Table 5.9 Q - V FORMULA FOR VEHICLE

Area	No. of land	Type of road	Speed (miles per hour) designed	limited	marginal	minimum	Capaticy for one direction
Urbanized Area	4	new	50	30	15	5	22500
		existing	40	30	15	5	18000
	2	new	40	30	15	5	6000
		existing (A)	40	30	15	5	4000
		existing (B)	35	30	15	5	3500
		existing (C)	30	30	10	5	3000
Sub-urban Area	4	new	60	40	15	5	29000
		existing	50	40	15	5	20500
	2	new	45	40	15	5	7500
		existing (A)	40	40	15	5	5000
		existing (B)	35	35	10	5	4000
Highway	4	new	80	50	15	5	32000

5. In the case of the Penang Bridge and the ferry collect tolls, the toll is added to the travel time which corresponds to the toll paid. To convert the toll paid to the travel time, divide the toll by the time value.

6. The traffic assignment is conducted through using the O-D table. Therefore, the size of the traffic zone limits the traffic assignment. The detailed traffic volume on each road cannot be obtained from this method and, also, there is more traffic than there actually should be around the zone node which represents a particular zone because all the trip generation and attraction of one zone are generated and attracted to/from this node. This should be kept in mind when looking at the results of trip assignment.

5.3.2 Estimation of Future Traffic Demand on Road Network

1. Estimation for Traffic Assignment

The alternative road network plans for traffic assignment are already selected as follows;

1979 Present

1985	Base Case
	Under Planning
	Proposed
	Under Planning & Proposed
2000	Under Planning & Proposed
	Ultimate

Estimations for traffic assignment are conducted according to Table 5.10.

Table 5.10 ESTIMATE FOR TRAFFIC ASSIGNMENT

	Year / O-D Type / Road Network	1979	1985		2000			
		Present	Plan A	Plan B	Plan A	Plan B	Plan C	Plan D
	Present	Present						
	Base Case		Base		Base			
1	Under Planning		1-A					
2	Proposed		2-A					
3	Under Planning & Proposed		3-A	3-B	3-A	3-B		
4	Ultimate				4-A	4-B	4-C	4-D

2. Comparison of Travel Speed by Each Case

One figure which is able to show the objective evaluation about the degree of road network improvement is the travel speed by road network plans.

In 1985, the average travel speed in all cases will exceed the present speed, even in the situation of "base case" due to the completion of the Penang Bridge and the dispersal roads.

In the year 2000, only the average travel speed of "ultimate" road network will be on par with the present level.

This shows that a large investment is required for the improvement of road networks in order to keep the traffic congestion at the present level.

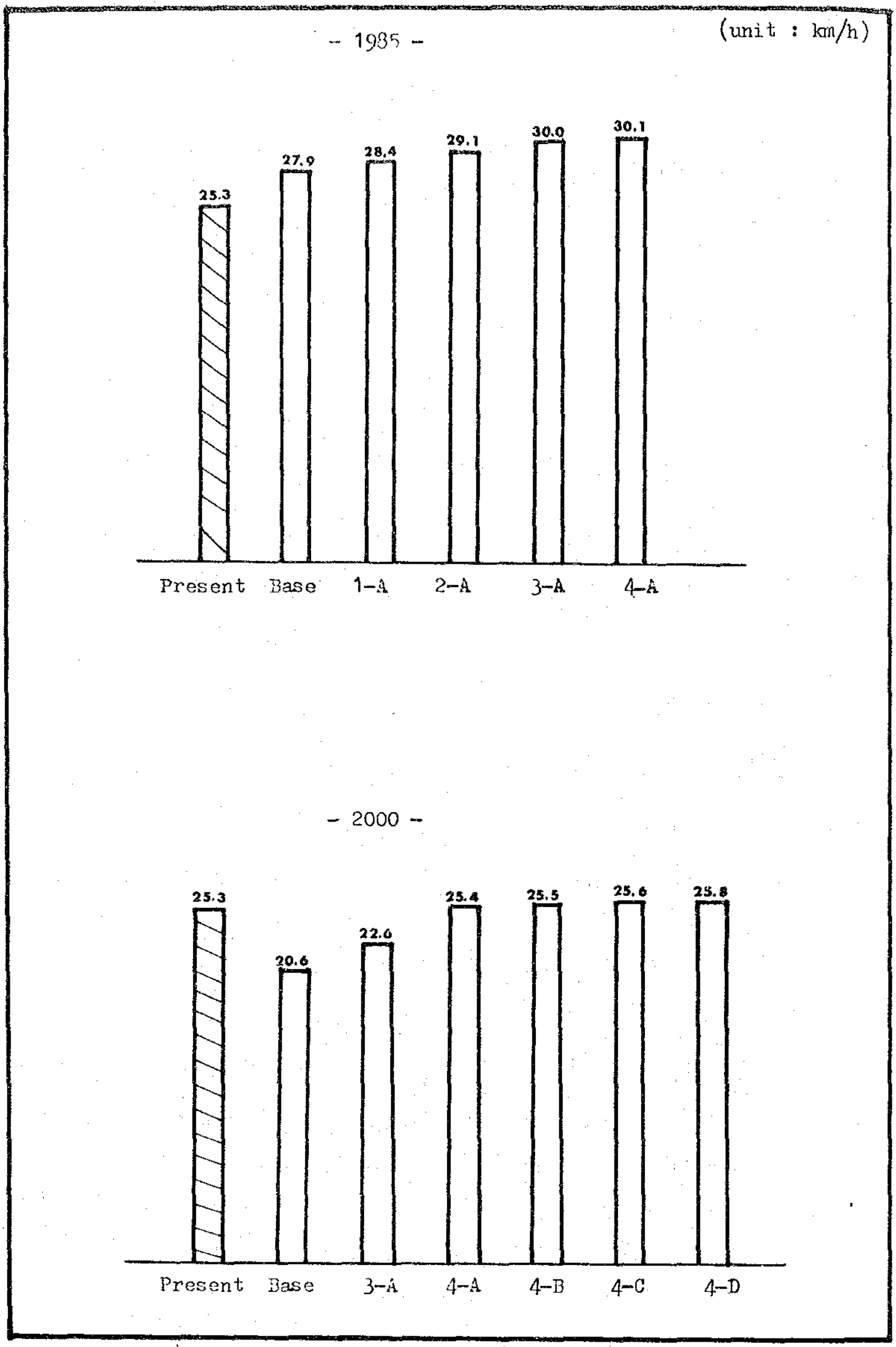


Fig. 5.12 The Comparison of Travel Speed

3. Comparison of the Degree of Congestion by Road Network Plans

Another way to compare the road network plans is to use the degree of congestion.

In this section, a comparison between those cases which can illustrate the apparent differences will be made. For a calculation of the degree of congestion the daily capacity is used as in Fig. 5.11 according to the type of road.

Table 5.11 THE DAILY CAPACITY

(Unit : 1000 p.c.u.)

	Urbanized Area		Sub-urban Area		Highway
	Existing	New	Existing	New	
2 lane	8000	12000	10000	15000	64000
4 lane	36000	45000	41000	58000	

(a) Comparison for the year 1985

For the year 1985, a comparison is made between road network "Under Planning" and "Under Planning & Proposed". Fig. 5.14 clearly shows the difference in the congestion degree. Therefore, it is advisable to complete the road network "Under Planning & Proposed" after opening of the Penang Bridge.

(b) Comparison for the year 2000

For the year 2000, a comparison is made between road network "Under Planning & Proposed" and "Ultimate". Due to the tremendous increase in traffic demand, there will be some congested links, even in the case of, "Ultimate". Therefore, this road network must be planned in time for the year 2000.

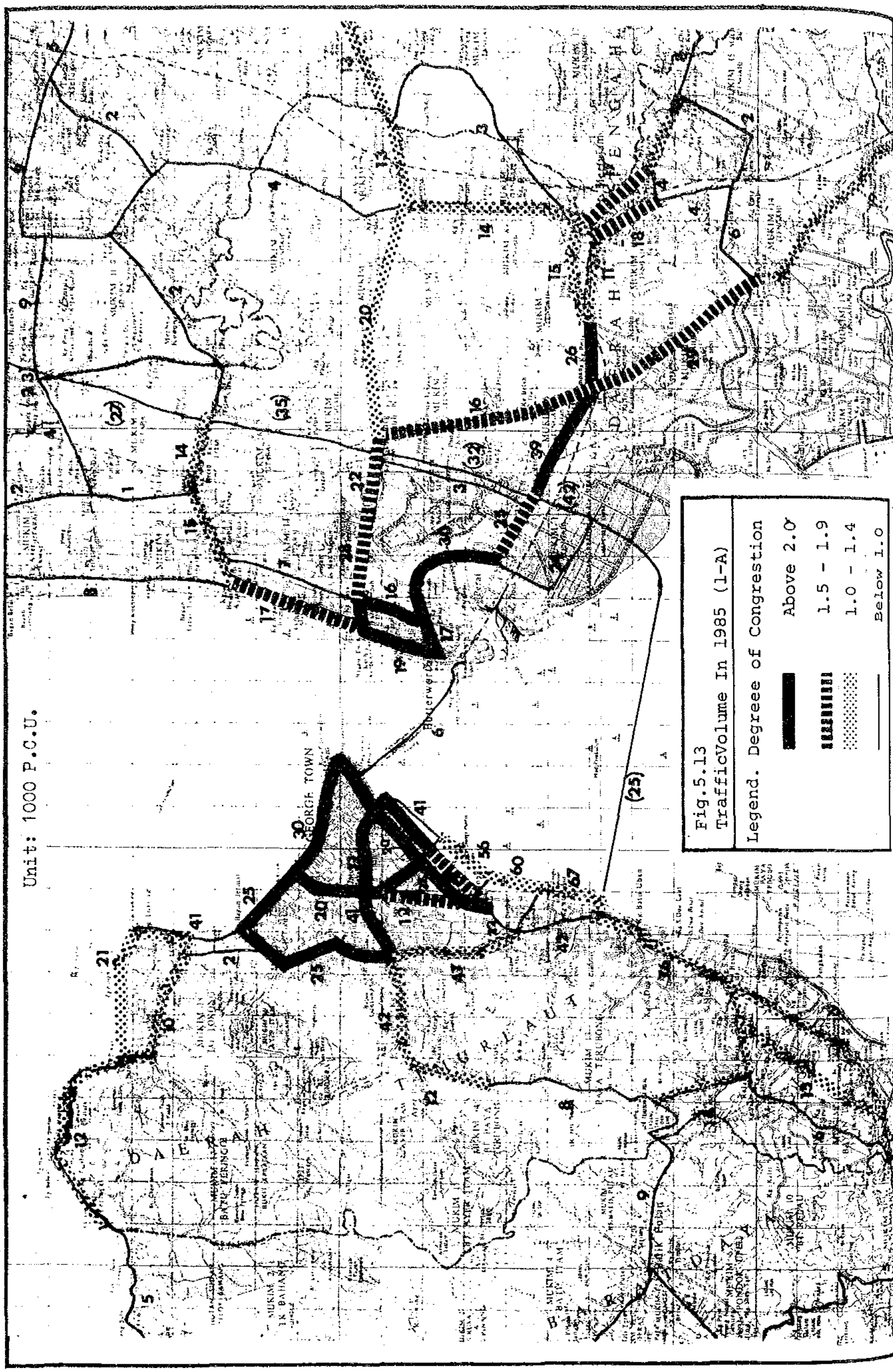


Fig.5.13
TrafficVolume In 1985 (1-A)

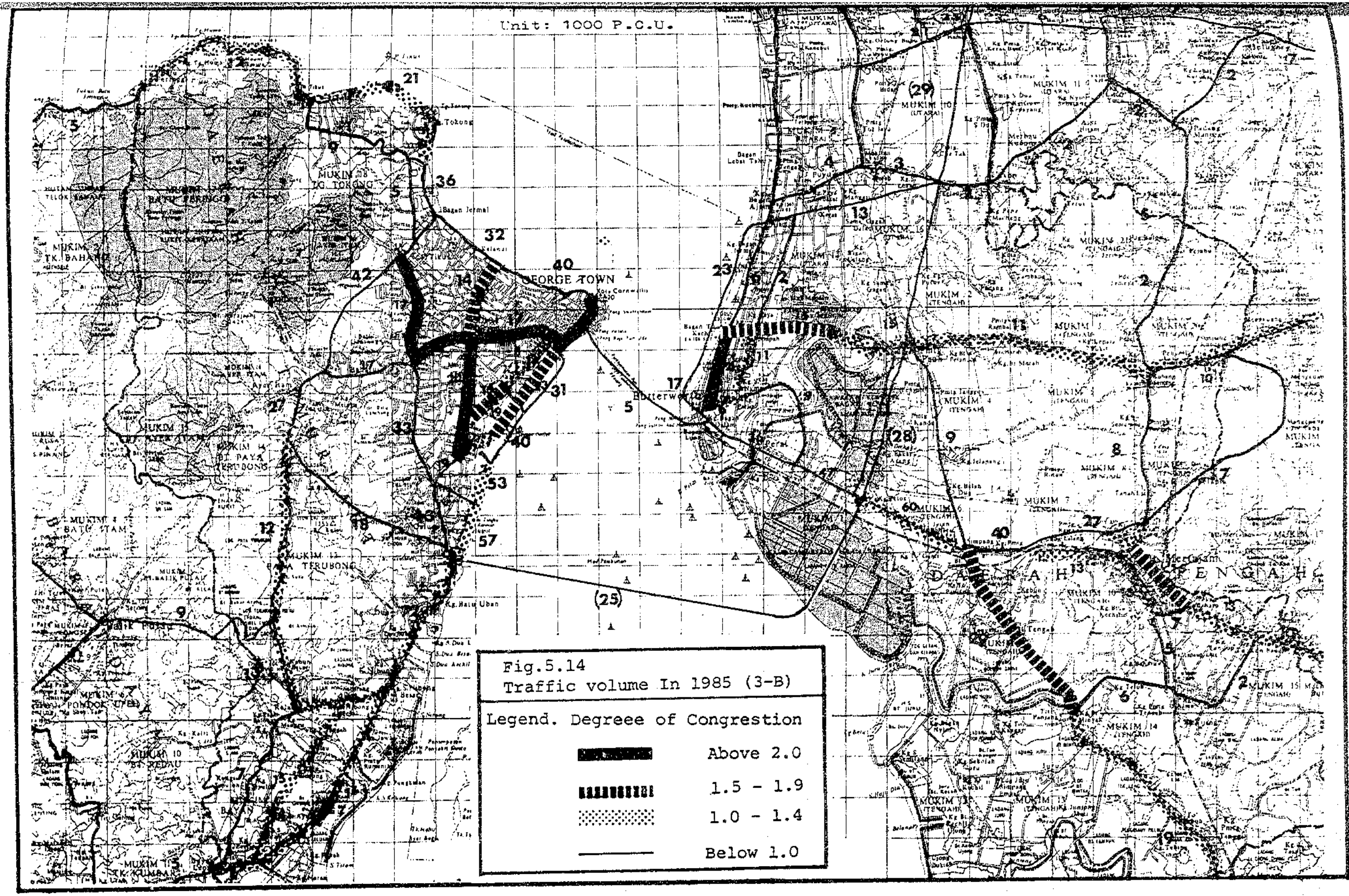


Fig.5.14
Traffic volume In 1985 (3-B)

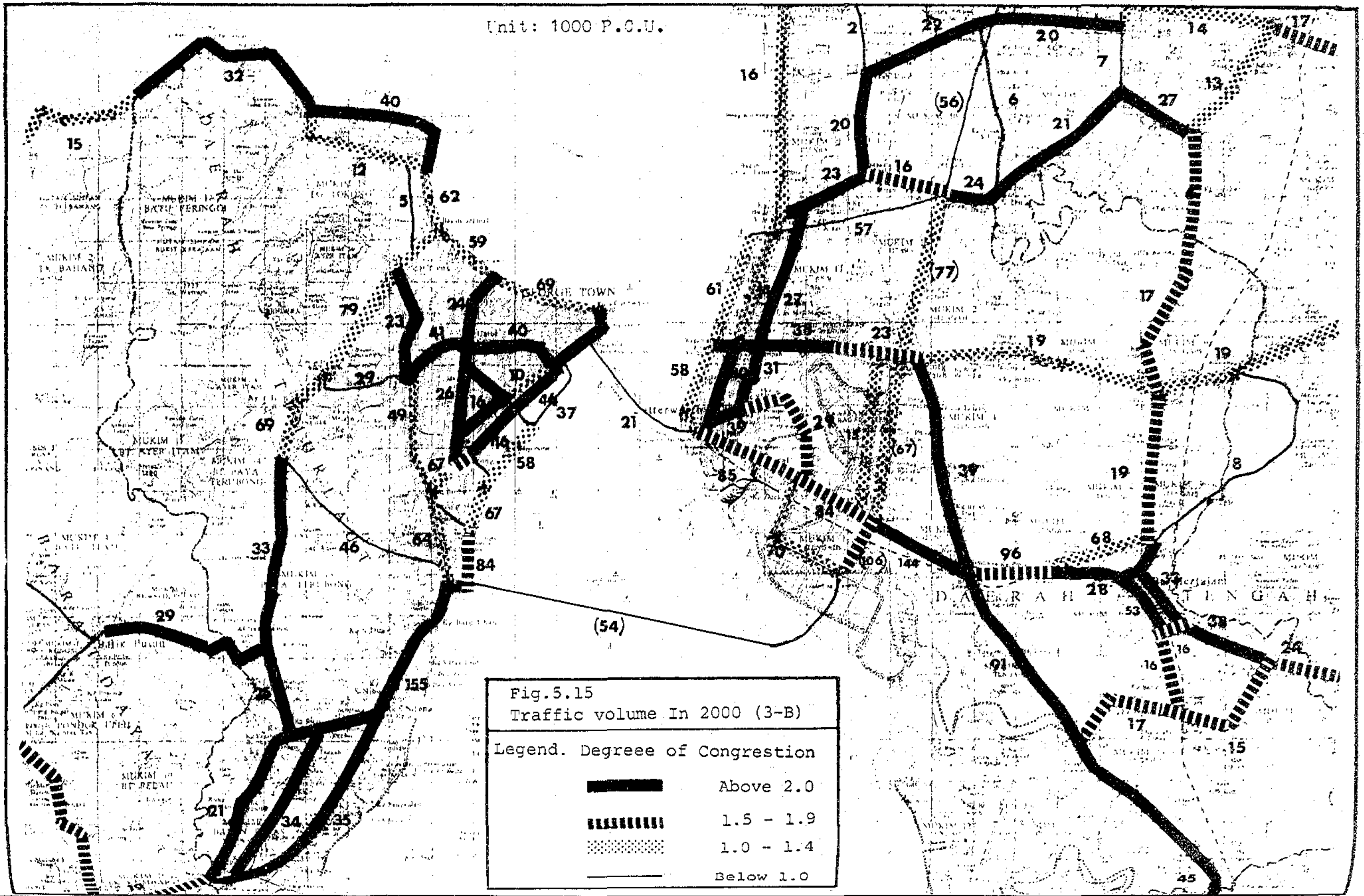


Fig.5.15
Traffic volume In 2000 (3-B)

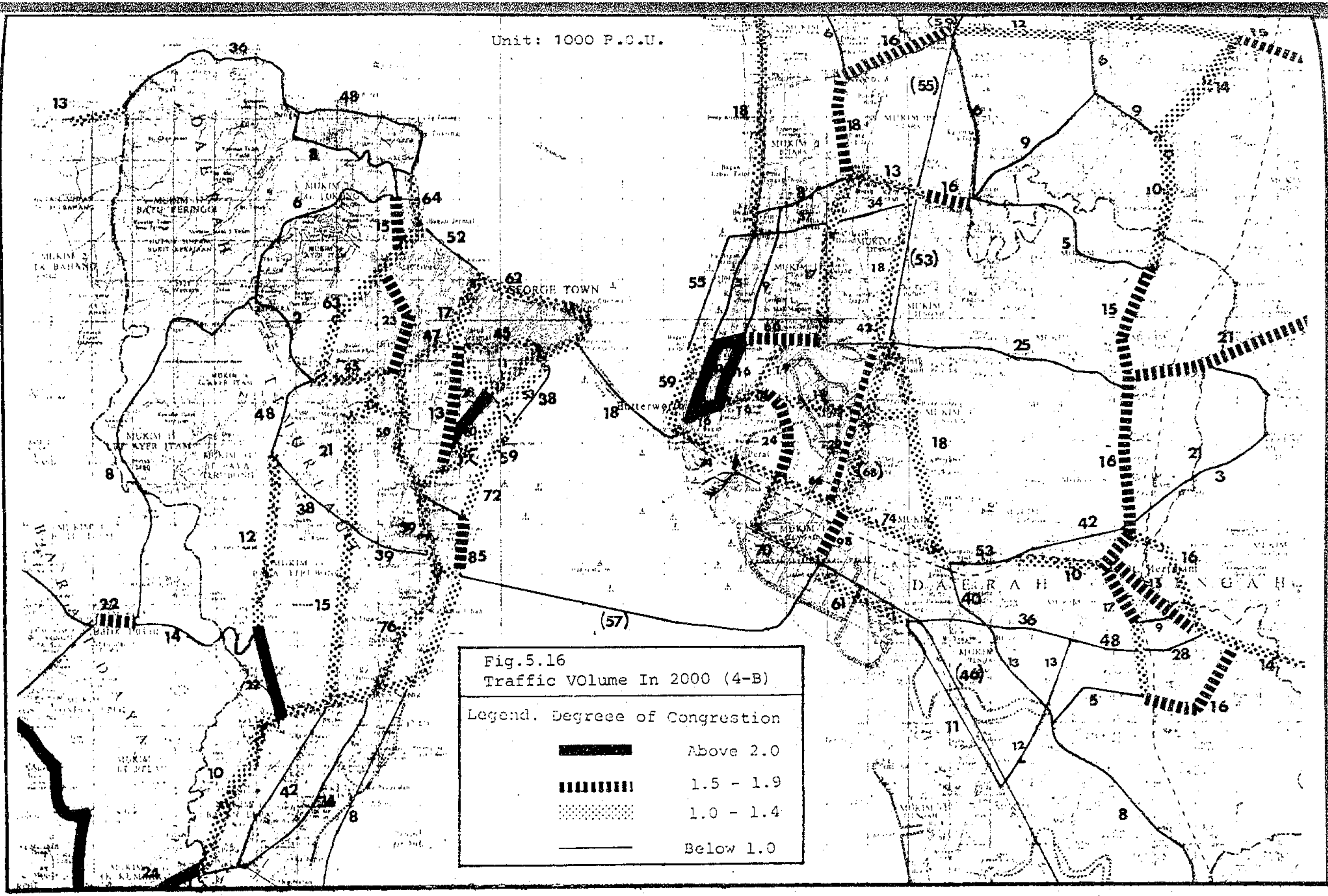


Fig.5.16
Traffic VOlume In 2000 (4-B)

5.3.3 Comparison of Traffic Demand Related to the C.B.D. by Alternative Plans

In order to compare the traffic demand by alternative transport policies, an inner and a center cordon line are planned (See Fig. 5.17). The results of the transport policies are particulary visible on these two (2) lines as the transport policies are devised to prevent traffic congestion around C.B.D.

1. Comparison for The year 1985

The decrease in traffic volume on these lines through execution of parking controls and introduction of exclusive bus lanes is shown in the following table:-

Table 5.12 DECREASE IN TRAFFIC VOLUME BY PLANS

(Unit : 1000 p.c.u.)

plan / line	Plan A	Plan B	difference (A - B)
inner cordon	183.7	178.2	5.5
center cordon	269.8	261.4	8.4

Note: Inner cordon : the line which surrounds the zone 111.
Center cordon : the line which surrounds the C.B.D. area (zone 111, 121, 131)

The reduction volume, which at first sight seems to be insignificant, corresponds to a capacity of a 2-lane road; therefore, it is advisable to introduce these policies by the year 1985.

(Unit: 1000 P.C.U.)
( ): The degree of congestion.

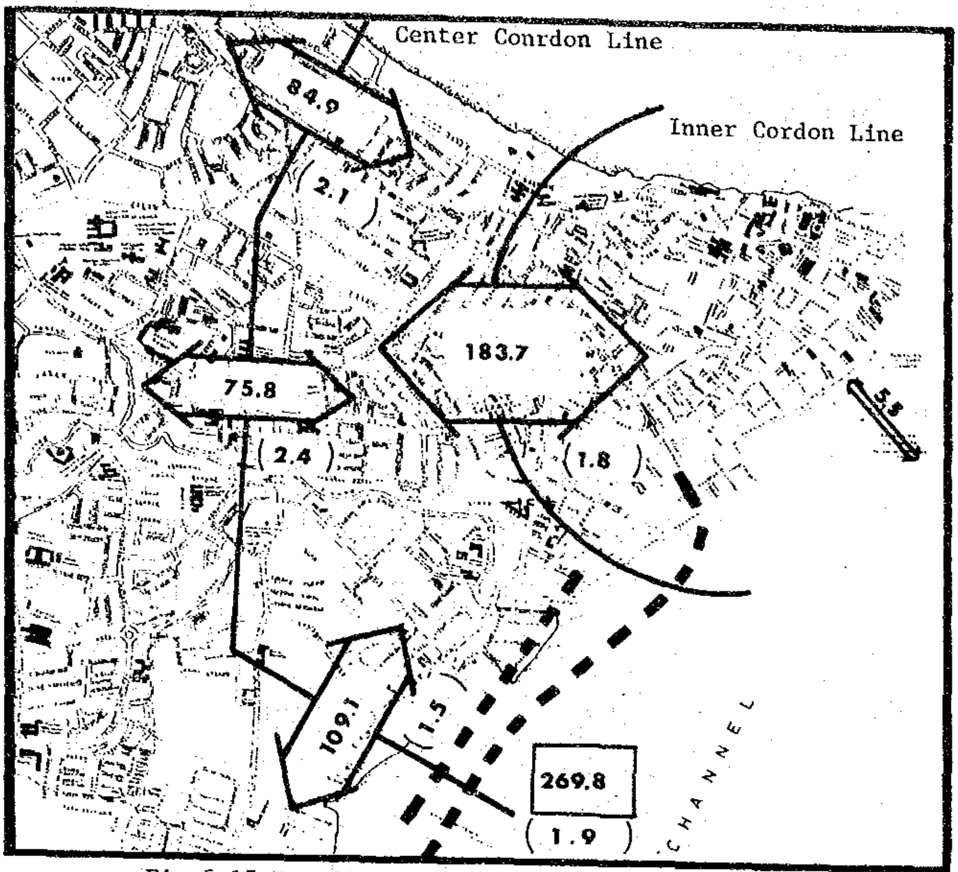


Fig.5.17 Traffic Volume by Plan 1-A in 1985

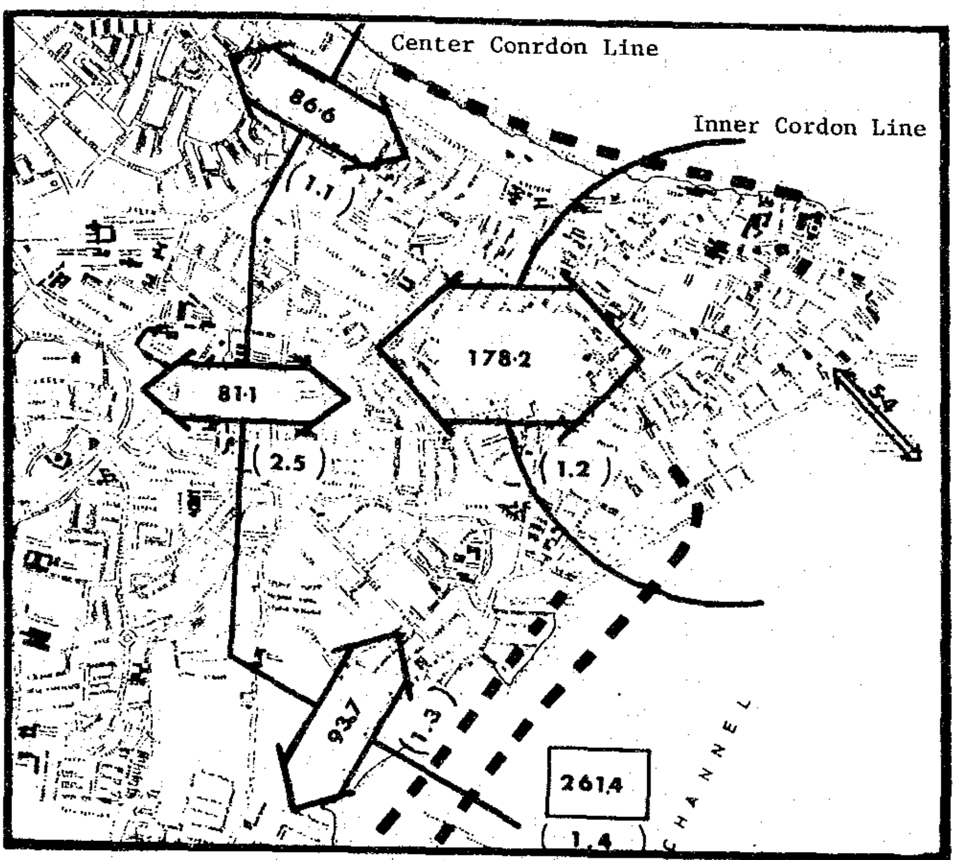


Fig.5.18 Traffic Volume by Plan 3-B in 1985

2 Comparison for the year 2000

For the year 2000, the following three (3) policies are examined:-

1) The control of parking demand and the introduction of exclusive bus lanes.

2) The introduction of N.T.S.

3) The execution of car pooling system.

The decrease in traffic volume through these policies is as follows:-

Table 5.13 DECREASE IN TRAFFIC VOLUME BY PLANS

(1000 : p.c.u.)

	Plan A	Plan B	Plan C	Plan D
Inner cordon	302.2	281.6	274.0	225.3
Difference from A	-	-20.6	-28.2	-76.3
Center cordon	428.5	400.0	393.8	337.2
Difference from A	-	-28.5	-34.7	-91.3

All policies produce, to a certain extent, the intended effect on present conbested traffic situations. However, the most effective policy is the car pooling system, whereby the traffic volume will be reduced by about 76,000 - 91,000 p.c.u. The difference between Plan B and Plan C is about 6,000 - 8,000 p.c.u., due to the introduction of N.T.S. This diversion volume from car to N.T.S. is not so large because the scheduled speed of N.T.S. and the travel speed of cars are not so different.

However, these figures will be re-examined in detail when the introduction of N.T.S. is close to actualization. Thus, in order to raise the function of the C.B.D. area, the level of traffic congestion should be kept, that is, the degree of congestion on the cordon line should not exceed 1.5. Fig. 5.24 shows that the above objective is effectuated only through introduction of Plan D. Therefore, it will be necessary to bring the car pooling system into effect by the year 2000.

(Unit:1000 P.C.U.)
( ):The degree of congestion.

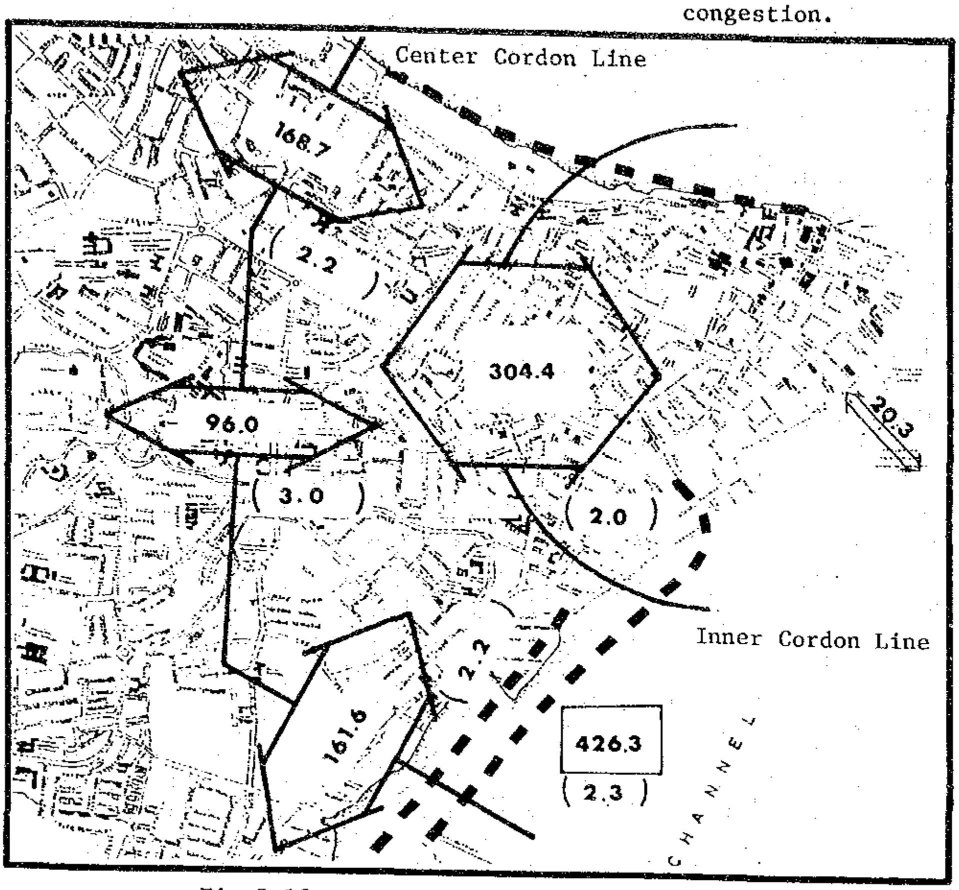


Fig.5.19 Traffic by Plan 3-A in 2000

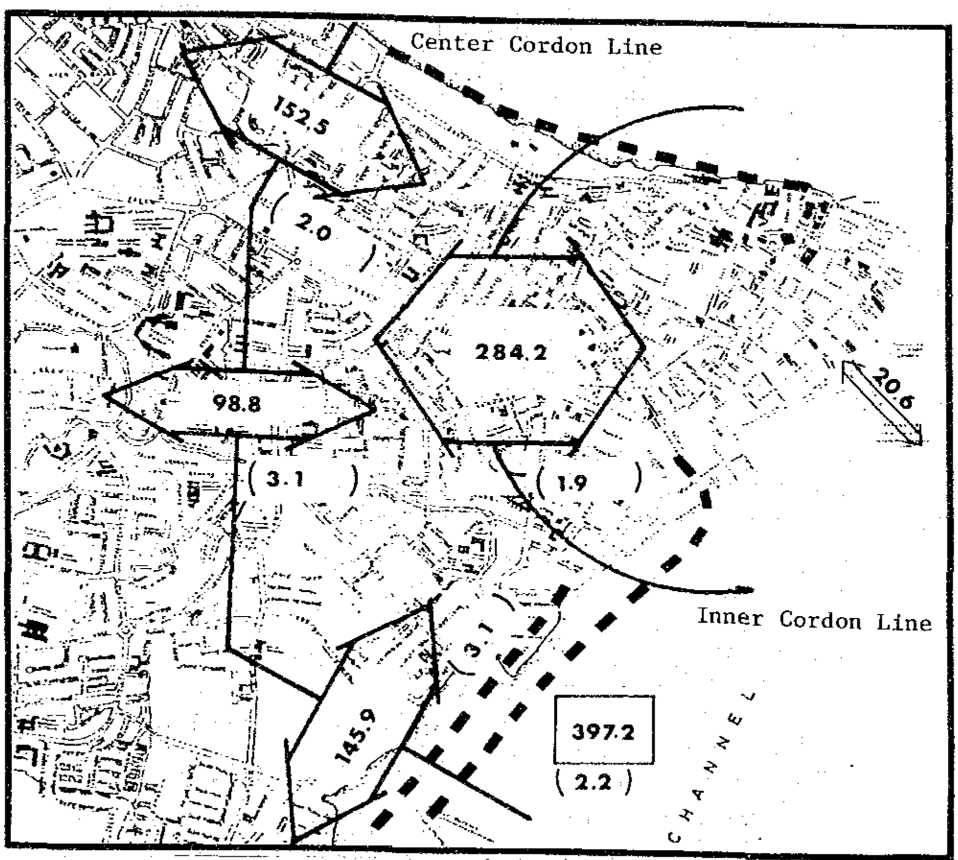


Fig.5.20 Traffic Volume by Plan 3-B in 2000

(Unit:1000 P.C.U.)
( ): The degree of congestion.

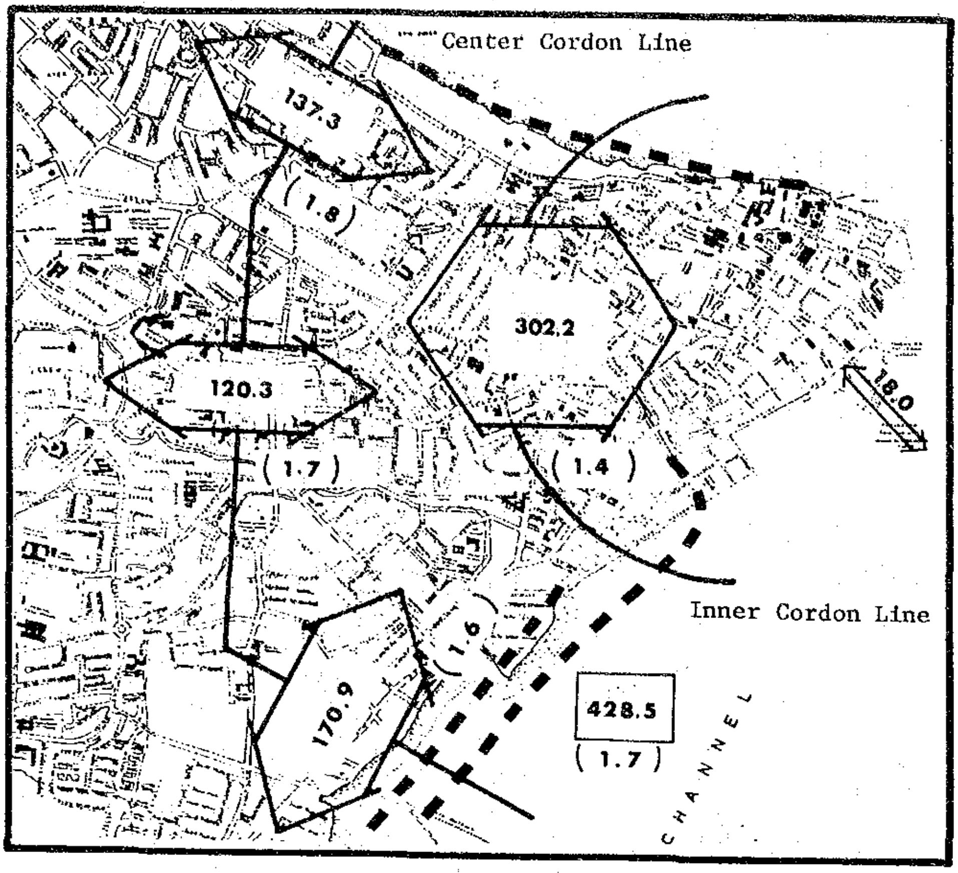


Fig.5.21 Traffic Volume by Plan 4-A in 2000

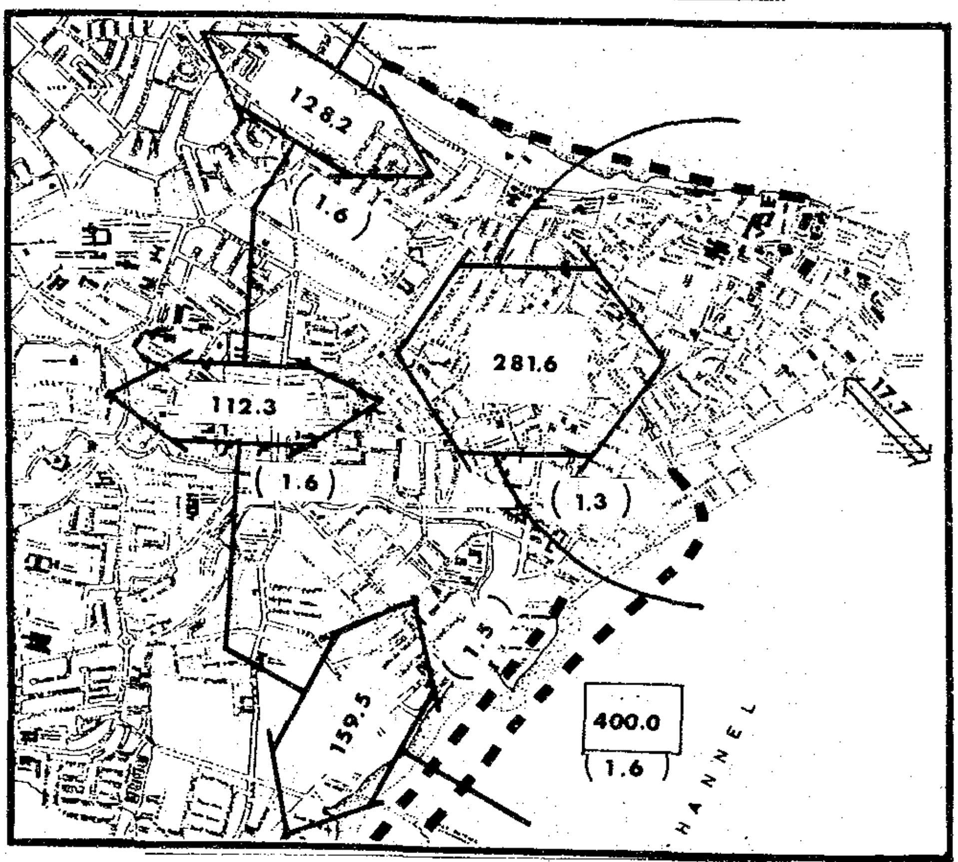


Fig.5.22 Traffic Volume by Plan 4-B in 2000

(Unit:1000 P.C.U)
( ):The degree of
congestion.

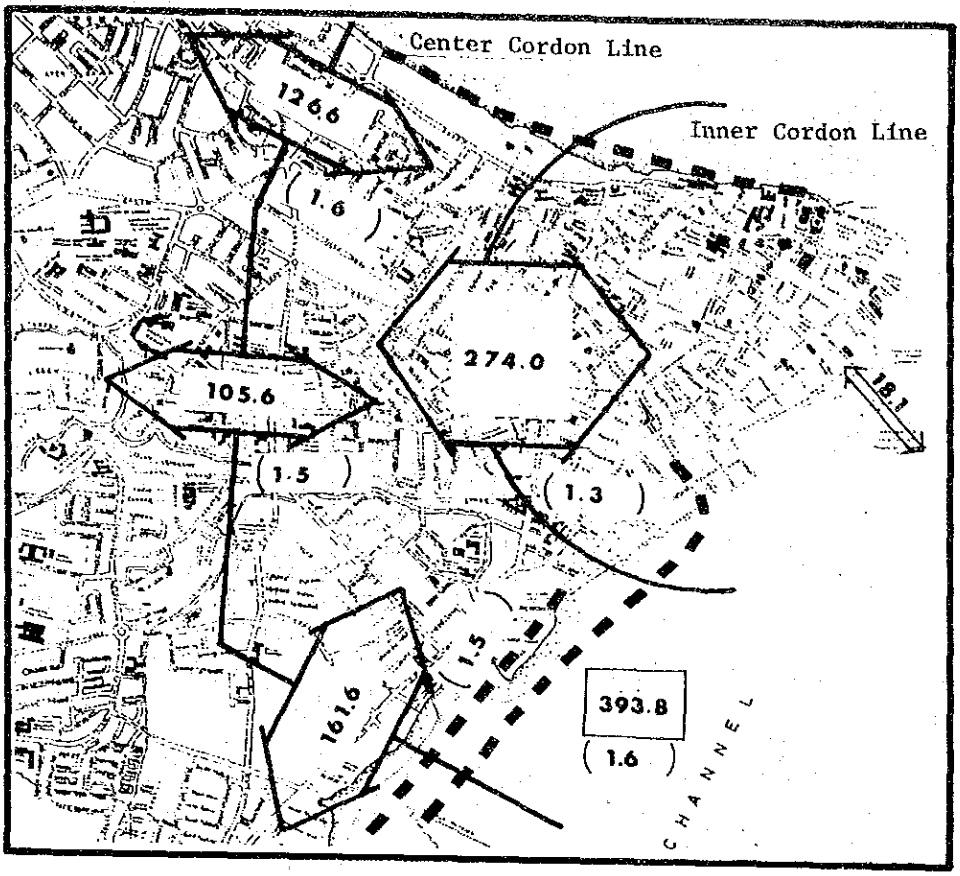


Fig.5.23 Traffic Volume by Plan 4-C in 2000

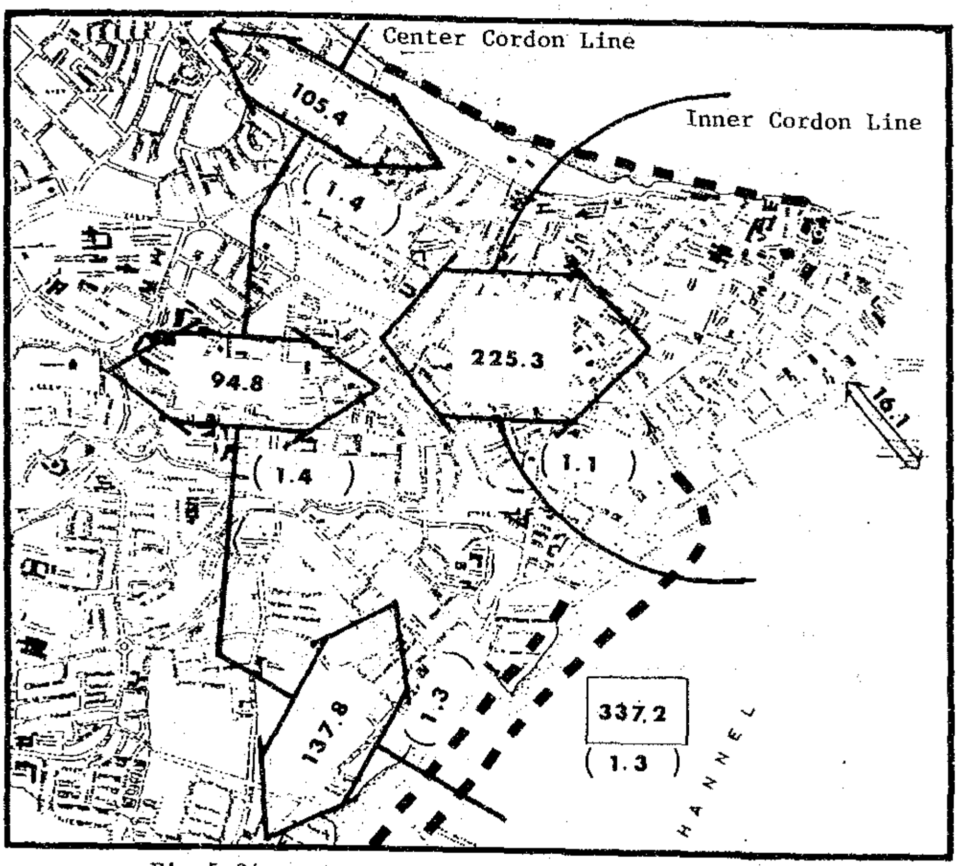


Fig.5.24 Traffic Volume by Plan 4-D in 2000

( ):The degree of congestion.

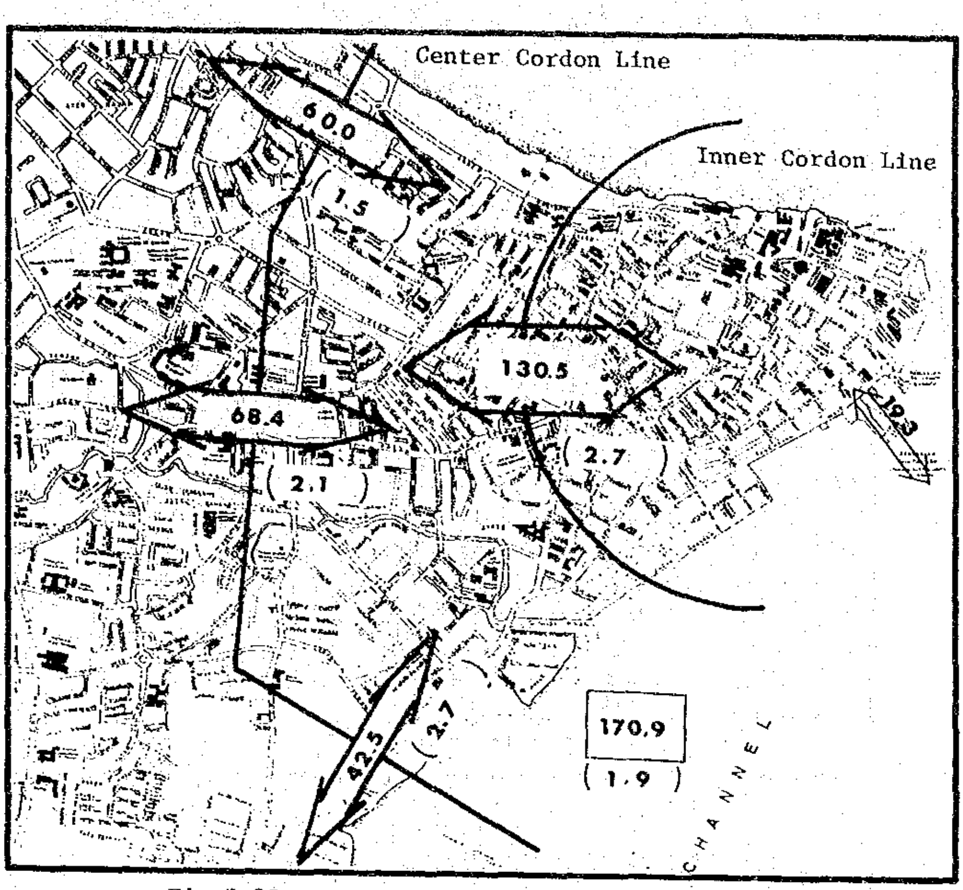


Fig.5.25 Present traffic Volume.

5.4 Estimation of the Future Traffic Demand on the Ferry

The ferry service plays a very important role at present due to it being the only means of public transport between George Town and Butterworth.

This situation will continue until the Penang Bridge is constructed. After the completion of the bridge, there will be two ways across the straits and so some changes in the overall traffic volume are expected when the services of both the ferry and the bridge are available without any protective strategies.

As the situation of the ferry service will be affected, our study should be divided into tow (2) phases; phase A being "before the completion of the bridge" and phase B being "after the completion of the bridge". Besides this, the progress from phase A to phase B should also be considered.

Although the ferry service in the future will surely experience a different situation, there are still some unknown factors such as the toll for the bridge, the actual terms of operation and so forth; thus, it can be said that the future role of the ferry is one of uncertainty. To ascertain this to a close extent, we will examine future demand in phase A and in phase B separately, after which the progress is considered.

5.4.1 Before Completion of the Bridge (Phase A)

The completion of the Penang Bridge is expected to be in late 1984. Prior to this, the ferry service is the only means to and fro across the straits. Thus, the role of the ferry will be the same as before.

1. Demand Forecast

The demand for the ferry service depends mainly upon the urban activity potential and partly upon the level of its service.

As the present service level seems almost adequate for satisfying the demand except during peak hours at Butterworth, it will be possible to forecast future demand by menas of tracing the present trend.

Some forecasts have already been done by a consultant in April 1978. Here, a summary of the projections is shown.

Table 5.14 FORECAST OF FERRY TRAFFIC GROWTH

(One Way Trips in Thousands)

		*Upper Bound		Growth rate (%)	*Lower Bound		Growth rate (%)
	1977 (actual)	1980	1985		1980	1985	
Trucks	486	640	1004	9.5	620	933	8.5
Motorcars	2900	4300	8570	14.0	3910	6450	10.5
Motor-cycles	3858	5870	11800	15.0	5210	8580	10.5
Bicycles	1084	990	850	-3.0	930	720	-5.0
Passengers	19644	23070	30147	5.5	21220	24120	2.6

*Note: "Upper Bound" as referred to in the data source is a "relatively straightforward extrapolation of the trend over the past 5-10 years. "Lower Bound" is based on macroeconomic indicators and follows the earlier projections made in connection with "The Penang Bridge Study".

Source: "Analysis of the capacity of the Penang Ferry Service", 1978. - E.G. Frankel Inc., U.S.A.

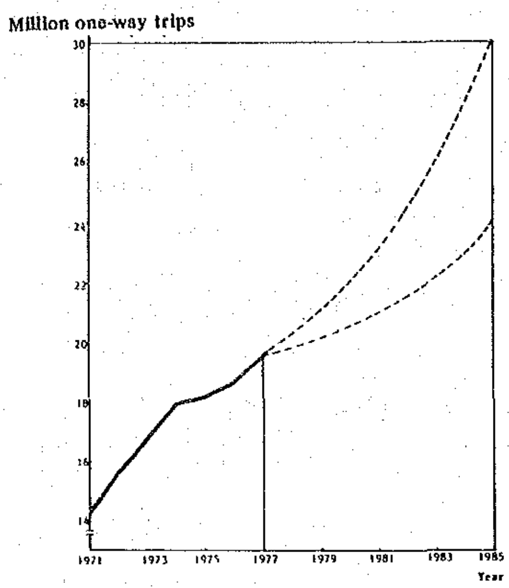


Fig. 5.26 Annual Passenger Traffic

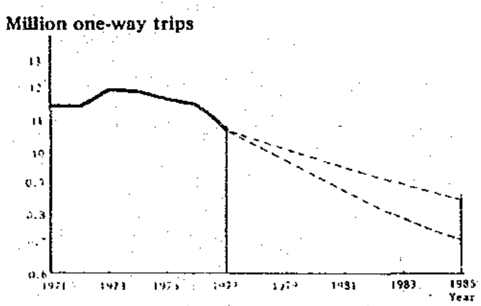


Fig. 5.27 Annual Bicycle Traffic

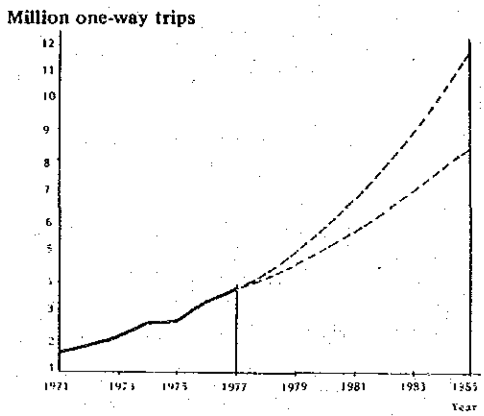


Fig. 5.28 Annual Motorcar Traffic

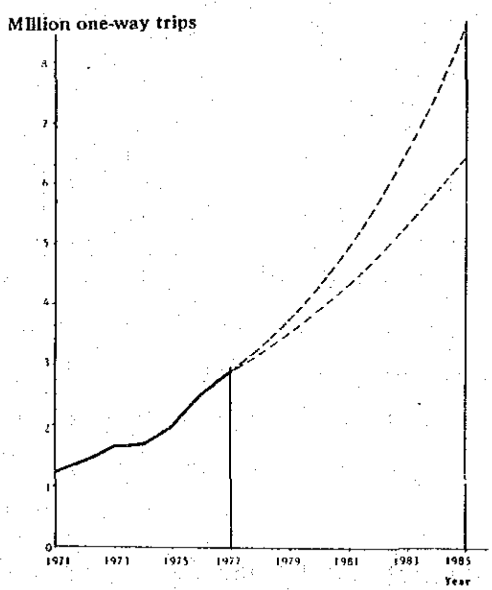


Fig. 5.29 Annual Motor-cycle Traffic

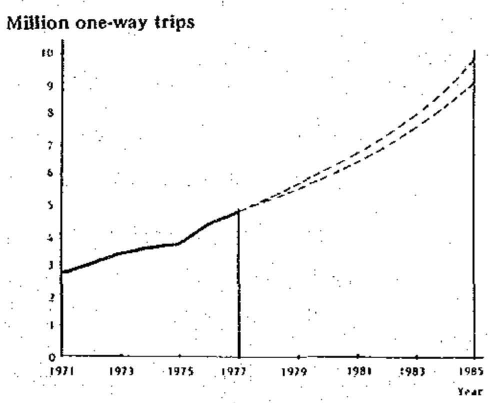


Fig. 5.30 Annual Lorry Traffic

According to these results, all traffic volume excluding bicycles are forecasted to increase by an annual growth rate of 5 percent to 15 percent in the upper bound and 3 percent to 11 percent in the lower bound.

When these estimates are examined against actual results in 1978, those of motor-cycles, trucks and passengers indicate a greater volume than that estimated in 1978; whereas the volume of cars and bicycles is within the range estimated. Therefore, it will be possible that in the future the demand will be beyond the upper bound estimated here above, even if some of the ferry capacity is strengthened according to the increase in demand.

In addition, the study team forecasted the traffic volume of motor-cycles, cars and trucks utilising the ferry in 1985 without the Penang Bridge.

The brief results are shown below.

Table 5.15 ESTIMATED FERRY TRAFFIC
(No. of vehicles/day)

	Motor-cycles	Vehicles	(Car , Trucks)
1979	13,000 (100)	10,800 (100)	(9,150 , 1,650)
1985	14,400 (111)	14,600 (135)	(12,170 , 2,430)

These estimates are obtained by the least square method (linear curve) from the results of in 1965 to 1979, and so these are less than those which are forecasted by applying quadric curve.

The traffic volume of the ferry will mainly depend on the ferry capacity provided, and the forecasted results range from 14,600 vehicles to 24,380 vehicles per day. Since the range of the forecasted results is very wide, it is difficult to reach a decision on the most correct forecasted volume. This can be done however by comparing the traffic volume before and after the Penang Bridge.

5.4.2 After Completion of the Bridge (Phase B)

1. Demand Forecast

The situation of the ferry service will completely change after the completion of the Penang Bridge. The projection of traffic volume until 1985, before the completion of the Penang Bridge, was made in the earlier section while in this section part of the results forecasted for 1985 and the year 2000 are shown.

In our traffic assignment, we obtained the traffic volume on the Penang Bridge and the ferry as well as on each road section by including these links in the whole network and by using the method in which the bridge toll and ferry fares are converted into the time resistance factor.

The folloiwng assumptions are made:

* The toll of the bridge is almost the same as that of the ferry.
* The time values are 3.7 M$/hour in 1979, 4.5 in 1985 and 7.3 in the year 2000 for passenger cars.
* Both fares are variable in accordance with the increase of time value.
* It takes over 5 minutes depending on the demand at the access of ferry terminal.

As a result the time resistance is calculated as 4.80 minutes/kilometer for the ferry and 1.40 minutes/kilometer for the bridge in case of passenger cars.

The results which are estimated based on these assumptions are shown as follows.

Table 5.16 TRAFFIC VOLUME ACROSS THE STRAITS

(per day)

Year	Type of Vehicel	Ferry	Bridge	Total
1979	Motor-cycle	13,000	–	13,000
	Car	9,150	–	9,150
	Truck	1,650	–	1,650
	(P.C.U.)	(19,300)	–	(19,300)
1985 Plan A	Motor-cycle	6,500	8,200	14,700
	Car	1,400	11,460	12,860
	Truck	280	6,060	6,340
	(P.C.U.)	(5,400) (17.1)	(26,200) (82.9)	(31,600) (100)
2000 Plan A	Motor-cycle	6,200	9,300	15,800
	Car	10,000	26,180	36,180
	Truck	1,840	14,880	16,720
	(P.C.U.)	(17,700) (23.4)	(58,000) (76.6)	(75,700) (100)

Regarding passengers, the share of fellow passengers in vehicles has increased as shown in section 2. If the ratio of fellow passengers by type of vehicle is constant and the diverted volume to the bridge is small, the following results are estimated.

Table 5.17 PASSENGER VOLUME ON FERRY

(Unit : person per day)

	Real passengers	Fellow passengers	Total
1979	39,800	16,300	56,100
1985	43,180*	3,240	46,420
2000	52,940**	17,840	70,780

* Estimated from the results in 5.4.1.

** Estimated by annual growth rate 1979 to 1985.

The volume of bicycles is also estimated from the trend.

Table 5.18 BICYCLE ON FERRY

	1979	1985	2000
No. of Bicycles	2,870	2,150	-

2. Effects of Bridge Tolls

When the traffic volume on the ferry and on the bridge are compared with each other, it is supposed that the time resistance factor influences the share of traffic demand to a large extent.

Four (4) cases of the bridge tolls are presented below in order to measure their effects in 1985.

The assumed factors are as follows.

Table 5.19 FARE & TOLL RESISTANCE EXPRESSED IN TERMS OF TIME (MIN/KM)

	Linkage (10.5 km)		Ferry (3.0 km)
Base Case	1.40	(1.00)	4.80
Case 1	0	(0.00)	4.80
Case 2	2.10	(1.50)	4.80
Case 3	2.80	(1.50)	4.80
Case 4	4.20	(3.00)	4.80

* Calculated by $\frac{\text{fare (cent/km)}}{\text{time value (cent/min.)}}$

The following results indicate only vehicle volume in P.C.U.

Table 5.20 COMPARISON OF EACH CASE

(unit : p.c.u.)

	Ferry	Linkage	Total
Base Case	2,170 (9.2) (100)	21,320 (90.8) (100)	23,490 (100)
Case 1	910 (3.9) (42)	22,580 (96.1) (106)	23,490 (100)
Case 2	2,570 (10.9) (1.18)	20,920 (89.1) (98)	23,490 (100)
Case 3	3,040 (12.9) (1.40)	20,450 (87.1) (96)	23,490 (100)
Case 4	4,530 (19.3) (209)	18,960 (80.7) (89)	23,490 (100)

Any change in the toll does not influence the traffic volume of the ferry greatly. The reasons seem to be as follows:

1. The total traffic volume across the straits is not so heavy compared with the capacity of access roads to the bridge in 1985.

2. In case of the ferry, the share of fare resistance to the total is smaller than that in case of the Penang Bridge.

5.5 Estimation of the Future Traffic Demand of Bus Passenger by Plan

The bus network for traffic assignment is provided based on the present one with the network in future not modified very much except for some new routes as the present network coverage is almost adequate in the Study Area.

The assumed running factors in consideration of the average speed of other vehicles and present conditions are as follows:-

Table 5.21 RUNNING SPEED

	in 1985	in 2000
Suburban Area	18km/hour	14km/hour
City Area	12	9

5.5.1 Effect of Introducing Exclusive Bus Lanes

In order to improve the service against the worsening road conditions, the study team proposed to introduce exclusive bus lanes in George Town and from Butterworth to Bukit Mertajam.

In forecasting the passenger volume, two (2) steps are taken into consideration; one is the diverted volume from vehicles by a control system of parking demand and the other is the diverted volume from vehicles and motor-cycles by exclusive bus lanes. The following shows only brief resutls.

Table 5.22 BUS PASSENGERS BY PLAN B

(Unit : 1000 passengers)

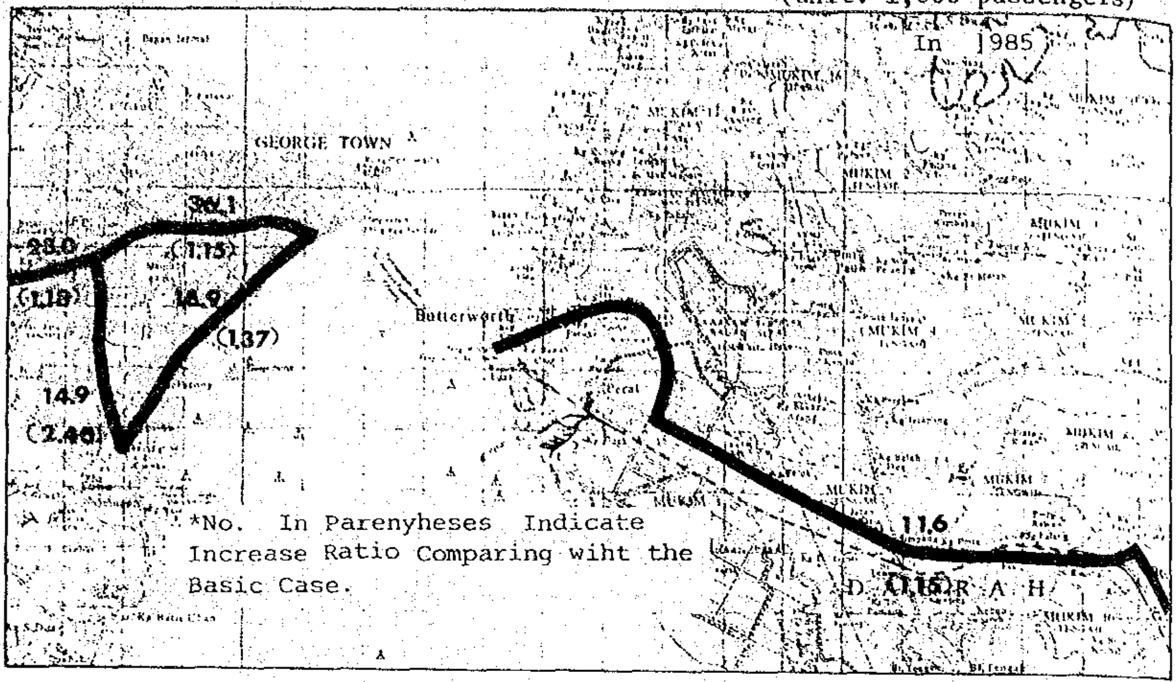
		in 1985	in 2000
Basic volume		249.1 (100)	296.4 (100)
Diverted volume by parking		9.5 (6.7)	41.1 (29.3)
Diverted volume by exclusive bus lane	Vehicle	3.9 (2.8)	7.3 (5.2)
	Motor-cycle	5.6 (4.7)	6.8 (5.7)
Total		268.1 (108)	351.6 (119)

Some bus priority measures are expected to increase the passenger demand to 8 percent in 1985 and 19 percent in the year 2000 respectively.

The assigned passenger volume along exclusive bus lanes is summarized as follows.

IN 1985

(unit: 1,000 passengers)



IN 2000

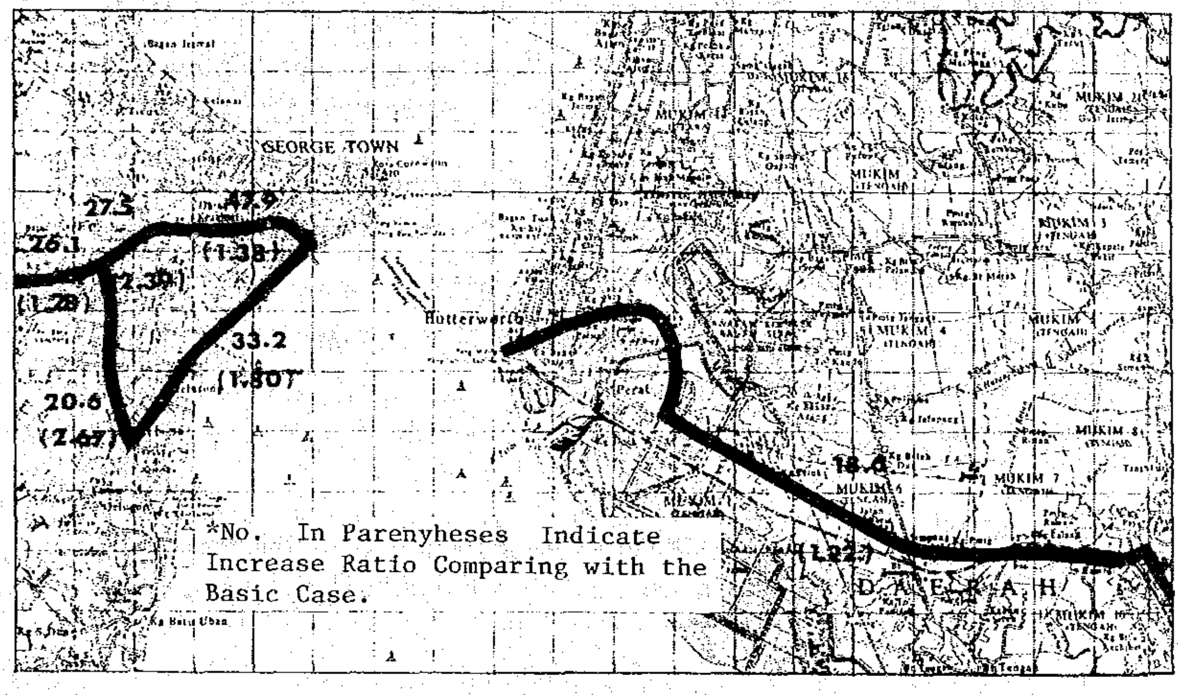


Fig. 5.31 BUS PASSENGERS ALONG EXCLUSIVE BUS LANES

As shown above, the effect of exclusive bus lanes is overwhelmingly great to attract passengers along these lanes.

5.6 Estimation of the Traffic Demand of New Transport System

According to the tremendous increase of motor vehicle traffic, the service of public transport on roads is deteriorating and various kinds of new transport systems are considered for the improvement of public transport service all over the world. The search for a new transport system is directed towards the invention of new modes of transportation which will satisfy the demand volume between that of bus transport and urban railway.

However, this is not the main subject in our study but nontheless, some comments on the new transport system will be made for the distant future, such as in the year 2000. This is because there seems to be certain possibilities on the introduction of a new transport system in such a city area as this which has a population of over 1 million.

Before an estimation of demand can be made, the following are assumed to be the basis of the New Transport System.

1. Route

   From the results of the bus passenger assignment, the most heavily demanded routes are chosen; that is from Air Itam to the center of the C.B.D. and from Bayan Lepas to the middle former section.

   The reason why these routes are chosen is either because it is possible to equip guideways and station facilities or because of sufficient road width.

2. Characteristics

   System type : Light guideqay system
   Scheduled speed : 25km/hour
   Capacity : 60 persons/car
   Operation interval : 5 minutes (for peak hour)

5.6.1 Demand Forecast

The demand forecast is done roughly according to the following procedure.

The diverted volume forecasted by the exclusive bus lane is added into the volume and the total volume of public transport passengers are estimated. This volume is 371,600 passengers.

Also, this volume is divided into N.T.S. passengers and bus passengers in consideration of both services.

The area measuring 500m along both sides of the route is supposed to be the service area and the traffic zones are classified into three (3) categories depending upon the share which the service area has in the zone.

The divertion ratio to N.T.S. by each zone pair are assumed according to the categories classified above, then the diverted volume is estimated.

The estimated result for N.T.S. is 92,500 and the O-D pattern is as follows:-

Table 5.23 N.T.S. PASSENGER O-D in 2000

Zone \ Zone	110	120	130	140	310	320	330	410	510	94	Total
110	-	78	100	116	-	6	58	69	-	2	429
120		-	78	50	1	4	17	20	-	1	249
130			16	68	1	11	52	48	-	2	392
140				-	-	1	20	22	2	1	280
310					-	-	0	0	-	0	2
320						-	20	16	-	0	58
330							8	17	-	1	201
410								16	-	-	224
									Total		92500

1. Traffic Volume by Section

The assignment of the demand is summarized as follows:-

(Unit : 1000 passengers per day)

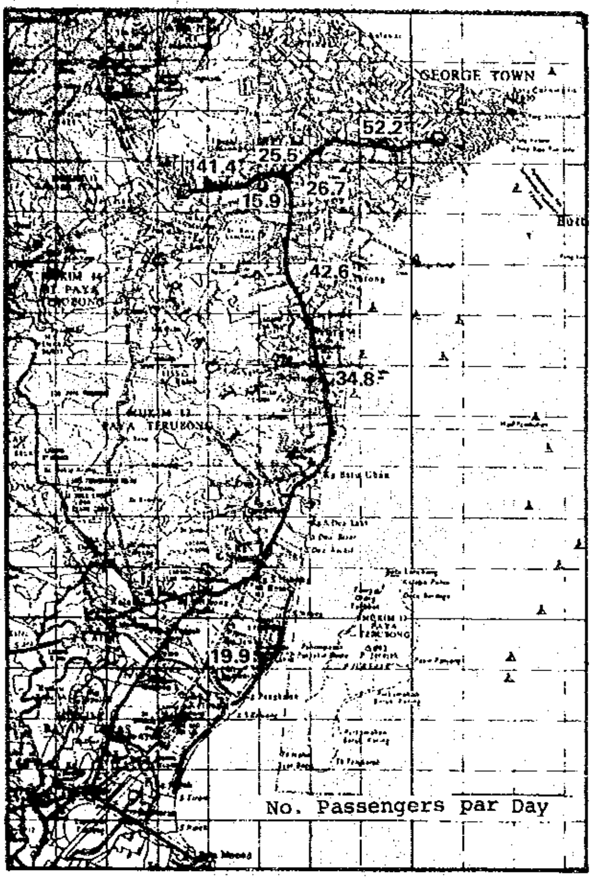


Fig. 5.32 N.T.S. PASSENGER ASSIGNMENT

2. Summary

The result of N.T.S. passengers demand are summarized as follows:

Length of the route	:	22km (Route 1 = 7km, Route 2 = 12km)
Total No. of passengers	:	92,500 pass/day
Passenger kilometers	:	742,100
Average kilometers	:	8.02 kilometer
Running hours	:	24,700
Average hours	:	16.05 minutes

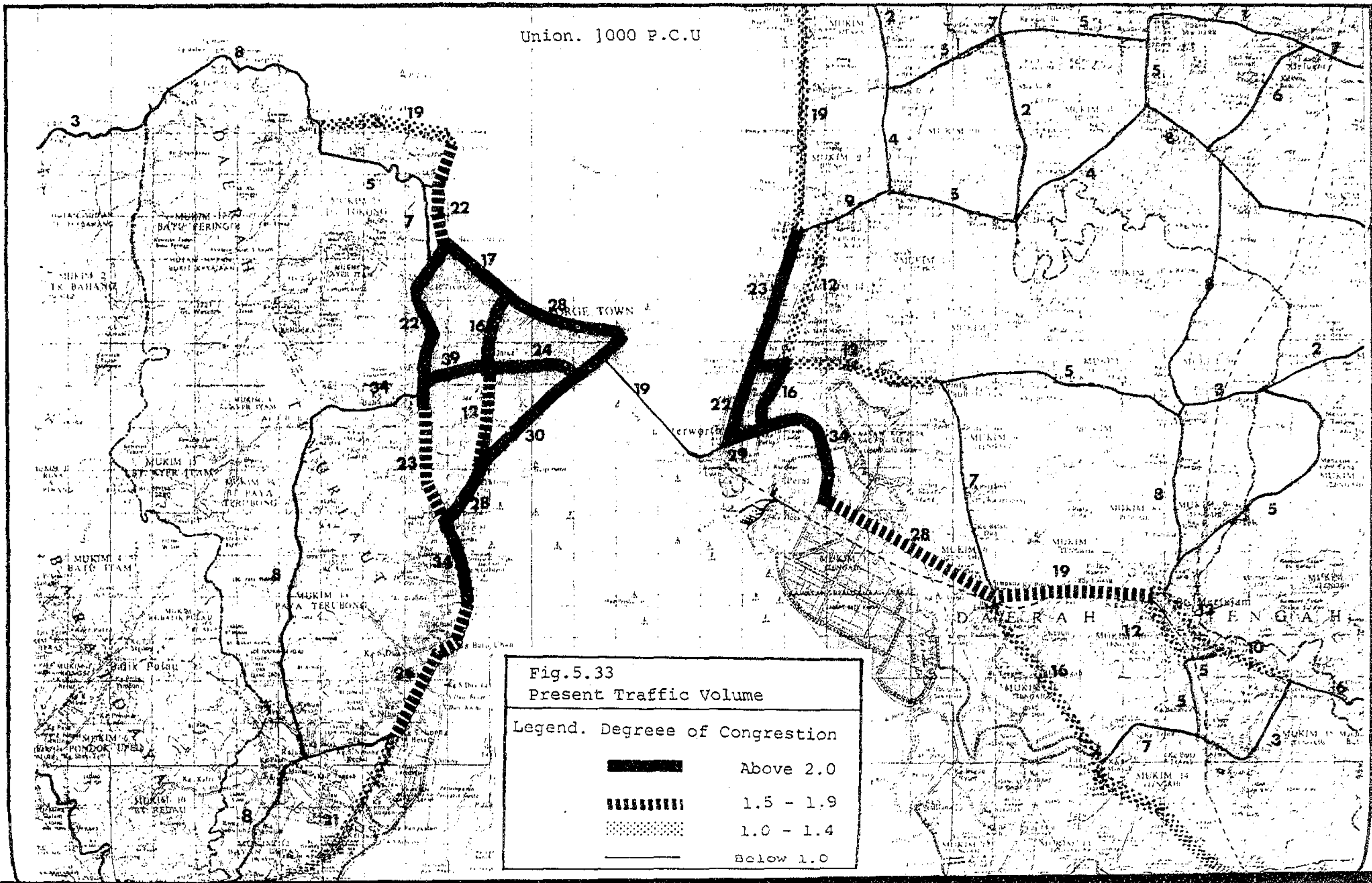
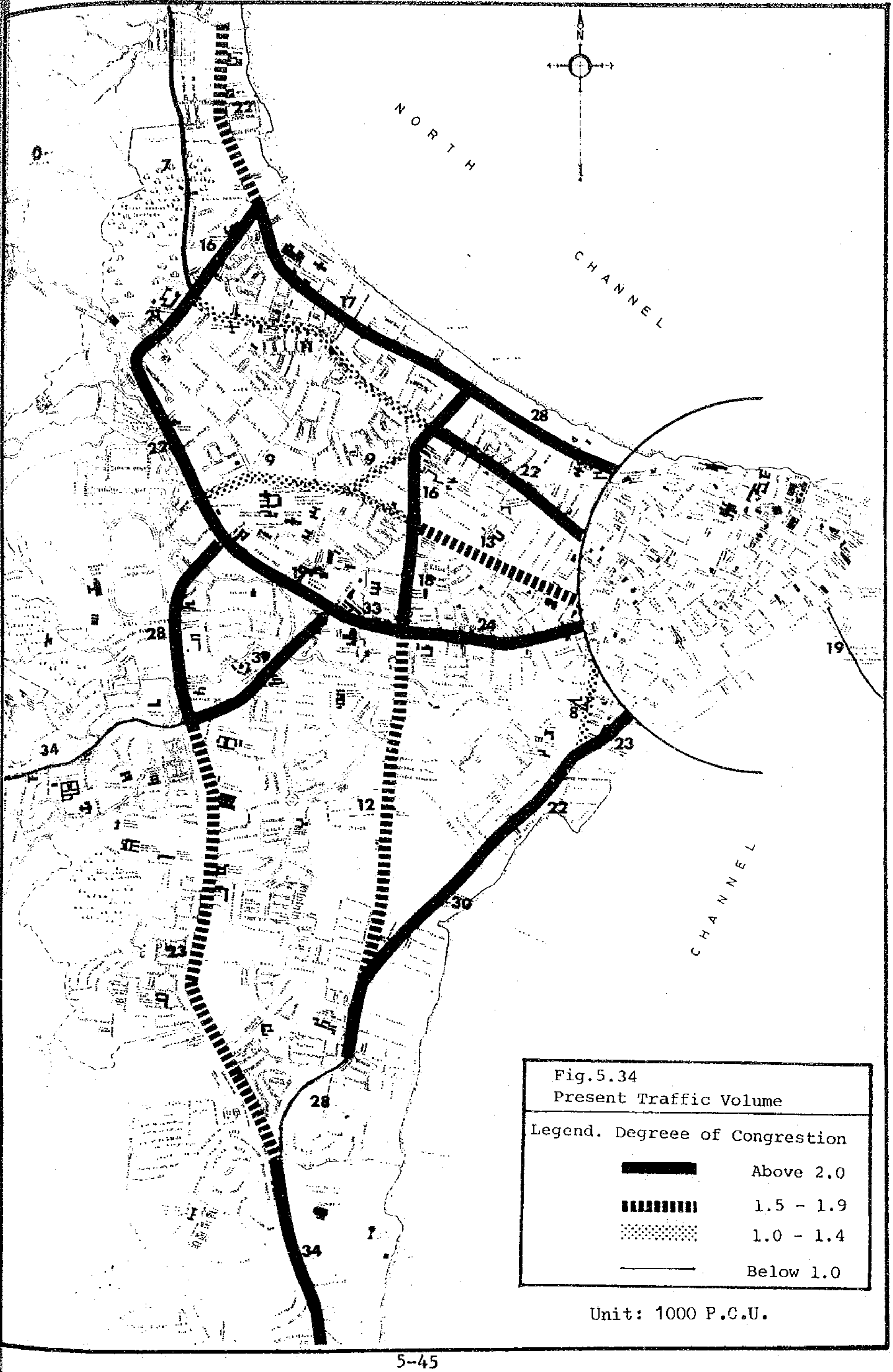


Fig.5.33
Present Traffic Volume


NORTH CHANNEL
CHANNEL
N
Fig.5.34
Present Traffic Volume
Legend. Degreee of Congrestion
Above 2.0
1.5 - 1.9
1.0 - 1.4
Below 1.0
Unit: 1000 P.C.U.

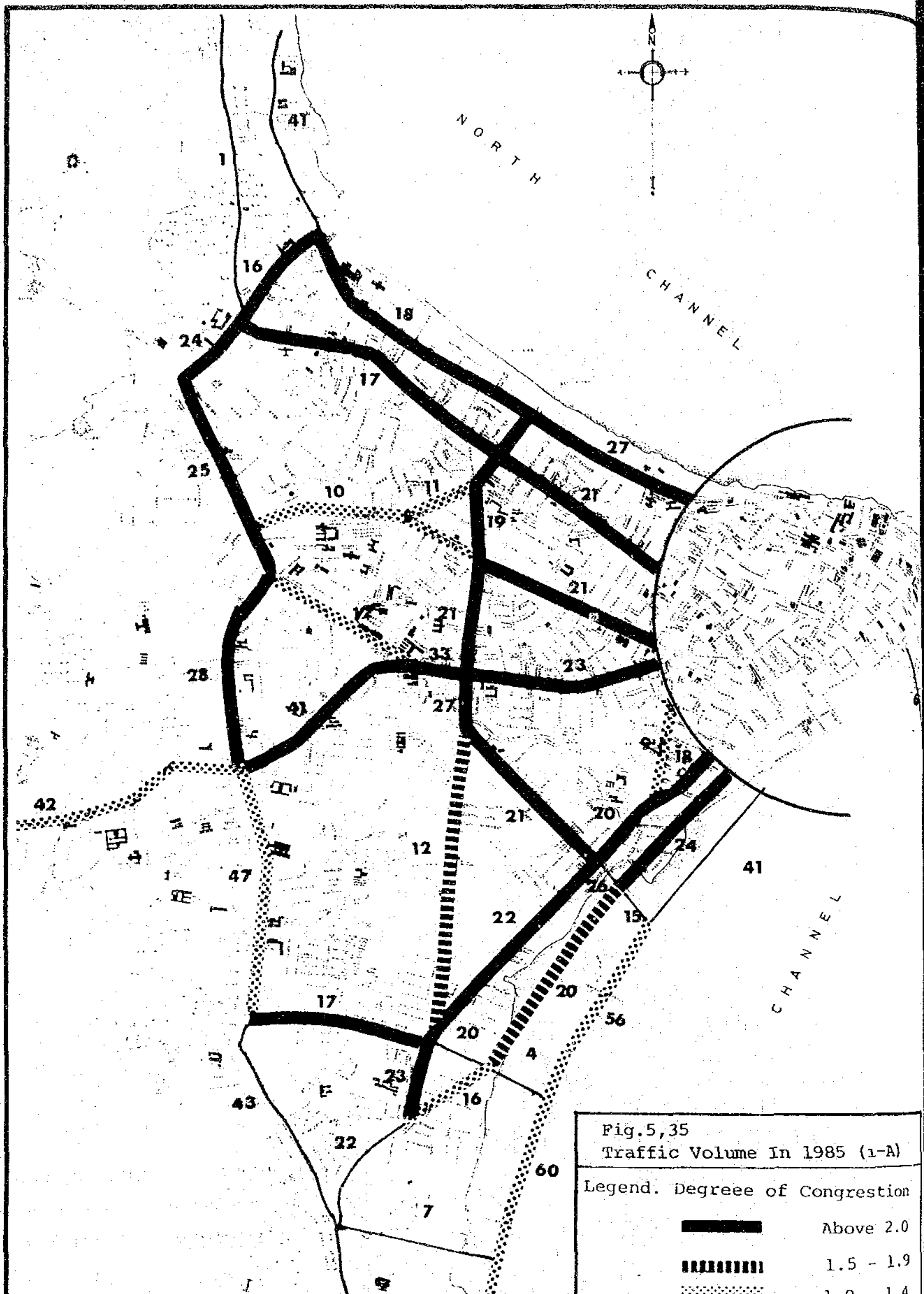


Fig.5,35
Traffic Volume In 1985 (1-A)

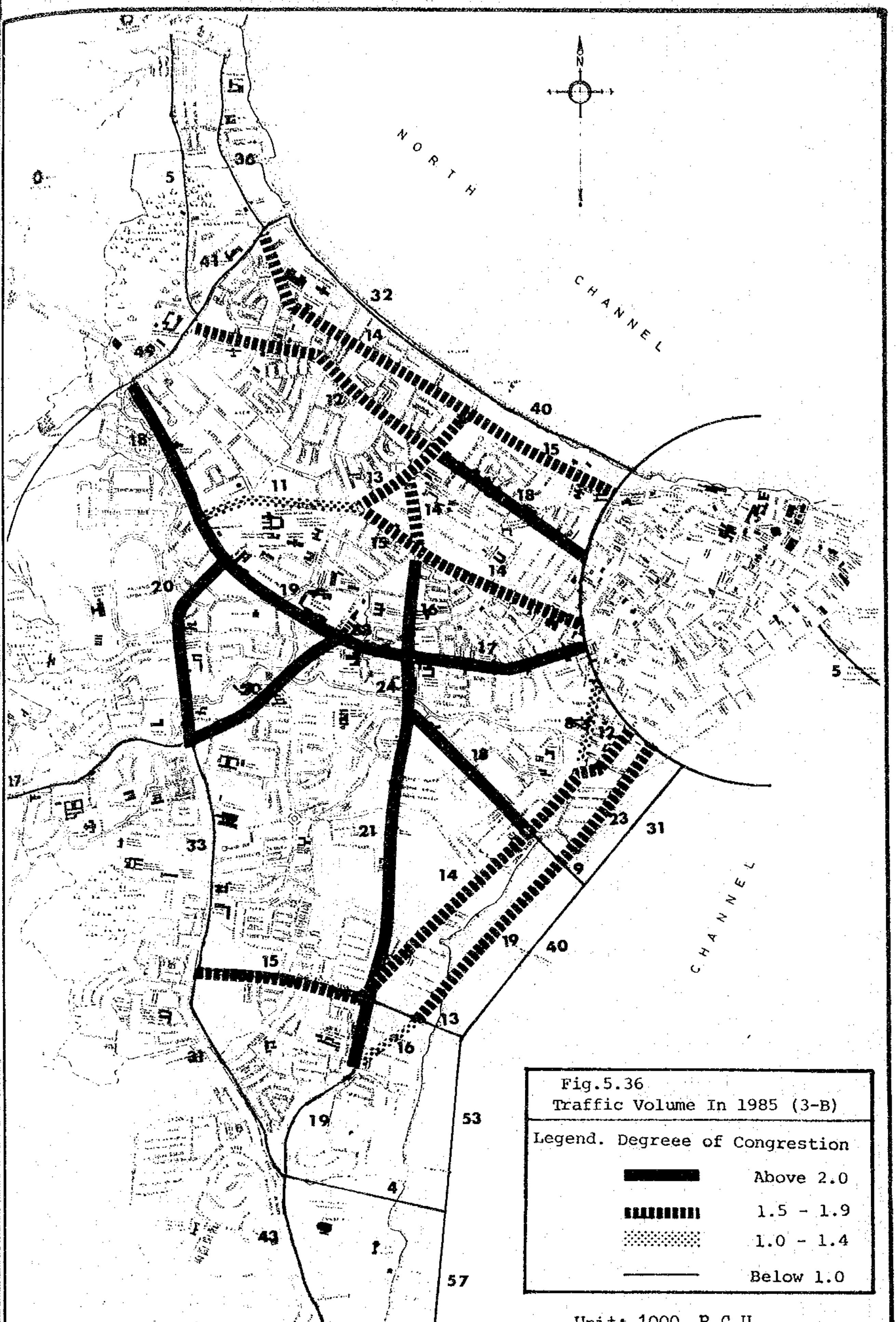


Fig.5.36
Traffic Volume In 1985 (3-B)

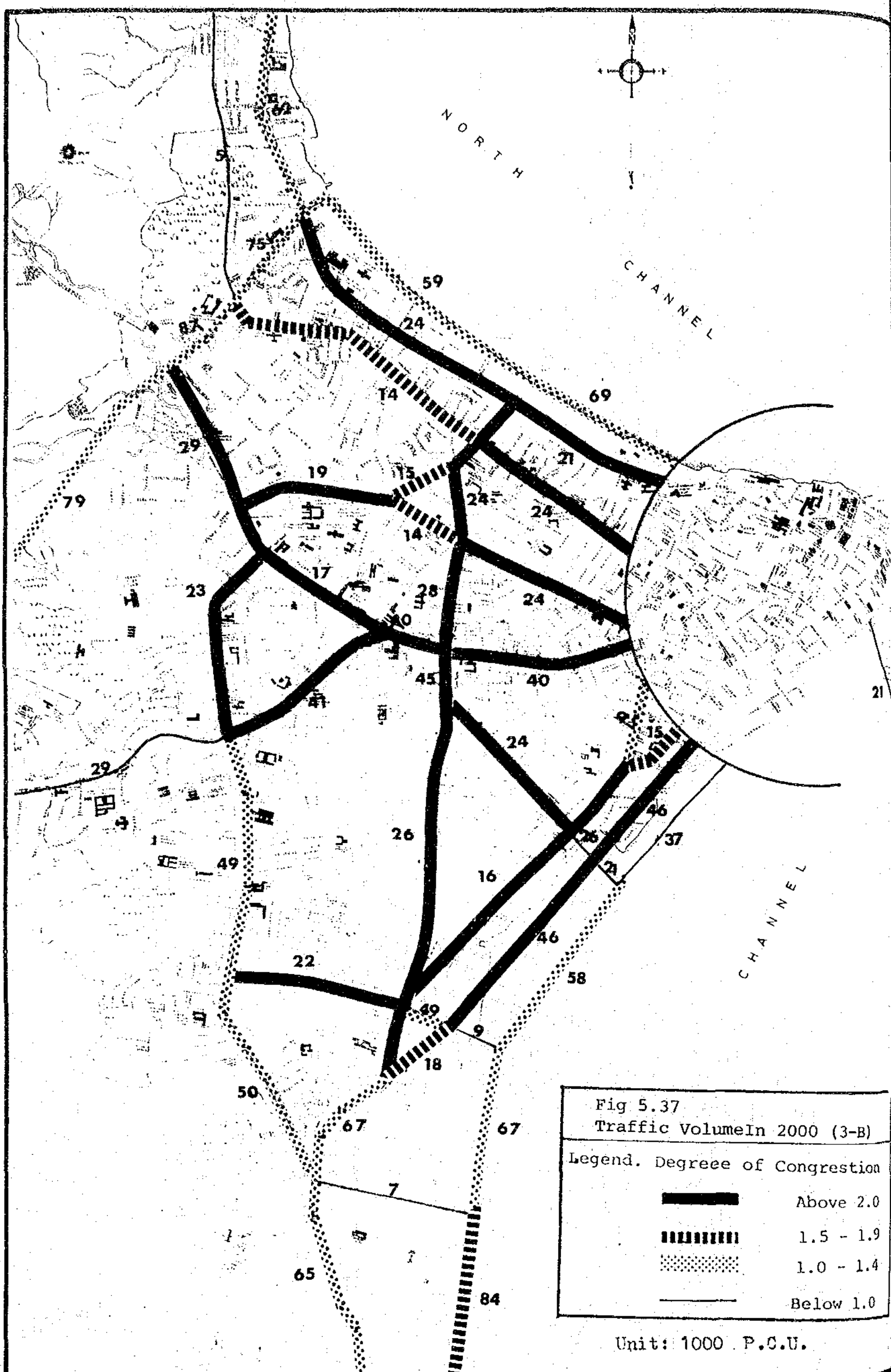


Fig 5.37
Traffic VolumeIn 2000 (3-B)

Legend. Degreee of Congrestion

(solid line)	Above 2.0
(hatched line)	1.5 - 1.9
(dotted line)	1.0 - 1.4
(thin line)	Below 1.0

Unit: 1000 P.C.U.

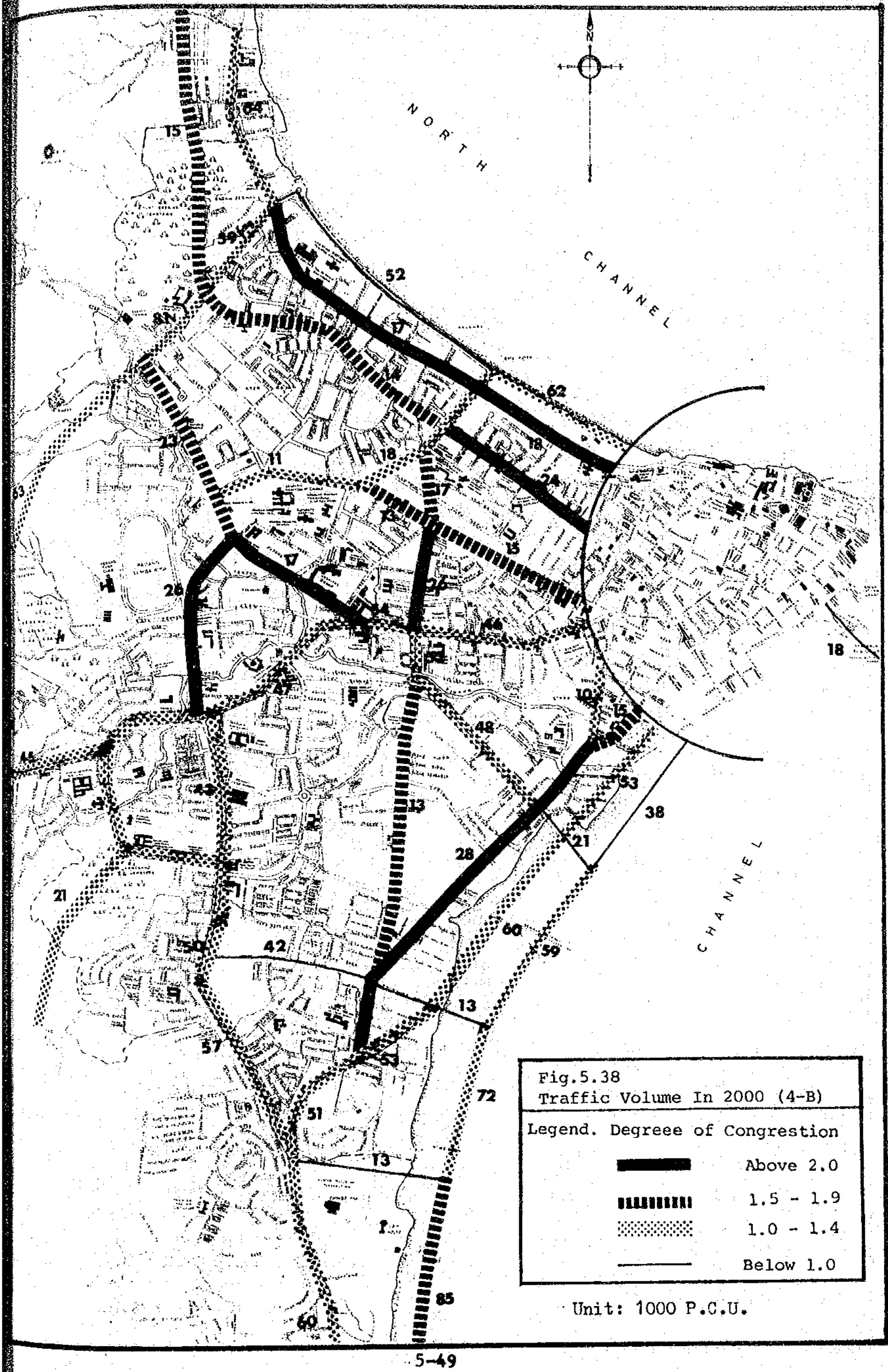


Fig.5.38
Traffic Volume In 2000 (4-B)

Legend. Degreee of Congrestion

(solid heavy line)	Above 2.0
(hatched line)	1.5 - 1.9
(dotted line)	1.0 - 1.4
(thin line)	Below 1.0

Unit: 1000 P.C.U.

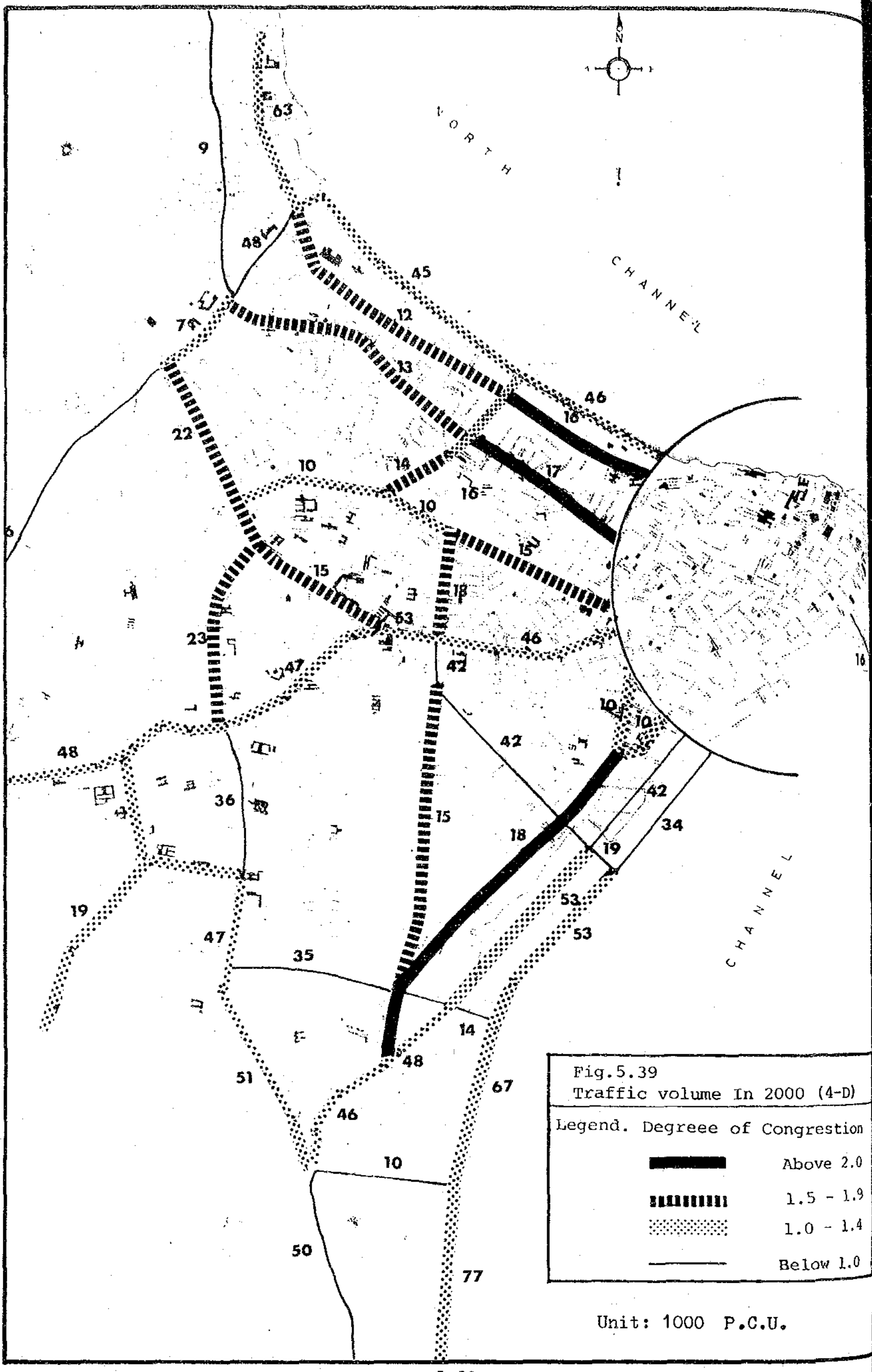


Fig.5.39
Traffic volume In 2000 (4-D)

6. 計画案の設計、コスト推計

目　　次

LIST OF TABLES

LIST OF FIGURES

6.1 はじめに

道路、公共交通、交通管理、交通ターミナル、交通公園について具体的に計画し、コスト推計を行う。

6.2 道　　路

6.2.1 道路網計画

都市幹線、地区幹線、補助幹線、アクセス道路の４機能によって道路を分類し、計画を行う。

6.2.2 設計基準

マレイシアの基準を基に都市内道路断面を計画した。

6.2.3 断面の決定

機能区分に応じて、適切な断面を設定した。

6.2.4 コスト積算

ペナン島で総延長１０２.３㎞に対し4.０４億ドル、ウエルスリー県では総延長８5.8㎞に対し2.２５億ドルの建設費となった。

6.3 公共交通

6.3.1 バ　　ス

バス停改良費が約３９０万ドル、バス専用レーンの設置には8.6万ドルの投資が必要である。

6.3.2 新交通システム

７㎞と１５㎞の２つのルートを計画した。１車輛の場合には2.５３億ドル、８車輛では4.０２億ドルの投資が必要である。

6.4 交通管理

6.4.1 歩　　道

現在ほとんど歩道が整備されていないので、約２５０万ドルの投資によって１０4.5㎞の道路延長に対し歩道整備をはかる。

6.4.2 交 差 点

４４ケ所の交差点が改良、整備が必要で、6,５６１万ドルのコストとなる。

6.4.3 信号機

現況信号機の改良に5.8万ドル、新設に303万ドルの費用が必要である。

6.4.4 分離

車線・方向の分離をはかり安全性の確保をはかる、コストは127.5万ドルと推計される。

6.5 駐車場

6.5.1 駐車容量

2000年のジョージ・タウンC.B.D.の駐車容量を21,000台と設定する。

6.5.2 立体駐車場

1ケ所当り250台規模が利用者には便利である。

6.5.3 建設費

全て4階建の立体駐車場で1.18億ドルのコストとなる。

6.6 交通ターミナル

6.6.1 背景

公共交通の強化、中心部の交通コントロールという観点から交通ターミナルが必要である。

6.6.2 位置

ジョージ・タウンの中心部に近い埋立地に想定する。

6.6.3 機能

単純なバス乗換えから、再開発を促がすような総合的ターミナルなどが考えられる。

6.6.4 施設計画

A,B,Cの3案を作成し、施設内容を計画した。

6.6.5 建設費

建設費はC案で約1,990万ドルとなった。

6.7 交通公園

6.7.1 背景

交通安全に対する必要性がますものと考えられる。

6.7.2　目　　　的

市民の交通安全教育、マナー向上を目的とする。

6.7.3　位　　　置

交通ターミナルの近傍を想定する。

6.7.4　内　　　容

教室等を含む建物と、野外教育施設、公園よりなる。

6.7.5　建　設　費

約７６４万ドルになるものと推計される。

6. DESIGN AND COST OF ALTERNATIVE PLANS

6.1 Introduction

This study is aimed at designing and estimating the capital cost of short-term and long-term transport proposals. The transport proposals can be divided into the following:

1. Proposals concerning roads.
2. Public Transport.
   a. Bus transport
      Improvement of bus-stops
      Introduction of exclusive bus lanes
      Expansion of bus fleet
   b. New Transport System
3. Traffic Operations and Management
      Side-walks
      Traffic Signals
      Intersections
      Delineators
4. Parking.
5. Transport Terminal.
6. Transport Amusement Park.

6.2 The Highway

6.2.1 <u>Highway Proposals</u>

The transport network plan which will be reality in the year 2000, is shown in Fig. 6.3a. In this proposal, a long list of highway schemes were prepared on the basis of the pattern of future land use, traffic demands, the suitability of network configuration and other factors. Fig. 6.3b illustrates the road network by type of improvement. The study team proposed that roads be classified into four (4) categories in terms of their functions. They are:

(a) <u>Primary distributors</u>

These roads form the primary network for the town as a whole. All long-distance traffic movements to, from and within the town should be channelled to the primary distributors. The primary distributors may be divided into two (2) types; one type between urban areas (inter-urban) while the other in the urban areas (intra-urban).

(b) District distributors

These roads distribute traffic within the residential and industrial areas and principal business districts of the town and form a link between the primary network and the roads within the surrounding areas.

(c) Local distributors

These roads distribute traffic within the surrounding areas forming a link between district distributors and access roads.

(d) Access roads

These roads give direct access to buildings and land within the surrounding areas.

6.2.2 Design Criteria

The Malaysian design standard for roads is applicable only to the rural areas. This is the "Minimum Geometric Design Criteria for New Road." At present a Malaysian design standard for roads in the urban areas is non-existent although the various local authorities have their own criteria. The design criteria for roads proposed by the study team in terms of the functions of the roads as mentioned in section 2.1 are shown in Fig. 6.1 and Table 6.1.

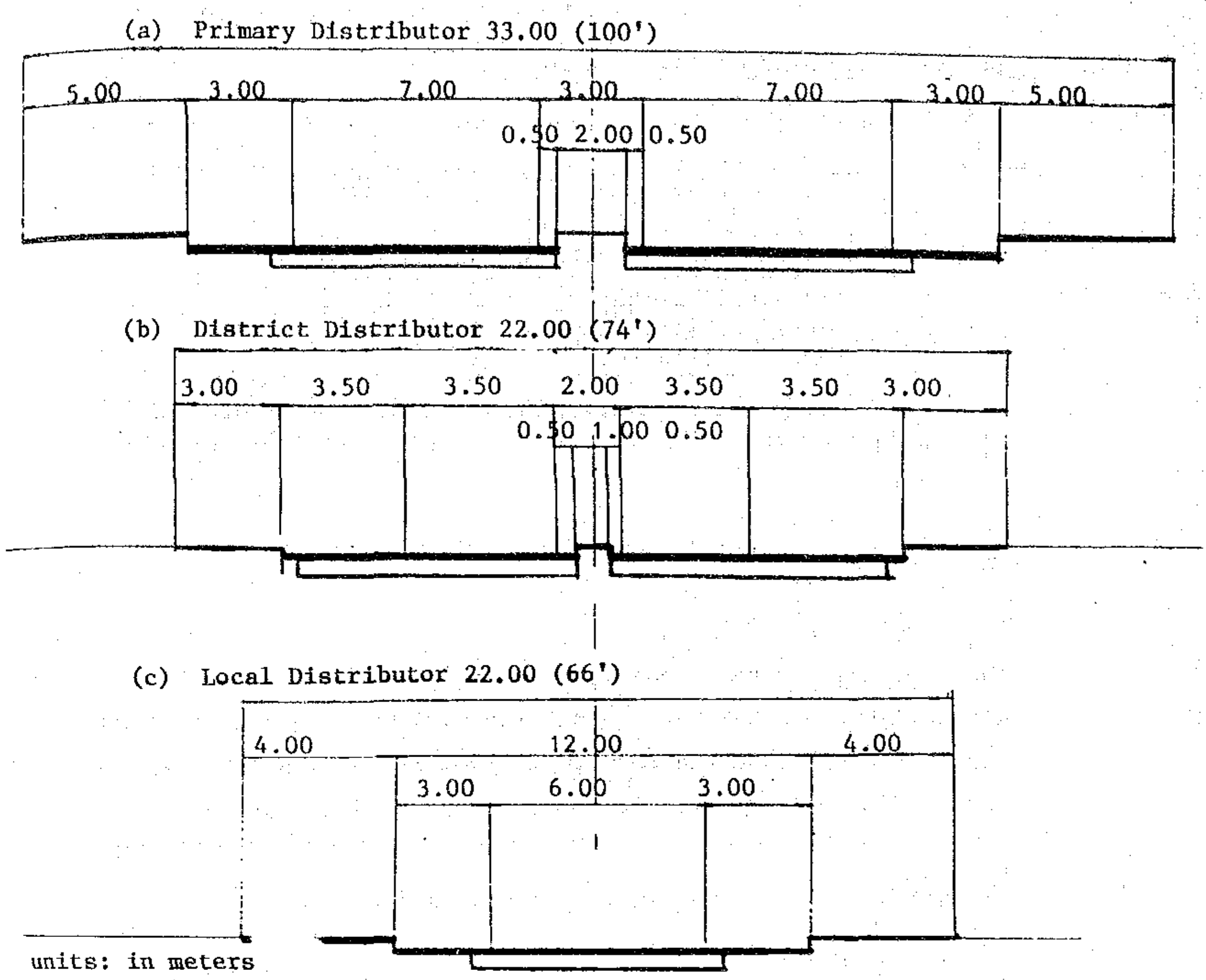


Fig. 6.1 DESIGN CRITERIA FOR ROAD SECTIONS BY FUNCTIONAL CATEGORIES
(Units: in meters.)

Table 6.1 ROAD CRITERIA

Classification of roads. \ Criteria		Number of lanes	Design speed (k/h)	Width of lanes (m)	Length of each (km)	Structure	Access Control	Parking	Intersection	Group of Standard
(a) Primary distributor	inter-urban	4–6	over 80 k/h	over 3.75	5.0–15.0	divided	full	No	Interchange	06
	intra-urban	4–6	60–80	over 3.5	1.4–5.0	divided	partial	No	grade separation	06
(b) District distributor road		2–4	40–60	over 3.0	0.5–1.0	divided	–	only in certain parts	at grade	05
(c) Local distributor road		2	30–50	over 3.0	0.2–0.5	–	–	OK	"	04 03

6.2.3 Types of Roads in Each Classification

Seven (7) types of cross-sections were prepared for the proposed road network based on the basic design criteria and local conditions.

Functional Classifications	Types of Roads
Primary Distributor	A. B. E. F. G
District Distributor	C
Local Distributor	D

The design criteria for every road proposed was also planned.

6.2.4 Cost Estimate

1. Unit Cost

The unit cost of road construction was arrived at from discussions with the J.K.R. of Penang, the City Council of George Town and from a study of the results of the various studies, eg., the Penang Dispersal Study, the New Federal Route 1 study and others.

The assumptions in the estimation are as follows.

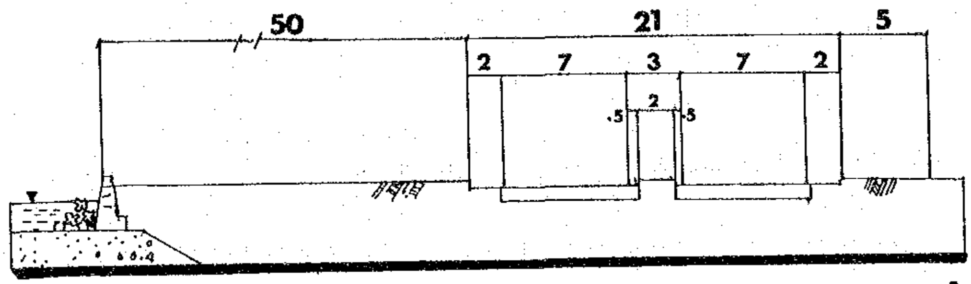
1) Site Clearance
In mountainous and rolling terrain, depth of site clearance is about thirty (30) centimetres.

2) Excavation
Including transport cost.

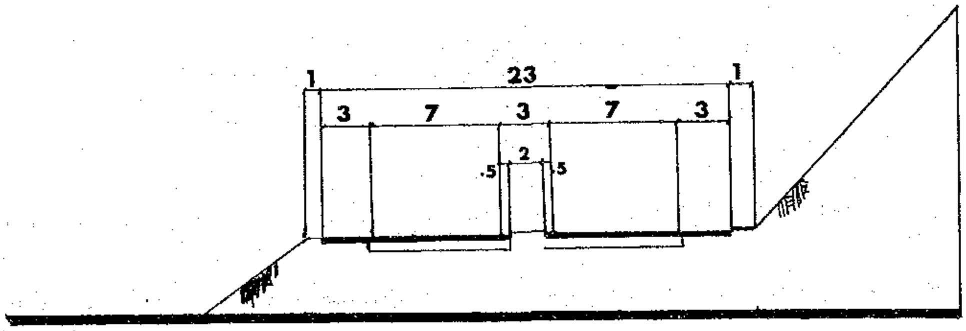
3) Embankment
Common soil is used for embankment with the compacting cost included.

Fig. 6.2 Cross-Section of Road

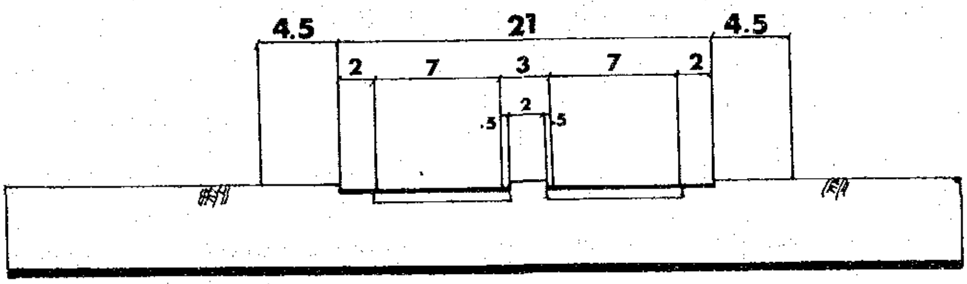
Units in Meters



type A



type B



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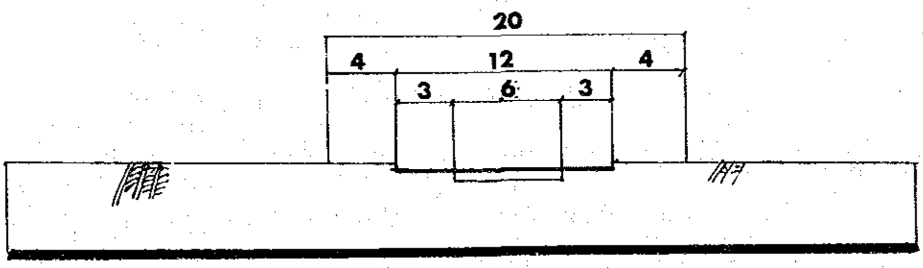
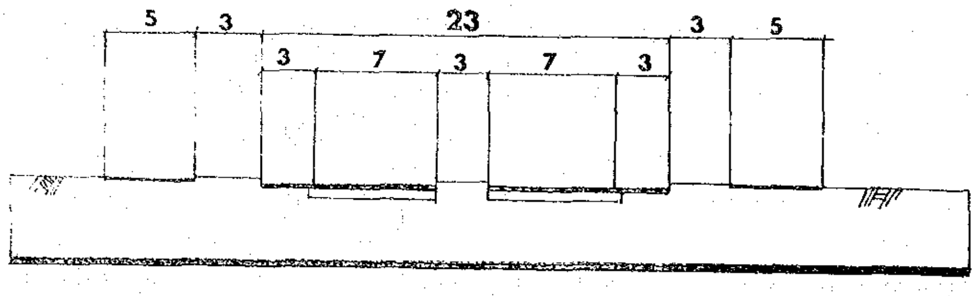
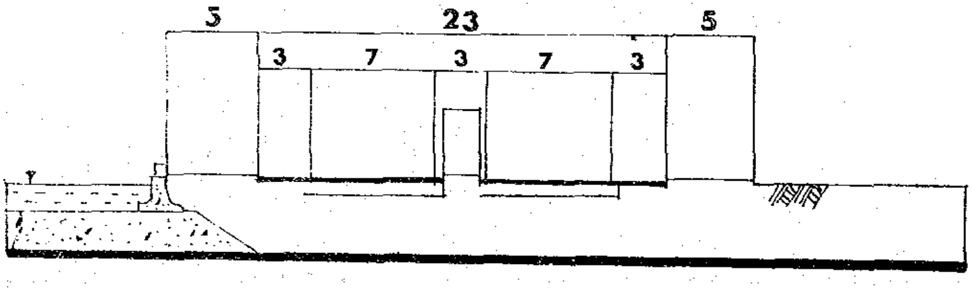


type D

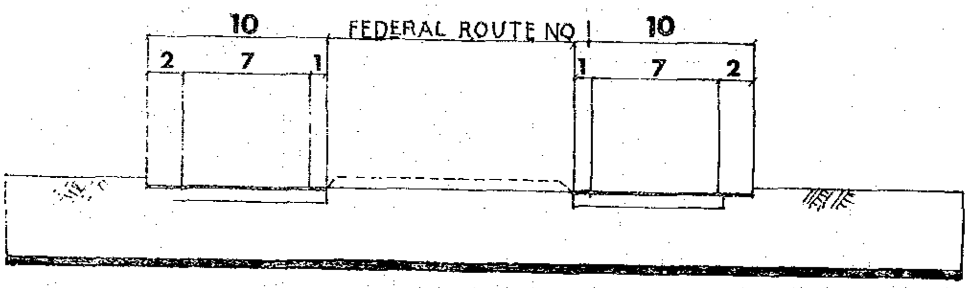
(Cont'd)



type E



type F



type G

Table 6.2 LIST OF UNIT COST

Specification	Description	Unit	Unit Cost (M$)	Remarks
1. Site Clearing		Km^2	200,000	
2. Excavation	common rock marine clay	m^3 " "	5 10 8	
3. Embankment	common	"	5	
4. Turfing	close tree	m^3 "	3 5	
5. Pavement	carriage-way pedestrian shoulder	" " "	25 15 15	
6. Drain	V-shaped U-shaped	m "	20 20	
7. Culvert pipe	Rc ϕ 600 Rc ϕ 900 Rc ϕ1,000 Rc ϕ1,500 Rc ϕ1,800	m " " " "	150 250 380 540 710	
8. Culvert Box	1.0 x 1.0 1.5 x 1.5 2.0 x 2.0 2.5 x 2.5 3.0 x 3.0	" " " " "	210 490 610 1,470 1,790	
9. Reinforced concrete	$\bar{\sigma}_{28}$=280kg/cm^2 $\bar{\sigma}_{28}$=240kg/cm^2 $\bar{\sigma}_{28}$=180kg/cm^2	m^2 " "	260 200 150	Bridge Wall Foundation
10. Form	wood	m^2	26	
11. Reinforcement	SD 30	Ton	1,200	
12. Sand		m^2	21	Transport 5km
13. Gravel	$\frac{3}{4}$"	"	25	
14. Crushed stone	2"	"	20	
15. Guard-rail		m	50	
16. Block	concrete	m^2	29	
17. Median	3.00 a.m.	m	20	

2. Cost Estimate

Construction cost was estimated from the following procedures.

1) Classify the cross-section of the proposed road network.

2) Estimate the cost per unit length of each type of road.

Table 6.3 ROAD PLAN & COST IN PENANG ISLAND
(In Thousand Dollars at 1979 Prices) Province Wellesley.

	Typical Cross-Section	Total Length (Kms)			Detailed Engineering and Construction Supervision	Construction Cost			Total Project Costs
		Improvement Section	New Construction Section	Total		R-O-W Acquisition Cost	Construction Cost	Total	
1. Gurney Drive Extension	A	1.5	3.1	4.6	3,377	–	42,211	42,211	45,588
2. Outer Ring Road from Bayan Jermal to Ayer Itam	B	1.5	4.0	5.5	2,241	23,750	28,016	51,760	54,007
3. Outer Ring Road from Ayer Itam to Green Lane	B	0	9.5	9.5	1,900	28,325	23,750	52,075	53,975
4. Green Lane from Ayer Itam Road to Roundabout	C	5.0	0	5.0	295	–	3,685	3,685	3,980
5. Scotland Road from Ayer Itam Road to Western Road	C	1.4	0	1.4	83	1,680	1,032	2,712	2,795
6. Western Road from Scotland Road to Gottlieb	C	1.5	0	1.5	88	1,800	1,106	2,906	2,994
7. Middle Ring Road (Perak Road, Pangkor Road)		2.4	0	2.4	141		1,769	1,769	1,910
8. Weld Quay Extension	C	0	4.0	4.0	406	–	5,080	5,080	5,486
9. Pair Route from Ayer Itam to Outer Ring Road	D	0	5.3	5.3	444	5,300	5,545	10,845	11,289
10. Pair Route from Outer Ring Road to Dispersal Road	D	0	3.5	3.5	283	3,500	3,535	7,035	7,318
11. Bayan Lepas Road	B	0	3.6	3.6	366	4,320	4,572	8,892	9,258
12. East Coastal Road	C	0	5.8	5.8	469	–	5,858	5,858	6,327
13. North Coast Road from Tanjong Bungah to Batu Feringgi	D	5.4	6.1	11.5	1,116	14,790	13,944	28,734	29,850
14. Penang Island Road from Airport to Telok Kumbar	D	4.6	0	4.6	320	3,220	4,000	7,220	7,540
15. Penang Hill Road Section 1	D	0	5.0	5.0	404	5,000	5,050	10,050	10,454
16. Penang Hill Road Section 2	D	0	13.0	13.0	1,050	13,000	13,130	26,130	27,180
17. Penang Hill Road Section 3	D	0	2.0	2.0	162	2,000	2,020	4,020	4,182
18. Jelutong Road	I	0.3	0	0.3	25	3,600	314	3,914	3,939
19. Leboh Mc. Nair	H	0.2	0	0.2	12	2,400	147	2,547	2,559
20. Maxwell Road	H	0.9	0	0.9	187	4,792	2,343	7,135	7,322
21. Dato Keramat-Ayer Itam Road to Ayer Itam Intersection	F	2.2	0	2.2	2,112	1,621	26,400	28,021	30,133
22. Ayer Itam Road from Ayer Itam	F	4.0	0	4.0	3,832	2,948	48,000	50,948	54,780
23. Penang View Road	J	0	6.5	6.5	1,099	6,500	13,741	20,241	21,340
Total		30.9	71.4	102.3	20,412	128,546	255,248	383,794	404,206

Table 6.4 ROAD PLAN & COST IN PROVINCE WELLESLEY
(In Thousand Dollars at 1979 Prices) Province Wellesley

Name of Roads	Typical Cross-Section	Total Length (Kms)			Detailed Engineering and Construction Supervision	Construction Cost			Total Project Costs
		Improvement Section	New Construction Section	Total		R-O-W Acquisition Cost	Construction Cost	Total	
1. S. Dua Road from Kg. Bagan Ajam to S. Dua	F	4.5	0	4.5	265	6,498	3,317	9,815	10,080
2. West Coastal Road from Kg. Bagan Ajam to New Port	F	0	5.5	5.5	2,712		33,897	33,897	36,609
3. West Coastal Road from New Port to intersection at Alor Star - Changkat Jering Highway	E	2.0	3.0	5.0	1,620	10,800	10,255	31,055	32,675
4. Federal Route 1 of Intersection at Alor Star - Changkat Jering Highway and Jalan Methopalaniapa	E	7.5	0	7.5	442	10,830	5,528	16,358	16,800
5. Ring Road in B. Mertajam from Kg. Uma to P. Jatoh	E	0	2.5	2.5	400	5,000	3,175	8,175	8,575
6. Ring Road in B. Mertajam from P. Jatoh to Alor Star - Changkat Jering Highway	E	0	5.5	5.5	559	11,000	6,985	17,985	18,544
7. Permatang Pauh Road from Kg. Sama Gagah to S. Ampat	C	6.5	0	6.5	383	9,386	4,791	14,177	14,560
8. B. Tengah Road from S. Ampat to Kg. Bukit Minyak	C	5.0	0	5.0	297	7,187	3,718	10,905	11,202
9. Bukit Minyak Road to Alor Star - Changkat Jering Highway	C	0	3.9	3.9	624	7,800	4,953	12,753	13,377
10. Jalan Mohamed Saad - Jalan Bagan Lalang	D	0	4.0	4.0	210	880	2,628	3,508	3,718
11. Road from S. Puyu to Mak Mandin	D	0	3.7	3.7	168	814	2,098	2,912	3,080
12. Road from Mak Mandin to Chain Ferry Road	D	0	1.8	1.8	82	396	1,021	1,417	1,499
13. Heng Choon Thiam Extension	D	0	3.8	3.8	172	836	2,155	2,991	3,163
14. Prai Road	E	2.6	0	2.6	264	5,200	3,302	8,502	8,766
15. Permatang Pauh Road	E	5.0	0	5.0	508	7,220	6,350	13,570	14,078
16. Frontage Road from Kg. Tok Hamid to Kg. Bagan Serai	G	0	4.0	4.0	217	1,600	2,716	4,316	4,533
17. Frontage Road from Kg. Bagan Serai to Kg. Telok	G	3.9	0	3.9	212	1,560	2,648	4,208	4,420
18. Frontage Road from Prai Industrial Estate to Kg. Tok Kangar	G	0	5.8	5.8	315	2,320	3,938	6,258	6,573
19. Jalan Raja Uda - Jalan Siram - Jalan S. Nyior	D	0	2.5	2.5	270	5,000	3,375	8,375	8,645
20. Sg. Nyior, Siram, Raja Uda Roads	F	2.8	0	2.8	165	1,960	2,063	4,023	4,188
Total		39.8	46.0	85.8	9,885	96,287	138,913	215,200	225,085

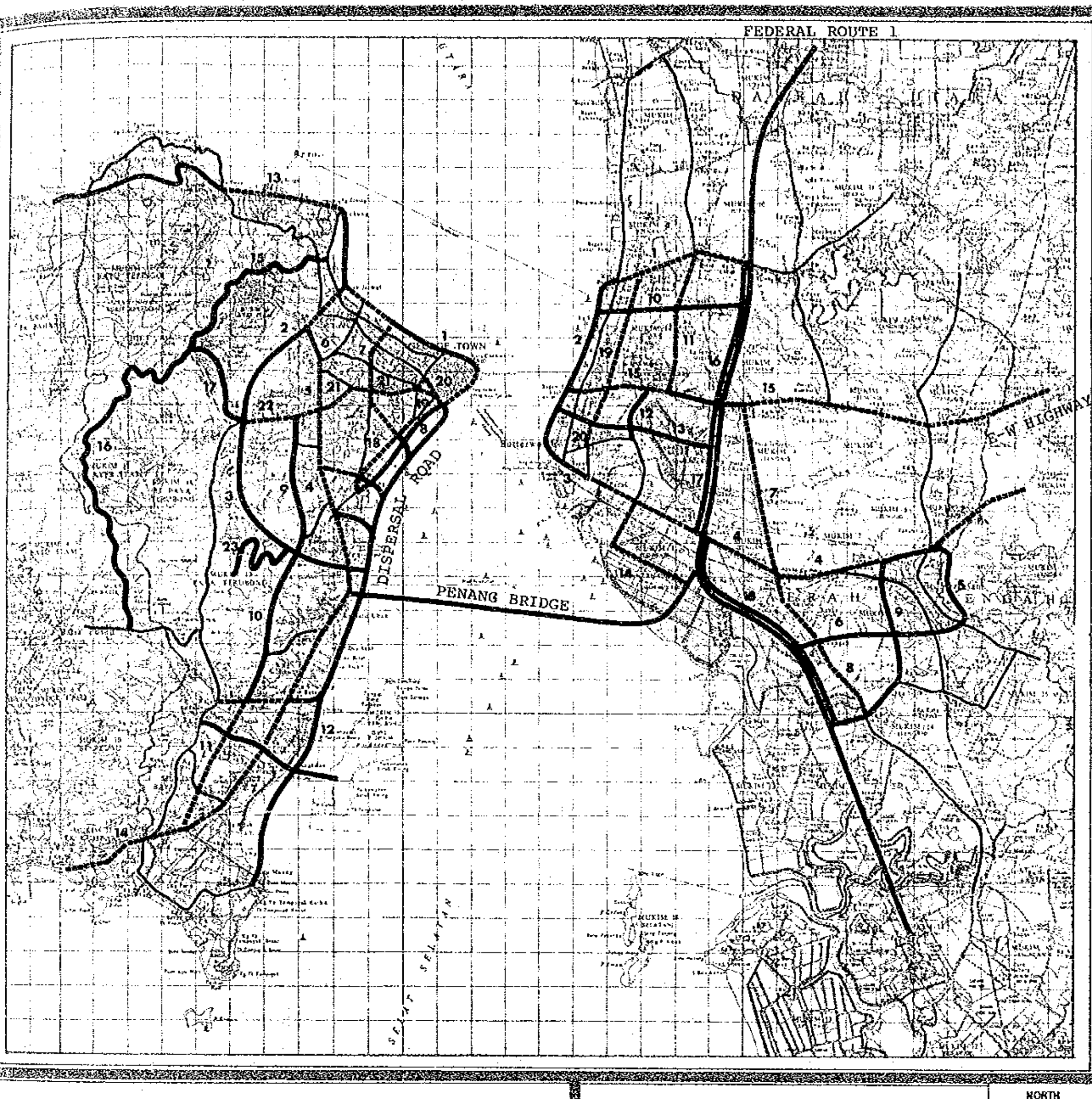


Fig. 6.3(a) Proposed Road Network and Road Number

NORTH

Construction

Improvement

Existing Roads

Note: Numbers correspond to tables 5.1 and 5.2 respectively

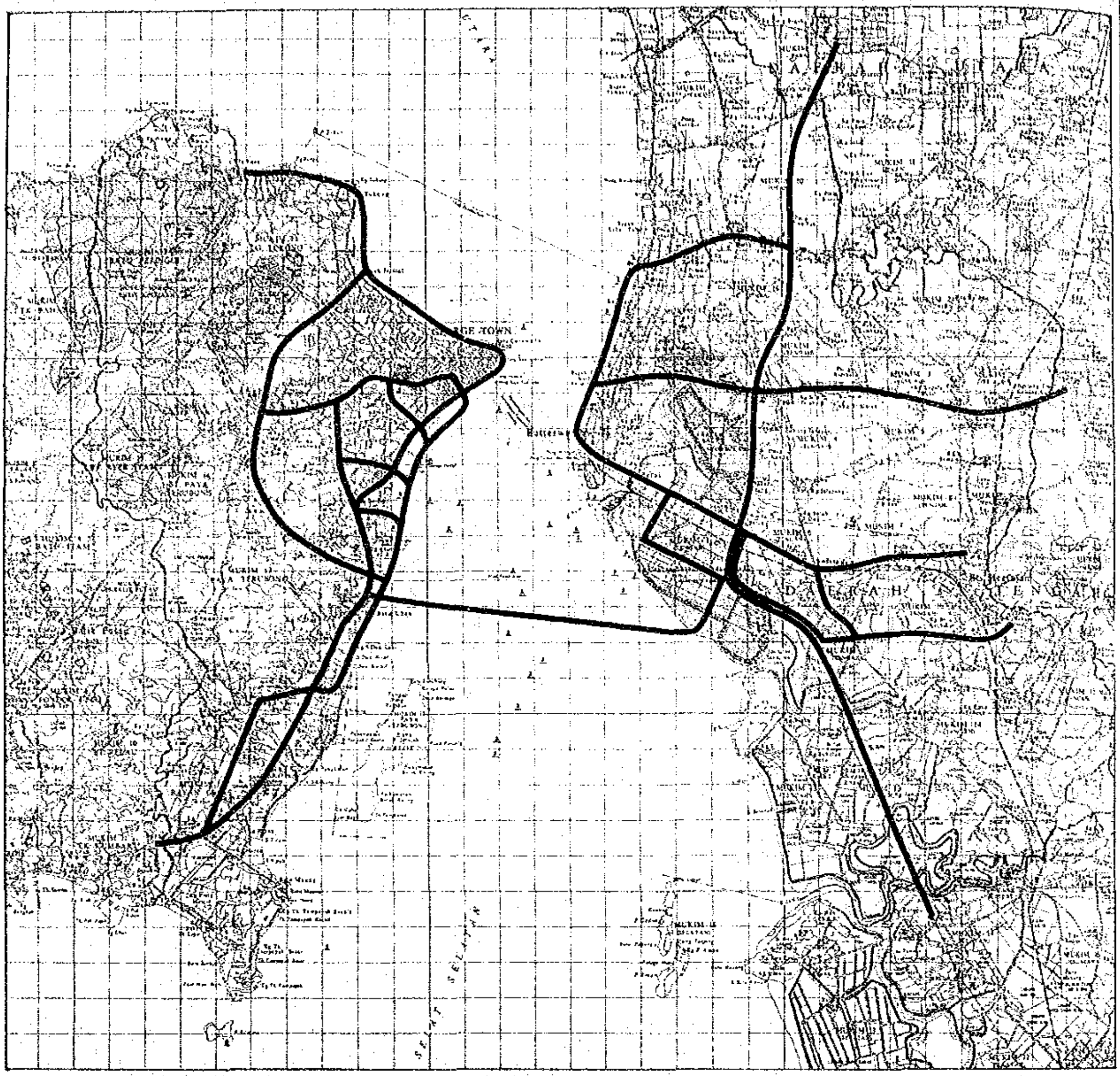


Fig.6.3b Roads with 4 lanes

NORTH

Road with 4 lanes

PENANG URBAN TRANSPORT STUDY

URBAN TRANSPORT STUDY IN GREATER METROPOLITAN AREAS OF GEORGETOWN, BUTTERWORTH AND BUKIT MERTAJAM

Page.

6.3 Public Transport

6.3.1 Bus Transport

1. Improvement of Existing Bus-stop

(a) Type of existing bus-stop

There are many routes with more than 250 stops in George Town and 184 stops in Province Wellesley. These bus-stops may be classified into four (4) different types.

Type A, A'

These are actually bus-stops on sections of pedestrian ways located on both sides of the road. There are no special facilities at these bus-stops except for a small indicating board identifying them. Also, there are no special bus-bays.

Type A bus-stops are those described above but having shelters. Type A' is the same except they do not have shelters.

Type B, B'

Type B and B' is the same as type A or A' except that in type B and B' spaces are provided for the buses to stop. Type B is provided with a shelter but type B' is not.

Type C, C'

Type C, C' is the most popular type of bus-stop. There is no pedestrian way and so the shoulder of the road is used for the buses to stop. In the Type C bus-stop, shelter is provided. Type C' is the same except that it has no shelter.

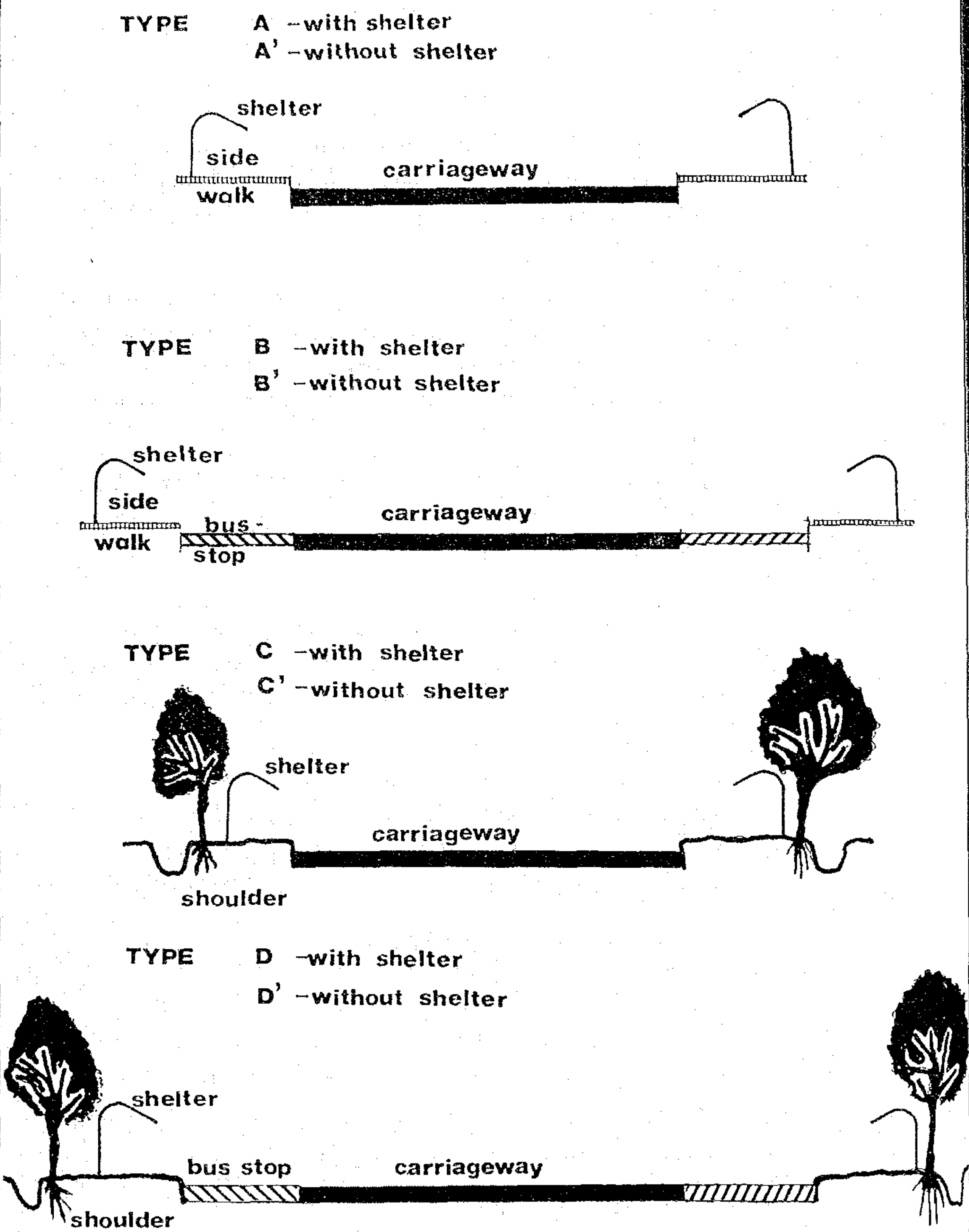
Type D, D'

For this type, there is no pedestrian way but there is additional space provided for buses to stop. Just as for type C & C', the shoulder of the road is used for the buses to stop. Type D has shelter but type D' does not have shelter.

(b) Improvement plan of existing bus-stops

(i) Objectives of improvement

Fig.6.4 Conditions of Existing Bus Stops



The most important thing in the improvement of existing stops is the provision of additional space to bus-stop lanes. This is because almost all existing roads are two-lane highways or carriage-ways with a width of about 9.0 metres. As such, when a bus is at a stop, it obstructs the smooth flow of traffic and vehicles following behind have to wait until the bus starts moving again.

In such a situation, the traffic capacity is decreased and traffic congestion occurs. Therefore, the proposal to provide additional space to bus-stop lanes will improve the existing condition of traffic.

(ii) *To improve existing conditions of bus-stops*

The small indicating board which identifies a bus-stop is the only facility available and as such does not provide information on the time schedules of buses. The proposal to improve existing conditions of bus-stops will raise the quality of the bus service to users.

(iii) Items for improvement at bus-stops

Items for improvement are as follows:

(1) Provide additional bus-stop lanes.
(2) Provide pedestrian way.
(3) Provide shelters for waiting passengers.
(4) Provide information at bus-stops.
(5) Provide lighting facilities.
(6) Others.

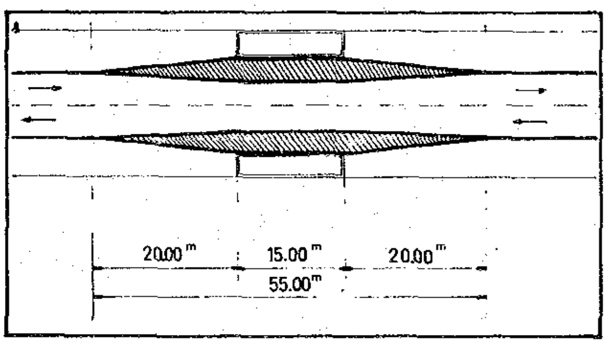


Fig. 6.5 SITE PLAN OF BUS-STOPS Unit: in meters

(c) Cost estimates

Costs of improvement are shown in Tables 6.5 and 6.6.

Table 6.5 NUMBER OF BUS-STOPS ACCORDING TO TYPE AND COST OF IMPROVEMENT (PENANG ISLAND)

Name of Road	Number of existing Bus-stops by Type								Cost
	A	A'	B	B'	C	C'	D	D'	(M$1,000)
Clthrop Road						1			10.5
Green Lane			6	4		3			52.2
Jalan Scotland	4								35.3
Western Road			2	5	3				45.1
Jalan Residency						2			21.0
Jalan Gottlieb						2			21.0
Jalan Bagan Jermal		1				2			30.9
Waterfall Road						5			52.3
Lorong Batu Lanchang					6				56.0
Jalan Ayer Itam	2	1	15	3		1			70.8
Kampong Baru						1			10.5
Jalan Padang						4			41.9
Boundary Road						6			62.9
Jalan Kampong						7			73.3
Hill Railway Road					4	2			58.3
Jalan Balik Pulau						1			10.5
Jalan Batu Lanchang					6	3			87.5
Jalan Jelutong	7		2	1	1	8			160.9
Jalan Perak	2	1			8	2			116.9
Jalan Free School			1	2		1			17.7
Jalan Caunter Hall					5	5			99.1
Jalan Macalister					12	6			175.0
Jalan Kelawai			8						13.0
Lorong Maktab						2			21.0
Jalan Burma						17			178.0
Jalan Anson						4			41.9
Jalan Dato Keramat	6	2							72.8
Jalan Pantai						5			52.3
Jalan Sungai Pinang						5			52.3
Transfer Road					1				9.4
Argyll Road					1				9.4
Brick Kiln Road	4								35.3
Penang Road		3							29.8
Leboh Sandilands						1			10.5
Leboh McNair						2			20.9
Leboh Carnavon						2			20.9
Jalan Kg. Kolam						2			20.9
Leboh Chulia		4		2					45.3
Leboh Pitt						2			20.9
Leboh Light	1	1		1		1			31.9
Pengkalan Weld		1			1	2	3		64.6
Gat Leboh Chulia						1			10.5
Gat Leboh China						1			10.5
Pesara King Edward									10.5
Total	26	14	34	18	48	110	3	0	2,092.2

Table 6.6 Province Wellesley

Name of Road	Number of existing Bus-stops by Type								Cost (M$1,000)
	A	A'	B	B'	C	C'	D	D'	
Jalan Bagan Luar (Jalan Kuala Bekah)						10	11	12	304.6
Jalan Sungai Tembus					1	3			40.7
Jalan Pasir Begu						7			73.2
Jalan Kampung Kuala						6		1	72.0
Jalan Permatang Tiga Ringgit							1	3	35.8
Jalan Sungai Dua						10			104.6
Jalan Lahar Yoi						10			104.6
Jalan Seberang To'Doi						3			31.4
Jalan Tasek Gelugor						7		1	82.4
Jalan Kampong Selamat					1	11			124.4
Jalan Bagan Tuan Kechil-Permatang Pauh					1	1	4	1	61.5
Jalan Permatang Pauh - Nibong Tebal	1	10	2			18	1	6	363.4
Jalan Bagam Dalam - *Simpang Ampat*						10	6		153.2
Jalan Simpang Ampat - Bukit Mertajam						7		1	82.4
Jalan Bukit Mertajam - Macang Bubok						17			177.8
Total	1	10	2		3	120	23	25	1,812.0

2. Exclusive Bus Lane and Cost Estimates

(a) Route of Exclusive Bus Lanes

The following are recommended to be exclusive bus lanes.

1)	GREEN LANE	L = 3,100m
2)	JALAN AYER ITAM	L = 4,000m
3)	JALAN DATO KERAMAT	L = 1,400m
4)	BRIDGE STREET	L = 1,000m
5)	BRICK KILN ROAD	L = 900m
6)	JALAN JELUTONG	L = 3,500m
7)	FEDERAL ROUTE 1	L = 8,500m
8)	JALAN PERMATANG RAWA	L = 3,500m
	Total	L =25,900m

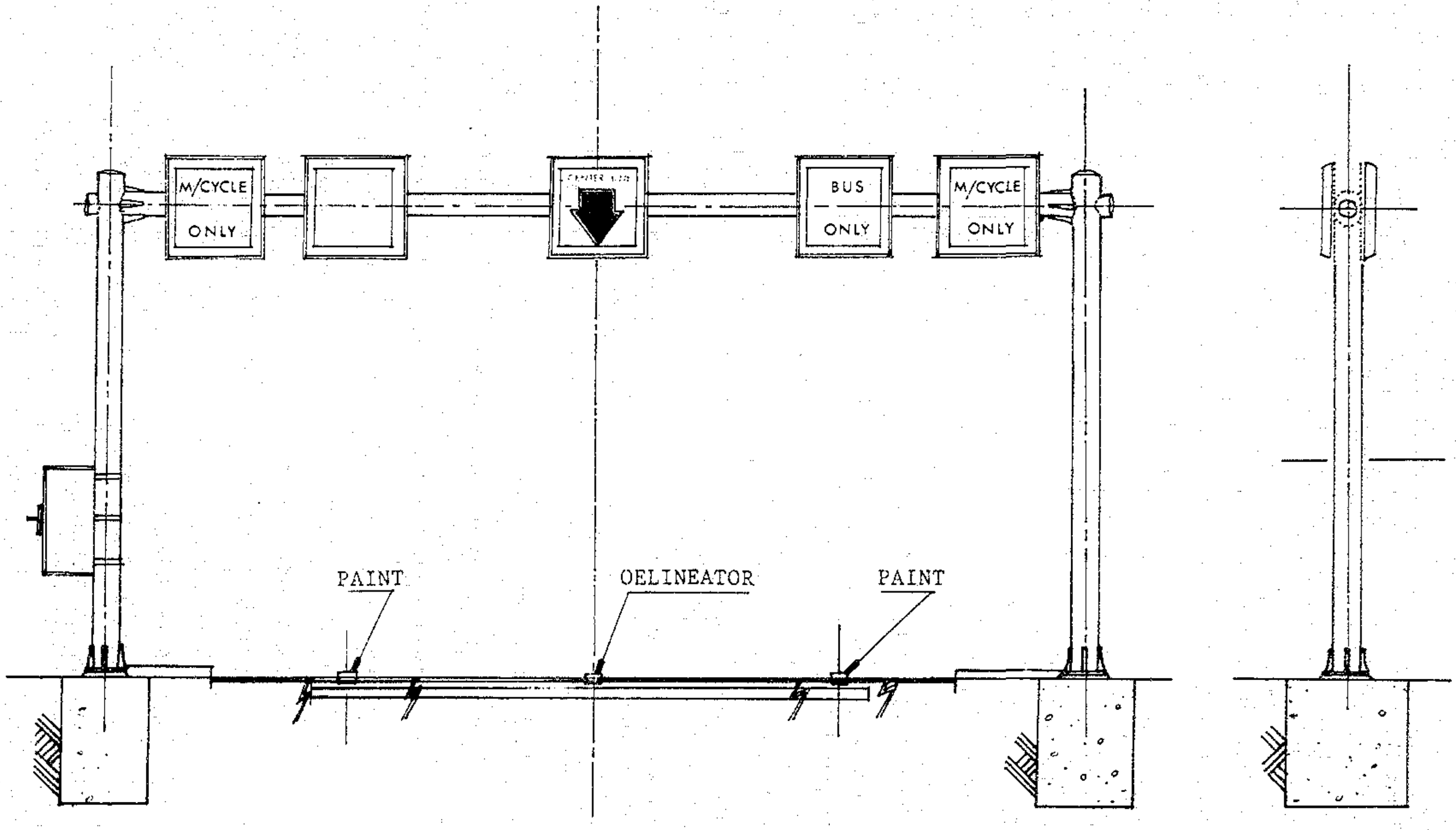


Fig.6.6 Sign-Board

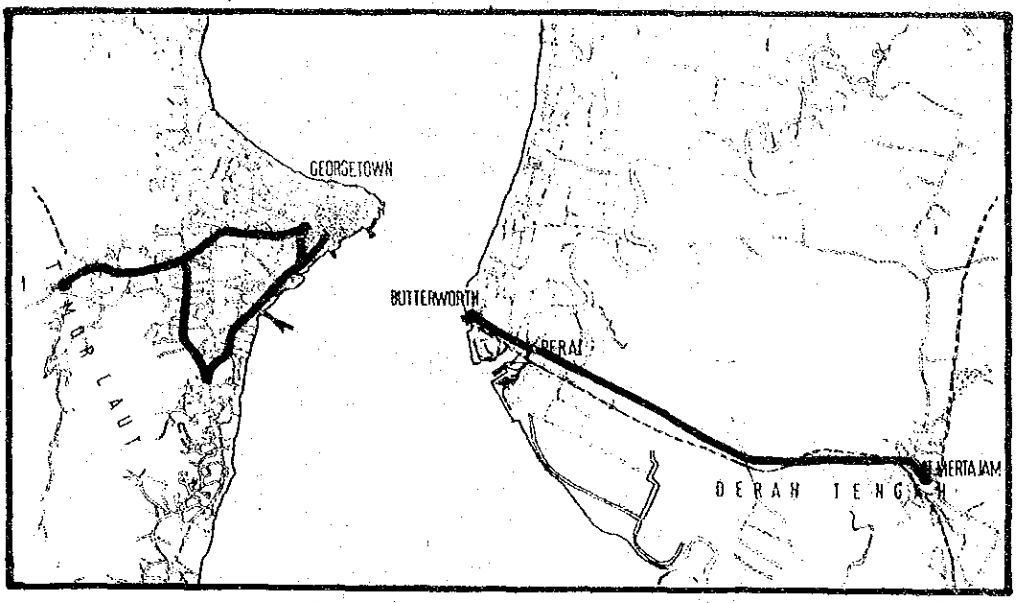


Fig. 6.7 LOCATION OF EXCLUSIVE BUS LANES

(b) Preparation for Exclusive Bus Lanes

Exclusive Bus Lanes are prepared as follows:

1) Sign-boards (shown in Fig. 6.6)
Sign-boards should be set up as a guide to the location of the exclusive bus lanes.

2) Lane Marks
In addition, signs should be installed, to indicate the existence of exclusive lanes so that they can be noticed easily.

(c) Cost Estimates

Sign-boards should be:

1) set up at intervals of every 1,000 metres.

2) installed at exclusive bus lanes indicating 'Bus' at intervals of every 500 metres.

Table 6.7 CONSTRUCTION COST

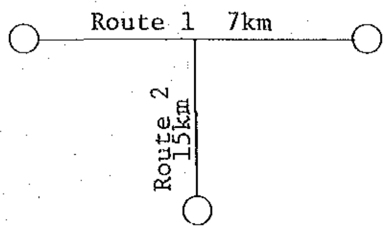
Description	Unit	Number	Unit Cost	Cost ($'000)
Sign-boards	Vol.	26	2,000	57
Marking	km.	25.9	1,000	29
Total				86

6.3.2 New Transportation System

1. General

The approximate construction cost and the relationship between the number of passengers and operation cost per trip is discussed below.

1) Length of Routes



2) Items for premise of estimation

i. Average length between stations = 1.0km

ii. Schedule speed = 25km/h

iii. Operation interval during peak hour = 5 minutes for each route.

3) Number of trains required

i. Required time for one way journey in each route

Route 1 $\frac{19}{25}$ x 60 min. = 45.6 min.

Route 2 $\frac{7}{25}$ x 60 min. = 16.8 min.

ii. Required number of trains

Route 1 $\frac{45.6}{5}$ x 2 ways = 18 trains or 19 trains (including reserve)

Route 2 $\frac{16.8}{5}$ x 2 ways = 6 trains or 7 trains (including reserve)

2. Approximate Construction Cost (KM$ = M$1,000)

This amount includes both fixed and variable cost. Variable cost is related to the number of trains.

1) Train

Tracks, electrical equipment, buildings, factories for repair and maintenance, excluding land cost.

200KM$/car x 22 = 4,400KM$ .... (1)

2) Power station

Capacity of power station.

75kw/car x 24 = 1,800kw
1,800kw x 2KM$/kw = 3,600KM$ .... (2)

3) Third rail

800KM$/km, one-way x (15km + 7km) x 2-ways
= 35,200 .... (3)

4) Signal equipment

800KM$/km, one-way x (15km + 7km) x 2-ways
= 35,200 .... (4)

5) Telecommunication equipment

200KM$/km, one-way x (15km + 7km) x 2-ways
= 8,800 .... (5)

6) Train car

500KM$/car x 26 = 13,000 .... (6)
(ATS, excluding ATO)

Total

(3), (4), (5) = 79,200KM$
(1), (2), (6) = 21,000 x N = Number of cars/train

Tracks and Stations 154,400KM$

Gross total (233,600 + 21,000 x N)KM$

Double Tracks/km (10,600 + 950 x N)KM$

3. Relationship between the number of passengers and investment cost (total construction cost).

1) Transporting capacity per day.

i. Fixed capacity per car = 60 persons.

ii. Peak ratio of 1 hour to a car = 12%

iii. Number of trains per hour = 12

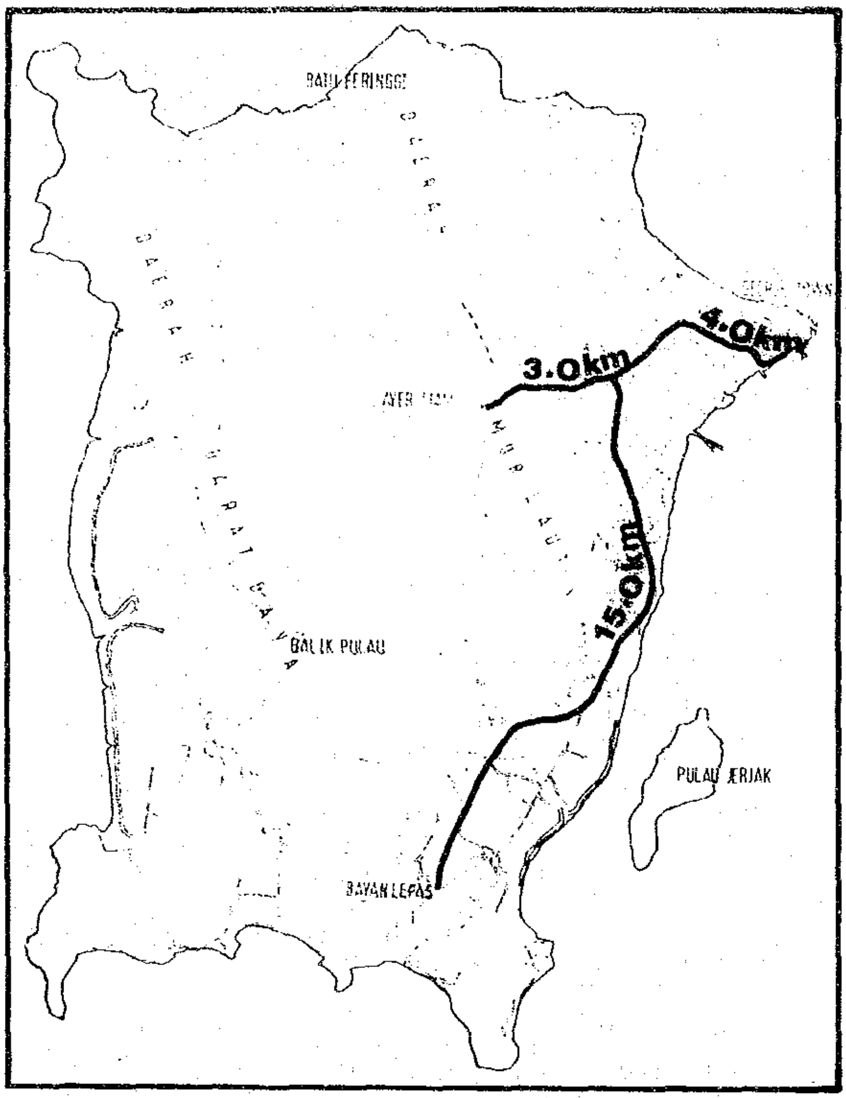


Fig. 6.8 <u>LOCATION OF NEW TRANSPORT SYSTEM</u>

2) The transporting capacity per day of a number of cars per train is M.

   60persons x 12trains x 2ways x 2routes x N
   = 2,800 x N persons/bothways 2-routes/hour

   $2{,}880 \times N \times \frac{100}{12} = 24{,}000 \times N$ persons/day

3) Relationship between construction cost & transporting capacity.

Table 6.8 CONSTRUCTION COST AND TRANSPORTING CAPACITY

No. of cars/train	Capacity/hour, 2-ways, 2-routes	Capacity/day, 2-ways, 2-routes	Total construction cost KM$
N = 1	2,800 persons	24,000 persons	253,000
2	5,600 "	48,000 "	275,600
4	11,200 "	96,000 "	317,600
6	16,800 "	144,000 "	359,600
8	22,400 "	192,000 "	401,600

4. Rough Estimate of Running and Other Costs

1) Number of persons required for operating the following.

Station

2 persons per station x 31 stations x 2.5 shifts

= 155 persons

Drivers and Conductors

2 persons per train x 24 trains x 3.5 shifts
(excluding stand-bys)

= 168 persons

Maintenance

* Truck. 0.6 person/one-way, km x 22km x 2 ways = 27

* Electricity. 0.7 person/one-way, km x 22km x 2 ways = 31

* Car. 0.5 person/car x (26 x N) car = 13 x N

For other operations, it will be 10% of the above total = 38 + 1 x N.

Total (419 + 11 x N) persons.

2) Personnel cost

M$600/month x 12 month x (419 + 14 x N) = 42,011 + 67.2 x N KM$/year.

3) Maintenance cost

* Tracks
M$20,000/double tracks/year x 22km = 440KM$

* Electricity
M$40,000/double tracks/year x 22km = 880

* Cars
12,000 KM$/car/year x 26 x N = 312 x N

Total = 1,320 + 312 x N

4) Power cost

* Total running distance

$$6 \text{ trains/hour} \times 22\text{km} \times 2 \text{ way} \times \frac{100}{12} \times N = (2{,}200 \times N)\text{km/day}$$

* Electricity consumption

0.12 KWH/ton. km x 12 ton/car x 2,200 x N

= (3,170 x N)KWH/day

* Power Cost

(3,170 x N)KWH x 365days x M$0.1/KWH = (116 x N)KM$/year

5) Transporting cost (for tickets and others)

1 cent/passenger x (24,000 x N)passengers/day x 365

= 87.6 x N KM$/year

6) Other costs

20 percent of above total cost

Personnel	2,011 + 67.2	x N KM$/year
Maintenance	1,320 + 312.0	x N KM$/year
Power	116.0	x N KM$/year
Transporting	87.6	x N KM$/year
	3,331 + 583	x N KM$/year
Other costs	666 + 117	x N KM$/year
Total	3,992 + 700 x N	

7) Rate of depreciation

Assuming that the rate of depreciation per year is 4 percent of total construction cost.

(273,600 + 21,000 x N)KM$ x 0.033 = (7,700 + 690 x N)KM$/year

8) Interest rate

Assuming that all construction costs are borrowed at an interest rate of 4 percent per annum.

(233,600 + 20,000 x N) x 0.04 = (9,344 + 840 x N)KM$/year

9) Total annual expenditure

Running cost	3,997 + 700 x N KM$/year
Depreciation	7,700 + 690 x N KM$/year
Interest	9,344 + 840 x N KM$/year
	21,041 + 2,230 x N KM$/year

Table 6.9 NUMBER OF PASSENGERS AND FARE PER TRIP

No. of cars/ train	Daily capacity (Persons)	Capacity per year ('000 persons)	Total construction cost KM$	Total annual expenditure KM$	Fare per trip $	Fare per trip, excluding depreciation & interest
N=1	11,000	4,015	253,600	24,698 (6,194)	6.15	1.54
2	22,000	8,030	273,600	26,820 (6,856)	3.34	0.85
4	44,000	16,060	313,600	31,064 (8,180)	1.93	0.51
6	66,000	24,090	353,600	35,308 (8,504)	1.46	0.39
8	88,000	32,120	393,600	39,552 (10,828)	1.23	0.34
10	110,000	40,100	433,600	43,796 (12,152)	1.09	0.30

( ): Running cost only
(excluding depreciation and interest)

Table 6.10 COST OF TRACKS AND STATIONS (per 22.0km)

Description	Class	Unit	Quantity	Unit Cost	Cost (M$'000)
1. Station	terminal	vol.	4	1,148,000	4,592
Station	minor terminal	vol.	19	574,000	10,906
2. Steel		Ton.	26,540	2,000	73,080
3. Concrete		M^3	6,160	150	924
4. Pillar		Ton.	3,762	2,000	7,524
5. Excavation	common	M^3	73,500	5	367
Sub-total					97,393
Per Kilometre					3,985
6. Land Acquisition	commercial	M^2	70,000	600	42,000
	other	M^2	150,000	100	15,000
Sub-Total					57,000
Total					154,39

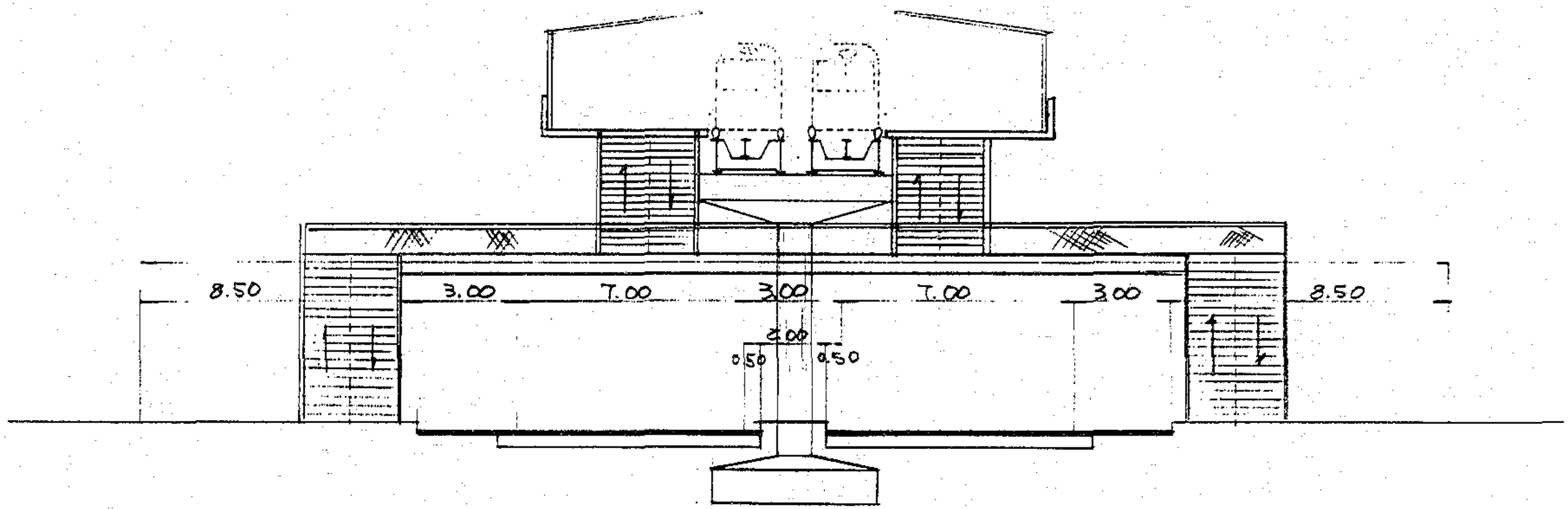


Fig. 6.9 Cross-Section of Station (Unit: in meter)

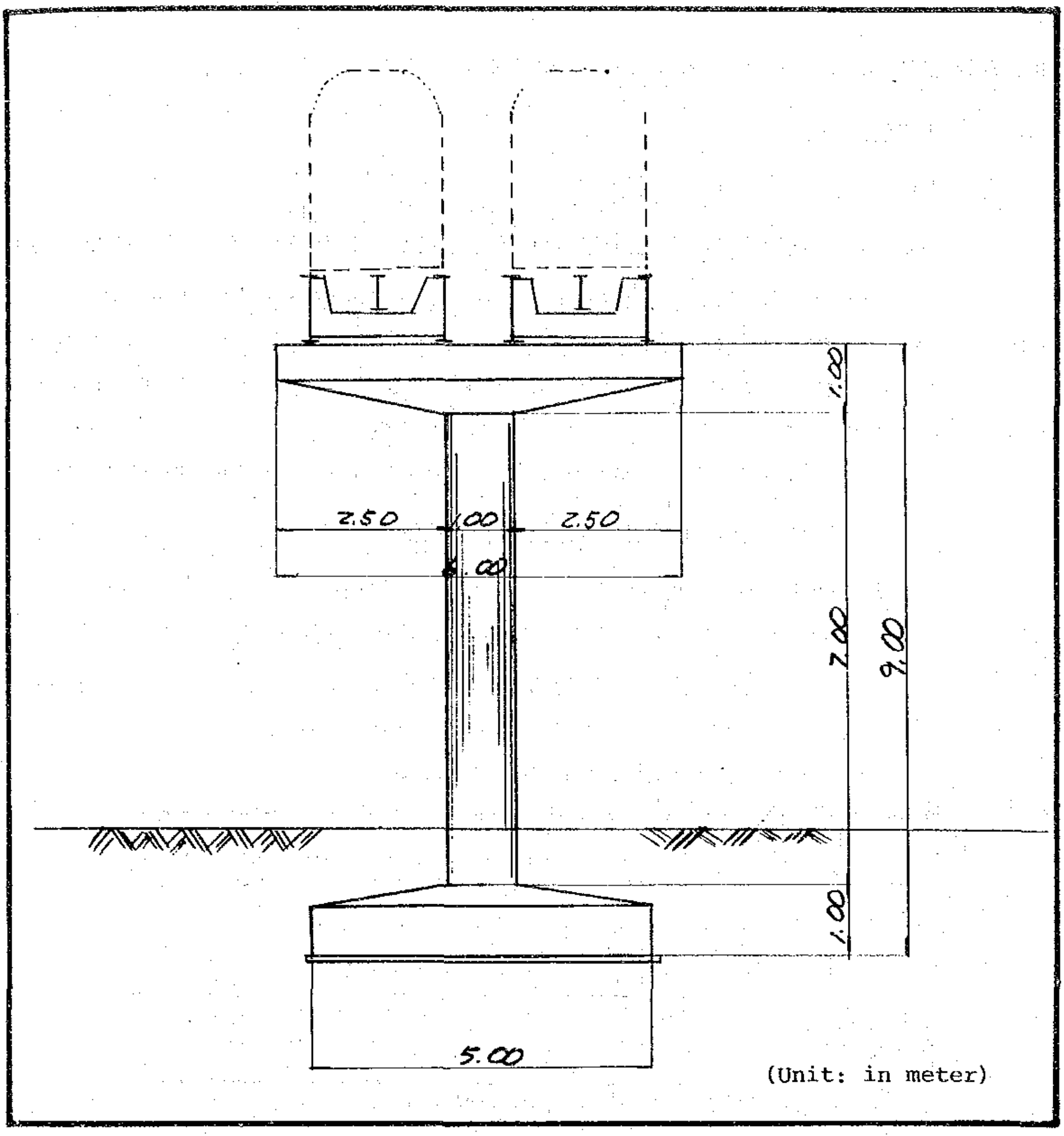


Fig.6.10 General Cross-Section of Guideway

6.4 Traffic Operation and Management

6.4.1 Sidewalks

1. Aspects of Sidewalk Plan

(a) Avoidance of cutting trees in the construction of sidewalks

Roadside trees contribute to a pleasant environment in towns and cities. In a situation where there is not enough space for the construction of a sufficiently wide sidewalk due to the presence of roadside trees, a narrow sidewalk can be constructed and thus roadside trees can be preserved.

(b) Relation of sidewalks to existing roads

Sidewalks are different in urban areas and in the suburbs as they are in the C.B.D. and in other built up areas.

As a general rule, sidewalks should be established in district and local distributors in urban areas as well as district distributors in the suburbs.

District		district distributors	local distributors
Urban area	C.B.D	*	*
	Other built-up area	*	*
Suburbs		*	-
Rural		-	-

* with sidewalks
\- without sidewalks

(c) Forms of sidewalk

Sidewalks must be distinquished from carriage-ways in that they are for the use of pedestrians while carriage-ways are for vehicles.

There are various ways of differentiating sidewalks and carriage-ways but the form of a particular sidewalk is derived from the existing road cross-section, traffic conditions and the use of the roads. In addition, safety of pedestrians, existing road conditions and costs have to be taken into consideration in deciding the type of sidewalk.

Sidewalks and carriage-ways are divided by kerb-stones. In urban areas, roads are narrow and as such the covered part of drains beside the roads are used as sidewalks.

(d) Avoidance of building removal in the construction of side-walks

Not only are roads in the urban areas narrow but there are also built-up areas along both sides of them and thus there is insufficient space wide enough for sidewalks. In this situation, there is no need to remove the buildings, instead, the width of sidewalks must be decreased.

(e) To provide sidewalks of adequate width

Demand for sidewalks vary according to adjacent land use patterns and road conditions. In the commercial areas especially, sufficient space for pedestrians is required not only from the point of view of safety but also from the need to provide amenities for urban living. Therefore parking control should be considered if there is insufficient space for sidewalks.

2. Types of Sidewalk

As mentioned above, sidewalks are constructed along limited arterial streets and circulating roadways. These may be divided into eight (8) different cross-sections (See Fig. 6.12) and the sidewalk for each cross-section is recommended by taking into consideration these different cross-sections of the roads.

1) Type A

This is suitable for narrow circulating roadways in the C.B.D. The width of the right of way is about 12.0m and drains run along both sides of the road. Thus, sidewalks with widths of 1.5m can be constructed along side the drains allowing enough space for two (2) persons walking side by side.

The mount-up of the sidewalk should be about 15cm high which is enough to ensure that no hindrance is caused to either pedestrians or vehicles.