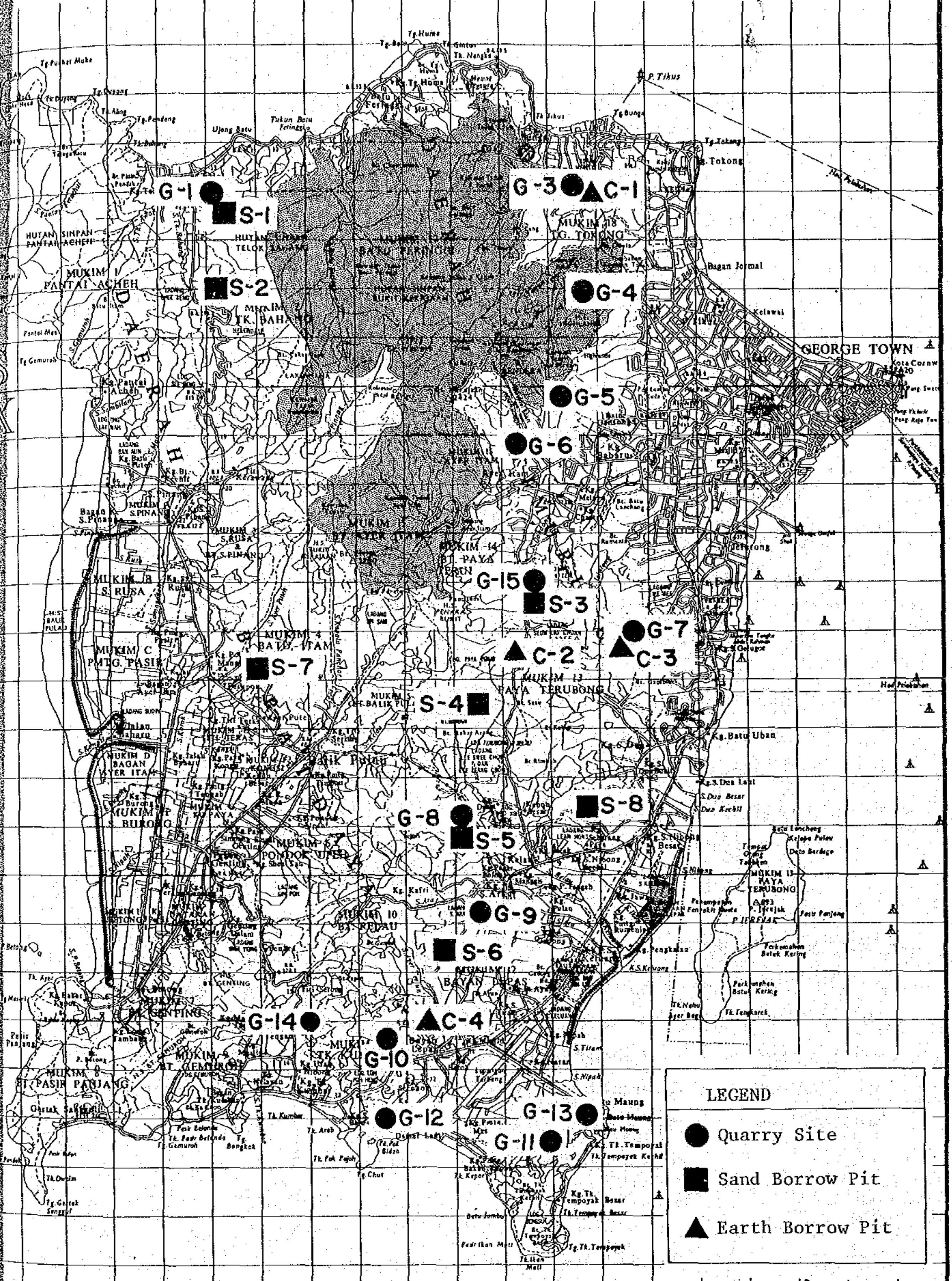


FIG. 4.2 LOCATION OF MATERIALS
(Coarse and Fine Aggregates and Embankment Material)

Table 4.1 SOURCE OF FINE AGGREGATE (SAND)

SOURCE NO.	SOURCE OF BORROWED SAND	ADDRESS OF OFFICE	PRESENT APPROX. PRODUCTION CAPACITY
S-1	LIM KHENG KIM	82-H, Free School Road	100 to 300 tons/day
S-2	FAR EAST DEVELOPMENT CO.	700, Mk.2, Jln. Sungei, Telok Bahang*	100 to 300
S-3	LAU GEOK SWEE CO. LTD.	324, Mk. 17, Batu Ferringhi	100 to 300
S-4	RELAU ESTATE	-	100 to 300
S-5	LIM KHENG KIM	82-H, Free School Road	100 to 300
S-6	POSSIBLE SOURCE (SEPULOH KONGSI)	-	-
S-7	NIMBUS SDN.BHD. (LIM TANG HOE)	156, Mk. 4, Ayer Puteh, Balik Pulau	500
S-8	TEOH CHEE KEONG	156, Beach Street	100 to 200

Note: * means site location

Table 4.2 SOURCE OF SUBGRADE MATERIALS

SOURCE NO.	NAME OF LOCATION
C-1	Mukin 18, Tanjong Tokong
C-2	Paya Terubong Estate
C-3	Mukim 13, Paya Terubong
C-4	Bukit Lada Mati

4.3 Urban Development

The central business district of George Town is highly developed due to the limitation of available land and also to it being surrounded by hills and the sea as shown in the following schematic figure; therefore, various housing development schemes have been undertaken at the fringe of George Town.

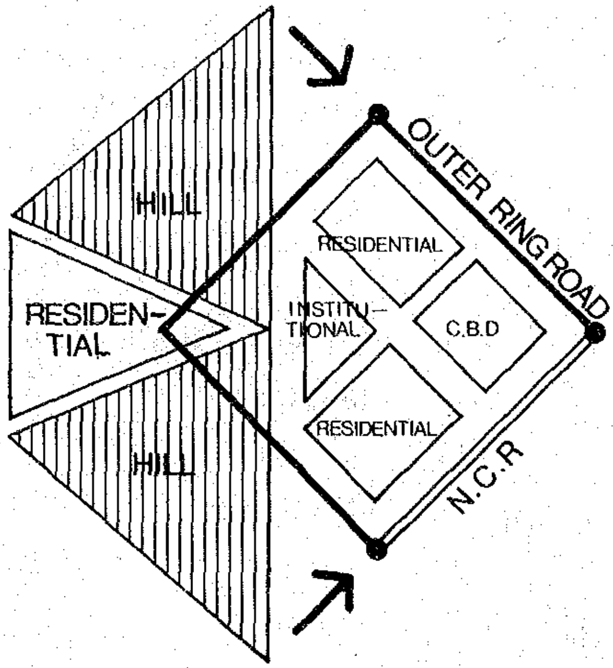


Fig. 4.3 URBAN STRUCTURE IMAGE OF GEORGE TOWN

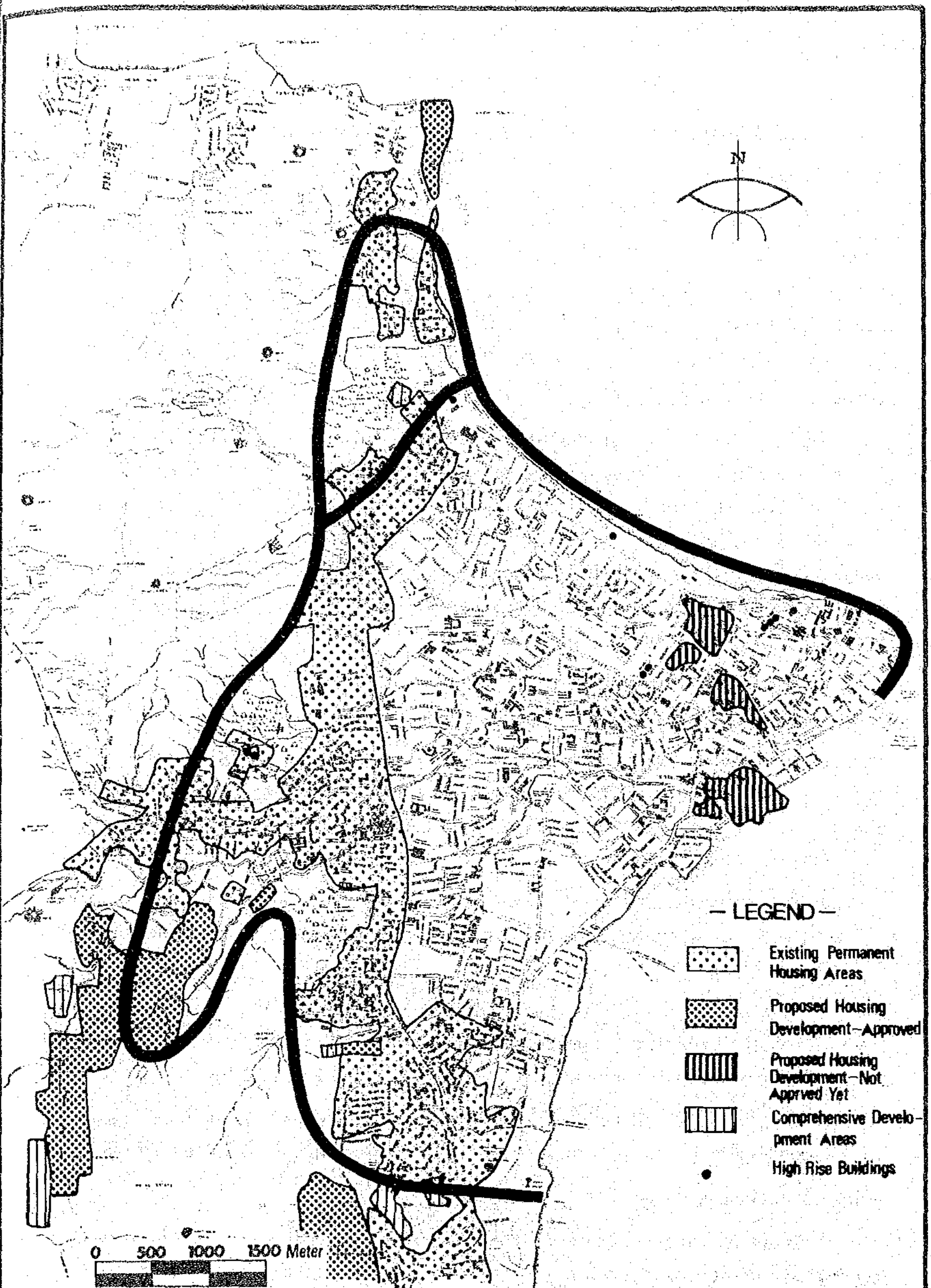
The location of the major housing schemes which are approved or expected to be approved is shown in Fig. 4.4. One of them in Ayer Itam is semi-approved and is likely to be affected by the Project Road.

Along the north coastal area, off Gurney Drive and Tanjong Tokong, some agencies have the intention of land reclaimation but at this time, there are neither plans approved nor programmes to implement it.

Also there is a notion to build some flats at Bukit Rumania which, due to its height, poses an obstacle to the smooth alignment of the Outer Ring Road. However, this idea is not considered in the premise of the study as there is uncertainty about it. As such, it is necessary for the Outer Ring Road to make a detour.

Regarding urban re-development, the Interim Zoning Plan prepares three comprehensive development zones located in the C.B.D. Also, the re-development projects by the private sector are observed along the north coastal area where the Interim Zoning Plan specifies as the commercial zone, due to its favourable accessibility to the C.B.D as well as to the abundance of available sites.

Concerning the effect on development pressure by the Outer Ring Road after its completion, no direct effects are envisaged to promote development along the road because it mainly passes through built-up as well as hilly areas. However, the development of Ayer Itam may be encouraged due to the improvement of accessibility to other areas.



URBAN TRANSPORT STUDY

Fig. 4.4
EXISTING & FUTURE DEVELOPMENT
ALONG PROPOSED ROAD

4.4 Basic Considerations for Preliminary Engineering

4.4.1 General

The Project Road was proposed as a Primary Distributor for intra-urban traffic by the Phase I Study carried out in 1979.

According to the traffic demand projection of the Phase I Study, the traffic volume entering and leaving the C.B.D. of George Town will show increases of 1.6 times in 1985 and 2.5 times in the year 2000 as compared with the present.

Due to the difficulties involved in widening the existing road in the area which is densly built-up and congested with traffic, measures to cope with the increase of traffic demand are limited although there do exist two possibilities, namely, to control the demand in the C.B.D. and also to disperse traffic to the outside of the town. Threfore, the Outer Ring Road is proposed to pass outside and around the city limit according to the above-mentioned strategy.

4.4.2 Characteristics of the Project Road

The road network pattern of George Town is basically of a ring and radial type. The road between the C.B.D. and Bagan Jermal is considered a radial road while the remainder of it serves as a ring road. Therefore, the main functions of the Outer Ring Road in terms of a transport system are as follows:

1) Through traffic of the C.B.D. in George Town can detour to the Outer Ring Road without passing through heavy congestion in the C.B.D.

2) The section from the C.B.D. to Bagan Jermal is identified as a radial road serving traffic commuting to the center of town from the northern suburbs.

3) The Outer Ring Road can disperse traffic generated from the surrounding towns such as Ayer Itam, Bayan Baru and Tanjon Tokong.

4.4.3 Basic Planning Policy

Based on the functions of the Outer Ring Road and the environmental conditions of the area, the basic policies for its planning are as follows:

a. To provide a quick and convenient route for long distance trips.
b. To ensure a smooth and safe traffic flow.

c. To avoid disruption of the community and to maintain a better urban environment.

Therefore, guidelines for the road design are adopted as follows:

(1) The alignment of the Outer Ring Road should be designed, as far as possible, in suitable areas for development identified in the environmental evaluation in order to preserve the existing urban environment.

(2) Mitigation measures such as providing a buffer zone and landscaping should be prepared where need be in order to create a better environment. Especially along the north coastal area, the Outer Ring Road should have the characteristics of a parkway so as to foster recreational activities and beautify the scenery.

(3) In order to make long distance trips flow smoothly and safely, the access of local roads to the Outer Ring Road should be controlled.

(4) The Outer Ring Road should be able to absorb the traffic demand generated from adjacent lands by providing for intersections.

(5) Major intersections of the Outer Ring Road are invariably grade separated or at-grade depending on their importance. Traffic on minor intersections will not be allowed to cross the Project Road.

(6) Roadside parking on the Outer Ring Road should be prohibited in order to ensure a smooth and safe traffic flow.

4.5 Design Standards

4.5.1 Road Design Standards

(1) Design Speed

The following design speed for the Outer Ring Road is recommended on the basis of characteristics, functions and the surrounding conditions of the Project Road.

Terrain	Design Speed
Flat	80 km/hr
Rolling	80 km/hr
Mountainous	80 km/hr

(2) <u>Operating Speed</u>

The operating speed on the Project Road is assumed to be 60 kms per hour ensuring traffic safety.

(3) <u>Design Vehicles</u>

For geometric design use, a semitrailer is selected as a "design vehicle" due to the Project Road having the definition of a Primary Distributor Road

(4) <u>Geometric Design Standard</u>

The Malaysian design standard is developed to be applicable for roads in the rural areas. In this study, therefore a comparative analysis between the Malaysian design standard, AASHTO and the Japanese Standard are made. As a result, it is judged that the Malaysian design standard is applicable for not only roads in rural areas but also for those in urban areas. The geometric design standard adopted for the Outer Ring Road is shown in Table 4.3.

Table 4.3 DESIGN STANDARD

Items	Unit	Description
Adopted Group	-	04 - 06
Design Vehicles	-	All type of vehicles
Design Speed	Km.p.h.	80
Carriageway width	m	3.5 each lane
Central Reservation	m	3.0 each lane
Shoulder Width	m	Flat 2.0 Mountain 1.5
Maximum Gradient		
- Flat Terrain (F)	%	4
- Rolling Terrain (R)	%	5
- Mountain Terrain (M)	%	7
Critical Grade Length	m	F = 330 R = 240 M = 150
Stopping Sight Distance	m	105
Passing Sight Distance	m	540
Minimum Radius	m	210
Transition Curves Length	m	72
Vertical Curves (crest)	-	25.5
Vertical Curves (sag)	-	22.5

Note: F : Flat Terrain

R : Rolling Terrain

M : Mountain Terrain

4.5.2 Bridge Design Standard

(1) Specification

The British Ministry of Transportation Memorandum is basically employed for:

* Specification for loads .... B.S.5400 Part 2
* Specification for steel girder bridge .. B.S. 153
* Specification for concrete bridge ...... B.S.5400 Part 4
* Specification for material .... B.S. 153 B.S.5400
* Specification for foundation .... C.P. 2004

(2) Vertical Clearance

The minimum vertical clearance used in Malaysia is 4.35 meter (14'6") but the re-surfacing of the existing road and others should be considered. Therefore the minimum vertical clearance adopted in this study is 5.0 meter which measures from the lowest point of the deck structure to the highest road level over rivers.

4.5.3 Intersection Design Standards

(1) At-grade intersection

The at-grade intersection design standards are adopted from "A Policy on Design of Highways and Arterial Streets" (AASHTO).

(2) Interchange

The interchange design standards are adopted from "A Policy on Geometric Design of Rural Highways". Design speed of ramp is adopted to be 40 km/hr.

4.5.4 Pavement Design Standard

Asphalt concrete pavement design standards are based on the "Manual for Design and Construction of Asphalt Pavement, 1980 (Japan Road Association)" "Asphalt Institute of U.S.A." and "Shell Pavement Design Manual" are also referred to.

4.5.5 Drainage Criteria

The Malaysian Drainage Standard, referred from "Urban Drainage Design Standards and Procedures for Peninsular Malaysia" is adopted as basic data.

4.6 Alternative Route Study

4.6.1 Basic Guideline of Route Study

(1) Route Location Site

As mentioned before, the area of route location is as follows:

a. From the intersection of the existing Weld Quay and North Coastal Road to the intersection of Pesars King Edwward.

b. From the intersection of Pesara King Edward to Tanjong Tokong.

c. From Tanjong Tokong to Waterfall Road.

d. From Waterfall Road to Jalan Air Itam.

e. From Jalan Air Itam through Glugor to the North Coastal Road.

(2) Route Location Policy

The important function of the road alignment is to make for smooth, safe traffic flow and therefore with this purpose in mind, the following should be considered as a design policy from the route.

a. To conform to the existing ground level.

b. To conform to the existing and future landuse pattern.

c. To conform to the existing environmental value.

d. To harmonize with the horizontal alignment, vertical alignment and cross-section.

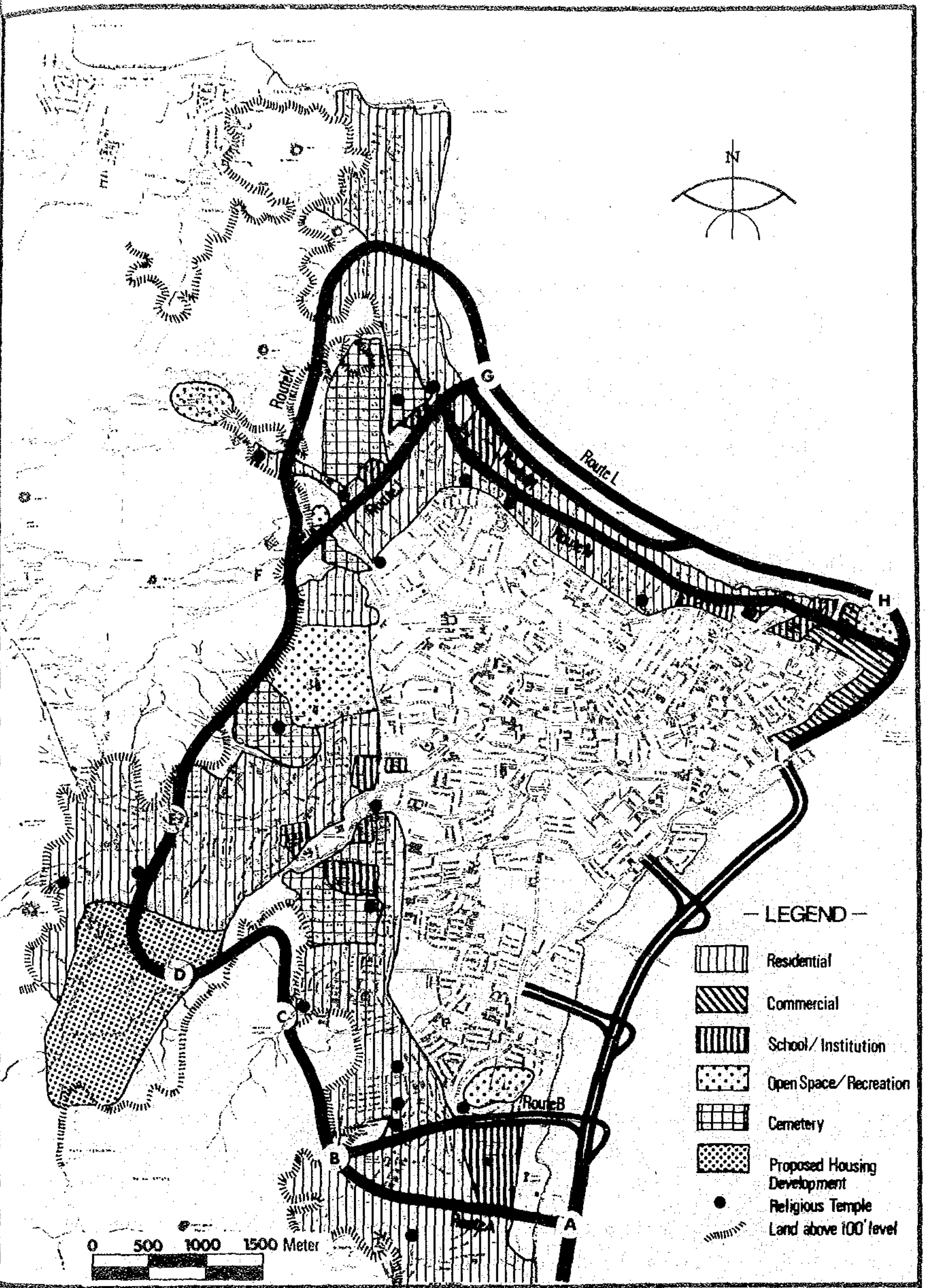
e. To examine the safety of traffic operations and its economics.

f. To conform to the decided geometric design standards.

g. To decrease construction cost.

4.6.2 Proposed Route Alternatives

It is possible to classify eight areas having different characteristics by section, in the Study Area as shown in Fig. 4.5 with the route location of the Outer Ring Road being studied by each section as follows.



URBAN TRANSPORT STUDY

Fig. 4.5 LOCATION OF ALTERNATIVE ROUTES

(1) A-B Section

The Outer Ring Road connects to the North Coastal Road already committed and the premise in the study.

The interchange is to be located without disturbing the traffic flow of the North Coastal Road, where landuse of the area is mainly residential with it also having a cemetery and so therefore, the route should be designed with as little disturbance as possible to these areas.

Also taking the geometric constraint into account, two alternative routes are proposed, one is alternative route 'A' starting at the new interchange about 1.6 km north from the interchange of the Penang Bridge, while the other is alternative route 'B' connecting directly to the interchange committed in the North Coastal Road Project.

(2) B-C-D Section

The landuse of the area is composed of residential area, a cemetery and a hill. The former two, of which the highest point is about 20-25 m above sea level, are developed on the outskirts of the hills. Therefore, the route is proposed to pass through a narrow area for about 60 m to 90 m above sea level between the residential area and a steep, rocking hill.

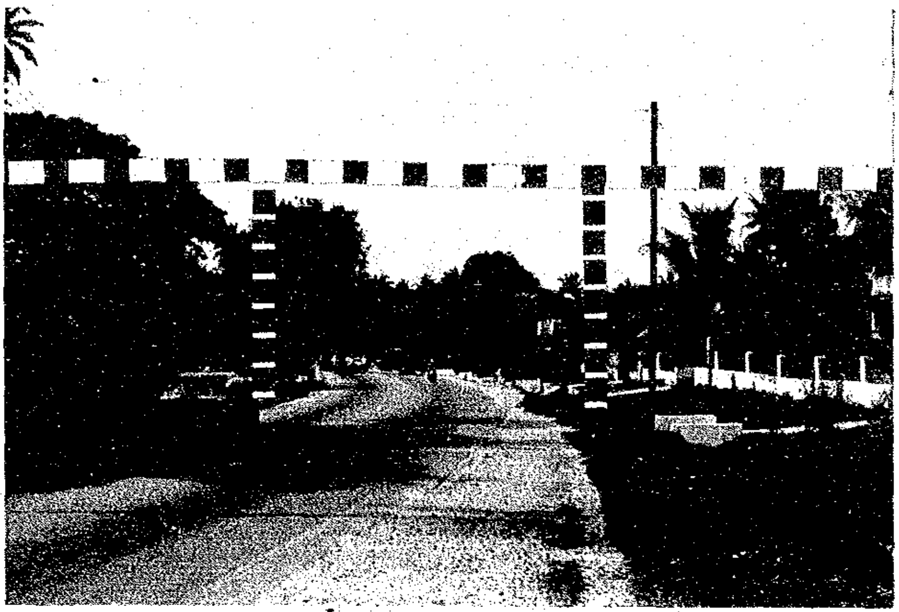
(3) D-E Section

In this area the Outer Ring Road needs to pass through the town of Ayer Itam, therefore the following area is carefully examined.

a. Future Development Plan (Ayer Itam)

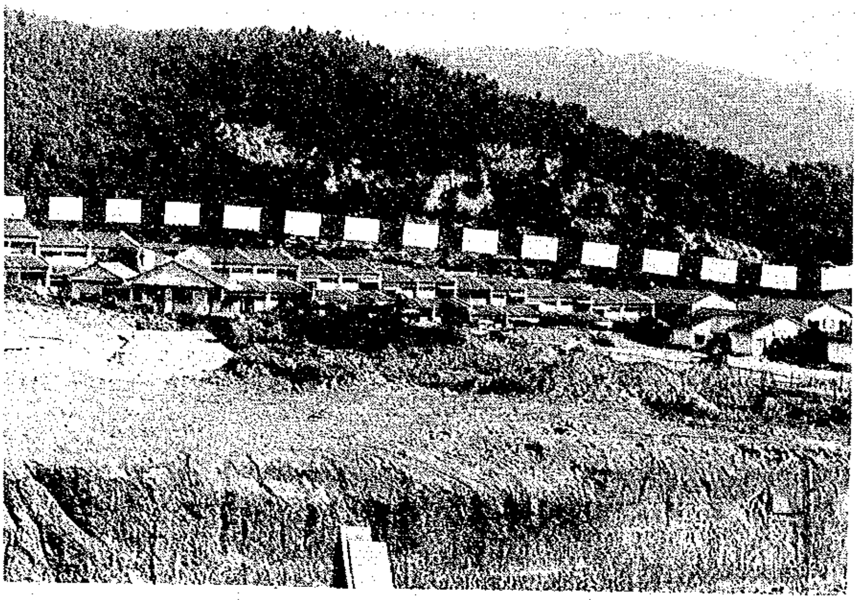
The future development plan which stretches to the south from the existing built up areas has already been carried out by the Planning Department of the MPPP, and has been approved.

According to the future plan, the main road with a right of way of about 44 meters (40' + 66' + 40' = 146') is located in the center of this residential area.

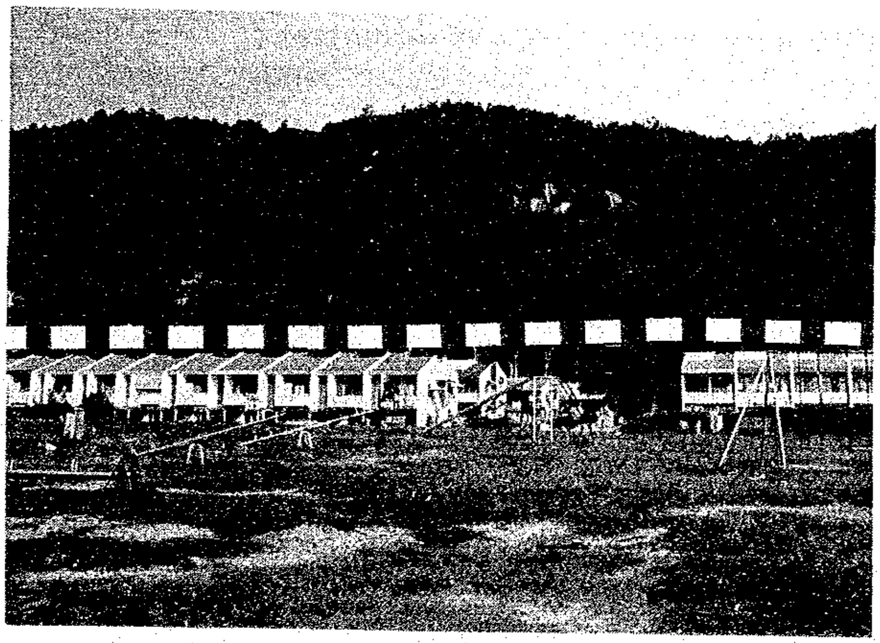


A-B Section Route A
Grade Separation of Glugor Road

A-B Section Route A



B-C Section



B-C Section

b. Existing Residential Area

The existing residential area is of high density housing consisting of a few very old houses, therefore route is proposed after a careful comparison of the several alternatives so as to minimise the disruption to the existing residential area and to conform to the on-going housing scheme, also with intensions not to disrupt the central area of Ayer Itam.

(4) E-F Section

This area is topographically classified into two areas i.e. rolling terrain which is used for residential area, cemetery and recreational facility up to height of 45 meters (150 ft) above sea level and mountain terrain which is rocky, reaching a height of 90 meters (300 ft) above sea level.

Three cases are preliminarily prepared to determine the optimum route.

Case 'A'. (The route is located 120 meters above sea level).
The maximum gradient will be 10% with the high construction costs due to the route having to pass throgh rocky area.

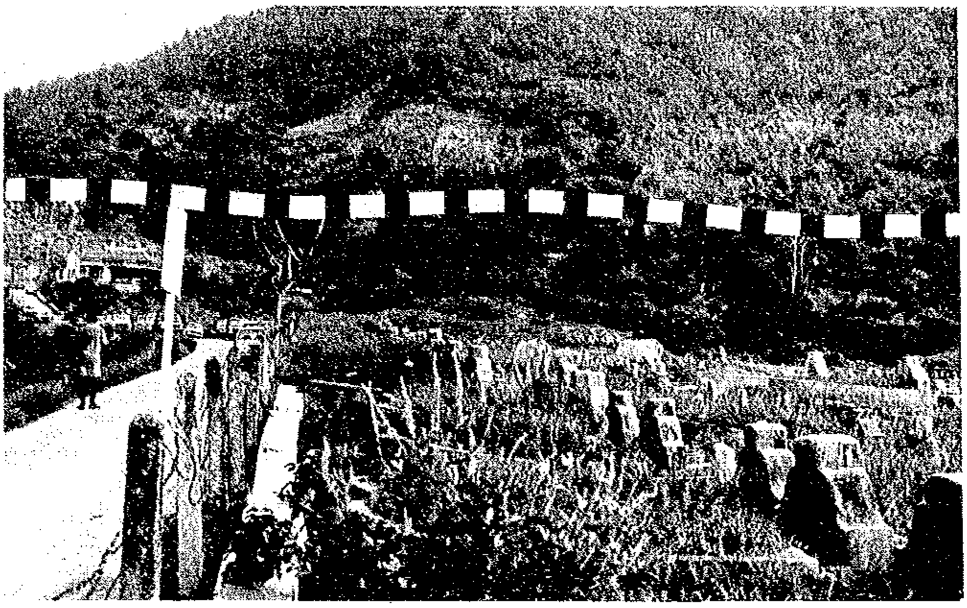
Case 'B'. (The route is located between 60 meters to 90 meters above sea level).
A maximum gradient of 6% makes it possible to pass through this area that has no rocks or developed areas.

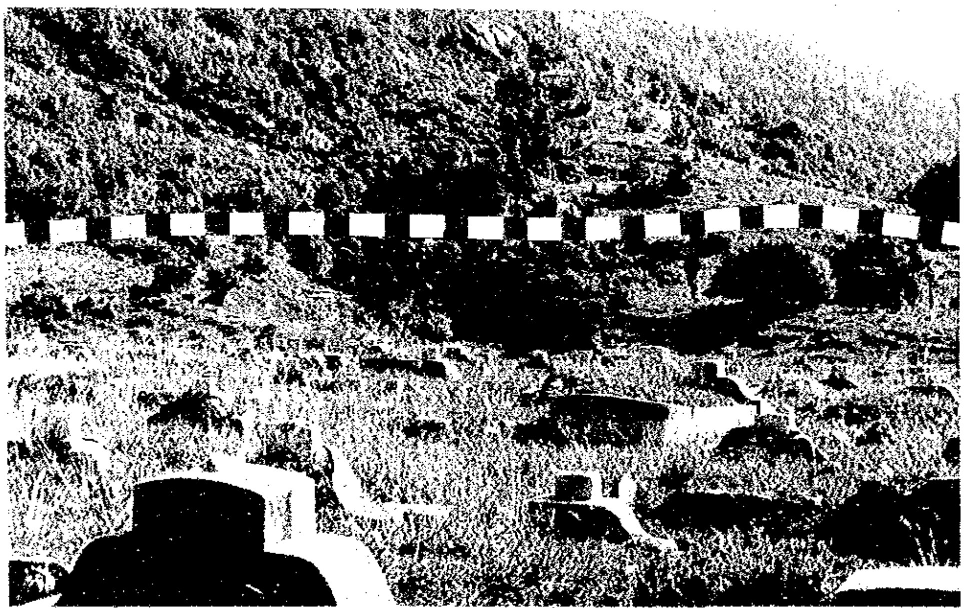
Case 'C'. (The route is located about 30 meters above sea level).

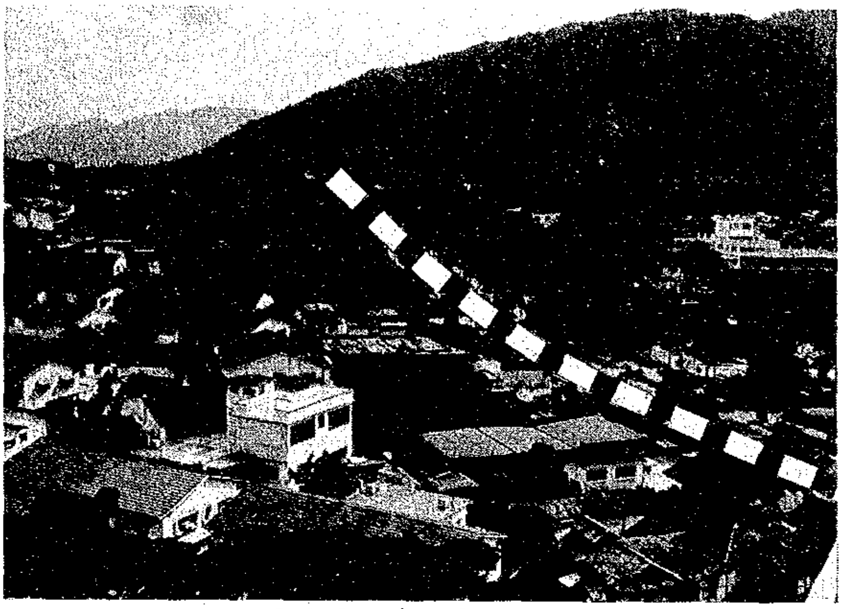
As a result of this study, Case B is proposed as the optimum route.

(5) F-G Section

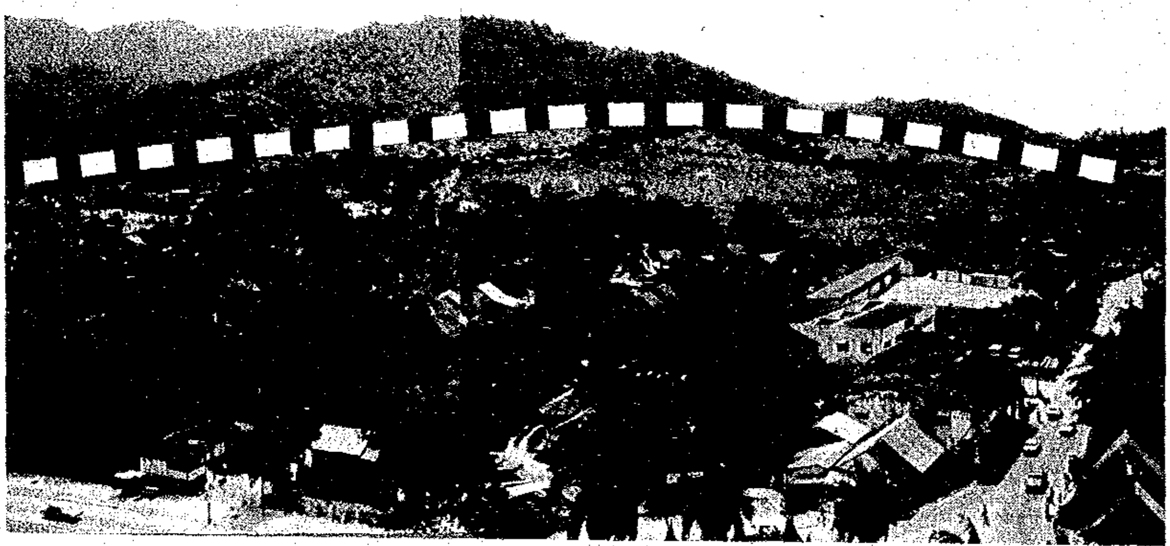
Two alternative routes, route 'J' and route 'K', are proposed. Route 'J' connects Jesselton Heights and Bagan Jermal by the shortest distance. However this would require widening of Jalan Bagan Jermal and Jalan Gottlieb now a single carriageway having beautiful royal palms as roadside trees, a school as well as a residential area all in good condition.


E-F Section


E-F Section



F-G Section Route J



F-G Section Route K

In order to avoid disrupting these areas, route 'k' is proposed to through the frontage of the hill by passing the cemetery and running along the seashore to meet Bagan Jermal, however the length of the route is about two times greater than route 'L'.

(6) G-H Section

Since this area is characterised by its beautiful scenery which has encouraged recreational activities especially along Gurney Drive, and also since it is the location of hotels and other establishments, the route should be preserved and entranced to provide a better environment as much as is possible.

Taking the above mentioned into consideration, three alternatives are proposed.

a. Route 'L'

This route runs about 80 meters off the existing seashore by reclaiming the land. The green belt for landscaping is provided along the road in order to create an attractive scenery and to mitigate any adverse impacts on the existing environment.

b. Route 'M'

Gurney Drive is improved and extended to connect to point 'H' with landscaping of the adjacent land designed to the same extent as that of route 'L'.

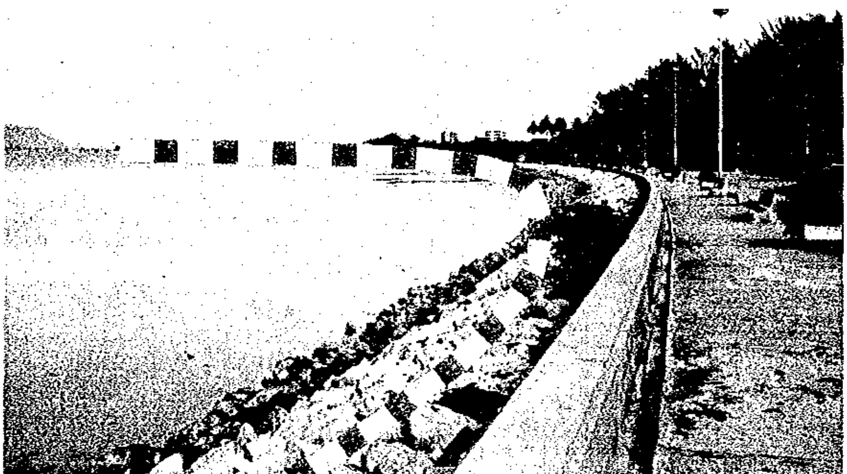
c. Route 'N'

Instead of constructing a new road, the improvement of Jalan Kelawai and Jalan Northam now a single carriageway, is proposed as a route for dealing with the increase of traffic.

d. 'H-I' Section

The improvement of Weld Quay which consists of a dual and a single carriageway is proposed due to the difficulties in cutting through the existing port which is located at the tip of the town.

F-G Section Route K



G-H Section Route M

TAble 4.4 COMPARISON OF ALTERNATIVE ROUTES

	Item / Route	A - B Section		F - G Section		G - H Section		
		Route A	Route B	Route J	Route K	Route L	Route M	Route N
Outline	Length	2.80 Km	2.50 Km	2.65 Km	6.47 Km	4.45 Km	4.40 Km	5.00 Km
	Plan	New Construction & Improvement of existing Valley Road	New Construction	Improvement of existing Jalan Gottlieb and Jalan Bagan Jermal	New Construction	New Construction	Improvement of existing Gurney Drive & New Construction	Improvement of existing Jalan Kelawai and Jalan Northam
	Land Use	Existing housing area & Future housing area	Existing housing area	Existing housing area	Mountainous area	Seashore	Existing housing area & seashore	Existing housing area & commercial area
Driving Comfort	Max. Grade	Below 3.00%	Below 3.00%	Below 6.00%	6.00%	Below 3.00%	Below 3.00%	Below 3.00%
	Min. Radius	Over 600 m	Over 500 m	Over 300 m	Over 300 m	Over 300 m	Over 300 m	Over 100 m
	Alignment	Smooth Almost flat	There are up and down slopes	Almost flat	There are up and down slopes	Very smooth Almost flat	Very smooth Almost flat	There are many curves.
Con-struc-tion	Construction Condition	Easy	Many problems	Some problems	Easy	Easy	Easy	Some problems
	Land Acquisition	Easy	Many problems	Many problems	Easy	Easy	Easy	Many problems
	Safety	More safe than Route B	Moderate	Moderate	More safe than Route J	More safe than Route N	More safe than Route N	Moderate
Environment	Community	Route passes through the border of the community	Route passes through the community	Route passes through the border the community	Separate from the community	Separate from the community	Separate from the community	Passes through the border of the community
	Greenery	Can maintain existing good environment	Some problems in creating good environment	Some problems in creating good environment	Some problems existing good environment	Can maintain existing good environment	Can maintain existing good environment	Some problems in creating good environment
	Decreasing noise level	Some problems	Many problems	Some problems	No problem	No problem	No problem	Many problems
	View from Road	-	-	-	Beautiful	Beautiful	Beautiful	-
	View from Road	-	-	-	Mitigation	Mitigation	Mitigation	-
Construction Cost	Construction Cost	14,297	18,360	10,416	21,015	26,795	22,937	4,457
	Land Acquisition & Compensation	7,993	12,059	17,381	9,443	0	0	25,064
	Total	22,290	30,419	27,797	30,458	26,795	22,937	29,521

4.6.3 Screening of the Alternative Routes

(1) General

On the basis of the alternative routes as shown in Fig. 4.5, seven (7) alternative plans were produced and discussed, from the technical and environmental viewpoints in the third Technical Committee Meeting.

The comparison of the alternative routes are described in Table 4.4.

(2) Comparison of the Alternative Routes

a. Route 'A' and Route 'B'

1) Technical Aspect

* Construction costs of Route 'A' and Route 'B' are estimated to be M$22,290,000 and M$30,419,000 respectively, showing that Route 'A' is oviously the least expensive route to construct.

* A grade separation intersection is planned by the Malaysian Government on the existing Glugor intersection. Therefore, a three-tier bridge will be necessary in the case of Route 'B', which makes it very difficult to connect Route 'B' to the existing Jalan Glugor and Green Lane. On the other hand, there is no major obstacle to connect Route 'A' and the existing Jalan Glugor.

* Route 'A' passes through along the existing Valley Road, most of which is government land. However, the site which Route 'B' passes on is almost all private land, and therefore, the land acquisition for Route 'A' is easier to acquire than for Route 'B'.

2) Socio-Environmental Aspect

* As there is only a small housing area along the existing Valley Road, Route 'A' which passes through along the above-mentioned road few environmental problems seem likely to arise.

The existing Glugor residential area is enjoying a pleasant environment and also has formed into a single community, however disturbance to these will be brought by Route 'B' passing through its centre. Therefore in consideration of this, Route 'A' is recommended.

b. Route 'J' and Route 'K'

1) Technical Aspect

* The construction cost of Route 'J' and Route 'K' is estimated to be M$27,792,000 and M$30,458,000 respectively showing Route 'J' to be cheaper than Route 'K' by about 10 percent.

* Route 'J' passes through along the existing Jalan Gottlieb and Jalan Bagan Jermal where many houses, commercial buildings and some schools exist therefore, problems in land acquisition are anticipated, but on the other hand with Route 'K' passing through a mountainous area land acquisition is expected to be easier.

2) Socio-Environmental Aspect

A good environment exists along Route 'J' and therefore it is important that this be preserved even with the construction of the Route, however, in the case of Route 'K' passing through mountainous areas such environmental problems are comparatively few.

* Route 'J' calls for the improvement of the existing road from a 2-lane to a 4-lane dual carriageway, however as there are a number of schools along the existing road, the safety and well-being of the school children will be one of the major problems anticipated when an increase in traffic volume is brought about by the 4 lane road.
From the technical and socio-environment viewpoint, Route 'K' is considered positively but since the road networks of Route 'J' and Route

'K' differ greatly, further comparison and selection between both routes will be taken up in the economic evaluation as described in Chapter 6.

c. Route 'L', Route 'M' and Route 'N'

1) Technical Aspects

* The construction cost of Route 'L', Route 'M' and Route 'N' are estimated to be M$26,795,000, M$22,937,000 and M$29,521,000 respectively, showing the least expensive as Route 'M'.

* Land Acquisition is easy to gain for Route 'L' and Route 'M' because these roads will be constructed on reclaimened land. However, Route 'N' is planned along Northam Road along which many houses and schools are located, and therefore, some problems in gaining land acquisition will be encountered.

2) The Socio-Environmental Aspect

* The width of the open space of Route 'L' and Route 'M' is 50 meters and 20 meters respectively with the above mentioned routes able to ensure the present favourable condition of the environment along Gurney Drive.

* A good environment exists along the present Northam Road but on its improvement from a 2-lane dual carriageway to a 4-lane dual carriageway, problems in maintaining the environmental condition will be encountered.

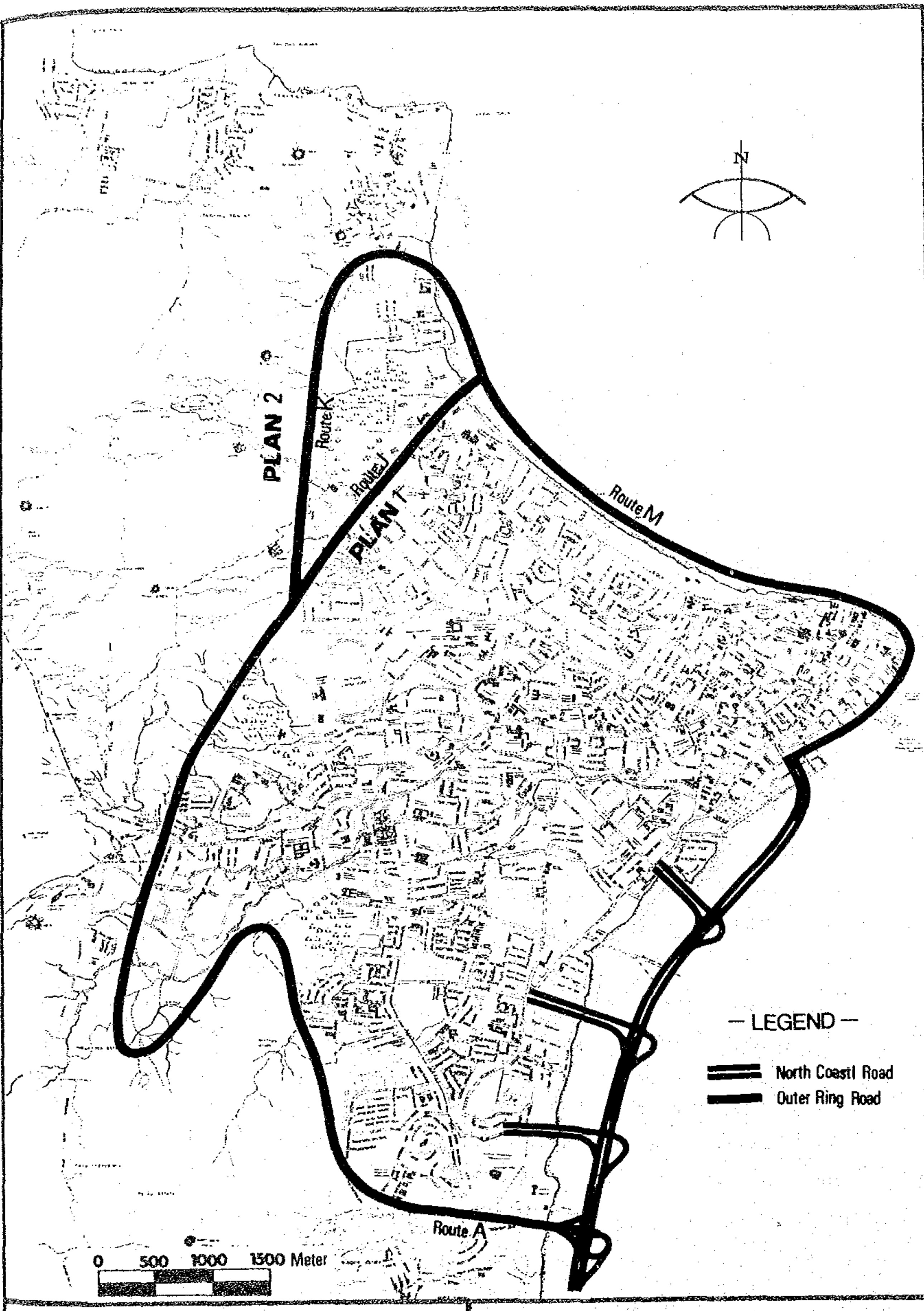
Therefore from the above-mentioned, viewpoint Route 'M' is recommended in this section.

Through the above-mentioned screening, two alternative routes are formulated for further analysis by combinating Route 'A', Route 'J', Route 'K' and Route 'M' as such.

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

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

These two plans are shown in Fig. 4.6.



URBAN TRANSPORT STUDY

Fig, 4.6 ALTERNATIVE ROUTES SELECTED

4.7 Preliminary Design

4.7.1 General

Based on the planning policy and the survey, items of the Project Road are designed on the following scale.

Table 4.5 SCALE USED IN THE DESIGN OF THE PROJECT ROAD

Items		Scale	Remarks
Road Design	Plan	1 : 3,000	Topographical Map
	Profile	H = 1 : 3,000 V = 1 : 500	
	Cross-Section	1 : 200	
Typical Cross-Section		1 : 100	
Intersection Design		1 : 500	
Bridge Design		1 : 500	Survey Map
Land Acquisition		1 : 3,000	

4.7.2 Alignment

(1) Horizontal alignment

Following the result of the route location study, the horizontal alignment is designed on the topographical map to a scale of 1:3,000.

(2) Vertical alignment

The maximum gradient is adopted to be 6.00% while the minimum gradient to be 0.30% due to drainage being taken into account. From the result of wave calculation, the proposed height of the Gurney Drive Extension Road is adopted to be 3.00 meter from Tanjong Tokong to the front of M.P.P.P. building. As the route passes through reclaimed land, it will be easy to install a drainage system.

4.7.3 Cross-Section

The cross-section is adopted from the J.K.R. standards.

a. Carriageway width

Driver convenience, ease of operation and safety are directly influenced by the width of carriageway. On low volume roads where available funds are usually limited, narrow carriageways are justified and sufficient for their needs on most occasions.

For high volume roads, wide lanes are absolutely essential in providing a safe smooth flow of traffic and should be the priority consideration during designing.

The J.K.R. standard 04 - 06 is adopted for the design criteria of the Outer Ring Road. Therefore, each lane of the carriageway is 3.5 meters wide.

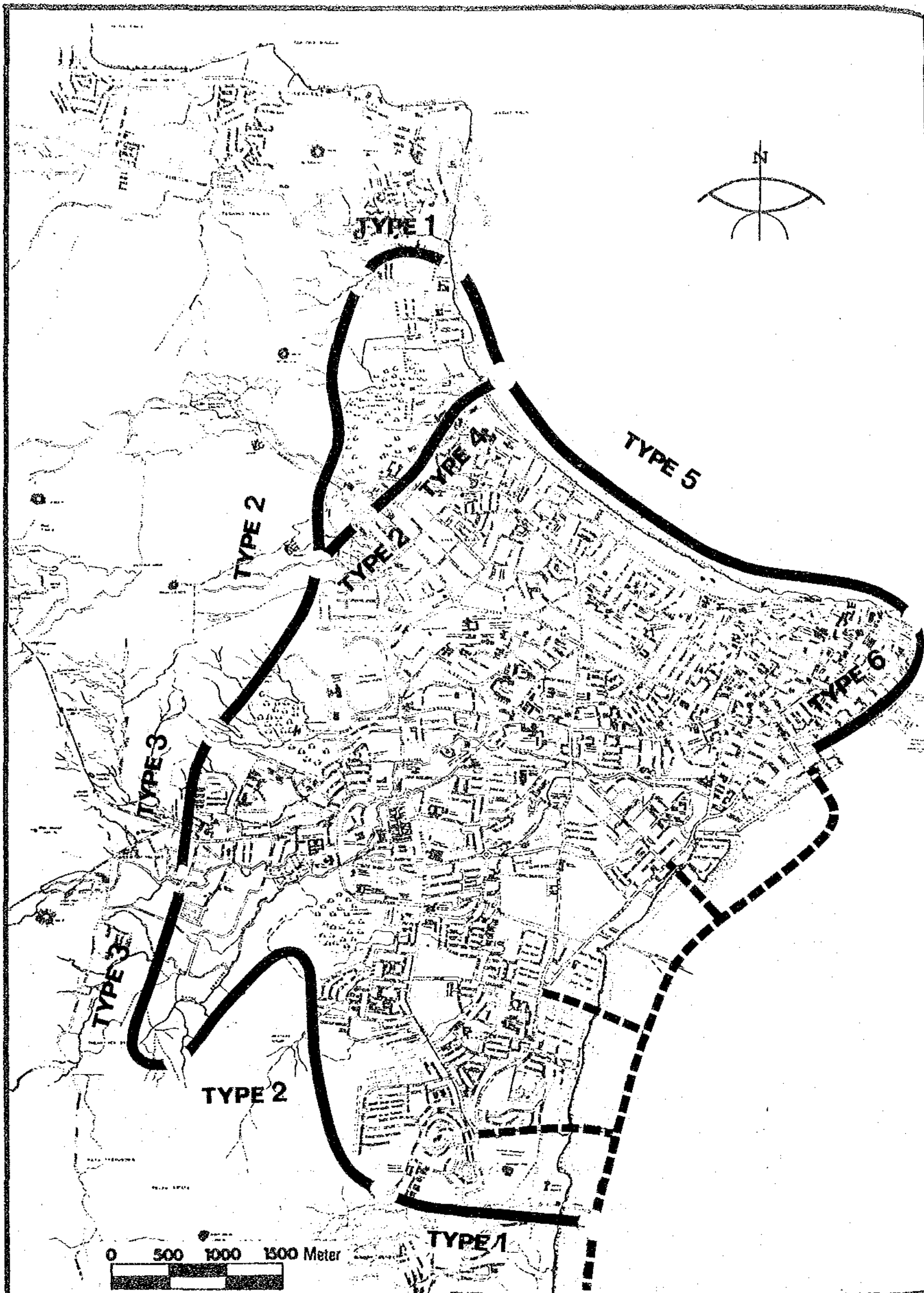
b. Width of shoulder

The actual width of shoulder should be considered as the width that can accommodate a vehicle for emergency or parking stops. In addition to this primary function others are to keep pedestrians and cyclists off the carriageway, to provide lateral support to the pavement, to improve sight distance in cut sections thus reducing road hazards, to provide space for avoiding potential accidents or in reducing their severity plus a host of others.

According to the J.K.R. standards, the shoulder width of flat terrain and mountain terrain is 3.0 meters and 1.5 meters respectively. However, a width of 2.0 meters is adopted for flat terrain due to the following reasons.

* The cost of land acquisition is extremely high in the flat terrain where most of the area is greatly urbanized.

* The width of 2.0 meters is enough to accommodate for emergency parking without disruption of the traffic flow expected on such occasions. In mountain terrain the width of 1.5 meters is adopted.



URBAN TRANSPORT STUDY

Fig. 4.7
LOCATION OF EACH CROSS-SECTION TYPE

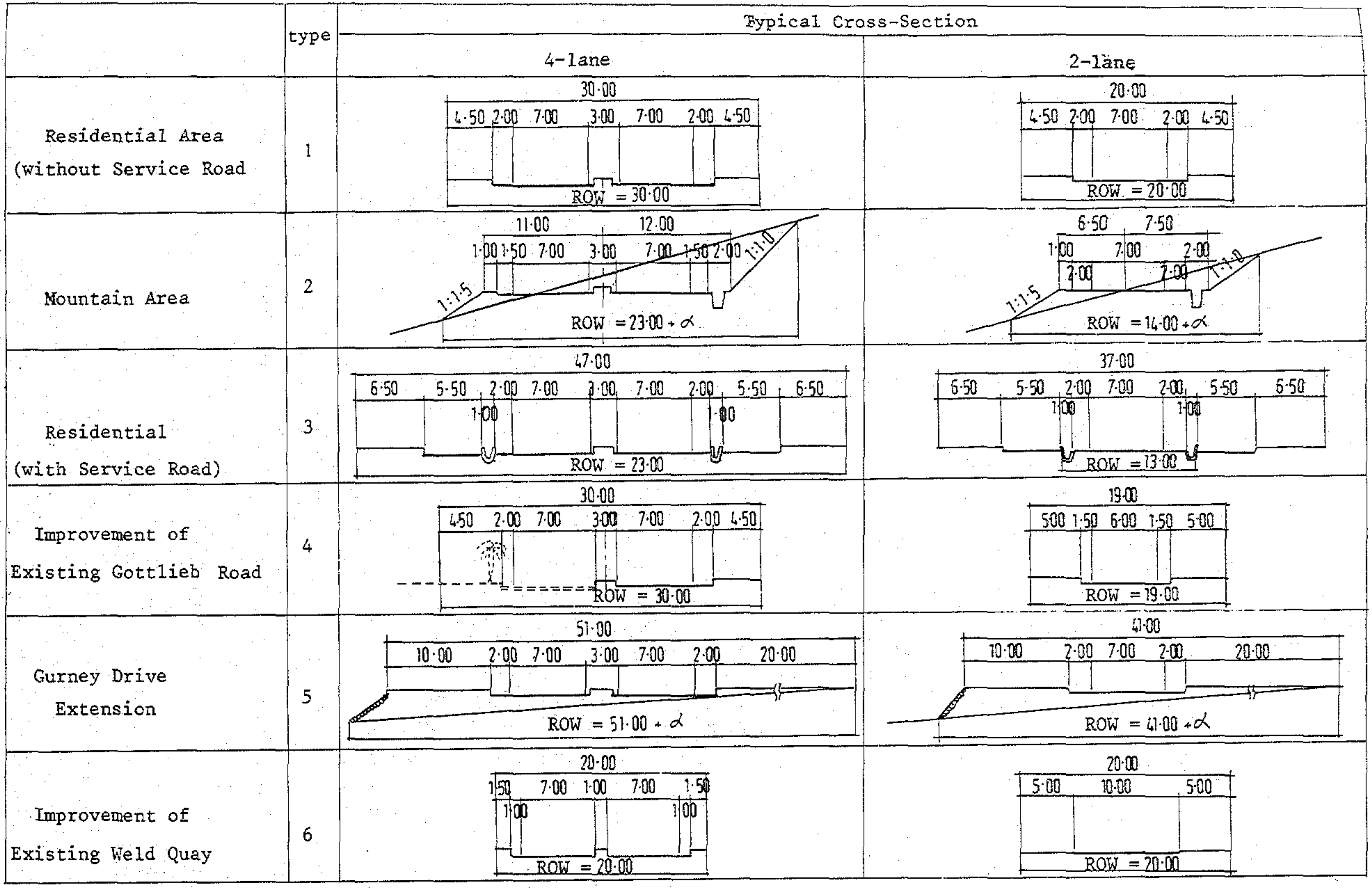


Fig. 4.8 TYPICAL CROSS-SECTION

c. Central reservation

Central reservation, as generally known, is the zone in the roadway formation that separates opposing streams of traffic; thus with a guard fence the glare of opposing head lights can be considerably reduced.

In the above consideration, it is necessary that the width of the central reservation be more than 3.0 meters. The central reservation consists of a separator and an inner shoulder. The width adopted for the separator and the inner shoulder are 2.0 meters and 0.5 meters respectively.

d. Right of way

The right of way in the residential area is 30 meters (about 100 ft) except in the case of the new housing areas at the southern part of Ayer Itam where the right of way is 23 meters. The cross-section of each site is illustrated in Fig. 4.7 and 4.8.

4.7.4 Intersection Design

(1) General type of intersection

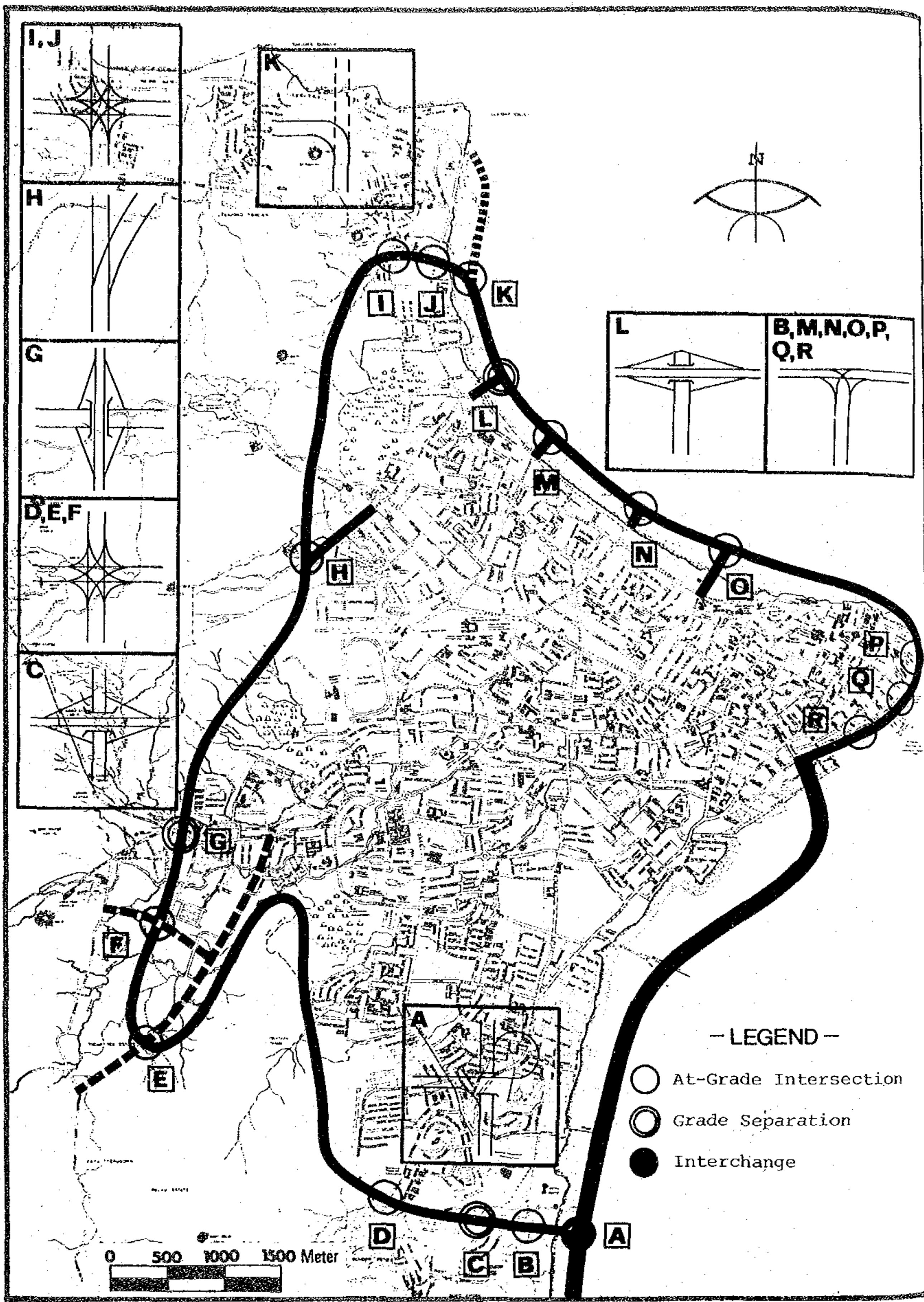
The Outer Ring Road is a primary distributor for intra-urban traffic, so the operating speed should be higher than that of the existing road and has to be able to provide an uninterrupted traffic flow. Generally, the type of intersection which is mot suitable between the Outer Ring Road and the related roads are shown in Table 4.6.

The table describes the type of intersections generally but these are subject to change after conditions of the actual site and stage construction are considered.

Table 4.6 TYPE OF INTERSECTION

Intersection of Outer Ring Road	At-grade intersection		grade separation	Remarks
	non-signalled	signalled		
to Primary Distributor inter-urban	X	X	0	
to Primary Distributor intra-urban	X	X	0	
to District Distributor	X	0	X	
to Local Distributor and Access Road	X	X	X	access control
to Approach Road (relating to Project Road)	X	0	X	

Note : 0 - suitable type of intersection.
X - not suitable type of intersection.



URBAN TRANSPORT STUDY	Fig. 4.9 INTERSECTION LOCATION & TYPE

(2) Location of intersection

The location of intersection is shown in Fig. 4.9. There is one interchange, 3 grade separation intersection and 13 at-grade intersections along the Outer Ring Road.

(3) Intersection design

1. 'A' Intersection (Refer to Fig. 4.9)

'A' Intersection is situated between a primary distributor inter-urban (North Coastal Road) and primary distributor intra-urban (Outer Ring Road). The two roads mentioned above are classified to be primary distributors, therefore the intersection is required to be grade separated. Three alternatives can be considered as shown in Fig. 4.10.

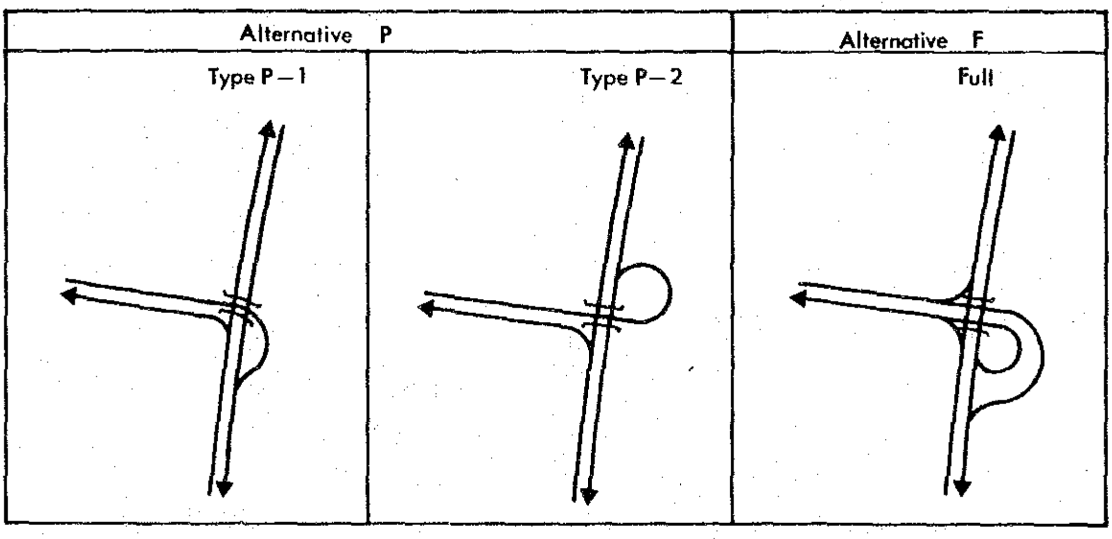


Fig. 4.10 ALTERNATIVE PLANS

Evaluation on these alternatives is made from the view-points of traffic flow, weaving length between this intersection and the Penang Bridge interchange and etc. Since there is little difference in alternatives about the traffic flow, the weaving length of alternatives is studied mainly.

Among the three, type P-2 can provide the highest service level of the weaving length (Service level C in 2000 years) and therefor is considered to be desirable.

2. 'B' Intersection (Refer to Fig. 4.9)

'B' intersection is situated between two primary distributor intra-urban roads (the Outer Ring Road and the Weld Quay Extension Road).

This intersection is projected to have heavy traffic volume, although the result of the traffic capacity analysis shows that the flow will not exceed the capacity of at-grade intersection until the year 2000, but with the distance from this intersection to A and C intersection being very close some problems will arise in constructing the grade separated intersection like shortage of weaving length and such therefore the intersection will be the at-grade type.

However, the grade separated intersection will be necessary after about the year 2000 due to the increase of traffic volume. Fig. 4.11 shows a sample of grade separation while it is recommended that an examination of the actual traffic volume be conducted at that time.

3. "C, G and L" Intersections (Refer to Fig. 4.9)

These inrersections are situated between two primary distributor intra-urban roads in George Town (the Outer Ring Road and Jalan Glugor/Jalan Ayer Itam) of which Table 4.6 shows them as grade separted intersections.

4. "K" Intersection (Refer to Fig. 4.9)

K-Intersection should be grade separated as shown in Fig. 4.11 in order to secure a function of the Outer Ring Road if the Tg. Tokong Road is constructed by land reclaiming. At this moment, however, at-grade separation is planned, as the plan of the Tg. Tokong Road is still uncertain.

5. Other Intrsections

Other intersections are situated between the Outer Ring Road and District Distributor and Local Roads. The traffic volume on district and local distributors is not unduly heavy, so the at-grade intersection equipped with signals is desirable.

Fig. 4.11 **GRADE SEPARATION PLAN**

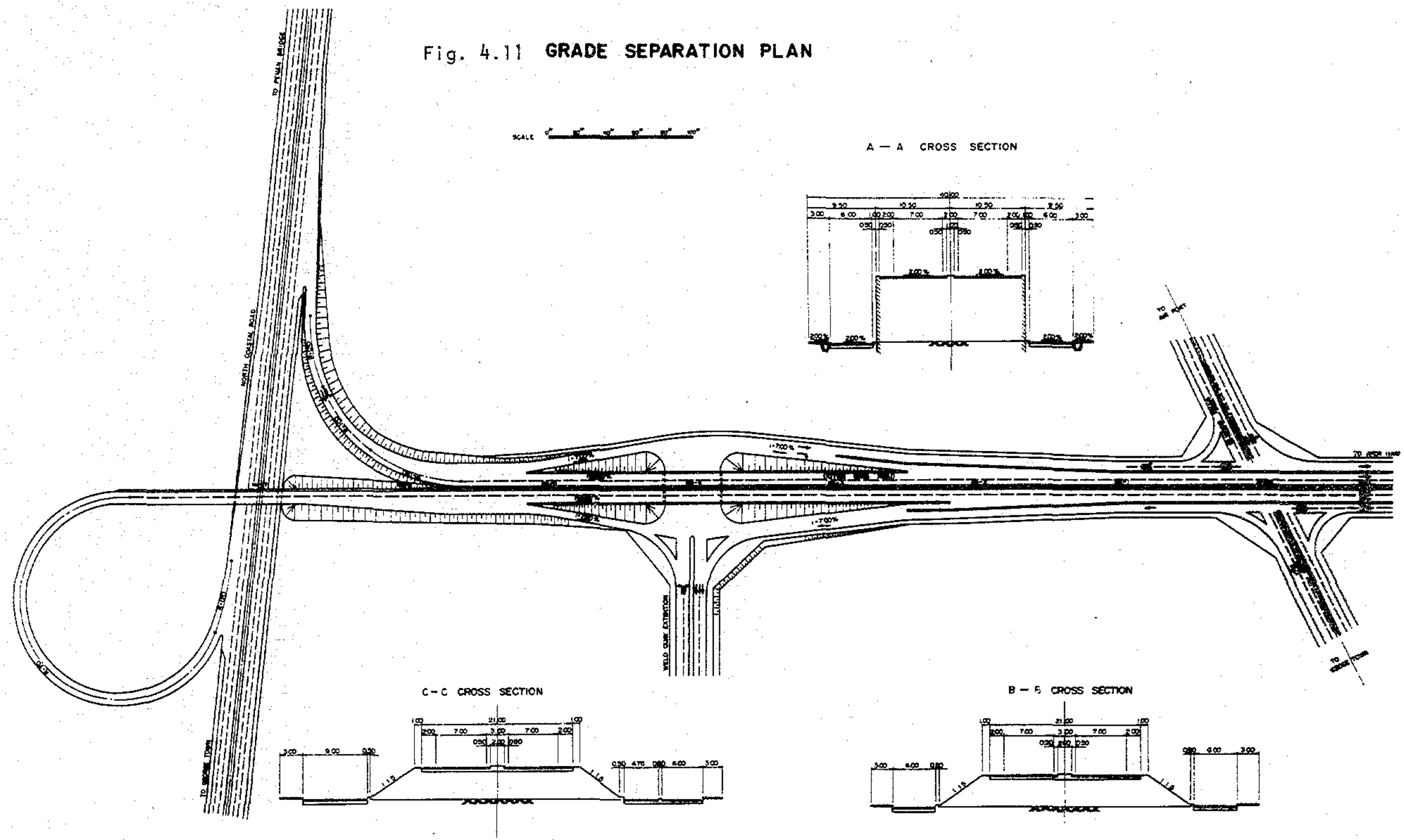
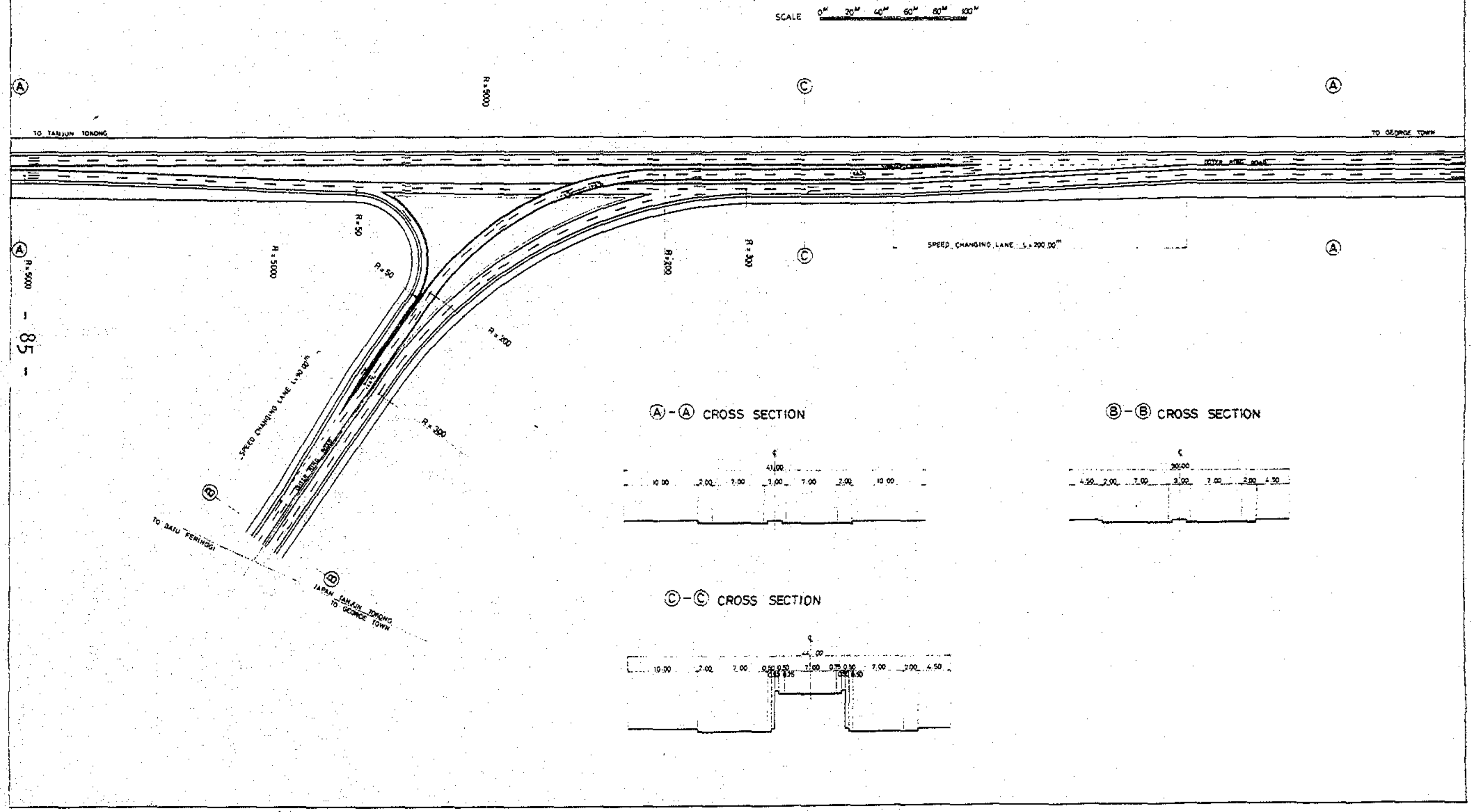


Fig. 4.12 GRADE SEPARATION PLAN (STA 145')
(ALTERNATIVE PLAN)



4.7.5 Bridge Design

(1) Superstructure

Concrete bridges including those of reinforced concrete or prestressed concrete will be best in conformity rather than the steel bridges found in Malaysia of which there are many types such as steel type, reinforced concrete type, prestressed concrete type, post-tension concrete type and so on.

The maximum length of reinforced concrete bridge and prestressed concrete bridge (taking into account economic consideration) is about 30 - 40 meters and 15 - 20 meters respectively.

Taking into account the above-mentioned, the post-tension bridge is better adopted for the Outer Ring Road, as the lowest point of the undulating land is very deep.

(2) Abutment

Concerning the positioning of abutment such points as the existing ground level, construction method, existing landuse, river, existing road, and construction cost should be considered.

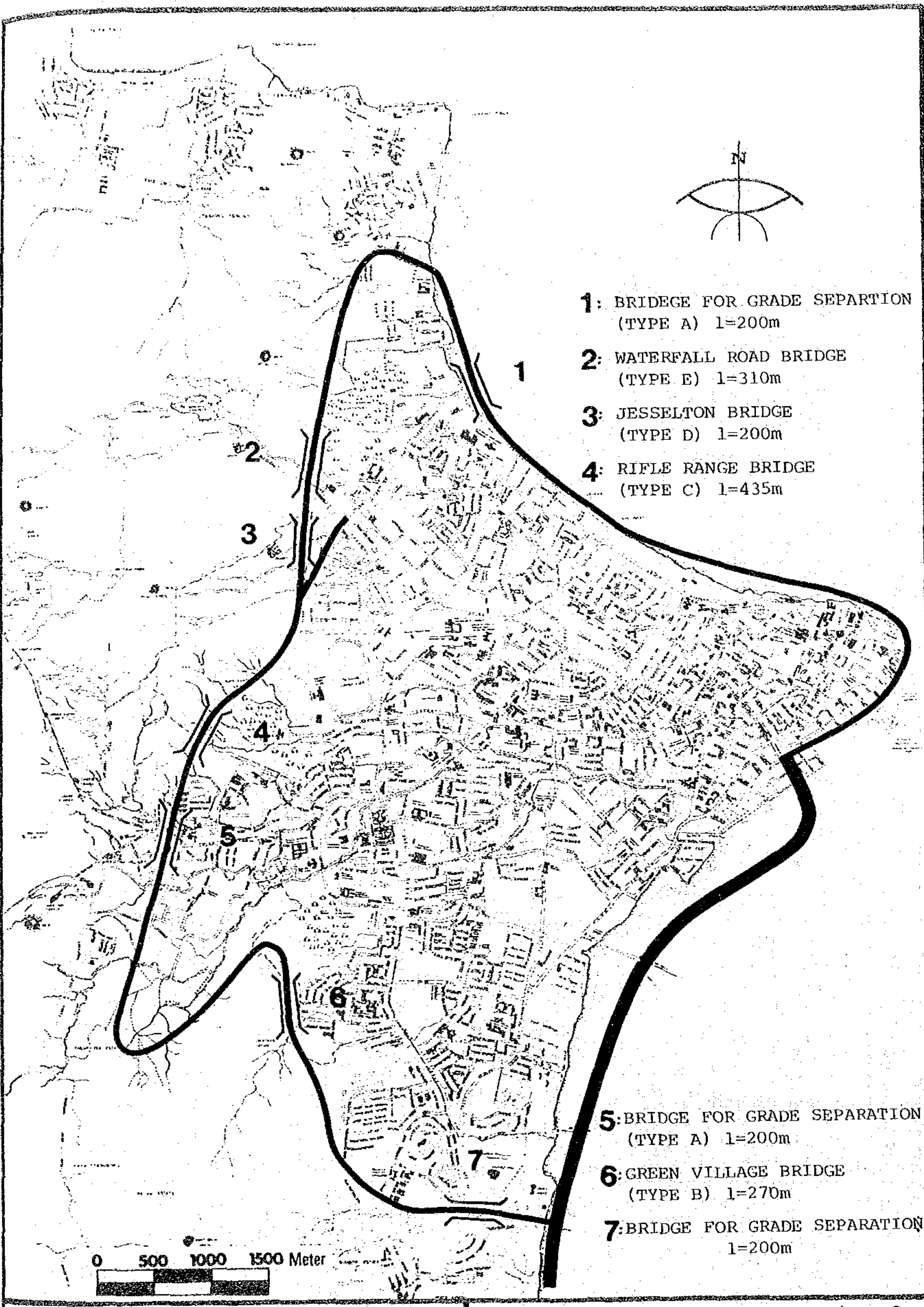
The grade separation bridge, planned in the urban area, when the site of abutment is decided should be considered in light of environment aspects of natural scenery and wind.

From the viewpoint of establishing open space under the bridge, the location of the abutment will be at a site where the distance between the girder of the bridge to the existing ground level is about 2.0 meters.

(3) Piers

The position of piers should also be governed by the same factors as the abutment. The undulating area of the bridge location site in the mountain area is very deep, and as such the height of the pier should also be likewise established. As the cost of a high pier is very great, a long span bridge is recommended from the economic viewpoint.

In the grade separated intersection bridge, the distance between the piers should take into account the traffic flow under the bridge.



URBAN TRANSPORT STUDY

Fig. 4.13 LOCATION OF MAJOR BRIDGES

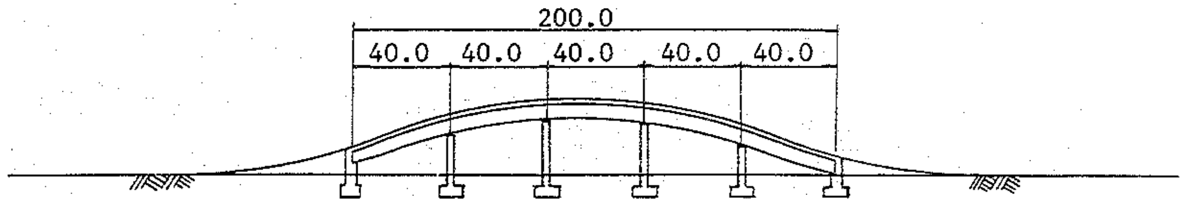
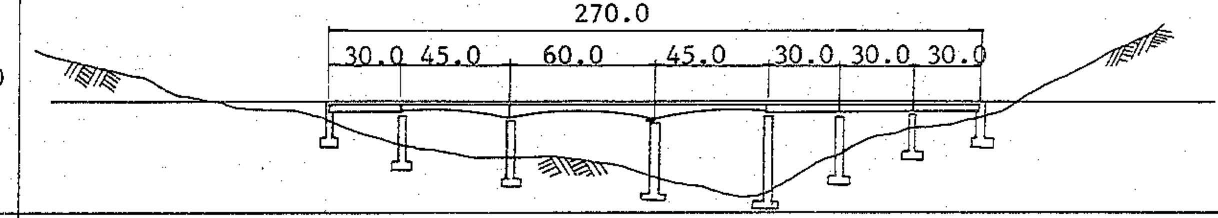
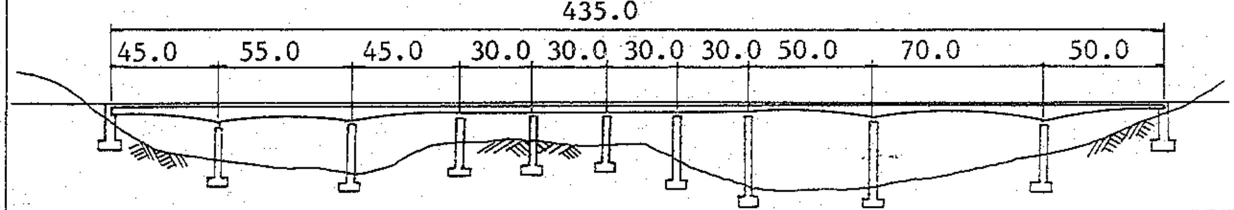
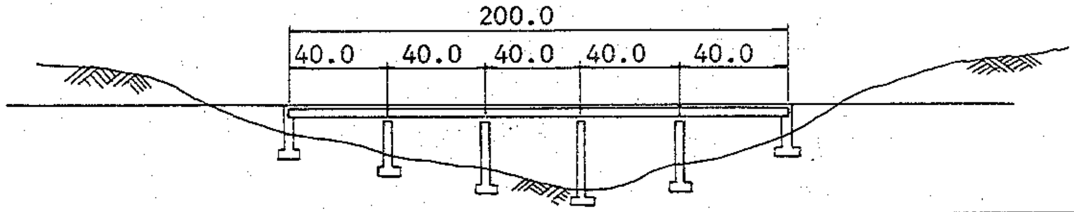
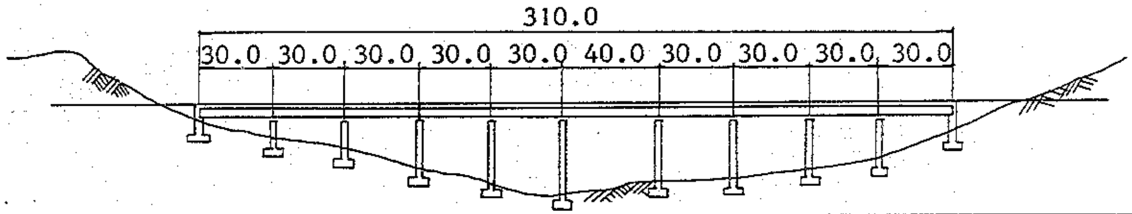
Station	Type	Length	Width	General Profile
No-1+0 No1+0 No77+50 No79+50 No153'+50 No130+10 (Grade Separation)	A	200	2 @ 9.00 = 18.00	
No27 + 70 No30 + 40 (Green Village Bridge)	B	270	2 @ 9.00 = 18.00	
No88 + 35 No92 + 70 (Riffle Range Bridge)	C	435	2 @ 9.00 = 18.00	
No103'+50 No105+50 (Jesselton Bridge)	D	200	2 @ 9.00 = 18.00	
No112'+40 No115'+50	E	310	2 @ 9.00 = 18.00	

Fig. 4.14 GENERAL VIEW OF MAJOR BRIDGES

(4) Foundation

From the results of the preliminary soil investigation in the mountanous area it appears that the rock depths are about 5.0 meters to 10 meters below the existing ground level in individual sites and therefore, the foundation for the mountainous area will be established by mass foundation. But at the grade separated intersection bridge located in flat terrain, the condition of the soil in that area is unfavorable neccesitating some kind of pile foundation construction. However the actual soil condition at each individual site should be investigated in the detailed design stage and then the most suitable type of foundation should be determined.

4.7.6 Revetment Design for Reclamation

(1) Type of Revetment

In general, the type of revetment is classified into three kinds, namely, sloping face, vertical face and composite types with the type of revetment constructed to be determined on the basis of the following conditions.

1) Hydrological Condition

2) Topography and soil conditions of the ground foundation

3) Construction material, period and cost

4) Utilization of the seashore

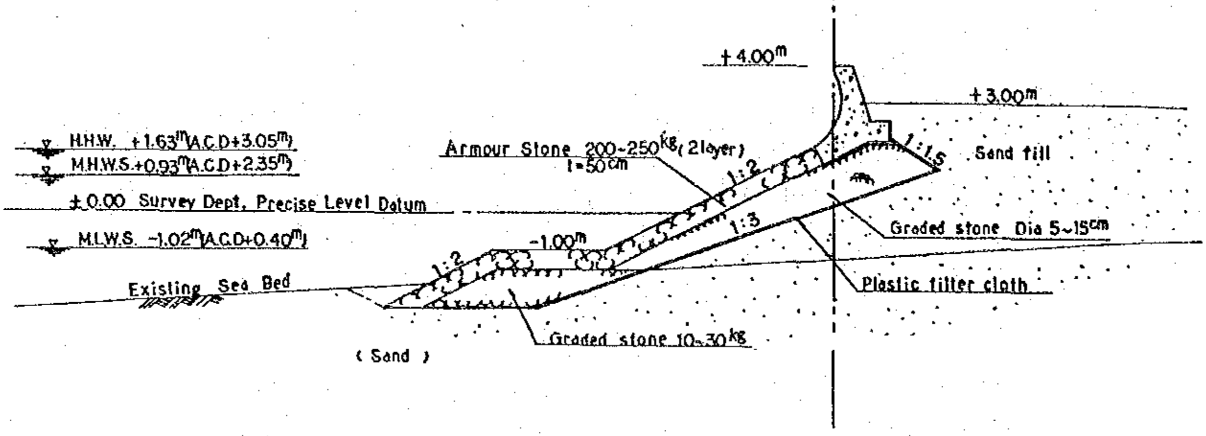
From the above condition, a stone pitching type slopped faced revetment is recommended as the most favourable type of structure for the proposed site. It will be possible to make use of the large volume of soil produced in the course of road construction in the mountainous area, and to provide for the soft surface layer of clay. Although the cost of concrete is relatively high the volume required will be small. A structure with a gradual slope will give the citizens some contact with the seashore.

(2) Crown elevation of revetment

On the basis of estimation of the allowable volume of overtopping, the crown elevation of revetment is determined. The

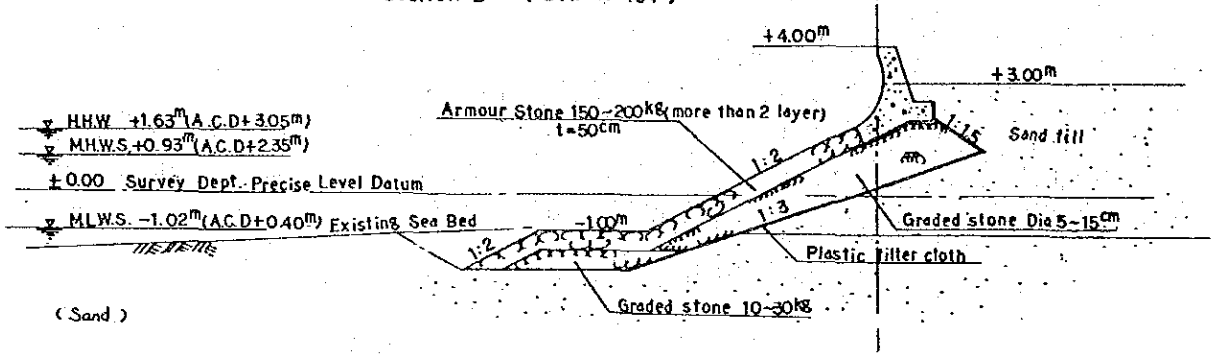
Fig. 4.15 REVENTMENT OF COASTAL ROAD

Section A (Sta.154~174)



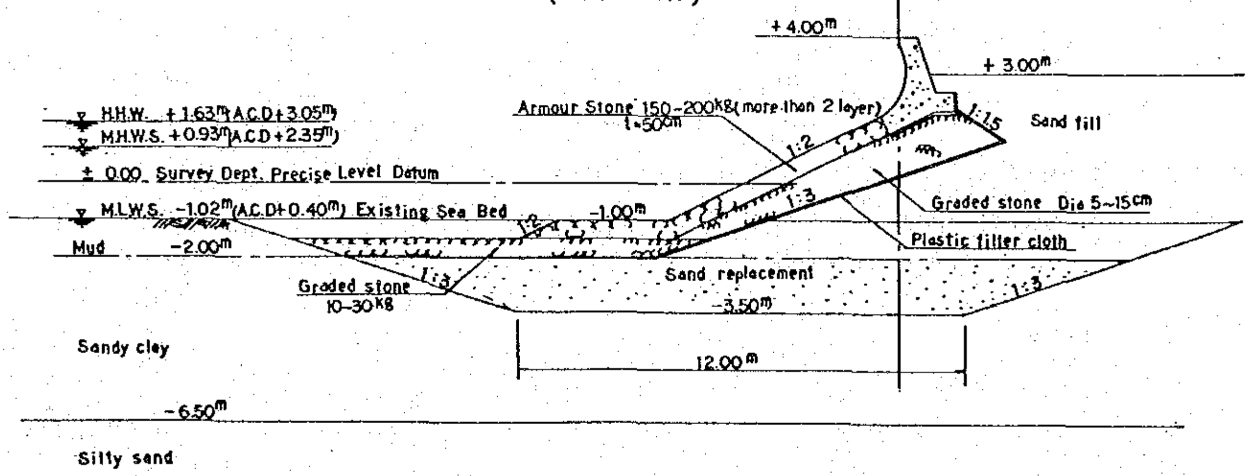
Revetment of coastal road

Section B (Sta.141~154)



Revetment of coastal road

Section C (Sta. ~141)



Scale

0 5 10m

allowable volume of overtopping is taken to be $10^{-4}m^3$/m.sec. As the volume of overtopping generally allowed on road is in the order of 10^{-4}, the above figure is considered to be a reasonable volume. From the result of calculation of the allowable volume of overtopping, the crown elevation of revetment is 4.0 meters above sea-level (Survey Department Level).

4.7.7 Slope Protection

(1) The slope of soil material

Generally, seed spraying or turfing are used in the protection of soil material on a slopes and for this project the turfing type is recommended.

a. In this country, turfing is carried out in many places and as a result it would be easy to perform.

b. The materials of seed spraying have to be imported from other countries although the materials for turfing are available locally.

(2) The Slope of Rock Material

Though many types of slope protection for rock material have been developed, the mortar or concrete spraying type is recommended because it is the most practical and effective method of protection against the weathering of granite which comprise the rock material of slopes.

4.7.8 Drainage Design

(1) Culvert Box

The culvert box is located in the slopes of undulating land and at existing narrow rivers with the capacity volume of the culvert box decided by the discharge volume in the undulating area.

Computation of the discharge volume is required for the section of culvert box which is 2.0 meters by 2.0 meters only. However, a culvert box of 3.0 meters by 3.0 meters is adopted because of the possibility that soil, sand, branches of trees and gravel might flow into it.

The result of the comparison between discharge volume and capacity discharge volume shows that the discharge volume of all culvert boxes is less than the capacity discharge volume.

Table 4.7- THE COMPARISON OF EACH VOLUME

Section	Section (m)	Discharge volume (m3/sec.)	Capacity discharge volume (m3/sec.)
No 6 + 40.00	3.00 x 3.00	4.29	30.00
No 35 + 0.00	"	0.93	"
No 39 + 0.00	"	1.39	"
No 42 + 0.00	"	0.90	"
No 33 + 50.00	"	1.52	"
No 123' + 10.00	"	1.79	"
No 123' + 70.00	"	1.79	"
No 126' + 20.00	"	3.36	"
No 131' + 70.00	"	3.44	"
No 132' + 60.00	"	3.44	"
No 133' + 40.00	"	1.84	"
No 134' + 80.00	"	1.76	"

(2) Roadside drainage

Roadside drainage is of two types, in mountainous areas and in residential areas. In the mountainous area, open channel drain with 1.0 m x 1.0 m section is used and in the residential area the covered-on drain with 0.5 m x 1.0 m section is used with the sidewalk as the cover.

Along the Outer Ring Road, the comparison between run-off volume and capacity run-off volume along the Outer Ring Road has been carried out.

From results of calculation, the discharge volume of each station is less than the capacity of discharge volume such as shown in Table 4.8.

Table 4.8 THE RESULT OF CALCULATION OF DISCHARGE VOLUME

Station		Section	% Gradient	Discharge volume (m^3/sec.)	Capacity of discharge volume (m^3/sec.)
No 8 + 0	STA No 0 + 0	0.5 x 1.0	4.1	1.43	2.1
No 0 + 0	No 6 + 0	0.5 x 1.0	2.5	1.07	1.7
No 6 + 0	No 9 + 0	0.5 x 1.0	2.0	1.07	1.6
No 9 + 0	No 16	1.0 x 1.0	6.0	7.79	8.0
No 16 + 0	No 28	1.0 x 1.0	3.0	1.9	1.9
No 28	No 37	1.0 x 1.0	4.0	0.9	2.0
No 37	No 42	1.0 x 1.0	5.0	1.15	2.5
No 42	No 50	1.0 x 1.0	1.34	0.81	1.4
No 50	No 80	0.5 x 1.0	-	-	-
No 80	No 88	0.5 x 1.0	6.00	2.44	2.8
No 96	No 104	1.0 x 1.0	6.00	2.5	2.8
No 106'	No 112'	1.0 x 1.0	6.00	2.25	2.8
No 116'	No 128'	1.0 x 1.0	1.09	1.19	1.2
No 128	No 140'	1.0 x 1.0	2.14	1.12	1.6

4.7.9 Pavement Design

(1) Type of Pavement

There are basically two different kinds of pavement, asphalt concrete and cement concrete pavement types, of which the former is adopted for the Outer Ring Road.
The reasons being as follows.

1. Lower construction cost

   In Penang Island, the source of sand for use in cement concrete pavement is limited as well as being expensive therefore making construction cost of cement concrete pavement higher than that of asphalt concrete pavement. For example, the construction cost of asphalt concrete pavement and cement concrete pavement are $28.8 per square meter and $33.4 per square meter respectively.

Table 4.9 COMPARISON OF CONSTRUCTION COST BETWEEN CEMENT CONCRETE PAVEMENT AND ASPHALT CONCRETE PAVEMENT

Unit: M$ per m^2

Items	Cement Concrete Pavement			Asphalt Concrete Pavement		
	Quantity	Unit Cost	Cost	Quantity	Unit Cost	Cost
Surface Course	0.20 m^3	141.3	28.3	0.10 m^3	196.0	19.6
Base Course	0.15 m^3	28.0	4.2	0.25 m^3	20.0	5.0
Sub-Base Course	0.20 m^3	4.7	0.9	0.20 m^3	20.8	4.2
Total	-	-	33.4	-	-	28.8

2. Easy availability of material needed

   The materials for base course and sub-base course of the asphalt concrete pavement can be obtained from the site of the Outer Ring Road, but fine aggregate such as sand for structure is not so easily available. The quantity of fine aggregate required for cement concrete pavement is greater than that for asphalt concrete pavement. Therefore, the materials required for asphals concrete pavement are more easily available.

   Reinforced concrete is required for cement concrete pavement with large volumes of such material being unavailable in Malaysia and as a result, construction of the asphalt concrete pavement will be easier than cement concrete pavement.

3. Technical know-how

   The asphalt concrete pavement has been in use in Malaysia for a long time and therefore, the technical know-how required in its construction is easily available.

4. Easy maintenance

   In the urban area, it will be necessary to re-construct road services like water supply, drainage and other road facilities therefore with this in mind, asphalt concrete pavement stands superior to cement concrete pavement because such facilities are easier to construct on asphalt concrete pavement.

(2) Design of pavement

1. Premises for design

a. On the basis of soil investigation, the C.B.R. value of subgrade is about 5% - 6%.

b. On the basis of traffic counting survey, the percentage of trucks and buses is less than 5.0%.

c. The average daily traffic volume is adopted to be 53,000/day; this volume is expected to pass through Jalan Ayer Itam and Watrfall Road in the year 2000.

d. The life-span of asphalt concrete pavement is adopted to be 20 years.

2. Calculation of thickness of individual course.

a. Material of individual course

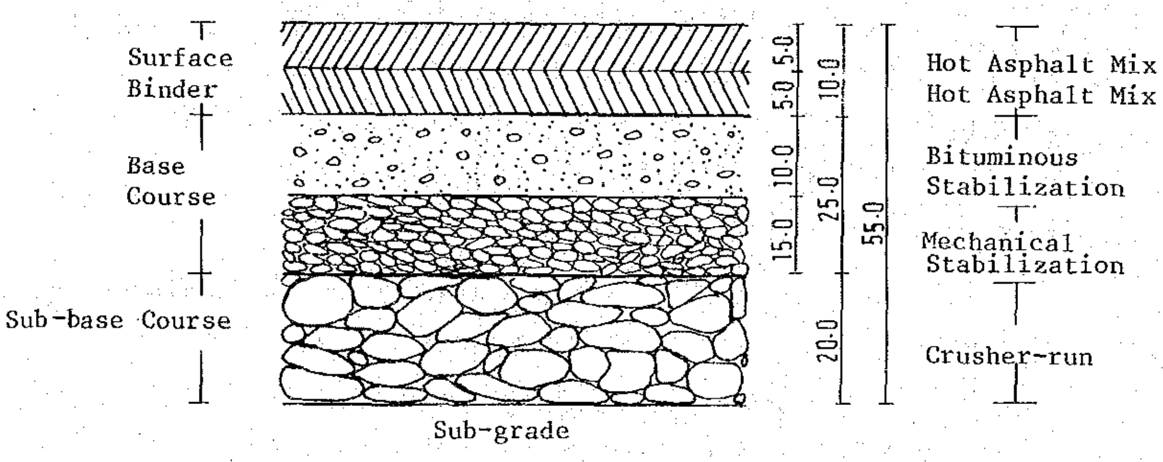


Fig. 4.16 CROSS-SECTION OF PAVEMENT

3. Examination of thickness

a. The thickness of each course is shown in Table 4.9.

Table 4.10 THE THICKNESS OF EACH COURSE

Course	Coefficient	Thickness	Total
Surface	(1.0)	5.0	55.0
Binder	(1.0)	5.0	
Bitumen Stabilized Course	(0.8)	10.0	
Mechanically Stabilized Course	(0.35)	15.0	
Crusher-run	(0.25)	20.0	

Note: ( ) is coefficient of relative strength for calculation. Refer to Table 4.10.

b. Road classification by volume of traffic

The average daily traffic volume is adopted to be 53,000/day with the percentage of heavy traffic is adopted to be 5.0. Therefore one way daily volume of heavy traffice is 132 V/D (53,000 x 0.5 x 0.05) and as such "Classification C" from Table 4.10 is relevant.

c. Thickness of T_A and H

According to Fig. 4-16 and Table 4.10, the thickness of T_A and H are calculated to be:-

$$T_A = 5.0 \times 1.0 + 5.0 \times 1.0 + 10.0 \times 0.8 + 15.0 \times 0.35 + 20.0 \times 0.25 = 28.25 \text{ cm} \quad \ldots\ldots\ldots\ldots \quad (1)$$

$$H = 55.0 \text{ cm} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Comparing with the values shown in Table 4.10 with the C.B.R. of sub-grade of 6% and road classification "C" the values for the above area are higher. Therefore the cross-section has enough thickness to support through traffic on the road.

TAble 4.11 TARGET VALUE FOR T_A AND FOR THE TOTAL PAVEMENT THICKNESS H

Unit : cm

Design CBR	Road Classification									
	L		A		B		(C)		D	
	T_A	H	T_A	H	T_A	H	T_A	H	T_A	H
2	17	52	21	61	29	74	39	90	51	105
3	15	41	19	48	26	58	35	70	45	83
4	14	35	18	41	24	49	32	59	41	70
(6)	12	27	16	32	21	38	(28)	(47)	37	55
8	11	23	14	27	19	32	26	39	34	46
12	-	-	13	21	17	26	23	31	30	36
20 or more	-	-	-	-	-	-	20	23	26	27

4.8 Environmental Considerations

4.8.1 Objectives of the Study

The purpose of the environmental study is to minimise the unexpected environmental and social conflicts which may presumably be generated by the Outer Ring Road and to involve the study of the socio-cultural needs in the future development of George Town with intentions to consider the desirable qualities of the environment.

The study consists of three major objectives which are:

a. To assess the roadside environment in terms of environmental protection.

b. To set up planning measures in order to mitigate foreseeable environmental disturbances.

c. To define the conceptual role of the road and the design policy for the strategic sections in order to meet with the social demands.

4.8.2 Study Approach

The study approach taken in this study consists of four major concepts as shown in Fig. 4.17. The evaluation of development potential is the first necessary step to be taken in order to eliminate the possibility of unsuitable route location and to select a more preferable alternative route location for the Outer Ring Road.

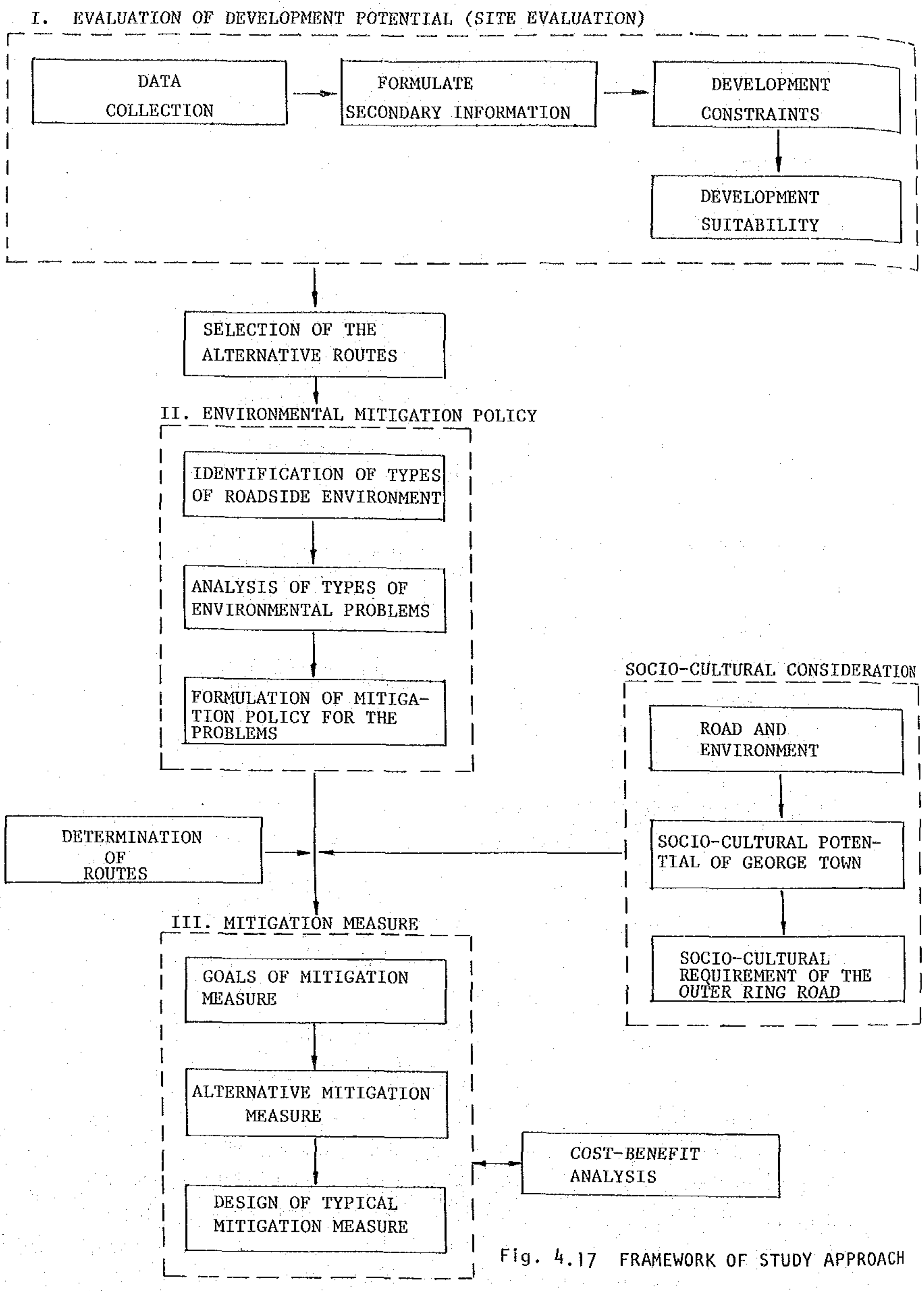


Fig. 4.17 FRAMEWORK OF STUDY APPROACH

The assessment of roadside environment is processed in the environmental mitigation policy which comprises three steps; identification of types of roadside environment, analysis of types of environmental problems and, formulation of mitigation policy for the problems.

The planning of mitigation measure comes after the mitigation policy with the study approach comprising two steps; first, the examination of alternative mitigation measures, and then, the design of typical mitigation measures.

The definition of the conceptual role and the design requirement of roads is to be carried out in the socio-cultural context of the roads in George Town with it comprising of the analysis on the implication of road and environment, socio-cultural potentials of George Town, and socio-cultural requirements of the Outer Ring Road.

The coverage of the environmental study in this chapter is focussed on socio-physical aspects and environmental effects on George Town by the Outer Ring Road.

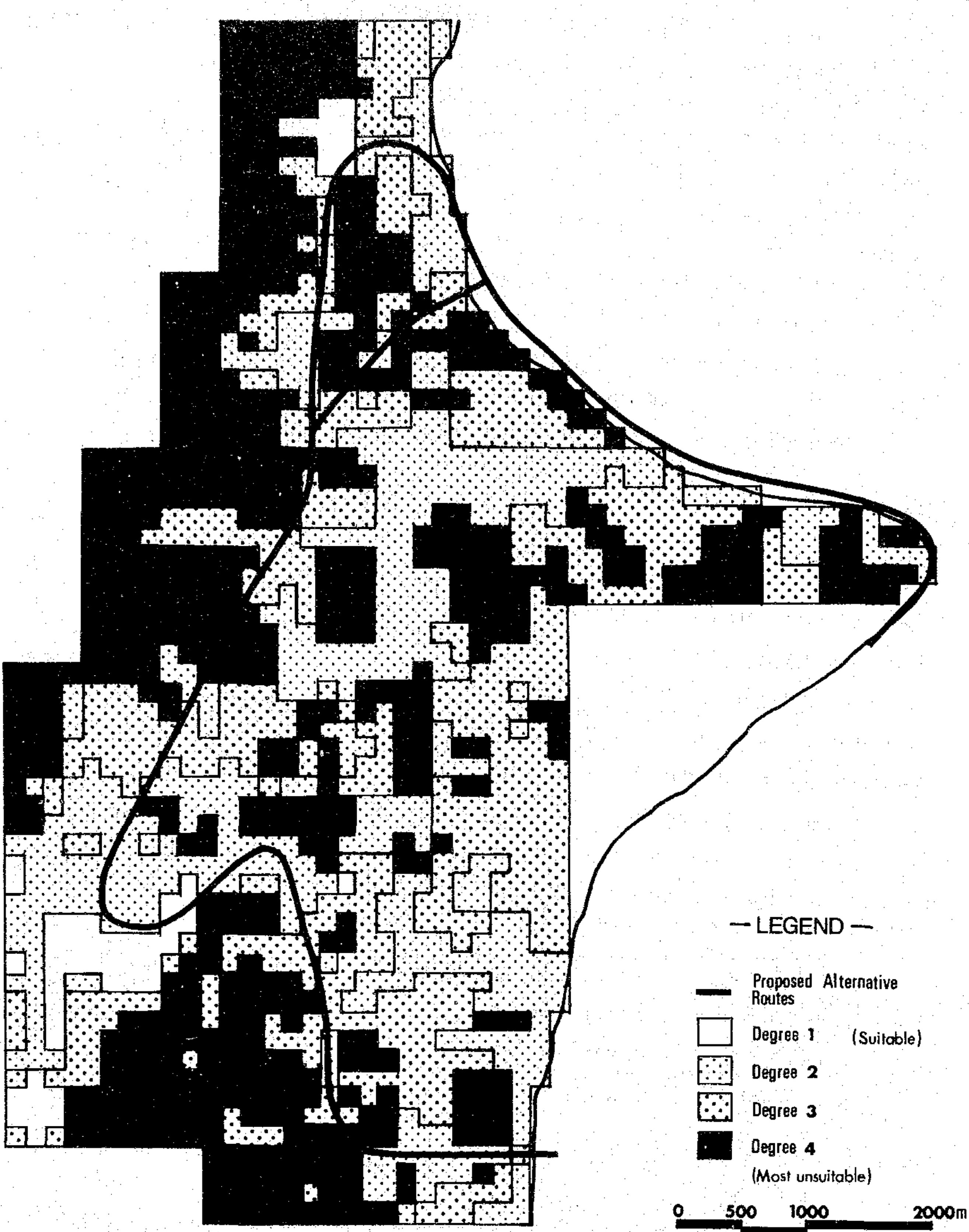
4.8.3 Site Evaluation

To preserve the existing urban environment, it is mot important that the location of the Project Road be properly selected so that the least conflict with the environment is expected.

From this purpose, the site conditions along the Project Road are evaluated and overlaid to assess the development suitability for the road construction by using a mesh system where the site has been evaluated for the following conditions.

Physical Condition	. Steepness of Slope . Distribution of Unstable Stones . Soil
Social Condition	. Environmental Assets (Historial ruins etc.) : Environmentally Sensitive Facilities (School, Hospital, etc.) . Population Density

The route of the Project Road is then examined by using the map of development suitability which has all these conditions.



URBAN TRANSPORT STUDY

Fig. 4.18
DEVELOPMENT SUITABILITY

4.8.4 Impact of the Road

The conceptual structure of the impact is shown in the basic framework of environmental impact. (See Fig. 4.19)

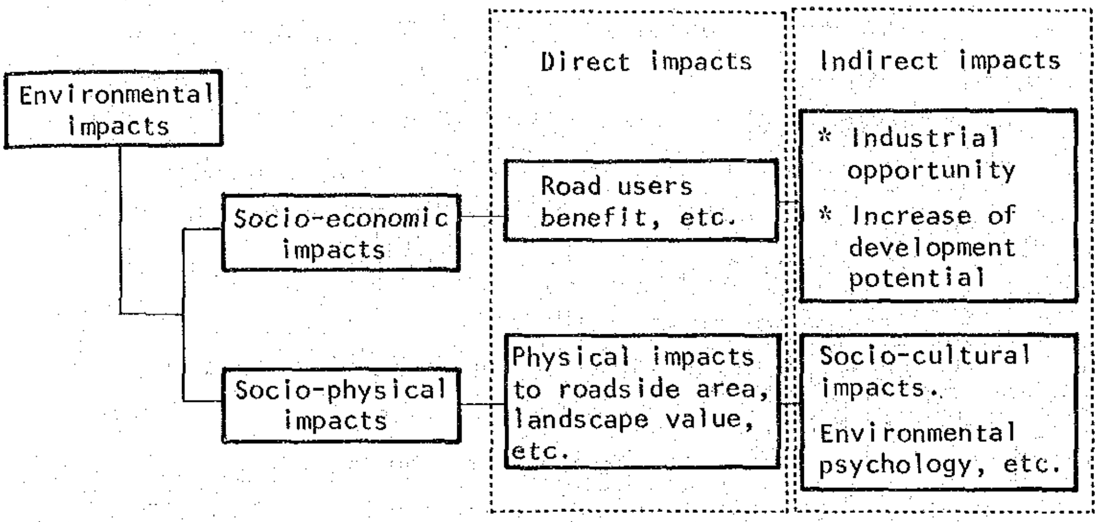


Fig. 4.19 BASIC COMPOSITION OF ENVIRONMENTAL IMPACTS

(1) Direct impacts

Direct impacts are essentially physical to the surrounding environment along the Outer Ring Road. The air pollution while only expected to spread to the regional scale might possibly be mitigated by strong north-south winds blowing into George Town therefore the direct impacts on the environment must preferably be assessed in the zone area limited to along the Outer Ring Road.

The characteristics of the direct impacts have generally been discussed from three aspects:

a. The impact by vehicular traffic mainly comprises of noise, air pollution, and vibration, and the noise is probably the predominant impact in the Study Area. It was concluded that the roadside space generated by planning minor access roads and/or by implementing the building line by-law relatering to a minimum of 6.0 m (20') from the road reserve, can function effectively as a buffer zone.

Therefore, in newly developed residential areas along the Outer Ring Road, it is proposed that minor access roads should be planned whereby a space width of 12.0 m (40') is provided to the building lots. In existing residential areas, buildings within 6.0 m (20') from the reserve of the Outer Ring Road are considered for compensation. In a particular segment of the Outer Ring Road, namely the North Coastal Area, a buffer zone with a width of 10 m to 50 m is proposed between the road reserve and the building lots.

b. The impacts by the structure of the road are found predominantly to generate landscape disturbance and community segregation. Compensation for houses within 6.0 m (20') from the proposed road reserve, planning of the landscape and of pedestrian crossing system are proposed.

c. The impacts from construction work may be noise, vibration and dust from construction sites and disturbance by heavy lorry traffic. The need for careful planning for the construction stage plan and for a comprehensive labour management programme is strongly urged.

In addition to the above general impacts and mitigations, the landscape design on the North Coastal Area is proposed for implementation to the whole stretch of the section.

(2) Indirect impacts

The indirect impacts involve those of socio-economic and socio-cultural with the former impact, mainly being analysed in this chapter.

The socio-cultural impacts are generally invisible and take time before they become evident moreover they can only be discussed in a wider context. There is, so far, no quantitative analysis method established to reflect the socio-cultural impacts in the feasibility studies, although they will have to be tackled later. The road as a physical element is generally the most endurable infrastructure of environments, and has strong potential to control the future image of George Town especially where there are strong historical socio-cultural identies.

The Outer Ring Road in George Town will be expected to serve as a main approach to the built up area from the airport, sea and the other major centres as well as it also being considered to form the decisive edge of the town in combination with the topographical feature.

These imply that the role of the Outer Ring Road in the environment should presumably be programmed to satisfy the following conditions:

a. The Outer Ring Road is planned to be an intra-urban primary road in the total hierachical system. The clear functional and spatial differentiation can be effective in setting up the legibility of the urban environment which is necessary for a better human environment.

b. The Outer Ring Road itself in combination with the topographical periphery forms the physical edge of George Town. Therefore, it will be one of the basic visual elements which will identify the territory of George Town.

c. The road winding at a level of 30 m (100') to 60 m (200') above sea-level can provide various scenic views of the town from the road and as a result has the potential to become a new tourist attraction for Penang as a parkway road system.

d. The parkway road system includes the coastal road off Gurney Drive as an important section of the total parkway system therefore, it making desirable that the plan of the road should involve the development of recreational space along the route.

e. The Outer Ring Road can contribute to an improvement of the quality of existing landscape of George Town by means of emphasizing vegetation and landscape design with roadside vegetation along the Outer Ring Road expected to become one of the landscape infrastructures in the town.

4.8.5 Mitigation Measure

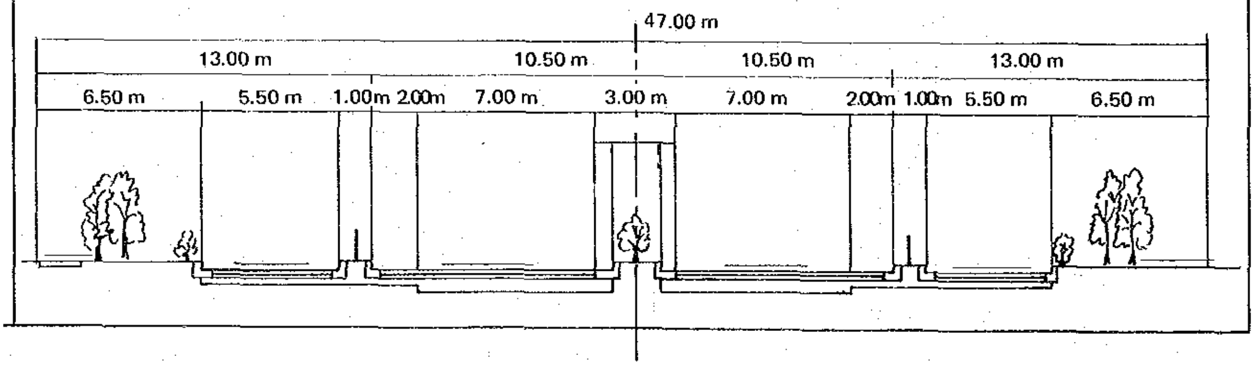
Considering the impact from the Project Road, various types of physical mitigation measures are evaluated, and a buffer zone, the planting of vegetation, embankment and a buffer wall are combined to mitigate the impacts according to the structure of the Project Road. Especially in the residential area and the area off Gurney Drive, the following measures are proposed.

a. Residential area

Landscaping with:

. Roadside trees in service road
. Hedge for property limits
. Planting in the median strip
. Pedestrian sidewalk

Residential Area with Service Road



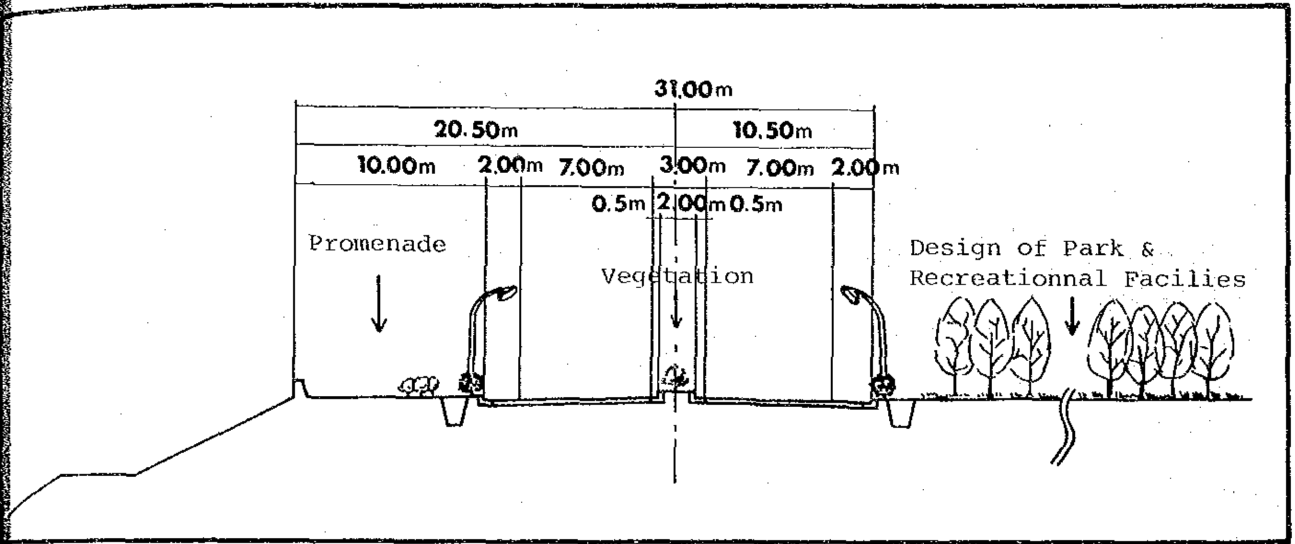
b. Off Gurney Drive

Lanscaping with:

. Vegetation in the Green Belt
. Design of park and recreation facilities
. Pedestrian promenade along the seashore
. Parking bays / Bus-bays

. Telephone booths, postage stands
  and other street facilities
. Sign board control
. Promoting hedges for property limits

MITIGATION MEASURES AT GURNEY DRIVE EXTENSION



5. ESTIMATION OF THE PROJECT COST

5.1 General

Construction cost is calculated in 1980 prices, with reference to the East-West Supporting Road, the Inter-Urban Toll Expressway and the North Coastal Road Reports.

5.1.1 Cost Estimation Method

The cost estimation process is shown in Fig. 5.1.

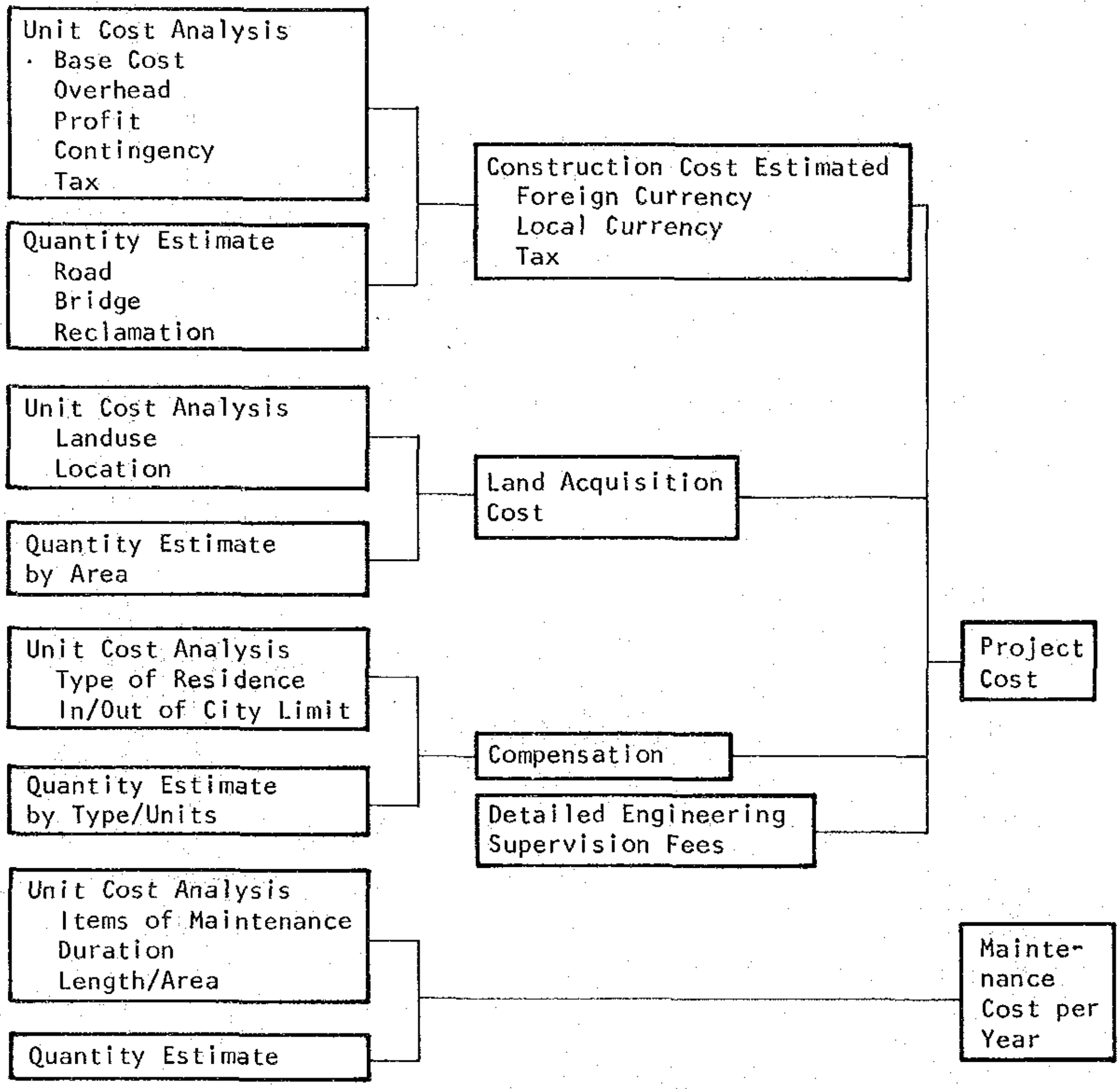


Fig. 5.1 FLOW OF THE COST ESTIMATION PROCESS

5.1.2 Conditions

1) The construction cost is presented in Malaysia dollars. (Ringgite) (M$)

2) Cost estimate is carried out based on 1980 prices.

3) The construction cost is split into Foreign currency, Local currency and Tax.

5.1.3 Base Cost

Base cost consists of:

1) The cost of labour

2) The equipment and material for construction, and

3) Other necessary items.

5.1.4 Construction Cost

Construction cost consists of:

1) Base cost

2) Overhead cost

3) Profits of contractor

4) Contingency

5) Tax

5.1.5 Foreign Currency

Foreign currency is incurred on:

1) Costs of imported machineries (CIF price), and materials such as steel products and others

2) A portion of the detailed engineering and supervision survice fees

3) A portion of the overhead, profit and contingency costs.

5.1.6 Local Currency

Local currency is incurred on:

1) The purchase of Domestic products such as cement, soil, sand etc.

2) A portion of the detailed engineering and supervision service fees

3) Labour cost and transport cost

4) Cost of land aquisition and compensation.

5.2 Unit Cost Analysis

The unit cost analysis is carried out during the feasibility study of this project with reference to "The Penang Island Dispersal Study Report", "East-West Highway Supporting Road Report", "Penang Bridge Project Report" and "Inter-Urban Toll Expressway Project Report".

5.2.1 Component of Unit Cost

The unit cost itself is also split into three parts, as foreign currency, local currency and tax. The foreign currency and local currency includes four components, namely base cost, overhead, profit of contraction and contingency. The percentage distribution of the above cost component's are shown in Table 5.1.

Table 5.1 PERCENTAGE OF COST COMPONENT'S

	Percentage (%)	Remarks
Base Cost	100	
Overhead	10	of the Base Cost
Profit	10	of the Base Cost
Contingency	5	of the Base Cost

5.2.2 Labour Cost

The labour cost is shown in Table 5.2.

Table 5.2 LABOUR COST

	Items	Unit Cost per 8 hour day (M$)
1	General Labourer	14.00
2	Concrete Labourer	20.00
3	Mason	20.00
4	Mason's Labourer	16.00
5	Carpenter	22.00
6	Carpenter's Labourer	18.00
7	Steel Bender and Fixer	20.00
8	Pneumatic Tool Operator	22.00
9	Fitter	28.00
10	Welder	28.00
11	Painter	22.00
12	Truck Driver	24.00
13	Earth Moving Equipment Operator	32.00

5.2.3 Material Cost for Construction

The major material cost for constructions is derived after discussions with the State J.K.R., the Engineering Department of H.P.P.P. and other related office. The list of material cost is shown Table 5.3.

Table 5.3 MAJOR MATERIAL COST

Materials	Discription	Unit	Market Price (M$)	Remarks
Red Earth	Standard	M^3	5.2	
Sand	25-5 40-5	" "	20.9 20.9	
Crushed Stone	Granite dust ø 20 ø 40 ø 150-200	" " " "	11.8 30.1 23.5 17.0	
Concrete	1:3:6 1:2:4 $1:1\frac{1}{2}:3$	" " "	141.3 176.6 282.5	
Cement	Portland	T	167.5	
PC Pipe	ø 200 ø 500 ø 800 ø 1,000	1.83 m 1.52 m 1.52 m 1.52 m	29.0 69.5 129.5 159.0	
Steel Bars	ø 6 ø 13 ø 22 ø 32	T " " "	845.0 872.0 817.0 817.0	
Steel Angle	U type H type L type	" " "	940.0 1,299.0 1,053.0	
Frame Work	Wood	M^2	3.2	
Drainage	230 mm	M	48.0	
Guardrail	JKR standard	M	31.0	
Kerb	Concrete	"	13.0	
Tree		Nois	50.0	by MPPP
Painting	110 mm width	M	0.9	
Turfing	Grass	M^2	5.0	
Fence	H = 1.70 m	M	17.0	

5.2.4 Construction Equipment

The Unit Cost of various plants in Malaysia was analysed recently. Based on this information, the cost performances of the plants which are considered suitable for the Project Road construction in its size and capacity range are described as follows:

(i) Service life of plant - 8 years.

(ii) Working hours per annum - 2,160 hrs.

(iii) Interest per capital outlayed - 8%.

(iv) Spare parts cost per annum - 5% of initial cost of plant.

(v) Maintenance and repairs - 5% of the initial cost of plant.

(vi) Average plant efficiency - 70%.

5.2.5 The Result of Unit Cost Analysis

The result of unit cost analysis is shown in Table 5.4. This unit cost consists of direction cost, overhead, profit of contractor and contingency.

Table 5.4 UNIT COST

Item	Sub-Item	Class	Unit	F.C	Unit Cost (M$) L.C	Tax	Total
Site Clearance	Residential		M^2	1.80	1.20	0.15	3.15
	Field		"	0.25	0.16	0.02	0.43
	Mountain		"	0.35	0.20	0.03	0.58
Excavation	Soil		M^3	1.18	0.85	0.1	2.13
	Rock		"	5.51	10.58	0.81	17.0
Embankment	Soil		M^3	1.4	0.9	0.11	2.41
Slope	Grass		M^2	0	5.0	0.3	5.3
	Concrete		"	4.8	3.8	0.7	9.3
Turfing	Sidewalk	Grass & Tree	M^2	1.2	4.7	0.3	6.2
	Open Space	Grass	"	0	5.0	0.3	5.3
Drainage	Roadside	0.5 x 1.0	M	48.5	101.3	6.1	155.9
		1.0 x 1.0	"	54.0	99.1	6.6	159.7
	Pipe Culvert	ø = 600	"	59.3	91.4	6.8	157.5
	Box Culvert	3.0 x 3.0	"	609.5	702.15	77.4	1,389.05
		5.0 x 5.0	"	1,374.3	1,563.9	162.7	3,100.9
	Demolishing	0.5 x 1.0	"	6.8	3.1	0.9	10.8
Wall	Concrete	H = 1.0	M				
	Concrete	H = 5.0	"	459.6	557.9	58.3	1,075.3
	Masonry	H = 5.0	"	76.0	116.8	9.7	202.5
	Revetment	Stone	"	671.1	1,110.5	123.6	1,905.2
	Demolishing						
Pavement	Carriage-way	Asphalt	M^2	15.9	11.6	1.3	28.3
	Shoulder	Asphalt	"	12.4	8.3	1.0	21.7
	Service Road	Asphalt	"	12.4	8.3	1.0	21.7
	Side Walk	Concrete Block	"	6.1	8.4	0.8	15.3
	Overlay	Asphalt	"	2.5	10.3	1.4	14.2
	Removing	Asphalt	"				
Additional Facility	Kerb	Concrete	M	5.7	12.6	0.9	19.2
	Central Reservation	Concrete	"	10.4	25.2	1.8	37.4
	Guard Rail	Steel	"	34.5	10.3	4.4	49.2
	Lighting	Steel	"	11.0	9.0	1.0	21.0
	Lane-Marks	Paint	"	0.3	0.6	0.05	0.95
Inter-Section	At-grade		No.	30,534.8	59,728.4	2,706.2	92,969.4
	Grade Separation						
	Interchange		Vol.	705,314.0	775,542.6	74,928.8	1,555,785.4
Bridge	L = 50	Concrete	M^2				
	L = 50	Concrete	M^2	380	570	50	1,000
Approach Road			M	428.2	461.3	45.1	934.6

Note: F.C : Foreign Cost
L.C : Local Cost

5.3 Construction Quantities Estimate

On the basis of priliminary highway design on a map using a scale 1 to 3,000, the construction quantities are estimated.

5.3.1 Material Quantity

(1) Excavation and filling volume

From the viewpoint of the balance between excavantion volume and embankment fill volume, it is approximately equal, but from a comparison of each section, in the mountainous area, the excavation volume is larger than embankment fill volume. Generally speaking, since there is a large excavation volume in the mountainous area, there is no need to establish a borrow pit or spoil bank, but taking into account stage construction a borrow pit will be established along the Outer Ring Road area and a spoil bank will be established on the Gurney Drive area. The soil conversion factor of soil and rock is 0.9 and 1.5 respectively with the total volume of excavation being 2,685,000 m^3 (1,400,000 x 0.9 + 950,000 x 1.5) and for embankment volume, 2,500,000 m^3. Therefore, a volume of 185,000 m^3 will be used in construction of revetment, pavement, bridge and so forth.

(2) Embankment fill material for reclamation

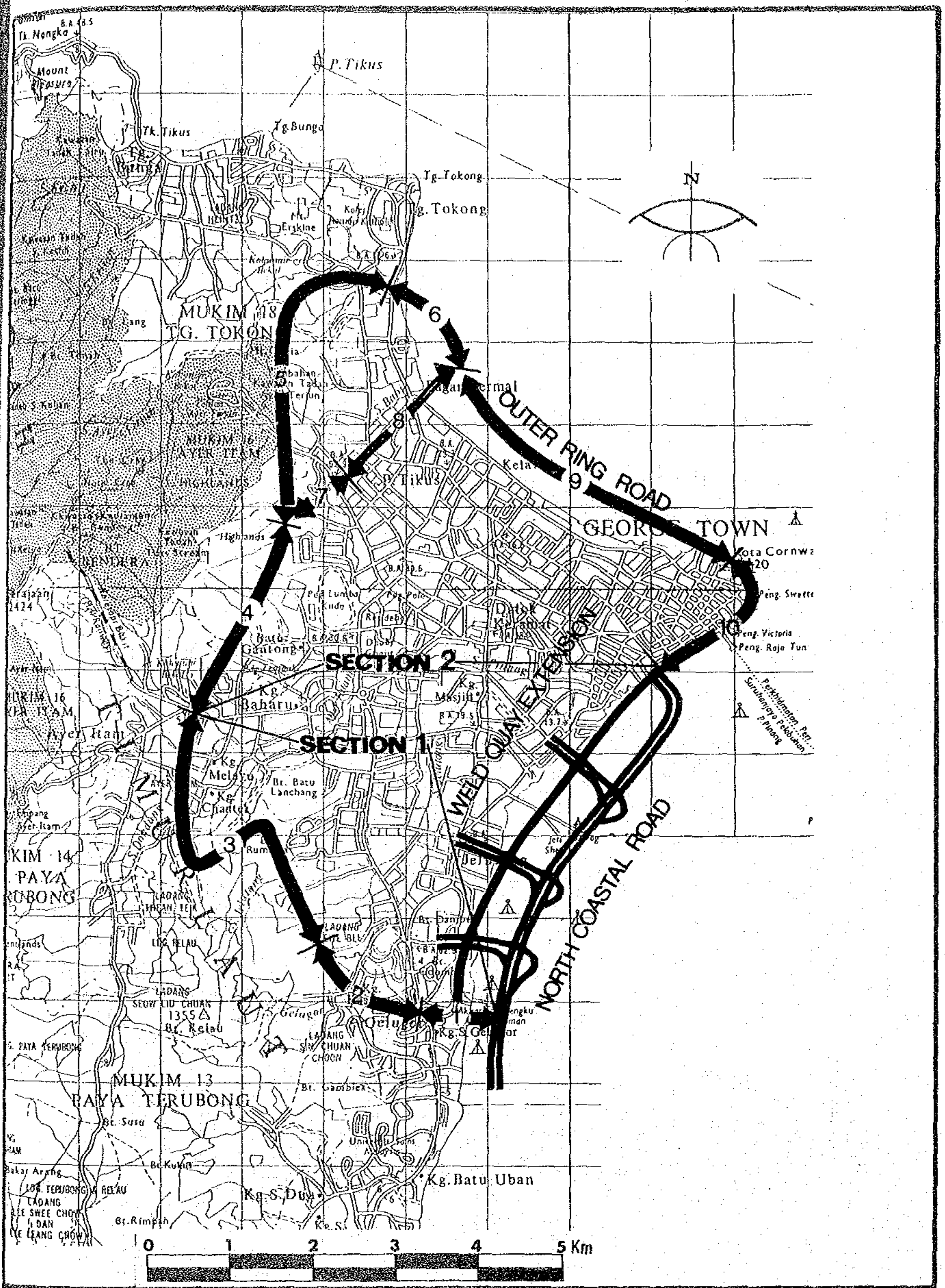
The volume of the embankment fill in the reclamation is about 1,760,000 m^3. These materials can be obtained from the Outer Ring Road project site while the material of revetment for protection of lane can also be obtained from the Outer Ring Road project site.

(3) Pavement material

The total area of pavement in the Outer Ring Road is about 330,000 m^2. Crushed stone will be used as the material of base-course and sub base-course with the volume of crushed stone calculated to be about 130,000 m^3 which will be obtained also from the Outer Ring Road project site.

5.3.2 Construction Quantity by Segment

The construction quantity of all items is calculated by each segment (see Fig. 5.2) as tabulated in Tables 5.5 and 5.6.



URBAN TRANSPORT STUDY	Fig. 5.2 THE ROUTE AND SEGMENTS OF THE PROJECT ROAD

Table 5.5 QUANTITY LIST (4-lane)

Item	Sub-Item	Class	Unit	Quantity									
				Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6	Segment 7	Segment 8	Segment 9	Segment 10
Site Clearance	Residential		M^2	25,400	75,260	0	0	0	0	0	15,000	0	0
	Field		"	0	0	0	0	0	0	0	0	0	0
	Mountain		"	0	0	297,030	80,190	163,130	0	45,670	0	0	0
Excavation	Soil		M^3	18,000	263,800	579,500	168,600	353,000	0	88,000	11,250	0	0
	Rock		"	0	328,800	234,100	162,050	223,500	0	169,400	0	0	0
Embankment	Soil		M^3	12,600	47,650	503,750	30,650	164,200	273,250	13,550	0	1,490,660	0
Slope	Grass		M^2	1,160	12,690	44,520	17,790	29,850	0	9,400	0	0	0
	Concrete		"	0	23,260	23,970	14,480	21,590	0	14,470	0	0	0
Turfing	Side Walk		M^2	1,160	755	0	0	0	1,150	0	1,700	44,500	0
	Open Space		"	0	0	16,450	0	0	0	0	0	157,400	0
Drainage	Roadside	0.5 x 1.0	M	1,600	4,000	4,500	0	1,600	1,150	0	1,900	8,900	4,000
		1.0 x 1.0	"	0	1,100	3,600	2,150	7,000	0	1,120	0	0	0
	Pipe Culvert	ø = 600	"	60	120	468	172	344	92	89	90	360	0
	Box Culvert	3.0 x 3.0	"	0	40	185	0	265	325	0	200	180	0
		5.0 x 5.0	"	0	0	0	0	0	0	0	0	0	0
	Demolishing	0.5 x 1.0	"	0	0	0	0	0	0	0	1,900	0	4,000
Wall	Concrete	H = 1.0	M	0	0	0	200	0	0	0	0	0	0
	Concrete	H = 5.0	"	0	200	200	300	0	200	200	0	0	0
	Masonry	H = 5.0	"	0	0	0	0	0	0	0	0	0	0
	Revetment	Stone	"	0	0	0	0	0	1,150	0	0	4,500	0
	Demolishing	Concrete	"	0	0	0	0	0	0	0	200	0	0
Pavement	Carriageway	Asphalt	M^2	14,200	33,400	90,280	28,440	50,240	18,400	18,400	12,000	71,200	0
	Shoulder	Asphalt	"	2,400	5,400	13,015	4,230	7,080	3,450	2,400	2,250	13,350	0
	Service Road	Asphalt	"	0	0	0	1,800	0	0	0	0	0	0
	Side Walk	Concrete	"	7,400	7,600	3,480	7,480	6,400	11,500	0	6,000	44,500	3,000
	Overlay	Asphalt	"	0	0	0	0	0	0	0	17,000	0	28,000
	Removing	Asphalt	"	0	0	0	0	0	0	0	0	0	0
Additional Facility	Kerb	L = 50	M	1,600	4,000	11,700	4,300	8,600	2,300	2,240	3,400	8,900	4,000
	Central Reserved		"	800	2,000	5,850	2,150	4,300	1,150	1,120	1,700	4,450	2,000
	Guard Rail		"	800	1,000	4,500	2,150	4,300	2,300	0	3,200	8,900	4,000
	Lighting		"	0	0	0	0	0	1,150	0	0	4,450	0
Inter-Section	Lane-Marks		M	800	2,000	5,850	2,150	4,300	1,150	0	1,700	4,450	0
	At-grade		Vol.	1	1	2	0	3	0	0	4	3	3
	Grade Separation		Vol.	1	1	1	0	1	1	1	1	1	0
Bridge	Interchange		Vol.	1	0	0	0	0	0	0	0	0	0
	L = <50		M^2	0	0	1,755	540	0	0	450	0	0	0
	L = >50		M^2	1,800 0	1,800 0	6,600 0	9,630 0	7,380 0	3,600 0	1,800 0	3,600 0	1,800 300	0 0

Table 5.6 QUANTITY LIST (2-lane)

Item	Sub-Item	Class	Unit	Quantity									
				Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6	Segment 7	Segment 8	Segment 9	Segment 10
Site Clearance	Residential		M^2	17,430	40,920	0	0	0	0	0		0	
	Field		"	0	0	0	0	0	0	0		0	
	Mountain		"	0	0	190,690	55,660	118,125	0	35,170		0	
Excavation	Soil		M^3	10,600	204,959	433,244	136,650	272,050	0	64,350		0	
	Rock		"	0	258,800	183,000	140,100	178,700	0	13,200		0	
Embankment	Soil		M^3	8,550	27,200	238,600	15,600	102,160	273,250	6,900		1,009,960	
Slope	Grass		M^2	1,160	11,930	45,450	20,370	30,170	0	9,720		0	
	Concrete		"	0	24,560	26,700	16,720	23,050	0	16,470		0	
Turfing	Side Walk		M^2	1,160	755	0	0	0	1,150	0		0	
	Open Space		"	0	0	16,450	0	0	0	0		146,720	
Drainage	Roadside	0.5 x 1.0	M	1,160	4,000	4,500	0	1,600	1,150	0		9,000	
		1.0 x 1.0	q"	0	1,100	3,600	2,150	7,000	0	1,120		0	
	Pipe Culvert	ø - 600	"	60	80	351	114	229	92	89		0	
	Box Culvert	3.0 x 3.0	"	0	30	155	0	205	325	0		90	
		5.0 x 5.0	"	0	0	0	0	0	0	0		0	
	Demolishing	0.5 x 1.0	"	0	0	0	0	0	0	0		0	
Wall	Concrete	H = 1.0	M	0	0	0	0	0	0	0		0	
	Concrete	H = 5.0	"	0	0	0	300	0	0	0		0	
	Masonry	H = 5.0	"	0	0	0	0	0	0	0		0	
	Revetment	Stone	"	0	0	0	0	0	1,150	0		2,700	
	Demolishing	Concrete	"	0	0	0	0	0	0	0		0	
Pavement	Carriageway	Asphalt	M^2	6,400	16,000	52,440	13,250	25,120	9,200	9,700		46,400	
	Shoulder	Asphalt	"	2,400	6,000	19,665	5,070	9,420	1,725	3,645		8,700	
	Service Road	Asphalt	"	0	0	0	0	0	0	0		0	
	Side Walk	Concrete	"	6,400	3,000	3,480	5,200	6,400	11,500	0		45,000	
	Overlay	Asphalt	"	0	0	0	0	0	0	0		0	
	Removing	Asphalt	"	0	0	0	0	0	0	0		0	
Additional Facility	Kerb	L = 50	M	1,600	4,000	0	4,300	8,600	2,300	2,240		0	
	Central Reserved		"	0	0	0	0	0	0	0		0	
	Guard Rail		"	0	1,000	4,500	2,150	4,300	2,300	0		0	
	Lighting		"	0	0	0	0	0	1,150	0		0	
Inter-Section	Lance-Marks		M	800	2,000	5,850	2,150	4,300	1,150	0		0	
	At-grade		Vol.	2	0	3	0	4	1	1		4	
	Grade Separation		Vol.	0	0	0	0	0	0	0		0	
Bridge	Interchange		Vol.	0	0	0	0	0	0	0		0	
	L = < 50		M^2	0	0	405	270	0	0	0		0	
	L = > 50		M^2	0	0	1,350	4,050	4,050	0	0		0	

5.4 Construction Cost

5.4.1 Road Construction Cost

Road construction cost includes earthwork, pavement drainage, concrete wall and culvert pipes and box. Construction cost of segment 2 and 7 is higher by about four (4) million dollars per kilometer, due to excavation of a big volume of scattered rocks in these segments being very costly. The construction of other sections is about 2.0-2.5 million dollars per kilometer.

In order to decrease construction cost in the mountainous area, the cutting volume should be decreased as far as possible. However the bridge length needs to be longer if the road is so located as to decrease the cutting volume.

5.4.2 Bridge Construction Cost

The structure cost relates to only the bridge construction estimated by each type such as simple girder 30 meters span, simple girder 40 meters span, three span continuous girders and so on.

The bridge construction cost by area size is estimated at about 630 dollars per square meter to 810 dollars per square meter.

5.4.3 Reclamation Cost

Reclamation cost consists of the embankment fill of reclamation and the revetment of seaside of which all materials for reclamation are obtainable from the other segments of the road.

5.4.4 Construction Cost Estimate

All of these construction costs are summed up by each Road segment and tabulated as shown in Table 5.8 (in the case of 2 lane) and Table 5.9 (in the case of 4 lane).

Total construction cost by plan is shown in Table 5.7 while the construction cost of segment 1 by alternative plans is shown in Table 5.10.

Table 5.7 CONSTRUCTION COST BY PLAN

(in '000 M$)

Item Access to North Coastal Road Plan			Base Cost	Others			Tax	Total
				Over head	Profit	Contingency		
Plan 1	4 lane	Partial	67,375.2	6,737.52	6,737.52	3,368.76	4,732	88,951
		Full	67,578.4	6,757.84	6,757.84	3,378.92	4,745	89,218
	2 lane	Partial	48,504.8	4,850.48	4,850.48	2,425.24	2,978	63,609
		Full	48,708.0	4,870.80	4,870.80	2,435.40	2,991	63,876
Plan 2	4 lane	Partial	73,362.4	7,336.74	7,336.24	3,668.12	5,089	96,792
		Full	73,565.6	7,356.56	7,356.56	3,678.28	5,102	97,059
	4 lane	Partial	51,958.4	5,195.84	5,195.84	2,597.92	3,429	68,377
		Full	52,161.6	5,216.16	5,216.16	2,608.08	3,442	68,644

Note: Plan 1 : Segment 1, 2, 3, 4, 6, 7, 8, 9, 10.

Plan 2 : Segment 1, 2, 3, 4, 5, 6, 7, 9, 10.

Table 5.8 CONSTRUCTION COST BY SEGMENT

(2-lane)

(in '000 M$)

Item / Segment	Length (m)	Construction Cost: Road F.C	Road L.C	Road Tax	Road Total	Bridge F.C	Bridge L.C	Bridge Tax	Bridge Total	Reclamation F.C	Reclamation L.C	Reclamation Tax	Reclamation Total	Land Acquisition and Compensation	Total Cost: Total (F.C + L.C)	Total F.C	Total L.C	Tax	Total
Segment 1	700	1,063	1,235	110	2,408	323	216	29	568	0	0	0	0	1,712	4,549	1,386	3,163	139	4,688
Segment 2	2,000	2,579	4,033	332	6,944	323	216	29	568	0	0	0	0	3,685	10,836	2,902	7,934	361	11,197
Segment 3	5,900	3,923	4,969	445	9,337	1,692	1,612	149	3,453	0	0	0	0	13,288	25,484	5,615	19,869	594	26,078
Segment 4	2,100	1,724	2,514	221	4,459	2,300	1,434	203	3,942	0	0	0	0	5,874	13,846	4,024	9,822	429	14,275
Segment 5	4,300	3,070	4,331	370	7,771	1,682	1,191	145	3,018	0	0	0	0	6,278	16,552	4,752	11,800	515	17,067
Segment 6	1,150	635	700	72	1,407	399	266	35	700	1,154	1,523	172	2,849	0	4,677	2,188	2,489	279	4,956
Segment 7	1,200	558	670	62	1,290	403	269	36	708	0	0	0	0	387	2,287	961	1,326	98	2,385
Segment 8	1,600	0	0	0	0	723	482	64	1,269	0	0	0	0	0	1,205	723	482	64	1,269
Segment 9	4,390	1,453	2,682	194	4,329	399	266	35	700	6,093	7,302	798	14,193	0	18,195	7,945	10,250	1,027	19,222
Segment 10	2,100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 5.9 CONSTRUCTION COST BY SEGMENT

(4-lane)

(in '000 M$)

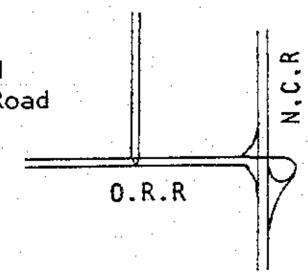
Item / Segment		Construction Cost: Road F.C.	Road L.C	Road Tax	Road Total	Bridge F.C.	Bridge L.C.	Bridge Tax	Bridge Total	Reclamation F.C	Reclamation L.C	Reclamation Tax	Reclamation Total	Land Acquisition and Compensation	Total Cost: Total (F.C + L.C)	Total F.C	Total L.C	Tax	Total
Segment 1	700	1,229	1,333	126	2,688	646	431	57	1,134	0	0	0	0	2,331	5,970	1,875	4,095	183	6,153
Segment 2	2,000	3,568	5,357	446	9,371	646	431	57	1,134	0	0	0	0	5,662	15,664	4,214	11,450	503	16,167
Segment 3	5,900	5,507	6,560	607	12,674	3,385	3,224	298	6,907	0	0	0	0	16,433	35,109	8,892	26,217	905	36,014
Segment 4	2,100	2,144	2,998	265	5,407	4,600	2,869	415	7,884	0	0	0	0	9,757	22,368	6,744	15,624	680	23,048
Segment 5	4,300	3,937	5,310	462	9,709	3,363	2,381	290	6,034	0	0	0	0	9,056	24,047	7,300	16,747	752	24,799
Segment 6	1,150	876	901	97	1,874	798	532	70	1,400	1,154	1,523	172	2,849	0	5,784	2,828	2,956	339	6,123
Segment 7	1,200	1,646	2,528	212	4,386	807	538	71	1,416	0	0	0	0	476	5,995	2,453	3,542	283	6,278
Segment 8	1,600	647	833	83	1,563	1,445	963	127	2,535	0	0	0	0	16,905	20,793	2,092	18,701	210	21,003
Segment 9	4,390	2,860	4,044	621	7,525	798	532	70	1,400	6,712	7,773	848	15,333	0	22,719	10,370	12,349	1,539	24,258
Segment 10	2,100	583	1,052	103	1,738	0	0	0	0	0	0	0	0	0	1,635	583	1,052	103	1,738

Table 5.10 CONSTRUCTION COST OF SEGMENT 1

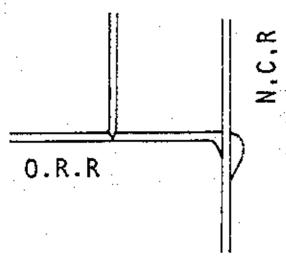
(in 1,000 M$)

Items Type	Length (m)	Cosntruction Cost												Land Acquisition and compensation	Total Cost			
		Road				Bridge				Reclamation								
		F.C	L.C	Tax	Total	F.C	L.C	Tax	Total	F.C	L.C	Tax	Total		F.C	L.C	Tax	Total
4-Lane																		
F	700	1,229	1,333	126	2,688	646	431	57	1,134	0	0	0	0	2,331	5,970 1,875	4,095	183	6,153
P-1	700	953	1,110	101	2,164	646	431	57	1,134	0	0	0	0	2,331	5,470 1,599	3,872	158	5,629
P-2	700	1,119	1,189	113	2,421	646	431	57	1,134	0	0	0	0	2,331	5,716 1,765	3,951	170	5,886
N	400	289	321	28	638	646	431	57	1,134	0	0	0	0	1,561	3,252 935	2,317	85	3,337
2-Lane																		
F	700	1,063	1,235	110	2,408	323	216	29	568	0	0	0	0	1,712	4,549 1,386	3,163	135	4,684
P-1	700	787	1,012	85	1,884	323	215	29	568	0	0	0	0	1,712	4,050 1,110	2,940	114	4,165
P-2	700	953	1,091	97	2,141	323	216	29	568	0	0	0	0	1,712	4,295 1,276	3,019	126	4,421
N	400	234	303	22	559	0	0	0	0	0	0	0	0	1,005	1,542 234	303	22	1,564

TYPE F



TYPE P-1



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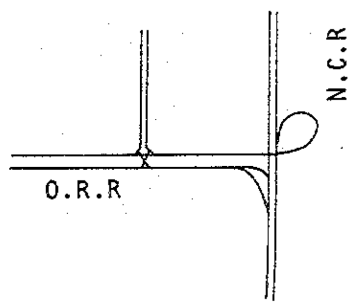
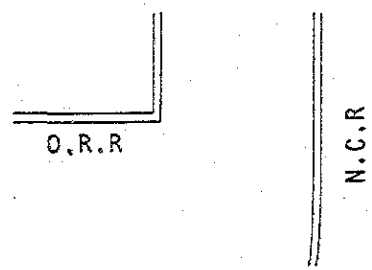


TYPE N



O.R.R: Outer Ring Road
N.C.R: North Coastal Road

5.5 Land Acquisition Cost and Compensation

5.5.1 Land Acquisition

(1) General

In the areas affected by the Project Road, the landuses range from residential areas and commercial areas to hill land. The values used in the study are decided upon after discussion with the authorities from the Land Valuation Office with confirmation from the Technical Committee. It must be noted that not only does the land values differ by the type of landuses but also by the location and function of any road in relation to the land. For example, land behind a wide road will have a higher value than behind a small road. In this report, the cost is estimated by area and different lots of varying values are grouped together and therefore the acquisition cost may not reflect the true value of any of the types of landuse.

(2) Procedure

In order to obtain the value of the land along the route of the Outer Ring Road, a survey is done to place a value on the land affected.

The length of the right of way of the road is used as a measure to estimate the land to be acquired. A type of cross-section is set up at every 100 meters along the Outer Ring Road. The right of way area is calculated by the following method.

$$\frac{W1 + W2}{2} \times \text{Distance between Cross-Section} = \text{Right of Way Area}$$

W1 = Width of Right of Way of Cross-Section of first 100 m.

W2 = Width of Right of Way of Cross-Section of second 100 m.

The cost of the land per sq. meter varies according to the type and condition of the land. For the purpose of calculating the acquisition costs of land, the average unit cost for different landuse is estimated. For instance, the hilly area behind Island Glades is estimated at $22 per sq. m., the area behind the Batu Gantong Chinese Cemetery is valued at $11 per sq. m. and the area behind the Mt. Erskine cemetery is valued between $16 and $22 per sq. m. The result of land acquisition cost estimation are as follows:

Table 5.11 SUMMARY OF LAND ACQUISITION COST BY SEGMENT

Unit : M$

Segment	Land Acquisition Cost	
	4-lane	2-lane
1	2,330,790	1,711,710
2	3,675,970	2,374,380
3	13,804,620	11,553,390
4	6,789,960	3,916,020
5	5,442,220	3,892,800
6	-	-
7	475,970	386,870
8	11,947,500	-
9	-	-
10	-	-

5.5.2 Compensation

(1) General

It is imperative to study the landuse and type of buildings that exist in the route way of the Outer Ring Road in order that reasonable compensation can be given for these buildigns that are affected adversely by the Outer Ring Road resulting in their demolition. This study looks into the subject of compensation costs which is taken to mean the suitable payment which is given to make up for the loss of house, land and all the non-tangible benefits that were enjoyed in terms of convenience, attachments formed, and etc.

(2) Procedure

a. Survey of affected Buildings
In order to obtain the value of residences affected along the Outer Ring Road, a survey is done to count the number of houses and to catagorise them according to type. All houses that are located along a distance of two lots from the existing road are denoted as affected buildings. These are identified on a map of

scale 1 : 3000 and the data documented according to location, type of building, distance of building to new road, landuse, building use, number of storeys and condition of building.

b. Categorisation of Area

Being aware of the fact that the value of houses varies greatly according to location, not only is the categorisation made according to terrace, semi-detached and detached houses but also by area, that is, within the city limit and outside of the city limits.

After an assessment of the whole course of the route of the Outer Ring Road, most of the affected buildings are in the following areas:

1) Ayer Itam
2) Jalan Batan Jermal/Jalan Gottlieb
3) Jalan Kelawai/Jalan Northam
4) Gurney Drive
5) Waterfall Road
6) Jalan Tnajong Tolong/Fettes Road

The first four areas are those within the city limit where the value of detached houses is very high. The last two areas are out of the city limit where the value of detached houses is of a low or medium value.

c. Value of Affected Residential Units

In order to obtain the value of the affected residential units, the average area is first estimated and then multiplied by the average cost per sq. ft. These also differed in terms of whether the location is in or out of the city limit. The following table shows the method by which the average cost of houses (excluding land cost) is estimated.

It must be brought to attention that there is no difference indicated between the area size of houses within the city limit and those outside of it. Also, only detached houses have been classified in terms of size and cost per unit. This is due to the vast difference in size that exists among detached houses that should not be overlooked.

The average unit cost of house by each type is shown in Table 5.12.

The cost by segment is shown in Table 5.13.

Table 5.12 UNIT COST OF HOUSE

Location	Type of House	Unit Cost Per Sq. Ft. (M$)	Average Area of House (sq.ft)	Average Cost of House (M$)
Within City Limit	1. Terrace	29	Single-Storey - 800 Double-Storey - 1,600	23,200 46,400
	2. Semi-detached	36.5	Single-Storey - 1,500 Double-Storey - 3,000	54,750 109,500
	3. Detached	42.5	Single-Storey - Low - 1,000 Medium - 1,500 High - 2,400 Double-Storey - Low - 1,500 Medium - 2,250 High - 3,600	Low - 42,500 Medium - 63,750 High - 102,000 Low - 63,750 Medium - 95,625 High - 153,000
Out of City Limit	1. Terrace	26	Single-Storey - 800 Double-Storey - 1,600	20,800 41,600
	2. Semi-detached	32.5	Single-Storey - 1,500 Double-Storey - 3,000	48,750 97,500
	3. Detached	38	Single-Storey Low - 1,000 Medium - 1,500 High - 2,400 Double-Storey Low - 1,500 Medium - 2,250 High - 3,600	Low - 38,000 Medium - 57,000 High - 91,200 Low - 57,000 Medium - 85,000 High - 136,800

Table 5.13 SUMMARY OF COMPENSATION COST BY SEGMENT

Segment	Compensation Cost (M$)	
	4-lane	2-lane
1	0	0
2	1,987,000	1,311,400
3	2,628,000	1,734,500
4	2,967,000	1,958,200
5	3,614,000	2,385,200
6	0	0
7	0	0
8	4,957,000	0
9	0	0
10	0	0

5.6 Project Cost Estimate

The project cost consists of the construction cost, and acquisition cost, compensation and detailed engineering and supervision fees.

Detailed engineering and supervision fees is estimated as about 9,300 thousands Malaysian Dollars in this study.

The project cost by plan is shown in Table 5.14.