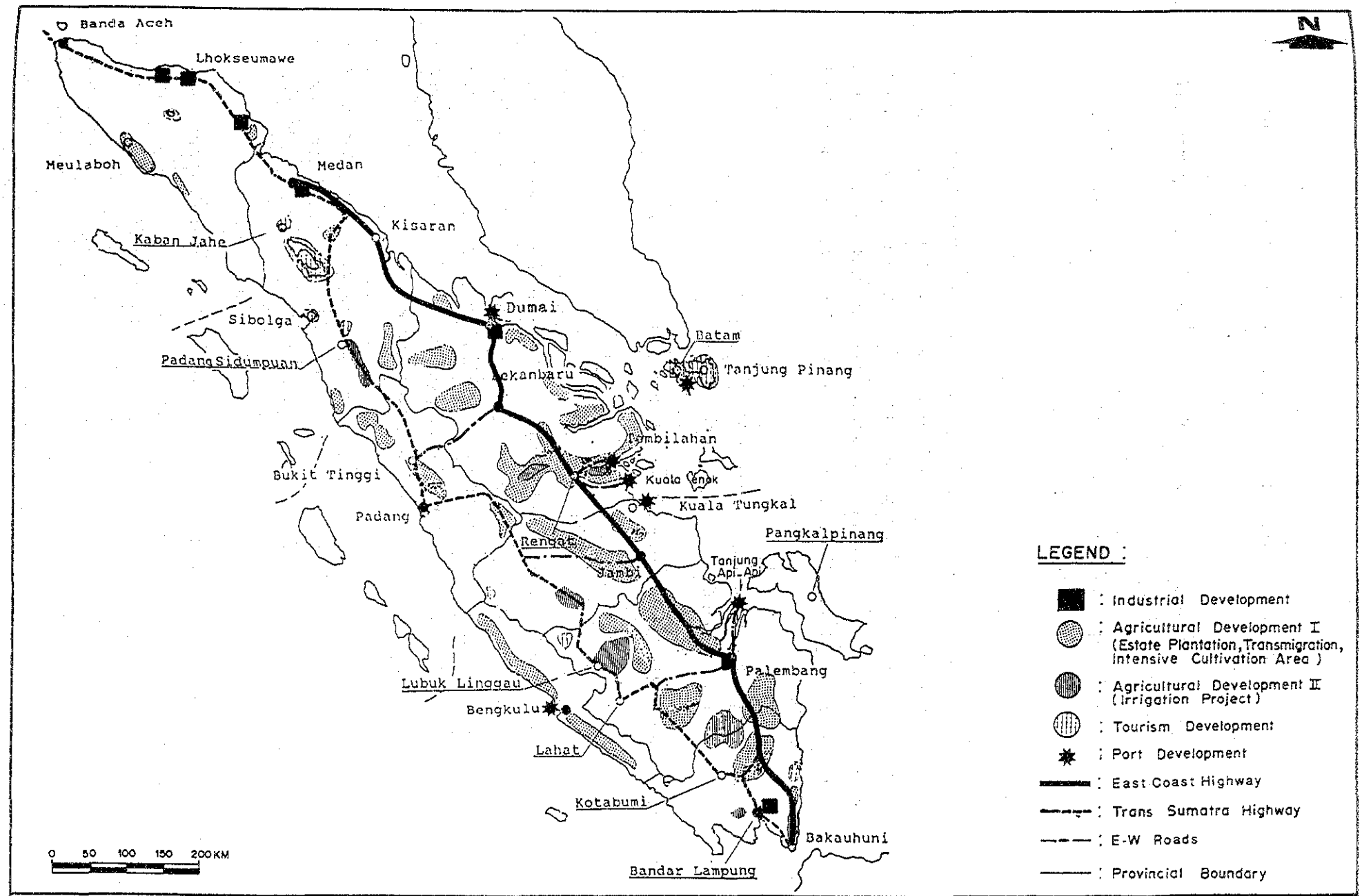
(2) In order to accomplish early realization of the important proposed road system, and to keep the construction cost at an acceptable level, the road construction work will basically consist of improvement of existing roads (existing National and Provincial roads).

(3) The roads will not be exclusive highways but public roads where access will be allowed at all times with no restrictions.

(4) The number of lanes will be determined basically by the traffic demand.

In cases where a rehabilitated road cannot meet the traffic demand, the road width will be increased or by-pass roads will be constructed, giving consideration to the conditions of the roadway system.

(5) Where the existing national and/or provincial roads have a roundabout route a bypass route will be newly constructed to increase the convenience of the roadway.



COASTAL ROADS IN EAST COAST OF SUMATRA

Fig. 7.1 Conceptual Trunk Traffic Axes in Sumatra

(6) The horizontal and/or vertical alignment of the existing roadways may be improved as required.

(7) In the wetland areas, the roadways will be constructed so as to permit traffic throughout the year.

(8) The negative effects that may be caused to the natural or social environment will be kept to the lowest level possible.

7.5 Alternative Routes

The proposed Sumatra East Coast Highway will be planned in accordance with the basic design policies of interconnecting the principal cities on the east coast, and to utilize the existing roads (National and/or Provincial) to the greatest extent possible. However, in the following two sections there are several alternative routes which can be considered. These routes were decided after investigation of the best route possible.

Bakauhuni - Menggala	(Section 7)
Vicinity of Pakanbaru	(Section 3)

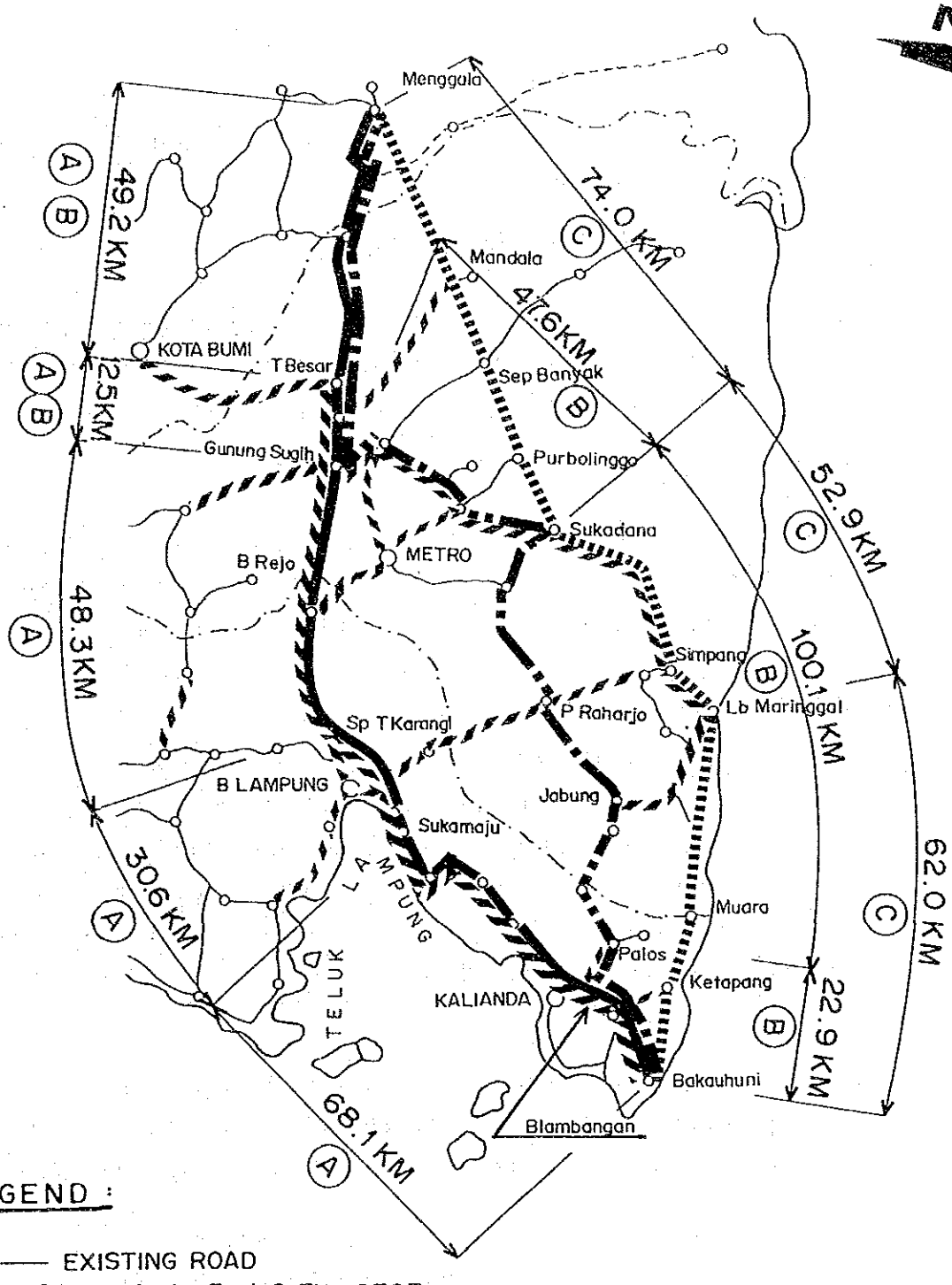
7.5.1 Comparison of the Routes in Lampung Province

(1) Establishment of the Route

The traffic on the Trans-Sumatra Highway within Lampung Province has a high rate of mixed large vehicles, and the average daily traffic in 1990 was 15,000 to 20,000 vehicles/day. If this rate of traffic were transposed on the Sumatra East Coast Highway, the amount of traffic would exceed the capacity of the highway and it can be easily assumed that there would be traffic congestion.

However, from the viewpoint of regional development, the hilly area from the center of Lampung Province to the east coast is where government organizations and private investors are planning to promote development by making use of the proximity to Java Island.

By considering the above conditions, the followings three alternative routes are proposed. (See Fig. 7.2, Alternative Comparative Routes).



COASTAL ROADS IN EAST COAST OF SUMATRA	**Fig. 7.2** **Alternative Routes in Bandar Lampung Vicinity**

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 Coast

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

(2) Description of the Region

A) Route 7-A

The Trans-Sumatra Highway will be utilized from the starting point at Bakauhuni to Tanjung Penan, and from Tanjung Pusat the National Road will be utilized to the vicinity of Menggala. By-pass routes will be planned along this route to divert traffic away from the urban areas near Bandar Lampung.

A plantation is being developed by the Transmigration Program along the roadway from Bakauhuni to Sukamaju, and an industrial complex is being developed from Sukamaju to Tanjung Karang for which a by-pass route will be planned.

From Tanjung Karang to Tanjung Pusat land development is underway near Bandar Lampung, however, as the route goes further away from Bandar Lampung there is almost no land development in progress.

There is a high volume of traffic in the section between Sukamaju and Tanjung Pusat due to traffic from the city center of Bandar Lampung and Panjang Port, with a mixture of large size vehicles.

For the rehabilitation work, the road pavement is proposed to be widenend from 6.0 m to 7.0 m from Sukamaju to Tanjung Pusat as part

of the proposed 1st Nine Provinces and 3rd Nine Provinces Projects (excluding the by-pass road section).

For the Bakauhuni to Sukamaju road sector there is a two-lane roadway (paved width 7.0 m) constructed as an OECF project, and new road climbing lanes are planned for roads with steep gradients.

B) Route 7-B

The Trans-Sumatra Highway will be utilized for the road section from the starting point, Bakauhuni, to Blambangan.

From Blambangan to Jabung approximately 15 km of the Provincial Road which will be utilized, after which there will be a new road section, also approximately 15 km, constructed to Jabung .

From Jabung to Sukadana, it is proposed to utilize the Provincial Road. In this sector the town of Raharjo is at the intersection of the road that connects the city center of Bandar Lampung and the town of Simpang on the east coast. The road provides access between Bandar Lampung and the east coast.

This region has many plantations and farm lands, with many residences spotted along side the road. Near Sukadana there are relatively many residences, the terrain is hilly, and there is a segment where it will be necessary to improve a section of the road alignment due to poor horizontal and vertical alignments. A project has been prepared to rehabilitate the section from Sukadana to Gunnugsugih (widening of the pavement from 4.5 m ~ 5.0 m ~ 6.0 m).

C) Route 7-C

This route extends from the starting point, Bakauhuni , and proceeds to the north directly along the east coast and will utilize the existing road to the greatest extent possibles. It passes through Ketapang fishing port and along the proposed road (right-of-way of approximately 20 m), within the transmigration site, to the Maringgai fishing port.

This region is used mainly for rice paddies except for the hills near Bakauhuni. The area has many developed narrow roads with many residences spotted throughout. At the Sekampaung river a new bridge

has been constructed with a 70 m span, 6.0 m width, together with several new roads.

From Maringgai to Sekadana the existing road which passes through the southern tip of the National Park will be utilized. This area is comparatively well developed with an old transmigration colony. There is a road right-of-way of 20 m, 5.5 m width, which will be subjected to a road improvement project which will widen the pavement to 6.0 m.

In order to reduce the road length for the section from Sekadana to Maringgai a straight alignment is proposed. The roadway will be planned so as to cause as little adverse impact as possible on the transmigration colony and the nearby residences. The colony is situated along the existing road and it may be necessary to relocate some of the residences for the newly planned roadway.

(3) The Optimum Route

A comparative list for the three alternative routes has been prepared as shown in Table 7.1.

From review by 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 of Sumatra, and it may be necessary to develop this road along with the recommended Route 7-C.

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

1) Economic Aspect

A preliminary economic analysis was conducted for the comparison of route alternatives, assuming an individual development for each related route.

Table 7.1 Bakauhuni - Menggala Route Comparison

	Route 7-A	Route 7-B	Route 7-C
Aims/Purposes of the Route	To utilize the existing road (utilizes the existing bypass and does not pass through the congested city near Lampung)	To support the development plan (to promote regional development, to reduce vehicle running time and to mitigate traffic congestion in city)	To provide short route length (to promote regional development, to reduce the vehicle running time and to mitigate traffic congestion in city)
Total Length of Route	• Route total length L= 209 km • New construction length L= 0 km • Existing road length L= 209 km	• Route total length L= 232 km • New construction length L= 12 km • Existing road length L= 220 km	• Route total length L= 189 km • New construction length L= 45 km • Existing road length L= 144 km
Total Length of the Main Structures	Bridge length • New construction br. L= 680 m (4-lane) • Bridge widening L= 200 m (2-lane)	Bridge length • New construction bridge L= 550 m (13 long span bridges) • Bridge widening L= 550 m (48 bridges)	Bridge length • New construction bridge L= 1000 m (4 long span bridges) • Bridge widening L= 40 m (2 bridges)
Construction Cost (A-Route : 1.00)	1.00	1.07	1.13
Total Length of Land Utilization	Plantation (60 %) Cultivated Area (30 %) Urban Area (10 %)	Plantation (40 %) Cultivated Area (40 %) Rice paddy (10 %) Forest (10 %)	Plantation (20 %) Cultivated Area (30 %) Rice paddy (35 %) Forest (15 %)
Regional Development Plan	There is no authorized large scale development plan	Transmigration plan and irrigation plan	Transmigration plan and irrigation plan
Specifics of the Route	• Route length is between B- and C-Routes lengths. • Houses are close to the existing road so there is difficulty in 4 lane widening. • Extensive utilization of existing road rehabilitation.	• Longest route. • Necessitates partial improvement of existing road. • Utilization of rehabilitation roads is recommended. • Supports development plan between the Trans-Sumatra Highway and the eastern coast.	• Shortest route. • Construction cost is the highest. • Necessitates partial improvement of the existing road. • Supports the isolated transmigration settlements along the coast. • Supports the development plan of harbour/port along the east coast.
Route Evaluation	• Advantage of extensive utilization of existing road rehabilitation. • Requires a section of 4-lane widening and land acquisition cost is high. • Running time is less than B-Route. • Lampung Province is part of the Jakarta economic influence area and industrial development is underway. As the route passes Bandar Lampung and other main cities such as Kalinda and Metro, industrial development will be promoted.	• Industrial district plan, irrigation plan and transmigration plan are promoted by the road construction in Jabung and Sukadana area. However this route is the longest and there are some problems from the view point of function of the East Coast Highway of Sumatra.	• This route will have a large effect for the regional development plans such as harbour/port, transmigration, irrigation, etc. but the construction cost is high compared to the other routes. • The route passes about 50 km from the provincial capital of Bandar Lampung so there is little relationship between the provincial capital and the route.

a) Basic assumption for cost-benefit analysis

The analysis followed the conventional discounted cash flow method in determining the economic internal rate of return (EIRR), the net present value (NPV) and the benefit cost ratio (B/C).

The following assumptions for analysis were made:

Project life	:	25 years after development of the proposed road
Prices	:	1992 prices
Residual value	:	None

Benefits comprise a direct benefit and an indirect benefit (for examing development effects for each alternative route) as follows:

Direct benefit

Saving of vehicle operating cost and vehicle time cost brought about by road development.

Indirect benefit

Agricultural output increase in the vicinity along the alternative routes due to good access to market and expansion of market area caused by road development. Details of the estimation are referred to Appendix A-7.1.

b) Economic cost-benefit analysis

The economic project costs were estimated, the implementation time schedule was established and the economic direct benefits from savings in vehicle operating cost and time cost for the planning years (1997 and 2010) were calculated.

The indirect economic benefit was also estimated for the above planning years.

Following the conventional discounted cash flow method, the efficiency measures were calculated and the results are summarized in Table 7.2. The details of comparison of economic efficiency measures are referred to Appendix A-7.2.

Table 7.2 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.

In terms of economic comparison, the differences between the three alternative routes are not so distinct, and an optimum route is difficult to determine only by economic analysis.

Consequently, further examination of the other three aspects are required, and an optimum route will be determined by examination of roles and functions of the proposed road in the area of Lampung Province.

2) Practical Difficulties in Widening the Existing Road (Route 7-A)

There are many houses being constructed in the suburbs of Lampung from Tanjung Karang to Tanjung Besar. It is considered very difficult to construct a 2-lane road in this area due to land acquisition.

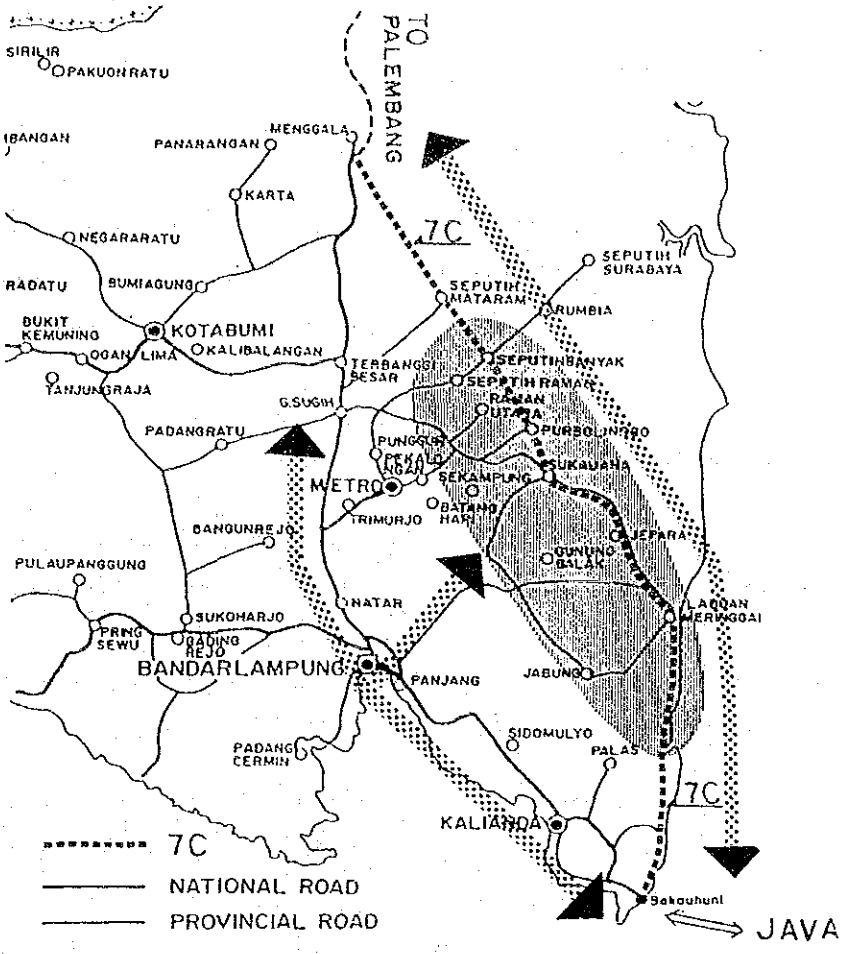
In order to mitigate future road congestion, there is a plan to build a by-pass road.

When this problem of developing the site is considered, and the role that the east coast region will play in the acceleration of development in the area, Route 7-C is considered to have the best route alignment.

3) Road Network Construction Aspect

The road network in Lampung Province has a tendency to extend to the west using the Trans-Sumatra Highway as the basis (National Road), while the roads towards the east coast are tributaries of Provincial Roads branching off from the National Roads (Refer to the following Figures).

The latter road network provides for the traffic which is generated along the east coast, passes through Bakauhuni and proceeds to Java Island. In the former case the traffic which passes through Menggala, and accesses Palembang and nearby cities, will be required to pass through Bandar Lampung. This will impose a bottle neck in the establishment of regional development. Route 7-C is considered to improve the road network.



Road Network and Traffic Routes in Lampung Province

4) 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, potential for future development of the Province will be high in the east coast area, and will require solutions for the areas with poor traffic facilities.

In order to accelerate regional development it will be 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.

7.5.2 Comparison of the Routes in the Vicinity of Pekanbaru

Comparison of the merits of the road routes are made where they pass through the large cities on the east coast of Sumatra, and as an example Pekanbaru City has been selected. The analysis made herein can be applied to Palembang, Medan, and other cities.

(1) Selection of the Routes:

Pekanbaru has a problem of traffic congestion within the city, and in order to solve this problem all large vehicles are required to take the by-pass route from approximately 5 km outside the city limits. At the present time, another new by-pass is being constructed which is further outside the existing by-pass route. The following three comparative routes can be considered. (See Fig. 7.3)

Route 4-A: Proposed Plan to By-Pass the City in the Northeast Sector:
The location of the by-pass route is based on the demand forecast (principal traffic flow), and it is proposed to shorten the road towards the Dumai side. It will be directly connected with the city center of Pekanbaru. This plan places stress on the benefit of the through traffic.

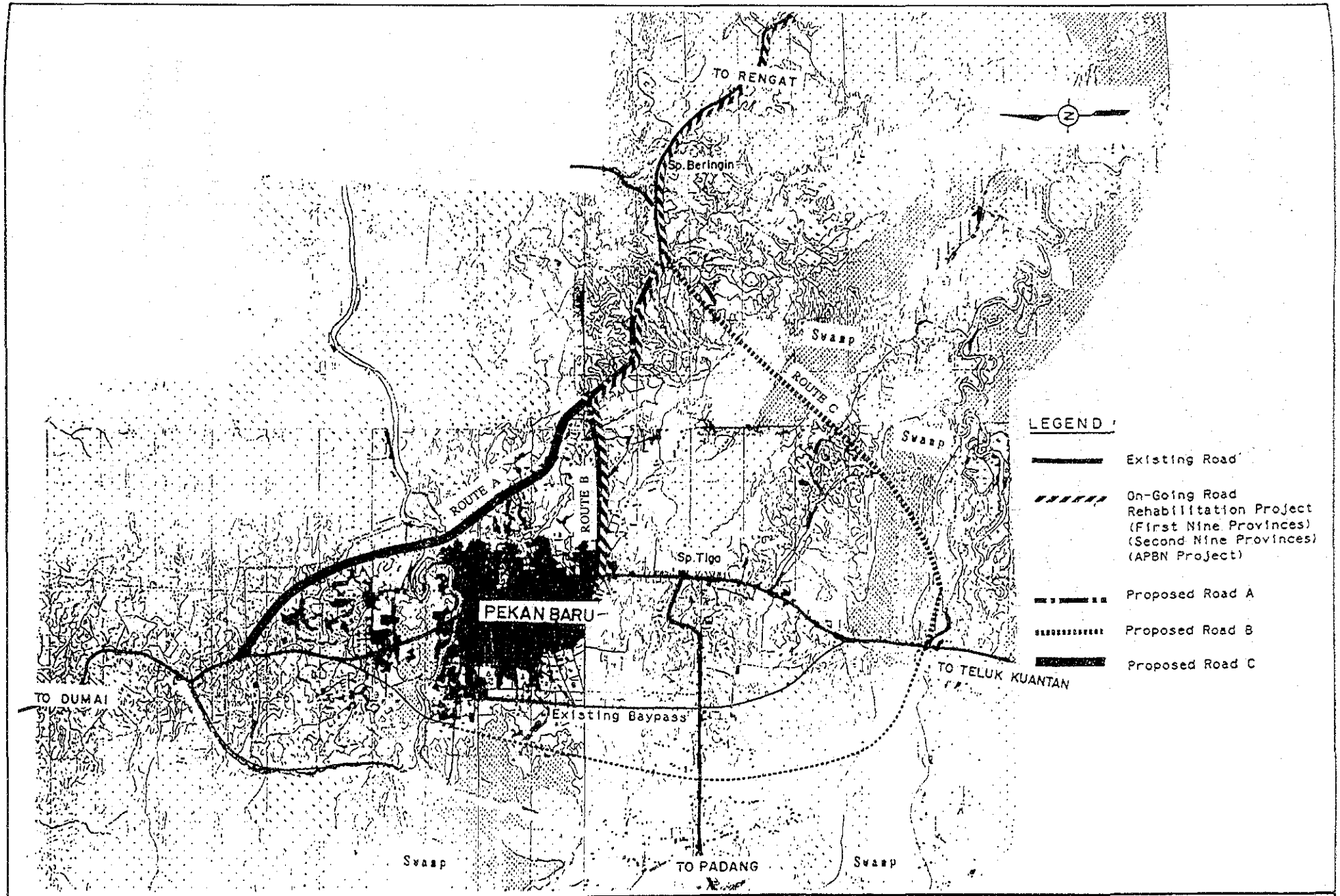
Route 4-B: Proposed Plan to Connect Directly with the City Center of Pekan baru:
This plan proposes to affect the urban areas of the city which function as past of Pekanbaru.

Route 4-C: Proposed Plan to Route the By-Pass on the West Side of the City:
This plan proposes to by-pass the city similar to Route 4-B, but to connect with the by-pass route presently under construction, and to relate with the regional road network system.

(2) General Description of the Region:

A) Route 4-A:

The starting point is some 9 km north of Pekanbaru, on the west of Simpan Beringin and generally to the east of Pekanbaru. The total length is approximately 25 km, and forms the by-pass on the north of



COASTAL ROADS IN EAST COAST OF SUMATRA

Fig. 7.3 Alternative Routes in Pekanbaru Vicinity

Pekanbaru. 6 km of the 1st Nine Provinces which are being rehabilitated will be utilized and the remaining roads will be newly constructed. The surrounding terrain is generally flat, and there are rice paddies and farm lands along the Siakbesar river.

B) Route 4-B:

Route 4-B generally makes use of the existing roads. The starting point is the same as Route 4-A, at about the 6 km point it will turn towards the village on the west, and run all the way to the National Road (connecting Padang and Dumai). From this point the national road will be utilized and run in a northerly direction, through the city area of Pekanbaru and reach its terminal of Route 4-A. The total length of this route will be approximately 30 km. The terrain of the surrounding area is generally flat. One-third of the total length of this route will pass through commercial areas and the remaining sections of the road will run through paddy field and other farm lands.

C) Route 4-C:

Route 4-C will branch off from a junction with Routes 4-A and Route 4-B, and run on the south side of Pekanbaru. This route will become a part of the loop road system of Pekanbaru in the future. The route will traverse flat paddy fields and swamp areas.

(3) Recommended Route:

Comparison of the above routes is given in Table 7.3, Pekanbaru Route Comparison.

From the role of Pekanbaru City Plan the recommended route is Route 4-B. In terms of traffic congestion within the city it may be necessary to plan for a by-pass route to protect the environment of the city, and with due respect to the traffic demand forecast (main traffic flow), it may be necessary to adopt Route 4-A.

* The Role of Pekanbaru City:

The east coast of Sumatra has cities such as Pekanbaru with potential capacity for accelerated development. It will therefore be important to allow Pekanbaru, which is the center of regional growth, to influence the outlying region with its growth, industrial capacity and other good characteristics.

Table 7.3 Pekanbaru Area Route Comparison

	A-Route	B-Route	C-Route
Aims/Purposes of the Route	Avoids passing through Pekanbaru city. Connects to Municipal Area using existing road which is now being improved within 1st 9 Province Project. Good access to Dumai direction.	Passes through Pekanbaru city.	Aims to connect with Pekanbaru city bypass road which is connected to Dumai and Padang.
Total Length of Route	L = 25 km • Utilization of existing road L = 6 km • Construction of new road L = 19 km	L = 30 km • Utilization of existing road L = 30 km • Construction of new road L = 0 km	L = 55 km • Utilization of existing road L = 32 km • Construction of new road L = 13 km
Pavement Area	132,000 m^2	40,000 m^2	100,000 m^2
Construction Economy	2 (between B-Route and C-Route)	1 (cheaper than A-Route)	3(more expensive than A-Route)
Route Alignment Improvement	Improvement of part of the existing road alignment is required	Improvement of part of the existing road alignment is required	Improvement of existing road alignment is not required
Length of Swampy Area	L = 0 km	L = 0 km	L = 12 km
Route Evaluation	• Direct connection to Pekanbaru city is possible. • Total road length for "The Coastal Roads in East Coast of Sumatra" is shortest. • As through traffic to Dumai direction uses the bypass the traffic congestion should be solved for Pekanbaru city's traffic management. • This route is a part of the future Pekanbaru Ring Road (A-Route plus B-Route). • This route is recommended for the ultimate stage, considering long-term Pekanbaru master plan.	• Direct connection between Rengat and the city of Pekanbaru. • Total road length for "The Coastal Roads in East Coast of Sumatra" is short. • As the route passes through Pekanbaru Municipal Area, future improvement of the road capacity of the existing road is required. • This route is recommended for the initial stage.	• No direct connection to Pekanbaru city. • Total road length for "The Coastal Roads in East Coast of Sumatra" becomes long due to detour route. • Traffic volume to Dumai is large in this section. Traffic volume to Padang, Teluk Kuantan using C-Route is little.

7.6 General Description of the East Coast Highway Plan and Economic Evaluation

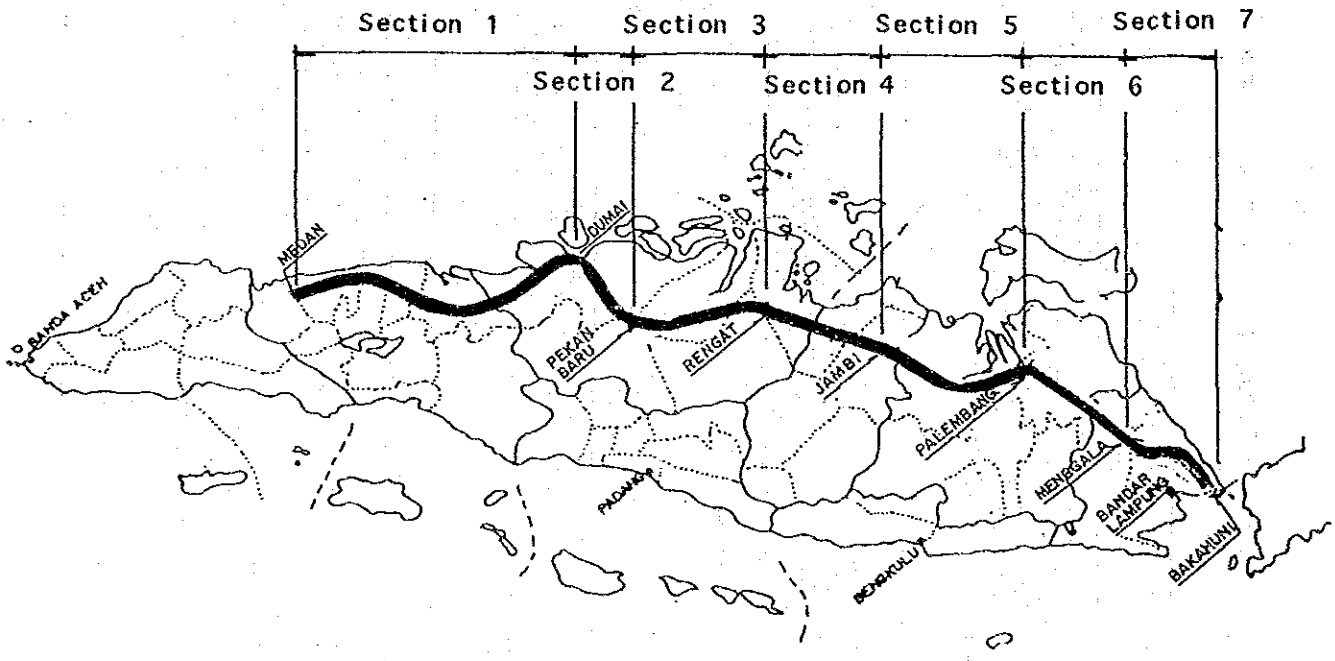
The Sumatra East Coast Highway will be constructed in accordance with the basic criteria formulated, and will generally utilize existing roads and interconnect the major cities on the east coast of the island of Sumatra.

A general description of the Sumatra East Coast Highway, the economic analysis, and evaluation is given in the following paragraphs.

7.6.1 General Description of the Sumatra East Coast Highway

(1) Establishment of Road Sections

The total length of the Sumatra East Coast Highway will be 1,906 km. The topography of the route will vary with the regions it passes through. For this reason the highway will be divided into seven Sections, using cities as the point of demarcation (refer to the following figure).



(2) The Planned Traffic Volume

Based on the traffic demand forecast in Chapter 6, the traffic volumes in the year 2010 are given in Fig. 7.4

The planned traffic volumes in 2010 are expected to be as follows:

In suburbs of cities	35,000 ~ 40,000 vehicles/day (P.C.U.)
In rural areas:	15,000 ~ 20,000 vehicles/day (P.C.U.)

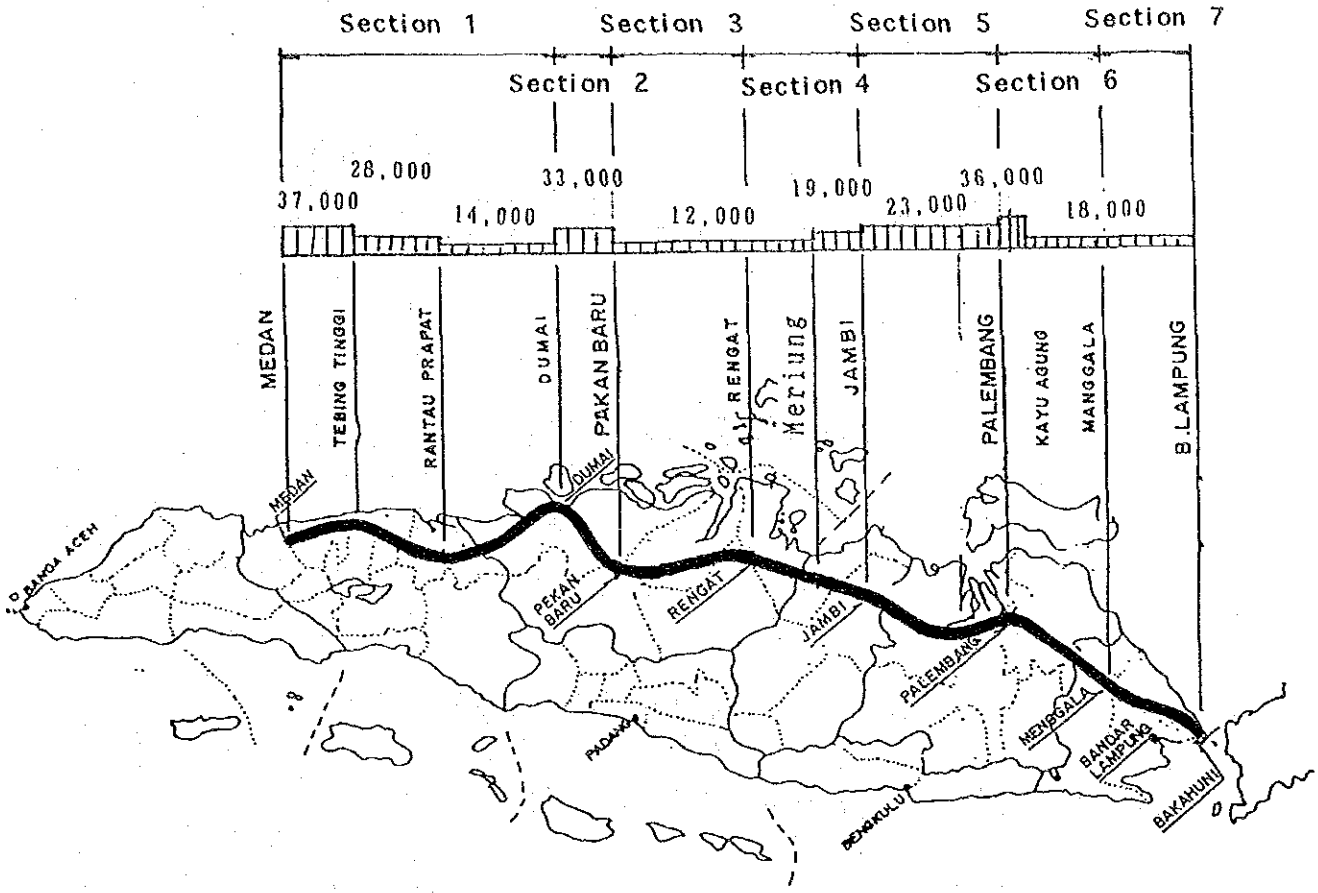


Fig. 7.4 Designed Traffic Volume in 2010 (PCU/day)

(3) Road Design Criteria

The Sumatra East Coast Highway will be planned to interconnect the cities as its role and function. For this reason, the following design criteria have been established:

- the basic road criteria will be Arterial Road Class II B.
- where the road traffic volumes require 4-lane roadways due to traffic volumes in the suburbs, the criteria will be Arterial Road Class II A.

(4) Standard Cross Section

The standard cross section is shown in Fig. 7.5.

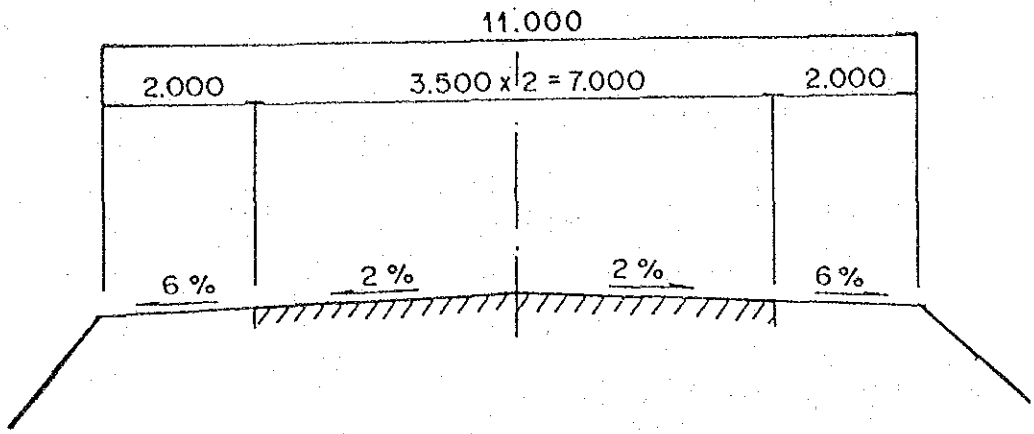


Fig. 7.5 Standard Cross Section

(5) Description of Each Section

A) Section 1:

Section 1 starts at the Provincial Capital of North Sumatra, Medan, and extends to the principal port city of Dumai which is the main marine port of Sumatra.

The highway proceeds to the south from the starting point, and runs through Kabupaten and the cities of Tebing Tinggi and Rantau Prapat. The port city of Sp. Kwat is also on this route.

The road reaches the Provincial Border of North Sumatra and Riau. From the Provincial Border, the National Road connects directly to Dumai. The road crosses the Lokon River on which 270,000 people and 500 tons of goods are transported annually. The bridge across the river has a length of 225 m and a width of 6.0 m.

The port of Bagansi Api-api and the Provincial Capital City of Pekun Baru are connected by Provincial Roads.

The route will then connect with the main port city of Dumai which is the main port of marine transport in Indonesia. Rehabilitation work is being performed from Medan to Rantau Prapat.

B) Section 2:

Section 2 is from Dumai to Pekanbaru, the Riau Province capital city.

This section from Dumai to Pekanbaru is an oil producing area with industrial factories of the Dori Minas area along the National Road. The road traffic is dense and the road is well maintained. Pavement width is 6.0 m.

The Siak River is crossed in this section. The river is utilized by 155,000 people and transports 17,000 ton of goods annually. The bridge over the river is 350 m long, with a width of 7.30 m.

A by-pass road has been planned for the city of Pekanbaru to connect the Capital City Padang of West Sumatra Province with Dumai, and with Teluk Kuantan where coal is produced. Construction work has already started on a section of the road. For a description of the section of Sumatra East Coast Highway which passes through Pekanbaru City refer to paragraph 7.5.2, Alternative Routes.

C) Section 3:

Section 3 is the section from Pekanbaru to Rengat. For this section it is proposed to use the existing road from Pekanbaru via Sp. Lago, and this will utilize the shortest route. At the present time rehabilitation work has started on a part of the route.

The roadway in the vicinity of Sp. Lago has been developed for large expanses of palm oil plantation under the transmigration project, and road rehabilitation is underway at the present time. The condition of the road is therefore good. However, it will be necessary to change the road construction criteria to conform with Trunk Highway requirements and much more work needs to be performed.

The Indragini river flows through the city of Rengat and the city center is established along the river.

The Sumatra East Coast Highway passes approximately 15 km away from the center of Rengat and crosses over the Indragiri River by a bridge.

The road to the center of Rengat city is asphalt paved with a width of 6.5 m. For a detailed description of Rengat city environs, refer to Chapter 8, Pre-Feasibility Study.

D) Section 4:

Section 4 is from Rengat to Jambi.

The section from Rengat to Jambi is generally in hilly and mountainous country, however some sections are flat. At other sections the vertical alignment will have to be improved.

From a point some 30 km from Jambi on the Rengat side there are the flood lands of the Batang Hari River, where there are many river crossing facilities (bridges and box culverts).

The bridge crossing the Batang Hari River is 508 m long and 7.0 m wide. The Sumatra East Coast Highway will make use of this bridge. For a detailed description of the environs of the city of Jambi, refer to Chapter 8, Pre-Feasibility Study.

E) Section 5:

Section 5 covers the section from Jambi to the capital city of South Sumatra Province, Palembang.

The existing road from Jambi to Palembang is 4.5 m to 5.0 m wide and although comparatively narrow it is paved with asphalt and in good condition. In the environs of Palembang city the road widens to a 4-lane roadway and Ampera Bridge crosses the Musi River in the center of the city. Ampera Bridge has been rehabilitated, and it will be possible to use this bridge for the Sumatra East Coast Highway.

The ringroad encircling the city of Palembang is currently being constructed. The method for the Sumatra East Coast Highway to pass through the city will be similar to the method used for Pekanbaru, and will for the time being directly connecte through the city. There will be a by-pass route planned in the long-term.

F) Section 6:

Section 6 will be from Palembang to Menggala.

The National Road from Palembang to Kayu Agung is presently being rehabilitated with asphalt paving to a width of 6.0 m, and this repaired road will be used.

The roadway from Kayu Agung to Menggala is presently being rehabilitated by APBN (Budget of Ministry of Public Works) for a paved width of 4.5 to 6.0 m and in a few years this section will be rehabilitated.

For a detailed description of the Kayu Agung to Menggala section, refer to Chapter 8, Pre-Feasibility Study.

G) Section 7:

Section 7 is from Menggala to Bakauhuni, the ferry landing to Java island.

For a detailed description of this section, refer to paragraph 7.5.1, Comparison of Routes and Chapter 8, Pre-Feasibility Study.

(6) Road Length and Estimated Cost

The length of the Sumatra East Coast Highway by section and the costs are given in Table 7.4. The total cost for the total length of 1,906 km is expected to be Rp.852 billion. (Cost as of 1992).

Table 7.4 Summary of Estimated 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

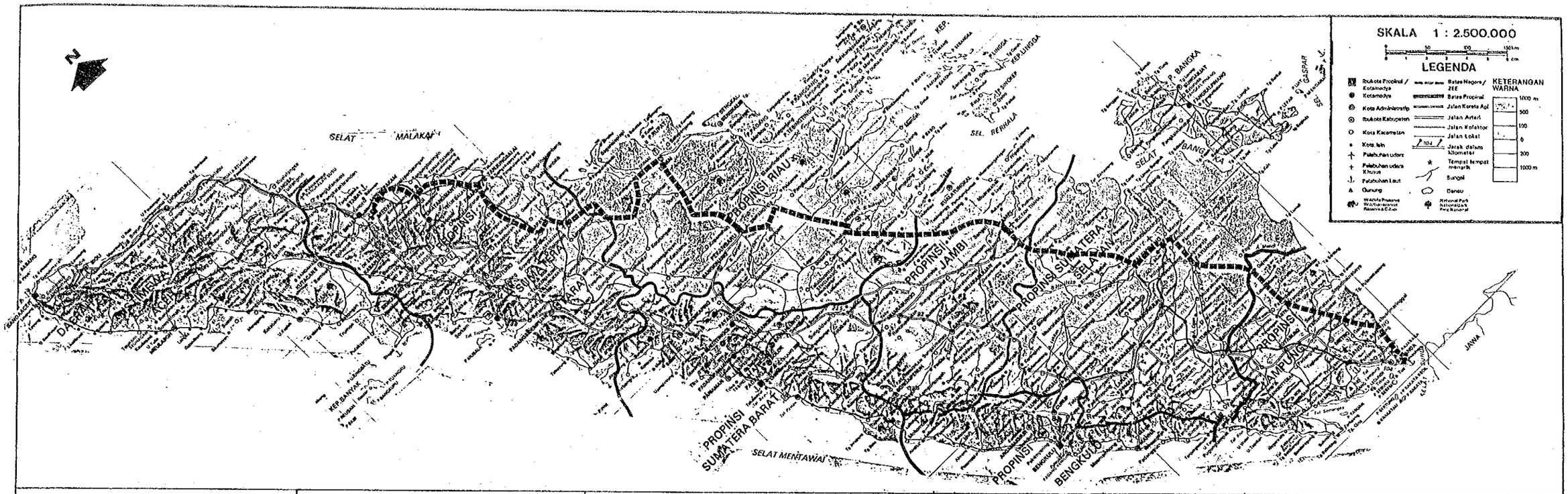
(7) Description of the Improvements

The road development Masterplan for the year 2010 is shown in Table 7.5. Of the total road length of 1,906 km, 93 % of the work required will consist of widening of existing routes.

Table 7.5 Development Masterplan of East Coast Highway

Proposed Project	Length
1. New construction	75 km
2. Additional lane construction	0 km
3. Widening of carriageway to 7 meters	1,774 km
4. Reconstruction (improvement of pavement structure)	0 km
5. Existing road without improvement (urban areas in main cities)	57 km
Total	1,906 km

The whole outline of road development for the East Coast Highway is summarized in Table 7.6.



PROVINCE		SUMATRA UTARA						RIAU							JAMBI			SUMATRA SELATAN						LAMPUNG			REMARK
MAJOR CITY			MEDAN	TEBING TINGGI	TANJUNG BALAI	RANTAU PRAPAT		DUMAI		PEKAN BARU	SP. LAGO		RENGAT (PK. HERAN)		JAMBI			PALEMBANG		KAYU AGUNG			MENGGALA		B. LAMPUNG	BAKAUHUNI	
ROAD LENGTH (Km)			L=78	L=87	L=114	L=92		L=131	L=205	L=201			L=96		L=168	L=40		L=236		L=66	L=102		L=81	L=189			TOTAL LENGTH L = 1906 Km
			L=371					L=653							L=208			L=405					L=270			
POPULATION (1000 PERSONS)			1.731	117	108					399							34			1141					(637)		
TERRAIN			FLAT			ROLLING		FLAT SWAMP		ROLLING	FLAT		ROLLING		ROLLING	MOUNTAIN	ROLLING	FLAT SWAMP		ROLLING		FLAT SWAMP		ROLLING		FLAT SWAMP	ROLLING	
EXISTING CONDITIONS	IRI (AVERAGE)		6.0	5.9	5.3	3.9		2.7	3.2	3.1	11.1		9.6		10.6		9.6	3.7		3.5		6.9	9.2	11.4	—	—	3.0	—	12.1 —
	CARRIAGEWAY WIDTH		7.0	6.0	4.5~6.0	5.1~6.0		5.0~7.0	6.0~7.0	7.0	4.5~6.0		6.0~7.5		4.5~8.0		6.0~7.0	6.0~7.0		4.5~5.0	6.0~7.0	6.0~14.0	3.0	—	3.5	5.5	3.5	3.0~3.5
	SURFACE		AC	AC	AC	AC		AC	AC	AC	EARTH		EARTH	AC	EARTH or DBST		EARTH	AC	AC	AC		AC	EARTH or MACADAM	—	HRS		MACADAM	
RELATED ROADS REHABILITATION PROJECT				G.(ON GOING) A.(PLANNED)						G.N.(ON GOING) A.(PLANNED)		APBN (ON GOING)			G.(ON GOING) A.(PLANNED)		APBN (ON GOING)	M.(ON GOING)			N.(ON GOING) A.(PLANNED) G.(ON GOING)	APBN.(ON GOING)	APBN.(PLANNED)				M : EX-OECF G : FIRST NINE PROVINCES N : SECOND NINE PROVINCES A : THIRD NINE PROVINCES APBN : PROJECT BY NATIONAL BUDGET
PROPOSED CONDITIONS	TRAFFIC VOLUME (1000 VEHICLES/DAY)		37	28		14		33		12			12		19		23	36		18		18					
	ROAD CLASSIFICATION		PRIMARY ARTERIAL ROAD CLASS IIB (2 LANES)																								
	CROSS SECTION		CLASS IIB (2 LANES) CARRIAGEWAY 2x3.5=7.0M SHOULDER···2.0M																								

COASTAL ROADS IN EAST COAST OF SUMATRA

Table 7.6 Route Description

7.6.2 Economic Evaluation of East Coast Highway

(1) General

The economic evaluation of the East Coast Highway (implementation of the whole section of Coastal Roads in East Coast of Sumatra) is performed on the basis of the following procedure:

Considering the physical scale of construction work of the whole implementation, a staged construction by road section is assumed. For this purpose, an individual evaluation for each road section (sections 1 to 7) is made, and the staged construction work schedule by section is assumed.

In accordance with the staged construction work schedule, the project costs of the whole implementation project are distributed for each year. The project benefit is estimated also in accordance with the staged construction work schedule.

(2) Assumption on Staged Construction

The whole implementation project extends approximately 1,900 Km in total length. The total project cost for initial investment amounts to about 900 billion Rupiah(1992 financial price). This is rather a large amount of investment to be made for a single project and implementation of the whole section at one time is unrealistic due to the scale of the physical and financial aspects.

Accordingly, considering the constraints of the finance and construction resources, a staged construction is planned. This is planned by assuming implementation priority for each road section (sections 1 to 7). The staged construction work schedule follows the implementation priority.

Implementation priority is based on the individual evaluation of investment efficiency for each road section.

(3) Evaluation of Investment Efficiency for Each Road Section

For comparison of investment efficiency for each road section, an economic analysis is made with an assumption of the individual development for each section. For this analysis, benefits of saving on vehicle operating cost and vehicle time cost are adopted.

The result of the comparison of the investment efficiency for each road section is summarized in Table 7.7.

Table 7.7 Summary of Investment Efficiency Comparison for Each Road Section

Road Section	EIRR	Priority Assessment
Section 1	11.3 %	5
Section 2	10.2 %	6
Section 3	8.4 %	7
Section 4	12.2 %	4
Section 5	17.6 %	3
Section 6	19.1 %	1
Section 7	18.4 %	2

Note) 1) EIRR : Economic Internal Rate of Return
2) Section 7 : Section 7c

Details of the comparison of investment efficiency for each road section are shown in Appendix A-7.3.

(4) Assumptions for Staged Construction Work Schedule

a) Order of construction schedule

The order of the construction work schedule follows the priority determined by the results of the evaluation of investment efficiency.

b) Implementation schedule of staged construction

An implementation schedule of staged construction is assembled on the basis of the following assumptions:

1) The construction period required for one road section is three years.

2) The starting year of service operation of the first road section to be constructed is 1997, and that of the last road section to be constructed is 2005.

3) Considering the physical scale of construction work, the seven road sections are arranged into three construction packages.

4) The construction work of one construction package can start immediately after the preceding package.

5) Reginal continuity of the road links is taken into account.

Consequently, for the staged implementation schedule the construction packages are assumed as shown below, and the construction schedule by road section is assumed as shown in Fig. 7.6.

Construction Package 1	:	Section 6 and 7
Construction Package 2	:	Section 4 and 5
Construction Package 3	:	Section 1, 2 and 3

(5) Project Costs

The total project costs for the Masterplan are shown in Table 7.8.

Table 7.8 Total Project Costs for East Coast Highway

(Million Rp. at 1992 price)

(Financial Costs)	
a) Initial Costs	
Construction, Engineering, & etc.	669,691
Land Acquisition	182,084
Total	851,775
b) Whole including Maintenance	2,135,587
(Economic Costs)	
a) Initial Costs	
Construction, Engineering, & etc.	608,810
Land Acquisition	182,084
Total	790,894
b) Whole including Maintenance	1,974,359

Note : Present value of economic whole costs discounted at rate of 15% is 373,200 million Rp.

In accordance with the staged implementation schedule by road section the construction costs by section were distributed for each year.

(6) Economic Benefit

Benefits by implementation of the whole road section are considered as the following categories:

a) Direct benefit

Development of the project road brings about savings in the vehicle travel costs (vehicle operating cost and vehicle time cost).

b) Indirect development benefit

As an effect of service operation of the East Coast Highway, it is expected that some constraints such as transportation means, transportation time and transportation costs will be relieved.

Consequently, the distribution of materials and the products of agriculture, industry, etc. will possibly be stimulated which have not previously entered into markets because of the above previous constraints.

Thus, development of the East Coast Highway has the potential to stimulate, industrialization, changes of industrial structure will be anticipated, regional development in Sumatra will improve, and an upgrade of regional incomes will result.

(7) Estimation of Direct Benefit

The economic benefits related to normal traffic, including diverted traffic, (saving in vehicle operating cost and vehicle time cost) were estimated based on the traffic assignment results with the road network condition corresponding to the staged construction schedule. For the convenience of the calculation process benefits were estimated in accordance with the starting year of service operation of the assumed construction packages. The benefits in the intermediate years were interpolated.

A conceptional illustration of the benefit distribution by year is shown in Fig. 7.6. The annual benefit amounts in 1997 and 2010 in accordance with the implementation stages and the annual benefit amounts adopted finally for starting years of road service operation are shown in Table 7.9 and Table 7.10 respectively.

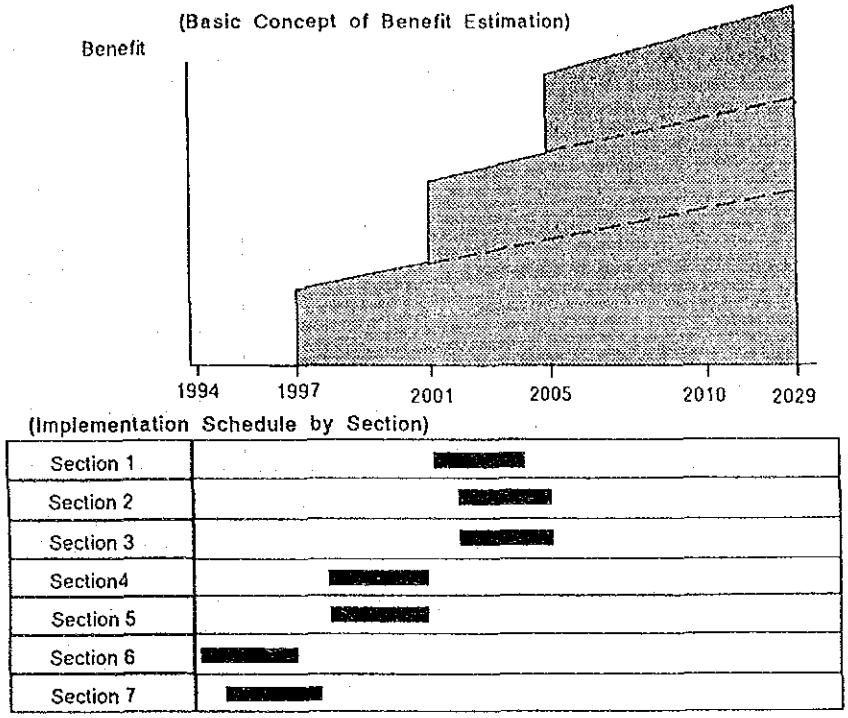


Fig. 7.6 **Assumed Implementation Schedule and Basic Concept of Direct Benefits Estimation**

Table 7.9 **Economic Direct Benefit by Construction Package**

(Million Rp. at 1992 price)

	Year	VOC Saving	Time Saving	Total Benefits
Construction Package 1	1997	24,434	2,437	26,871
(Section 6 & 7 developed)	2010	114,802	14,691	129,493
Construction Package 2	1997	54,289	5,440	59,729
(Section 4,5,6 & 7 developed)	2010	207,977	26,759	234,736
Construction Package 3	1997	71,643	7,367	79,010
(All Sections developed)	2010	340,910	47,484	388,394

Table 7.10 Economic Direct Benefit Applied for Planning Year

(Million Rp. at 1992 price)

Planning Year (Starting Year of Road Service Operation)	VOC Saving	Time Saving	Total Saving
1997 1)	24,434	2,437	26,871
2001 2)	101,578	12,000	113,577
2005 3)	237,346	32,054	269,400
2010	340,910	47,484	388,394

Note : 1) Starting year of road service of Section 6 and 7. In the traffic assignment, the starting year of road service of Section 7 is assumed as 1997.
2) Starting year of road service of Section 4 and 5.
3) Starting year of road service of Section 1, 2 and 3.

(8) Estimation of Indirect Benefit

The development benefit, namely the upgrade of regional incomes, is assumed to be produced by the activity of the whole industrial sector, as an effect of shortening of travel time of commodities and passengers, due to the East Coast Highway development.

By using Gross Regional Domestic Product (GRDP) as a dependent variable and travel time distance between the provincial capital cities and the largest cities in Sumatra (i.e. Medan and Palembang) as an independent variable, a regression analysis was made, and the development benefit was estimated. Details of the estimation are presented in Appendix A-7.4 and the results are summarized in Table 7.11.

Table 7.11 Estimated Indirect Benefit

(Million Rp. at 1992 price)

Year	Indirect Benefit Amount
1997	14,410
2010	554,027

(9) Results of the calculation of economic analysis in terms of direct benefit, indirect benefit and the total of direct and indirect benefits are shown in Table 7.12, Table 7.13 and Table 7.14 respectively.

Table 7.12 Economic Analysis (Related to Direct Benefit)

Description	
EIRR (Economic Internal Rate of Return)	24.6%
NPV (Net Present Value) at Discount Rate of 15%(Million Rp.)	406,800
B/C (Benefit Cost Ratio) at Discount Rate of 15%	2.1

Table 7.13 Economic Analysis (Related to Indirect Benefit)

Description	
EIRR (Economic Internal Rate of Return)	32.5%
NPV (Net Present Value) at Discount Rate of 15%(Million Rp.)	681,700
B/C (Benefit Cost Ratio) at Discount Rate of 15%	2.8

Table 7.14 Economic Analysis (Related to Total of Direct and Indirect Benefits)

Description	
EIRR (Economic Internal Rate of Return)	44.3%
NPV (Net Present Value) at Discount Rate of 15%(Million Rp.)	1,461,700
B/C (Benefit Cost Ratio) at Discount Rate of 15%	4.9

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

7.7 Effects on the Environment

7.7.1 General

The impact on the environment caused by road construction work is covered by the guideline issued by the Ministry of Public Works in 1990 entitled "Environmental Impact Analysis" (EIA). (No. 779/KPTS/1990)

Road construction works will have many positive and negative effects on the surrounding environment, and it will be necessary to mitigate the negative effects to the greatest extent possible. It will be necessary to find the effects that will influence the required environment due to implementation of the Sumatra East Coast Highway Project, together with information which should be collected for analysis in the road section to be described in the Feasibility Study.

Fig. 7.7 gives a general description of the Environmental Impact Analysis.

7.7.2 General Description of the Highway Project and the Impact on the Environment

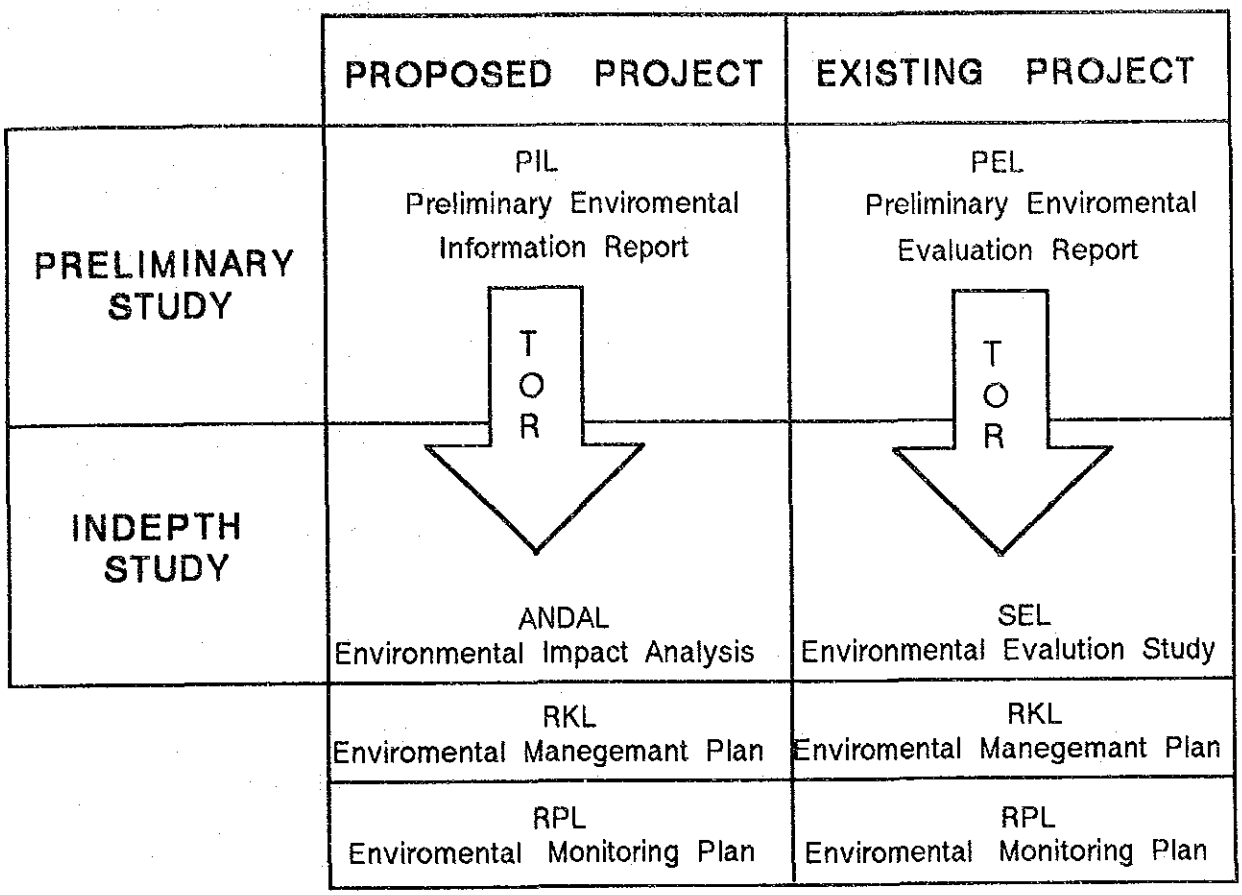
(1) Description of the Proposed Project

• Title of the Planned Roadway	:	Sumatra East Coast Highway
• Starting Point	:	Medan ~ Bakauhuni
• Total Road Length	:	1,906 km
• Number of Lanes	:	2-lanes
• Design Speed	:	60 km/hr
• Description of the Project	:	To basically widen and rehabilitate the existing road system.

(2) It will be necessary to obtain further information on the Environment .

Since the project highway will consist of road widening and improvement of the alignment, planning, design and construction will require the following environmental information to be obtained:

a) In the Socio-Economic Field
- the number of houses which will have to be relocated due to the road widening.



PIL:	Penyajian Informasi Lingkungan
PEL:	Penyajian Evaluasi Lingkungan
ANDAL:	Analisis Dampak Lingkungan
SEL:	Studi Evaluasi Lingkungan
RKL:	Rencana Pengelolaan Lingkungan
RPL:	Rencana Pemantauan Lingkungan

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IN
EAST COAST SUMATRA

Fig. 7.7 **Environment Impact Analysis**

b) In the Physical Natural Field

- changes in the quality of water due to the road rehabilitation
- changes in river channels due to the road rehabilitation, and any new occurrence of flood areas.

c) In the Ecology Field

- the impact on the ecology before and after the construction operation

7.8 Selection of the Order of Priority for the Sumatra East Coast Highway

This study selects the road rehabilitation work that will have to be implemented by 1997 in order to realize the First Phase of the road rehabilitation work for the Project Year of 2010.

7.8.1 Selection Standard for the Priority Sections

Priority sections (Pre-Feasibility Study Related Projects) are those sections which will be selected for implementation by 1997. The investigation established selection standards based on the necessity and the roles played by the Sumatra East Coast Highway, from both the physically necessary and strategically necessary viewpoints:

(1) Physical Necessity

1) road link sections which are missing from the Sumatra East Coast Highway System.

2) existing road sections in the Sumatra East Coast Highway System which are defective.

3) new road sections which will greatly shorten the distances and which would strengthen the existing detours.

4) road sections which would cope with the future traffic demand load.

(2) Strategic Necessity

5) road sections which have been selected in the Main Trunk Routes in the road improvement program.

6) road sections which have a high investment return potential.

7) road sections which have a higher development potential or would strengthen the effectiveness of the development.

8) road sections which will be effective as access to export/import base ports in the Sumatra East Coast Highway System.

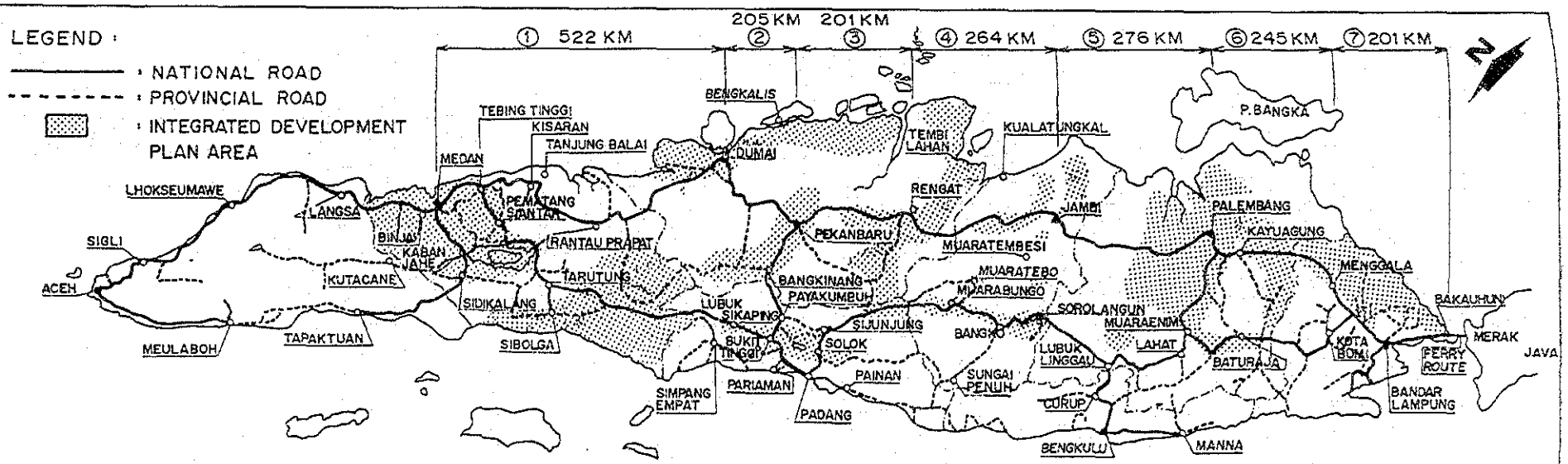
9) road sections which have a high development potential.

10) road sections which will contribute to regional developments, linked with the Jakarta Economic Zone.

7.8.2 Selection of Priority Sections

In accordance with the above priority criteria evaluation of the seven sections is given in Table 7.15. The following three road section have been selected as the priority sections:

Section 4:	Rengat ~ Jambi	Road Length 255 km
Section 6:	Palembang ~ Menggala	Road Length 183 km
Section 7:	Menggala ~ Bakauhuni	Road Length 189 km



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	X	○	X
2. UNSUITABLE ROAD CONDITION	△	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	△	X	○	○	△	○	△
8. ROLL OF ACCESS TO THE HINTERLAND OF PORT	○	○	○	○	○	○	△
9. PROMOTION OF LOW DEVELOPMENT AREA	△	○	○	○	△	○	○
10. LINKAGE WITH JKT ECONOMIC ZONE	X	X	X	X	X	○	○
TOTAL OF EVALUATION	○ 3	○ 4	○ 5	○ 5	○ 3	○ 10	○ 4
LEGEND : ○ MOST EFFECTIVE	△	△	—	◎	△	◎	○
△ MEDIUM EFFECTIVE	△ 5	△ 2	△ 2	△ 3	△ 5	△ 0	△ 4
X LESS EFFECTIVE	X 2	X 4	X 3	X 2	X 2	X 0	X 2

COASTAL ROADS IN EAST COAST OF SUMATRA

Table 7.15 Selection of Priority Sections

Chapter 8

PRE-FEASIBILITY STUDY

CHAPTER 8

PRE-FEASIBILITY STUDY

8.1 Outline of the Study

This section describes the three road sections selected in the Master Plan of the Sumatra East Coast Highway Project in Chapter 7 for the Pre-Feasibility Study.

Table 8.1 gives the design criteria for the roadways of the Pre-Feasibility Study, and Fig. 8.1 indicates the routes selected. The total length of highway will be 627 km.

Table 8.1 Road Sections for Pre-Feasibility Study

	Section (4) Rengat to Jambi	Section (6) Kayuagung to Menggala	Section (7) Menggala to Bakauhuni
Road Length (km)	255	183	189
Present Status	National Collector	Non Status	National Arterial
Planned Status	National Arterial	National Arterial	National Arterial

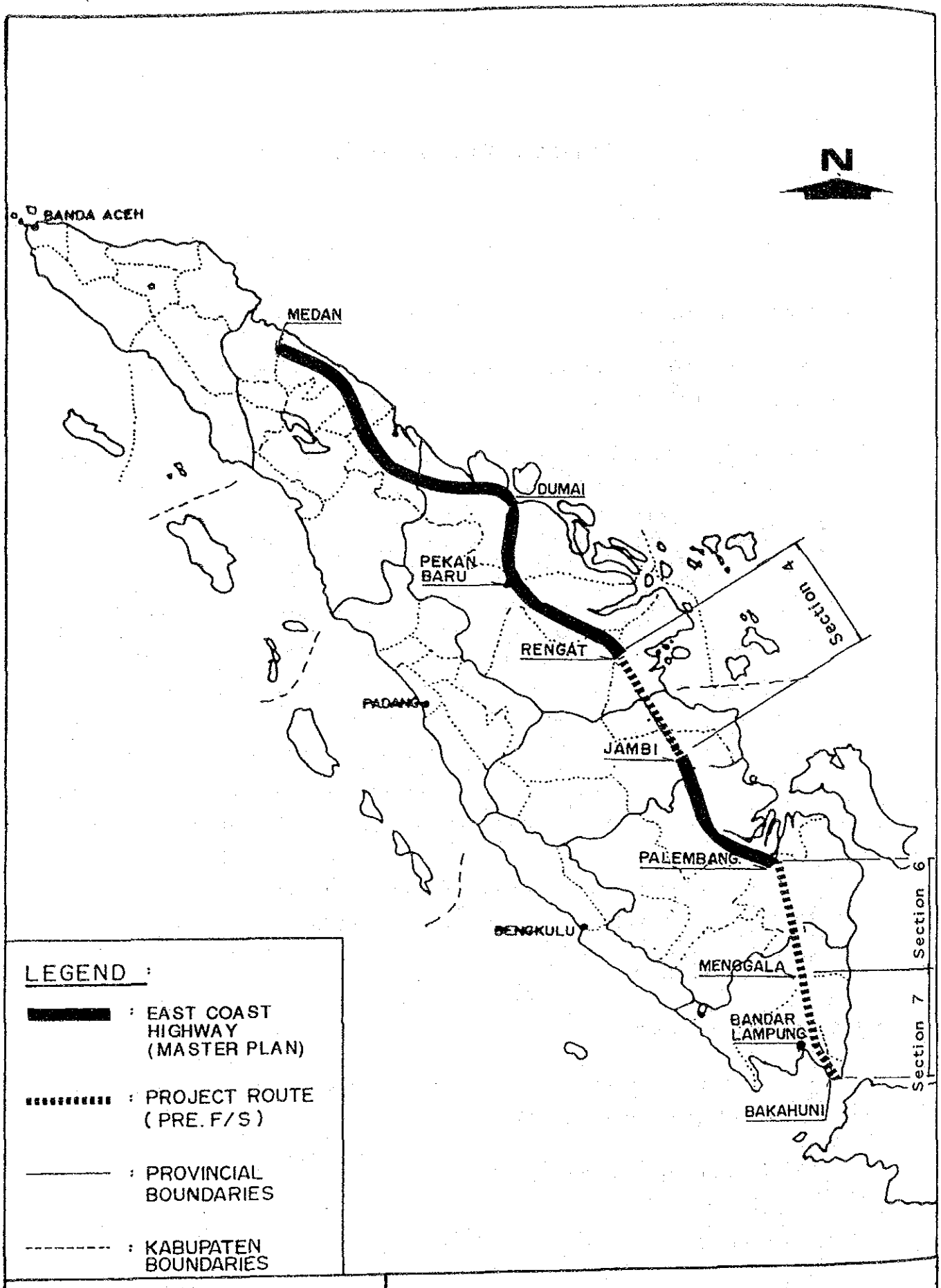
Notes: The road design criteria give representative criteria. The road length gives the total length of the road in the Pre-Feasibility Study. (The location of the starting point for the Pre-Feasibility Study is based on the present road condition. A detailed description is given in paragraph 8.4, Description of the Region and Existing Bridges).

8.2 Design Standards

8.2.1 Geometric Standard

The geometric structural standards for the roads are given in the following standards (1), (2), and reference (3).

(1) Standard Specifications for Geometric Design of Rural Highway, No. 13/1970, 1980.



COASTAL ROADS IN EAST COAST OF SUMATERA

Fig. 8.1 Location of Pre-F/S Sections

Table 8.2 Geometric Design Standard

Item	Unit	Standard Specification for Geometric Design of Rural Highway		Containers Transportation on the Road	Recommendation
Road Class		Class II A	Class II B	Class II B	Class II B
Terrain		Flat, Rolling and Mountain	Flat, Rolling and Mountain	-	Flat, Rolling and Mountain
Design Traffic Volume	pcu/day	6,000 ~ 20,000	1,500 ~ 8,000	-	1,500 ~ 8,000
Design Speed	km/hr	100 80 60	80 60 40	60	60
R.O.W. Width	m	40	30	-	30
Lane Width	m	2 x 3.5 m or 2 x (2 x 3.5 m)	2 x 3.5 m	2 x 3.5 m	2 x 3.5 m
Shoulder Width	m	3.0 2.5 2.5	3.0 2.5 2.5	2.0	2.0
Median Width	m	1.5	na	-	na
Crossfall of Pavement	%	2	2	-	2
Crossfall of Shoulder	%	4	6	-	6
Max. Superelevation	%	10	10	-	10
Min. Radius Curve	m	350 210 115	210 115 50	115	115
Max. Gradient	%	4 6 7	5 7 8	5	5
Min. Clearance	m	4.5	4.5	5	5
Max. Axle Loading	ton	-	-	10	10

(2) Container Transportation on the Road: 1990 Ministerial Decree by Minister of Transport and Communication.

(3) Standard Specification for Geometric Design of Rural Highway (Final Draft): Directorate General of Highways, Department of Public Works 1990.

The Sumatra East Coast Highway is designated as an inter-city-connecting roadway and so the Arterial Road Criteria will be applied. The geometric structural standards are given in Table 8.2 obtained from the above design standards.

8.2.2 Structural Design Standards

(1) Bridge Widths:

Bridge widths have been cited in the Indonesian Integrated Road Management System, and are the minimum widths based on the daily average traffic volumes. (See Table 8.3)

Table 8.3 Minimum Bridge Widths

AADT	Minimum Bridge Width
Less than 3,000	4.5 m
3,000 to 8,000	6.0
8,000 to 20,000	7.0
Greater than 20,000	14.0

(2) Loads:

In designing the bridge structures, the loads for road bridges given by Bina Marga will be used.

(3) Planned High Water Level:

The clear space between the planned High Water Level and the underside of the bridge beam is a minimum of 1.00 m. Table 8.4 gives the Return Period and the Minimum Vertical Clearances for bridges.

Table 8.4 Vertical Clearance of Bridges

Classification	Return Period (years)	Minimum Vertical Clearance (meters)
Major River	50	1.0
Medium River	50	1.0
Small River (<20 m wd)	25	1.0
Box/Pipe Culvert	10	0.5
Roadside Structure	3	-
Major River		

8.2.3 Pavement Design Standards

The road pavement design standards will be based on the following references:

- Guide for Flexible Pavement Design (Pedoman Penetuan Tebal Perkerasan Lentur Jalan Raya SNI-1732-1989F), published by Bina Marga.
- Container Transportation on the Road (km 74-1990: Ministerial Decree: Minister of Transportation and Communication.
- AASHTO Guide for Design of Pavement Structures, 1986.

8.3 Road Traffic Capacity and Number of Lanes

The number of lanes will be determined from the ratio of the road and the planned road capacity.

8.3.1 Road Traffic Capacity

The road traffic capacity of the road sections to be evaluated in the Pre-Feasibility Study will differ between the regular section, bridge section and the existing road section, therefore road traffic capacity will be calculated for each type of section (3 cases).

Case-1: For the road width component of Sumatra East Coast Highway:

- Road Width: 3.5 m
- Number of Lanes: 2
- Shoulder Width: 2.0 m

Case-2: For the bridge width component

- Road Width: 3.0 m
- Number of Lanes: 2
- Shoulder Width: 0.0 m

Case-3: For the 1 Lane Road (Road Width 4.50 m) width component:

- Road Width: 4.5 m
- Number of Lanes: 1
- Shoulder Width: 1.0 m

The following references were used to calculate the traffic volumes:

- Standard Specification for Geometric Design Rural Roads (Final Draft), December 1990.
- Highway Capacity Manual by Japan Road Association.

(1) Case-1:

$$STV = BHC \times Fw \times \frac{Fu}{Kfactor}$$

Where:

STV	:	carriageway traffic factor
BHC	:	basic traffic capacity
Fw	:	correction factor of carriageway and shoulder width
Fu	:	correction factor for road conditions in the vicinity
Kfactor	:	ratio of daily traffic volume versus hourly traffic volume.

Standard values:

BHC	:	2,800 (PCU/hr)
Fw	:	0.97
Fu	:	1.0
Kfactor	:	0.06

Hence:

STV = 2,800 x 0.97 x 1.0/0.06 = 45,000 PCU/day

(2) Case-2:

Standardized values:

BHC	:	(as in Case-1)	:	2,800 (PCU/hr)
rL	:	correction factor of carrigeway width	:	0.94
rC	:	correction factor of leteral clearance width	:	0.86
rI	:	correction factor of roadside conditions	:	0.80
rT	:	correction factor of heavy vehicle composition	:	0.77
Kfactor	:	(as in Case-1)	:	0.06

STV = BHC x rL x rC x rI x rT / Kfactor

= 2,800 x 0.94 x 0.86 x 0.8 x 0.77/0.06 = 23,000 PCU/day

(3) Case-3:

Since there is no calculation method in Indonesia for 1-lane traffic volume, the 1-lane traffic volume was calculated by applying the Indonesian standard for road widening (See Table 8.5).

Table 8.5 Pavement Widening Criteria

ADT	Pavement Surface Width (m) (Pd)	Shoulder Width (m) (S)
< 3,000	4.5	1.0
3,000 - 8,000	6.0	1.5
8,000 - 20,000	7.0	2.0
> 20,000	2 x 7.0	2.0

Source: Road Work Design System by Bina Marga

8.3.2 Design Traffic Volume

The traffic volumes to be used for the Pre-Feasibility Study Sections are given in Table 8.6.

Table 8.6 Design Traffic Volumes

Section	Design Traffic Volume (pcu/day) 2010
Section 4, Jambi - Rengat	19,000
Section 6, Kayuagung - Menggala	18,000
Section 7, Menggala - Bakauhuni	18,000

8.3.3 Calculation of Required Traffic Lanes

The traffic volume, capacity and the required number of traffic lanes for the Pre-Feasibility Study Sections are given in Table 8.7.

Table 8.7 Traffic Volume, Capacity and Required Number of Lanes

	Section 4 Jambi to Rengat	Section 6 Kayuagung to Menggala	Section 7 Menggala to Bakauhuni
Design Traffic Volume (PCU/day) in 2010	19,000	18,000	18,000
Traffic Capacity (PCU/day)			
Case-1 (Road Section)	40,000		
Case-2 (Bridge Section)	20,000		
Case-3 (1-Lane Section)	3,000		
Number of Traffic Lanes Required in 2010	2-Lanes		

From the above table, the number of lanes required will be 2-lanes.

8.4 Description of the Region and Existing Bridges

8.4.1 Rengat ~ Jambi Section

The starting point of this section is approximately 16 km south of Rengat at Pematang Reba, and the end is approximately 11.5 km west of Jambi at Mendalo. The road network for the Rengat ~ Jambi section is shown in Figs. 8.2 and 8.3.

From the starting point at Pematang Reba to the center of Rengat, the existing road (9.5 m total width paved road, 6.5 m carriageway) will be used for access to the city. The total length of the access road is approximately 16 km (See Fig. 8.2).

From the end of the road section at Mendalo, access to Jambi city will be by using the existing 9.0 m wide paved road (the Ex-OECF road is presently being rehabilitated), and another 11.5 m wide paved road (See Fig. 8.3) will be used.

The condition of the roadways at present is as follows:

- The terrain in this area is generally low hilly country, except for the hills in the vicinity of the provincial border of Riau and Jambi Provinces. In the low hill and flat plateau areas there are some problems with the vertical alignment, and in the mountainous area road section there are some steep vertical gradients.

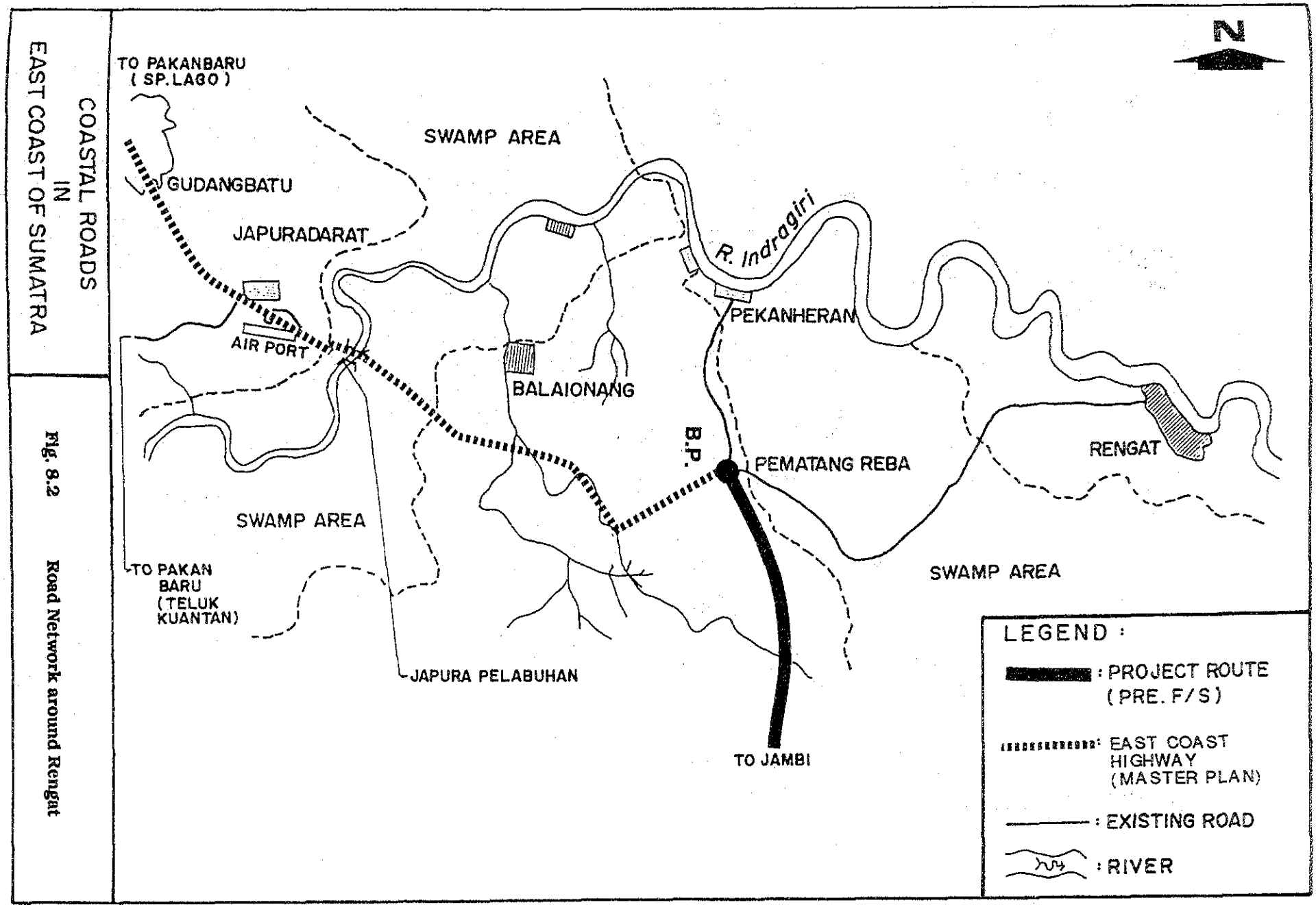
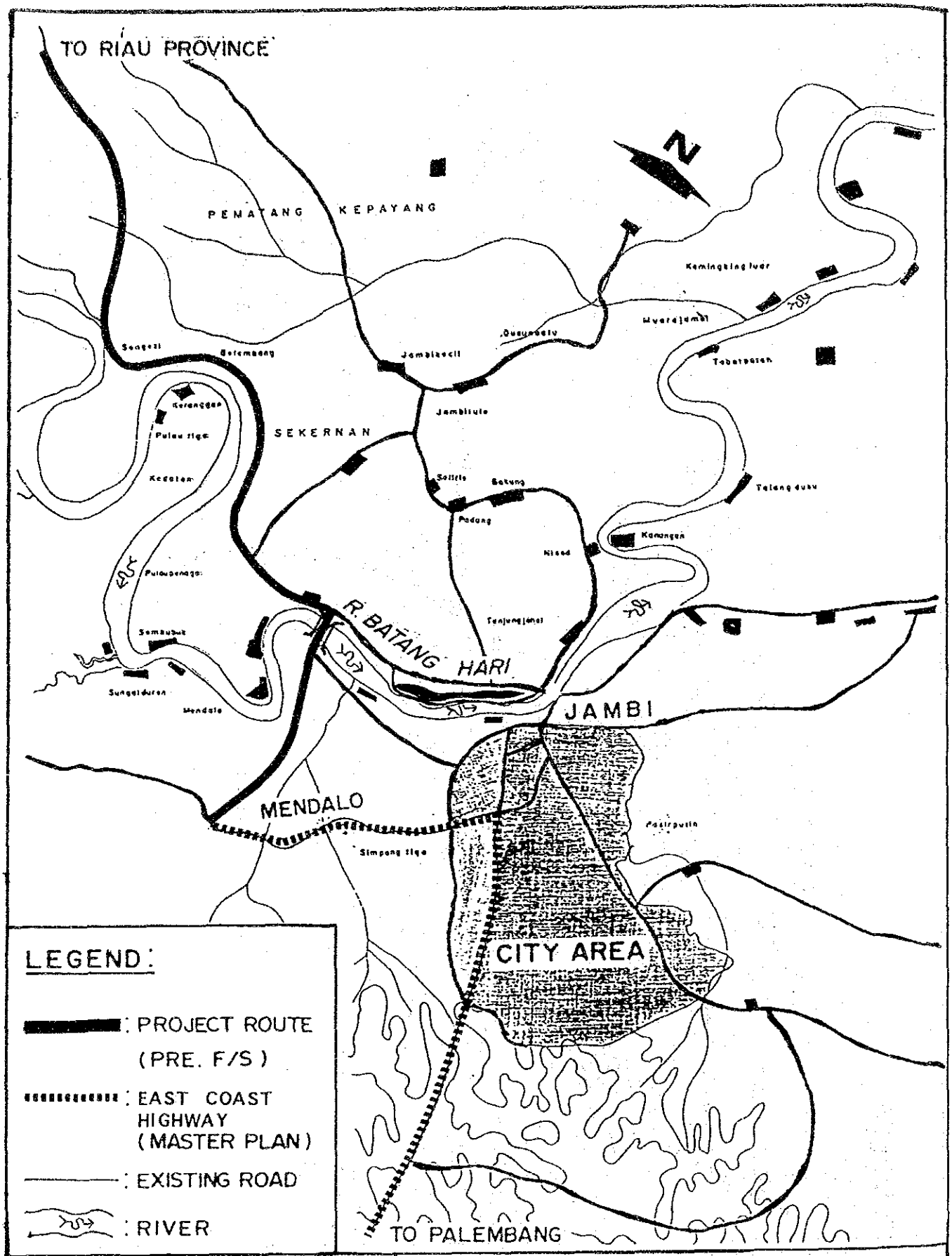


Fig. 8.2 Road Network around Rengat



COASTAL ROADS IN EAST COAST OF SUMATRA

Fig. 8.3 **Road Network in Jambi and Its Vicinity**

- The road width is 4.5 m in Riau Province, and 4.5 m and 7.0 m in Jambi Province. The compared roads comprise 50 % of the total section.
- The paved roads in Riau Province are of Double Bituminous Surface Treatment (DBST), and in the rainy season the roads become impassable and are generally in a poor condition.
- At the present time, the roads are being resurfaced with APBN (Indonesian Public Works Budget) and funds provided by OECF. This work is expected to be completed by the end of 1992.
- At Rengat and along the Batang Hari River (Jambi), there are sections that experience frequent flooding. The existing road has a high road bed for the high waters, and so it will not be necessary to raise the road bed for the new road section.

8.4.2 Kayuagung ~ Menggala Section

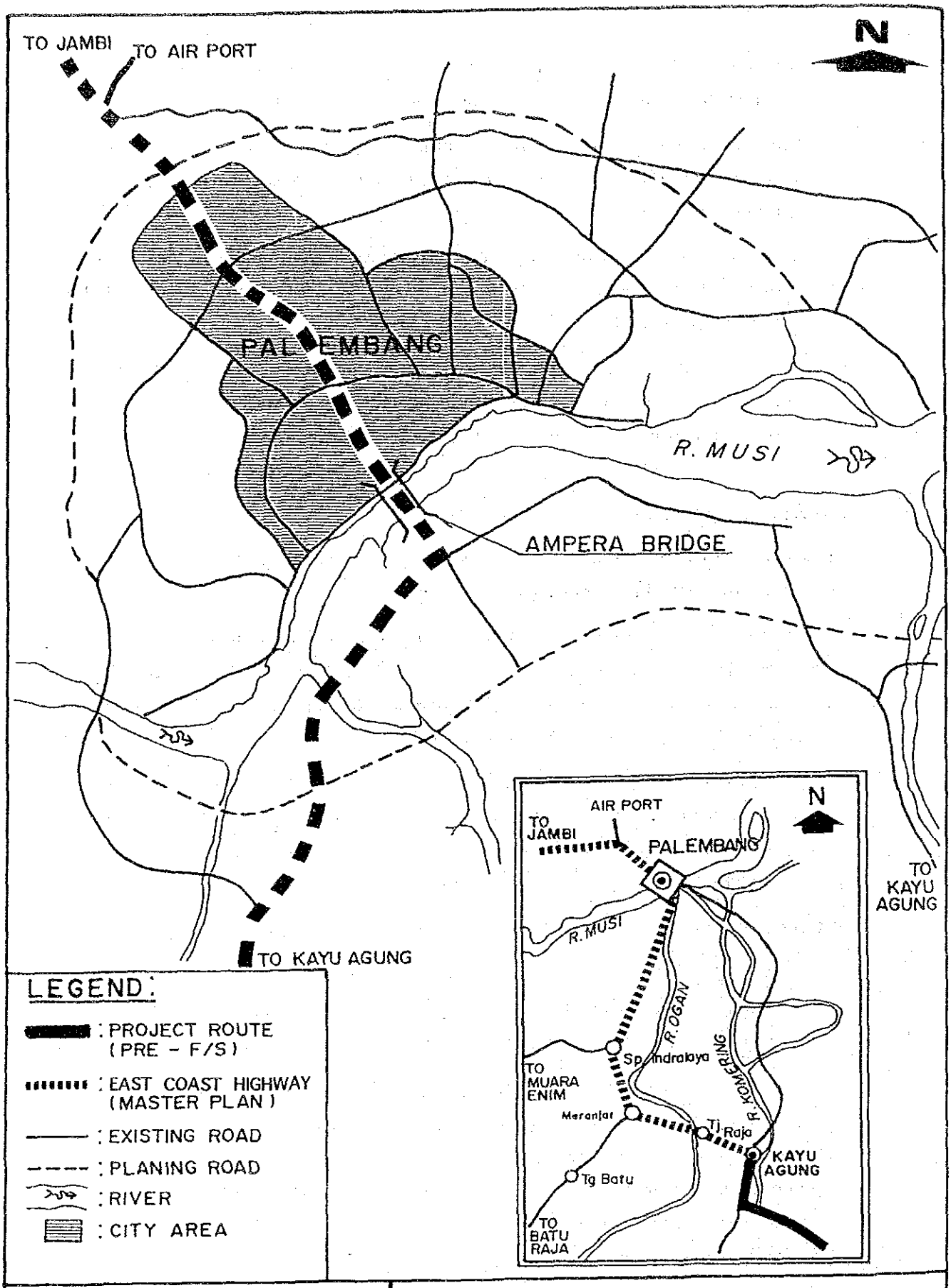
This section starts at Kayuagung 45 km south of Palembang, and ends at Menggala 100 km north of Bandar Lampung (See Fig. 8.4).

At the starting point in the Kayuagung Region a road rehabilitation project is underway. Pavement of the National Road in the Palembang ~ Kayuagung section will be widened to 6.0 m, and the rural roads from Kayuagung in the Penyudingung direction are being rehabilitated to 4.5 m width.

The paved road width has been fixed at 4.5 m except for the sections that are being paved to a width of 6.0 m. At the end of the section in the vicinity of Menggala, the road will be similar to the APBN road project. The center of Menggala city is approximately 6 km north from the end of the section.

The present condition of the roads is as follows:

- This section of 170 km is presently being rehabilitated with APBN financing basically to a paved width of 4.5 m. There are some road sections that are currently being provided with a 6.0 m width on the South Sumatra side.
- The terrain in this sector is of two types; low hills and flat lands. The low hills extend from the Provincial Border to Menggla in Lampung Province. From the Provincial Border on the South Sumatra side the land is comparatively flat, and 2.0 km of the road in this sector pass through swamplands. The road levels in this area are 2.0 m higher than the surrounding ground level, and the fill for the roads is well consolidated.



COASTAL ROADS IN EAST COAST OF SUMATRA

Fig. 8.4 **Road Network in Palembang and Its Vicinity (Including Kayuagung)**

8.4.3 Menggala ~ Bahauhuni Section

This section of the road is a continuation of the section in the previous paragraph.

For a description of the roadway, refer to the alternative roadways for Bakauhuni ~ Menggala in paragraph 7.5.1.

8.4.4 Bridges

The present condition of the bridges in the Pre-Feasibility Study Sections is based on the data base of the Bina Marga Bridge Management System (BMS). There is a total of 172 bridges in the Pre-Feasibility Study sector. (including some bridges presently under construction)

Bridge statistics including the size, type, year of completion, and lengths are given in Tables 8.8 to 8.11.

- Most of the bridges are constructed with reinforced concrete beams, but recently steel truss bridge components that have been imported from Australia are being used for bridges with spans from 35 m to 60 m.

- Many of the bridges have been built after 1970 and the bridges are in fairly good condition.

  However, some of the bridges are structurally not well constructed, and there are some which are not safe. Bridges which should be mentioned in the section from Rengat to Jambi are 3 wooden bridges of 4.0 to 4.5 m width which should be replaced as soon as possible.

  In the section from Menggala ~ Kayuagung some bridges are being constructed prior to completion of the roads. According to information from Bina Marga bridges of a width of 6.0 m or wider will be completed within 1992 at Penyundingung near Kayuagung and in the vicinity of Bj. Tenuk.

- Mesui Bridge which is near the Provincial Border of Lampung and South Sumatra is a 2-span trussed bridge with spans of 45 m and 60 m was constructed in March 1992.

Table 8.8 Number of Bridges by Year of Construction

Section	1990 - 92	1980 - 89	1970 - 79	1960 - 69	Earlier	Total
(1) Rgt-Jambi	39	21	-	-	-	60
(2) Kyagng-Mgl	24 + (14)	13	-	-	-	51
(3) Mgl-Bkh	-	29	24	5	3	61
Total	77	63	24	5	3	172

Table 8.9 Number of Bridges by Type

Section	Steel Girder	Steel Truss	Reinf. Concrete	Prestress Concrete	Wooden	Other	Total
(1) Rgt-Jambi	9	9	39	-	3	-	60
(2) Kyagng-Mgl	-	3 + (2)	34 + (12)	-	-	-	51
(3) Mgl-Bkh	10	5	42	2	-	2	61
Total	19	19	127	2	3	2	172

Table 8.10 Number of Bridges by Carriageway Width

Section	4.5 m	6 m	6.5-7 m	8 m	9 m	Total
(1) Rgt-Jambi	8	46	2	2	2	60
(2) Kyagng-Mgl	2	35 + (14)	-	-	-	51
(3) Mgl-Bkh	-	22	14	25	-	61
Total	10	117	16	27	2	172

Table 8.11 Number of Bridges by Length

Section	< 19 m	20-49 m	50-99 m	100-130 m	> 500 m	Total
(1) Rgt-Jambi	41	15	3	-	1	60
(2) Kyagng-Mgl	32 + (10)	2 + (2)	1 + (1)	2 + (1)	-	51
(3) Mgl-Bkh	45	12	4	-	-	61
Total	128	31	9	3	1	172

Note: Numbers in parentheses indicate bridges under construction

8.5 Design Policy

8.5.1 Highway Design Policy

The East Coast Highway is planned to raise the living standards of the residents, to increase the land use, and to formulate a basis for regional development. In performing the road design, based on the road rehabilitation objective and the road planning basic policy, it is intended to rehabilitate the existing roadways and to design the roads in accordance with the following basic rules:

- when the horizontal and vertical alignment do not satisfy the geometric structural standards for a speed of 60 km/h, the existing roadway will be rehabilitated.
- in areas where the existing roadway is subject to overtopping by floodwaters, the road bed will be raised.
- in sections where the vertical alignment is steep, and improvement by rehabilitation will not be economical, a climbing lane will be provided.
- bridges with a carriageway width of more than 6.0 m will be used where possible.

8.5.2 Geometrical Structural Standards

Table 8.12 gives the geometrical structural standards for the East Coast Highway following the standards described in paragraph 8.2.1.

Table 8.12 Geometric Design Standard

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

8.5.3 Standard Road Cross Section

The road width has been planned based on the Indonesian Geometric Structural Standards (Paragraph 8.2.1, Geometric Structural Standard), and the calculated number of road lanes (Paragraph 8.3 Traffic Capacity and the Required Number of Lanes) as follows:

Road Width Components

- Number of Lanes : 2 Lanes
- Lane Width :

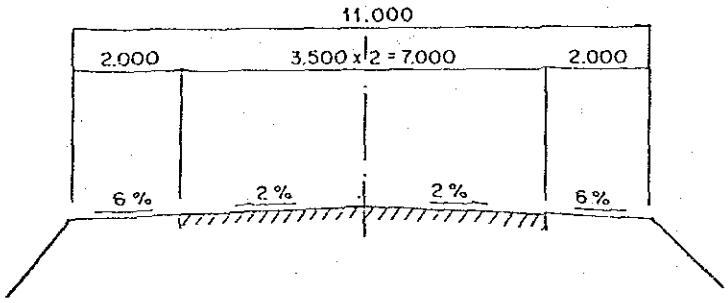
			Superelevation	
Regular Section	:	3.5 m	Carriageway	: 2 %
Bridge Section	:	3.0 m	Shoulder	: 6 %

- Shoulder Width

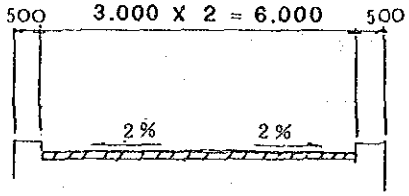
Regular Section	:	2.0 m
Bridge Section	:	0.25 m (on land)

The standard cross section is as shown below:

Regular Section



Bridge Section



8.5.4 Bridge Design

The use of existing bridges in the Pre-Feasibility Study Section is clarified into the following 3 cases. The bridge program is given in Table 8.13.

- Newly Constructed Bridges : Bridges for new road routes
- Replacement Bridges : Structurally inadequate bridges, such as wooden bridges
- Parallel Bridges : For bridges with inadequate width, construct another 1-lane bridge in parallel

Table 8.13 Bridge Replacement and Duplication Program

Existing Bridge								Replacement & Duplication		
Province	Bridge No.	Bridge Name	Location	Bridge Type	Year Built	Length (m)	Width (m)	Bridge Type	Width (m)	Replacement or Duplication
RIAU	09.021.001	S. Rambutan	PBR 206.05	WO	1983	8.3	3.5	RC	7.0	Replacement
	09.021.003	S. Jerinjing	PBR 208.55	WO	1983	11.5	3.5	RC	7.0	Replacement
JAMBI	11.028.004	Tayas	JMB 116.80	RC	1983	25.0	4.5	SG	4.5	Duplication
	11.028.008	Melawai	JMB 125.40	RC	1983	12.0	5.0	RC	4.5	Duplication
	11.028.009	Buluh/Binjai	JMB 131.40	RC	1983	12.0	5.0	RC	4.5	Duplication
	11.028.010	Pesapuan	JMB 137.70	WO	1983	10.0	4.5	RC	7.0	Replacement
	11.028.011	Asan II	JMB 140.20	ST	1983	30.0	5.0	RC	4.5	Duplication
	11.028.013	Lumahan	JMB 154.50	ST	1983	19.7	4.5	RC	4.5	Duplication
LAMPUNG	17.021.001	W. Arteri	TLB 0.00	SG	1984	9.5	8.0	RC	7.0	Duplication
	17.021.001	W. Campang III	TLB 14.30	SG	1984	8.0	8.0	RC	7.0	Duplication
	17.021.002	W. Arteri II	TLB 24.00	SG	1984	10.0	8.0	RC	7.0	Duplication
	17.001.001	W. Kandis	TLB 14.70	RC	1968	8.5	7.5	RC	7.0	Duplication
	17.001.002	W. Merak Batin	TLB 20.55	RC	1970	6.0	7.5	RC	7.0	Duplication
	17.001.003	W. Panas	TLB 21.15	SG	1958	6.5	6.0	RC	7.0	Duplication
	17.001.004	W. Branti	TLB 29.05	RC	1958	6.0	7.5	RC	7.0	Duplication
	17.001.005	W. Sekampung	TLB 33.45	ST	1980	99.0	7.5	PC	7.0	Duplication
	17.002.001	W. Bernai	TLB 39.04	STONE	1968	9.0	7.5	RC	2 X 7.0	Replacement & Duplication
	17.002.002	W. Wates	TLB 41.35	RC	1979	12.0	7.5	RC	7.0	Duplication
	17.002.003	W. Kebagusan	TLB 45.80	RC	1968	12.0	7.5	RC	7.0	Duplication
	17.002.004	W. Tatay Lunik	TLB 52.10	RC	1969	5.0	7.5	RC	7.0	Duplication
	17.002.005	W. Tatay Balak	TLB 52.50	RC	1968	12.0	7.5	RC	7.0	Duplication
	17.002.006	W. Tipo	TLB 57.80	ST	1977	21.4	7.5	RC	2 X 7.0	Replacement & Duplication
	17.003.001	W. Seputih	TLB 59.55	RC	1977	85.0	7.0	RC	7.0	Duplication
	17.003.002	W.S. 14 IIC	TLB 64.30	RC	1973	12.0	7.5	RC	2 X 7.0	Replacement & Duplication
	17.003.003	W.B.D.3	TLB 66.95	RC	1973	4.0	7.5	RC	7.0	Duplication
	17.003.004	W. Pengubuan	TLB 70.60	ST	1980	73.2	6.0	PC	7.0	Duplication
	17.013.010	W. Betung Balak	TLB 91.35	STONE	1978	8.0	6.0	RC	7.0	Replacement
	17.013.011	W. Betung Lunik	TLB 95.72	STONE	1981	8.4	6.0	RC	7.0	Replacement
	17.022.011	W. Lubuk	TLB 51.45	SG	1979	20.0	7.0	RC	7.0	Replacement
	17.062.002	W. Tulang Bawang	TLB 127.40	ST	1985	120.0	4.5	ST	4.5	Duplication
	17.062.007	W. Pedada	TLB 146.30	RC	1980	35.0	3.8	RC	4.5	Duplication

Bridge Type RC: Reinforced Concrete
SG: Steel Girder
ST: Steel Truss
WO: Wooden Bridge
PC: Prestressed Concrete

8.5.5 Pavement Planning

The design load and pavement life will be based on Heavy Loaded Road standards. Pavement design will be in accordance with the AASHTO Design Guide for Pavement Structure, 1986, and will be divided into an overlay portion and a widened portion, as shown in Fig. 8.5.

- Design Load, Axle Load (MST) : 10 t
- Pavement Life : 10 years

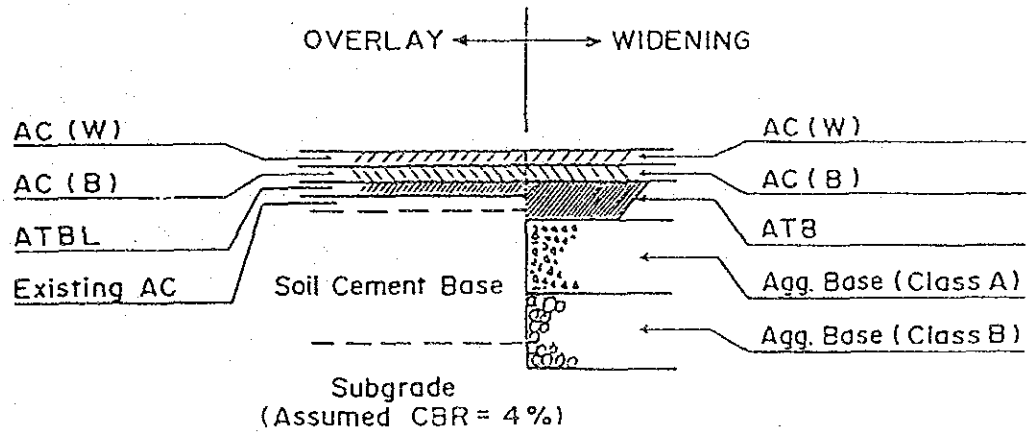


Fig. 8.5 Pavement Design of Overlay and Widening

8.6 Calculation of the Construction Cost

The construction cost for the Pre-Feasibility Study Sections are given in Table 8.14. The cost estimates were prepared from a topographic map with a scale of 1 to 50,000.

Table 8.14 Construction Cost of the Pre-Feasibility Study Sections

Unit: million Rp.

	Section 4	Section 6	Section 7
Road Length (km)	225	183	189
Earthwork	6,502	4,409	5,069
Subbase and Base	35,874	23,629	28,398
Surface	31,877	22,849	17,326
Structure	2,465	4,112	11,820
Miscellaneous	11,508	8,244	9,394
Construction Cost	88,226	63,243	72,007
Administration	18,528	13,282	15,122
Land Acquisition	20,007	13,745	38,065
Project Cost	126,761	90,270	125,194
Average Unit Cost (/km)	497	493	662

8.7 Preliminary Economic Analysis

8.7.1 General

In this section a preliminary economic analysis is performed for Section 4, Section 6 and Section 7 (7C) which are the sections selected for the Pre-Feasibility Study.

Through the engineering study in the Pre-Feasibility Study stage, objective road links of the project road were reviewed for each of these three sections. As a result, some parts of the road links have been excluded from the project road for Section 4 and Section 6.

The project costs estimated on the basis of the engineering study in the Pre-Feasibility Study stage were applied for this economic analysis.

Also, the economic benefit estimate was based on the results of traffic assignment with the changed road link condition applied. That is, for the parts of the road links which were excluded from the project road it was assumed that no development was implemented in the traffic assignment conditions.

8.7.2 Project Costs

The project costs of Sections 4, 6 and 7 are shown in Table 8.15.

8.7.3 Economic Benefits

The economic benefits comprise savings in the vehicle operating cost and vehicle time cost.

The economic benefits for Sections 4, 6 and 7 are shown in Table 8.16.

Table 8.15 Project Costs of Sections 4, 6 and 7
(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	297,944	213,119	252,052
(Economic Costs)			
a) Initial Costs			
Construction, Engineering, etc.	97,049	69,568	79,208
Land Acquisition	20,008	13,746	38,066
Total	117,057	83,314	117,274
b) Whole Costs including Maintenance	272,677	194,994	232,599

Table 8.16 Economic Benefits for Sections 4, 6 and 7
(Pre-Feasibility Study Stage)

(Million Rp. at 1992 price)

		Section 4	Section 6	Section 7
1997	VOC Saving	5,124	9,871	7,470
	Time Saving	730	807	842
	Total	5,854	10,678	8,312
2010	VOC Saving	27,562	40,111	51,352
	Time Saving	3,971	3,797	7,693
	Total	31,534	43,908	59,045

8.7.4 Economic Analysis

The analysis followed the conventional discounted cash flow method in determining the economic internal rate of return (EIRR), the net present value (NPV) and the benefit cost ratio (B/C).

The following assumptions were made for the analysis:

Project life	:	25 years after development of the proposed road
Prices	:	1992 prices
Residual value	:	None

Results of the economic analysis for Sections 4, 6 and 7 are shown in Table 8.17. (Refer to Appendix A-8.1.)

Table 8.17 Economic Analysis

	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 %

8.8 Selection of Feasibility Study Section

From the results of the economic analysis of the above three sections of Sections 4, 6 and 7, the section with the highest EIRR, Kayuagung - Menggala, was selected for the Feasibility Study Section.

8.9 Environmental Impact Analysis for Pre-Feasibility Study Sections

Table 8.18 gives the results of Environmental Impact Analyses in the road sections of the Pre-Feasibility Study. The items to be evaluated are obtained from the Preliminary Environment Information Report (PIL) guideline for road projects issued by the Road Authority.

As shown in the Table, the project will consist of rehabilitation of existing roads, and accordingly there will be fewer impacts on the environment compared to a new road construction project.

a) The proposed road will protect cultural assets and the natural environment, and will not pass through reserved areas.

b) Since the roadways will mainly consist of rehabilitation of existing roads, there will be very little cut and fill earth works.

c) Since existing bridges will be utilized, there will be no major bridge constructed which could have a negative impact on the rivers, and there will be very few new bridges constructed.

d) There will be an adequate distance between the existing roads and residences along the roadways, and there will be very few dwellings required to be relocated.

Table 8.18 (1) Matrix of Environmental Effects for Pre-Feasibility Study Sections

PHASE	ACTIVITY WITH POTENTIAL IMPACTS	AFFECTIVE ENVIRONMENTAL COMPONENT	INFORMATION ON ENVIRONMENTAL EFFECTS											
			Rengat-Jambi				Kayudgung -Menggala				Manggala -Bakauhuni			
			(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
I. PRE CONSTRUCTION	1. Determination of project site and trace	a. Community's socio-economy	○				○					○		
		b. Natural resources and cultural remains	○				○				○			
	2. Land purchase	a. Land, plan, and building ownership		○					○					○
		b. People's livelihood	○					○						○
	3. Transmigration	a. Residents to remove	○					○					○	
		b. Residents at resettlement area	○					○					○	
II. (A). CONSTRUCTION	1. Material and heavy equipment mobilization	a. Settlement/ housing/public utilities	○				○				○			
		b. Public facilities/roads	○				○				○			
	2. Workers mobilization	a. Community socio-economic life	○				○				○			
	3. Construction/ operating of base camp service station, warehouse, etc	a. Settlement/ housing/public utilities	○				○				○			
		b. Water resources	○				○				○			
		c. Biological resources	○				○				○			
	4. Quarry management (by the project)													
	4.1. Detonation/ excavation (on land)	a. Settlement/ housing/public utilities	○				○				○			
		b. Field resources	○				○				○			
		c. Water resources	○				○				○			
		d. Building condition (detonation)	○				○				○			
	4.2. Excavation (at river-body)	a. Water resources	○				○				○			

NOTE:
Information on Environmental Effects show the following classification
(1). No Significant Effects
(2). Small Significant Effects
(3). Moderate Significant Effects
(4). Major Significant Effects

Table 8.18 (2) Matrix of Environmental Effects for Pre-Feasibility Study Sections

PHASE	ACTIVITY WITH POTENTIAL IMPACTS	AFFECTIVE ENVIRONMENTAL COMPONENT	INFORMATION ON ENVIRONMENTAL EFFECTS											
			Rengat-Jambi				Kayudgung -Menggala				Manggala -Bakauhuni			
			(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
(B). IMPLEMENTATION	1. Basic land preparation (land-	a. Settlement/ housing/building	○				○				○			
		b. Biological re - sources	○				○				○			
		c. Public utilities (telephone, PLN, gas, etc)	○				○				○			
	2. Cut and fill	a. Settlements/ housing/public liabilities	○				○				○			
		b. Road users		○				○				○		
		c. Water resources (runoff)		○				○				○		
		d. Ground water (resources hill cut - ting)	○				○				○			
		e. Public utilities (at certain depth)	○				○				○			
	3. Sub-base, base and surface - course	a. Settlements/ housing/public utilities	○				○				○			
		b. Road users			○				○				○	
	4. Transport of project materials and equipment	a. Settlements/ housing/public utilities	○				○				○			
		b. Public infra- structure/road	○				○				○			
		c. Road users	○				○				○			

NOTE:
Information on Environmental Effects show the following classification

(1). No Significant Effects
(2). Small Significant Effects
(3). Moderate Significant Effects
(4). Major Significant Effects

Table 8.18 (3) Matrix of Environmental Effects for Pre-Feasibility Study Sections

PHASE	ACTIVITY WITH POTENTIAL IMPACTS	AFFECTIVE ENVIRONMENTAL COMPONENT	INFORMATION ON ENVIRONMENTAL EFFECTS											
			Rengat-Jambi				Kayudgung -Menggala				Manggala -Bakauhuni			
			(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
	5. Bridge work													
	5.1. Lower structure (at river)	a. Water resource/ water course		○				○				○		
		b. Water traffic	○				○				○			
		c. Settlement	○				○				○			
	5.2. Low structure (on land)	a. Road users, crowded		○				○				○		
		b. Settlement housing/public utilities	○				○				○			
	5.3. Upper structure	a. Road users, crowded		○				○				○		
III. OPERATION AND MAINTENANCE	1. Road/Traffic operation	a. Settlements/ housing/public utilities	○				○				○			
		b. Road users	○				○				○			
		c. Biological resources	○				○				○			
		d. Residents socio -economy (especially tollway)	○				○				○			
	2. Road and Bridge maintenance	a. Settlements/ housing/public utilities	○				○				○			
		b. Road users	○				○				○			

NOTE:
Information on Environmental Effects show the following classification
(1). No Significant Effects
(2). Small Significant Effects
(3). Moderate Significant Effects
(4). Major Significant Effects

Chapter 9

FEASIBILITY STUDY

CHAPTER 9

FEASIBILITY STUDY

9.1 General

This section covers the Feasibility Study of Section 6 (Kayuagung - Menggala about 180 km road length) which was selected in the Pre-Feasibility Study Stage. The route map and related network map are shown in Fig. 9.1 and Fig. 9.2 respectively.

9.2 Investigation of the Natural Conditions

In order to obtain more detailed field information for the Feasibility Study, field survey, soils investigation and environment investigations were performed. For a detailed description of the Environment Impact Study, refer to Chapter 10.

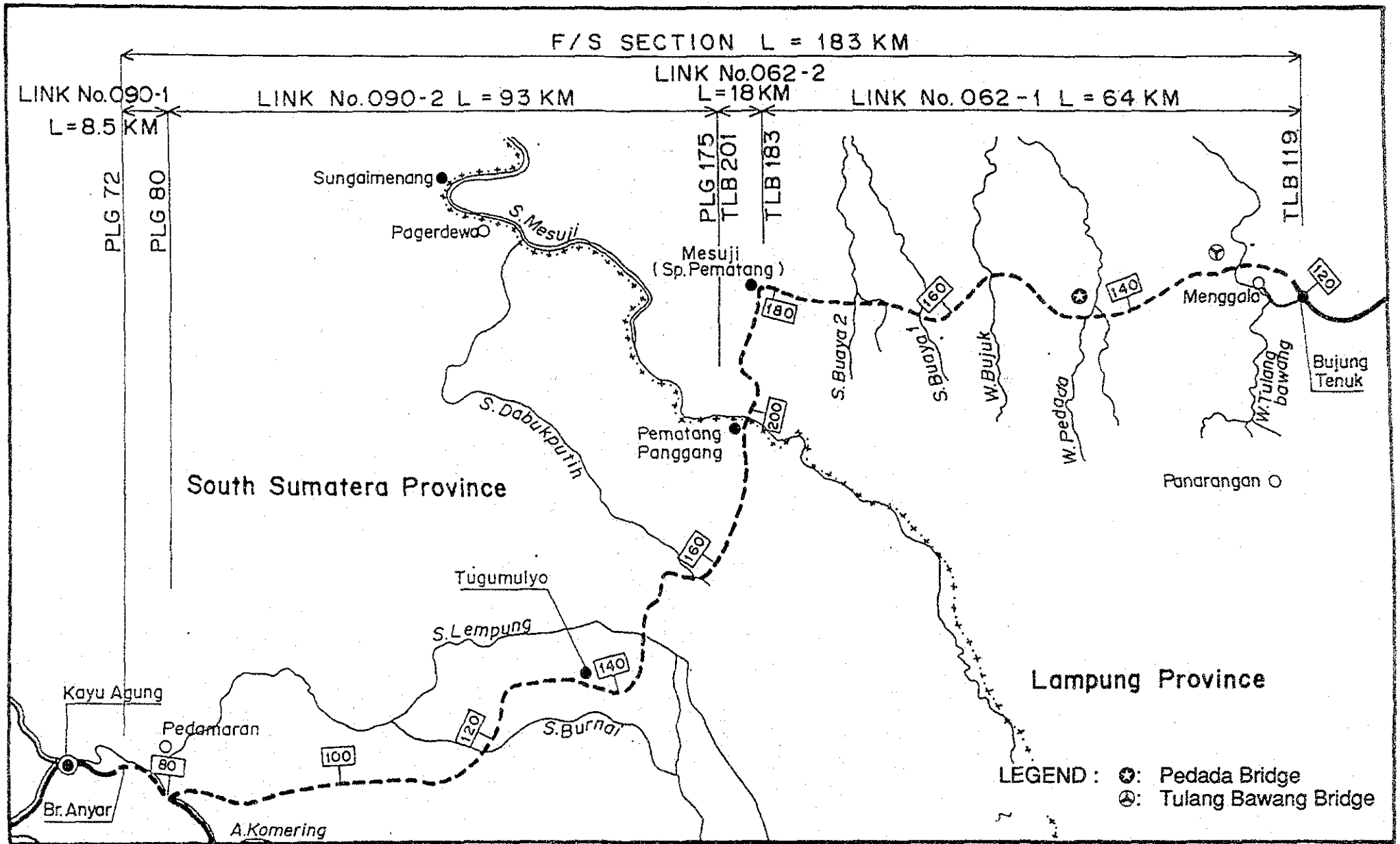
9.2.1 Field Survey

Field surveys of the roads were conducted as described in Table 9.1. The field survey was implemented during May to July in 1992 by P.T. Wira Nusantara Bumi (Bandung) under supervision of the Study Team.

Table 9.1 Description of Field Survey

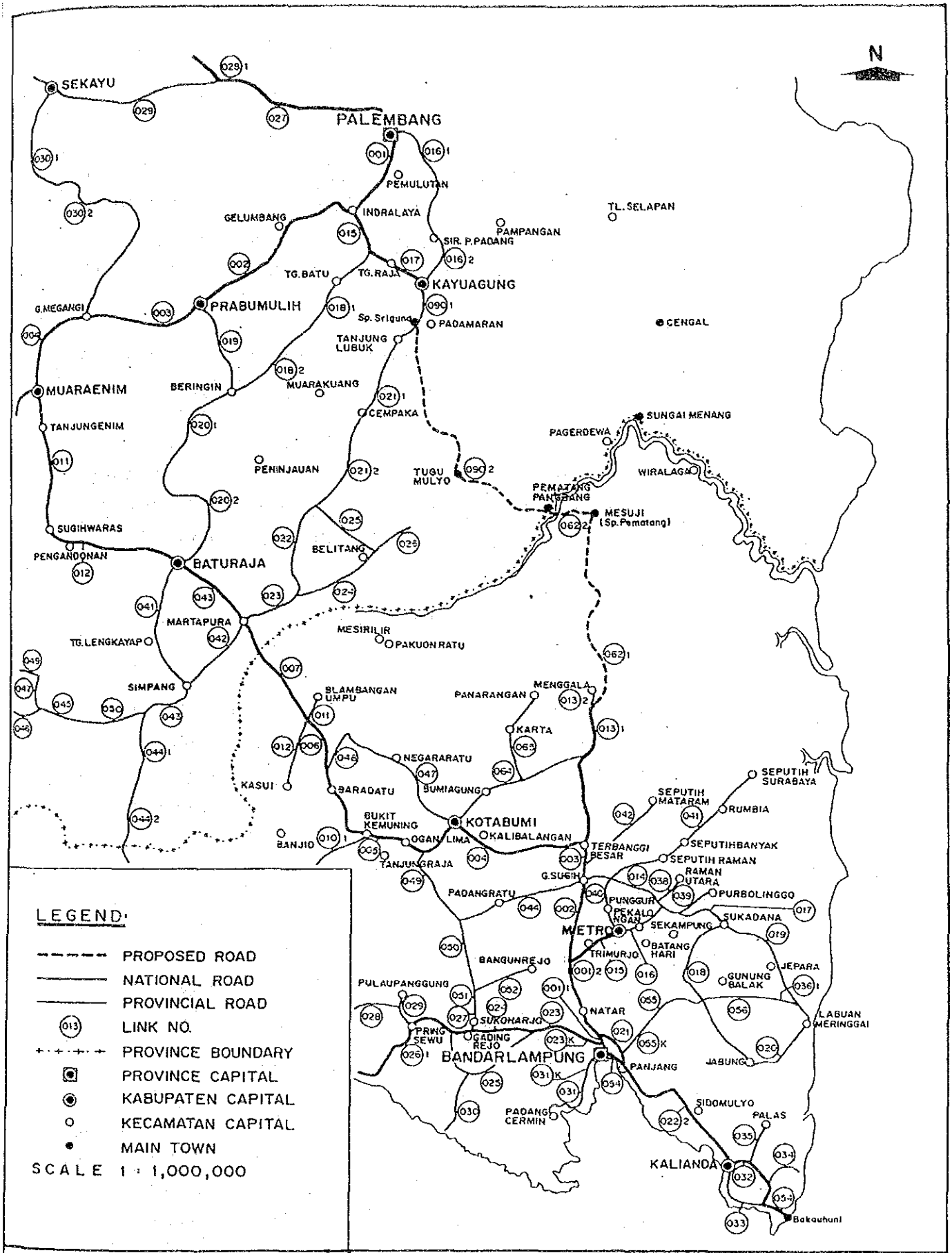
Survey Type	Scale	Remarks
Profile Leveling (Road Way)	H = 1/5,000, V = 1/500	
Profile Leveling (Road Site)	H = 1/500, V = 1/50	
Cross Sections	H = 1/100, V = 1/100	
Topographic Map	1/500	1 m contours

The elevation reference was T3434 (Elv. = 21.8 m), a triangulation point located about 20 km south from Sp. Sriguna. The allowable accuracy of leveling is grade "C" specified in the JICA Field Survey Standard.



COASTAL ROADS IN EAST COAST OF SUMATERA

Fig. 9.1 Route Map



COASTAL ROADS IN EAST COAST OF SUMATERA

Fig. 9.2 Road Network in Project Area

9.2.2 Soils and Materials Investigation

(1) Introduction

The objective of the geological investigation is to provide information and data for earthwork, pavement, structures and other designs for the feasibility study of the project road. Machine boring, standard penetration tests, samplings, laboratory tests, etc. were carried out in parallel with a materials survey of borrow pit materials.

The survey was carried out for whole of the length of the Menggala - Kayuagung Project road, from June to July 1992. Local consulting firm, PT. Wira Nusantara Bumi undertook the works.

Machine boring was conducted for a total of 63 holes (1,634.78 m) with 771 standard penetration tests carried out. A materials survey was implemented at 15 locations. The samples taken from these surveys were tested by PT Wira Nusantara Bumi at their laboratories in Bandung.

Summary of Field Works and Laboratory Works

Field Works

1.	Machine Boring (63 location)	1,634.78 meters
2.	Standard Penetration Test	771 each
3.	Undisturbed Sampling	59 each
4.	Test Pits/Sampling	15/30 each

Laboratory Works

1.	Machine Boring:	
	- Classification Test	
	• From Thin Walled Tube Sampler	59 test
	• From Split-spoon Sampler	145 test
	- Unconfined Compressive Test	54 test
	- UU Triaxial Compressive Test	59 test
	- Consolidation Test	57 test
2.	Test Pits:	
	- Classification Test	30 test
	- Compaction Test	30 test
	- Laboratory CBR Test	30 test

(2) Stratigraphy

1) General

The geology of southern Sumatra consist of sedimentary and igneous rocks of the Paleozoic, Mesozoic and Cenozoic age. Sedimentary rocks of the Tertiary age are extensively distributed in the east and west of southern Sumatra. Igneous rocks of Cretaceous, Tertiary and Quaternary age are widely distributed in central and southern Sumatra.

Alluvium deposits of the Quaternary age are widely distributed in the eastern coastal plane. These are illustrated in a simplified geological map (Fig. 9.3) and are tabulated below.

Explanation of Sedimentary and Igneous Rocks

Geological time			Formation		Description
Cenozoic	Quaternary	Holocene	Alluvium	(Qa)	Gravel, sand, silt and clay
			Swamp	(Qc)	Mud, silt and sand
		Pleistocene	Kasai	(QTK)	Pumiceous tuff, sandy tuff and tuffaceous sandstone
	Tertiary	Pliocene	Muaraenim	(TmPm)	Tuffaceous claystone, siltstone and sandstone with coal intercalations
		Miocene	Airbenakat	(Tma)	Alternation of claystone, shale and siltstone, mostly calcareous and carbonaceous
			Gumai	(Tmg)	Claystone, shale in some places calcareous with limestone intercalation
		Oligocene	Talangakar	(Tomt)	Calcareous very coarse to fine-grained sandstones, siltstone and claystone, with shale
Palaeozoic	Permian		Limestone	(pl)	Clastic limestone, recrystallized, foraminifera and algae
		Igneous rocks			
Cenozoic	Quaternary	Holocene	Young volcanics	(Qhv)	Andesitic volcanic breccia, lava and tuff
		Pleistocene	Pasumah	(Qpv)	Rhyolitic lava and tuff
			Panau	(Qrv)	Dicitic to ghyolite tuffs
			Andesite	(Qpva)	Andesitic rocks in the form of dykes
Mesozoic	Cretaceous		Quartz diorite	(kdi)	Diorite, fine to medium grained, slightly altered