Final Report
for
The Master Plan Study of Public Transport System
in
Negara Brunei Darussalam
(Summary Report)

June, 1985

Japan International Cooperation Agency

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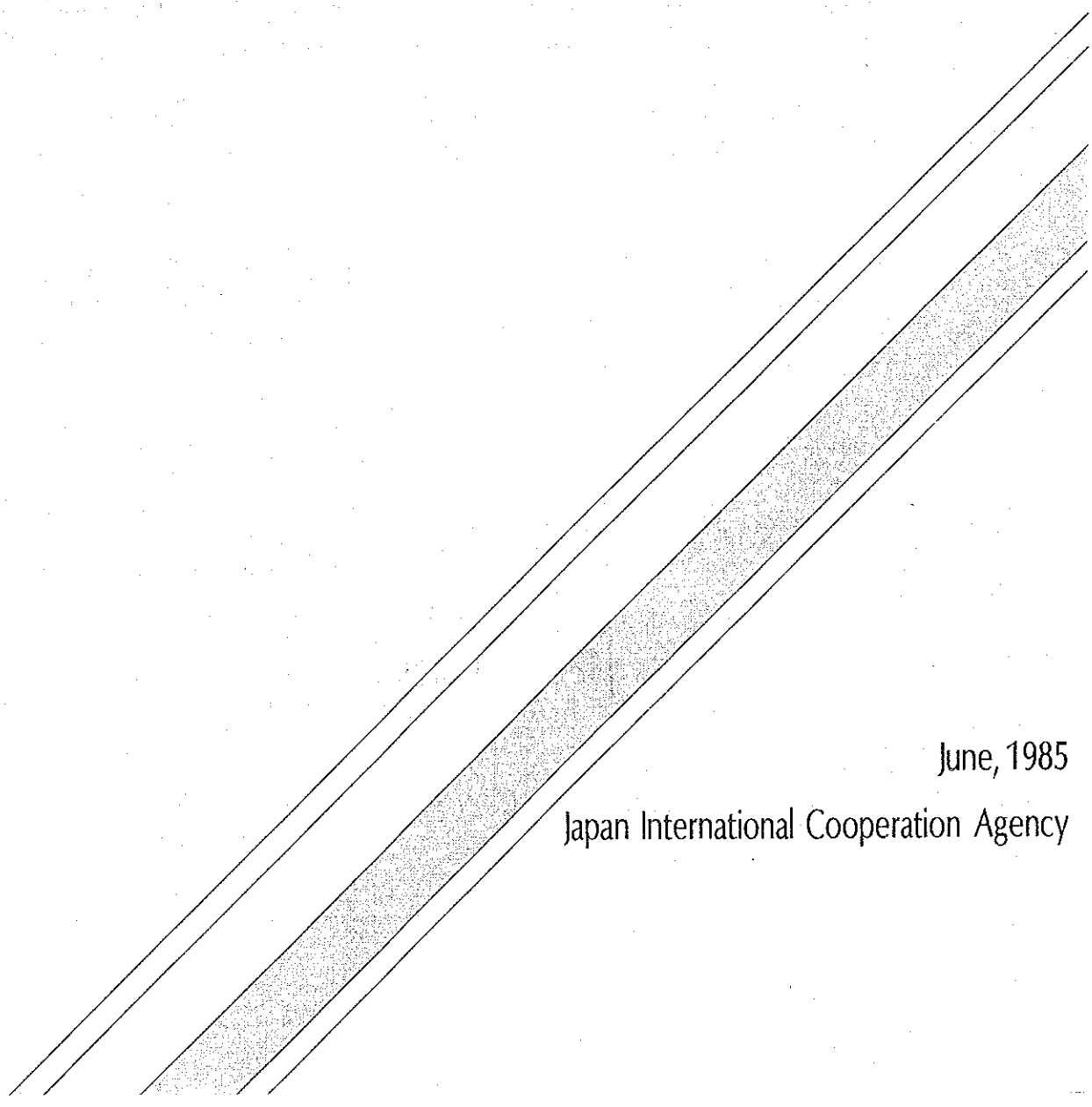

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PREFACE

In response to the request of the Government of Negara Brunei Darussalam, the Government of Japan decided to conduct a study on the master plan of the public transport system improvement project in Negara Brunei Darussalam and entrusted it to the Japan International Cooperation Agency (JICA).

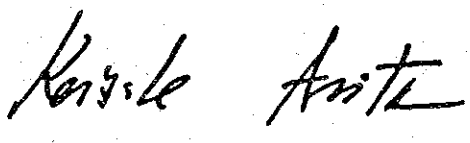
The JICA sent to Brunei a survey team headed by Mr. Hirokazu Ito from August 6 throuch October 13, 1984.

The team exchanged views with the officials concerned of the Government of Brunei on the project and conducted a field survey in the region involved. After the team returned to Japan, further studies were made and the present report has been prepared.

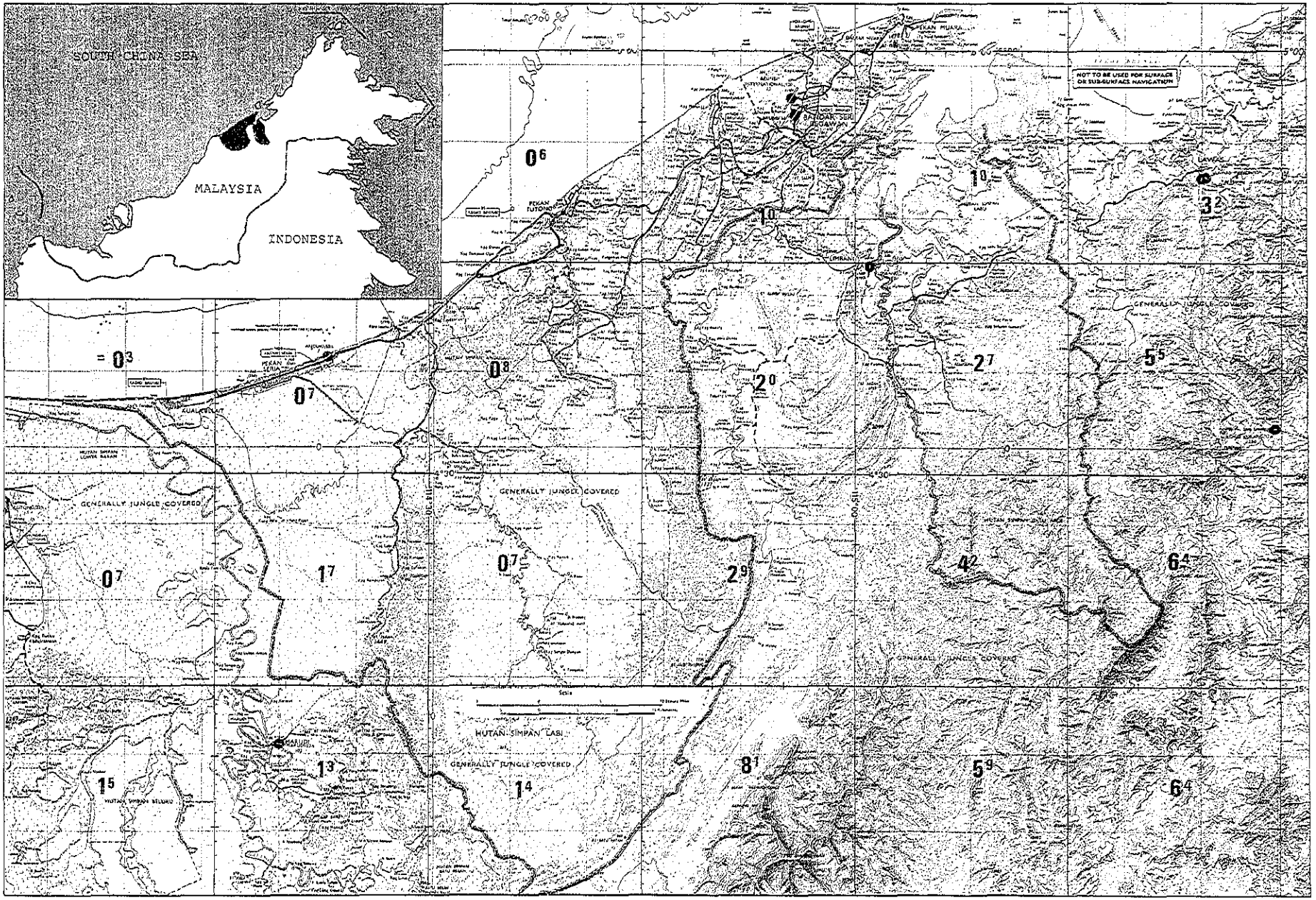
I hope that this report will serve for the development of the project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of Negara Brunei Darussalam for their close co-operation extended to the team.

June, 1985



Keisuke Arita
President
Japan International Cooperation Agency



PUBLIC TRANSPORT STUDY AREA

CONTENTS

CHAPTER 5 TRAFFIC DEMAND ESTIMATION

CHAPTER 6 PRELIMINARY DESIGN AND COST ESTIMATION

CHAPTER 7 EVALUATION OF ALTERNATIVE PLANS

CHAPTER 8 RECOMMENDATIONS

Abbreviation

B.S.B.	:	Bandar Seri Begawan
K.B.	:	Kuala Betait
O.D.	:	Origin-Destination
hrs.	:	hours
Km/h	:	Kilometers per hour
B$	:	Brunei Dollar
Kg.	:	Kampung = Village
Jln.	:	Jalan = Road
Sg.	:	Sungai = River
GDP	:	Gross Domestic Products
LTD	:	Land Transport Department
EPU	:	Economic Planning Unit
TCPD	:	Town and Country Planning Department
PWD	:	Public Works Department
HDD	:	Housing Development Department
EDB	:	Economic Development Board
Alt.	:	Alternative
F/S	:	Feasibility Study
D/D	:	Detailed Design
SV	:	Supervision
B/C	:	Benefit/Cost Ratio
NPV	:	Net Present Value
EIRR	:	Economic Internal Rate of Return
FIRR	:	Financial Internal Rate of Return
NDP	:	National Development Plan

Currency Equivalent

Currency Unit = Brunei Dollar

US$ 1.00 = B$ 2.09

B$ 1.00 = US$ 0.48

System of Weights and Measures: Metric

1 meter (m) = 3.28 feet (ft)

1 square meter (m^2) = 10.76 square feet (ft^2)

1 cubic meter (m^3) = 35.29 cubic feet (ft^3)

1 kilometer (km) = 0.62 mile

1 square kilometer (km^2) = 0.39 square mile

1 hectare (ha) = 2.47 acres

1 metric ton = 2.204 pounds

1 gallon = 4.55 liter

In all figures decimal point is indicated with a dot and thousand, million and billion are marked off with a comma.

CHAPTER 1 INTRODUCTION

1-1 Background and Outline of the Study

The country of Brunei Darussalam as an oil producing country being endowed with the ample natural underground resources has, in recent years, achieved the remarkable increase in its economic growth, rapidly increased the national income, and become an economically rich country.

This economic richness of the country has resulted in the occurrence of a wide-spread of private cars which is accompanied by delay in development of the public transport sector of the country. As a result, traffic congestion of high density has been brought forward in the capital city of Bander Seri Begawan and is making it increasingly difficult to ameliorate socio-economic activities. Moreover, it is predicted to cause a future shortage of the public transport capacity to even between the metropolitan area and satellite cities.

In order to solve the above problems, the Government of Brunei Darussalam requested the Government of Japan to provide technical assistance for the formulation of a master plan for the public transport system through particularly improvement of bus transport.

In response to the request made by the Government of Brunei Darussalam, the Government of Japan dispatched a 15-member survey team through the Japan International Cooperation Agency during August - October, 1984 in order to conduct the master plan study.

The master plan was worked out by the team with the view of making free from the confronting traffic congestion and of ameliorating the public transport service in close cooperation with a counterpart team organized by the Government of Brunei Darussalam.

1-2 Objective of the Study

The objective of the Study is:

To prepare a Master Plan for the improvement and an intermediate programme of the Public Transport System within the Study area, taking into account existing plans, programme and transport policy where no restrictive policy is established to use and own a car at present by the government. The main target year of the Study is the year 1995 A.D. The objective area of the investigation shall be major cities in Brunei and trunk lines connecting these cities.

The study shall be divided into two phases. In the first phases, we conduct field investigation including Brunei's urbanization plan, land use situation, public transportation network and traffic situation and traffic demand, and evaluate the current public transportation system plan, prepare an approximate design of the system and calculate the cost, and review the traffic control methods and traffic regulations.

1-3 Investigation Area

The whole country shall be the study objective on the subjects of current indices of the population, economic frame and traffic demand and on the estimation of future indices. However, on such concrete subjects as public transportation improvement plan and plan for the related facilities, road facility plan, the objective shall be limited to the areas of comparatively densely populated.

In other words, while the overall study objective area is the country of Brunei, the project areas for the plans of concrete facilities shall be urban areas like B.S.B. and its outskirts, Muara, Tutong Seria, and Kuala Belait and trunk roads connecting these cities.

1-4 Traffic Zones

To analyze public traffic, four administrative districts and one metropolis were divided into 24 zones, considering land use, network of local facilities, and topography. The following table indicates the codes of these zones.

Table 1-1 Zone Code Table

District Code	District	Zone Code	Name
10	B.S.B.	11	Pusat Bandar
		12	Kianggeh
		13	Tasek
		14	Kumbang Pasang
		15	Jalan Tutong
		16	Kampong Air (1)
		17	Kampong Air (2)
20, 30	Brunei-Muara District	21	Kota Batu
		22	Berakas (1)
		23	Berakas (2)
		24	Berakas (3)
		25	Gadong (1)
		26	Gadong (2)
		27	Kilanas
		28	Sengkurong
		29	Pengkalan Batu
		30	Lumapas
		31	Mentiri, Serasa
40	Belait District	41	Kuala Belait
		42	Seria
		43	Labi
50	Tutong District	51	Tutong
		52	Lamunin
60	Temburong	61	Temburong

The following is the zone map of: (1) Brunei, (2) Brunei-Muara District, (3) B.S.B.

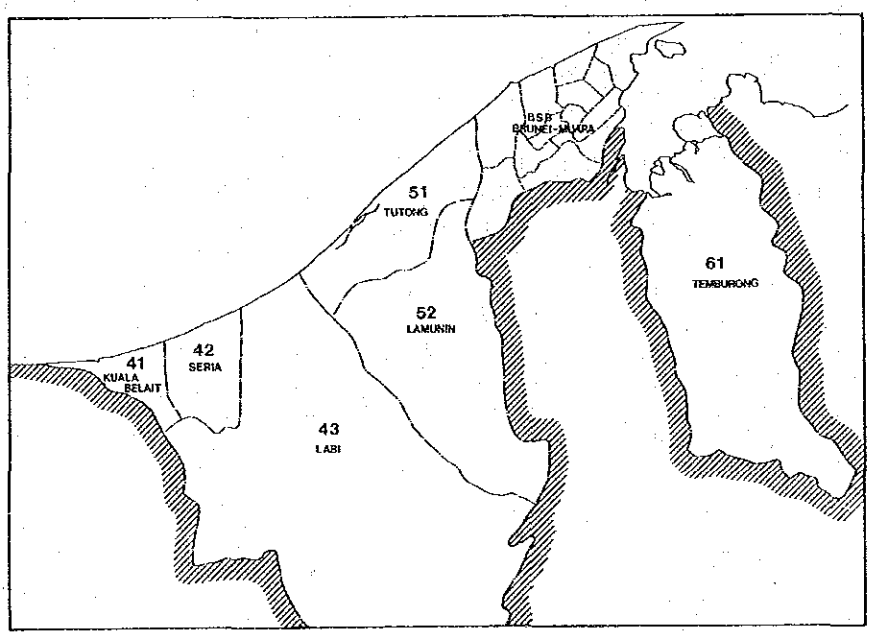


Fig. 1-2 Zone Map (1) – Brunei

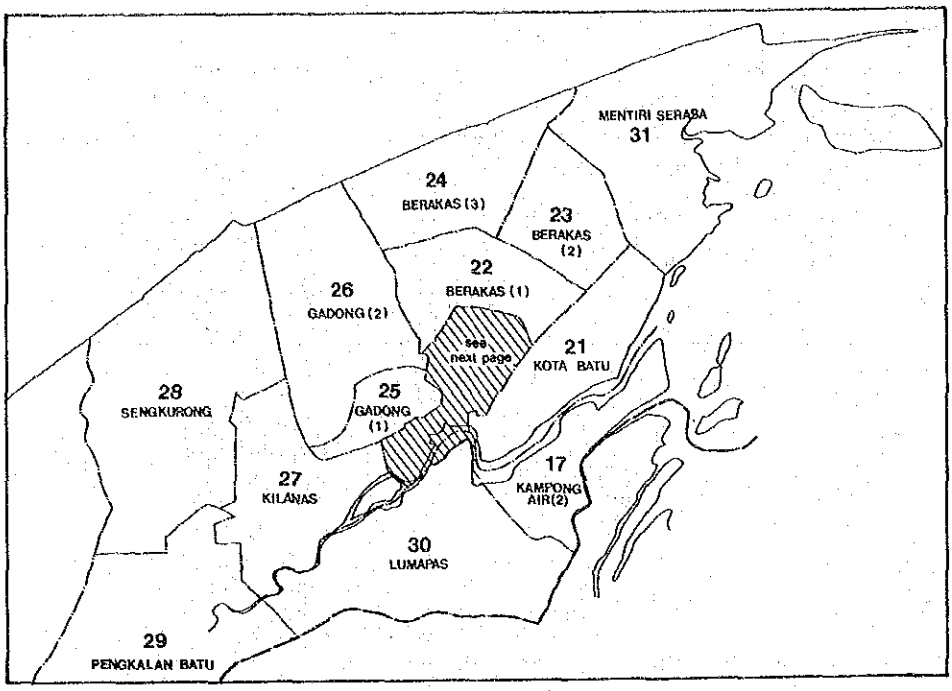


Fig. 1-3 Zone Map (2) – Brunei-Muara District

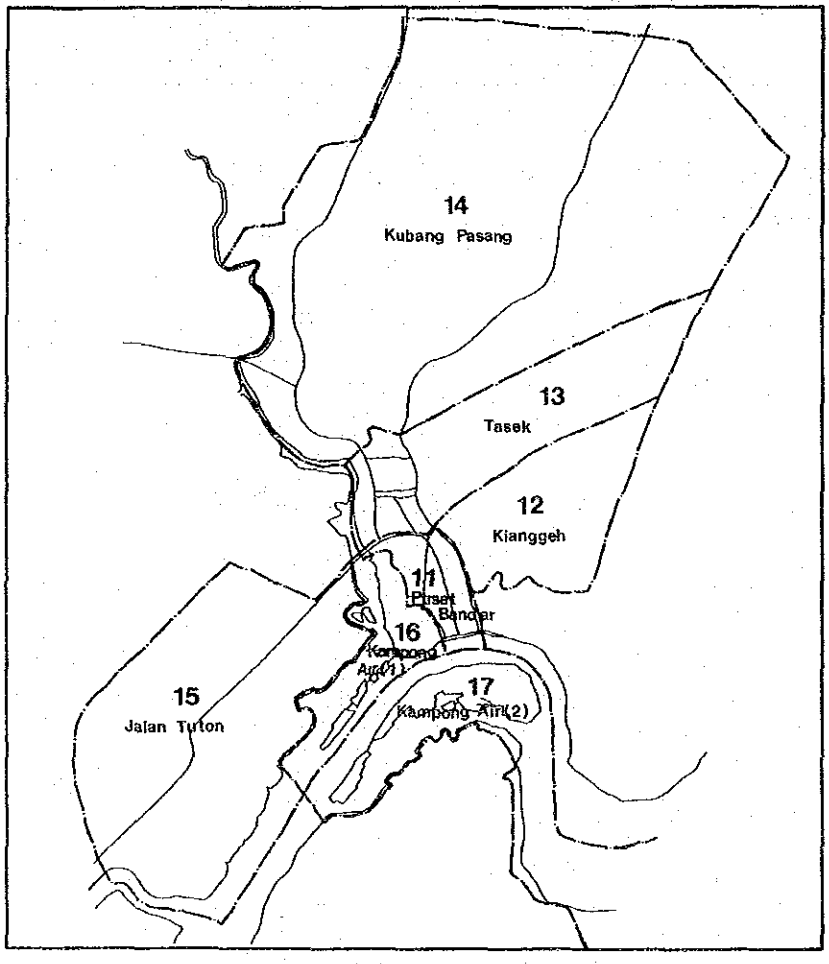


Fig. 1-4 Zone Map (3) – B.S.B.

CHAPTER 2 PRESENT LAND TRANSPORT SYSTEM

2-1 Traffic Survey Points

The traffic survey of eight categories has operated, as follows:

(1) Bus passenger survey
(2) Road-side O.D. survey
(3) 12 hour traffic count survey
(4) 24 hour traffic count survey
(5) One week traffic count survey
(6) Traffic count at the intersection
(7) Actual survey in parking areas
(8) Bus floating survey

The above surveys were conducted nation-wide for half a month. The traffic volume learned in the surveys are shown in the following figure.

Interviews were made at ten selected points which were made up of four points on radial routes crossing the cordon line around urban areas of B.S.B.

According to these road patterns, the traffic volume tends to increase toward the center of B.S.B. As a result, the road capacity in and around the center of B.S.B. has been almost reached.

Fig. 3-3 Traffic Volume (1) Aug./1984

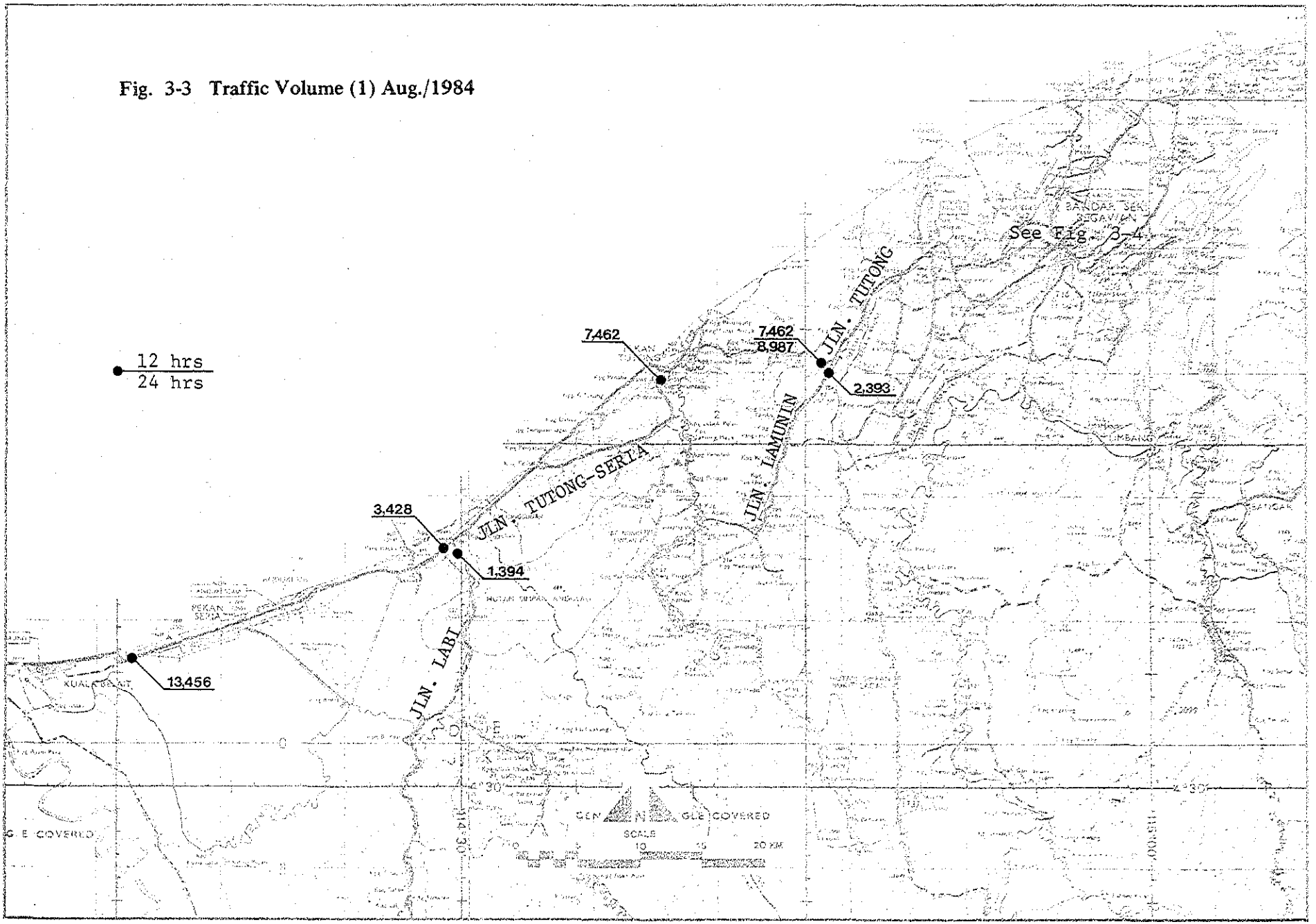
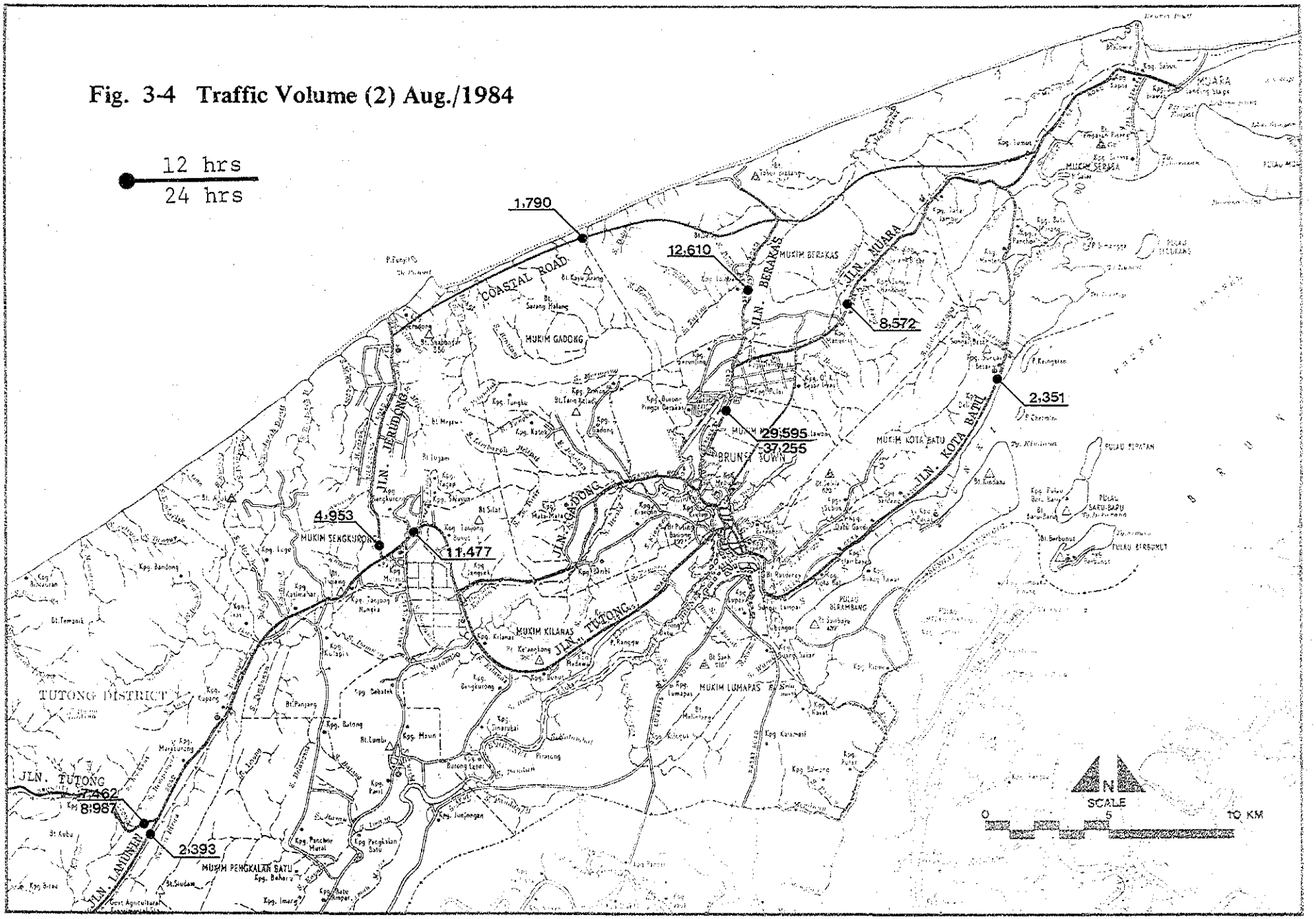


Fig. 3-4 Traffic Volume (2) Aug./1984



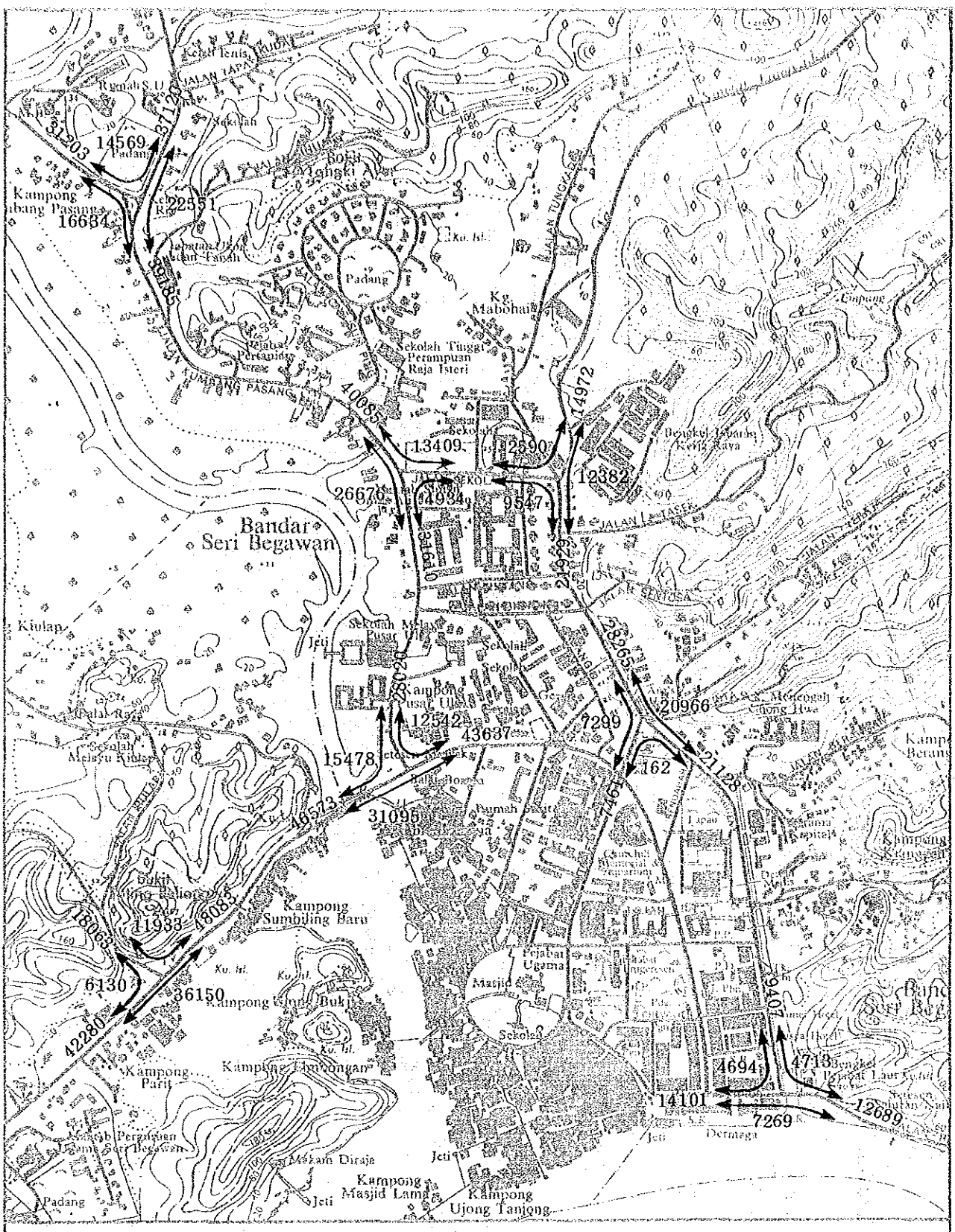


Fig. 3-26 Traffic Volume (3) Aug./1984 (12-hour)

2-2 Traffic Distribution by Modes

The desired line among zones by three modes of bus, passenger car and goods vehicle is shown in Fig. 3-9. In the case of any modes, connection between B.S.B. and each zone is strong. Especially in bus traffic, this phenomenon is remarkable and interflow of traffic between zones except B.S.B. is found little.

In passenger car and goods vehicle traffics, interflow of traffic among three zones of B.S.B., Berakas and Gadong is larger than that among other zones.

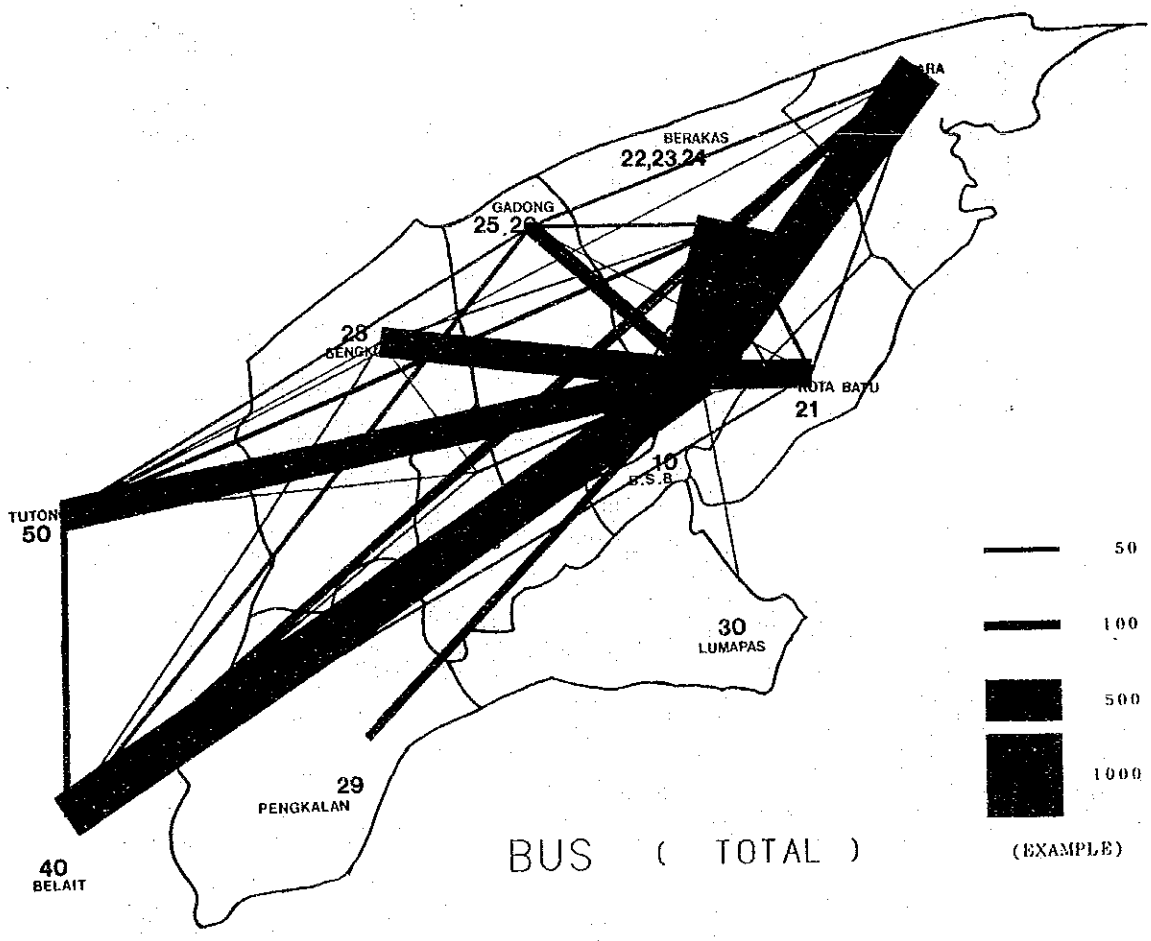
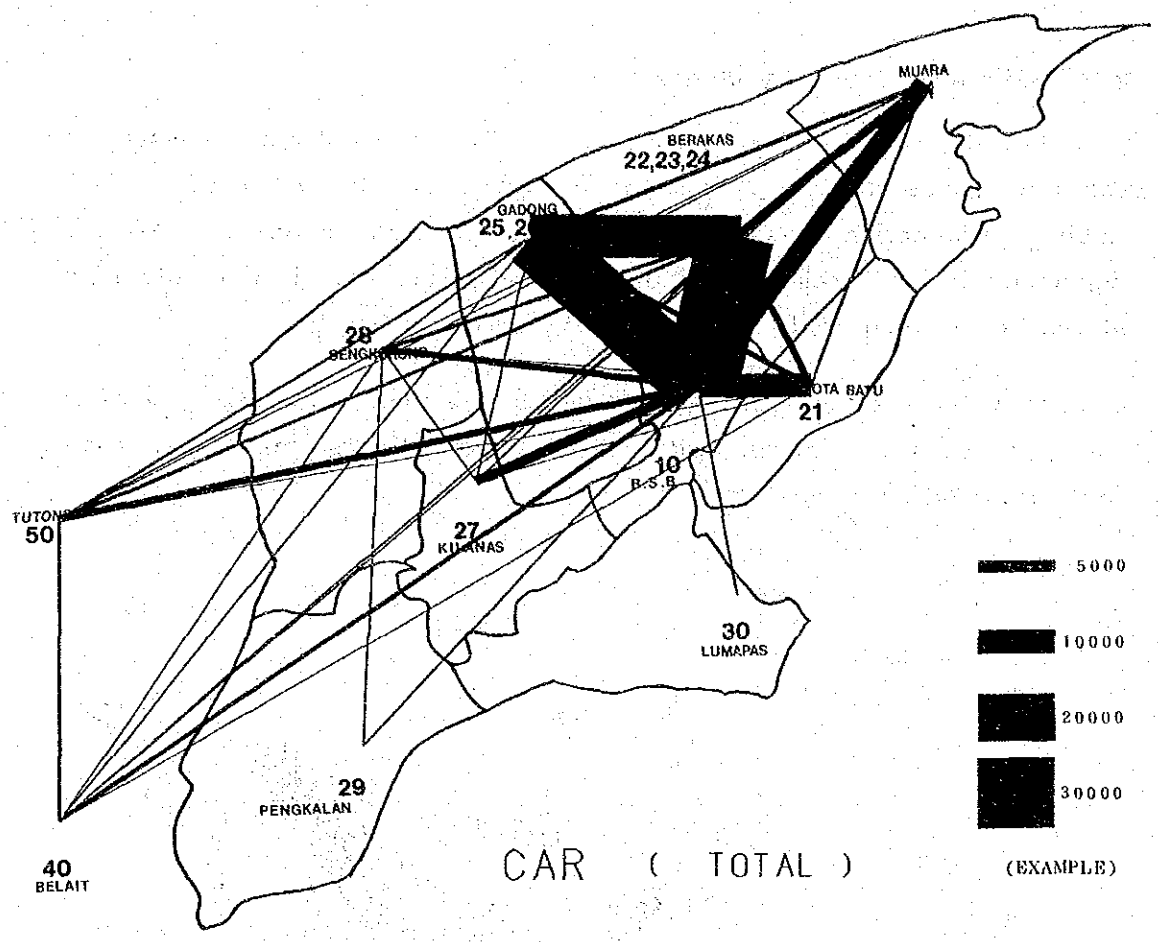


Fig. 3-9 Present Desired Route Line by Traffic Modes


MUARA
BERAKAS
22,23,24
GADONG
25,26
28
SENGKONG
OTA BATU
21
10
B.S.B
TUTONG
50
27
KUANAS
30
LUMAPAS
29
PENGKALAN
40
BELAIT
5000
10000
20000
30000
CAR (TOTAL)
(EXAMPLE)

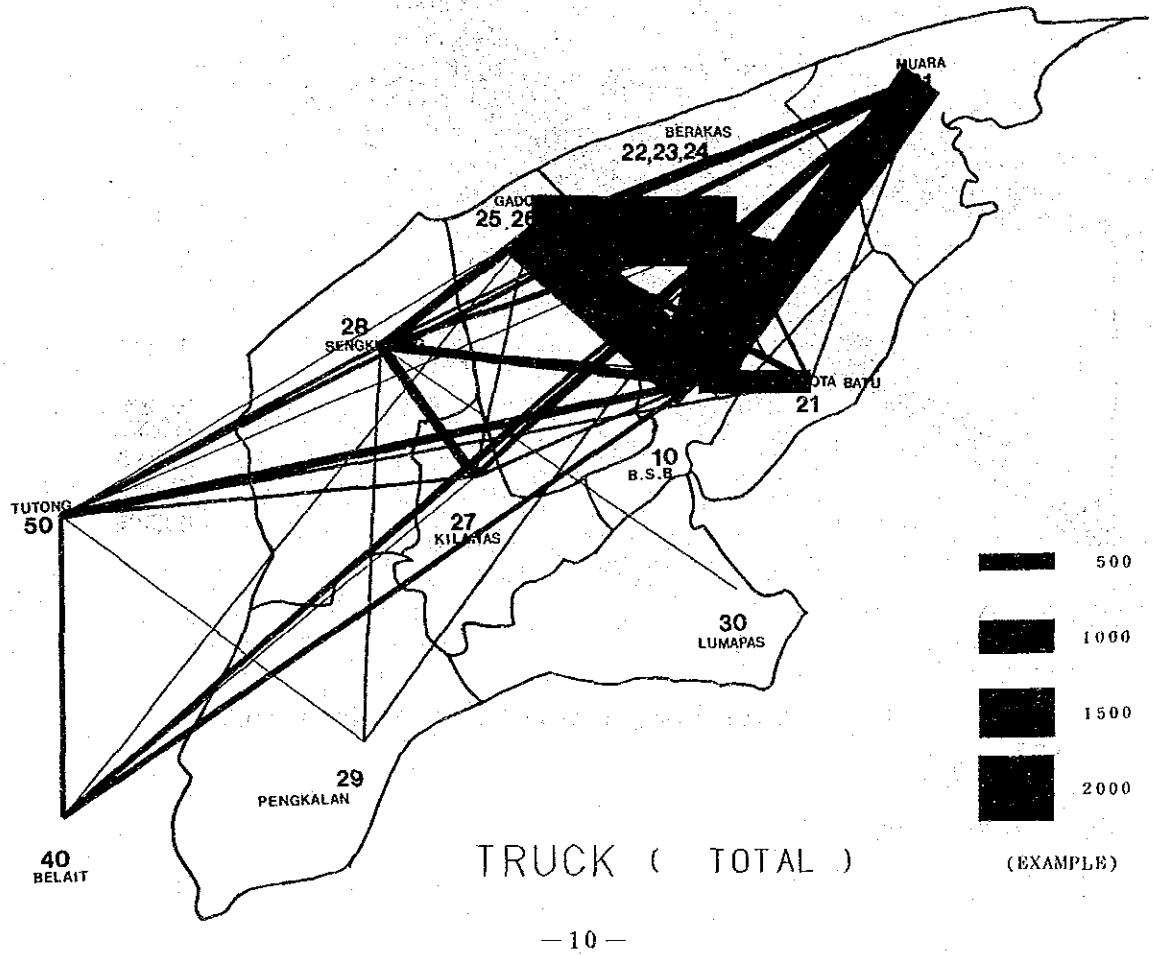

MUARA
BERAKAS
22,23,24
28
OTA BATU
21
10
B.S.B
TUTONG
50
27
30
LUMAPAS
29
PENGKALAN
40
BELAIT
500
1000
1500
2000
TRUCK (TOTAL)
(EXAMPLE)

Table 3-7 shows the results of consciousness survey about the bus services to car users carried out at the same with the road-side OD survey. One of the reasons why car users do not choose bus services is that the trip by bus takes too much times, and this answer is given most. As for what should be improved for bus services, "regular operation" is required. If the above problems are settled, 54% of the answerers told that they would utilize buses more.

Table 3-7 Results of Bus Operation Improvement Consciousness Survey to Car Users

Question	Answer		
Why didn't you choose bus services for your trip?	1. Bus fare is expensive	442	5.6%
	2. Too much travel time	2,302	29.2
	3. Crowded	1,219	15.5
	4. Frequency is to dense	777	9.9
	5. Operating schedule is irregular	1,185	15.0
	No-answer	1,956	24.8
	Total	7,877	100.0
What kind of improvement of bus services do you want?	1. Low fare	1,079	13.7
	2. To increase bus frequency	1,263	16.0
	3. Comfortable bus services	1,366	17.3
	4. To keep a regular operating schedule	1,904	24.2
	5. To speed-up bus running	425	5.4
	No answer	1,840	23.4
	Total	7,877	100.0
If passengers are provided with improved bus services, will you prefer bus for your trip?	1. Yes	4,257	54.0
	2. No	2,023	25.7
	No answer	1,597	20.3
	Total	7,877	100.0

Table 3-8 shows the results of consciousness survey about the bus service to bus passengers. The most reason why bus passengers utilize buses is that they do not own their cars and 60% of answerers answered so. The next most is that they do not have drivers' licenses. About 80% of the answerers use buses by the above reasons.

Table 3-8 Results of Bus Improvement Consciousness Survey to Bus Passengers

Question	Answer		
Why did you choose bus services for your trip?	1. Bus fare is cheeper than car	61	5.8%
	2. Bus services are better than car	172	16.3
	3. I have no car	624	59.4
	4. I have no driver license	183	17.4
	No answer	10	1.0
	Total	1,050	100.0
What kind of improvement of bus services do you want	1. Low fare	212	20.2
	2. To increase bus-frequency	120	11.4
	3. Comfortable bus services	362	34.5
	4. To keep a regular operating schedule	285	27.1
	5. To speed-up bus running	57	5.4
	No answer	14	1.3
	Total	1,050	100.0
If passengers are provided with improved bus services, will you take bus more often than present?	1. Yes	973	92.7
	2. No	62	5.9
	No answer	15	1.4
	Total	1,050	100.0

2-3 Publi Buses

(1) Operation

In the object areas of the survey, 45 bus service companies operate public buses on 17 routes. 73 buses are registered as public buses, and the average number of buses owned by each company is 1.6.

The public bus routes in the object areas of survey are shown in Table 3-10 and Fig. 3-12. The highest service is made on the route between Seria and Kuala Belait, and 72 bus trips with average operation interval of 23 minutes are made a day.

The next highest is on the route between B.S. Begawan and Seria, 51 bus trips a day with 26 minutes interval, and next on the route between B.S. Begawan and Berakas, 32 trips a day with 37 minutes interval, the route between B.S. Begawan and Muara, 30 trips a day with 40 minutes interval and so on. These routes form a main bus route. The total average operation interval including main routes and branch routes is 48 minutes.

The features of operation are given as follows.

① Bus routes are not fixed and some routes are changed by the request of passengers. Buses stop anywhere users want. These services are made to meet the request of users but such irregular operation is inconvenient to those who take routine actions.

② Except some routes, no time table service is given even at the bus terminals.

③ Recently bus operation companies have talked over regular time operation at the bus terminals adjusted, but according to the present state investigation, regular operation is not still made completely.

Due to no checking of operating condition by the Government, they start buses when the number of passengers reaches to the capacity on the routes where some companies operate buses competitively, which is the reason of irregular operation.

④ However in B.S. Begawan Seria and Kuala Belait, bus terminals have been adjusted and regular time operation has been tried. As the result, it is reported that the number of bus users is increasing.

⑤ In Brunei, bus routes are constructed radially among cities and bus users move along the routes between B.S.B. and other cities. That is, passengers who are along the bus routes use buses when they go to the urban area of B.S.B. or to other cities only.

However when they go to other cities over B.S.B., they seldom use buses because of little information on bus routes, long interval of bus operations and inconvenient transfer, which makes car utilization increasing.

(2) Bus terminal, bus stop

a) Bus terminal

Bus terminals are at present distributed in three areas of B.S. Begawan, Seria and Kuala-Belait.

The bus terminal in B.S. Begawan is placed on the basement of the terminal building built in 1984, and provided with modern facilities adjusted for 20 berths and chairs for passengers. However as operation information such as time table and bus routes is not complete, these facilities may be inconvenient even if they are modern.

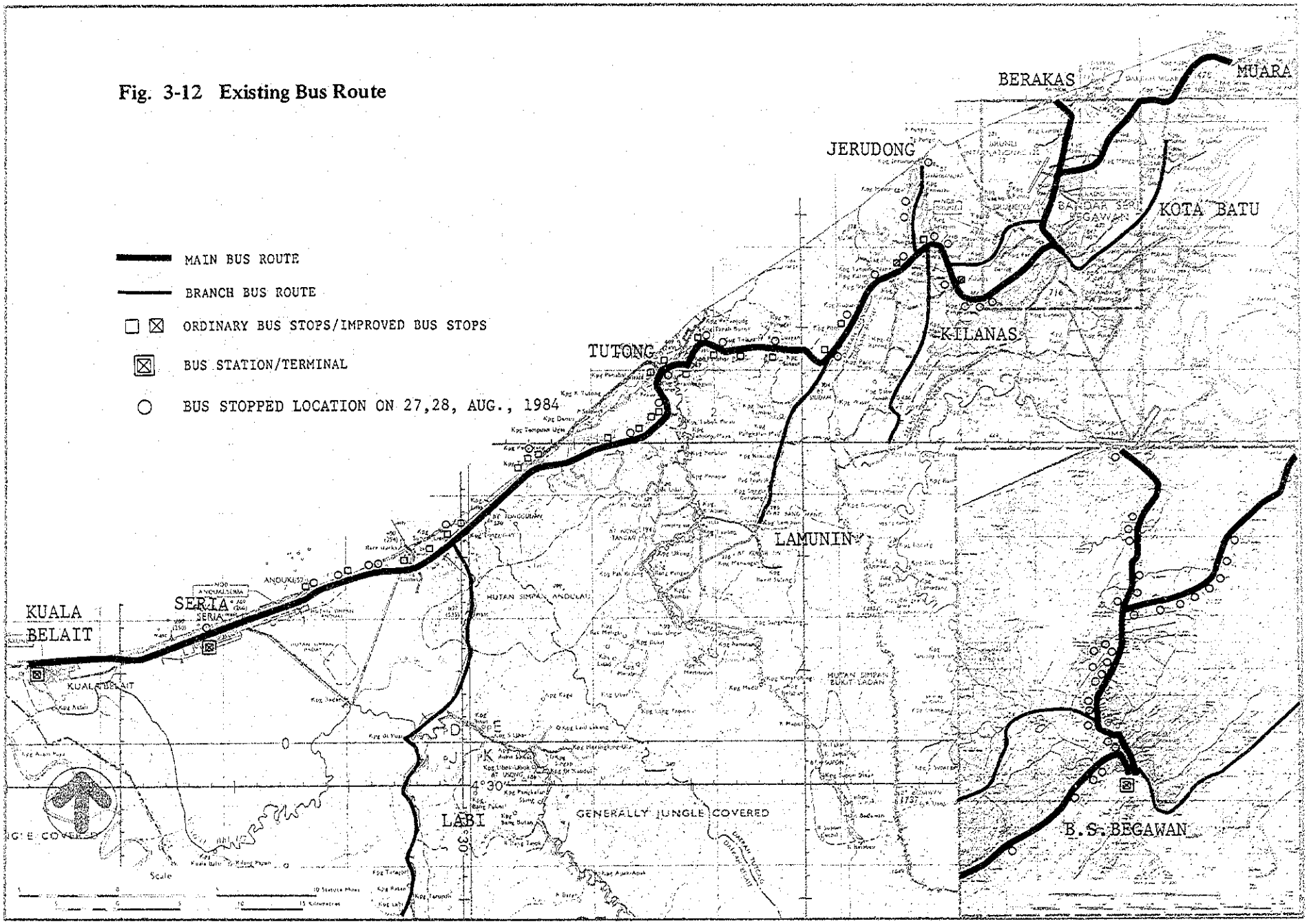
The bus terminal in Kuala Belait was constructed recently and is provided with modern facilities such as five berths waiting room for passengers, the offices of bus companies, and with information of time tables.

The bus terminal of Seria provided with 12 berths, waiting facilities for passengers and offices of bus companies is old. Time table of buses is provided, but it is necessary to adjust it for modern bus terminal.

Table 3-10 Existing Bus Route

No. of Route	Origin - Destination	No. of Companies	No. of Buses Registered	Operating Trips	Operating Hours	Average Departure	Average Trip Time	Distance	Trip Speed	Fare
						minutes	minutes	km	km/h	
1	B.S.B. - Gadong	1	1	12	8:26 - 16:27	85	-	6.4	30	$1/6.4 km
2	B.S.B. - Berakas	1	3	32	6:30 - 16:26	37	37	15	25	$1/15 km
3	B.S.B. - Muara	11	11	30	6:30 - 16:46	40	56	26	28	$2/26 km
4	B.S.B. - Kota Batu	1	1	24	7:36 - 18:00	50	17	10	35	$1/10 km
5	B.S.B. - Jerudong	1	1	10	7:40 - 17:50	142	42	25	36	-
6	B.S.B. - Limau Maris	1	2	8	7:44 - 16:48	136	45	32	43	$2/32 km
7	B.S.B. - Lamunin	4	4	2	6:47 - 9:27	-	57	45.4	48	$2/
8	B.S.B. - Tutong	1	1	-	-	-	-	-	-	-
9	B.S.B. - Seria	16	20	51	6:20 - 17:32	26	110	92.5	50	$4/92.5 km
10	B.S.B. - Hospital	-	-	16	6:33 - 17:50	80	4	2.0	30	$0.6/2 km
11	B.S.B. - Airport	1	2	30	6:25 - 17.05	52	20	9	28	$0.9/9 km
12	Sungai Kabum - Lumapas	1	1	-	-	-	-	-	-	-
13	Tutong - Tutong Camp	1	1	-	-	-	-	-	-	-
14	Seria - Kuala Belait	1	16	72	6:20 - 19:30	23	30	16	32	$1/16 km
15	Seria - Labi	3	3	20	-	60	46	40.3	53	-
16	Seria - Sungai Liang	2	2	-	-	-	20	20.3	60	-
17	Kuala Belait - Miri	1	4	12	7:30 - 15:00	90	-	-	-	-
	Total	47	73	319	-	48	-	339.9	-	-

Fig. 3-12 Existing Bus Route



b) Bus stop

Numerous simple bus stops are placed along bus routes at present. These bus stops have no bus bay, no sign as bus stop and no information such as time table.

To deal with such a condition, the Government is carrying out two projects in the 1979 - 1984 Five-Year Plan.

. Bus stop construction in Brunei District
. Bus stop construction in Kuala Belait

Some of bus routes are changed by the request of passengers, but most bus stops are used as shceduled. When the number of bus passengers is increased, improved bus stops will be required.

(3) Present state of bus service companies

In the survey to bus service businesses, 13 (29%) out of 45 service companies asked answered to questions.

According to the table, one service company owns average 3.6 buses. Comparing this with total average figures of 1.6, the above 13 companies have business scale twice or more as much as of the total average one.

The results of the survey are as follows.

The number of staff of a company is 10.6 and out of them, 1.6 persons belongs to the head office and 3.6 persons are engaged in driving.

The average operation a day is 12.2 trips, total average traveling length is 284.2 miles and 312 persons are carried. That is, 1 trip takes 23.3 miles and carries 25.6 persons.

The average income is 14,441 B$/month and earning rate is 149%.

2-4 School Bus

The Educational Transport Department of Brunei operates school bus for attending school of public school students (From Malay school to Junior/Senior college).

102 school buses are in service for students living in the areas 3 miles far or more from schools for 28 schools in three destricts in the morning and partially in the afternoon on two return trips. The total number of 28 schools is 17,174 and 32.6%, 5,595 out of them use school buses.

However when considering the ratio of students using school buses including students of private schools, it is 9.3% and considerable number of students use passenger cars.

2-5 Type of Bus

Buses are classified into 13 types from models before 1969 to those of 1983, and their capacity is changed from 4 to 52.

Model distribution of buses is given next. 29.4% are buses constructed after 1980 and 42.0% are those of 1975 - 1979. But 28.5% are those made 10 years ago.

If the present buses will be used in the future, models after 1980 will be main in services. These models are Isuzu, Nissan and Hino buses, 25.2% of the total. In case of settling the present problems on bus adjustment, standardization of types is required. Therefore, it is desirable to standardize buses to the above three types.

2-6 Taxi

The number of registered taxis in Brunei has been increased or decreased since 1965, but from 1979 to 1983, average number is 117.

Present taxis are not cruising only arranged in taxi pools of B.S.B., airport, main hotels and main towns only. Moreover, radio taxi service and taxi service by telephone are not provided. When taxi users get taxi, they must go to the taxi pool.

Thus, present condition of taxi services is poor and utilization of taxi by general people is very small. Taxi fare is generally higher, and foreign travelers use them.

2-7 Parking Condition

(1) Location and capacity of parking block

Parking blocks are made up by those provided on road side, toll open space parking lots provided on the site of off street and toll multistory parking building. The capacity of parking area is shown in Table 3-20 and the location is shown in Fig. 3-17.

Table 3-20 Parking Capacity in Central Area on B.S.B.

On Street and Off Street	Hourly	1,307 lots
	Season	165 lots
	Reserved	290 lots
Multi-storey Parking	Hourly	380 lots
	Season	106 lots
	Total	2,248 lots

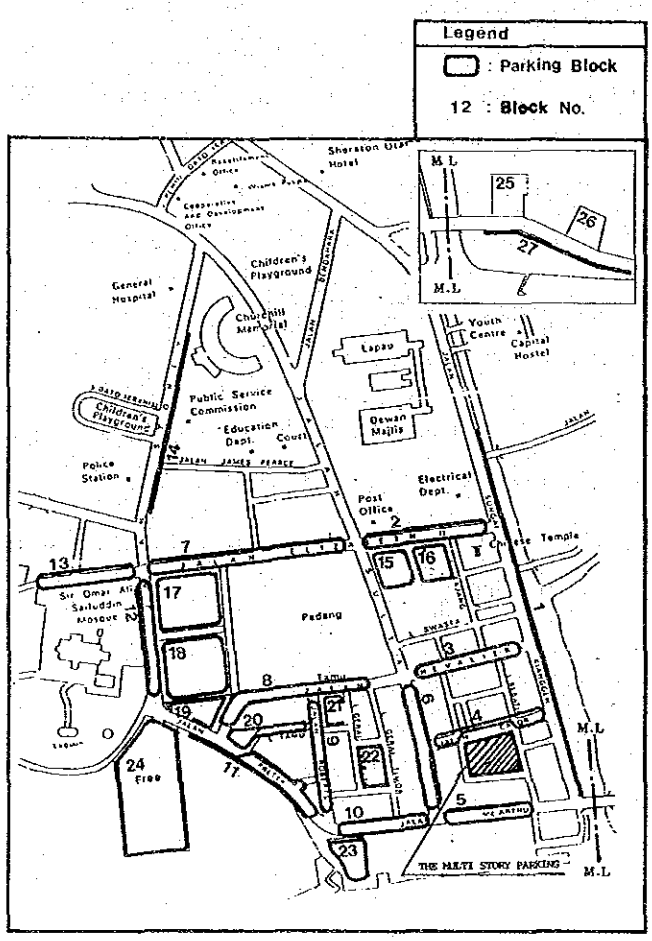


Fig. 3-17 Location of Public Parking Space – Central Area

The current situation and problems on car parking are as follows:

. The peak of parking in the whole central urban area is at 10:00 a.m. and 3:00 p.m., with a parking rate of 80% and 70%, respectively.

. The purposes of parking cars in the central urban area are business (including daily commutation to work site), shopping and miscellaneous, each sharing one third.

. As to the distance from the parking spot to the destination, close to 80% of the total are in distances of within 10-minute walk.

. The occupancy of parking spaces in the central area on B.S.B. is 80% in peak hour and in the central business area, it is 90% all day long. Then, double parking on streets due to the full parking of parking lots is seen, especially in Jln. Sultan (Block No. 6), Jln. McAothur (Block No. 5, 10) and Jln. Chevalier (Block No. 3), which disturbs road traffic. On the northern aspect road in Jln. Kianggeh, many vehicles are parking in spite of no parking space.

. At present, two parking area construction plans are executed in the central area.

  . Construction of a multi-storey parking area at the site of closed market in the central area

  . Construction of a ground parking area after reclaiming the river along Jln. Pretty

  The estimated number of cars that can be parked additionally in these new facilities is about 700.

(2) Traffic control

As the main traffic control means in the central areas, linked linear system of traffic signals will be provided from 1985.

17 intersections with traffic signals provided on the central areas are divided into 4 sub areas, and signals are operated at the interval of 90 - 120 seconds according to the day of the week and time zone systematically to prevent lowerness of traffic capacity by continuous intersections.

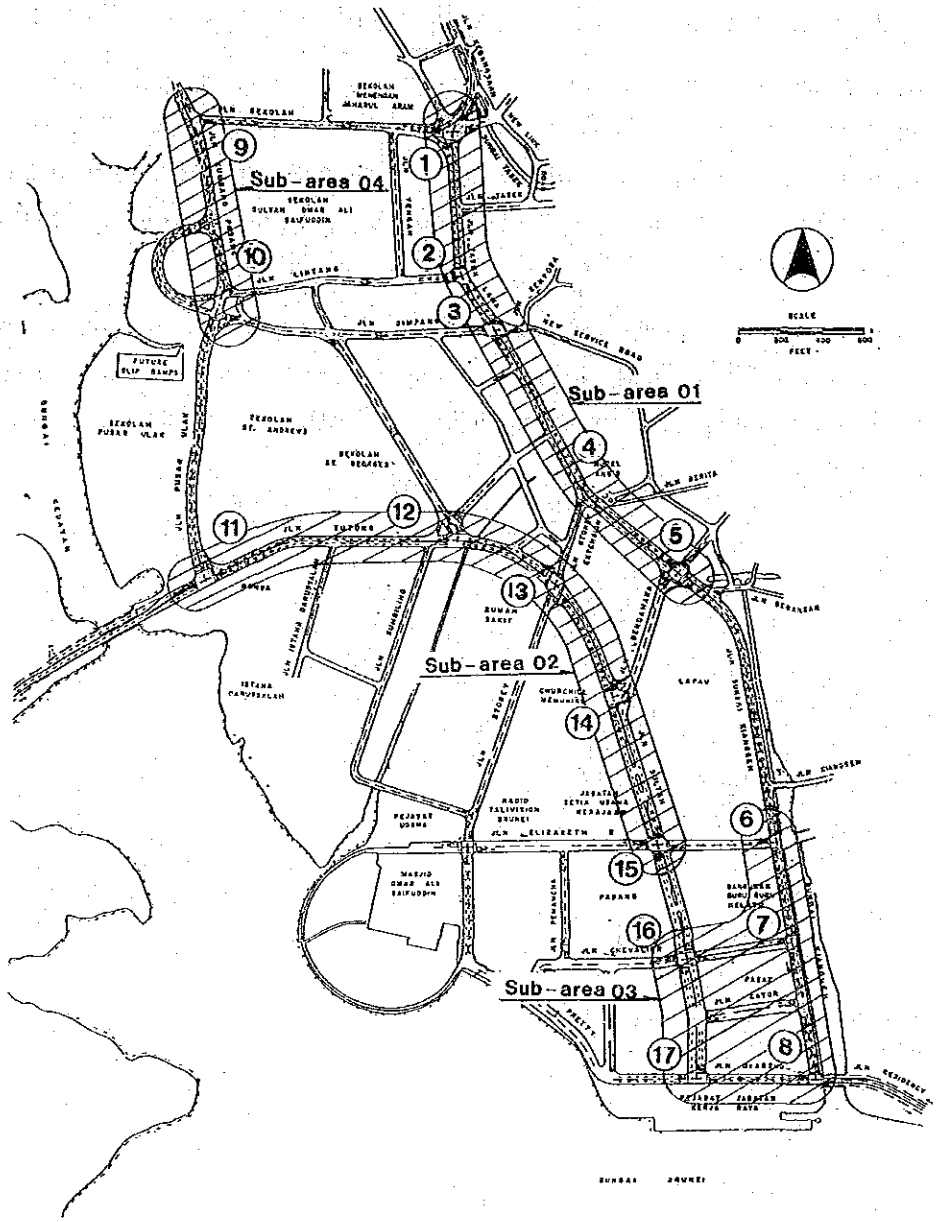


Fig. 3-22 Linked Linear System of Traffic Signal in B.S.B.

2-8 Evaluation of Present Traffic Network

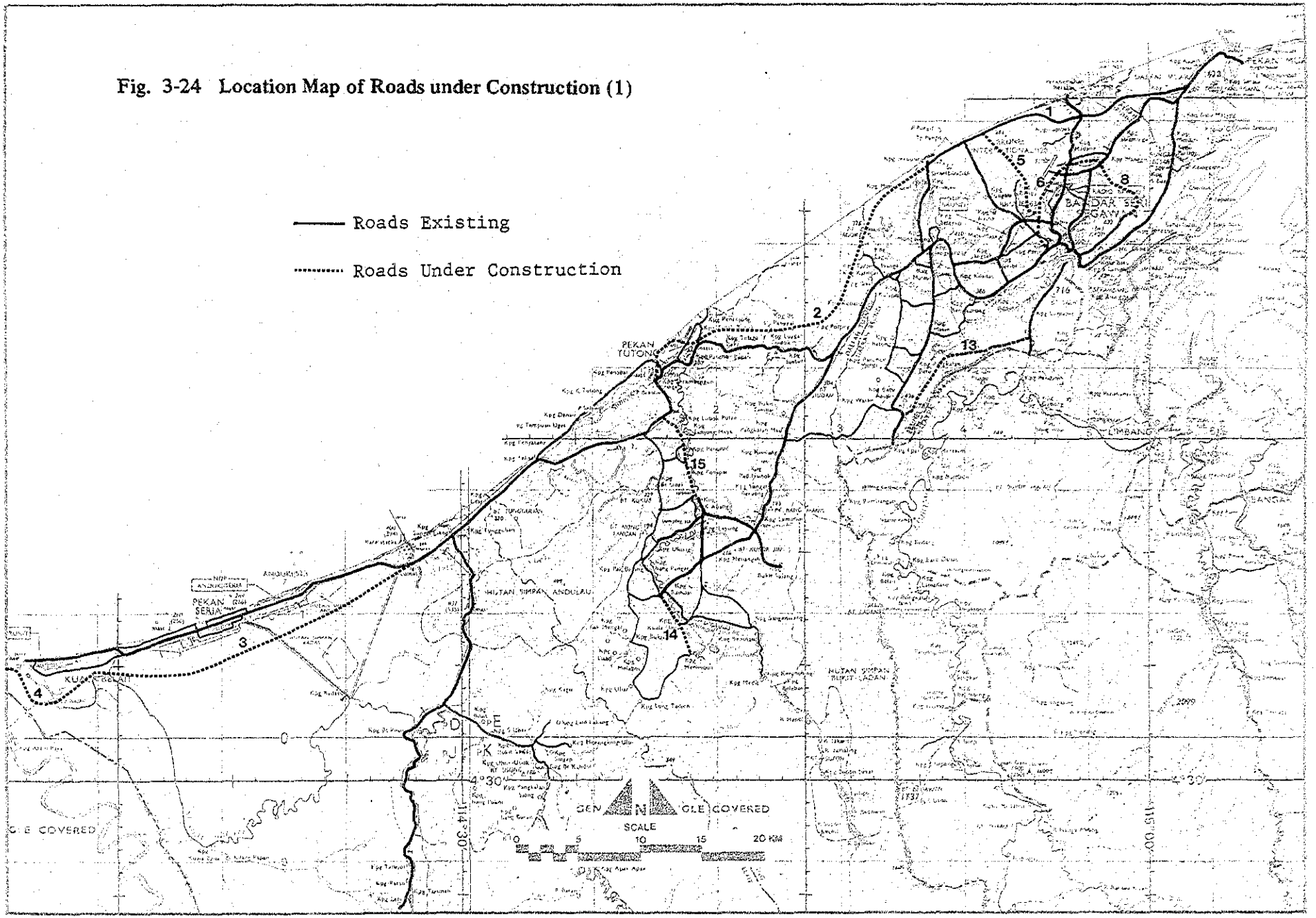
(1) Problems of present road network

To main problems are found in the present road network. One of the problems is the traffic jam at the entrances of urban area of B.S.B. in peak hours of morning, noon and evening, especially in the morning peak hour. The other is the road which is not corresponding to the expansion of urban cities, that is, insufficient services for pedestrians such as non-adjusted pedestrian roads along the arterial road and non-adjusted pedestrial crossing at the intersections.

Excessive concentration of cars to the urban and radial road system are the causes of the traffic jam. As improvement measures, dispersion of urban function in the suburbs and construction of ring roads connecting radial roads mutually are considered.

As for these measures, the Brunei Government is promoting at present. The followings are the road construction projects including construction of ring roads with the completion schedule by 1990.

Fig. 3-24 Location Map of Roads under Construction (1)



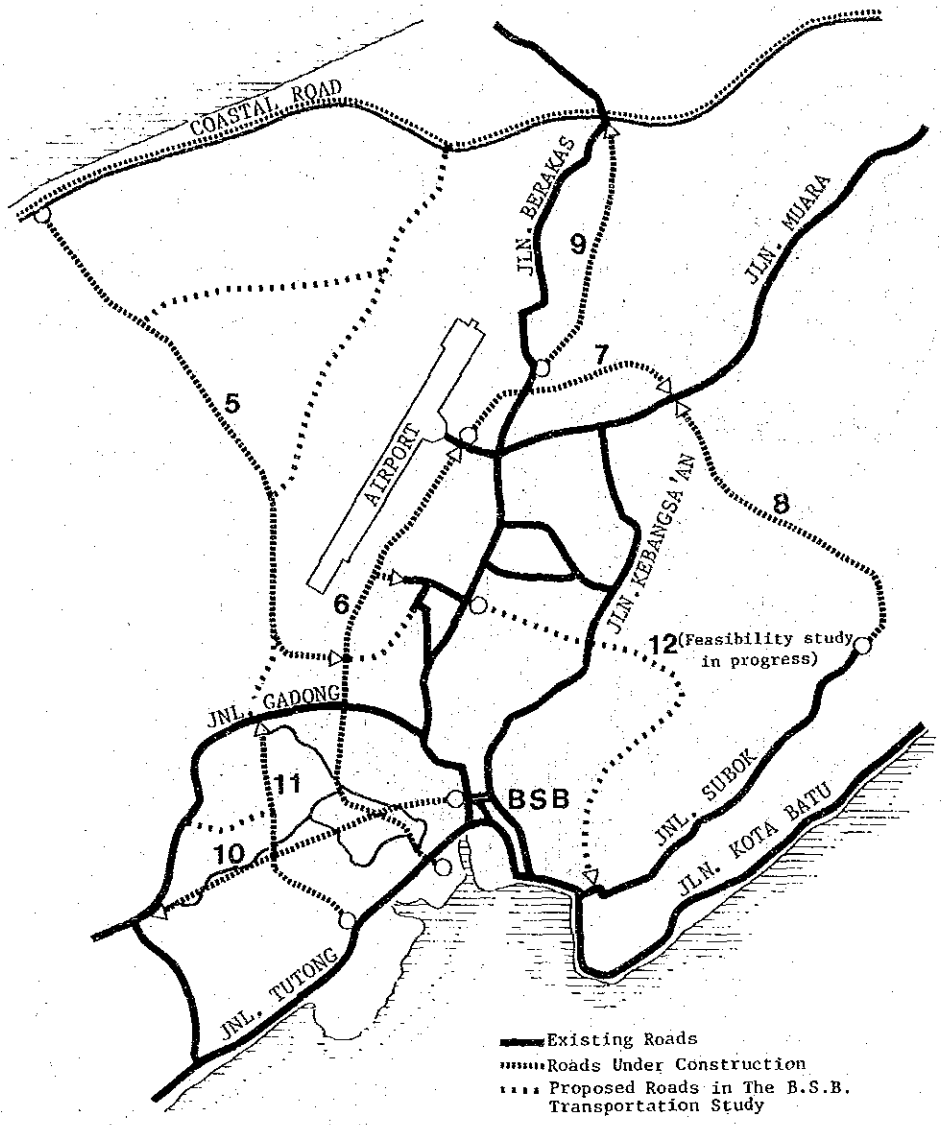


Fig. 3-25 Location Map of Roads under Construction (2)

Table 3-21 Roads Under Construction

	DESCRIPTION	LENGTH (IN MILES)	SCHEDULE COMPLETED	REMARKS
1	MUARA/JERUDONG COASTAL ROAD	19.5	COMPLETED	Single Carriageway with provision for Future Double Carriageway.
2	JERUDONG/TUTONG COASTAL ROAD	18.0	Sep. 1985	- do -
3	SERIA BYPASS	17.0	End of 1986	
4	SUNGAI TUJOH ROAD	7.0	End of 1986	
5	TUNGKU LINK ROAD	6.0	End of 1985	
6	MAJOR ARTERIAL ROAD PHASE I	5.2	Early 1986	Dual Carriageway
7	MAJOR ARTERIAL ROAD PHASE II	2.3	End of 1988	Dual Carriageway
8	SUBOK/MANGGIS LINK	4.5	End of 1985	
9	BERAKAS LINK	2.4	End of 1986	
10	SG. KEDAYAN RADIAL ROAD	3.1	End of 1987	
11	KIARONG LINK	2.3	End of 1987	
12	BERAKAS/KEBANGSAAN/SUBOK LINK	5.1	-	Feasibility study in Progress
13	LIMAU MANIS/LUMAPAS ROAD	9.0	End of 1985	
14	RAMUI/MERIMBUN ROAD	4.0	End of 1986	
15	TANJONG MAYA ROAD	5.0	End of 1985	

(2) Evaluation of the present public transport system

Public bus

The present ratio of the number of bus passengers to that of total passengers occupies only 3% due to such a low service level as shown below:

a) Only a radial bus network is provided in the Brunei-Muara district and B.S.B. which are accompanied by a large population and a massive movement of passengers. This is not satisfactory for a various travel desire and transit passengers.

b) It is not desirable for regular passengers to travel by bus, because no fixed bus operation is provided.

c) Total average operation interval of bus departure is as long as 48 minutes which shows a long service level.

d) Such informations as operating time table, route map and bus fare, are not available not only even in B.S.B. bus terminal but also at bus stops.

e) Bus stops are not sufficiently improved.

f) The present situation that obsolete buses without air-conditioner are operating, constitutes a problems of unsatisfactory bus service for passengers.

g) The type, model and capacity of buses are different. So that is becoming extremely difficult to repair and maintain the buses.

h) There are a lot of small bus business companies so that is difficult to operate bus on schedule.

To cope with the above problems, the following improvement are deemed necessary.

a) Re-routing of the present bus network

b) Increasing of bus operating frequency

c) Improvement of bus terminals and bus stops

d) Improvement and standardization of bus type

e) Establishment of bus operating and management system as well as the maintenance facilities.

School bus

The following problems are acute in the present school bus

operation.

a) Out of the total, within 10% of students are enjoying the school bus service. The majority of them obliged to use their family cars.

b) The school bus operation seemed to be uneconomical due to its limited operating hours.

c) Shortage of school bus parking space in the B.S.B. town center would accelerate the traffic congestion more.

To cope with the above problems, the following improvements are deemed necessary.

a) Conversion of school bus to public bus

b) Increasing of bus operating frequency

c) Improvement of bus stops

d) Introduction of season tickets for students

Taxi

The following problems are acute in the present taxi business.

a) It is inconvenient for passengers to walk up to a small number of taxi pools.

b) It is inconvenient for passengers to call a taxi because a telephone calling system is not available.

c) A fare meter is not equipped with a taxi so that the fare is not reliable.

d) Positive investment to improve the existing taxi service cannot be expected in taxi business now, because most of taxi business companies are small and thereby lending to low profitability.

To cope with the above problems, the following improvements are deemed necessary.

a) Improvement of taxi stations

b) Introduction of a telephone calling system and radio taxi services

c) Incentive for improvement, etc.

CHAPTER 3 SOCIO-ECONOMIC TREND AND FORECASTS

3-1 Demographic Pattern

Total population of Brunei in the past decades was 83.9 x 10^3 in 1960, 136,3 x 10^3 in 1971, and 192.8 x 10^3 in 1981; characterized by the average annual increase rates of 4.5% during 1960 - 1971 and 3.5% from 1971 to 1981. The latest estimate for the year 1982 is 200.4 x 10^3. The pace of population growth was decline recently, in spite of the continuous inflow of a number of immigrant workers. From the viewpoint of population distribution, 2 major concentration centers have been formed around B.S.B. and in the area covering both K.B. and Seria with a sub-center at Tutong. Over half of the total pupulation was composed of residents in B.S.B. and Brunei-Muara District; the environs of B.S.B. such as Berakas, Gadong, Senkurong and Mentiri/Serasa (Muara) recorded remarkable increase rates from 1971 to 1981.

3-2 Population Projection

After taking all the factors having influence on population increase into consideration, the total population in 1995 was projected to be 304.7 x 10^3 with the inclusion of immigrants. The average annual growth rate from 1981 to 1995 was assumed at 3.3%. The projected population in 1995 was then assigned to Traffic Zones, for the purpose of preparing basic data in the traffic demand forecasting. Due considerations were taken at this stage for the planned large-scale resettlement schemes.

3-3 Overview of the National Economy

The constant GDP is available from 1974 onward in Brunei. The economic growth trend might be taken hold of from the values of constant GDP, which was B$2,612 x 10^6 in 1974 and B$3,501 x 10^6 in 1982 at 1974 prices; the growth rate in these 9 years was 3.7% per annum. The role and real growth of the respective industrial sectors are reflected in the values of nominal and constant GDP as shown below.

Unit: %

Industrial Sector	Percentage Contribution to Nominal GDP	Average Annual Growth Rate in Real Terms, 1974 - 1982
1. Agriculture, Forestry and Fishery	Around. 1.0	3.8
2. Mining/Quarrying and Manufacturing	78.0 to 89.0	1.8
3. Electricity, Gas and Water	Recently, minus	-
4. Construction	1.3 to 2.2	11.0
5. Commerce	Recently, around 9.0	22.7
6. Transport, Storage and Communication	Around 0.9	15.2
7. Other Services	8.2 in 1982	13.5

The composition of nominal GDP suggests that the oil sector (mining/quarrying and manufacturing in the above) has had a dominant position with around 80% of contribution to GDP; however, its growth shows a stagnant feature. High growth rates were attained in commerce, transport/storage/communication and other services, the percentage contribution of which were approximately 9.0%, 1.0% and 7.0%, respectively. Construction sector has maintained an almost constant contribution to GDP but its real growth was in a heavy fluctuation. Both contribution to GDP and real growth of primary industry (agriculture, forestry and fishery in the above) are considered nothing more than the slack. Whilst a gradual upward tendency is observed in service industries, the economy in Brunei has been still heavily dependent on the production and processing of oil and natural gas. From the past trend, it was revealed to be easily affected by the international market situation, having keen effects to the other industrial sectors.

3-4 Forecasts of Economic Growth and Income Level

Based on the assumed contribution to the national economy and the assumed real term growth towards 1995 by industrial sector, the economic growth rate was determined in 3 cases. Basic considerations

in the division of those 3 cases were oil price change and its influence to the others. It was assumed that the production amount would be constant in quantity. In High case, the present level of oil prices was applied and the growth rate of constant GDP was obtained to be 5.0%. 10% decline of oil prices was assumed for the next 10 years in Medium case, resulting in 3.2% of GDP growth. For Low case, less 20% of oil prices was assumed for the coming 10 years; the real term growth rate of GDP would be 1.3% per annum. The projected values of GDP and per capita GDP for the year 1995 are:

Case	GDP ($B\$10^6$)	Growth Rate (%)	Per Capita GDP (B$)	Growth Rate (%)
1. High	6,602	5.0	21,667	1.7
2. Medium	5,273	3.2	17,306	-0.1
3. Low	4,141	1.3	13,590	-1.9

Remarks: At constant prices of 1974.

3-5 Employment Projection

Working population in Brunei was 40.0×10^3 in 1971 and 68.1×10^3 in 1981 from the Census figures. As it was difficult to take correlation with either the production level or the contribution to GDP by industrial sector, only the total amount of employment was projected using the ratios of population aged 15 years and over, labour force and employment itself to the projected total population of the country. In consequence, 114.6×10^3 of the projected employment for the year 1995 was obtained. In the next step, the assignment to each Traffic Zone was carried out for the traffic demand forecasting, divided this total figure into 3 categories; namely, government officers, school teachers and private employees.

3-6 Forecast of Vehicle Ownership

Total number of registered vehicles in Brunei increased rapidly at an average annual growth rate of 13.6% from 1971 to 1982. As a result, the passenger cars per 10^3 persons was 272.2 (total number: 54,558) while the possession of goods vehicles numbered 8.652 in 1982. With the limitation of applicable data, the analysis was

conducted for the correlation between vehicle ownership and economic indicators for the period after 1974. Excluding the figures in 1981 and 1982, the number of passenger cars per 10^3 persons was revealed to have a close relationship with per capita production in non-oil sector and goods vehicles are to be connected to the production in non-oil sector. Through the regression, formulas to be applied were determined and the final resutls are:

Passenger cars in 1995 : 95,100 (312.3 per 10^3 persons)

Goods vehicles in 1995 : 12,900

The production figure in non-oil sector was derived from Medium case of the GDP projection.

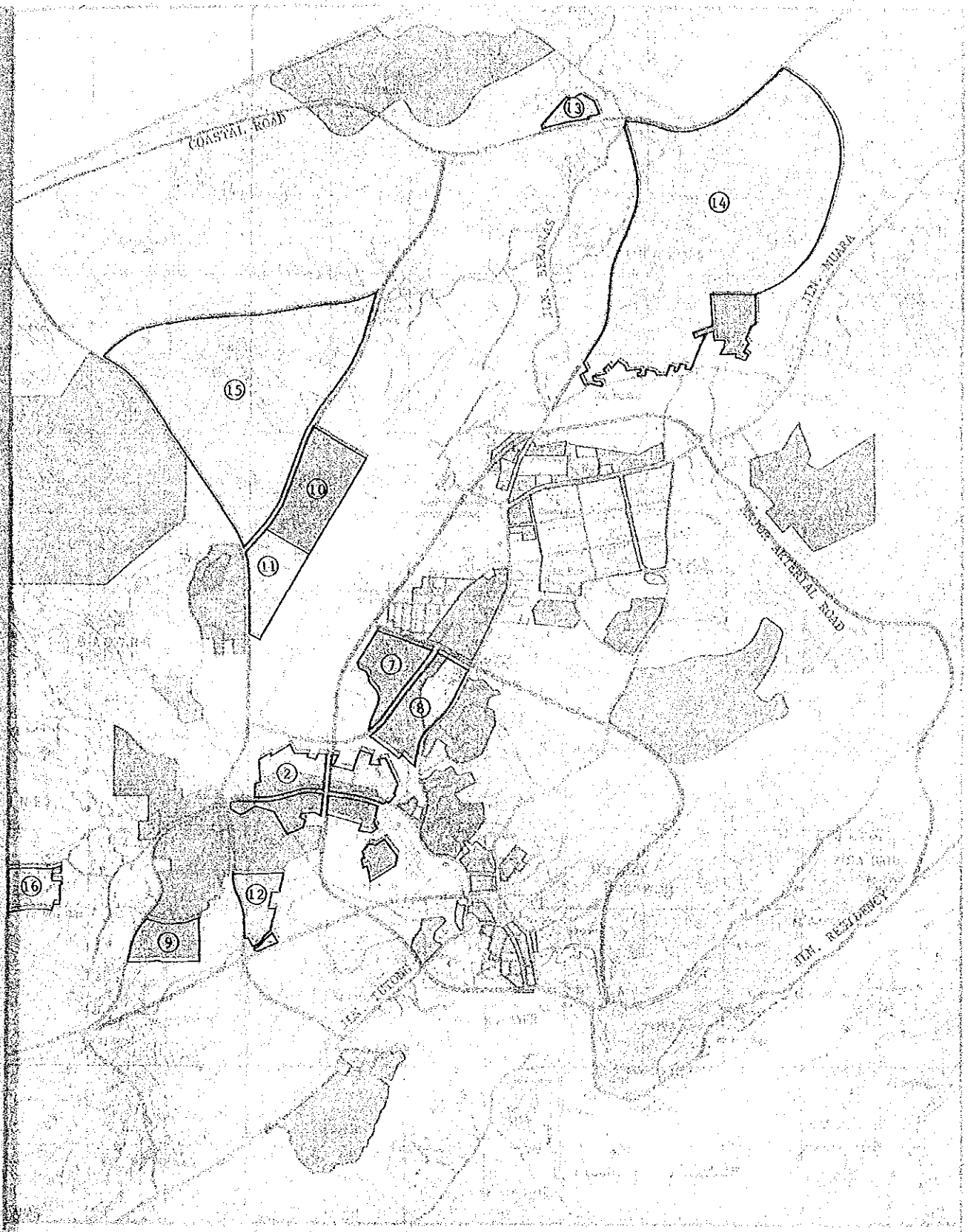
3-7 National Development Policy

The Government has formulated the National Development Plan usually for 5 year period; the next 5-year Plan for 1985 - 1989 is now in preparation. The previous 5-year Plan, 1980 - 1984, emunerates the aims and objectives such as real GDP growth, income level, employment level, economic diversification, fiscal and monetary policies, income distribution and the regional development. Total allocation of development fund was B$1,700 $\times$ 10^6 for 1980 to 1984 with the emphasis on roads, public buildings, education, government housing and medical/health.

3-8 Development Projects/Plans and Land Use Control

A number of development projects/plans have been proposed and implemented in the country, of which the focuses are placed in those undertaken by the Town and Country Planning Department (TCPD), Public Works Department (PWD) and the Housing Development Department (HDD). The TCPD has formulated the structure plans for inside and outside of the major populated towns; that is, B.S.B. and its environs, Muara, Tutong, K.B. and Seria, which have been utilized as basic tools in land use control but not for statutory interpretations. Development control has been carried out around Jalan Gadong 3.5 mile by the TCPD under the Gadong Development Planning Scheme. B.S.B. Structure Plan has a comprehensive feature as the configuration of various projects/schemes of the other

departments. Included in it are New Government Offices, government housing for the New Offices and at Kiarong, industrial areas at Jalan Gadong 6 mile and in the west of International Airport, Labour Line Site for immigrant workers, resettlement schemes of Lambak Kiri and Kg. Mata-Mata under the PWD; and 2 large-scale resettlement schemes, Lambak Kanan and Rimba, under the HDD. Lambak Kanan, about 10 km north from the twon center of B.S.B., is the pilot site of the several large-scale housing development all over the country by the HDD with 1989 as a general target year of completion. Over 14,000 residents will live in 2,000 housing units there. Rimba resettlement site will have the population of 9,000 in 1,500 housing unit but still at planning stage. The disperse settlement pattern with some suburban centers has been proposed in and around B.S.B. under this Structure Plan, disposed to continual planning by the governmental departments and the related agencies. The other housing development schemes under the HDD are found in Bukit Beruang, Tutong; Kg. Pandan, K.B.; Sungai Liang, Belait; Lorong Tengah, Seria; and Kg. Rataie, Temburong. Except for Kg. Rataie, all the resettlement sites will have the population of 6,000 to 9,000 and 1,200 to 1,500 housing units. The major aims of these resettlement schemes are: (1) aspiration of illegal squatters, (2) reallocation of the residents in Kampong Ayer, (3) dissolution of the over-crowded situation in built-up areas, and (4) absorption of natural population increase. The PWD has also carried out the resettlement schemes with its own planning; in addition to Lambak Kiri (130 housing units) and Kg. Mata-Mata (328 housing units), 2 small-scale sites have been prepared in Muara where the only port facilities exist for external trade.



B.S.B. Structure Plan and Development

(1): ④ : No. of development projects/schemes corresponding to that in Table 4-2 and Table 4-3

(2): Entire area is the coverage of B.S.B. Structure Plan by the Town and Country Planning Dept.

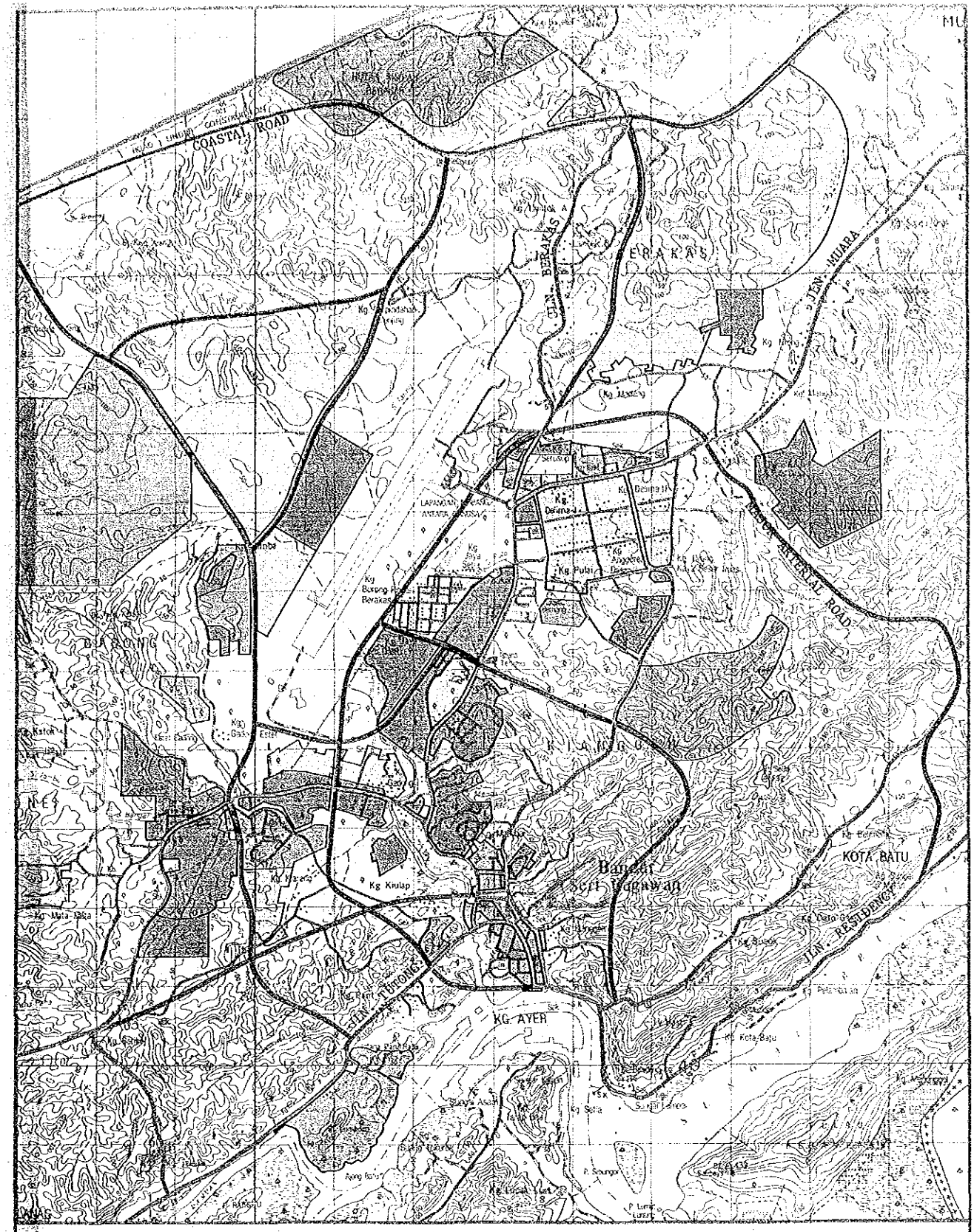


Fig. 4-1 B.S.B. – Major Land Uses

CHAPTER 4 ALTERNATIVES

4-1 Basic Policy of Transportation System

The current traffic system of Brunei greatly depends on automobiles and the improvement of public transport system are insufficient. Especially, serious traffic jams are occurring frequently in B.S.B. because of heavily concentrating automobiles and to maintain and promote healthy urban activities is extremely difficult if this situation remains unsolved.

In order to solve the heavy traffic, the government is planning to construct a ring road, coastal road and various access roads during the next 5-year plan period. However, since it is estimated that the future traffic demand will increase acceleratedly, it is considered that these traffic problems would not be eliminated if the measures are taken in a manner of widening the road and increasing the number of lanes only.

Accordingly, we determine that the public transportation system must be improved and transportation system in which automobiles and public transport facilities match must be established.

This essentially brings up the subject of what should be the proper service level of bus transportation and its network, since bus transportation is the main part of public transportation means.

On the questionnaire survey made to automobile users, about 50% of them answered that they would use buses if the bus service were improved, but according to the analysis results of traffic movement, a realistic share of buses is believed to be about 25% at the maximum. In our trial calculation using a correlational expression between the bus share and bus supply, if the bus share rate is 25%, the bus service must be improved to about four times as much as the current one in the service frequency, about three times if 15 to 20%, and about twice if 10%.

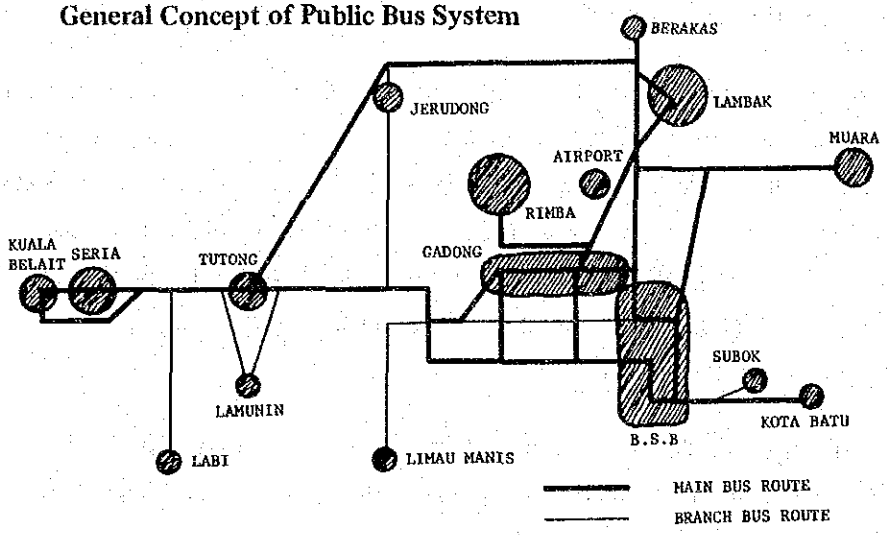
The main part of the current bus network is between cities and

Population coverage =

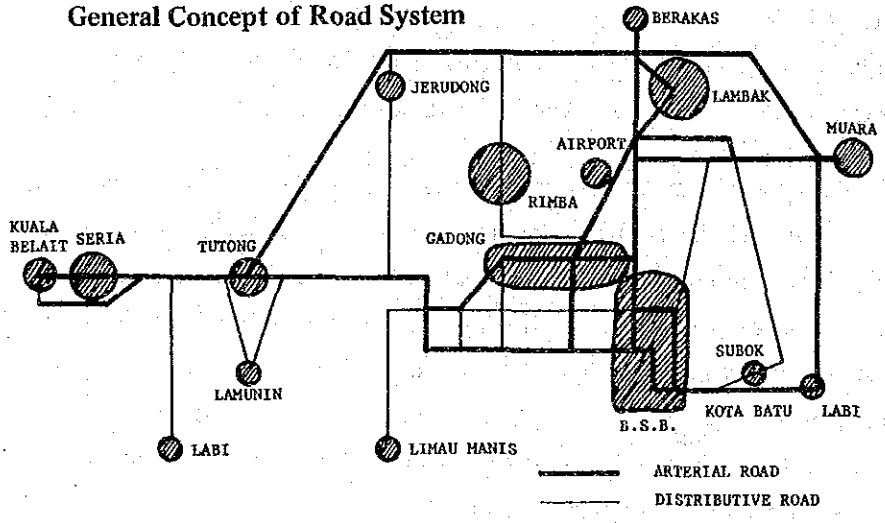
$$\frac{\text{Population distributed in 500 m zone along bus route}}{\text{Whole population}} \times 100$$

Also, the bus routes between central cities are improved, and helped by easier transit resulting from the improvement of bus terminals, a bus network in the country scale will be completed. Such varied passenger movement can be expected in the B.S.B. surrounding area because of the formation of radial and circular bus routes.

General Concept of Public Bus System



General Concept of Road System



Such a bus network envisioned for the future is a result of utilizing the existing radial bus routes between cities and matching

the network covers only about 53% of the whole population. This is one of the reasons for generating the large amount of automobile movement between cities, besides, it bears many other problems.

The future bus system must be constructed with a network that can eliminate the current problems and covers almost all cities in the whole country, enabling smooth traveling of varied passengers. It must have the following contents:

① Introduction of bus routes to almost all proposed development areas.

② New installation of bus routes to areas which have no bus route at present but where urbanization is planned.

③ New installation of circular bus routes in addition to radial bus routes in the B.S.B. surrounding area.

④ New installation of high-speed bus routes using high ways and connecting major cities for long-distance travelers.

⑤ Installation improvement of bus terminals at the transits between main bus routes and departing/arrival points where main bus routes concentrate to provide convenience and pleasantness to passenger.

⑥ Punctualness of bus service and arrangement of bus stops with improved bus bay, shelter, chairs and time tables to provide convenience and pleasantness to passengers.

⑦ Introduction of one-man bus standardized model and with air-conditioner for pleasant trip of passengers.

⑧ Conversion to public buses in order to efficiently operate the current school bus system.

If these are realized, the future bus network will cover 75% of the population and bus service will become available to most of kampongs. Also, there will be bus routes in all districts from various parts in the district to the central city of the district.

with the future land utilization plans and various development plans. What we are planning basically is not changes of the bus network by the alternatives. Instead, we are trying to arrive at conclusions on the relationship of share between automobiles and buses and on improvement of roads and facilities related to the bus service.

For the road network, we are setting a plan based on the use of existing roads and roads that are scheduled to complete in the next 5-year plan, with additional investment made not to generate traffic jams on the roads according to the future changes of automobile traffic that are estimated for each alternative.

4-2 Alternatives

As the traffic system of not generating traffic jams on the future traffic demand of up to 1995, there are two cases; one a traffic system in which the car transportation is used as the main part and the other is a traffic system in which the public transportation means are improved. In order to compare them, we have set five alternatives.

(1) Alternative 0

On Alternative 0, the governmental projects to be completed in the current and next 5-year plans are incorporated.

According to the traffic demand distribution results for 1995 as calculated for this alternative, there will be places where the demand exceeds the capacity in the Brunei-Muara district in spite of the governmental investment on the roads. Heavy traffic is expected especially in Capital B.S.B. and on the radial roads to the surrounding area.

Therefore, additional investment for improvement of the roads or public transportation means is needed to eliminate the traffic jam.

In order to measure the effects of these additional improvements, we are setting four alternatives aside.

(2) Alternative 1

Alternative 1 is set planning to manage the future traffic demand by improving the roads. In this alternative, the number of lanes of roads are added for the portion of the demand exceeding the capacity on Alternative 0.

When planning the concrete number of lanes to increase, we first classified all roads functionally and increased the number of lanes in the priority sequence from trunk roads.

The bus network and bus service level are set to the current ones.

(3) Alternative 2

Alternative 2 is to realize a maximum bus ratio of 25%, by increasing the average operational frequency four times more than the present service.

it is expected as a result that the car traffic volume of Alternative 2 will be reduced by about 25%, but congestion on roads of congestion rate 1.3 or higher in the result of the future traffic assignment in Alternative 0 cannot be solved. It is therefore necessary to increase the number of lanes of these roads. The areas in which 4-lane roads are additionally required in the road network of Alternative 2 are surroundings of Rimba and Lambak housing project areas and twon center of B.S.B. (See Fig. 5-3)

The bus network of Alternative 2 is shown in Fig. 5-6, and as it shows the bus service is available in most kampongs. Also, bus routes from various parts in a district to the central city of the district are established in each district. At the same time, bus routes connecting these central cities will be improved, and helped by the improvement of transit resulting from the bus terminal improvement, a bus network will be formed in the country scale. In the B.S.B. surrounding area also, passengers will be able to move in many ways because of the completed radial and circular bus routes.

The frequency of bus running is improved to about four times as much as the current one as a whole. However, this frequency is not uniform to all routes and the frequency on each route is set corresponding to the future bus demand.

In concrete, the most frequent run is at average intervals of five minutes and the intervals are lengthened as fit to each route.

The most infrequent run is at average intervals of 20 minutes, which is a substantial improvement, and we expect maximum conversion from automobile use to bus use.

(4) Alternative 3

Alternative 3 assumes a bus split ratio of around 15 to 20%.

Accordingly, the bus service level will be improved to a total average operating frequency (total average operation interval 17 minutes) which is about three times of the value at the present time.

The bus network of Alternative 3 is basically the same as that of Alternative 2. However, since a decrease of bus demand is estimated in this alternative from that of Alternative 2, Bus Route No. 1 is strengthened instead of the circulating bus of Bus Route No. 18-1 between B.S.B. and Gadong (refer to Fig. 5-6 and Table 5-3).

The bus running frequency is not set constant but varied frequencies are set corresponding to the estimated future bus demand. The average intervals of bus running is 10 minutes on the most frequent route and longer intervals are set to each route as fit. The average intervals at the most infrequent route have been improved to 30 minutes.

Although a decrease of about 15 to 20% is estimated on the automobile traffic in Alternative 3 because of the improvement of bus network, it is considered that elimination of traffic jam on roads having 1.2 or greater traffic heaviness is difficult based on the future traffic distribution result shown in Alternative 0. Accordingly, the number of lanes on these roads has been

increased and this resulted in the same road network as that of Alternative 2.

(5) Alternative 4

Alternative 4 assumes the bus split ratio of around 10%. Accordingly, the bus service level will be improved to a total average operating frequency (total average operation interval 27 minutes) which is about twice of the value at the present.

The bus network of Alternative 4 is set to the same network of Alternative 3, thereby securing the bus service at a certain level.

The bus running frequency of each route varies by the bus demand, and on a bus route of the highest frequency, the average intervals are set to 10 minutes, the same as that of Alternative 3, with adequate intervals set to other routes. Also, there are bus routes on which the average running interval is as long as two hours at present, causing a great deal of inconvenience to the passengers. An average running interval of 60 minutes at the longest is secured, making the average waiting time to not longer than 30 minutes.

Although a decrease of about 10% is estimated on the automobile traffic in Alternative 4, it is difficult to eliminate traffic jam on roads having 1.1 or greater traffic heaviness based on the future traffic distribution result shown in Alternative 0. As a result of effectively increasing the number of lanes on these roads, the road network of Alternative 4 is the total road networks on Alternatives 2 and 3 plus 4-lane roads for a partial area of Jalan Gadong.

Table 5-3 Level of Bus Services by Alternative Plans

Route No.	Origin/Destination	Average Interval of Bus Departure			
		Alt. 0,1	Alt. 2	Alt. 3	Alt. 4
		Minutes	Minutes	Minutes	Minutes
1	B.S.B. - Gadong	85	20	15	30
2	B.S.B. - Berakas	37	10	20	30
3	B.S.B. - Muara	40	10	10	20
4	B.S.B. - Kota Batu	50	10	15	20
5	Sungai Kebun - Lumapas	-	-	-	-
6	B.S.B. - Jerudong	142	20	30	60
7	B.S.B. - Limau Manis	136	20	30	60
8	B.S.B. - Lamunin	-	-	-	-
9	B.S.B. - Tutong	-	-	-	-
10	B.S.B. - Seria	26	10	10	20
11	B.S.B. - Hospital	80	-	-	-
12	B.S.B. - Airport	52	-	-	-
13	Tutong - Tutong Camp	-	-	-	-
14	K.B. - Seria	23	5	10	10
15	K.B. - Miri	90	-	-	-
16	Seria - Labi	60	20	20	60
17	Seria - Sugai Liang	-	20	30	60
18-1	B.S.B. - Gadong	-	10	-	-
18-2	B.S.B. - B.S.B.	-	10	10	20
19	B.S.B. - Subok	-	20	30	30
20	Lambak - Rimba	-	5	10	20
21	B.S.B. - K.B.	-	20	30	60
22	Tutong - Lamunin	-	20	30	60
	Average	48	12	17	27

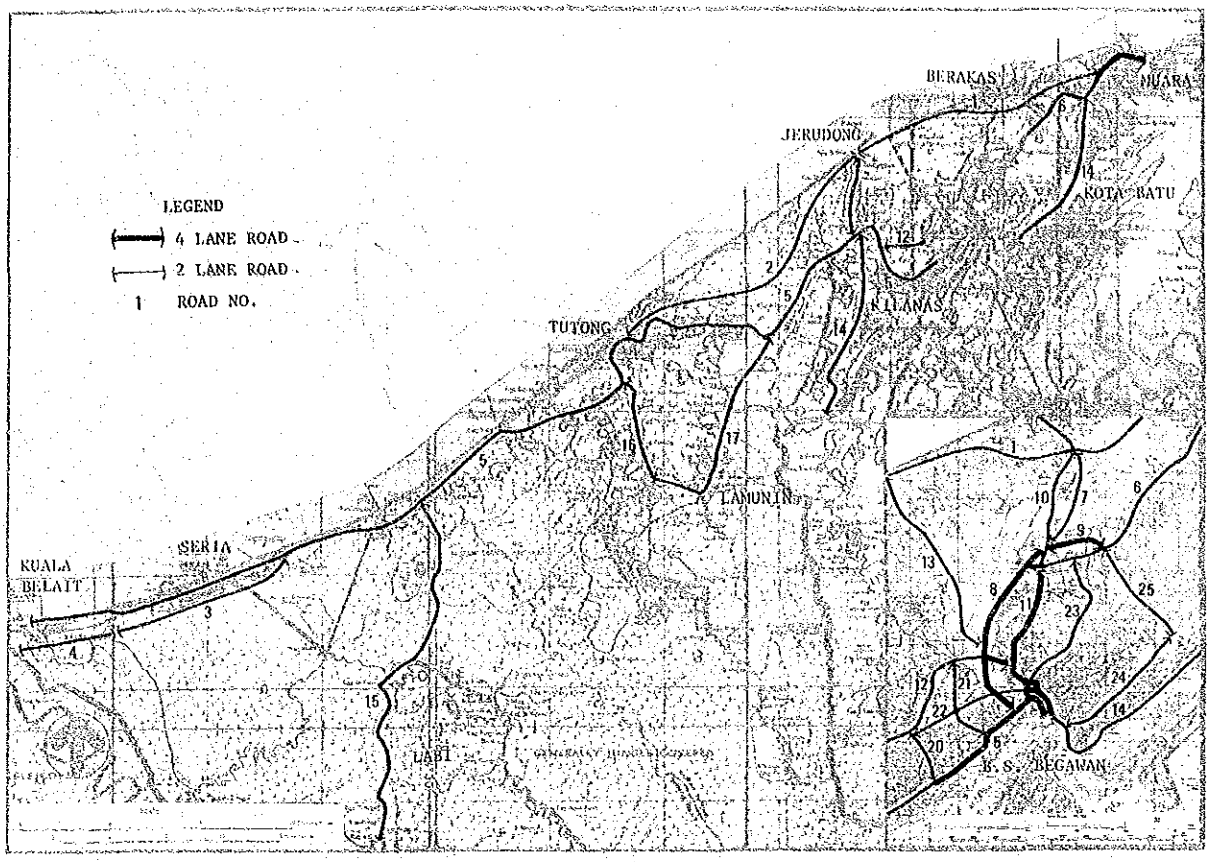


Fig. 5-1 Road Network (Alternative 0)

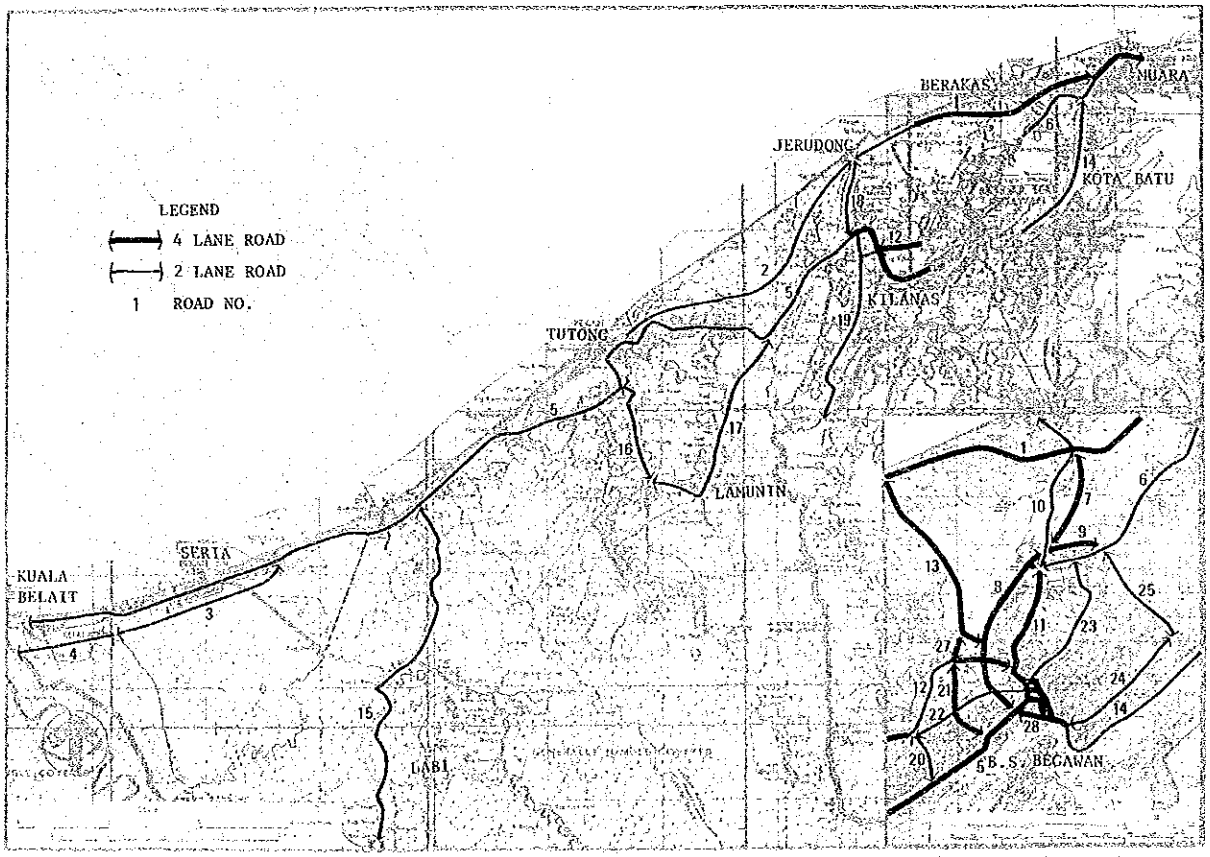


Fig. 5-2 Road Network (Alternative 1)

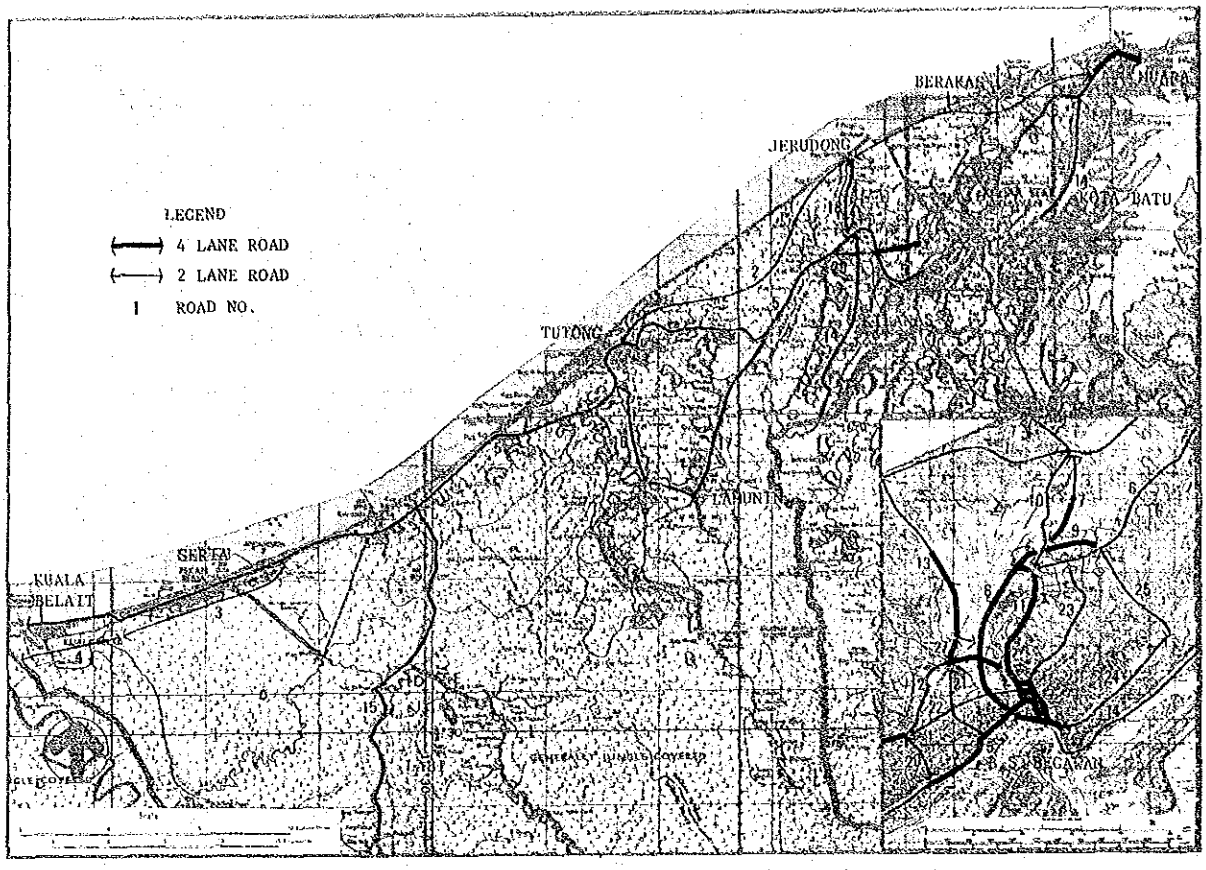


Fig. 5-3 Road Network (Alternative 2, 3)

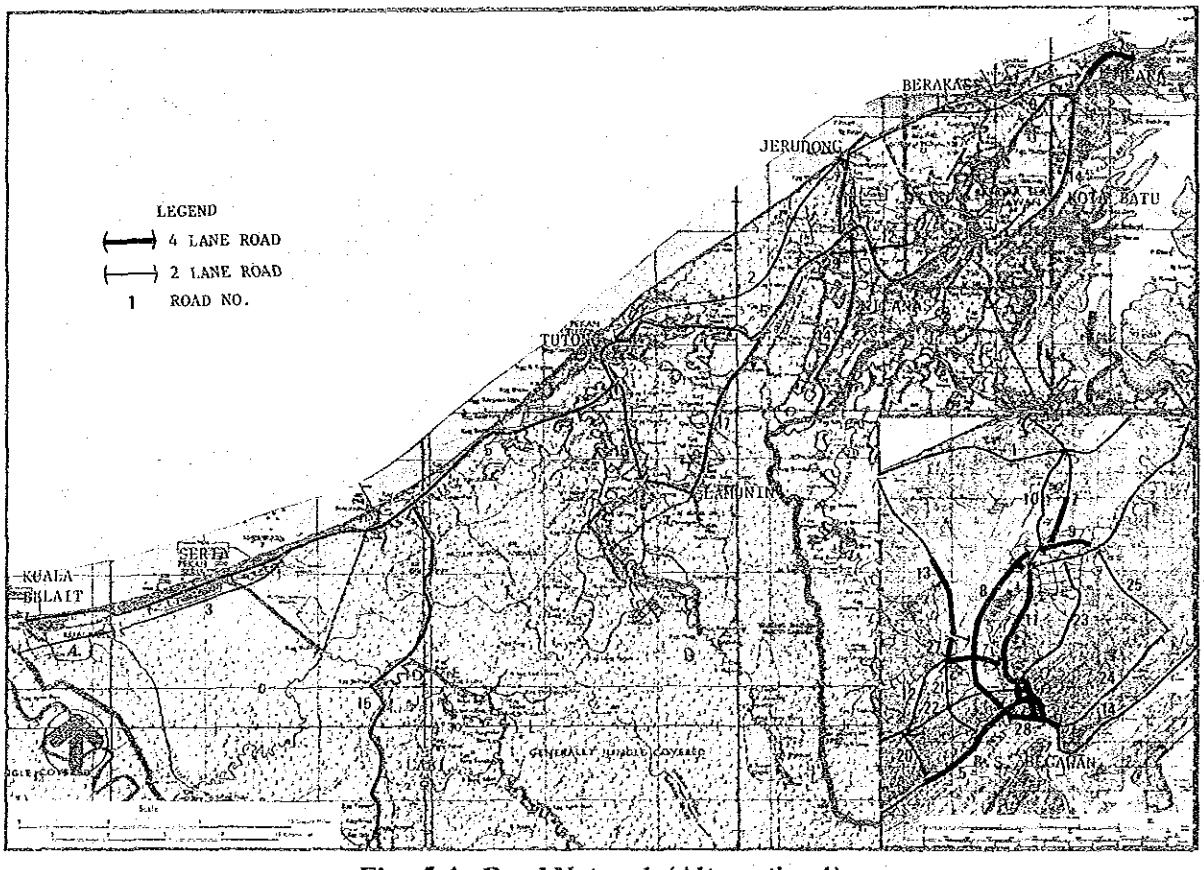


Fig. 5-4 Road Network (Alternative 4)

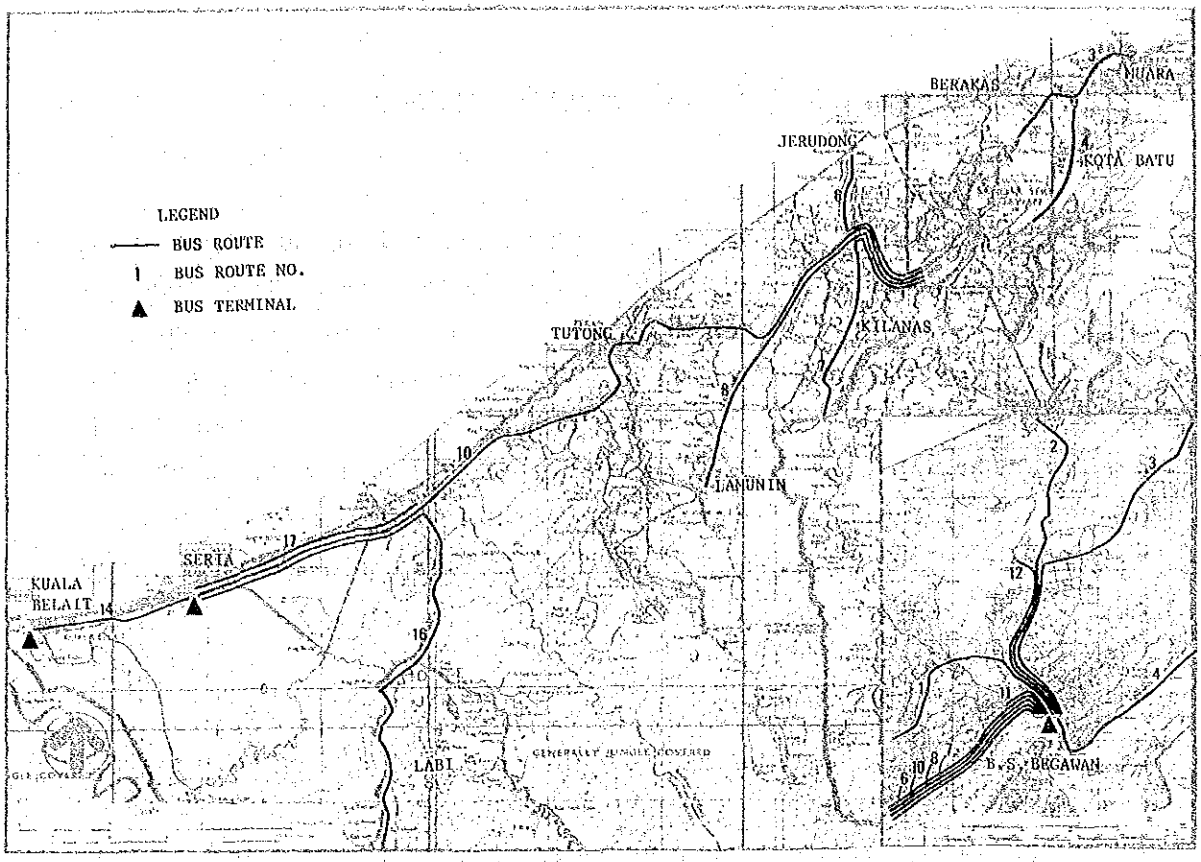


Fig. 5-5 Bus Network (Alternative 0, 1)

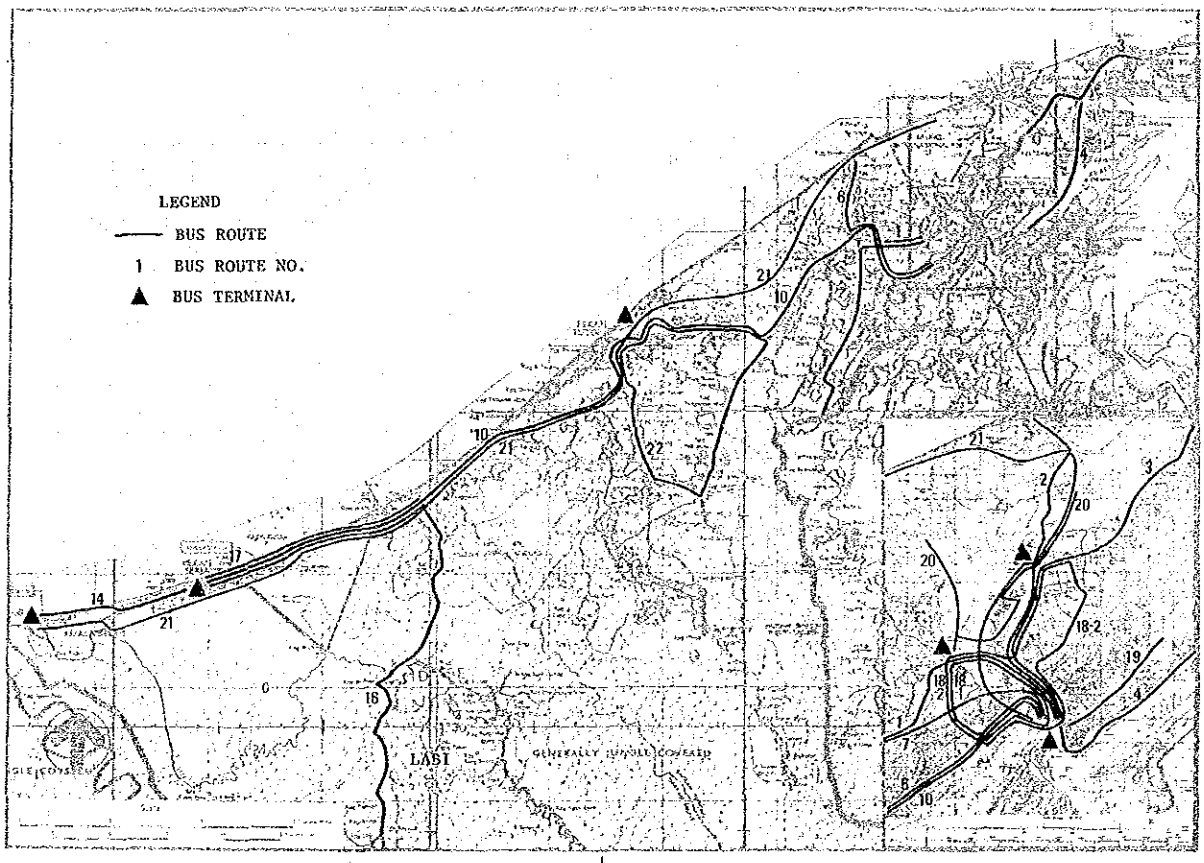


Fig. 5-6 Bus Network (Alternative 2, 3, 4)

CHAPTER 5 TRAFFIC DEMAND ESTIMATION

The future traffic demand is estimated covering the whole land of Brunei. The estimation is made by the person trip method through the processes of calculating the generated traffic volume by purposes, distributed traffic volume by purposes, distributed traffic volume by transportation means, and assigned traffic volume by transportation means. The purposes are classified into ① going to work, ② business, ③ returning home, ④ attending school and ⑤ others. The transportation means are classified into ① public bus, school bus, ② passenger car, ③ goods vehicle.

5-1 Generated Traffic Volume

We have calculated the future generated traffic concentration for each traffic zone using the population index and based on the current generated traffic concentration by purposes. The estimated number of trips by purposes are shown in the table below.

Table 6-2 Forecast of Number of Trips by Purpose

		1984		1995		Growth rate 1995/1984
		Number	Component ratio	Number	Component ratio	
Passenger cars + buses	Work	52,977	27.1	95,530	26.6	1.80
	Business	16,117	8.2	32,260	9.0	2.00
	Home	63,042	32.2	112,215	31.3	1.78
	School	11,804	6.0	18,924	5.3	1.60
	Others	51,823	26.5	99,699	27.8	1.92
	Total	195,764	100.0	358,598	100.0	1.83
Goods vehicles		24,751		49,476		2.00

5-2 Traffic Volume by Transportation Means

The traffic volume by transportation means is estimated using the modal split curve that explains the bus share based on the ratio of time needed by a passenger car and bus to travel between OD. The bus/passenger car modal split line prepared based on the existing OD table is shown in Fig. 6-5.

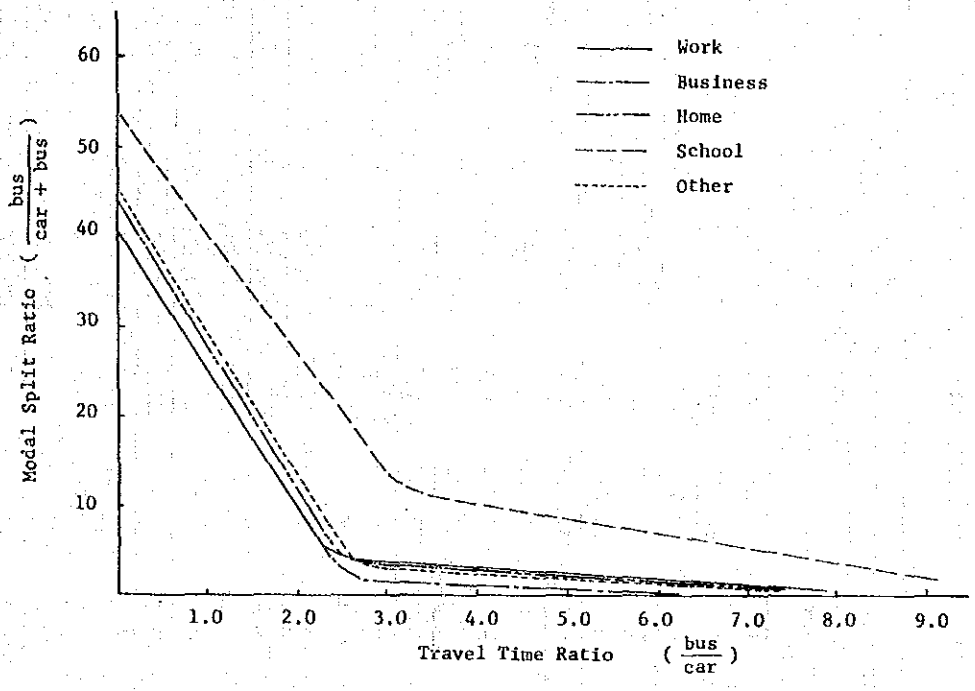


Fig. 6-5 Modal Split Line

The growth of traffic by the purpose and by the means for each alternative as estimated by the modal split line is shown in the table below. It shows different average split rates for each alternative corresponding to the service levels of bus and roads. On Alternative 2 on which the bus service level is the highest, the bus split rate is 21.6%, and the growth of number of trips is 12 times as much as that of the current one.

Table 6-8 Result of Estimation of Trip Distribution by Purpose and Transportation Mode (after correction)

		1984		1995									
				Alt-0		Alt-1		Alt-2		Alt-3		Alt-4	
		Number	Ratio of transport mode	Number	Ratio of transport mode	Number	Ratio of transport mode	Number	Ratio of transport mode	Number	Ratio of transport mode	Number	Ratio of transport mode
Work	Public buses	1,380	2.6	4,525	5.0	3,736	4.1	15,147	17.5	12,906	14.8	7,824	8.4
	Passenger cars	51,197	97.4	85,792	95.0	86,876	95.9	71,177	82.5	74,261	82.5	84,340	91.5
	Total	52,977	100.0	90,317	100.0	90,612	100.0	86,324	100.0	87,167	100.0	92,164	100.0
Business	Public buses	261	1.6	1,115	3.6	922	3.0	5,042	17.3	4,290	14.6	2,488	8.0
	Passenger cars	15,856	98.4	29,545	96.4	29,810	97.0	24,138	82.7	25,174	85.4	28,705	92.0
	Total	16,117	100.0	30,660	100.0	30,732	100.0	29,180	100.0	29,464	100.0	31,193	100.0
Home	Public buses	2,475	3.9	7,583	7.0	6,353	5.9	27,120	25.2	23,302	21.6	13,874	12.6
	School bus	4,370	6.9	4,370	4.1	4,370	4.1	0	0.0	0	0.0	0	0.0
	Passenger cars	56,197	89.1	95,552	88.9	96,904	90.0	80,600	74.8	84,467	78.4	96,336	87.4
	Total	63,042	100.0	107,505	100.0	107,627	100.0	107,720	100.0	107,769	100.0	110,210	100.0
School	Public buses	446	3.8	1,698	9.6	1,410	7.9	6,871	37.9	6,335	34.9	3,396	19.9
	School bus	4,370	37.0	4,370	24.8	4,370	24.6	0	0.0	0	0.0	0	0.0
	Passenger cars	6,988	59.2	11,562	65.6	11,987	67.5	11,254	62.1	11,797	65.1	13,674	80.1
	Total	11,804	100.0	17,630	100.0	17,769	100.0	18,125	100.0	18,132	100.0	17,070	100.0
Others	Public buses	1,378	2.7	4,936	5.3	3,971	30.6	16,868	19.3	14,615	16.5	9,461	10.0
	Passenger cars	50,445	97.3	88,541	94.7	9,000	69.4	70,493	80.7	73,900	83.5	84,800	90.0
	Total	51,823	100.0	93,477	100.0	12,971	100.0	87,361	100.0	88,515	100.0	94,261	100.0
Total	Public buses	5,942	3.0	19,857	5.8	16,392	4.8	71,048	21.6	61,448	18.6	37,043	10.7
	School bus	8,741	4.5	8,741	2.6	8,741	2.6	0	0.0	0	0.0	0	0.0
	Passenger cars	181,012	92.5	310,990	91.6	315,579	92.6	257,662	78.4	269,600	81.4	307,854	89.3
	Total	195,764	100.0	339,588	100.0	340,712	100.0	328,710	100.0	331,018	100.0	344,897	100.0

The bus trip induced effect of increasing the bus operation can be determined by counting the number of increased bus trips per bus run that is added to the base case (refer to Fig. 6-6). In this way, it is understood that the operation plan of Alternative 3 has the greatest induced effect.

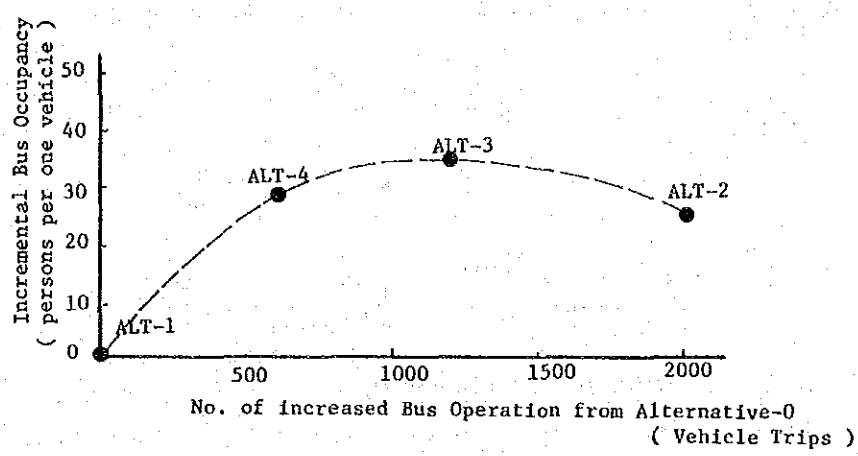


Fig. 6-6 Bus Trip Increasing Effect by Increase of Bus Operation

5-3 Assigned Traffic Volume

The traffic volume assignment model consists of a model road network and K-V curve formula. The capacity of each road of the model network is calculated using the following formula.

$$Q = B \times a \times b \times c \times d \times \frac{1}{e}$$

Q : Traffic capacity Number of automobiles/12 hours
B : Basic traffic capacity Number of automobiles/hr
a : Adjustment rate by entry of large size automobiles
b : Adjustment rate by road conditions
c : Adjustment rate by grade separated crossing
1/e : Peak rate (Traffic volume at peak/12-hour traffic volume)
d : Adjustment rate by planned level

The traffic capacity calculated by the above formula has been rearranged for each type and classified as shown in Table 6-10.

Table 6-10 Traffic Capacity of Each Link of Road Network (cars per 12-hour period)

	Road, 2 lanes	Road, 4 lanes	Road, 4 lanes (of which 2 lanes are exclusive bus lanes)	Expressway, 2 lanes	Expressway 4 lanes
Suburbs	14,000	50,000	25,000	14,000	50,000
Town area (general portion)	13,000	44,000	22,000	14,000	50,000
Town area (grade separated portion)	-	55,000	-	-	-
Central area	8,000	28,000	14,000	-	-
Central area (if, parking on the roads is excessive)	6,000	33,000	11,000	-	-

The K-V curve is set as shown in the figure below based on the traveling speed survey conducted to find out the relationship between the traveling speed and traffic volume and the currently effective legal traveling speed.

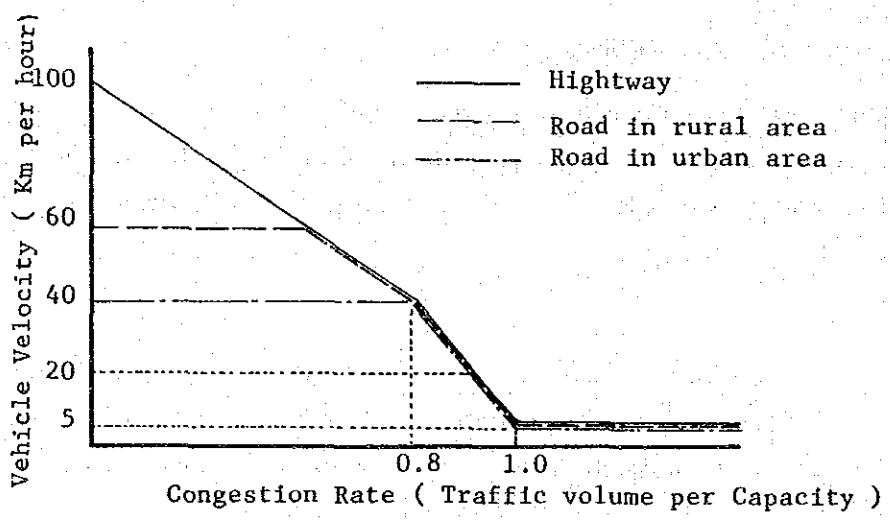


Fig. 6-8 K-V Line for Traffic Assignment

The actual assignment method is used for the traffic volume assignment in order to simulate the actual drivers' evasive behavior to a traffic congestion. The actual assignment is made by equally divided O.D. tables five times. The traveling speed on link at each assignment is determined by referring to the K-V curve. The estimated assigned traffic volume is shown in the figure below.

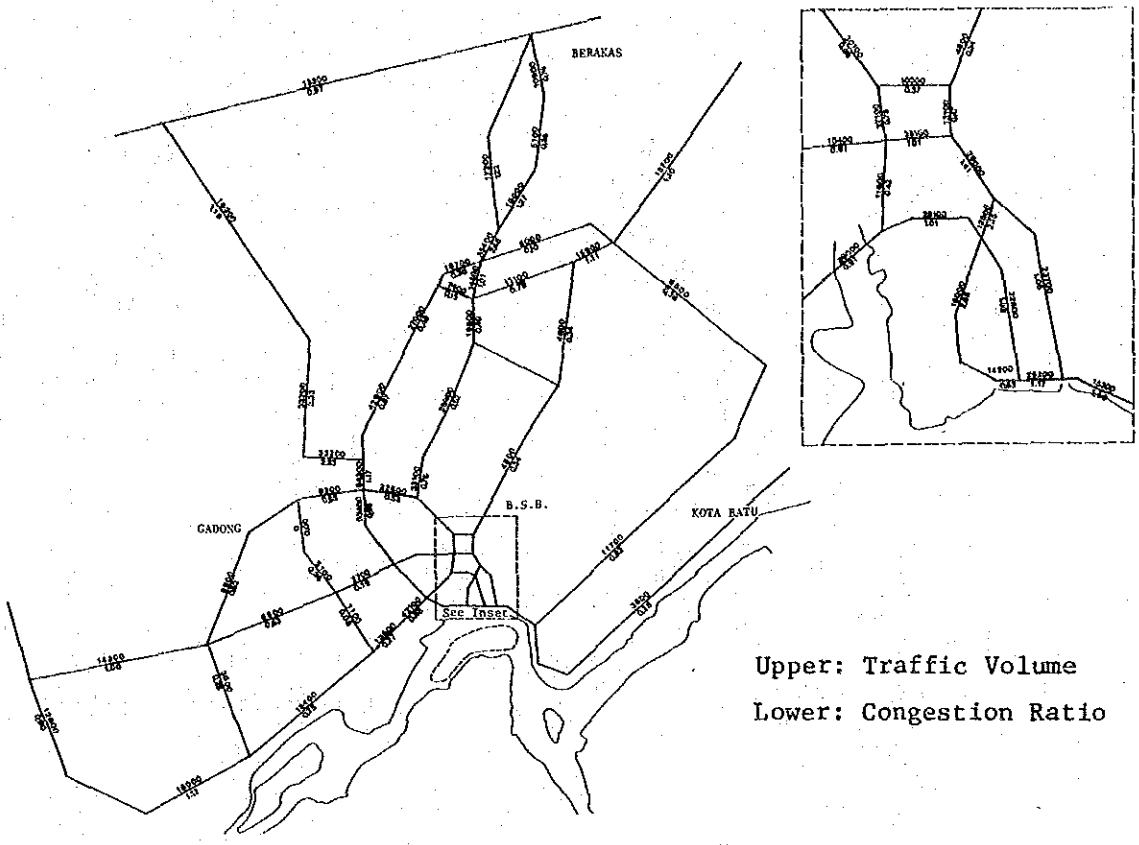


Fig. 6-10 Future Assigned Traffic (Alternative-0) – 2

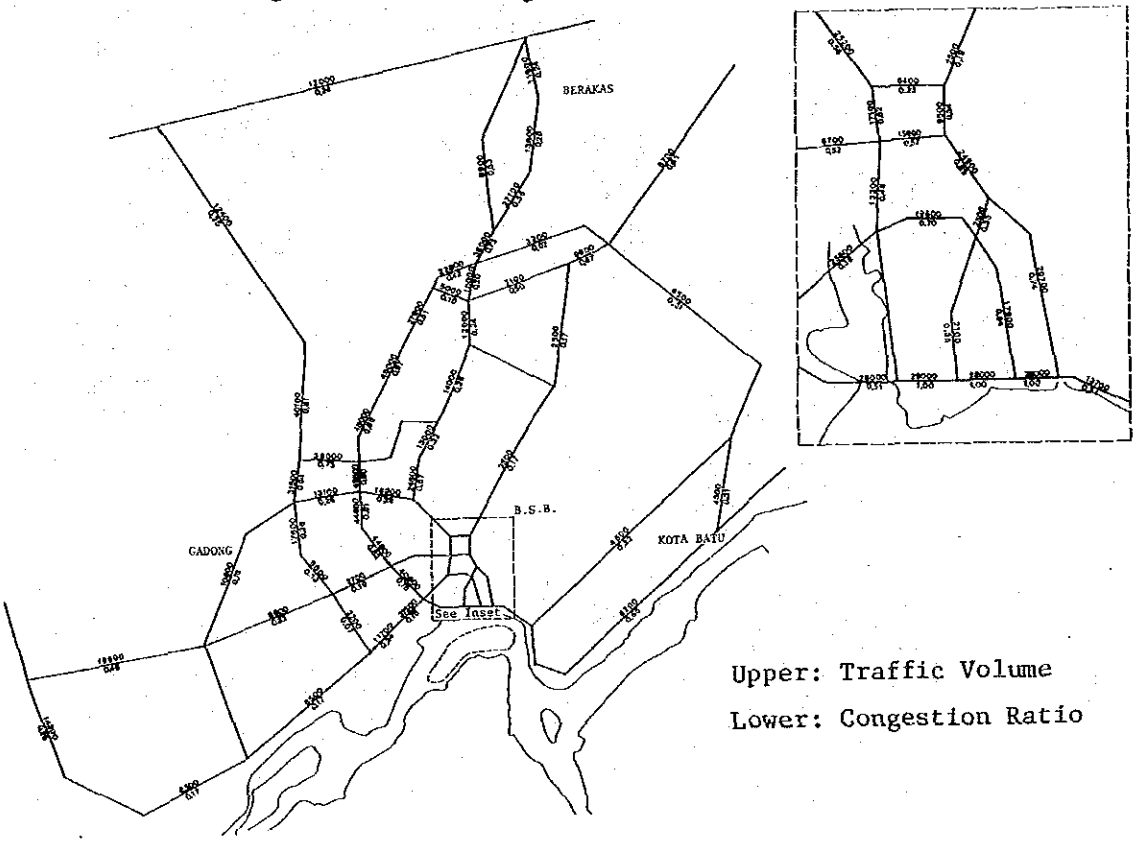


Fig. 6-12 Future Assigned Traffic (Alternative-1) – 2

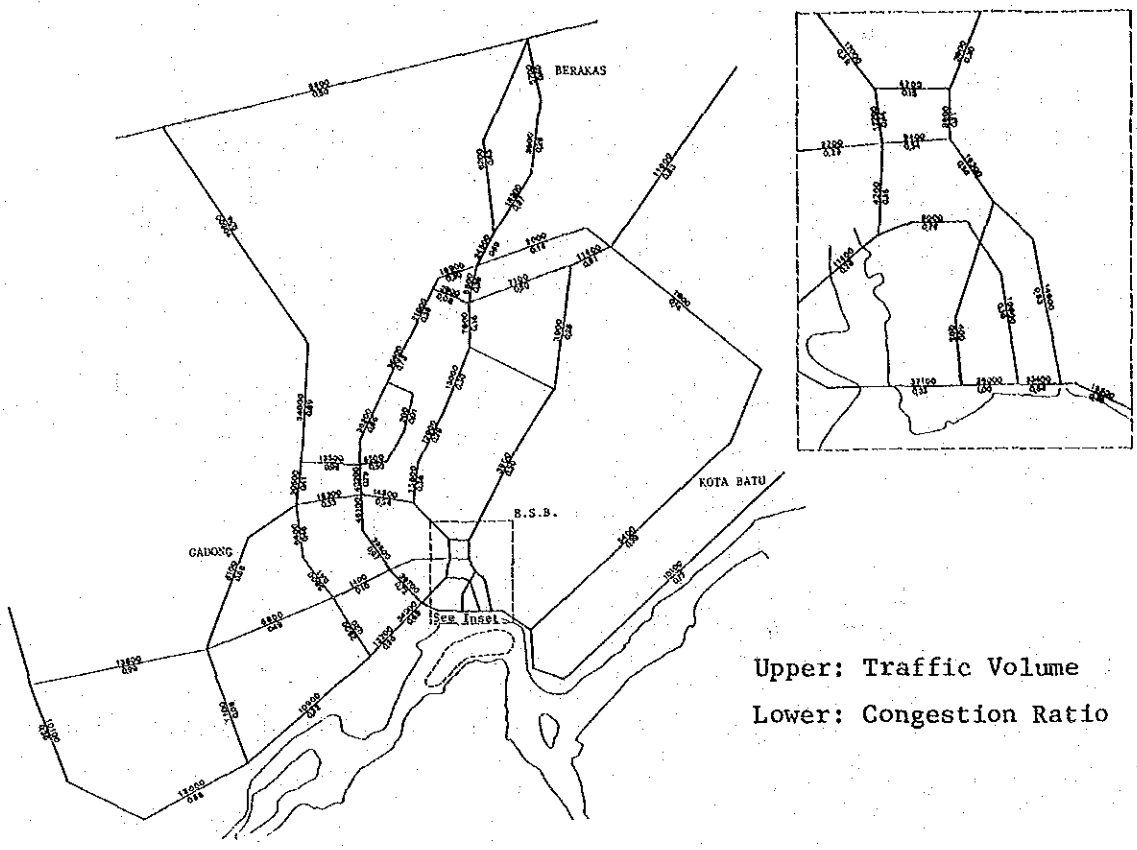


Fig. 6-14 Future Assigned Traffic (Alternative-2) – 2

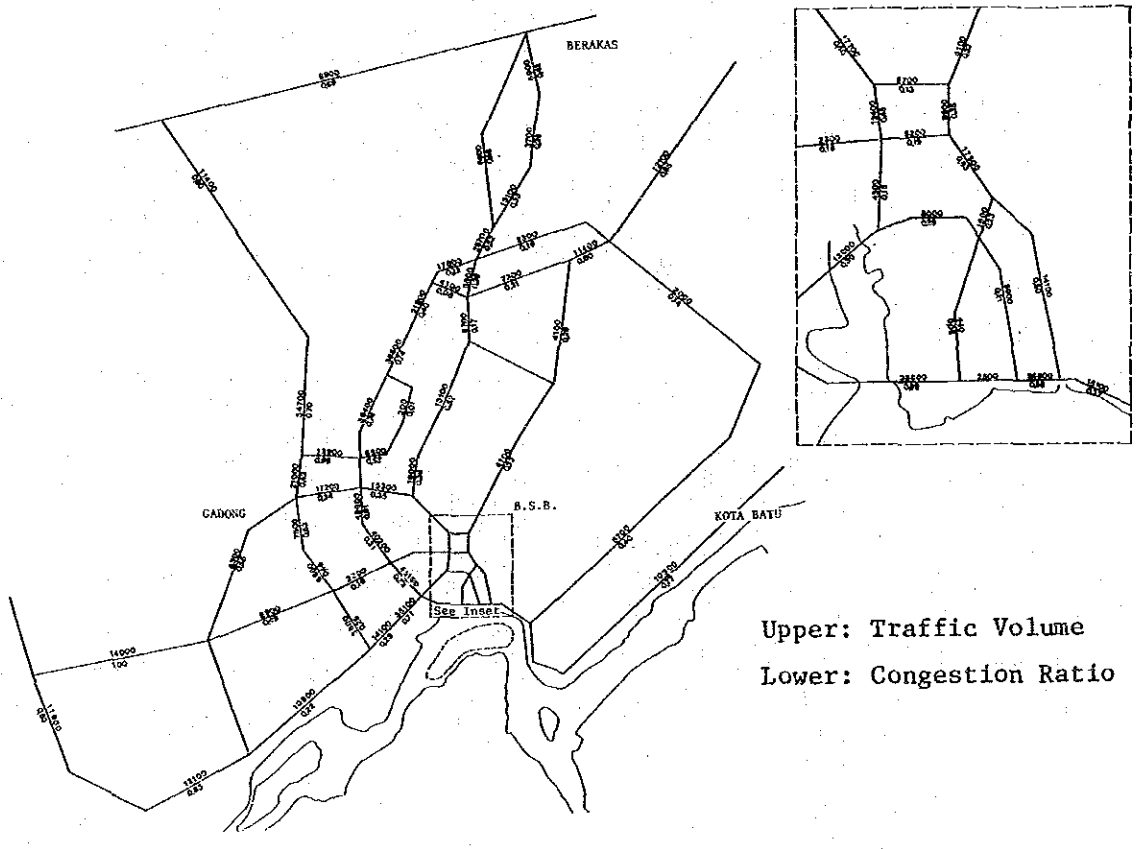


Fig. 6-16 Future Assigned Traffic (Alternative-3) – 2

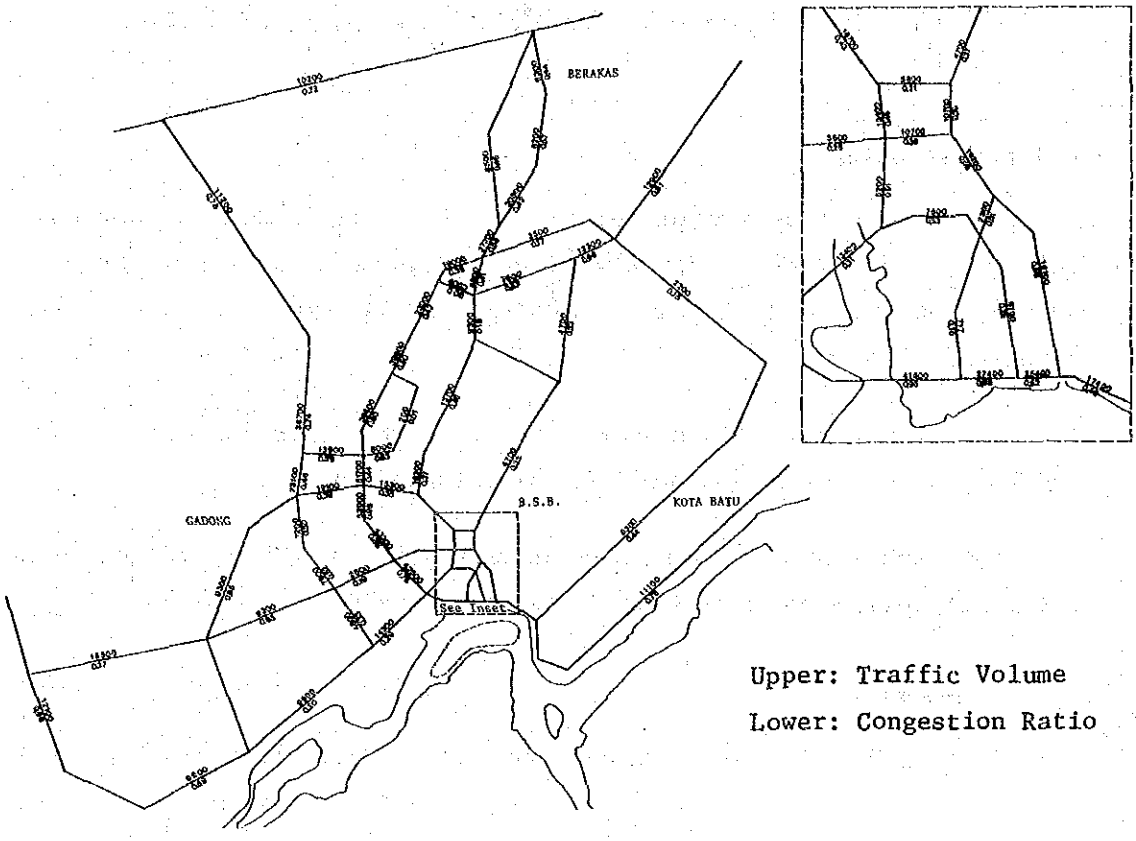


Fig. 6-18 Future Assigned Traffic (Alternative-4) – 2

CHAPTER 6 PRELIMINARY DESIGN AND COST ESTIMATION

6-1 Bus Operation Plan

The number of bus trips for each route is calculated as shown in Table 7-1 while taking the operation frequency, operation hours, traveling speed and average number of passengers for each alternative.

The total number of estimated bus trips is 2,340 for Alternative 2, 1,530 for Alternative 3, and 920 for Alternative 4.

The number of buses required is estimated as 340 for Alternative 2, 235 for Alternative 3 and 160 for Alternative 4.

6-2 Bus Terminal

The scales of bus terminals in each alternative are as follows.

Table 7-2 Proposed Bus Terminal by Alternative

Name of Bus Terminal	No. of Existing Berth	Alt. - 2			Alt. - 3			Alt. - 4		
		No. of Routes	Extra Berth	Proposed No.of Berth	No. of Routes	Extra Berth	Proposed No.of Berth	No. of Routes	Extra Berth	Proposed No.of Berth
Kuala Belait	5	3	2	5	3	1	5	3	1	5
Seria	12	5	5	10	5	3	10	5	2	10
Tutong	-	3	2	5	3	1	5	3	1	5
B.S. Begawan	20	11	11	22	10	6	20	10	4	20
Airport	-	5	5	10	5	4	10	5	3	10
Gadong	-	4	4	10	3	3	6	3	2	5

Table 7-1 Comparison of Bus Routes by Alternative

Origin/Destination	Existing				Alt.0	Alt.1	Alt. 2					Alt. 3				Alt. 4			
	No. of Bus holding	No. of Bus Trips	Average Interval of Bus Departure	Average Travel Speed	Proposed Travel Speed	Proposed Travel Speed	Distance	Proposed Travel Speed	Average Interval of Bus Departure	No. of Bus Trips	Proposed No. of Bus Holding	Proposed Travel Speed	Average Interval of Bus Departure	No. of Bus Trips	No. of Bus Holding	Proposed Travel Speed	Average Interval of Bus Departure	No. of Bus Trips	No. of Bus Holding
			min	km/hr	km/hr	km/hr	km	km/hr	min			km/hr	min			km/hr	min		
(1) BSB - Gadong	1	12	85	30	6	37	64	35	20	90	6	35	15	120	7	35	30	60	6
(2) BSB - Berakas	3	32	37	25	18	47	15	30	10	180	16	40	20	90	9	40	30	60	7
(3) BSB - Muara	11	30	40	28	30	38	266	35	10	180	22	40	10	180	20	40	20	90	12
(4) BSB - Kota Batu	1	24	50	50	30	49	10	40	10	180	10	45	15	120	8	45	20	90	7
(5) Sungai- Lumapas Kebun	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(6) BSB - Jerudong	1	10	142	36	13	55	25	35	20	90	13	40	30	60	9	40	60	30	7
(7) BSB - Limau Manis	2	8	136	43	11	47	213	30	20	90	13	40	30	60	8	40	60	30	7
(8) BSB - Lamunin	4	2	-	48	20	58	-	-	-	-	-	-	-	-	-	-	-	-	-
(9) BSB - Tutong	1	-	-	48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(10) BSB - Seria	20	51	26	50	24	56	92.5	50	10	120	48	50	10	120	48	50	20	60	26
(11) BSB - Hospital	-	16	80	30	5	32	-	-	-	-	-	-	-	-	-	-	-	-	-
(12) BSB - Airport	2	30	52	28	14	40	-	-	-	-	-	-	-	-	-	-	-	-	-
(13) Tutong - Tutong Camp	1	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1
(14) Kuala Belait - Seria	16	72	23	32	17	40	16.0	20	5	310	42	20	10	180	23	20	10	180	23
(15) Kuala Belait - Miri	4	12	90	-	-	-	-	-	-	4	4	-	-	-	4	-	-	-	4
(16) Seria - Labi	3	20	60	53	55	55	40.3	50	20	60	14	50	20	60	14	50	60	20	7
(17) Seria - Sungai Liang	2	-	-	60	51	51	20.3	50	20	60	9	50	30	40	7	50	60	20	6
(18) BSB - BSB							28.0	30	10	180	26	40	10	180	21	40	20	90	12
(19) BSB - Sulok							4.7	20	20	90	7	40	30	60	5	40	30	60	5
(20) Lambak - Rimba							23.1	20	5	360	59	40	10	180	18	40	20	90	11
(21) BSB - Kuala Belait							124.0	50	20	60	34	60	30	40	21	60	60	20	12
(22) Tutong - Lamunin							51.4	50	20	60	16	50	30	40	12	50	60	20	8
Total/Average	73	319	48	37	23	45	504.6		12	2,340	340		17	1530	235		27	920	160

1/ $= \left(\frac{60 \times \text{distance}}{\text{Travel speed}} + \text{Average interval}\right) \times 2 \times \frac{\text{Peak rate}}{\text{Average interval}}$

and peak rate = 2.0

The bus terminals to be additonally required are four places, i.e., Seria, Tutong, Airport and Gadong. Cost estimation is made using construction expenses for standard 5-berth and 10-berth bus terminals. (See Table 7-3)

Table 7-3 Bus Terminal Construction by Alternative

(Unit: 1000B$)

		Alternative 2	Alternative 3	Alternative 4
Number of standard 10-berth bus terminals to be constructed		3	2	2
Number of standard 5-berth bus terminals to be constructed		1	2	2
Bus terminal construction unit price	10 berths	632.2 (376.3) 1/	632.2 (376.3) 1/	632.2 (376.3) 1/
	5 berths	382.8	382.8	382.8
Construction Expenses	10 berths	1,640.7	1,008.5	1,008.5
	5 berths	382.8	765.6	765.6
	Total	2,023.5	1,774.1	1,774.1

1/ Unit price excluding land acquisition cost; for Seria bus terminal

6-3 Operation Office and Warkshop

The locations and construction costs of operation offices and workshops for each alternative are shown below.

Table 7-5 Bus Operation Office and Workshop Construction Cost by Alternative

(Unit : 1000 B$)

Item	Alt-2	Alt-3	Alt-4
No. of Operation Office	5	4	4
No. of Workshop	2	1	1
Typical Construction Cost			
Operation Office	1,677.5	1,677.5	1,677.5
Workshpp	1,733.3	1,733.3	1,733.3
Construction Cost			
Operation Office	8,387.5	6,710.0	6,710.0
Workshop	3,466.6	1,733.3	1,733.3
Total	11,854.1	8,443.3	8,443.3

6-4 Bus Stop

The installation standard of bus stop is set for each district and the bus stop construction cost is calculated. Since there is no change on the bus routes on all alternatives, the number of necessary bus stops and the construction cost remain unchanged on all alternatives.

Table 7-4 Bus Stop Construction Expenses by Alternative

Alternatives 2, 3, 4

	Main Bus Route	Branch Bus Route	Standard Number of Bus Stops	Number of Required Bus Stops		Total
				Number of Sheds	Number of Bus Bays	
Town center	5.2 km	-	2 places/ 500 m	20	20	
Urban area	103.9 km	12.9 km	2 places/ 1 km	234	208	
Rural area	71.2 km	68.8 km	2 places/ 5 km	56	28	
Highway	74 km	-	2 places/ 10 km	14	14	
Total	254.3	81.7 km	-	324	270	
Construction unit price per bus stop				10,850 B$	14,400 B$	
Construction expenses				3,515,400 B$	3,888,000 B$	7,403,400 B$

6-5 Road and Intersection

(1) Road design standards and typical cross section

a) Geometric design criteria

Table 7-7 Geometric Design Criteria

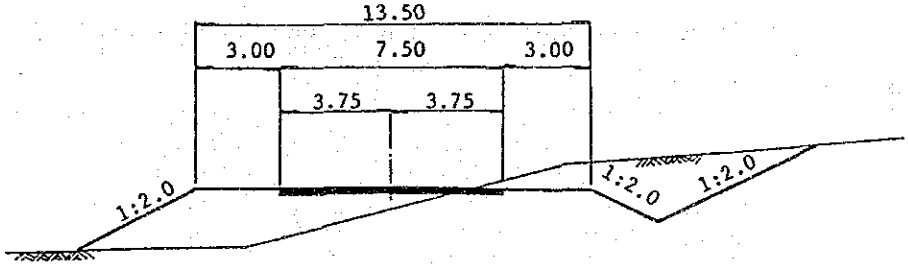
Item	Unit	Road Type	
		Two Lane Arterial	Four Lane Arterial
Design speed	km/hour	80	100
Minimum radius	m	280	460
Maximum gradient	%	5	4
Maximum superelevation	%	10	10
Vertical clearance over roadways	m	4.8	4.8

*1 Setup of design criteria is based on B.S. Standard, Road note No. 29 - 31.

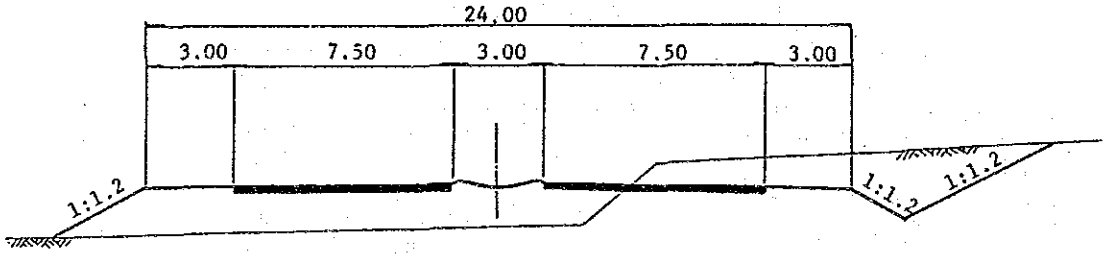
*2 The vertical gradient of the grade separated intersection of four lane arterial roads is maximum 5% with their extensions taken into account.

b) Typical cross section

Two Lane Arterial



Four Lane Arterial



(2) Unit construction costs

The unit construction costs are set as shown below based on the actual situation of construction equipment, materials and labor charges.

Table 7-8 Unit Construction Costs

As of 1984

Item No.		Items	Unit	Unit Cost	Remarks
	101			B$ 1.20	Common
01	102	Land Clearing	sq m	8.20	Swampy
02		Earthworks			
	101	Cutting	cu m	6.30	
	102	Filling	cu m	6.30	
	103	Cut/Fill & Transport	cu m	14.70	
03	101	Pavement	sq m	85.30	
04	101	Drainage Structures	km	200,000.00	0 2L. Const.
	102			300,000.00	1 4L. Const.
05	001	Turfing of Road Shoulder	sq m	10.00	
06		Slope Protection			
	101	Cutting Slope	sq m	4.70	
	102	Filling Slope	sq m	4.70	
07		Structures			
	101	Long Span Bridges	sq m	1,490.00	
	102	Short Span Bridges	sq m	1,040.00	
	103	Retaining Walls H=6.0M	m	4,470.00	
	104	Retaining Walls H=3.5M	m	2,730.00	
	105	Retaining Walls H=1.5M	m	350.00	
08	001	Highway Appurtenances	km	76,980.00	
				185,000.00	
09	001	Utilities	km	370,000.00	
10		Miscellaneouses	Unit	-	( ) 10% of aboves
				Total	
11		Design and Supervision	Unit	-	10% of Sub Total
12		Contigencies	Unit	-	10% of Sub Total
13		Land Acquisition			
	101	Urban Housing Area	sq m	320.00	
	102	Regional Housing Area	sq m	20.00	
	103	Regional Field	sq m	8.00	

(3) Road construction cost by alternatives

a) Road construction cost

The road construction cost of each alternative is estimated as shown below by applying the unit costs to the quantity of construction work as determined by the preliminary design. The planned routes on all alternatives are shown Fig. 7-6 to 7-9 in the draft final report

As the result of the traffic forecast in 1995, the link between JLN. Berakas to JLN. Muara (Major arterial road phase II) by each Alternative was proposed to be 2 lanes. Therefore, it was applied to the cost estimation and the economic evaluation that the cost reduction of 2-lanes was allocated the 4-lane link initially proposed by the government.

Furthermore, an additional economic evaluation to the under-construction 4-lane link is made after a series of economic analysis.

Table 7-9 Road Construction Cost

X10^{6}B$

Alternative	No. of Lanes and Extension		Total Cost	Breakdown	
Alternative 1	Expanded 2 lanes	51.8km	318.5 (310.2) 2/	Construction cost	200.1 (193.2)
	Newly constructed 2 lanes	1.5km		Engineering cost inclu-ding design	9.1 (8.8)
	Newly constructed 4 lanes	3.1km		Construction supervision cost	9.1 (8.8)
	Width reduced 2 lanes	(-2.4km) 1/		Land Acquisition cost	100.2 (99.4)
	Total	56.4km(54.0)			
Alternatives 2, 3	Expanded 2 lanes	7.4km	103.2 (94.9) 2/	Construction cost	62.7 (55.8)
	Newly constructed 2 lanes	6.3km		Engineering cost includ-ing design	2.9 (2.53)
	Newly constructed 4 lanes	2.5km		Construction supervision cost	2.8 (2.53)
	Width reduced 2 lanes	(-2.4km) 1/		Land acquisition cost	34.8 (34.0)
	Total	16.2km(13.8)			
Alternative 4	Expanded 2 lanes	11.2km	116.1 (107.8) 2/	Construction cost	71.7 (64.8)
	Newly constructed 2 lanes	6.3km		Engineering cost includ-ing design	3.3 (3.0)
	Newly constructed 4 lanes	2.5km		Construction supervision cost	3.3 (2.9)
	Width reduced 2 lanes	(-2.4km) 1/		Land acquisition cost	37.8
	Total	20,0km(17.6)			

1/ Width reduced 2 lanes means the section between JLN Berakas and JLN Muara of the 4-lane ring road - Major arterial road Phase II - currently under construction by the government, which is considered to be sufficient with two lanes from the viewpoint of the traffic demand in 1995. Computation is made as reduction of road cost with two lanes.

2/ Figures in ( ) are what take into account reduced cost of Major arterial road II to 2-lane road.

(4) Construction cost for grade separated intersection

It is judged that grade separation is required from the results of the future traffic demand at intersections of each alternative. As a result, Alternative 1 needs two grade separated intersections and Alternatives 2, 3 and 4 need one grade separated intersection, in addition to the three grade separated intersections that the government is constructing at present.

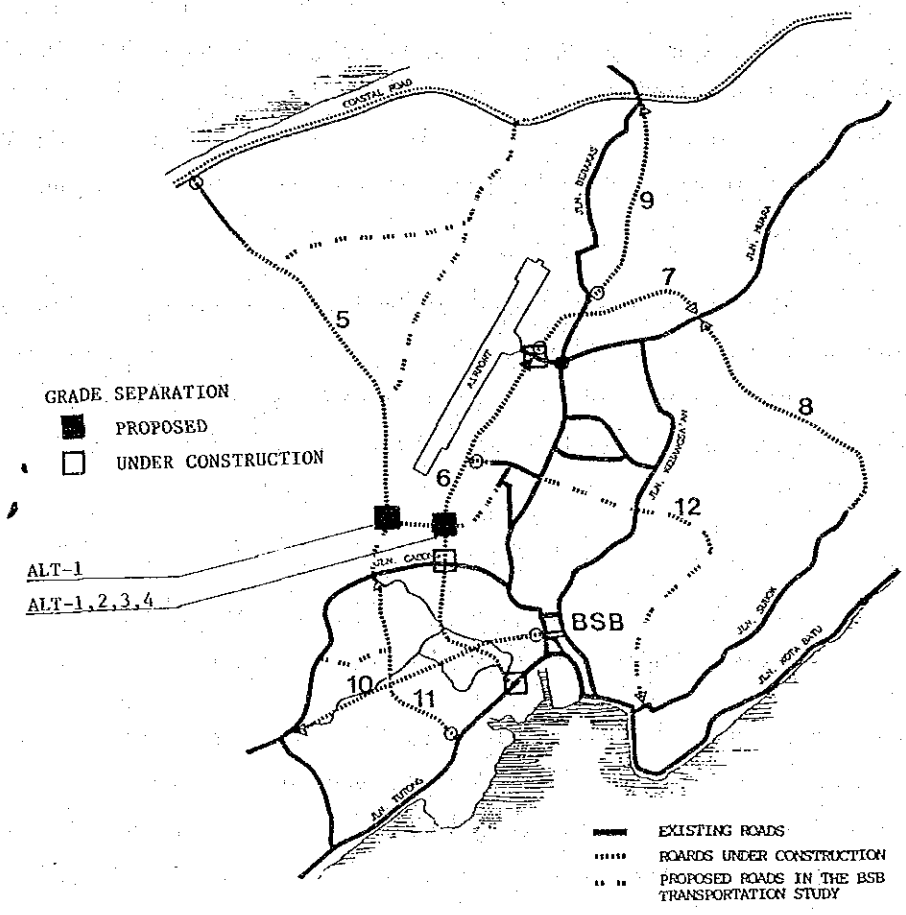


Fig. 7-10 Location Map of Grade Separation