MALAYSIA

URBAN TRANSPORT STUDY IN GREATER METROPOLITAN AREAS

OF

GEORGE TOWN, BUTTERWORTH AND BUKIT MERTAJAM

FINAL REPORT

PHASE II - STAGE 1

OUTER RING ROAD PROJECT

Main Volume

May 1981

JAPAN INTERNATIONAL COOPERATION AGENCY

GOVERNMENT OF MALAYSIA

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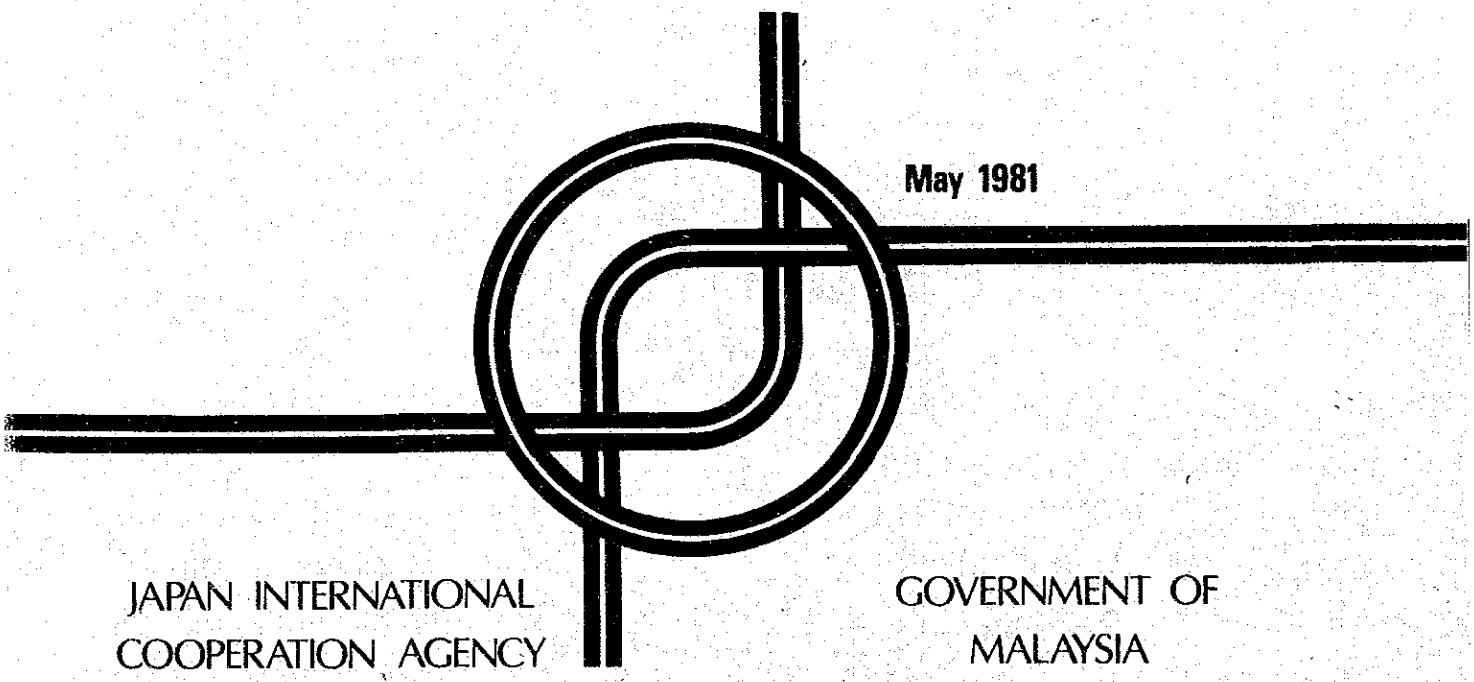

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JAPAN INTERNATIONAL COOPERATION AGENCY

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Preface

In response to a request of the Government of Malaysia, the Government of Japan decided to conduct a feasibility study on the Outer Ring Road Project in the Greater Metropolitan areas of George Town, Butterworth and Bukit Mertajam, and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA dispatched to Malaysia a study team headed by prof. Takashi Inoue from April 1980 to March 1981.

The team had a series of discussions with the officials concerned of the Government of Malaysia, conducted a full scale field survey as well as data analysis and has prepared the present report.

I hope that this report will surve a basic reference for development of the project.

I wish to express my deep gratitude to the officials concerned of the Government of Malaysia for their close cooperation extended to the Japanese team.

May, 1981

Keisuke Arita

Keisuke Arita
President
Japan International Cooperation Agency

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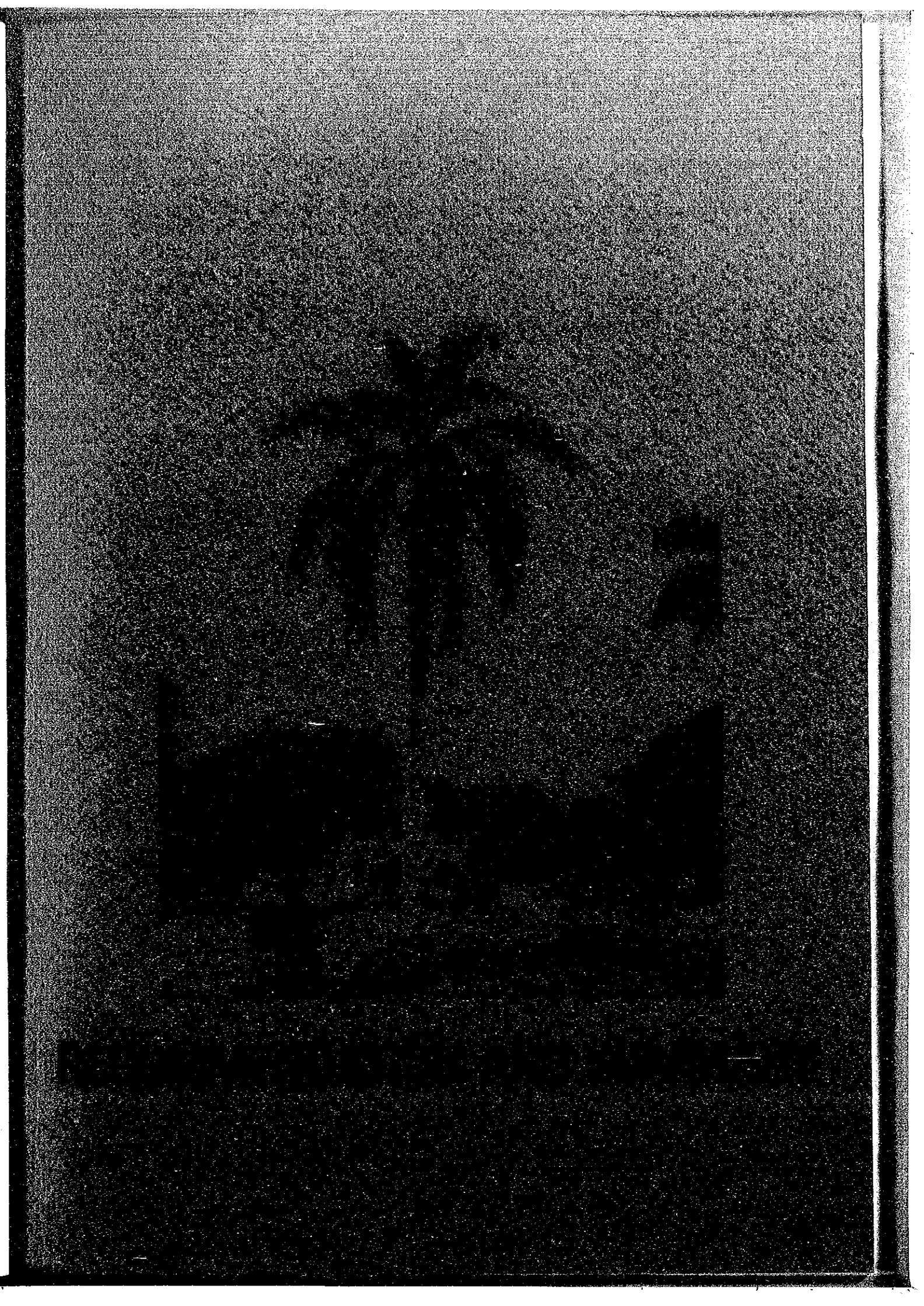
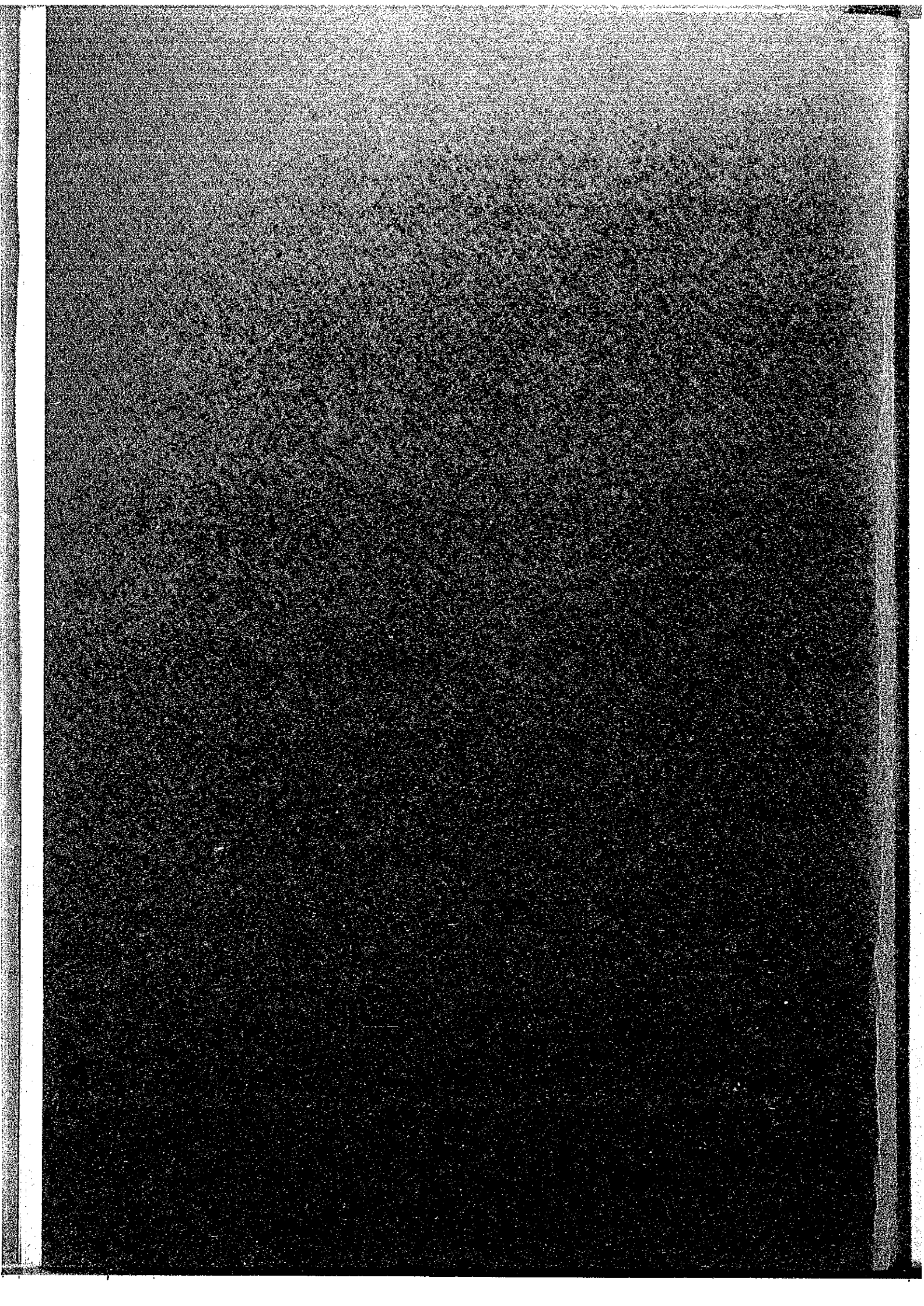




A. RECOMMENDATION

Due to the intensive economic development in the State of Penang as well as the rapid increase of traffic demand, the Metropolitan area has serious urban transport problems. Moreover, the Penang Bridge will bring about the necessity to renew the existing transport system in the region. Henceforth the Outer Ring Road is proposed in the Phase I study to disperse the traffic entering and leaving the center of George Town where built-up areas formulated through its long history makes construction of new roads difficult.

This road is proposed as an intra-urban primary distributor to encircle the town with the North Coastal Road which is currently in the design stage of planned construction. As a result of the feasibility study of the Phase II study, the Outer Ring Road project is feasible from the viewpoints of the economic evaluation, engineering and environmental studies.

Judging from the traffic demand projection and the result of economic and financial analysis, it is recommended that the Project should be implemented in stages and over a longer period from 1984 to 1991.

Major recommendations by the Phase II Study are described as follows:

A.1 Route and Design

The route of the Outer Ring Road is recommended to start at the existing Weld Quay and the North Coastal Road and to connect to the North Coastal Road at Glugor with a length of 23.84 km as illustrated in Fig. A.1.1.

It is recommended that the Outer Ring Road have direct access to the North Coastal Road in order to conform as a complete ring road of George Town. From the discussion with the Government of Malaysia on the choice of interchange the partial access type of interchange is selected.

The carriageway of the Outer Ring Road is recommended to have 4-lanes. In order to disperse traffic effectively as a primary distributor, the design speed of 80 km/hr is adopted.

In order to achieve the upmost efficiency of the Ring Road, and in view of the rapid increase of traffic demand from Bayan Baru Newtown and Industrial zones in the south, the Weld Quay extension has become indispensable.

A.2 Cost

The Project Cost is estimated to be M$149.7 million as tabulated in Table A.2.1.

A.3 Implementation Schedule

Resultjng from the economic evaluation and the predicted traffic volumes on the major roads, the following implementation schedule is recommended.

Phase 1 : Northern Section (Section 2) of the Project Road (1984 - 1989)
(Jalan Ayer Itama-ORR intersection to Jalan Prangin-Weld Quay intersection)

Stage 1 : Segments 4 and 7 (1984 - 1987)
(Jalan Ayer Itam-ORR intersection to Jalan Gottlieb-ORR intersection)

Stage 2 : Segments 9 and 10 (Mid 1984 - 1987)
(Jalan Bagan Jermal-Gurney Drive intersection to Jalan Prangin-Weld Quay intersection)

Stage 3 : Segments 5 and 6 (1986 - 1989)
(Jalan Gottlieb-ORR intersection to Jalan Bagan Jermal Gurney Drive intersection via Mount Erskine Road-ORR intersection)

Phase 2 : Southern Section (Section 1) of the Project Road (1987 - 1991)
(Jalan Ayer Itam-ORR intersection to NCR-ORR intersection)

The investment requirements corresponding to the aforementioned schedule is M$82.4 million for Phase 1 and M$58.1 million for Phase 2 as shown in Table A.2.2.

A.4 Environmental Consideration

Particular attention in Landscape and environmental designs are needed in this Project to maintain and preserve the beautiful Penang landscape, especially along the seashore areas. Bifunctional open space and buffer zones are suggested along Gurney Drive and the esplanade areas.

Table A.2.1 THE PROJECT COST

(In thousand M$ at 1980 prices)

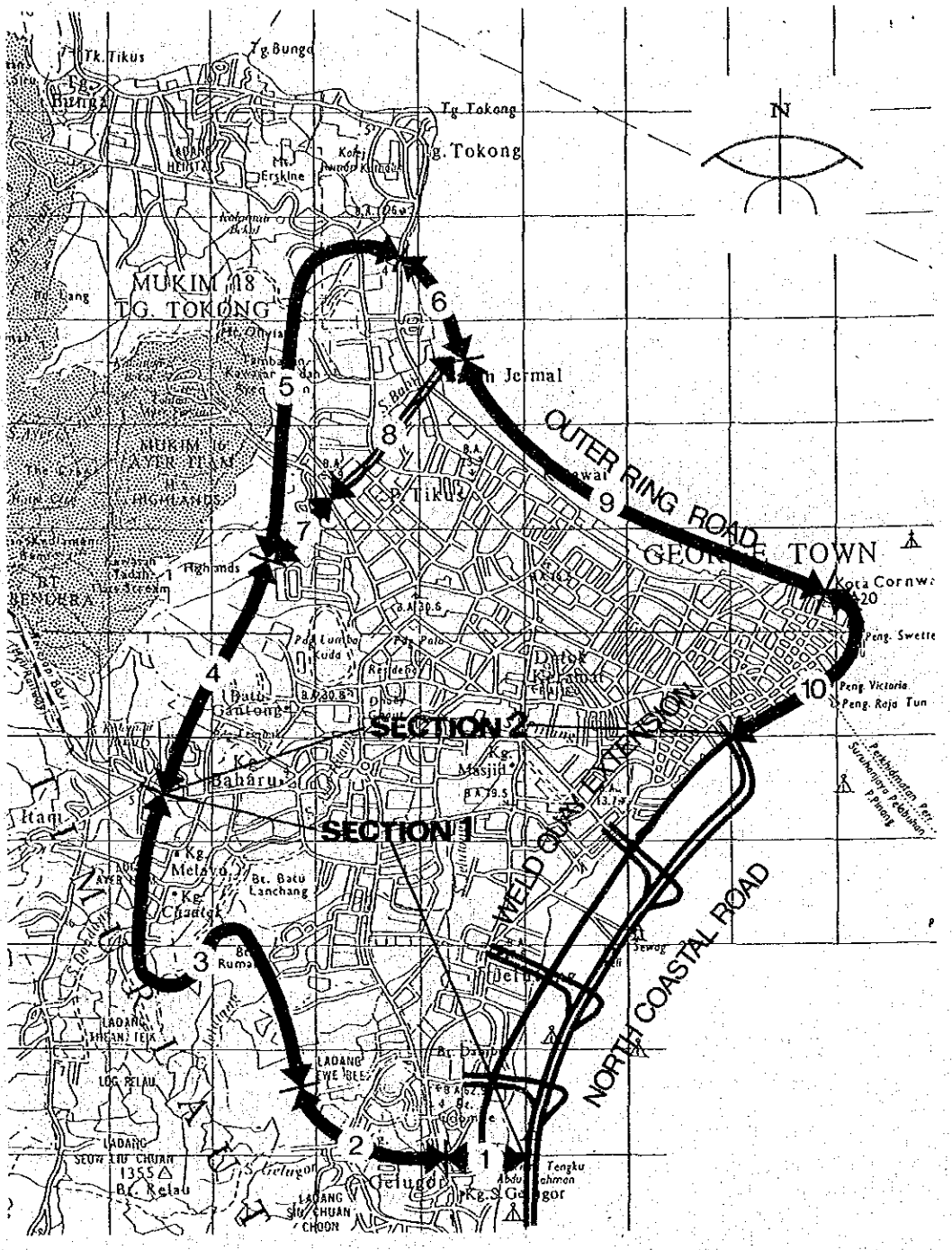
Land Acquisition & Compensation	43,626
Road Construction	96,792
Sub-Total	140,418
Professional Service	9,298
Total	149,716
In Foreign Currency	46,954
In Local Currency	97,160
Tax	5,602

Table A.2.2 SUMMARY OF FINANCIAL COST

(In thousand M$ at 1980 prices)

	Foreign	Local	Total
Detailed Engineering and Construction Supervision	3,297	6,001	9,298
Phase 1			
Land Acquisition	-	19,200	19,200
Construction	28,786	34,365	63,151
Sub-Total	28,786	53,565	82,351
Stage 1			
Land Acquisition	-	10,144	10,144
Construction	7,705	7,584	15,289
Sub-Total	7,705	17,728	25,433
Stage 2			
Land Acquisition	-	0	0
Construction	10,953	15,043	25,996
Sub-Total	10,953	15,043	25,996
Stage 3			
Land Acquisition	-	9,056	9,056
Construction	10,128	11,738	21,866
Sub-Total	10,128	20,794	30,922
Phase 2			
Land Acquisition	-	24,426	24,426
Construction	14,871	18,770	33,641
Sub-Total	14,871	43,196	58,067
Total Land Acquisition	-	43,626	43,626
Construction	43,657	53,135	96,792
Total	43,657	96,761	140,418
Grand Total	46,954	102,762	149,716

Note : Tax is included into local portion.



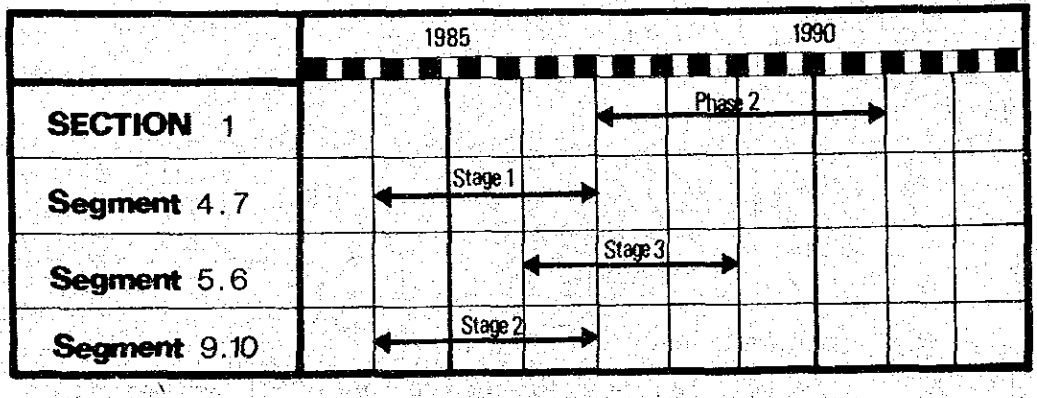


Fig. A.1.1 THE ROUTE AND SEGMENT OF THE PROJECT ROAD

B. SUMMARY

B.1 Introduction

B.1.1 Project Background

The Greater Metropolitan Area of George Town, Butterworth and Bukit Mertajam (Penang Metropolitan Area) has serious urban transport problems due to intensive industrial and other urban developments undertaken in the area, as well as the rapidly increasing number of prevate vehicles, particularly within the Central Business Districts (C.B.D.) of George Town and Butterworth. In addition, the opening of the Penang Bridge which connects Penang Island with Province Wellesley is expected to bring about a drastic change of transport conditions.

In order to solve the urban transport problems, the Government of Malaysia requested the Government of Japan to conduct an Urban Transport Study in the Greater Metropolitan Area of George Town, Butterworth and Bukit Mertajam (hereinafter called the "Study"). In compliance with the request of the Government of Malaysia, the Government of Japan had decided to undertake the study through the Japan International Cooperation Agency (JICA).

The Study is divided into two phases. Phase I of the study (hereinafter called the "Phase I Study") is aimed at formulating a master plan for the Penang Metropolitan Area and Phase II of the Study (hereinafter called the "Phase II Study") is aimed at determining the feasibility of a project selected on the basis of Phase I Study's recommendations.

The Phase I Study, conducted over a period of one year from March, 1979, has established the following set of recommendations for the implementation of its transport infrastructure.

a. Long Term Transport Plans

1. Construction and Improvement of Roads
2. Improvement of Public Transport
3. Private Vehicle Restraints
4. Construction of Transport Terminal Complex

b. Short Term Actions

1. Implementation of Traffic Engineering and Management Measures

2. Construction and Improvement of Roads

3. Improvement of Bus Transport

Among both the short and long-term plans and actions, the construction of an Outer Ring Road is identified as a high priority project.

In the Phase II Study, therefore, the Outer Ring Road Project in Penang Island is taken up and conducted.

B.1.2 Objectives of the Phase II Study

The objective of the Phase II Study is to determine the technical, economical and environmental feasiblity of the construction of the Outer Ring Road (hereinafter called the "Project Road") in accordance with a standard acceptable to Inrernational Financing Institution.

Furthermore, the Japanese team will seek to transfer its technology to their Malaysian counterpart during the study period.

B.1.3 Study Approach

The following are the principal activities and processes in the Phase II Study.

a. Route Location

b. Traffic Projection

c. Preliminary Engineering and Environmental Study

d. Cost Estimates

e. Economic Evaluation

f. Implementation Program

In this Study, alternatives for the following items of the Project Road are prepared and appraised from technical, environmental and economic stand points in order to achieve the best possible result.

a. Route

b. Cross-Section

c. Access to the North Coastal Road

d. Stage Construction by Road Section and Segment

B.1.4 *Study Area and Traffic Zoning*

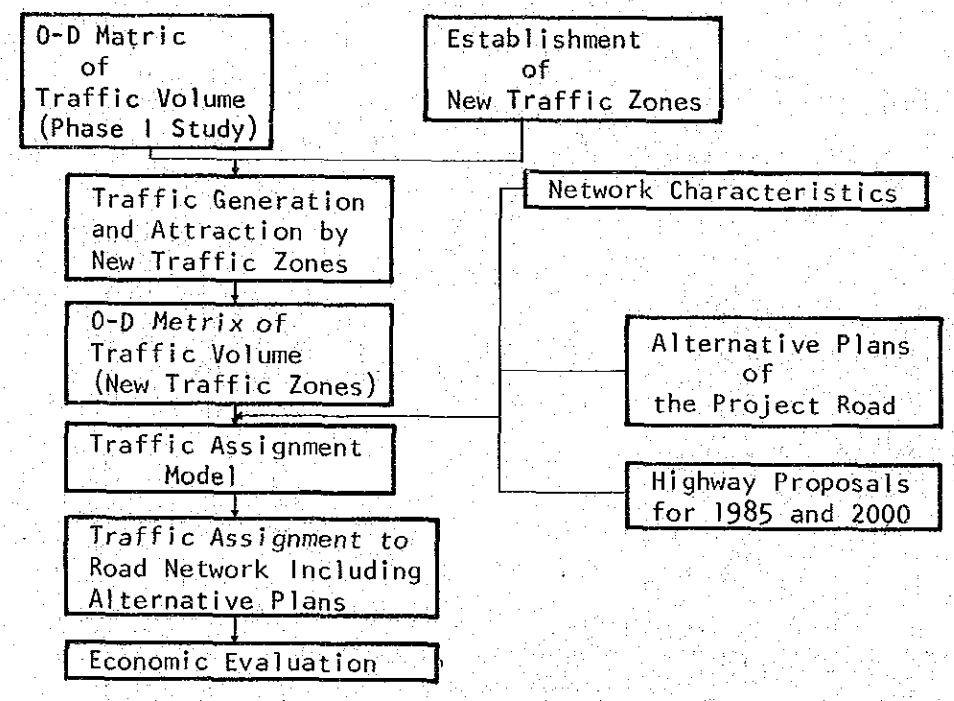
The Study Area in Phase II Study covers only the internal area of Penang Island which was defined in the Phase I Study. The traffic zones in Penang Island designed in the Phase I Study are subdivided into smaller zones in order to get more detailed traffic volume projections on the Project Road. The number of zones in the internal study area is 74 zones, while in the external area is 6 zones.

B.2 Projection of Traffic Demand

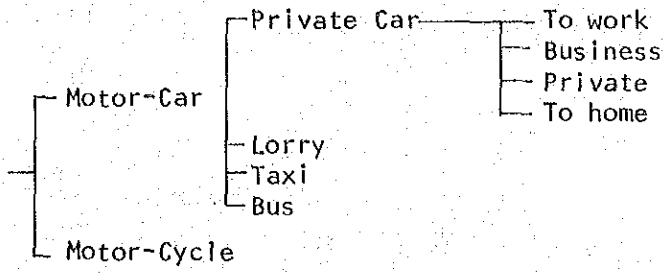
B.2.1 Procedure

The Phase II Study employs basic data and traffic projection models developed in the Phase I Study. The procedure of traffic demand projection is as follows.

Procedure for Traffic Projection



The future traffic demand is also given according to the following categories by vehicle type and trip purpose.



B.2.2 Socio-Economic Input

The socio-economic indicators projected for the year 1985 and the year 2000 in the Phase I Study are adopted as the premises of traffic projection.

The planned population in the Study Area is 519.3 thousand in 1985 and 677.0 thousand in the year 2000. Employment heads in the Study Area are expected to reach 162.4 thousand in 1985 and 240.9 thousand in the year 2000.

Based on the socio-economic trends, the number of vehicles in Penang State in expected to reach 261 thousand in 1985 and 471 thousand in the year 2000.

B.2.3 Transport Network

The transport network system in the year 2000 adopted in the Phase II Study follows Plan 4-B, proposed in the Phase I Study where all of the proposed roads are completed and a reduction of parking capacity at the C.B.D. of George Town with an introduction of exclusive bus lanes are undertaken. It is also assumed that the ferry services in transporting passengers, motor-cycles and motor-cars will continue its service even after the completion of the Penang Bridge and Weld Quay is extended to connect to the Project Road.

Regarding the Project Road, many alternative routes are prepared initially, after which engineering and environmental aspects as well as their effects on the traffic of George Town are then examined. Finally, after assessment, two alternatives are selected for the economic evaluation as described in the later chapters.

B.2.4 Results of Traffic Projection

(1) Trip Generation

Two cases are projected, i.e. Case 'A' and Case 'B'.

Case A

This case assumes that ownership transition from motor-cycle to motor-car will increase in time due to the rapid increase of per capita income, as is beeing observed very commonly in the world. The result of projection is tabulated in Table B.2.1.

Case B

This case assumes that the past growth rate of motor-cycle and the present number of trips per M/C will continue in spite of the high holding ratio of M/C in Penang, due to the increase of transport cost and other miscellaneous reasons.

The result of the projection is also tabulated in Table B.2.2. Though case A is mainly used in this study, case B is applied as a case in the sensitivity analysis of economic evaluation.

Table B.2.1 VOLUME OF TRIP GENERATION

CASE A

(Unit : 1,000 p.c.u.)

		1979	1985	2000
Motor-Car	Internal Area	277.1	353.4	691.3
	External Area	4.7	7.4	27.1
	Penang Island	281.8	360.8	718.4
		(100)	(128)	(255)
Motor-Cycle	Internal Area	135.9	139.7	125.0
	External Area	1.2	1.3	1.4
	Penang Island	137.1	141.0	126.4
		(100)	(103)	(92)
Total	Internal Area	413.0	493.1	816.3
	External Area	5.9	8.8	28.4
	Penang Island	418.9	502.0	844.6
		(100)	(120)	(202)

CASE B

(Unit : 1,000 p.c.u.)

		1979	1985	2000
Motor-Car	Internal Area	277.1	333.8	585.4
	External Area	4.7	7.0	22.9
	Penang Island	281.8	340.8	608.3
		(100)	(121)	(216)
Motor-Cycle	Internal Area	135.9	164.9	263.7
	External Area	1.2	1.5	2.4
	Penang Island	139.1	166.4	266.1
		(100)	(121)	(194)
Total	Internal Area	413.0	498.7	849.1
	External Area	5.9	8.5	25.3
	Penang Island	418.9	507.2	874.4
		(100)	(121)	(209)

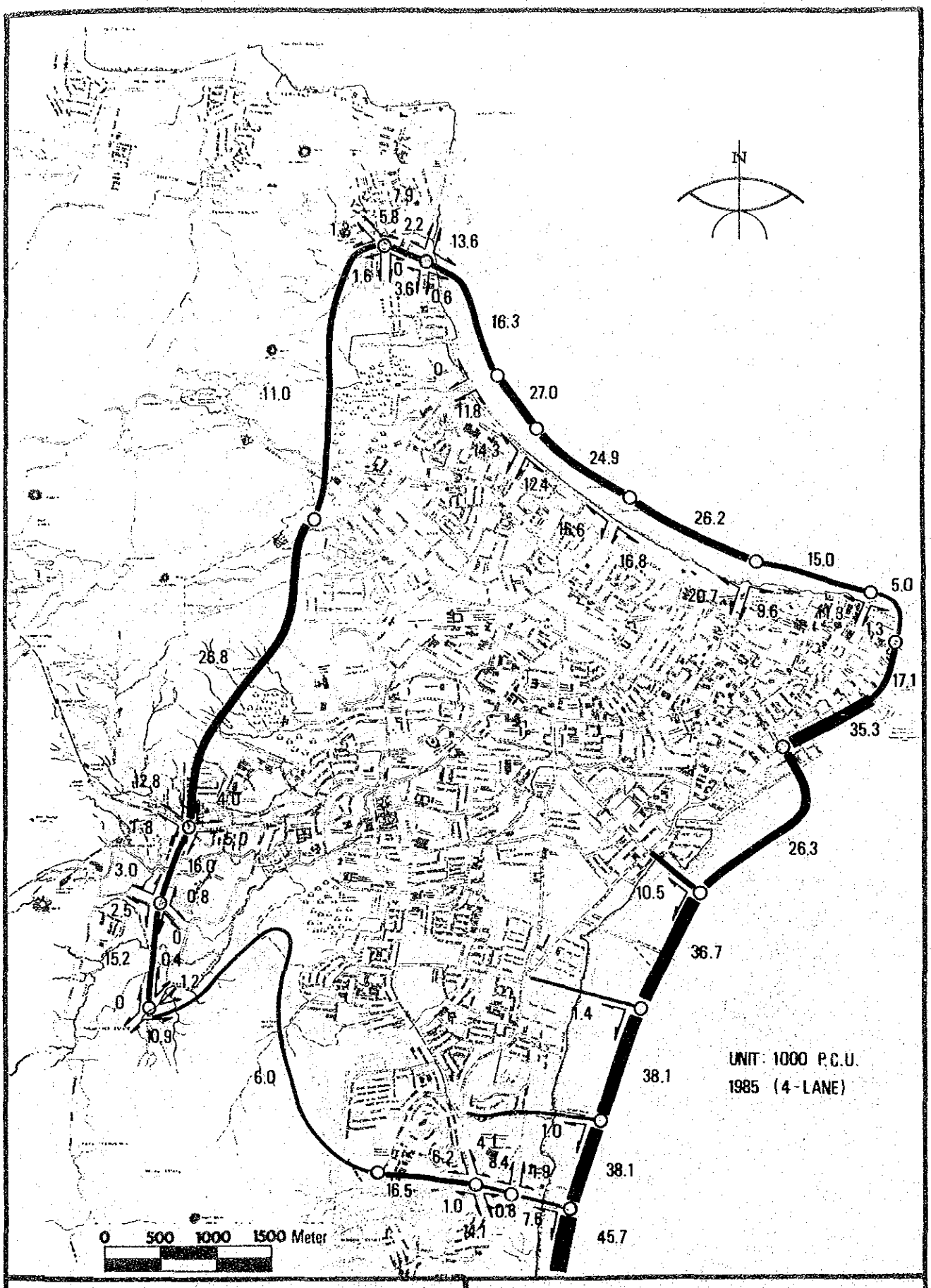
(2) Traffic Volume on the Project Road

The traffic volume on the Project Road estimated by the network assignment is shown in Fig. B.2.1 and Fig. B.2.2. According to these figures the following can be observed.

a. The projected traffic volume of the northern part of the Project Road is bigger than taht of the

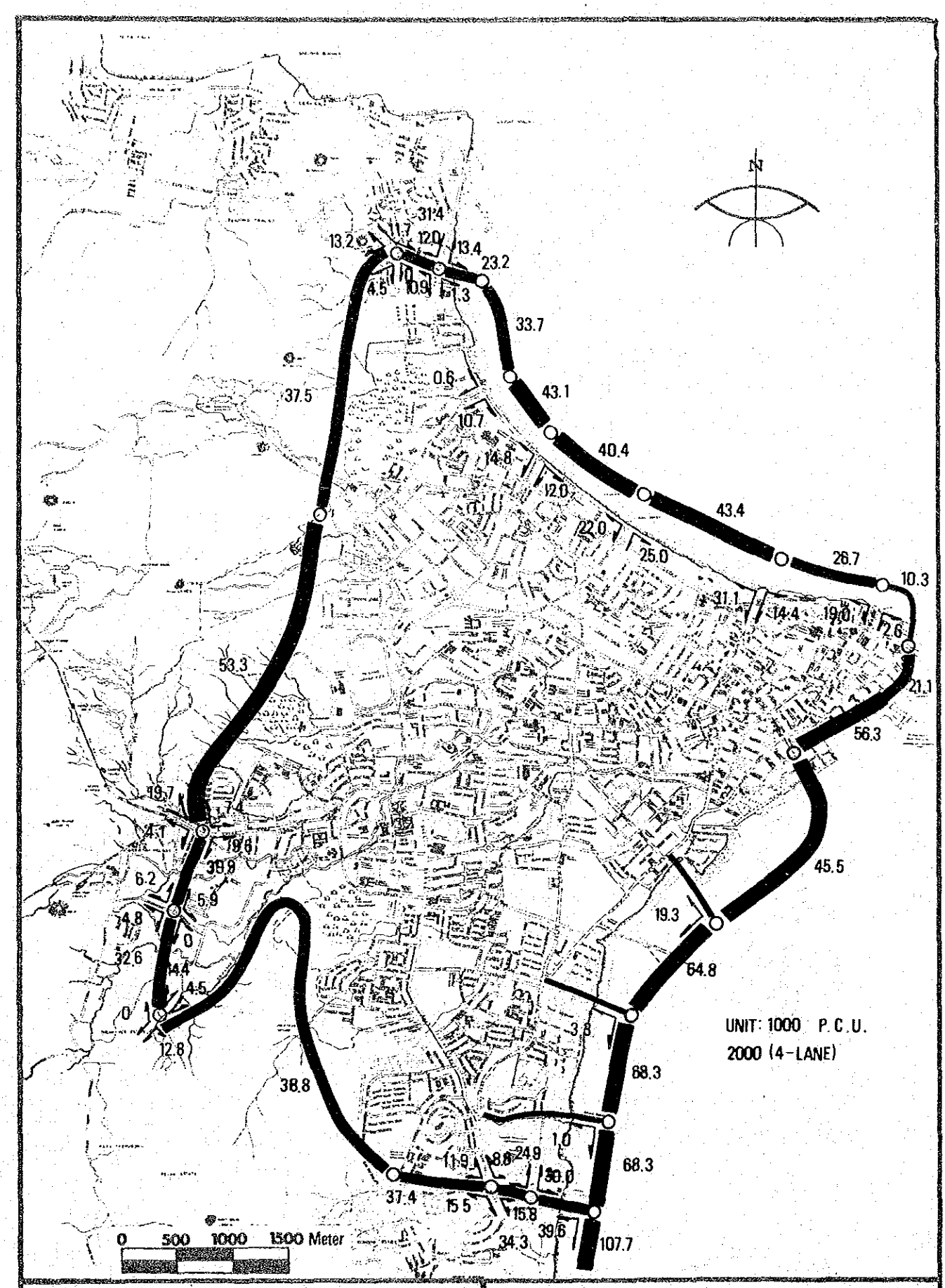
southern part of this road.

b. The daily traffic volume of the segments between Jalan Ayer Itama and Jalan Gottlieb and the north seashore is comparatively greater than that of the other segments.



URBAN TRANSPORT STUDY

Fig. B.2.1
TRAFFIC VOLUME ON RECOMMENDED ROUTE (1985)



URBAN TRANSPORT STUDY

Fig. B.2.2
TRAFFIC VOLUME ON RECOMMENDED ROUTE (2000)

B.3 Route Study and Preliminary Design

B.3.1 Characteristics of the Project Road

The Project Road was proposed as a Primary Distributor for intra-urban traffic by the Phase I Study. Since the road network configuration of George Town will form a ring and radial type of network, the Proposed Road is mainly expected to be functional as a ring road which disperses the traffic coming in and out the city center.

In order for its functions to be effective, it is necessary to control the access of minor-traffic and to have grade-separated major intersections.

B.3.2 Surveys for Preliminary Engineering

The following surveys are conducted in reference to a preliminary engineering study.

a. Topographic Survey

b. Oceanographic and Reclamation Surveys

c. Soil Investigation

d. Material Survey

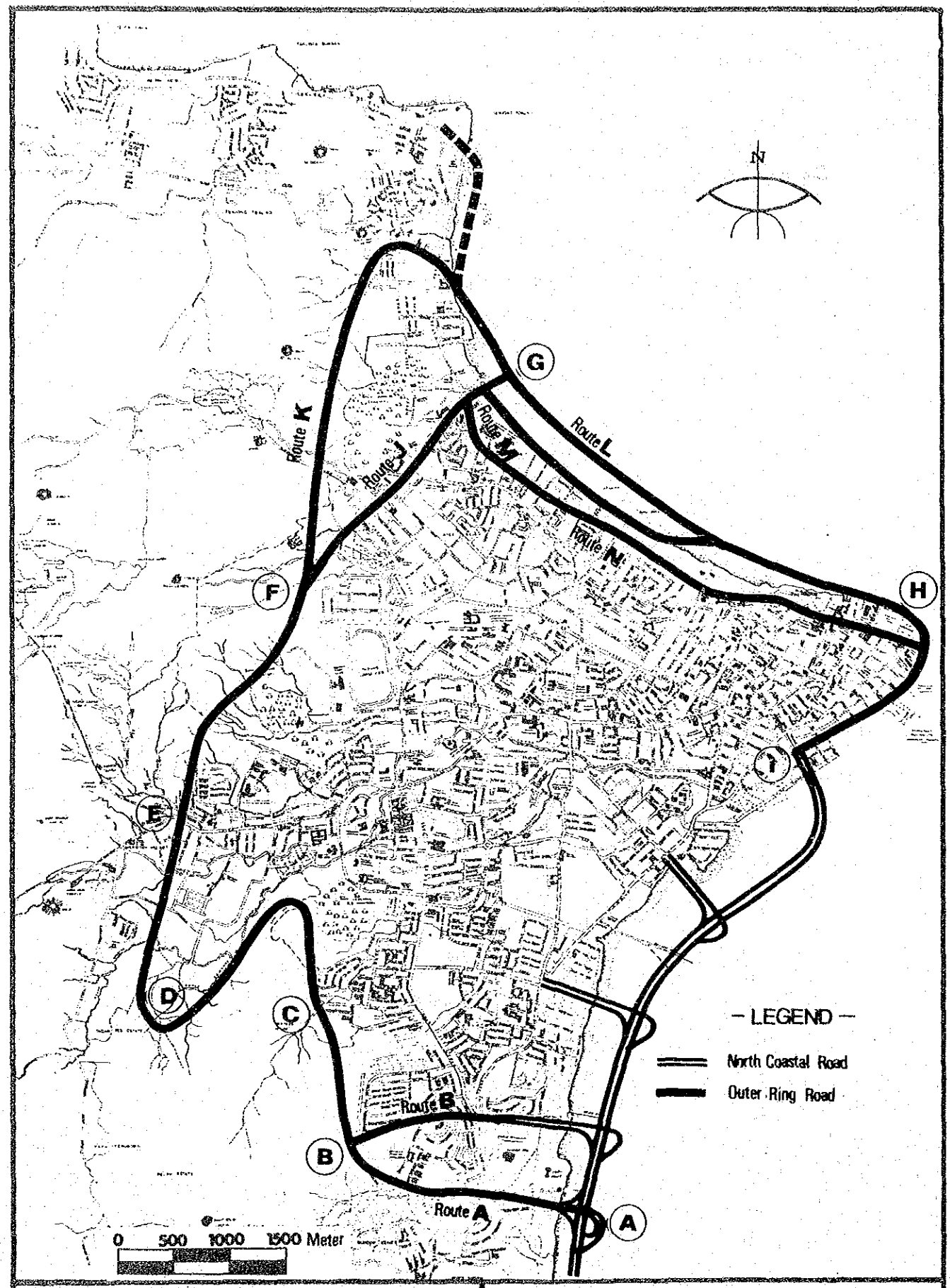
e. Environmental Survey

B.3.3 Design Standard

The Malaysian Design Standard is adopted for the Project Road design after a careful comparative review of other design standards. The design elements adopted are as follows:

Design Speed	80 kms/hr
Maximum Gradient	7 %
Minimum Radius	210 m
Carriageway	3.50 m
Central Reservation	3.0 m
Shoulder Width	2.00 m
Inner-Shoulder	0.5 m
Shoulder-Flat Area	2.0 m
- Hilly Area	1.5 m

Note: Operating speed in urbanized area is assumed to be 60 kms/hr.



URBAN TRANSPORT STUDY

Fig. B.3.1
LOCATION OF ALTERNATIVE ROUTES

B.3.4 Alternative Route Study

Based on the field investigations conducted, the environmental surveys along the proposed route, etc., the alternative routes are designed as shown in Fig. B.3.1.

The evaluation of the alternative routes consists of an assessment of their technical tenisibility environmental effects and cost. The results of the comparative analysis of each section are shown below.

Section A-B

		Route A	Route B
Disruption of Community		Small	Anticipated
Residences to be Affected		Small	Anticipated
Land Use		Developing area for residence	Developed area for residence
Design Factors	Max. Grade Min. Radius Alignment Number of Structure	Below 3% Over 600 m Smooth one (Over-bridge)	Below 3% Over 500 m Up and down slopes one (Over-bridge)
Cost ($'000)	Construction	14,297	18,360
	Land Acquisition and Compensation	7,993	12,059
	Total	22,290	30,419
Relation to the North Coastal Road		New Interchange Necessary	Utilizing the committed inrerchange

From the comparative analysis, Route A is recommended for this Section A-B.

Section F-G

		Route J	Route K
Disruption of Community		Small	Small
Residences to be Affected		Anticipated	Small
Impacts on Existing Institutional Building		Anticipated	Small
Land Use		Medium Density Residential/ Institutional Area	Hilly Area/ Developing Area for Residence
Design Factors	Max. Grade Min. Radius Alignment Number of Structure	Below 6% Over 300 m Flat Grade-Separated Bridge : 2	Below 6% Over 300 m Up and down slopes Grade-Separated Bridege : 2
Cost ($'000)	Construction Land Acquisition and Compensation Total	10,416 17,381 27,797	21,015 9,443 30,458

The difference in construction cost between both routes is only M$3 million (Route 'J' being ceaper than Route K; although this amount does not include the cost of the approach roads) while Route K may cause less environmental problems.

However the choice of these two alternatives is left to the result of economic evaluation described in Chapter B.5.

Section G-H

		Route L	Route M	Route N
Disruption of Community		No	No	Small
Residences to be Affected		No	No	Anticipated
Impact to Existing Institutional Buildings		No	No	Small
Land Use		Seashore	Seashore and Residential Area	Residential and Commercial Area
Design Factors	Max. Grade	Below 5%	Below 5%	Below 5%
	Min. Radius	Over 500 m	Over 500 m	Over 100 m
	Alignment		Flat	Flat
	Number of Structure	-	-	-
Cost ($'000)	Construction	26,795	22,937	4,457
	Land Acquisition and Compensation	0	0	25,064
	Total	26,795	22,937	29,521

The following conclusions can be derived from the above table.

1) From the viewpoint of the construction cost, Route M is most recommendable since it is cheaper than Route N by about M$6.6 million and in the case of Route L by about M$2.8 million.

2) From the viewpoint of the environment, Route N is not so readily recommendable due to its effect on present landscapes as well as to the residents near-by.

   In the case of Route L and Route M, if a proper buffer zone is provided between the existing seashore line and the Project Road, it could result in creation of attractive landscape.

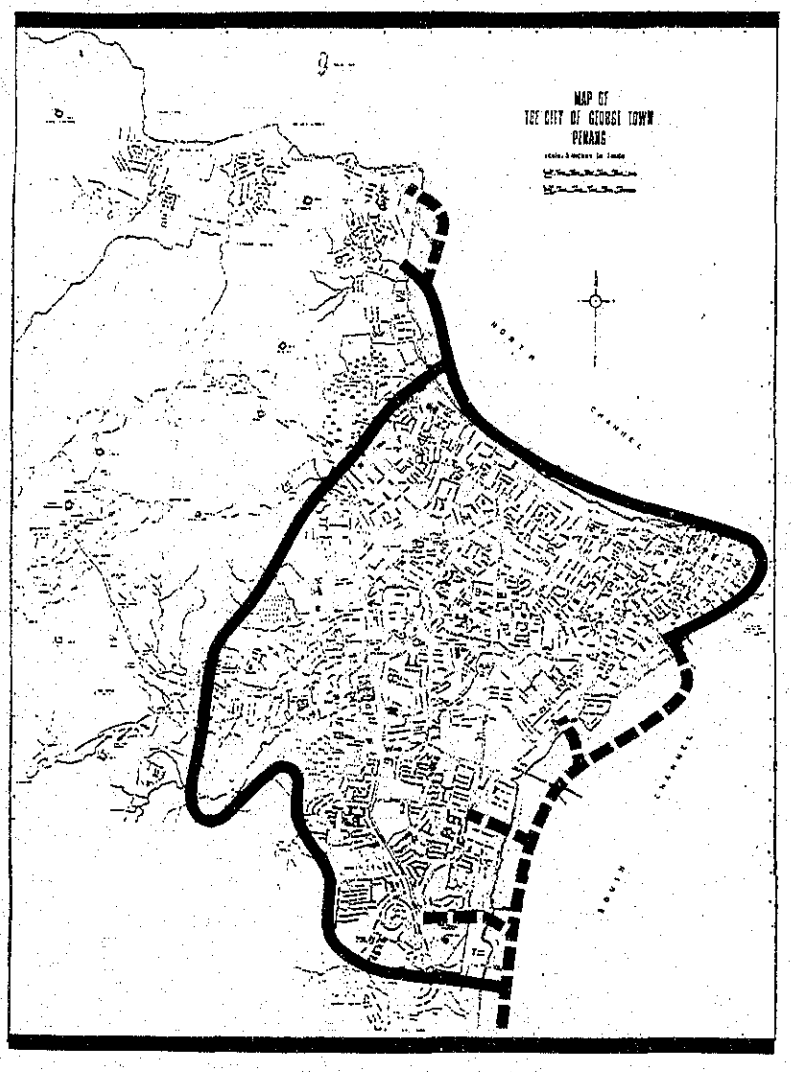
3) Therefore Route M is recommended.

As a result of route location study, two alternative routes as shown in Fig. B.3.2 are selected from the technical and environment standpoints.

Those are,

Plan 1 : Route A, Route J, Route M.

Plan 2 : Route A, Route K, Route M.

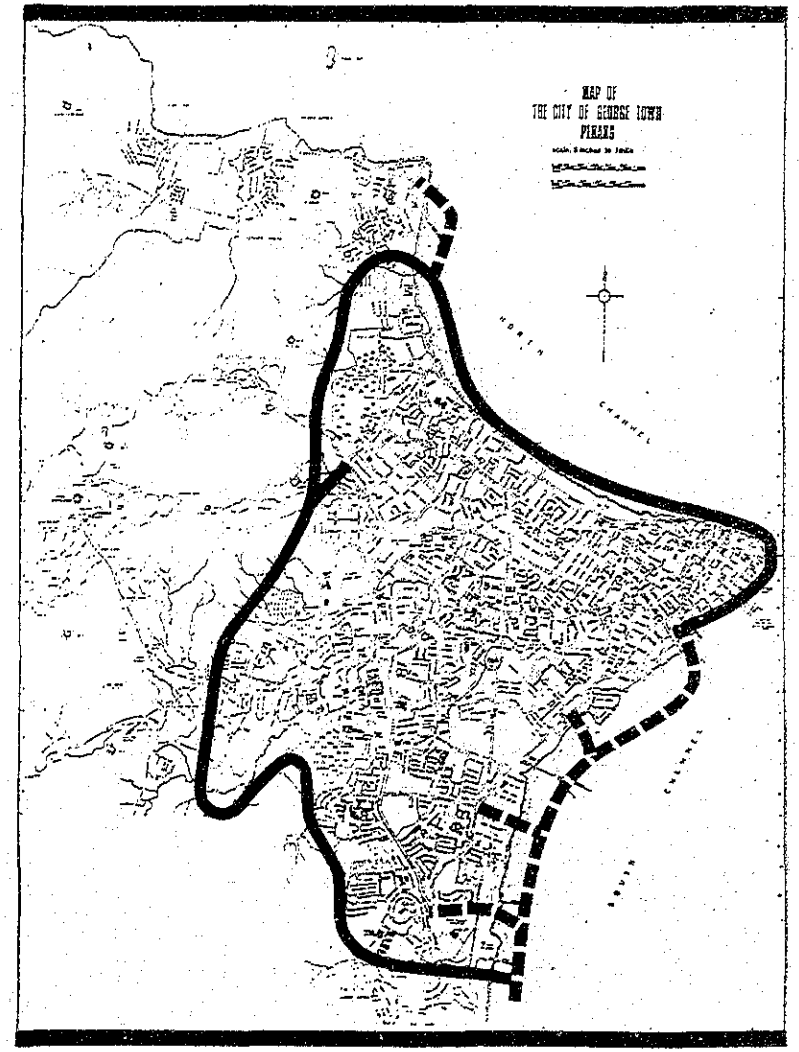


PLAN 1

— LEGEND —

Outer Ring Road

Planned Road



PLAN 2

Fig. B.3.2 ALTERNATIVE ROUTES

B.3.5 Preliminary Design

1) Road Cross-Section

Based on the projected traffic volume of the Project Road mentioned in Chapter B.3, both a two (2)-lane road (2-L Type) and a four (4)-lane road (4-L Type) are adopted as alternatives.

The width of each type of road is based on the J.K.R. standard. The cross-section for both type of roads is determined taking into consideration adjacent land use and the present site conditions. These are shown in Fig. B.3.3. Determination of the alternative cross-sections is subject to an economic analysis.

2) Pavement Design

Through a comparative analysis, it is recommended to employ asphalt concrete pavement for the Project Road not only from the technical but also from economical considerations. It likewise conforms to the recent works of pavement in Penang.

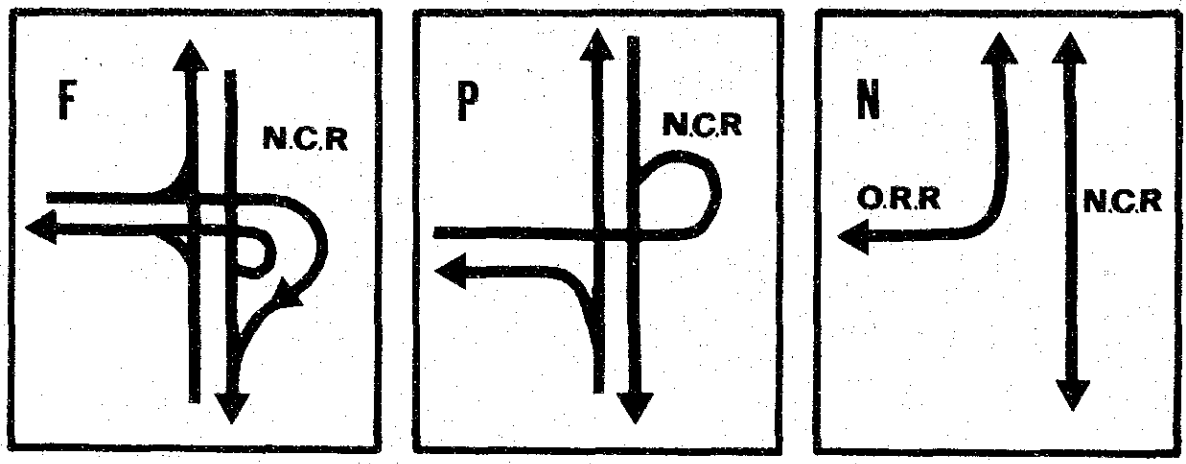
3) Bridge and S-ructure Design

The Project Road including the alternative route has 4 bridges with the type of bridge recommendable being of pre-stressed concrete in consideration of the various technical and economical feasibility aspects. The location of the main bridges are shown in Fig. B.3.4.

4) Intersection Design

Four (4) grade-separated intersections are recommended in this study and are shown in Fig. B.3.5. Regarding the interchange to the North Coastal Road a partial and a full type are prepared as the alternatives which are to be chosen finally in the economic evaluation.

Type of Interchange to N.C.R.



Full **Partial** **None**

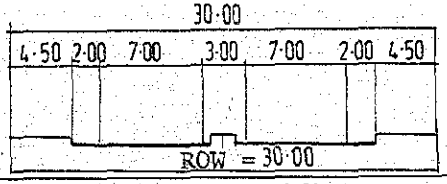
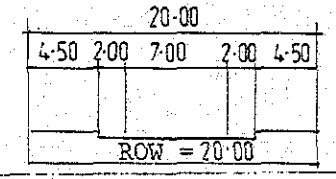
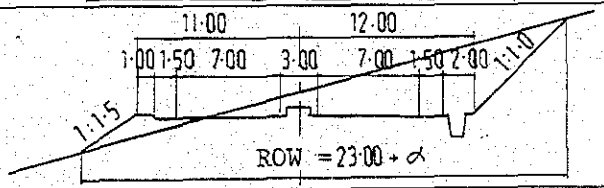
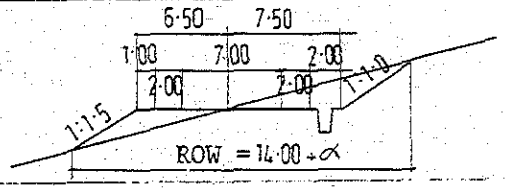
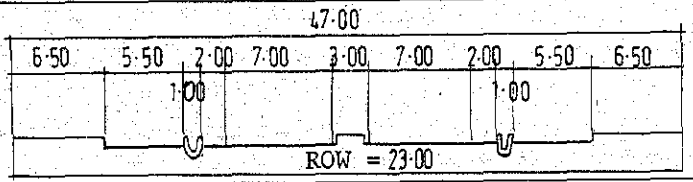
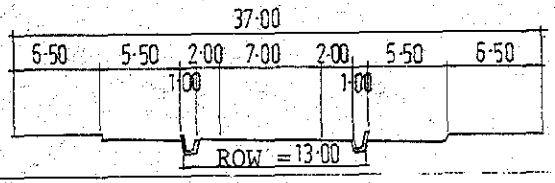
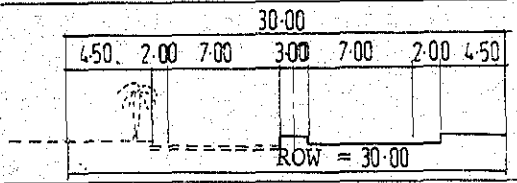
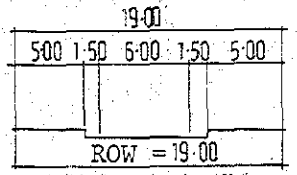
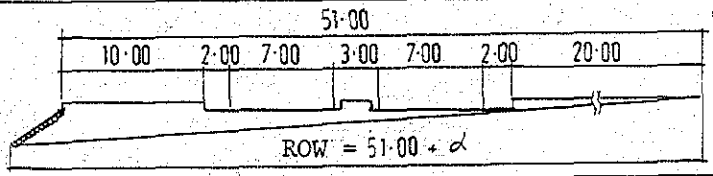
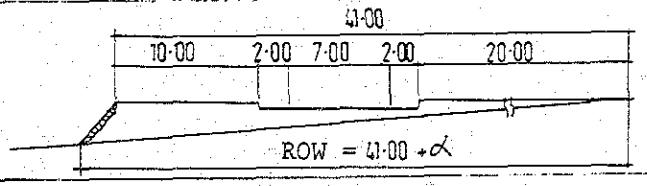
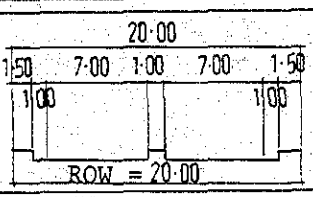
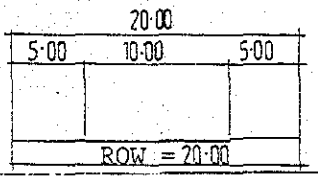
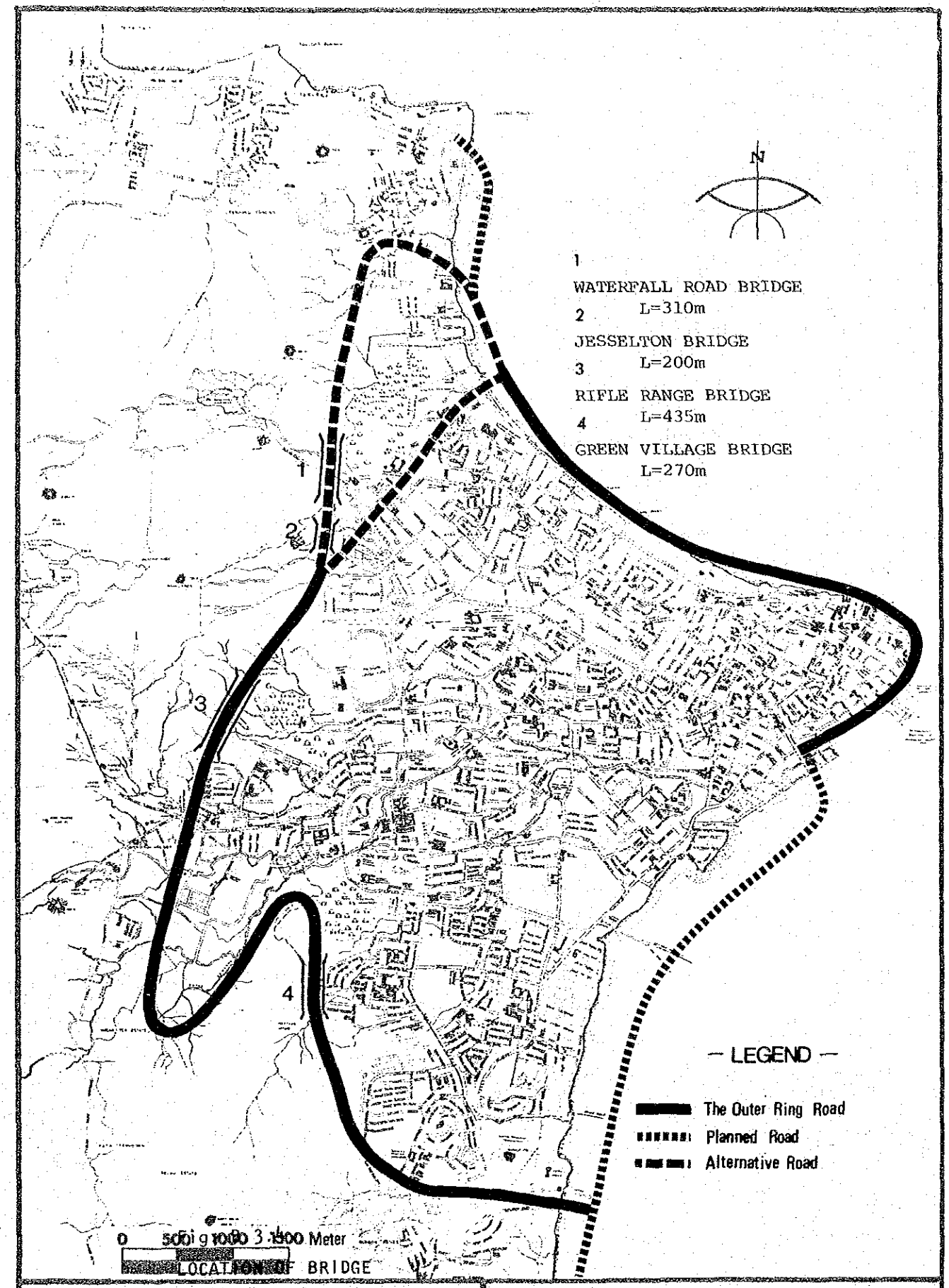
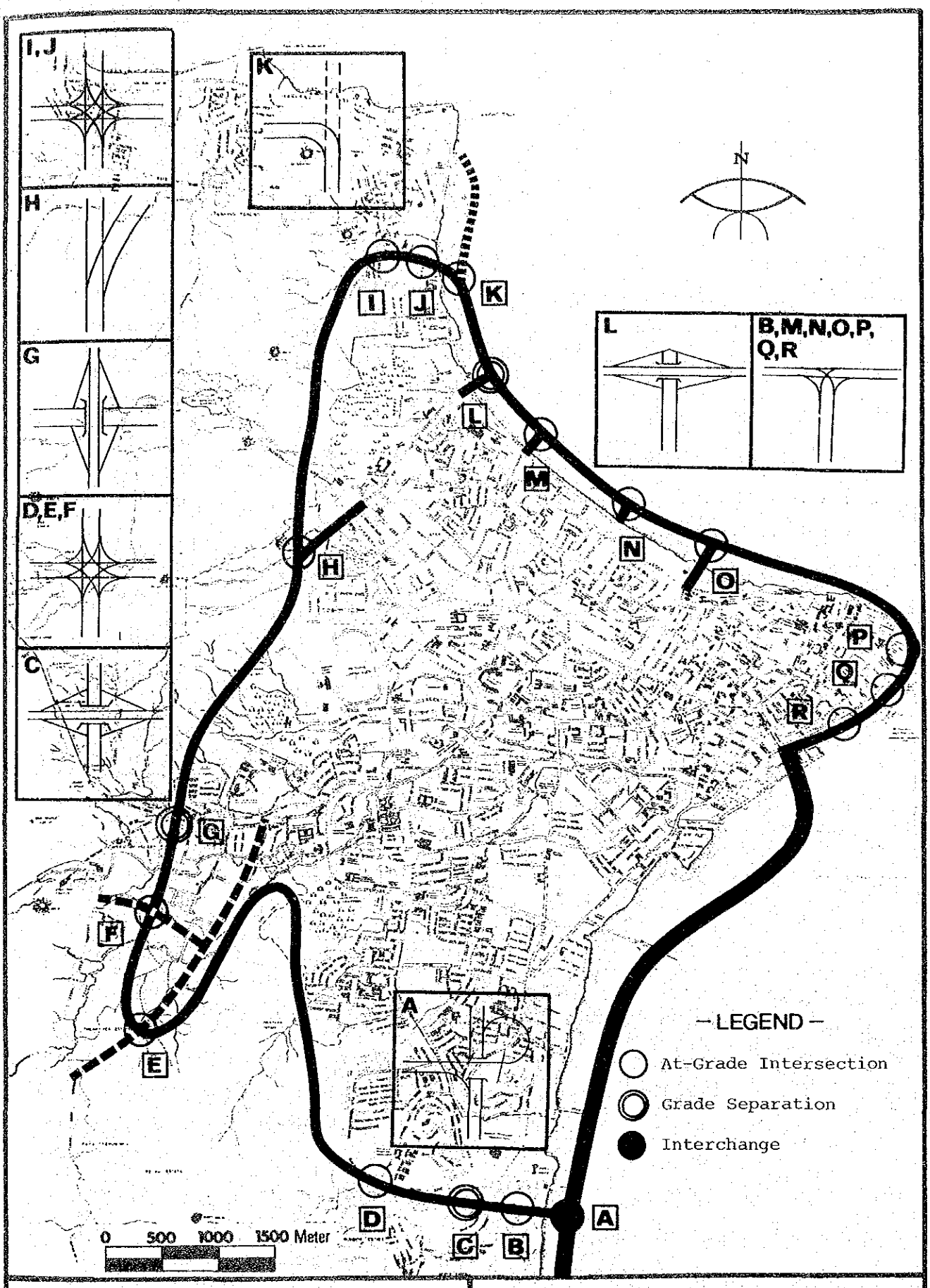
	type	Typical Cross-Section	
		4-lane	2-lane
Residential Area (without Service Road	1		
Mountain Area	2		
Residential (with Service Road)	3		
Improvement of Existing Gottlieb Road	4		
Gurney Drive Extension	5		
Improvement of Existing Weld Quay	6		

Fig. B.3.3 TYPICAL CROSS-SECTION



URBAN TRANSPORT STUDY

Fig. B.3.4
LOCATION OF BRIDGE



URBAN TRANSPORT STUDY

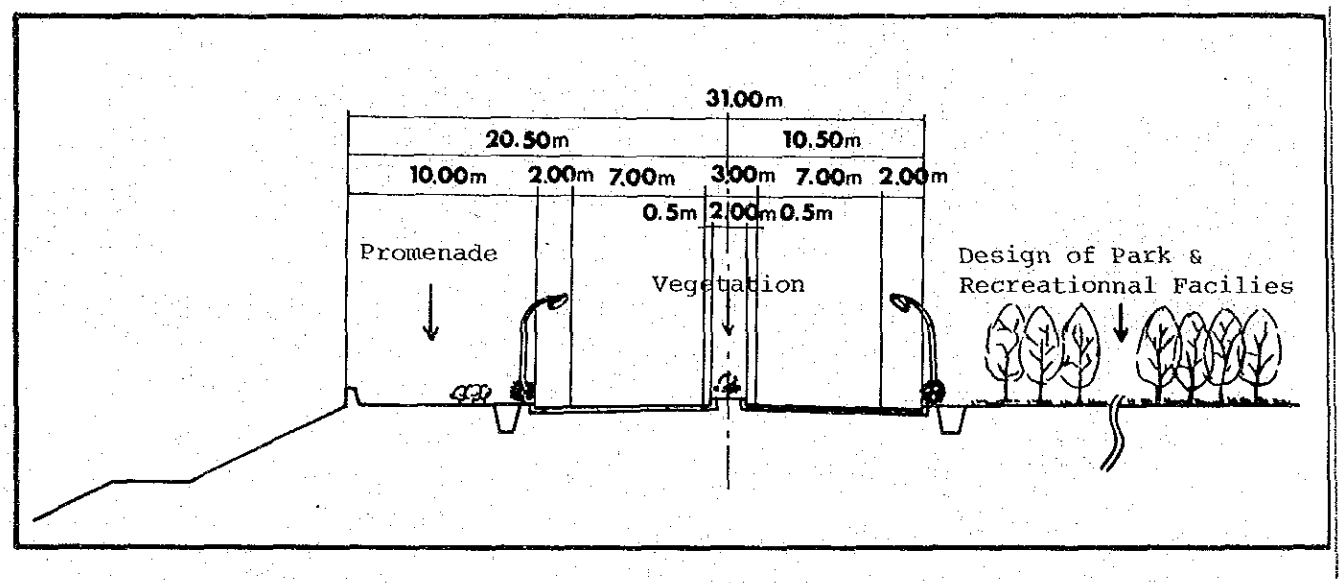
Fig. B.3.5 SECTION LOCATION & TYPE

B.3.6 Environmental Considerations

In order to design the Project Road with minimum adverse effects to the environment, the present conditions along the Project Road is studied.

According to these studies, mitigation measures for any foreseable disturbances such as providing a buffer zone and improving the landscape of the road are proposed. An example of such a design is shown below.

MITIGATION MEASURES AT GURNEY DRIVE EXTENSION



B.4 Estimation of the Project Cost

Since the construction cost differs to the alternatives of the route, the cross-section and the type of interchange to the North Coastal Road, the cost estimation is prepared for the following cases.

Route	Number of Lane	Type of Inter.
Plan 1	4 lane	Full
Plan 2	2 lane	Full
	4 lane	Partial
		None
		Full

B.4.1 Construction Cost

Based on the preliminary engineering study, the quantities for all work items by alternatives are calculated. Subsequently, the unit cost by work items is analysed from the aspects of material cost, labour cost, equipment, etc., taking into consideration the local conditions in Penang.

By multiplying the unit cost by the quantities for each work item, the construction cost is estimated and is split into foreign currency component, local currency component and taxes. They are shown in Table B.4.1.

B.4.2 Land Acquisition and Compensation Cost

The land acquisition and compensation cost are estimated based on unit cost and the land areas to be acquired. The unit cost is obtained from data from the Land Valuation Office. The result is shown in Table B.4.1.

B.4.3 Maintenance Cost

In estimating the maintenance cost, data from "The Malaysia Highway Maintenance Study" (1974, Public Works Department) and other related references are used. The maintenance cost includes that for resurfacing, planting of roadside trees, drainage facilities, kerbs, road marking, traffic lights, etc. (Table B.4.1)

The basic maintenance cost per year for two-lane and four-lane roads is about 23.9 thousand dollars per km and 29.7 thousand dollars per km, respectively.

Table B.4.1 CONSTRUCTION COST AND MAINTENANCE COST

(in thousand M$ at 1980 prices)

Route	No. of Lanes	Access to N.C.R	Construction Cost			Land Acquisition and Compensation	Total	Annual Maintenance Cost			
			F.C	L.C	Tax			F.C	L.C	Tax	Total
Plan 1 (21.14 km)	4-lane	Partial	39,941	44,278	4,732	51,564	140,515	238	357	30	625
		Full	40,051	44,422	4,745	51,564	140,782	238	357	30	625
	2-lane	Partial	30,386	30,245	2,978	24,946	88,555	238	357	30	625
		Full	30,496	30,389	2,991	24,946	88,822	238	357	30	628
Plan 2 (23.84 km)	4-lane	Partial	43,657	48,046	5,089	43,626	140,418	266	399	33	698
		Full	43,767	48,190	5,102	43,626	140,685	266	399	33	698
	2-lane	Partial	29,663	35,285	3,429	31,224	99,601	266	399	33	698
		Full	29,773	35,429	3,442	31,224	99,868	266	399	33	698

Partial : Partial Access to North Coastal Road

Full : Full Access to North Coastal Road

( ) : Length of the route

B.5 Economic Evaluation

B.5.1 General

The Project is evaluated by the following three indicators commonly used by the Economic Planning Unit (EPU).

(1) Internal Rate of Return (IRR)

(2) Net Present Value (NPV)

(3) Benefit - Cost Ratio (B/C Ratio)

In order to obtain the economic indicators, the following conditions are assumed:

a. Project Life: 25 years
b. Opening Year for Traffic: 1987
c. Opportunity Cost of Capital: 12%

B.5.2 Alternative Plans

The following alternative plans are subject to the result of the economic evaluation.

a. Route

The two alternative routes that have been selected from the engineering study are evaluated. (See Fig. B.3.2).

1) Plan 1 : passing through route 'J'

2) Plan 2 : passing through route 'K'.

b. Cross-Section

1) Four (4) - lane road (4-L)

2) Two (2) - lane road (2-L)

c. Access to the North Coastal Road

An additional interchange is required at the North Coastal Road and the Project Road. The type of access are as follows.

1) F : Fll Access Interchange

2) P : Partial Access Interchange

3) N : No Additional Interchange

d. Stage Construction by Section (Fig. B.5.1)

1) Section 1 : Southern Section of the Project Road

2) Section 2 : Northern Section of the Project Road

e. Stage Construction by Segment (Fig. B.5.1)

1) Segments 4 and 7

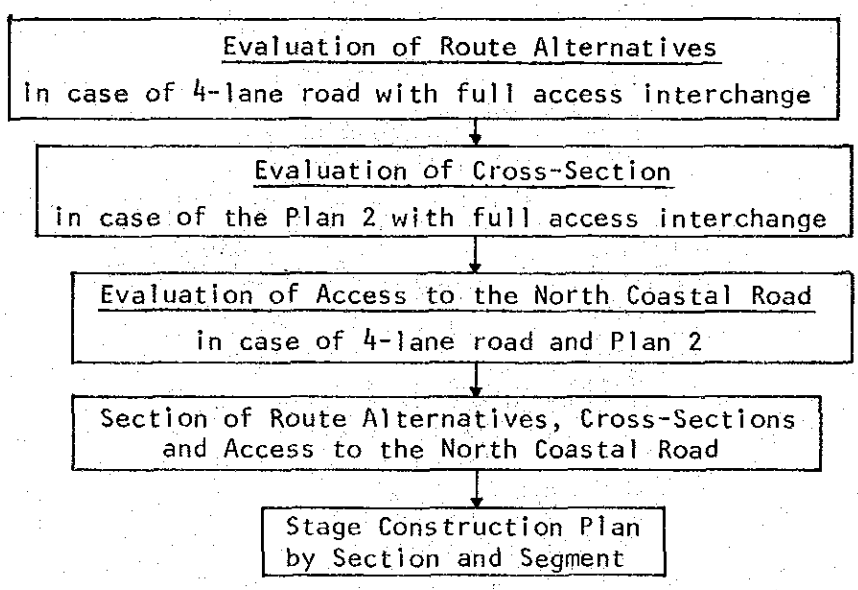
2) Segments 5 and 6

3) Segment 9

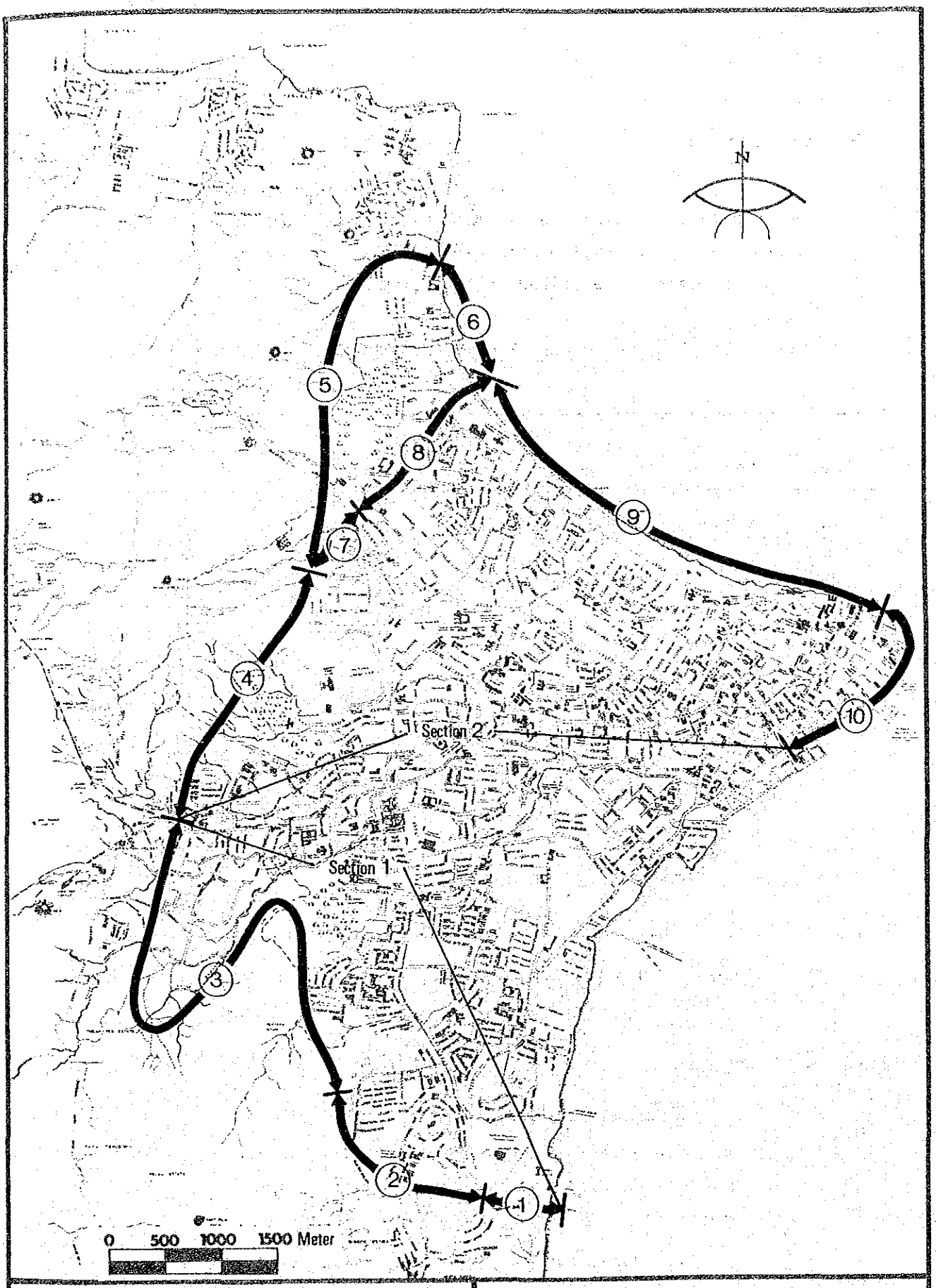
Section 1 of the Project Road is not divided into segments because any segment of section 1 cannot function as a road system by itself.

f. Evaluation Process of the Alternative Plans

In the economic evaluation, the alternative plans are evaluated through the following process.



By combining the alternatives mentioned above, the following types of alternative plans are prepared for the economic evaluation. (see Table B.5.1)



URBAN TRANSPORT STUDY

Fig. B.5.1
THE PROJECT ROAD BY SECTION AND SEGMENT

B.5.3 Economic Cost

For the economic evaluation of the project, the costs and benefits are expressed in economic values with the economic cost of each alternative obtained by deducting tax from the financial cost as described in Table B.5.1.

Table B.5.1 TYPES OF ALTERNATIVE PLANS AND ECONOMIC COST

Route	Cross-Section	Access Type	Stage Construction		Economic Cost (M$'000)
			Section	Segment	
Plan 1	4-lane	Full	All	All	137,791
Plan 2	2-lane	Full	All	All	102,673
			Section 1	All	42,995
			Section 2	All	59,678
				4 & 7	17,078
				5 & 6	22,662
				9	19,938
	4-lane	Full	All	All	144,393
			Section 1	All	59,839
			Section 2	All	84,554
				4 & 7	26,046
				5 & 6	31,821
				9 & 10	26,687
		Partial	All	All	144,114
		None	All	All	141,483

Note : This economic cost include the cost of the approach roads.

B.5.4 Benefit Calculation

(1) Unit Traffic Cost

Among various benefits, the following are the direct benefits derived from the construction of the Project Road which can be measured in terms of money.

1. Reduction in travel time (Time Benefit)
2. Saving in vehicle operating cost (Running Benefit)

- saving in running cost
- saving in fixed cost

In order to calculate benefits, it is necessary to set up the unit traffic cost which is described below.

The unit time value of each trip is calculated by using the monthly income of households and the monthly working hours of non-car owners, motor-cycle and car owners in relation to their trip purpose.

The time value of each vehicle type which is estimat ed from the composition by trip purpose and an average occupancy rate of each vehicle is shown below.

Type of Vehicles	Dollar/hr (1980 price)
Car	3.7
Motor-Cycle	1.3
Bus	23.0

Vehicle operating cost is composed of running cost which is dependent on distance travelled and time. The distance related running cost by travel speed and the time related cost per operational hour are estimated for the following eight (8) types of vehicles:

a. Motor-cycle

b. Car

c. Taxi

d. Mini-bus

e. Stage bus

f. Pick-up

g. Medium Truck

h. Heavy Truck

(2) Benefit Calculations

Using the network assignment model, the benefits of each alternative plan are calculated as follows.

Table B.5.2 BENEFITS OF ALTERNATIVE PLANS

(In thousand dollars at 1980 prices)

Alternative	Benefits in 1985	Benefits in 2000	Remarks 1)
Plan 1-F, 4-L	19,601	62,561	2001
Plan 2-F, 4-L	21,718	69,606	2001
Plan 2-F, 2-L	17,374	55,079	1993
Plan 2-P, 4-L	20,914	69,459	2001
Plan 2-N, 4-L	20,112	66,795	2001
Plan 2-F, 4-L			
Section 1	3,942	10,220	2001
Section 2	17,776	59,386	2000
Segments 4 & 7	9,378	31,182	1997
Segments 5 & 6	2,449	7,943	2011
Segments 9 & 10	5,949	20,261	2000
Plan 2-F, 2-L			
Section 1	3,942	10,220	2009
Section 2	13,432	44,859	1992
Segments 4 and 7	7,616	25,117	1990
Segments 5 & 6	1,653	5,847	2000
Segment 9	4,163	13,895	1990

Note : 1) Year that the traffic demand on the Project Road exceeds its capacity.
The yearly benefits are calculated based on the following assumptions:

(a) The yearly benefits are estimated using the annual growth rate of benefits of 1985 and the year 2000.

(b) The yearly benefits are constant after the traffic demand on the Project Road exceeds its capacity.

B.5.5 Economic Analysis

(1) Evaluation of Alternative Routes

The results of economic analysis of the alternative routes are summarized in Table B.5.3. The economic indicators show that both plans are feasible. However, Plan 2 is economically more feasible than Plan 1.

Table B.5.3 ECONOMIC INDICATORS BY PLAN

Route Alternative	Discounted Benefits ($'000)	Discounted Costs ($'000)	B/C Ratio	Net Present Value ($'000)	Internal Rate of Return (%)
Plan 1-F, 4-L	157,519	88,309	1.78	69,210	18.2
Plan 2-F, 4-L	175,019	92,021	1.90	82,998	19.1

Notes : a. Discount Rate : 12%

b. Project Life : 25 years

(2) Evaluation of Alternative Cross-Sections

The economic analysis of the alternative cross-section plans is shown in Table B.5.4. Both plans are economically feasible. However, the 4-lane road plan has greater feasibility than the 2-lane road plan as the former has higher values in its B/C ratio, NPV as well as the I.R.R.

Table B.5.4 ECONOMIC INDICATORS BY NUMBER OF LANES IN PLAN 2-F

Number of Lanes	Discounted Benefits ($'000)	Discounted Costs ($'000)	B/C Ratio	Net Present Value ($'000)	Internal Rate of Return (%)
Plan 2-F, 4-L (4-lane road)	175,019	92,021	1.90	82,998	19.1
Plan 2-F, 2-L (2-lane road)	111,087	65,811	1.69	45,276	18.5

Notes : a. Discount Rate : 12%

b. Project Life : 25 years.

(3) Evaluation of Access to North Coastal Road

The result of economic analysis of access plans is shown in Table B.5.5. From this table, it is found that Plan 2-F which has a full access interchange has higher feasibility compared with the other plans from the economic point of view.

Table B.5.5 ECONOMIC INDICATORS BY ACCESS PLAN

(Cross-Section : 4-lane)

Access Plan	Discounted Benefit ($'000)	Discounted Cost ($'000)	B/C Ratio	Net Present Value ($'000)	Internal Rate of Return (%)
Plan 2-F, 4-L (Full Service)	175,019	92,021	1.90	82,998	19.1
Plan 2-P, 4-L (Partial Service)	172,624	91,863	1.88	80,761	18.9
Plan 2-N, 4-L (No Service)	166,002	90,230	1.84	75,772	18.6

Notes : a. Discount Rate : 12%
b. Project Life : 25 years

(4) Evaluation by Section

It was clarified that Plan 2, which passes through Mount Erskine (Route K), is the most viable route. Here, the road sections according to each type of cross-sections are evaluated.

The results of the economic analysis of Section 1 and 2 with the four (4)-lane and two (2)-lane road plans are shown in Table B.5.6.

TAble B.5.6 ECONOMIC INDICATORS BY SECTION AND CROSS-SECTION

	Discounted Benefit ($'000)	Discounted Cost ($'000)	B/C Ratio	Net Present Value ($'000)	Internal Rate of Return (%)
Section 1,					
Plan 2-F, 4-lane	30,772	37,987	0.81	-7,215	10.1
Plan 2-F, 2-lane	29,892	27,391	1.09	2,501	12.8
Section 2,					
Plan 2-F, 4-lane	143,460	54,030	2.65	89,430	23.8
Plan 2-F, 2-lane	81,216	38,421	2.11	42,795	22.7

Notes : a. Discount Rate : 12%

b. Project Life : 25 years

This table reads as follows:

a) Section 2, compared to section 1 has a higher viability regardless of the type of cross-section.

b) In section 1, the two (2)-lane road plan is feasible with an IRR of 12.8%. However, the four (4)-lane road plan is not economically feasible and its economic indicators are just lower than the opportunity rate of capital. If the investment timing of the four (4)-lane plan is deferred year by year, this plan might be feasible. This will be analysed later.

c) In section 2, both the two (2)-lane and four (4)-lane road plans are economically feasible. However, the four (4)-lane plan has higher economic indicators than the two (2)-lane plan.

Fig. B.5.2 shows the relationship between the opening year of the 4-lane road of section 1 and the IRR. According to this figure, the four (4)-lane road plan of this section is feasible if this plan is implemented after the year 1991.

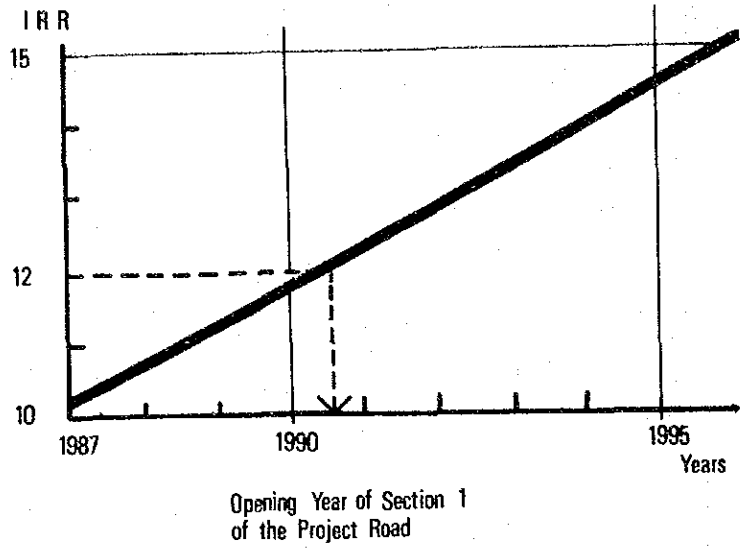


Fig. B.5.2 RELATIONSHIP BETWEEN IRR AND OPENING YEAR OF SECTION 1

(5) Priority Ranking of Road Segments

The purpose of this analysis is to clarify the priority ranking of the road segments in the Project Road. This analysis is made only for section 2 of the Project Road because the economic indicators of section 1 are comparatively low. The results of the analysis indicate that segments 4 and 7 (from Ayer Itam Road to Gottlieb Road) have first priority for construction of both the 4-lane road and the 2-lane. The second priority covers segments 9 and 10 while the last one is given to segments 5 and 6.

Table B.5.7 ECONOMIC INDICATORS BY ROAD SEGMENTS

Economic Indicators / Segment	Discounted Benefit ($'000)	Discounted Cost ($'000)	B/C Ratio	Net Present Value ($'000)	Internal Rate of Return (%)
Segment 9					
2-lane road	22,512	13,078	1.72	9,434	18.8
Segments 9 and 10					
4-lane road	46,806	17,150	2.73	29,656	23.7
Segments 4 and 7					
4-lane road	75,589	16,670	4.53	58,919	32.6
2-lane road	42,793	10,904	3.92	31,889	27.8
Segments 5 and 6					
4-lane road	21,065	20,212	1.04	853	12.5
2-lane road	15,911	14,440	1.10	1,471	12.9

Notes : a. Discount Rate : 12%
b. Project Life : 25 years

B.5.6 Sensitivity Analysis

A calculation is made to find the range of variation in the economic indicators of the Project Road and the results are shown in Table B.5.8.

From this table, the following observations can be made:

1. Even when the project cost is increased by 20% or the project benefit decreased by 20%, plans 1-F, 2-F and 2-P are still feasible.
2. Even when the project cost is increased by 20% and the project benefit decreased by 20% at the same time, all the 3 plans are found to be still feasible.
3. Even when the risky construction cost stream with the construction period kept constant is adopted, economic indicators change little.
4. Even when the project life is cut by 5 years to 20 years, the project still remains feasible.
5. Even when the motor-cycle trip increases to a higher growth rate than the original plan while the motorcar trip decreases to a lower growth rate, all plans are still feasible.

Table B.5.8 RESULTS OF SENSITIVITY ANALYSIS

Plan / Conditions	Plan 1-F (Full Service)			Plan 2-F (Full Service)			Plan 2-P (Partial Service)		
	B/C Ratio	NPV ($ '000)	IRR (%)	B/C Ratio	NPV ($ '000)	IRR (%)	B/C Ratio	NPV ($ '000)	IRR (%)
1. Original Results	1.78	69,210	18.2	1.90	82,998	19.1	1.88	80,761	18.9
2. 20% Cost Increase	1.49	52,034	16.1	1.59	65,163	16.9	1.57	62,957	16.7
3. 20% Benefit Decrease	1.49	42,955	16.1	1.59	53,828	16.9	1.57	51,992	16.7
4. 20% Cost Increase and 20% Benefit Decrease	1.24	25,779	14.2	1.33	35,993	14.9	1.32	34,188	14.7
5. Change in Cost Stream	1.73	66,441	17.7	1.84	80,086	18.5	1.82	77,857	18.3
6. Project Year 20 Years	1.64	56,529	17.7	1.75	68,891	18.6	1.73	66,651	18.4
7. Change in Growth Rate of M/cycle and M/car Traffic	-	-	-	1.66	60,341	17.3	1.54	49,412	16.5

B.5.7 Conclusions of Project Appraisal

Judging from the result of the economic evaluation and engineering and environmental studies, the Outer Ring Road is feasible.

And the following plans are concluded to be most recommendable.

(1) Route : Plan 2

(2) Cross-Section : 4-lane

(3) Access to North Coastal Road

Though the result of economic evaluation implies the full access plan as the highest priority plan, the partial access is recommended from the engineering viewpoint as well as from the result of discussions with the Government of Malaysia.

(4) Stage Construction :

1st Priority - Segments 4 & 7 (Sec. 2)
2nd Priority - Segments 9 & 10 (Sec. 2)
3rd Priority - Segments 5 & 6 (Sec. 2)
4th Priority - Segments 1, 2, 3 (Sec. 1)

B.6 Implementation Program

B.6.1 General

To establish the implementation program of the Project, the results of the economic analysis and financial funds allocated for the Project Road should be taken into account. In this study, a comparative analysis between highway funds and investment requirements is made based on the past record.

The results show that it is expected that a large amount of funds will be required for the improvement of the highway. Considering this and the results of the economic analysis, the Project should be implemented in stages and over a longer period from 1984 to 1991.

For the implementation program, the partial interchange is applied through the discussion with the Government of Malaysia.

B.6.2 Recommended Implementation Schedule

Taking into account the results of the economic evaluation and the predicted traffic volumes on the major roads, the following stage construction is recommended :

Phase 1 : Northern Section (Section 2) of the Project Road (Jalan Ayer Itam-ORR intersection to Jalan Prangin-Weld Quay intersection)

Stage 1 : Segments 4 and 7
(Jalan Ayer Itam-ORR intersection to Jalan Gottlieb-ORR intersection)

Stage 2 : Segments 9 and 10
(Jalan Bagan Jermal-Gurney Drive Intersection to Jalan Prangin-Weld Quay intersection)

Stage 3 : Segments 5 and 6
(Jalan Gottlieb - ORR intersection to Jalan Bagan Jermal-Gurney Drive intersection via Mount Erskine Road - ORR intersection)

Phase 2 : Southern Section (Section 1) of the Project Road
(Jalan Ayer Itam-ORR intersection the NCR-ORR intersection)

Following the stage construction plan, the implementation schedule for two phases and three stages, as shown in Fig. B.6.1, is recommended.

Table B.6.1 RECOMMENDED IMPLEMENTATION SCHEDULE