

5.4 INTERCHANGE PLAN AND DESIGN

5.4.1 Introduction

1) Study Approach

The main advantages of interchanges are :

- (1) The capacity of the through traffic lanes within the interchange can be made to approach or equal that outside the interchange.
- (2) Increased safety is provided for through and right turning traffic. Left turning movements make its same maneuver as on at-grade intersection that generally on a much higher type facility, which also results in greater safety.
- (3) Stops and appreciable speed changes are eliminated for through traffic. Drivers making turning movements usually slow down, but not excessively on adequately designs facilities. Overall, the ability to keep moving results in large savings in time and in vehicle operating cost and adds to the comfort and convenience of the motorist, and so forth.

On the other hand, there are some disadvantages derived from cost consideration and the practical aspect of providing desirable designs in areas of limited right-of-way and in difficult terrain. Therefore the interchanges should be planned and designed carefully.

Figure 5-4-1 shows a general approach of the interchange planning. Interchange locations are basically determined based on the functional highway network configuration taking into account traffic demand. And interchange types will be examined according to the class of highway crossing and toll levy system. Already general types of interchange have been established, which can be referred. The main issue on the interchange planning is how to provide desirable designs in the limited condition mentioned above. Preparation of the alternatives and then comparative evaluation will help to justify an interchange plan proposed.

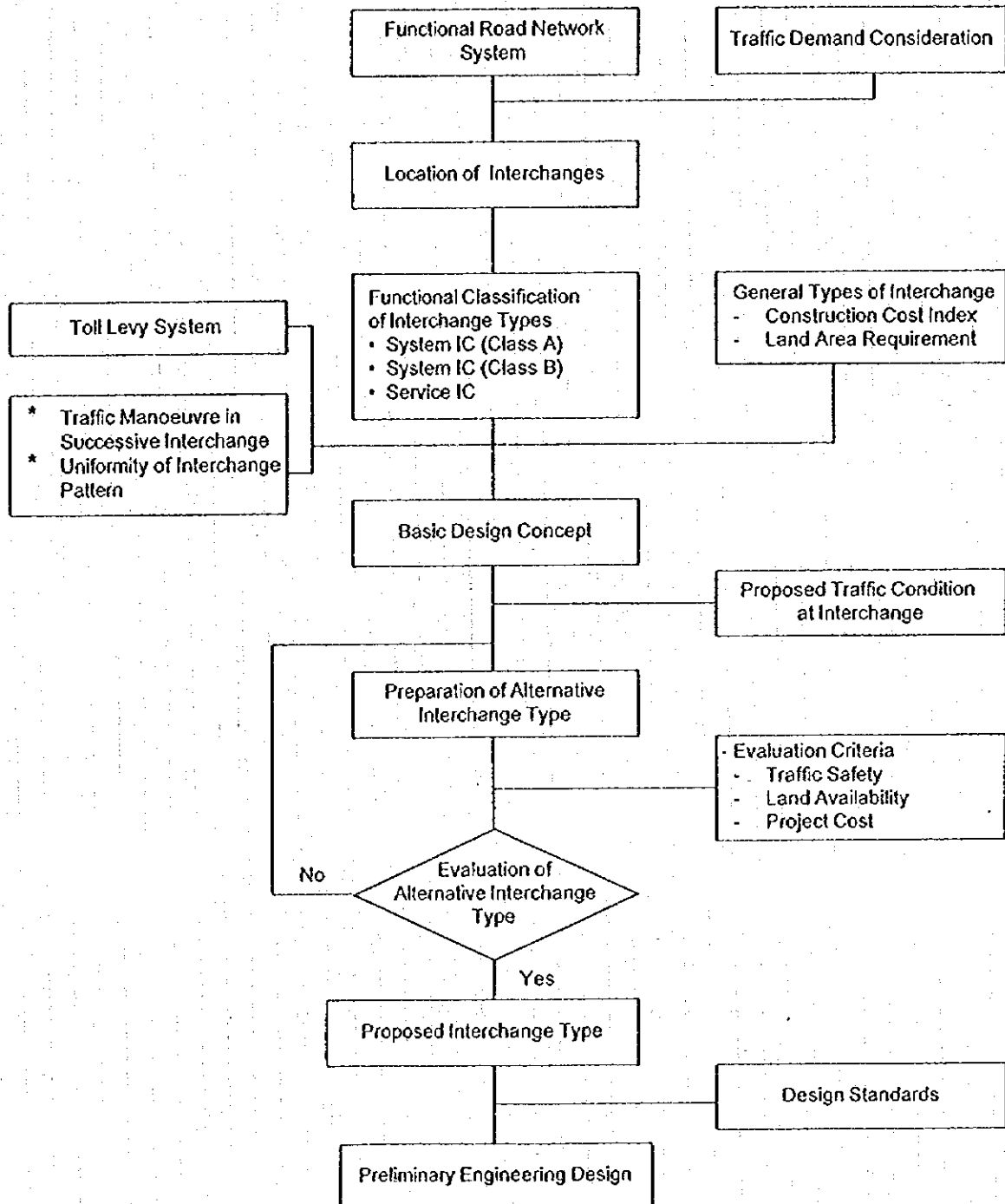


Figure 5-4-1 : General Approach of Interchange Planning

5.4.2 Classification of Interchange by Function

Interchange types can be divided into two categories, namely system interchange which connects an expressway or access control road to another access control road, and service interchange which connects an access control road to lesser facilities (such as primary, secondary, or local roads). A classification of interchange type according to crossing class of roads referred from "JKR Arahan Teknik (Jalan)" is show in Table 5-4-1.

Table 5-4-1 : Classification of Intersection Types by Function

According to Class of Roads Crossing.

(a) Rural Area

Expressway	Highway	Primary	Secondary	Minor	
					Expressway
			S.C. / S.C.	S.C.	Highway
		S.I.	S.I. / S.C.	S.C.	Primary
			S.C.	S.C.	Secondary
				S.C.	Minor

(b) Urban Area

Expressway	Arterial	Collector	Local Street	
				Expressway
		S.I.	S.I. / S.C.	Arterial
		S.I.	S.I.	Collector
			S.I.	Local Street

LEGEND :

I.C. : Interchange
 (System Interchange Class A Service Interchange)
 System Interchange Class B

S.I. : Signalized Intersections

S.C. : Stop Control

Source : JKR Arahan Teknik (Jalan)1287 - A guide to the design of Interchanges

System interchanges can be further subdivided into two classes, that is, system interchange - Class A which connects an expressway to another expressway and system interchange - Class B which connects an expressway to highway/arterial or a highway to another highway.

The former requires a high design speed so that directional or semi-directional ramps are preferred to loop ramps. Manoeuvres on at-grade intersection will not be acceptable because of the lower design speed compared to that of system interchange - Class A.

For service interchange, i.e., an interchange between an expressway or highway and lesser facilities which do not require a high mobility, an interchange type costing lesser and requiring smaller land area such as a diamond type is usually preferred to cloverleaf type.

Analysis for interchange type determination are made at the three types provided by system interchange - Class A, system interchange Class B and system interchange respectively.

5.4.3 General Types of Interchanges

Typical three-leg interchanges are trumpet and three-leg directional interchanges, and typical four-leg interchanges are diamond, cloverleaf and directional interchanges.

Diamond interchanges have numerous other configurations incorporating frontage roads and continuous collector or distributor roads. Diamond type interchanges with multiple levels may also be considered in urban area where space is limited.

A partial or half cloverleaf configuration containing cloverleaf loops and diagonal ramps configuration can be readily modified to follow the predominant traffic flow direction. A full cloverleaf has an independent ramp for each interchanging movement. Weaving maneuvers are generated on the stretch between loops. Therefore, contemporary full cloverleaf designs usually incorporate collector or distributor roads.

Directional ramps are generally required at the interchanges of high volume expressway in order to ensure high speed and high capacity without weaving. Directional interchange design is the assembly of one or more of the basic types of ramps. Generally, ramp connections are classified into the following four types as shown in Figure 5-4-2.

i) Outer Connection

It diverges from the left lane of through lane and merges to another through lane from the left. This type is always adopted for the left-turning ramp.

ii) Semi-direct Ramp

It diverges from the left lane of throughway and turns to the right. This type has the advantage in observing the left diverging rule.

iii) Direct Ramp

It diverges from the right lane of through lane and turns to the right. This type is usually used to manage heavy and high speed traffic.

iv) Loop

It diverges from the left lane of through lane and turns to the right by a 270 degree left turn. This type is generally used for minor and low speed traffic flow.

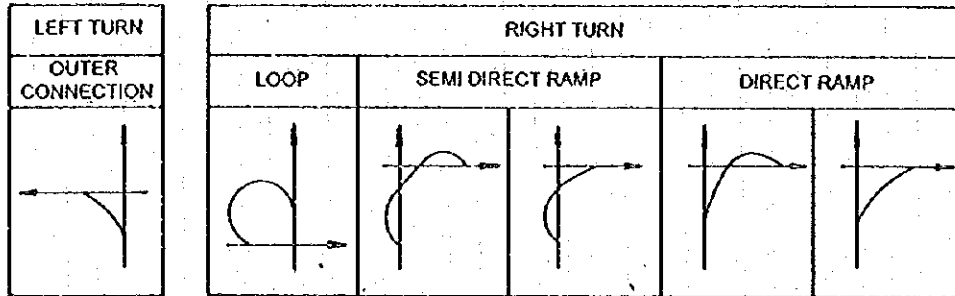


Figure 5-4-2 : Type of Ramp Connection

The layout for any specific ramp and type of traffic movement will reflect site conditions of topography and culture, cost and the degree of flexibility in traffic operation desired.

System interchange must provide high mobility for the traffic using expressways. Design speed of ramp way configuring system interchange, according to the "Arahan Teknik (Jalan)", is at least half of through lane design speed. Design speed of the expressway network is planned to be 100km/h. So the design speed of ramp way must ensure movement at 50km/h. In the case of having a loop ramp system interchange it will require a 125m minimum curve radius and excessive land area.

(1) Three Leg Interchange

Figure 5-4-3 shows several interchange types for 3-leg designs. Among these interchange types, alternative designs consisting of trumpet type from single -structure type shown in Figure 5-4-3 (A) and the types shown in Figures 5-4-3 (D) and 5-4-3 (F) from multiple structure types are chosen for comparative analysis because the design shown in Figures 5-4-3 (B) expressway at the same time and a three-level structure has no obvious advantage such as the need to construct an interchange in adverse topographic condition in the study road corridor, these costly structures are not considered as alternatives from the beginning. Figure 5-4-3 (G) is also neglected from standpoint of traffic safety in the weaving section hindsight.

(2) four leg interchange

A typical four leg interchange is cloverleaf interchange shown in Figure 5-4-4 -A-. It is a type of complete interchange which does not include at-grade crossing, but all right turning movements is treated by loop. It needs only one grade separation structure, but it needs

considerable wide land area.

For the traffic operational view point it contains weaving section between entrance and exit of loop which sometimes causes bottleneck at this intersection. And diverging and merging occur alternatively four times for through traffic. It is sometimes difficult to guide motorists properly to diverge and merge. To improve this faults collector-distributor lane is provided for main traffic flow as shown in Figure 5-4-4 -B-.

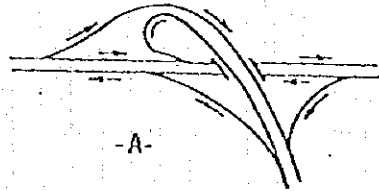
The second group of interchange is one that treat right turning movement by directional ramp. It can offers high speed running and high capacity. Therefore it is suitable type for system interchange (A). Figure 5-4-4 -C- shows full directional interchange. It need one but four level grade separation structure. Figure 5-4-4-D- shows so called turbine interchange. It needs many grade separation structure at several crossing points.

The third group of interchange is combination of loop ramp and directional ramp to treat right turning movement. It has advantage of cloverleaf and directional interchange as well. It can eliminate weaving section but needs only a few grade separation structures. It is also suitable type for system interchange (A), with it high speed running condition on directional rampway and high capacity.

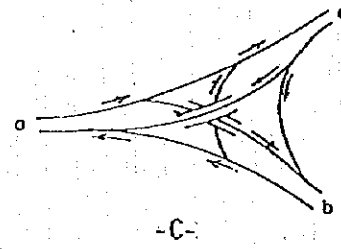
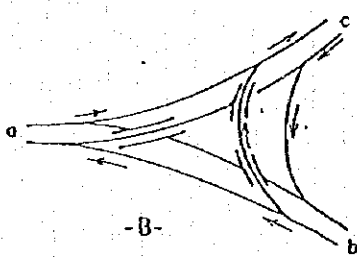
Another interchange type is so called double trumpet. It consists two trumpet shape connection as shown in Figure 5-4-3 -A- to expressway and to connecting roads. Connecting roads can be expressway, but commonly highway and primary road. It is used as service interchange. It contains weaving section between two trumpet. But, it is suitable type for toll road as toll booths can be installed at one location.

Among the many types of interchange configurations, ten (10) basic types considered to be practical for application to the study roads are shown in Table 5-4-2. A general comparison of their salient features, construction cost index and land area requirement is also summarized in Table 5-4-2. The cost index cover the relative cost of interchange types using a diamond types as base for system interchange on one hand, and a single structure trumpet for system interchange - Class A on the other hand.

Single Structure Trumpet



3-leg Directional



3-leg Semi-directional

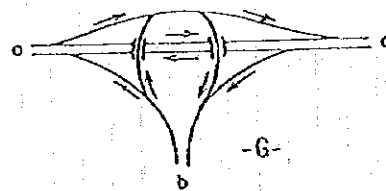
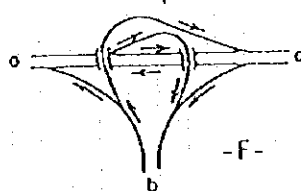
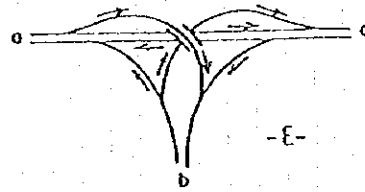
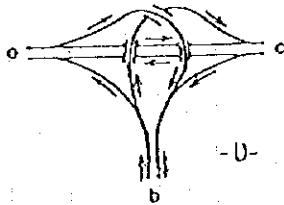
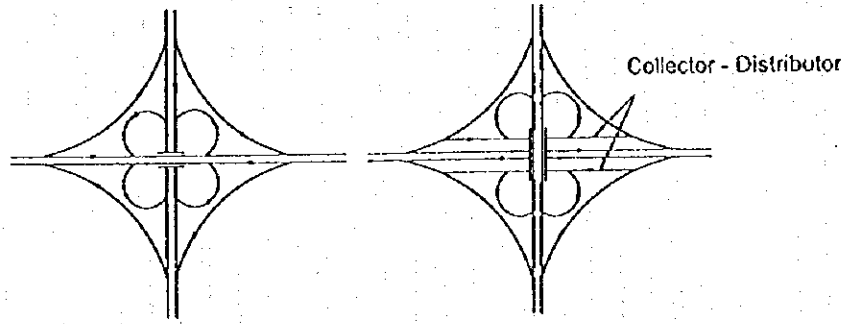


Figure 5-4-3 : Typical 3-leg Interchanges

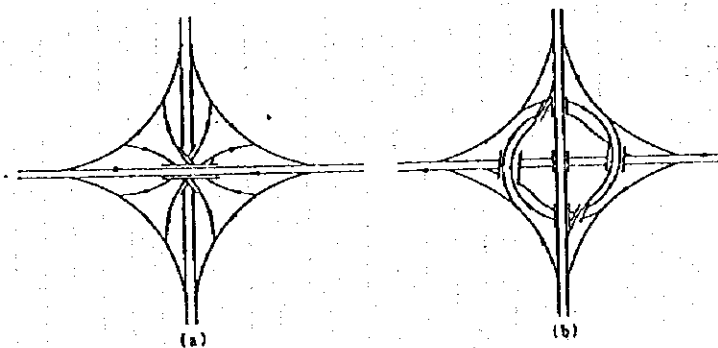
Cloverleaf Interchange



-A- Typical

-B- With Collector - Distributor

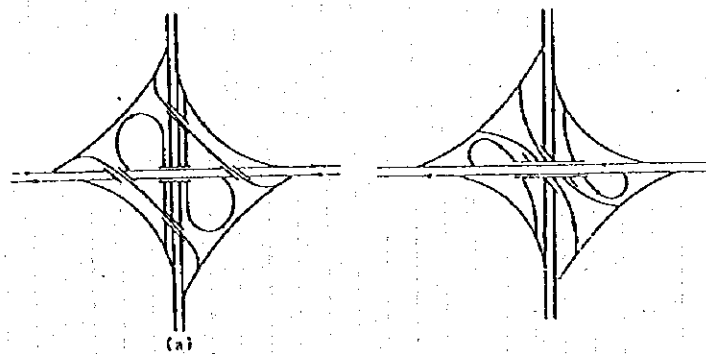
Directional Interchange



-C- Full Directional

-D- Turbine

Combination

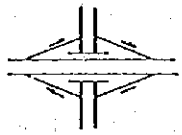
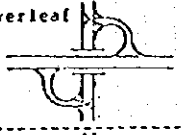

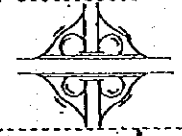
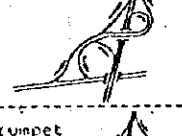

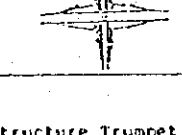

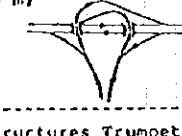
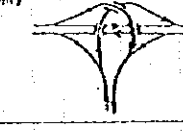


-E-

-F-

Figure 5-4-4 : Types 4 leg Interchanges

Table 5-4-2 : Typical Configuration of Some Practical Types of Interchanges and their Characteristic

Layout Configuration		Salient Features	(1) Construction Cost Index	(2) Land Area (ha)
SERVICE IC AND SYSTEM IC - CLASS B (4 LEGS)	1. Diamond 	Turning movements on minor road may be controlled by signals. Traffic detour distance is shortest	1.00	4.0
	2. Half Cloverleaf 	Its two loop ramps configuration is readily adaptable to allow free movement in predominant direction. Turning movements on minor road may be controlled by signals	1.05	5.1
	3. Full Cloverleaf 	Its four loop ramps configuration allows free movement in all directions. There are two entrances and two exits on throughway. Weaving occurs between loop ramps	1.29	6.8
	4. Full Cloverleaf with collector-distributor roads 	Free movement in all directions through four loop ramps. There is only one entrance and one exit on throughway. No weaving	1.79	9.0
	5. Trumpet 	Loop ramp occurs at one point. Turning movement on minor road may be controlled by signals. Favourable configuration if there is great difference between traffic volume by direction. Toll gates can be located at a single point	1.56	7.5
	6. Double Trumpet 	Loop ramps occur at two points. All turning movements pass through one point. There is weaving traffic but toll gates can be located at a single point. No signalisation is necessary	1.09	10.5
	7. Three-level Diamond 	Allows free movement for through traffic of crossing roads. Can increase interchange capacity efficiently in an area with limited space	3.27	4.0
SYSTEM IC - CLASS A (3 LEGS)	8. Single Structure Trumpet (R = 125m) 	A simple structure commonly used for 3-leg intersection. Requires a large area which is influenced by the minimum curve radius due to design speed	1.00	15.4
	9. Two Structures Trumpet (R = 125 m) 	Separate roadways are provided for each right turning movement with two 2-level structures separating the ramps from through traffic	1.01	14.0
	10. Three Structures Trumpet (R = 125m) 	Two double jug-handle configuration usually applies where the crossing road is of considerable importance too. Requires the use of three structures thereby reducing land area	1.06	10.6

- Note: (1) In the case of service interchange and system interchange-Class B, cost index is the relative cost of other interchange types when compared to diamond type taken as 1.00; in the case of system interchange type is compared to that of single structure trumpet (R=125m) when the later's cost index is taken to be 1.00.
- (2) All interchanges are compared on equal basis with regards to all factors influencing the construction of the interchanges on flat terrain.

5.4.4 Proposed Interchanges and Traffic Demand on the KLORR

Interchanges of Kuala Lumpur Outer Ring Road (Expressway) with the other road are studied and thirteen (13) interchanges are identified based on the future highway network configuration. Table 5-4-3 and Figure 5-4-5 shows the proposed interchanges with the classification and Figure 5-4-6 shows future traffic volume on the interchanges.

Table 5-4-3 : Proposed Interchanges and their Classification

IC No.	Location	Connecting Road	Classification of the Connecting Road	Classification of Interchange
1	Rawang	North - South Expressway	Expressway	System (A)
2	Templer Park	Federal Route 1 (Jln. Ipoh)	Highway	System (B)
3	Batu Dam	State Road B23 (Jln. Ulu Yam)	Primary	Service
4	Gombak	KL - Karak Highway	Highway	System (B)
5	Ulu Langat	Ampang Elevated Highway Network	Highway	System (B)
6	Ulu Langat	State Road B52 (Jln. Ulu Langat)	Highway	Service
7	Ulu Langat	East - West Link Detention	Primary	System (B)
8	Kajang	Federal Route 1 (Jln. Semenyih)	Highway	System (B)
9	Kajang	KL - Seremban Expressway	Expressway	System (A)
10	Putra Jaya	Putra Jaya Urban Motorway	Urban Expressway	System (B)
11	Putra Jaya	Damansara-Puchon Road	Primary	Service
12	Putra Jaya	Putra Jaya Service Road	Primary	Service
13	Kuala Langat	North-South Central Link Expressway	Expressway	System (A)

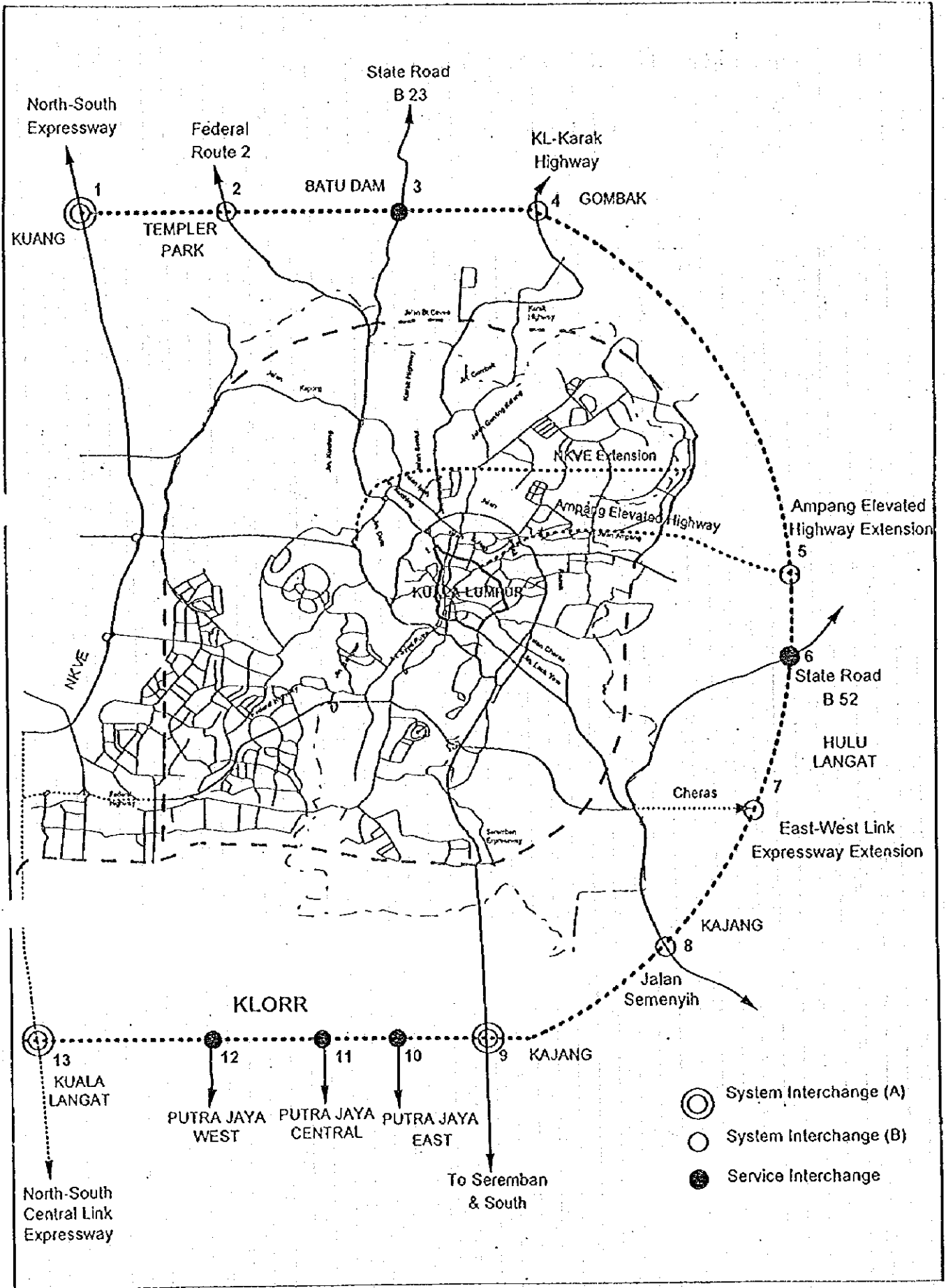


Figure 5-4-5 : Location of the Interchanges on the Project Road

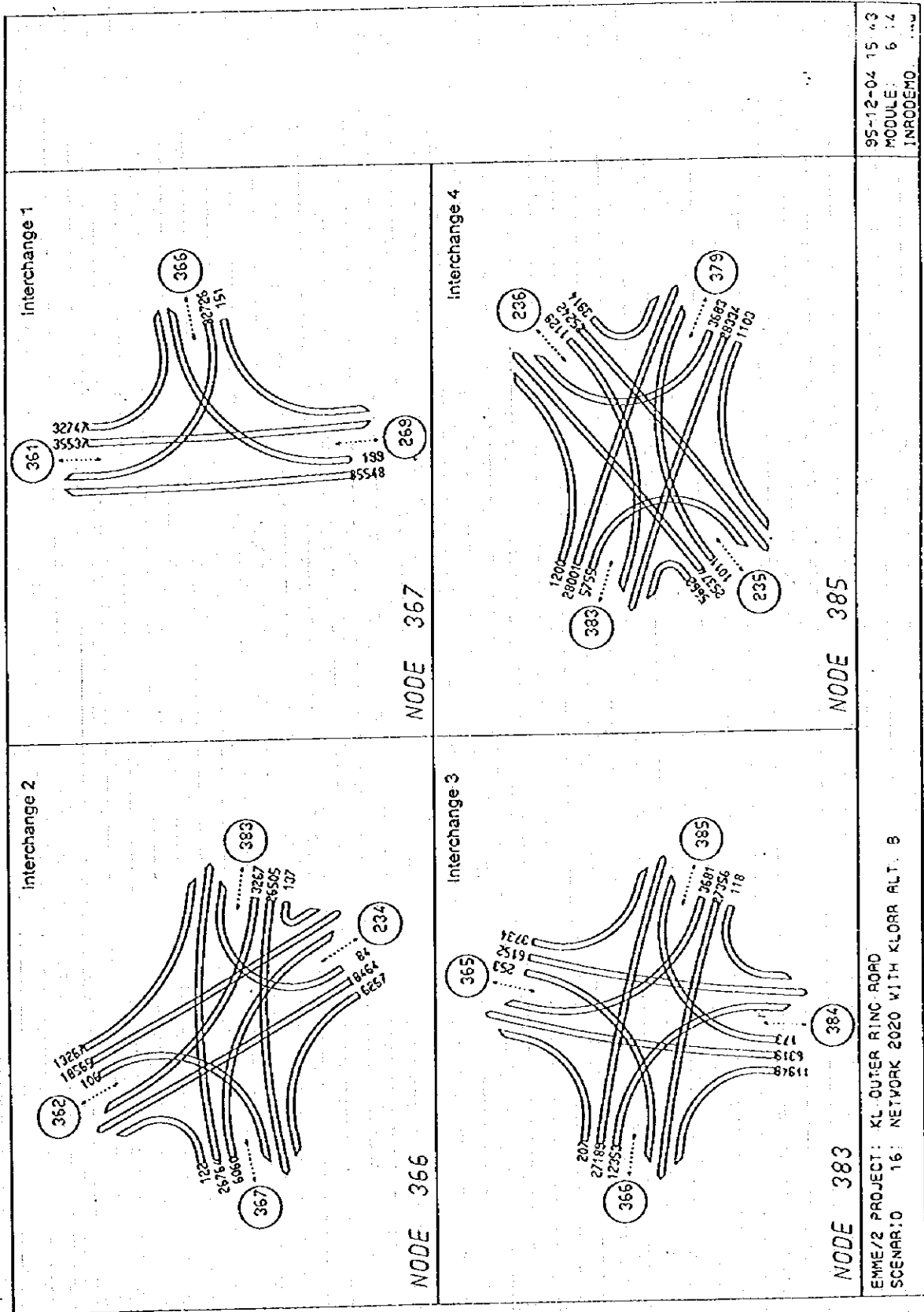


Figure 5-4-6 : Traffic Volume on Intersections

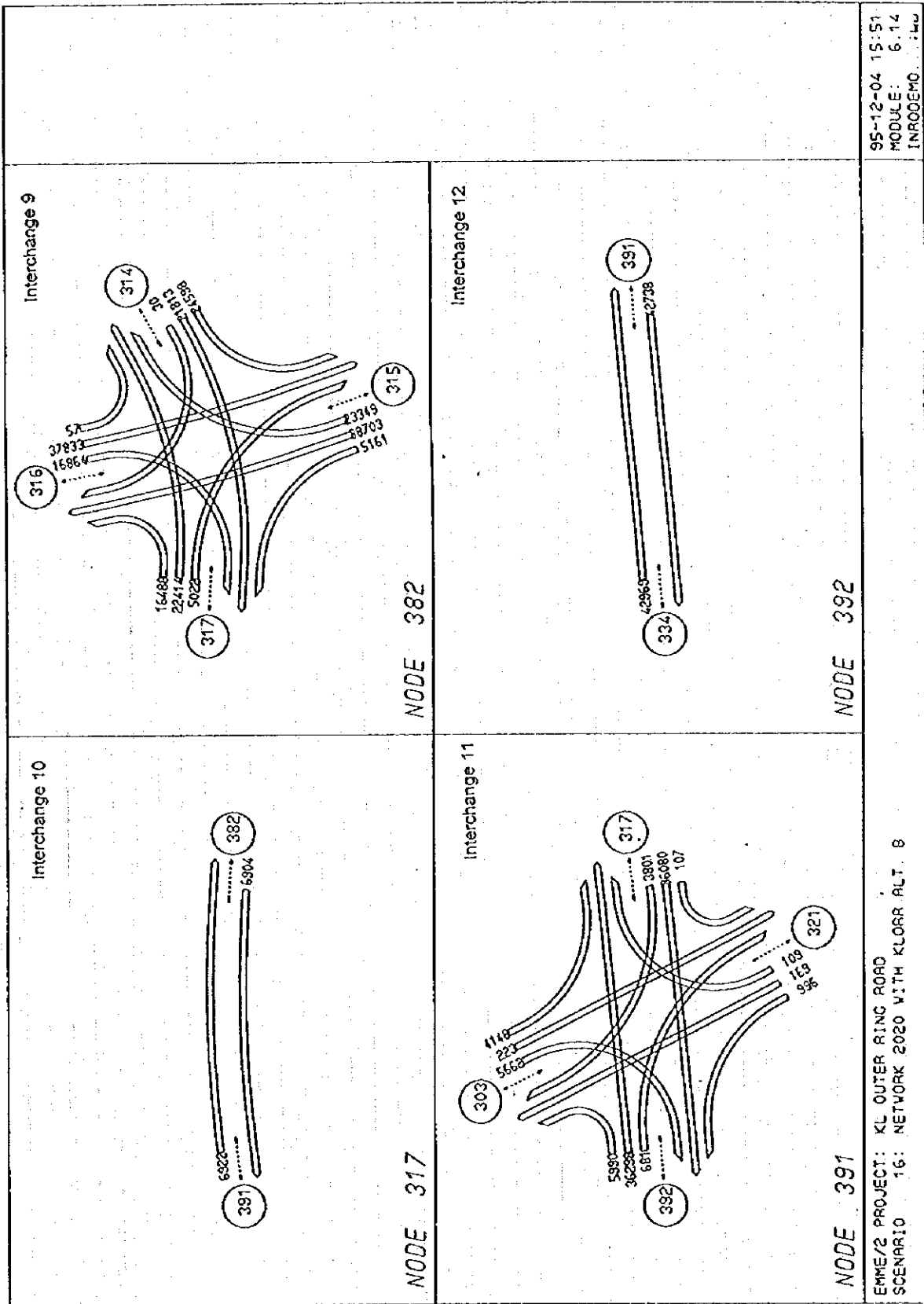


Figure 5-4-6 : Traffic Volume on Intersections (continued)

<p>Interchange 13</p> <p>NODE 334</p>			<p>95-12-04 15:51 MODULE: 6.14 INRODEMO...140</p>
<p>EMME/2 PROJECT: KL OUTER RING ROAD SCENARIO 16: NETWORK 2020 WITH KLORR ALT. B</p>			

Figure 5-4-6 : Traffic Volume on Intersections (continued)

5.4.5 Examination of Interchange Location and Type

1) Introduction

General approach of the interchange planning and selection of interchange types are described in earlier section. This section contains examination of the locations and types of the proposed interchanges for the KLORR.

Interchange locations are determined predominantly by the alignment of the proposed expressway, but sometimes they are determined due to the limited land availability for interchanges, constraints from near by existing or committed interchanges and difficult terrains condition and so on.

For example, the location and type of the interchange with North-South Expressway or KL-Seremban Expressway are planned and designed taken into account existing and committed interchanges which are located continuously with short intervals. For those interchanges, several alternative interchange plans are prepared and evaluated comparatively.

For the other interchanges, their locations and types by the physical condition in the proposed areas such as the land availability and difficult terrain are considered.

The KLORR will be implemented as a privatization project with tolls. A toll levy system is an important factor to confirm interchange locations and types. In order to provide smooth traffic flows on the Expressway network, a close toll levy system is recommended. Although several privatized companies are involved in the operation of the network, it is also recommended to provide free traffic flow without toll gate especially on the System Interchange (A) by introducing a common ticketing system.

The comparative evaluation of alternatives and major planning considerations for the each proposed interchanges are discussed below.

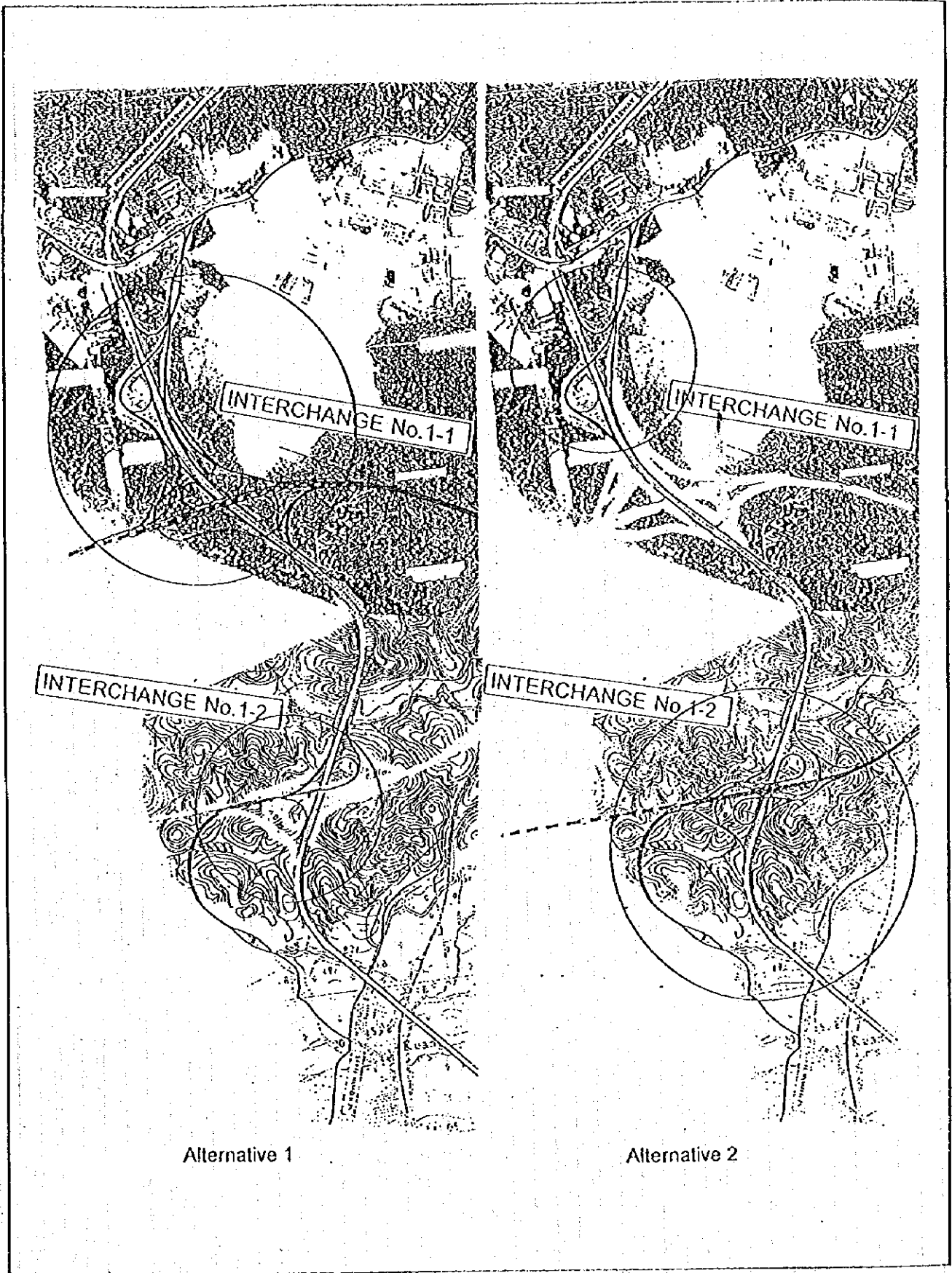
2) North-South Expressway (No.1)

The interchange with North-South Expressway which is an origin point of KLORR is planned to be located at near Rawang and Serendah areas. In the area, Rawang Interchange was constructed and two new interchanges are planned. One is in the north, Kg. Sungai Choh, approximately 5 km from Rawang IC. Furthermore, there is a service area in between. The other interchange which is planned in Kuang, approximately 4 km from Rawang IC. These interchanges and facilities are major constraints for the interchange planning of KLORR.

In the view point of future traffic demand, northern location of Rawang IC is preferable, for the KLORR interchange. The construction of the new interchange for KLORR in the norther area from the existing Rawang IC will be designed in terms of the traffic demand. However, spaces between the interchanges and service area are not sufficient to construct a new interchange. In addition, committed development projects along North-South Expressway and Federal Highway is also constrained for the alignment of KLORR, even if the interchange with KLORR could be integrated with the proposed Sungai Choh new IC.

Table 5-4-4 : Comparison of the Alternatives for Rawang IC (No. 1)

	Alt - 1 (IC No. 1-1-Figure 7)	Alt - 2 (IC No. 1-2 Figure 8)
(1) Planning Concept	To integrate with the existing Rawang IC.	To integrate with a new Kuang IC.
(2) Traffic flow and Operation	Merging Points = 14 Diverging Points = 14 Weaving Points = 0 • Merging and diverging points come cross continuously on the NSE. • More complicate ramp way configuration.	Merging Points = 8 Diverging Points = 8 Weaving Points = 0 • Major Traffic Flow (North of the NSE → will take a bit of longer distance.
(3) Ramp way and structure length	Total ramp way length = 7.3 km Total bridge length = 1.0 km	Total ramp way length = 8.7 km Total bridge length = 0.8 km
(4) Landuse and availability	• Industrial development under construction in the east side of the IC. • Hilly terrain, mainly forest land will be available.	• Hilly terrain, forest. • Land will be available.
(5) Influence to other interchanges	• Distance with the proposed Kuang IC may not sufficient.	• Minimum interval between interchanges will be provided.
(6) Evaluation	From the viewpoints of the traffic flow, the KLORR will be desired to diverge from North - South Expressway in the northern area. However the physical conditions such as existing or approved interchanges and Service Area will not allow to built a new interchange for KLORR. Comparing two alternatives, Alternative 2 (to integrate with a new Kuang IC) will have advantages in terms of complications of ramp way and cost as well as influences to other interchanges.	



Alternative 1

Alternative 2

Figure 5-4-7 : Interchange Location of the Interchange No. 1



Figure 5-4-8 : Engineering Design for Kuang IC

The interchange for KLORR, therefore, should be planned in the south of Rawang IC. As mentioned earlier, a new interchange in Kuang is approved in the south. It is difficult to construct a new interchange between two interchanges. Subsequently, two alternatives using either existing Rawang IC or new Kuang IC are considered. The function of the both alternatives are Service IC as well as a System IC.

Table 5-4-4 and Figure 5-4-7 shows a comparative evaluation of the two alternatives and interchange location with the adjacent interchange in Rawang and Kuang. The detail of the ramp way configuration is shown in Figure 5-4-8.

Comparing two alternatives, alternative 2 which integrates with a new Kuang interchange will have advantages in terms of complication of ramp way and cost of the construction, as well as influence to the adjacent interchanges.

3) KL-Seremban Expressway (No.9)

The physical condition on the KL-Seremban Expressway in Kajang area is similar to the one in Rawang area mentioned above. There are three interchanges with short intervals, namely UPM IC, Kajang IC and Bangi IC.

Based on the KLORR alignment continuation, basically two alternatives will be desired whether to use existing Kajang IC or construct a new interchange. On the plan of a new interchange construction, two options are compared. One is to maintain the existing Kajang IC, the other one is to close the Kajang IC to avoid the drivers' confusion caused by too many successive interchanges in short distance.

Table 5-4-5 shows the comparison of the three alternatives. The location and ramp way configuration are shown in Figure 5-4-9.

Alternative 1 is a new interchange construction and alternative 2 is a new interchange with closure of the Kajang IC, and alternative 3 is the plan integrated with the Kajang IC.

A new interchange in the alternative 1 is constructed with sufficient distance from the existing interchanges. The new interchange, therefore will be located in the west of the Kajang new town center, resulting the KLORR crossing the town centre.

The location is the same as the interchange of New South Klang Valley Expressway with KL-Seremban Expressway proposed by the Putra Jaya Development Plan.

To avoid crossing the town center, the new interchange will be shifted to the north consequently it become very close to the existing Kajang IC. Therefore, by alternative 2, it is recommended to close the Kajang IC, instead to provide a new access to Kajang town from KLORR.

Alternative 3 is to add the System interchange function on the existing Kajang IC (Service Interchange) to avoid the construction of any new interchange in the section of the KL-Seremban Expressway.

As a conclusion, alternative 2 will be preferable to the others in terms of the smooth traffic flow and interchange intervals, but land acquisition will be a main constraint. Alternative

Table 5-4-5 : Comparison of the Alternatives for Kajang (No. 9)

	Alt. - 1	Alt. - 2	Alt. - 3
Planning Concept	To build a new interchange at the location proposed in Putra Jaya development plan.	To build a new interchange To avoid many interchange in short distance, the existing Kajang IC will be closed. Instead of the closure, a new interchange will be constructed on the KLORR to provide an access to Kajang town.	Integration with existing Kajang IC to avoid a new additional interchange on the KL - Seremban expressway.
Traffic flow and operation	Merging Points = 8 Diverging Points = 8 Weaving Points = 0 It is important to manage the three successive interchanges on the KI - Seremban Expressway.	Merging Points = 8 (10) Diverging Points = 8 (10) Weaving Points = 0 () including a new interchange. The most smooth traffic flow can be provided among three alternatives.	Merging Points = 13 Diverging Points = 13 Weaving Points = 0 A proper information system is required to manage turning traffic flows smoothly.
Ramp Way and Structure Length	Total ramp way length = 6.8 km Total bridge length = 1.9 km	Total ramp way length = 6.8 km (9.0) Total bridge length = 1.9 km (2.0)	Total ramp way length = 12.8 km Total bridge length = 3.6 km
Landuse and availability	Crossing Bangi New Town Center.	The following land will be acquired <ul style="list-style-type: none"> • a part of Bangi New Town Centre • a part of the land for a new Mosque • TEN Training Center In addition, the land for the new IC will be required.	Using the existing interchange area and undeveloped land.
Evaluation	Major issues on this interchange planning are existing successive interchanges and land availability for the interchange. Alternative 2 will be preferable to the others in terms of the smooth traffic flow and interchange intervals, but land acquisition will be constrained. Alternative 1 is crossing Bangi New Town Centre and creating four (4) successive interchanges. Subsequently, Alternative 3 will be selected in spite of the complicated ramp way configuration.		



Figure 5-4-9 : Proposed Interchanges Location

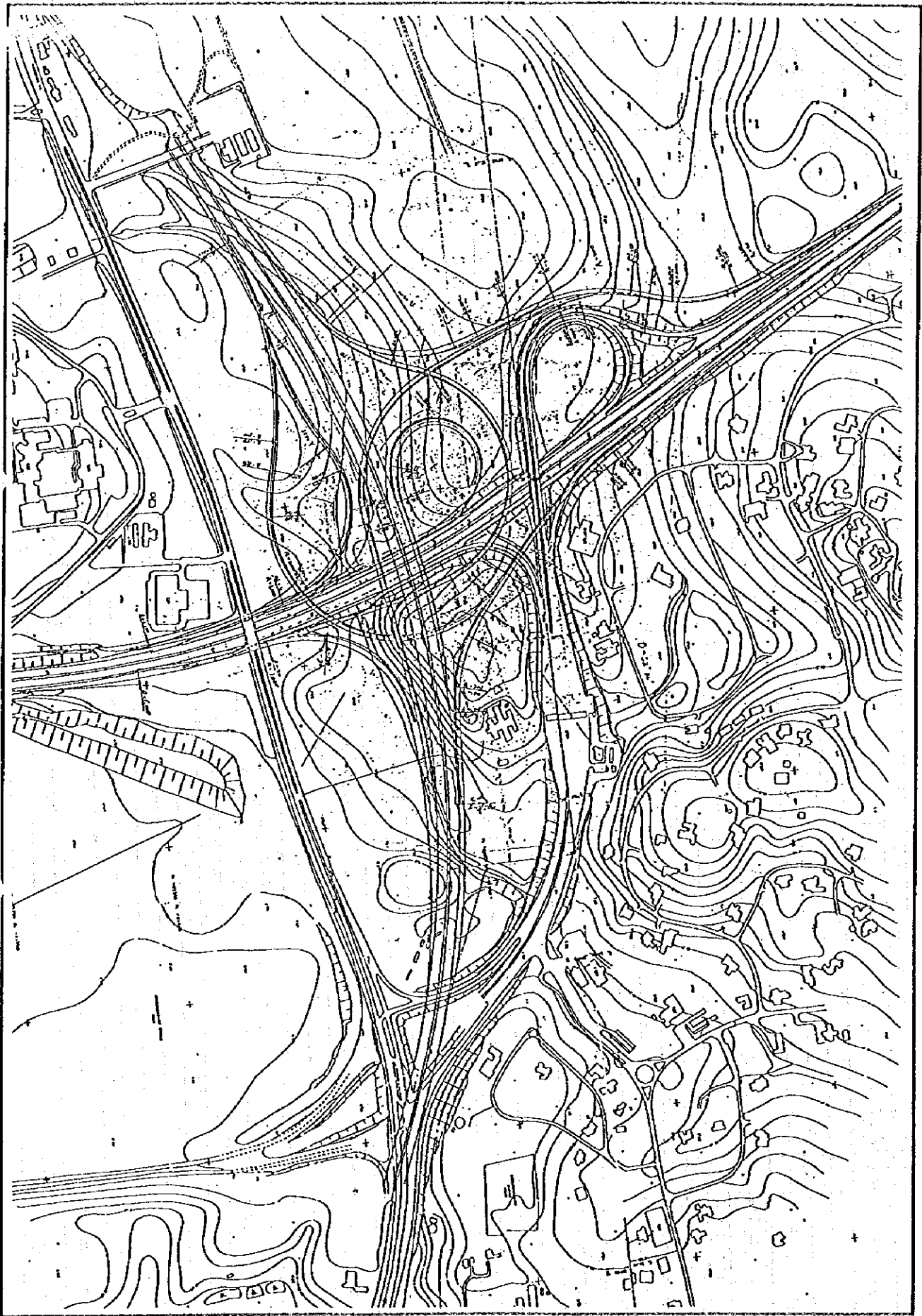


Figure 5-4-10 : Engineering Design for Kajang Interchange

1 is crossing Bangi New Town Center and Creating four (4) successive interchanges. Subsequently, alternative 3 will be selected in spite of the complicated ramp way configuration. It is recommended to provide a sufficient traffic information system for the proposed interchange. The proposed engineering design for the interchange is shown in Figure 5-4-10.

4) KL-Karak Highway (No.4)

Major constraints on the planning of the interchange with KL-Karak Highway are topographic condition and existing villages along Jalan Gombak. And also Islamic University and the KL-Karak Highway widening project including construction of a new toll gate both under construction should be taken into account.

Figure 5-4-11 shows the physical condition of the surrounding area of proposed interchange. The new toll gate and the university are located at south and north of the criss-crossing point with KL-Karak Highway. To minimize the influence to the existing villages, the proposed interchange is planned outside of the village as shown in the Figure 5-4-11. The interchange will be designed as a System Interchange (B), The detail is shown in Figure 5-4-12.

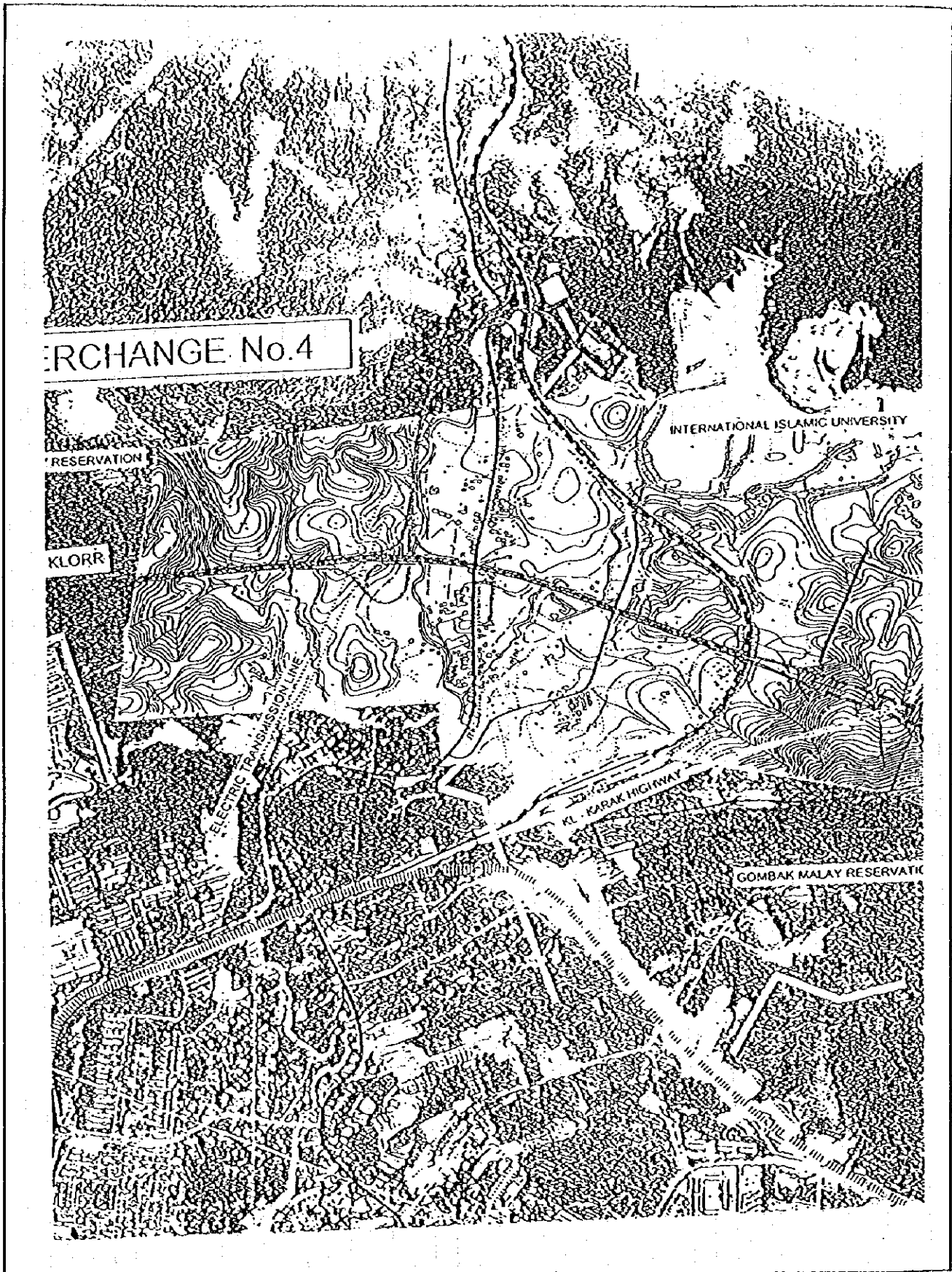


Figure 5-4-11 : Physical Condition in the Surrounding Area of Interchange No. 4



Figure 5-4-12 : Engineering Design for KL - Karak Highway

5.5 DESIGN OF BRIDGE AND TUNNEL

5.5.1) Design features of Proposed Bridge

The design features of the proposed bridge at section 1,2,and 3 are shown as follows.

Table 5-5-1 : Design Features of Proposed Bridges at Section 1

Station (km)	Type	Span Arrangement (m)
0+630-0+770	C.B.R	2@70
1+080-1+330	C.B.R	80+90+80
1+900-2+100	C.B.R	2@100
2+280-2+430	C.B.R	2@75
2+780-2+920	C.B.R	2@70
2+960-3+130	C.B.R	2@85
3+640-3+900	C.B.R	80+100+80
4+440-4+640	C.B.R	2@100
5+860-6+400	C.B.R	8@67.5
9+620-9+830	C.B.R	55+100+55
10+490-10+630	C.B.R	2@70
11+100-11+420	C.B.R	60+2@100+60
11+620-12+070	C.B.R	15@30
12+230-12+370	C.B.R	2@70
12+560-12+710	I.G	5@30
15+480-15-750	C.B.R	70+130+70
16+160-16+660	C.B.R & I.G	50+100+50+10@30
18+460-18+690	C.B.R	65+100+65
19+910-20-020	C.B.R	2@55
20+530-20+660	C.B.R	2@65
21+380-22+280	I.G	30@30
22+600-22+800	C.B.R	50+100+50

Table 5-5-2 : Design Features of Proposed Bridges at Section 2

Station (km)	Type	Span Arrangement (m)
2+160-2+890	C.B.G	85+7@80+85
3+530-3+670	C.B.G	2@70
4+000-4+130	C.B.G	2@65
4+660-4+990	I.G	11@30
5+250-5+370	C.B.G	2@60
6+060-6+210	I.G	5@30
6+630-7+140	C.B.G	105+3@100+105
7+600-7+900	I.G	10@30
8+270-8+430	C.B.G	2@80
9+160-9+360	C.B.G	65+70+65
12+930-13+200	C.B.G	85+100+85
13+740-13+870	C.B.G	2@65
14+530-14+630	C.B.G	2@50
14+790-14+840	I.G	2@25
15+100-15+180	I.G	20+2@30
15+670-15+860	I.G	35+4@30+35
15+640-15+920	C.B.G	70+140+70
16+150-16+760	C.B.G	75+4@115+75
19+200-19+530	I.G	11@30
20+280-20+730	I.G	15@30
21+500-22+230	I.G	20+23@30+20
22+600-22+800	I.G	6@30+20
23+580-23+700	I.G	4@30
24+140-24+190	I.G	20+30
24+330-24+500	C.B.G	2@85
24+770-24+940	C.B.G	2@85
25+320-25+500	C.B.G	2@90
25+970-26+050	I.G	20+2@30
26+400-26+640	C.B.G	3@80
27+690-28+110	I.G	14@30
30+350-30+500	C.B.G	2@75
30+900-31+050	I.G	5@30
32+800-33+000	C.B.G	50+100+50
33+380-33+550	C.B.G	2@85
34+080-34+480	C.B.G	5@80
35+600-35+720	C.B.G	2@60
36+120-36+350	C.B.G	65+100+65
37+150-37+580	C.B.G	35+12@30+35

Table 5-5-3 : Design Features of Proposed Bridges at Section 3

Station (km)	Type	Span Arrangement (m)
0+330-0+450	I.G	4@30
2+920-3+060	C.B.G	2@70
4+000-4+100	I.G	3@30+10
4+250-5+060	I.G	27@30
6+230-6+330	I.G	3@30+10
7+060-7+260	I.G	6@30+20
8+200-9+780	I.G	48@30+20+4@30
10+150-10+290	I.G	4@30+20
11+200-11+300	I.G	4@25
14+800-15+000	I.G	6@30+20
15+570-15+670	I.G	4@25
16+000-16+400	I.G	13@30+10
18+340-18+700	I.G	12@30
19+050-19+300	I.G	8@30+10
19+460-19+600	I.G	4@30+20
19+850-20+160	I.G & C.B.G	3@30+20+50+100+50
20+600-20+980	I.G	12@30+20
21+500-21+600	I.G	3@30+10
25+300-25+900	I.G	20@30
28+400-28+600	I.G	6@30+20

5.5.2 Length of Proposed Tunnel

The length of the proposed tunnel at Section 1 and 2 is shown in Table 8-15(a) and Table 8-15(b).

Table 5-5-4 : The Length of Proposed Tunnel at Section 1

Station (km)	Length (m)
6+550-7+870	1320
13+310-15+110	1800
16+930-17+350	420

Table 5-5-5 : The Length of Proposed Tunnel at Section 2

Station (km)	Length (m)
0+260-2+050	1790
9+400-12+560	3160
29+270-30+050	780

Technical Volume

Chapter 6

DRIVER INTERVIEW SURVEY

CHAPTER 6 DRIVER INTERVIEW SURVEY

6.1 Objective

The purpose of this survey is to gather information of the opinion and consciousness of drivers in driving in mountain side.

The result of survey will be reconsidered for suggest and propose to KLOOR planning which involved mainly by mountain side section on our JICA study and it design field.

At the same time, the survey results will be referred to consider for traffic management not only in KLOOR but also in existing highways and expressways.

6.2 Method

The following items are taken into consideration for this survey :

1. Survey method

Interview survey using the questionnaire (Following Page) is done by the technicians under the cooperation of HPU.

2. Survey Station and date

1) Karak Highway

Kawasan Service Area (Km 51.2), 25th November 1995, Saturday, 10:00am to 6:00pm.

2) N-S Expressway

Sungai Perak Service Area (km 249), 27th November 1995, Monday, 11:00am to 8:00pm.

3) Collected Data (Number of interviewer)

Karak Highway	102 cases (5 person M-3, F-2)
N-S Expressway	111 cases (5 person M-3, F-2)

3. Remarks

In interviewing, the following remarks were paid carefully;

- 1) Special traffic or engineering terms were changed to easier words and also explained more detail.
- 2) According to the driver, interviewer chose the driver such as Chinese speaking driver is interviewed by Chinese speak interviewer.

**QUESTIONNAIRE FOR DRIVERS IN MOUNTAIN SIDE SECTIONS ON EXPRESSWAY
JICA STUDY TEAM**

The purpose of this survey is to get an information about safety driving in mountain side sections on expressway and highway.

These information will be use to design and construct new expressway and highway, in order to satisfy more safety and comfortable road environment, in near future.

KINDLY ANSWER THE FOLLOWING QUESTION :

FACE SHEET: STATION : N-S Expressway (km 249 S.G. Perak S.A) DATE : NOV. 27 (Mon), 1995

1. AGE () 2. SEX (1.M,2.F) 3. DRIVING EXPE. () years F-1 F-2 F-3
4. FREQUENCY OF DRIVING ON STUDY ROAD F-4
 1) Almost every day 2) Once or twice a week 3.) Once or twice a month 4) Several times a year
5. TYPE (1. Private 2. Commercial or government 3. Other) F-5
6. TYPE OF VEHICLE F-6
 1) Passenger Car 2) Lorry 3) Bus 4) Motor cycle 5) Other

QUESTIONS:

Q.1 General Question About Driving between Ipoh ~ this S.A on N-S Expressway (N-S)

- a) Can you drive with your desired speed ?
 1. More than expected 2. same as expected 3. less than expected 4. Unknown Q1-a
- b) What do you think about the traffic volume in this section ?
 1. Heavy traffic 2. Normal traffic 3. Light traffic 4. Unknown Q1-b
- c) What do you think about the following factors while driving in this section ?
- Comfortability 1. Better 2. Good 3. Bad 4. Worse 5. Unknown Q1-c1
 - Safety 1. Better 2. Good 3. Bad 4. Worse 5. Unknown Q1-c2
 - Driving in Rain 1. Easy 2. Not so hard 3. Hard 4. Very hard 5. Unknown Q1-c3
- d) Do you feel anxiety whether high grade of slope in mountain side will slip down especially in raining in this section ?
 1. Always 2. Some times 3. Not so often 4. Never 5. Unknown Q1-d

Questions about Steep Slope

a) How do you feel about the following Steep Slope factors in this section ?

- No. of Steep Slope (1. Too many 2. Not so many 3. Unknown) Q2-a1

- Distance of Steep Slope (1. Too long 2. Long 3. not too long) Q2-a2

b) Do you feel hard to drive at the highest steep slope "After the Ipoh Tunnel" from K.L, in this section ?

Up slope { to Tunnel }

1. Extremely 2. Yes but not so 3. No 4. Unknown Q2-b1

Down slope {from Tunnel}

1. Extremely 2. Yes but not so 3. No 4. Unknown Q2-b2

Q.3 Question about Sharp Curve

a) How do you feel about the following sharp curve factors in this section?

- No. of sharp curve 1. Too many 2. Not so many 3. Unknown Q3-a

b) Which is more difficult, to drive a sharp curve in up slope or down slope section?

Sharp curve in (1. Up slope 2. Down slope 3. Unknown) Q3-b

Q.4 Question about Tunnel

a) How do you feel following questions about the Ipoh Tunnel (880 m) ?

- Visibility (1. Very poor 2. Poor 3. Not so bad 4. Good 5. unknown) Q4-a1

- Air circulation (1. Very poor 2. Poor 3. Not so bad 4. Good 5. unknown) Q4-a2

- Length-800 m (1. Very short 2. Short 3. Not so short 4. Long 5. unknown) Q4-a3

b) Do you feel worry to pass the tunnel ?

1. Yes 2. No 3. Unknown Q4-b

If your answer is 1. choose the main reasons as follows (select one);

- 1. Accident
- 2. Fire
- 3. Escape way in incidents
- 4. Emergency telephone
- 5. Location and operation of fireplug
- 6. Dark lighting
- 7. Others

Q4-b1

c) Do you feel the slope while you are driving inside the tunnel ?

1 Very much 2. Yes but not so 3. No 4. Unknown Q4-c

Q.5. Questions about Consciousness of Traffic Environment

PLEASE ANSWER THE FOLLOWING QUESTIONS AS GENERAL INHABITANTS

a) Are you concerned for transportation pollution such as air pollution, noise pollution or vibration by traffic ?

1. Very much 2. Yes but not so 3. No 4. Not at all 5. Unknown

Q5-a

b) Do you agree to follow the speed limitation by traffic enforcement in order to prevent pollution on express or highways, if necessary ?

1. Yes 2. No 3. Unknown

Q5-b

THANK YOU VERY MUCH FOR YOUR KIND COOPERATION

6.3 Result on Karak Highway

6.3.1 Face Sheet

1) Age

Driver's age was mainly shared by younger people, the peak of age group was in 30- aged and shared about 42%.

2) Sex

Almost all were shared by male (99%), female was only counted one out of 102 cases.

3) Driving Experience

The highest percentage was shown in 6 to 10 years driving and secondly shared by beginners (less than 5 years experience).

4) Driving Frequency on Karak Highway

Frequent drivers on Karak Highway were shared more than 30%, but over 30% of driver were not so high driving experience on Karak Highway. The reason can be attributed to the survey day, that is, the survey day was weekend and it seemed that a "Sunday driver" would be answered on that survey day.

5) Type of Vehicle

More than 70% was shared by passenger cars and lorries shared about 15%. Motor cycles and buses were very few. The vehicle usage in private type was shared more than 80% in total.

6.3.2 Simple and Cross Statistical Analysis

The result of simple analysis is shown by pie chart and second paragraph described by table is also shown as the result of cross analysis in each question. The cross analysis is only chosen in four (4) categories as follow;

1) Age Group

Young group less than 29 years old
Middle group More than 40 years old

2) Driving experience

Short group less than 5 years
Long group more than 10 years

3) Driving frequency on Karak highway

Frequent group almost every day and once/twice a week
Infrequent group several times a year

4) Type of vehicle

- Passenger car group
- Lorry group

6.3.2.1 General Driving Opinion on Karak Highway

1) Desire Speed

More than 60% of driver felt that they could drive with desired speed on highway but 30% of drivers could not drive with their desired speed.(Q1-A)

Frequent driving group judges it better on survey day rather than infrequent group. It means that frequent driving group usually drive with more lower speed and that speed will be general running speed for them.

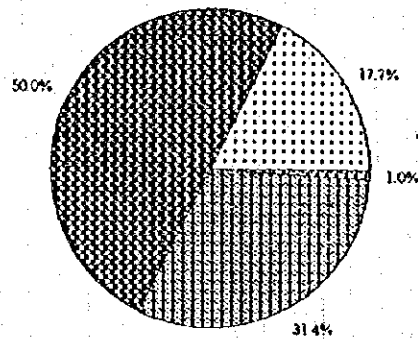
In type of vehicle, lorry group showed the highest percentage of 60% in "same as expected speed" and also answered with lowest percentage of 13% in "less than expected".

QUESTIONS

Q1.General question about driving on Karak Highway

A) Can you drive with desire speed ?

	More than expected	Same as expected	less than expected	Unknown	Total
	18	51	32	1	102
%	17.65	50.00	31.37	0.98	100.00



Legend: More Than Expected Same As Expected Less Than Expected Unknown

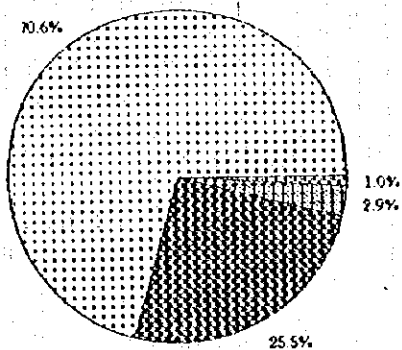
2) Traffic Volume

More than 70 % of driver felt the actual traffic volume was so heavy rather than their expectation. It is clear that existing traffic volume on Karak highway has been felt and judged to heavily. (Q1-B)

The middle age group felt as "heavy traffic" than young group and more sensitive answer is found in long experienced driving group, that is, their 90% of driver judges as "heavy traffic".

B) What do you think about the traffic volume on K/highway ?

	Heavy Traffic	Normal Traffic	Light Traffic	Unknown	Total
	72	26	3	1	102
%	70.59	25.49	2.94	0.98	100.00



Legend: Heavy Traffic Normal Traffic Light Traffic Unknown

3) Comfort

The comfort was felt and estimated as "Bad" in over 60% of driver. The estimation of comfortability might be different with several meanings or factors such as handling feeling, ride in driving, sound or vibration of traffic so on by each driver.

However, it is the fact that total feeling of comfortability which is judged by the driver is not satisfiable condition on Karak highway. (Q1-C-1)

There are no large differences in driving frequency groups in "comfortability" but large differences are found in two type of groups. In the age groups, young one judges more strict comfortability than middle age group.

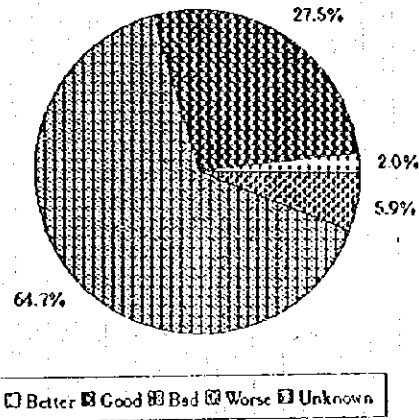
In type of vehicle, lorry group shows more calming judgement about comfortability than passenger car group.

The percentage of "good" estimation by lorry group is shown more than two (2) times higher than passenger group.

C) What do you think of the following factors while driving on K/Highway?

C1. Comfortability

	Better	Good	Bad	Worse	Unknown	Total
	2	28	65	6	0	102
%	1.96	27.45	64.71	5.88	0.00	100.00



4) Safety

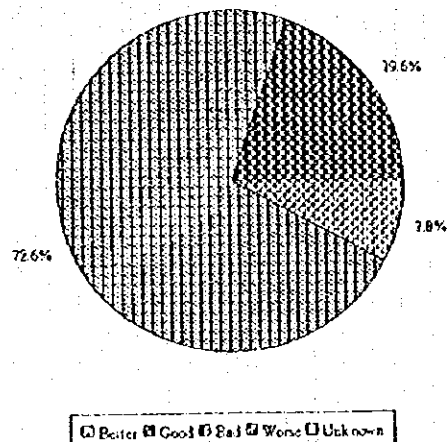
On Karak highway, driver feeling about safety in their driving is found that almost 80% of total drivers answered as "unsafe" feeling on highway. The "Worth" judgement is found about 10% in total.

In same as "comfortability" stage, driver's opinion will be multivocal meaning but it is true that most of driver on Karak highway drives within unsafe consciousness: (Q1-C-2)

The highest percentage in "bad and worth" in safety judgement is found in frequent driving group and that is 88%.

C2. Safety

	Better	Good	Bad	Worse	Unknown	Total
	0	20	74	8	0	102
%	0.00	19.61	72.55	7.84	0.00	100.00



5) Driving in Rain

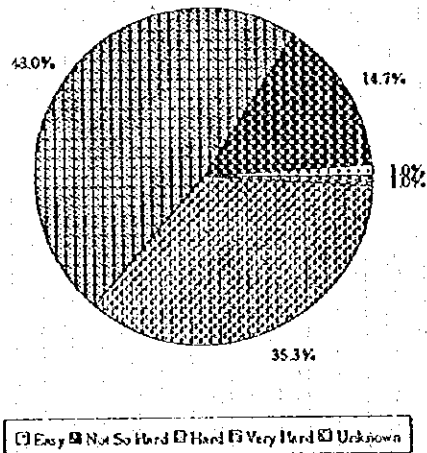
More than 80% (including very hard) of total driver answered that the driving in rain is hard on Karak highway.

It is common to hate drive in rain usually but that result must be put in mind for considering in road design and its management on the highway. (Q1-C-3)

Between three (3) groups, there are not so large differences in driving consciousness in rain except frequent driving group. Only that group shows the highest percentage in driving in rain, that is 97%.

C3. Driving in Rain

	Easy	Not So Hard	Hard	Very Hard	Unknown	Total
	1	15	49	36	1	102
%	0.98	14.71	48.04	35.29	0.98	100.00



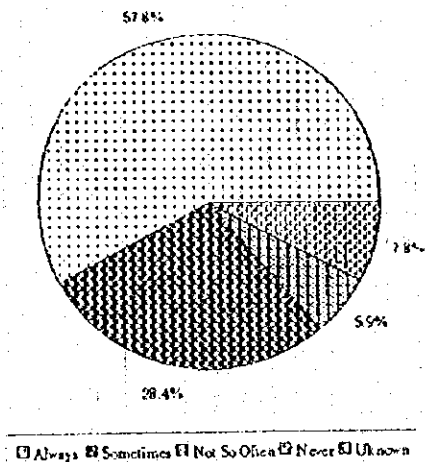
6) Slope Down

As one of the characteristics in mountain side section, it is normal that there are many slope sections along to highway. It is cleared that nearly 60% of driver always feel anxiety about slope down during their driving on Karak highway. The driver who do not feel anxiety of slope down is only shown aloud 10% in total drivers. (Q1-D)

The anxiety of slope down is typically found in young age group and driving frequency is higher group. The highest percentage of anxiety is also find in lorry driver group and that is 93%(included always).

D) Do you feel anxiety whether high grade of slope in mountain side will slip down especially in raining on K/highway ?

	Always	Some times	Not so often	Never	Unknown	Total
	59	29	6	8	0	102
%	57.84	28.43	5.88	7.84	0.00	100.00



6.3.2.2. Question About Steep Slope

1) Number of Steep Slopes

The opinion about numbers of steep slopes along to Karak highway is shared almost fifty-fifty, however a little bit agreed opinion is higher in disagreed opinion, that is, agreed opinion is 54%. (Q2-A-1)

The large difference is not founded in type of vehicle and frequency driving groups. In age group, young driver group shows lower percentage(44%) than middle group (59%). The result will be different that the driving of younger group will be more changeable and aggressive in mountain side section on highway.

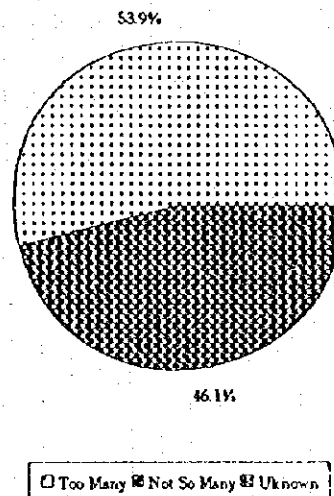
At the same time, in driving experience group the large difference is found that beginner group shows more than 60% and long experience group is 47% judged in "too many number".

Q2. Question about Steep Slope

A) How do you feel about the following Steep Slopes factors on K/Highway ?

A1. No. Of Steep Slopes

	Too many	Not so many	Unknown	Total
	55	47	0	102
%	53.92	46.08	0.00	100.00



2) Distance of Steep Slope

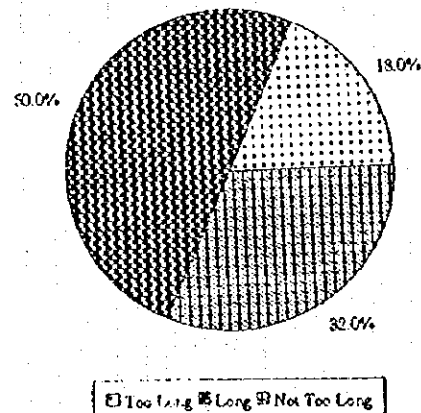
The percentage judged in "long or too long" was shown more than 60% and in "not too long" is 32%. According to the percentage, it is clear that more than 3 out of 5 drivers have a feeling in "too or long distance of steep slope" on existing Karak highway.

These driver's opinion will be based on the section that there are two sections with vertical alignment 8% on highway.(Q2-A-2)

The largest difference in percentage (too long) is found in type of vehicle group. The lorry grope shows the lowest percentage as 7% and passenger car grope is 17%.

A2. Distance of Steep Slope

	Too long	Long	Not too Long	Total
	18	50	32	100
%	18.00	50.00	32.00	100.00



3) Driving on Steep Slope

The question is done about the largest vertical alignment (8%) before the tunnel (km37 from K.L). The answer is that more than 80% of driver feels the hardness in steep slope driving. It is found also that they fell extremely hard to drive on up slope than the down slope. (Q2-B-1,2)

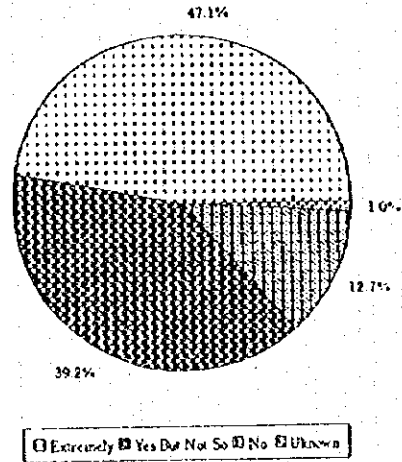
The opinion with hardest driving in up slope is found not only in the largest percentage(60%) but also in the largest difference(23%) in diving experience group.

The hardest driving in down slope is answered that the largest percentage is shown in lorry driver(53%) and largest difference also found between passenger car and lorry as 33%.

B. Do you feel hard to drive at the highest steep slope before the tunnel from K-L on K/ Highway ?

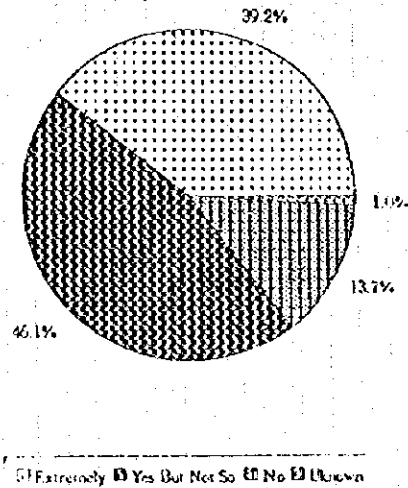
B1. Up slope {from KL}

	Extremely	Yes but no so	No	Unknown	Total
	48	40	13	1	102
%	47.06	39.22	12.75	0.98	100.00



B2. Down Slope { from Karak }

	Extremely	Yes but no so	No	Unknown	Total
	40	47	14	1	102
%	39.22	46.08	13.73	0.98	100.00



6.3.2.3 Question About Sharp Curve

1) Number of Sharp Curve

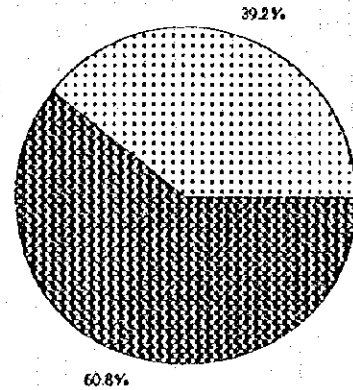
Many drivers (60%) do not feel there are so many sharp curves on highway. Less than 40% of drivers are not. According to that data it can be said that the existing number of sharp curve are accepted by drivers. (Q3-A)

The highest percentage of answer in "too many sharp curve" is found in beginner group (47%), and in young age group(40%). Other groups show not so high percentages(around 30%). The feeling in "too many" will be came by their short experience.

Q3. Question about sharp curve ?

Q3A) How do you feel about the following sharp curve factors in this section ?
No of sharp curve

	Too many	Not so many	Unknown	Total
	40	62	0	102
%	39.22	60.78	0.00	100.00



Legend: Too Many Not So Many Unknown

2) Driving Difficulty on Sharp Curve in Steep Slope

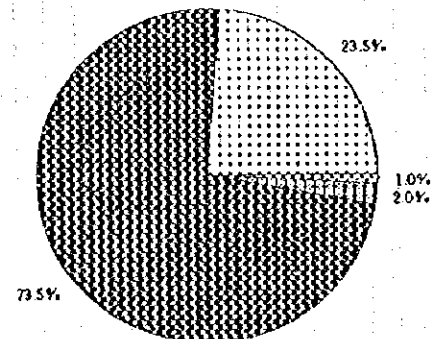
More than 70% of driver answers that it is more difficult to drive at sharp curve in down slope rather than the up slope. This opinion is fitted to the accident data on curve in steep slope. (Q3-B)

In difficulty driving on sharp curve in "up slope", lorry group shows the highest percentage in 40%.

In "down slope", long driving experience group shows the highest percentage in 83%.

Q3B) Which is more difficult, to drive a sharp curve in up slope or down slope section ?
Sharp curve in

	Up Slope	Down Slope	Unknown	Both	Total
	24	75	2	1	102
%	23.53	73.53	1.96	0.98	100.00



Legend: Up Slope Down Slope Unknown Both

6.3.2.4 Question About Tunnel

1) Visibility

Three out of 4 drivers (75%) points out the poor visibility in tunnel. It is the remarkable result even new tunnel is under constructed beside existing tunnel. In fact, the visibility is very poor with dust and exhaust in observation survey. (Q4-A-1)

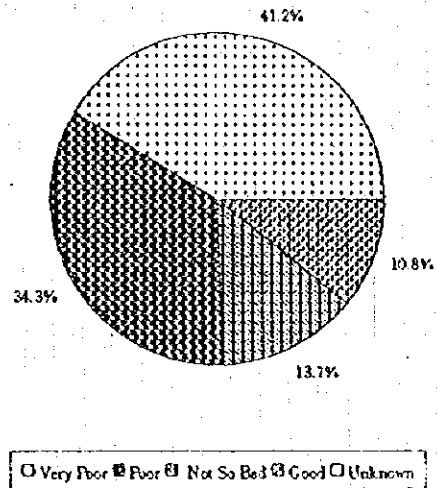
The highest percentage in "very poor" visibility is shown in young age group as 53%.

Q4. Question about Tunnel

A) How do you feel following questions about the Genting Sempah Tunnel (950m) ?

A1. Visibility

	Very poor	Poor	Not so Bad	Good	Unknown	Total
	42	35	14	11	0	102
%	41.18	34.31	13.73	10.78	0.00	100.00



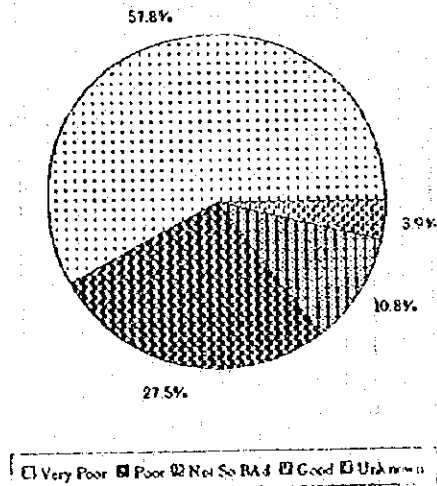
2) Air Ventilation

More than 80% of driver point out the poor air ventilation condition in tunnel. More over 50% of driver judges as "very poor" air ventilation in the tunnel. (Q4-A-2)

The highest percentage judged in "very poor" was found in beginner group as 63%.

A2. Air circulation

	Very poor	Poor	Not so Bad	Good	Unknown	Total
	59	28	11	4	0	102
%	57.84	27.45	10.78	3.92	0.00	100.00



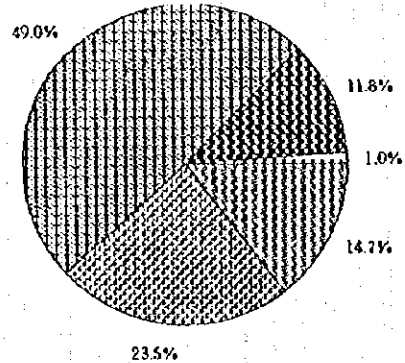
3) Length

The length of Genting Tunnel is 950m and the question about it done. The result is that 60% of total driver do not feel "long" but 20% of driver answered "long". (Q4-A-3)

The length of tunnel is judged in "long" is 20% of total driver but only lorry driver points out the highest opinion about it. They showed 53% in "long" about existing length.

A3. Length 950m

	Very short	Short	Not so Short	Long	Unknown	Total
	1	12	50	24	15	102
%	0.98	11.76	49.02	23.53	14.71	100.00



Very Short Short Not So Short Long Unknown

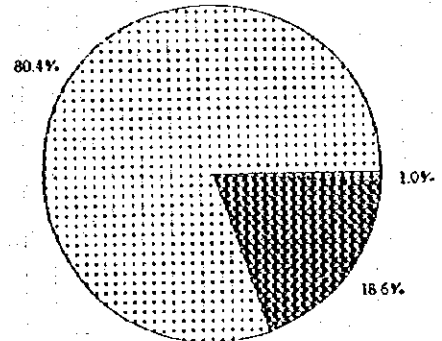
4) Anxiety in Tunnel

More than 80% of driver feel the worry in passing tunnel. The largest factor of worry or anxiety is accident in tunnel. The factor of accident in reasons is shown more than 60% and it is the largest in any other reasons. (Q4-B, B-1)

The most worried feeling group in tunnel is found in beginner group who has less than 5 years experience as 97%.

B) Do you feel worry to pass the tunnel

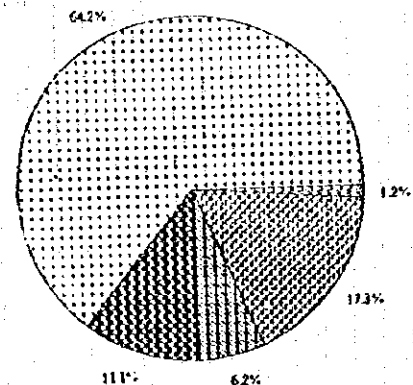
	Yes	No	Unknown	Total
	82	19	1	102
%	80.39	18.63	0.98	100.00



Yes No Unknown

B1. If your answer is 1. Choose the main reasons as follows (select one);

	Accident	Fire	Escapeway In accident	Emergency telephone	Location & op. fireplug	Dark lighting	Others	Total
	52	0	5		1	9	14	81
%	64.20	0.00	6.17	0.00	1.23	11.11	17.28	100.00



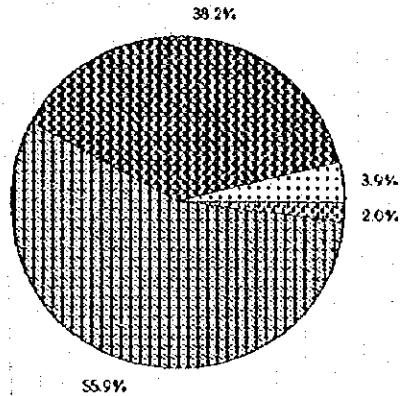
Accident Fire Escapeway in Accident Emergency Telephone Location & Op. Fireplug Dark Lighting Others

5) Slope in Tunnel

More than 50% of driver do not feel the slope inside the tunnel but 40% is feeling it. (Q4-C)

C) Do you the slope while you are driving inside the tunnel ?

	Very much	Yes but not so	No	Unknown	Total
	4	39	57	2	102
%	3.92	38.24	55.88	1.96	100.00



Very Much Yes But Not So No Unknown

6.3.2.5 Consciousness of Pollution

In traffic environment, there are many problems such as air pollution, noise pollution or vibration by traffic. Only air pollution matter is chosen in order to find the consciousness of driver. The result is that almost 90% of driver are very interested in air pollution now. The consciousness of air pollution can be said very high percentage. (Q5-A)

However, more than half of driver do not agree the opinion that the speed limitation should be introduced by traffic enforcement in order to prevent air pollution. (Q5-B)

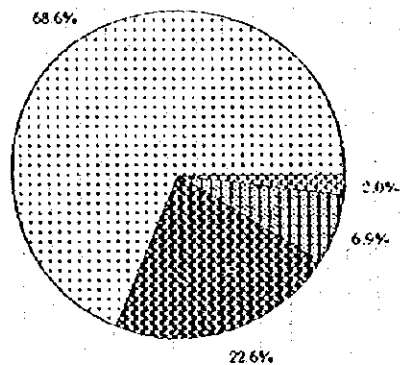
Even half of driver does not agree to introduce speed limitation for prevent traffic pollution, every lorry driver agree to take speed limitation and also more than 73% of beginner driver agree to take it.

On the other hand, passenger car group of vehicle type disagreed to introduce speed limitation and its percentage is 45% which is the highest in any other groups.

Q5. Question about consciousness of Traffic Environment

A) Are you concerned for transportation pollution such as air pollution, noise pollution or vibration by traffic ?

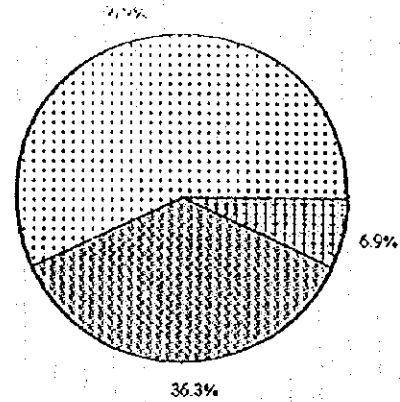
	Very much	Yes but not so	No	Not at all	Unknown	Total
	70	23	7	0	2	102
%	68.63	22.55	6.86	0.00	1.96	100.00



Very Much Yes But Not So No Unknown Not At All

B) Do you agree to follow the speed limitation by traffic enforcement in order to prevent pollution on expressway or highways. If necessary.

	Very much	No	Unknown	Total
	58	37	7	102
%	56.86	36.27	6.86	100.00



Yes No Unknown

6.4 Result on North South Expressway

6.4.1 Face Sheet

1) Age

Age of answered driver was mainly shared by younger people, the peak of age group was in 30-aged and shared about 48%.

2) Sex

Almost shared by male (95%) and female is counted only six(6) out of 111 cases.

3) Driving Experience

The highest percentage was shown in 11 to 20 years drivers (35%) and secondly it shared by 6 to 10 years experience.(26%)

4) Driving Frequency on N-S Expressway

Frequent drivers on N-S were shared only 18%, and more than 70% of driver were lower frequent drivers on N-S.

5) Type of Vehicle

More than 70% was shared by passenger cars and lorry shared about 6%. Motor cycles and buses were also same as lorry.

The vehicle using type was shared by private and its percentage was more than 70% in total.

6.4.2 Simple and Cross Statistical Analysis

The result of simple analysis is shown by pie chart and secondly paragraph described by table (shown in appendix with table number) is also shown as the result of cross analysis in each question.

The cross analysis is only chosen in four(4) categories as follow;

- (1) Age Group
 - Young group less than 29 years old
 - Middle group More than 40 years old
- (2) Driving experience
 - Short group less than 5 years
 - Long group more than 10 years
- (3) Driving frequency on N-S expressway
 - Frequent group almost every day and once/twice a week
 - Infrequent group several times a year
- (4) Type of vehicle
 - Passenger(private) group
 - Lorry group

6.4.2.1 General Driving Opinion on N-S Expressway

1) Desire Speed

More than 80% of driver feel that they could drive with desired speed on expressway and only 17% of drivers answered they could not drive with their desired speed.(Q1-A)

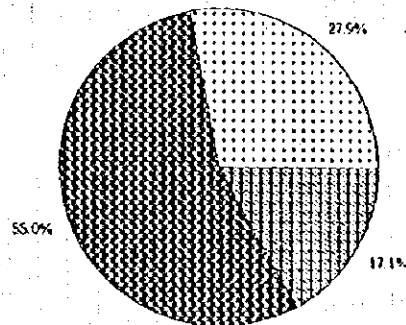
The large difference are found in age group that 60% of young age group answered they could drive with " more than expected speed" and its percentage is more than two(2) times higher than middle age grope.

In type of vehicle, lorry group shows the highest percentage as 85%,which is the highest percentage in any other group, in "same as expected speed" and also higher almost two(2) times than the private car group.

Q1. General question about driving between Ipoh-this S.A on N-S Expressway

Q1A) Can you drive with desire speed ?

	More than expected	Same as expected	Less than expected	Unknown	Total
	31	61	19	0	111
%	27.93	54.95	17.12	0.00	100.00



Legend: More Than Expected Same As Expected Less Than Expected Unknown

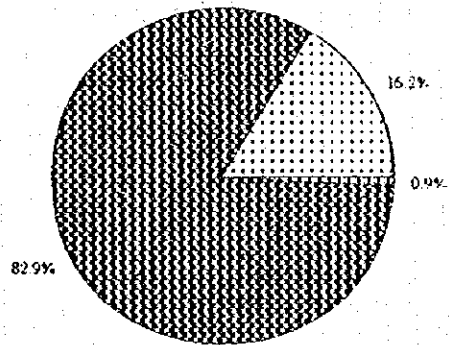
2) Traffic Volume

More than 80 % of driver judges the actual traffic was normal volume.(Q1-B)

The middle age group and lorry driver group estimated as heavy traffic than any other groups. Especially, in middle age group pointed out as 79% which is the highest score.

Q1B) What do you think about the traffic volume in this section ?

	Heavy traffic	Normal Traffic	Light Traffic	Unknown	Total
	18	92	1	0	111
%	16.22	82.68	0.90	0.00	100.00



Legend: Heavy Traffic, Normal Traffic, Light Traffic, Unknown

3) Comfort

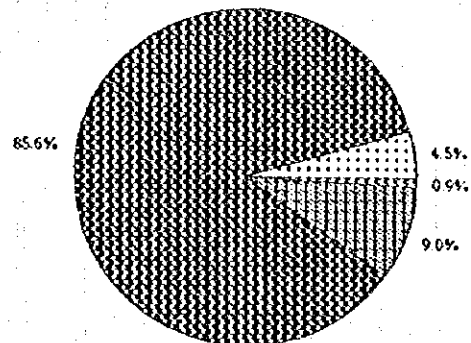
The comfort is judged and estimated as "good" in over 85% of driver. The estimation of comfortability will be different with several meanings or factors such as handling feeling, ride in driving, sound or vibration of traffic and so on by each driver. However, it is the fact that total feeling of comfortability are judged by the driver who is satisfiable condition on N-S expressway.(Q1-C-1)

There are no large differences between any driver gropes and their percentage are shown around 80 to 90%.

Q1C) What do you think of the following factors while driving in this section ?

Q1C1. Comfortability

	Better	Good	Bad	Worse	Unknown	Total
	5	95	10	0	1	111
%	4.5	85.59	9.01	0.00	0.90	100.00



Legend: Better, Good, Bad, Worse, Unknown

4) Safety

On N-S expressway, driver feeling about safety in their driving is found that more than 90% of total drivers answered as safe feeling on expressway. The judgement of "Worth" is found less than 1% in total.

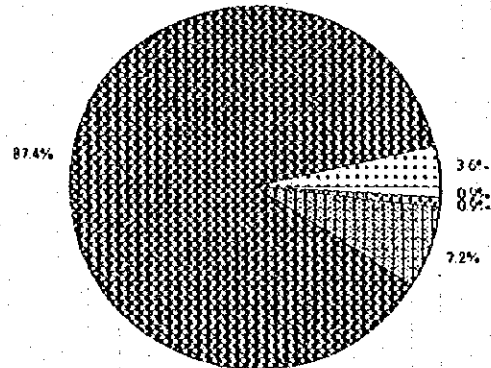
As the same in "comfortability" stage, driver's opinion will be multivocal meaning but it is true that most of driver on N-S expressway drive within safe consciousness.(Q1-C-2)

The high percentages are shown in each driver group and each percentage are found around 80 to 90% .

The highest percentage in groups is found in age group 40 years above and its scored in 94%.

Q1C2. Safety

	Better	Good	Bad	Worse	Unknown	Total
	4	97	601	1	1	111
%	3.60	87.39	7.21	0.90	0.90	100.00



5) Driving in Rain

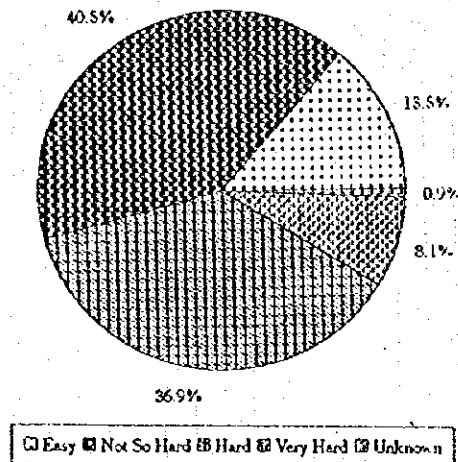
More than 40% (including very hard) of total driver answered that the driving in rain is hard on N-S. More than 50% of driver always drive with easy feeling even in rain on N-S.(Q1-C-3)

On driving in rain, the answer in "hard" is found in long driving experience group that is, short experience (less than 5 years) group shows in 47% which is the highest.

The lowest percentage answered in "hard" is shown as 14% in lorry driver group.

Q1C3. Driving in Rain

	Easy	Not so hard	Hard	Very Hard	Unknown	Total
	15	45	41	9	1	111
%	13.51	40.54	36.94	8.11	0.90	100.00



6) Slope Down

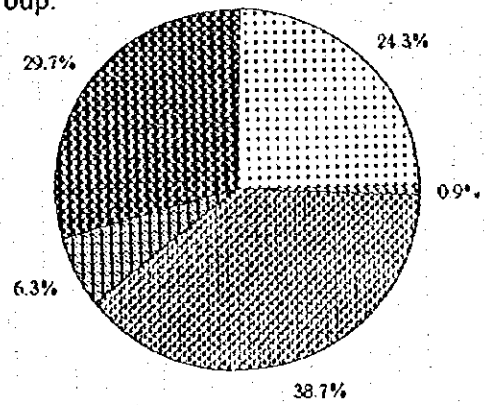
As the characteristics of mountain side section, it is normal that there are many slope sections along to expressway. It is cleared that more than 50% of driver feel anxiety about slip down of slope during driving on N-S. The driver who do not feel anxiety of slope down is shown almost 40% of total drivers.(Q1-D)

The anxiety of slope down is typically found in young age group and higher driving frequency group.
The highest percentage of anxiety is find in higher frequency driving group as 38%.

The lowest score, that is, driver "never" feel the anxiety of slip down of slope is found as 40% in passenger car group.

Q1D) Do you feel anxiety whether high grade of slope in mountain side will slip down especially in raining in this section ?

	Easy	Not so hard	Hard	Very Hard	Unknown	Total
	27	33	7	43	1	111
%	24.32	29.73	6.31	38.74	0.90	100.00



6.4.2.2 Question About Steep Slope

1) Number of Steep Slopes

Always Sometimes Not So Often Never Unknown

The opinion about number of steep slope along to expressway is shown more than 80% of driver do not feel so many numbers. Only around 10% of driver just answered as "too many" on expressway.(Q2-A-1)

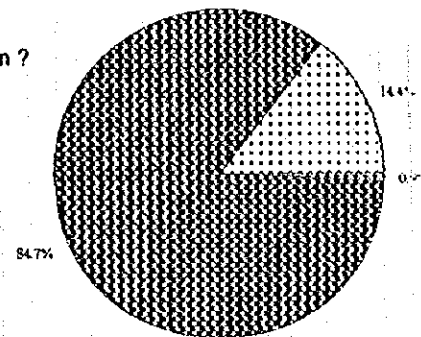
The large difference is not founded in judgement of steep slope number in any groups except lorry driver in type of vehicle. Only lorry group answered as "too many " and its rate is 100%.

Q2. Question about Steep Slope

Q2A) How do you feel about the following Steep Slopes factors in this section ?

Q2A1. No. of Steep

	Too many	Not so many	Unknown	Total
	16	94	1	111
%	14.41	84.68	0.90	100.00



Too Many Not So Many Unknown

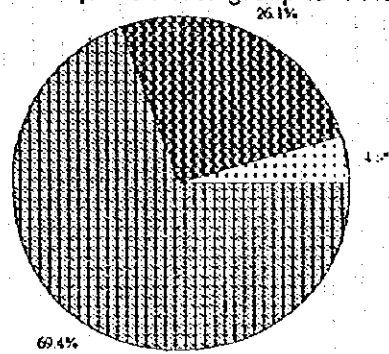
2) Distance of Steep Slope

The percentage judged as "long or too long" is shown in 30% and most of driver(almost 70%) do not feel the distance as long. According to the percentage, it is clear that nearly 3 out of 5 drivers have a feeling in "not too long distance of steep slope" on existing expressway.(Q2-A-2)

The largest difference in percentage (too long) is found in type of driving frequency group. The frequent driving group shows the highest percentage in any other group as 52% and lower frequent driver group is 14% in the answer is "long".

Q2A2) Distance of Steep Slope

	Too long	Not too long	Unknown	Total
	5	29	77	111
%	4.50	26.13	69.37	100.00



3) Driving on Steep Slope

The question about the largest vertical alignment (10%) before the tunnel (Km264) was done. Less than 10% of driver feel to hard in driving. It is found also that they fell extremely hard to drive on up slope than the down slope.(Q2-B-1,2)

The opinion with hardest driving in up slope is found not only in the largest percentage(24%) in young driver group.

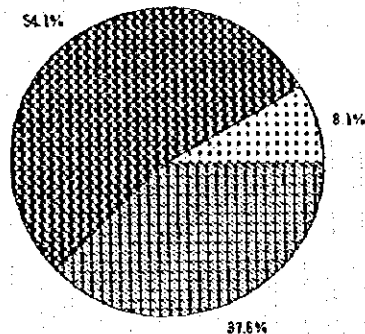
The hardest driving in down slope is answered that the largest percentage is shown in lorry driver(43%) and the largest difference also found between passenger car(5%).

Q2B) Do you feel hard to drive at the highest steep slope " After the Ipoh" K.L in this section ?

2B) Do you feel hard to drive at the highest steep slope " After the Ipoh" K.L in this section ?

Q2B1. Up slope (to tunnel)

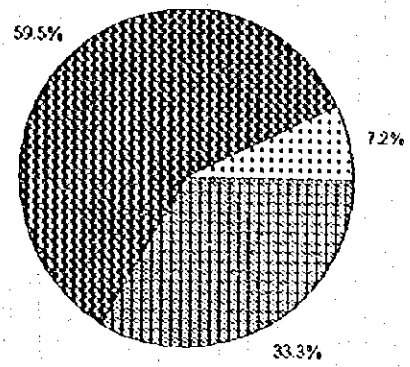
	Extremely	Yes but not so	No	Unknown	Total
	9	60	42	0	111
%	8.11	54.05	37.84	0.00	100.00



Q2B1. Up slope (to tunnel)

Q2B2. Down Slope (from tunnel)

	Extremely	Yes but not so	No	Unknown	Total
	8	66	37	0	111
%	7.21	59.46	33.33	0.00	100.00



Extremely Yes But Not So No Unknown

4.2.3 Question About Sharp Curve

1) Number of Sharp Curve

Almost every driver (90%) does not feel there are so many sharp curves on expressway. According to that data it can be said that the existing number of sharp curve are accepted by every driver.(Q3-A)

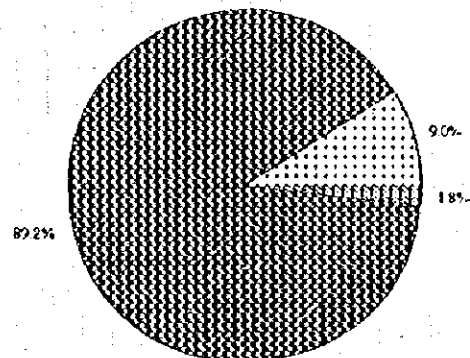
The highest percentage of answer in "too many sharp curve" is found in beginner group (18%). Other gropes do not show so high percentages(around 0.0 to10%).

The feeling of "too many" will be came by their less experience. These percentage is too much different to results of Karak highway.

Q3. Question about sharp curve ?

Q3A) How do you feel about the following sharp curve factors in this section ?
No. of sharp curve

	Too many	Not so many	Unknown	Total
	10	99	2	111
%	9.01	89.19	1.80	100.00



Too Many Not So Many Unknown

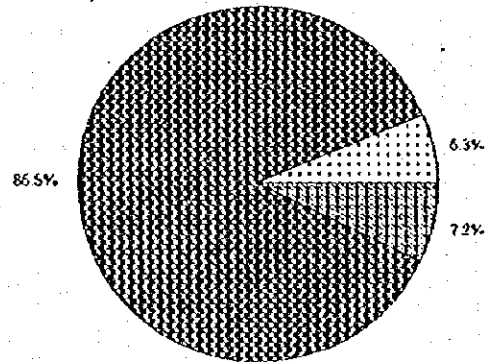
2) Driving Difficulty on Sharp Curve in Steep Slope

More than 86% of drivers answers that it is more difficult to drive at sharp curve in down slope rather than the up slope. This opinion is fitted to the accident data on curve in steep slope.(Q3-B)

The feeling of the most difficult driving is found in beginner group and lorry driver group. They answered perfectly difficult in "down slope" driving and each score is 100%.

Q3B) Which is more difficult, to drive a sharp curve in up slope or down slope section ?
Sharp curve in

	Up slope	Down Slope	Unknown	Both	Total
	7	96	8	0	111
%	6.31	86.49	7.21	0.00	100.00



Legend: Up Slope, Down Slope, Unknown, Both

6.4.2.4 Question About Tunnel

1) Visibility

Almost three out of 4 drivers (74%) points out the good visibility in tunnel. It is the remarkable result that the answer is exactly opposite to driver in Karak highway. (Q4-A-1)

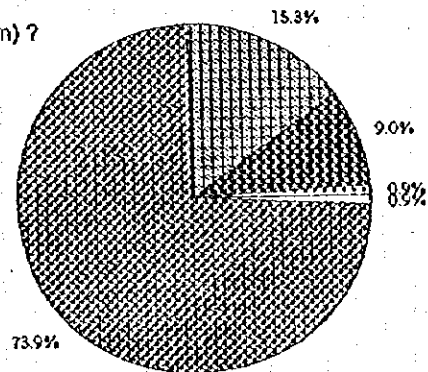
The judgement of visibility in tunnel as "very poor" is only found in young age and beginner group and their percentage shown in 4 to 5%.

Q4. Question about Tunnel

Q4A) How do you feel following questions about the Ipoh Tunnel (880m) ?

Q4A1. Visibility

	Very poor	Poor	Not so	Good	Unknown	Total
	1	10	17	82	1	111
%	0.90	9.01	15.32	73.87	0.90	100.00



Legend: Very Poor, Poor, Not So Bad, Good, Unknown

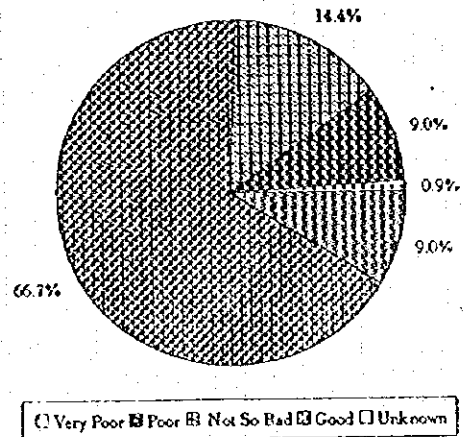
2) Air Ventilation

More than 80% of driver point out the good air circulation condition in tunnel. Only 10% of driver feel the poor visibility in tunnel.(Q4-A-2)

The highest percentage judges as "very poor" in air circulation is found in young age grope and beginner grope only, however the percentage is very low. These result is quiet different to Karak highway.

Q4A2. Air Circulation

	Very poor	Poor	Not so Bad	Good	Unknown	Total
	1	10	16	74	10	111
%	0.90	9.01	14.41	66.67	9.01	100.00



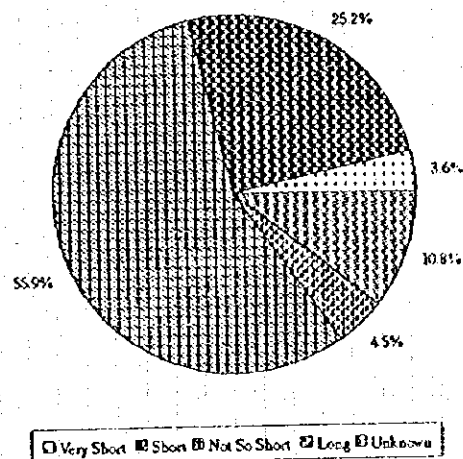
3) Length

The length of Ipoh Tunnel is 880m and its question is done. The answer is that 30% of total driver feel "short" and only 4% answered as "long". More than 50% of driver judged as "not so long".(Q4-A-3)

Almost in driver answered that the judged length of tunnel is "long" is less than 10% in any groups but passenger car driver shows in 6% and it is the highest percentage.

Q4A3. Length 880m

	Very Short	Short	Not so short	Long	Unknown	Total
	4	28	62	5	12	111
%	3.60	25.23	55.86	4.50	10.81	100.00



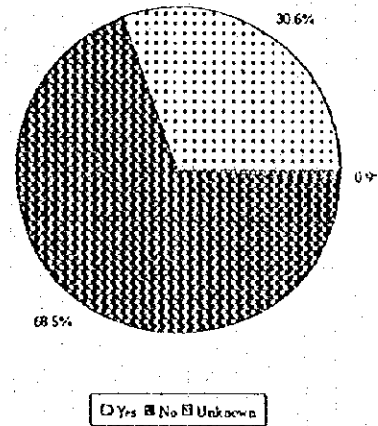
4) Anxiety in Tunnel

Almost 70% of driver do not feel the worry in tunnel and 30% of driver worry to pass it. Mostly worried driver feel with anxiety in "escapeway in accident". The result is quite different with survey results on Karak highway. (Q4-B and-1)

The highest worried group in tunnel is found in lorry group and its percentage is 43%.

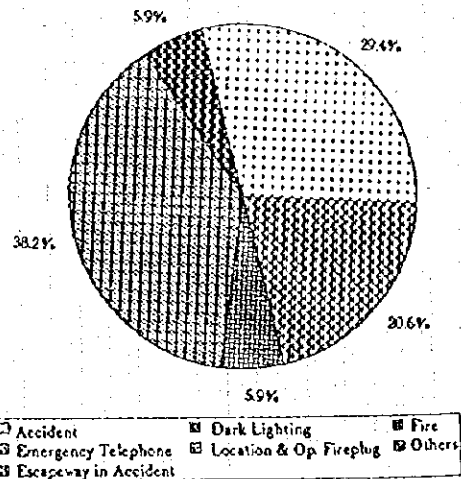
Q4B) Do you feel worry to pass the tunnel

	Yes	No	Unknown	Total
	34	76	1	111
%	30.63	68.47	0.90	100.00



Q4B1. If your answer is 1. Chose the main reasons as follows (select one)

	Accident	Fire	Escapeway in accident	Emergency telephone	Location & op. fireplug	Dark lighting	Others	Total
	10	2	13	0	0	2	7	34
%	29.41	5.88	38.24	0.00	0.00	5.88	20.59	100.00

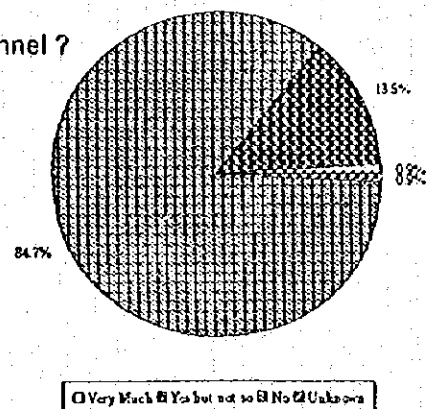


5) Slope in Tunnel

More than 85% of driver do not feel the slope inside the tunnel but only 10% is feeling it. (Q4-C)

Q4C) Do you feel the slope while you are driving inside the tunnel ?

	Very much	Yes but not so	No	Unknown	Total
	1	15	94	1	111
%	0.90	13.51	84.68	0.90	100.00



6.4.2.5 Consciousness of Pollution

As traffic environment, there are many problems such as air pollution, noise pollution or vibration by traffic. Only air pollution matter is chosen in order to find the consciousness of driver. The result is that almost 90% of driver are very interested in air pollution now. The consciousness of air pollution can be said very high percentage.(Q5-A)

However, more than half of driver agree with the opinion that the speed limitation which will be introduced by traffic enforcement in order to prevent air pollution.(Q5-B) This result is also different of survey results on Karak highway.

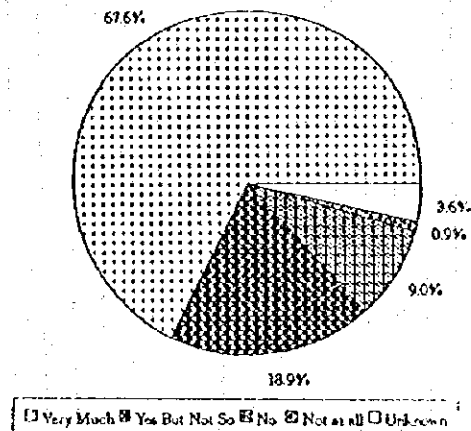
The highest consciousness for air pollution is found in frequent driver group and its score is 79%.

Although more than half of driver agree to introduce speed limitation for prevent traffic pollution, middle age group shows higher percentage than average. The percentage of it is 66% and it is the highest score in any other group.

Q5. Question about Consciousness of Traffic Environment

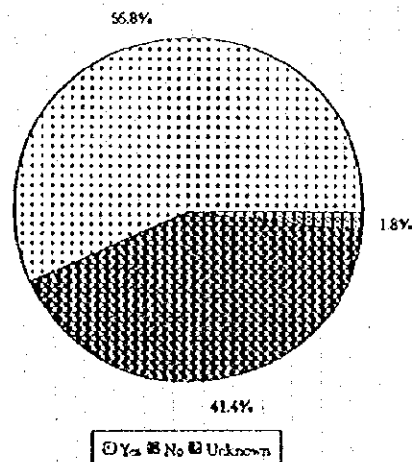
Q5A) Are you concerned for transportation pollution such as air pollution, noise pollution or vibration by traffic ?

	Very much	Yes but not so	No	Not at all	Unknown	Total
	75	21	10	1	4	111
%	67.57	18.92	9.01	0.90	3.60	100.00



Q5B) Do you agree to follow the speed limitation by traffic enforcement in order to prevent pollution on express or highways. If necessary ?

	Yes	No	Unknown	Total
	63	46	2	111
%	56.76	41.44	1.80	100.00



Technical Volume

Chapter 7

**CLASSIFICATION OF ROAD SIDE
AREAS FOR THE ENVIRONMENT
PRESERVATION**

CHAPTER 7 CLASSIFICATION OF ROAD SIDE AREAS FOR THE ENVIRONMENT PRESENTATION

7.1 GENERAL

Areas that are experiencing a high level of traffic volume will face environmental pollution problems. On the other hand, the high level of accessibility will increase the development potential of the land.

The value of the land and development pressure along the road side will increase for non residential purposes, such as commercial complexes, industrial lots, power plants, etc. This type of land use functions as a buffer zone and can be an effective counter measure to traffic related environmental problems.

The following discusses aspects of such countermeasures for potential road side development.

7.2 CLASSIFICATION OF ROAD SIDE AREAS

Considering the anticipated pollution problem and the construction of highways, the following shows the classification of area development :

- Existing Urban Area - Areas that have been gazetted for development
- Planning Urban Area - Areas to be part of the urban area
- Undeveloped Area - Area outside the urban areas that have potential to be part of the urban area in the future.

1) Classification of Existing Area (type a)

An area that is to be gazetted as the existing urban area must have the following criteria :

- Density of population must be higher than the requirement
- Building location should be more desist than the requirement
- Urban facilities (road and park, etc) should be praised more than the requirement
- The area should be presently gazetted in the Structure Plan.

For this type of existing area, the environmental and reservation area should comprise the development planning conditions as shown in Figure 7-1.

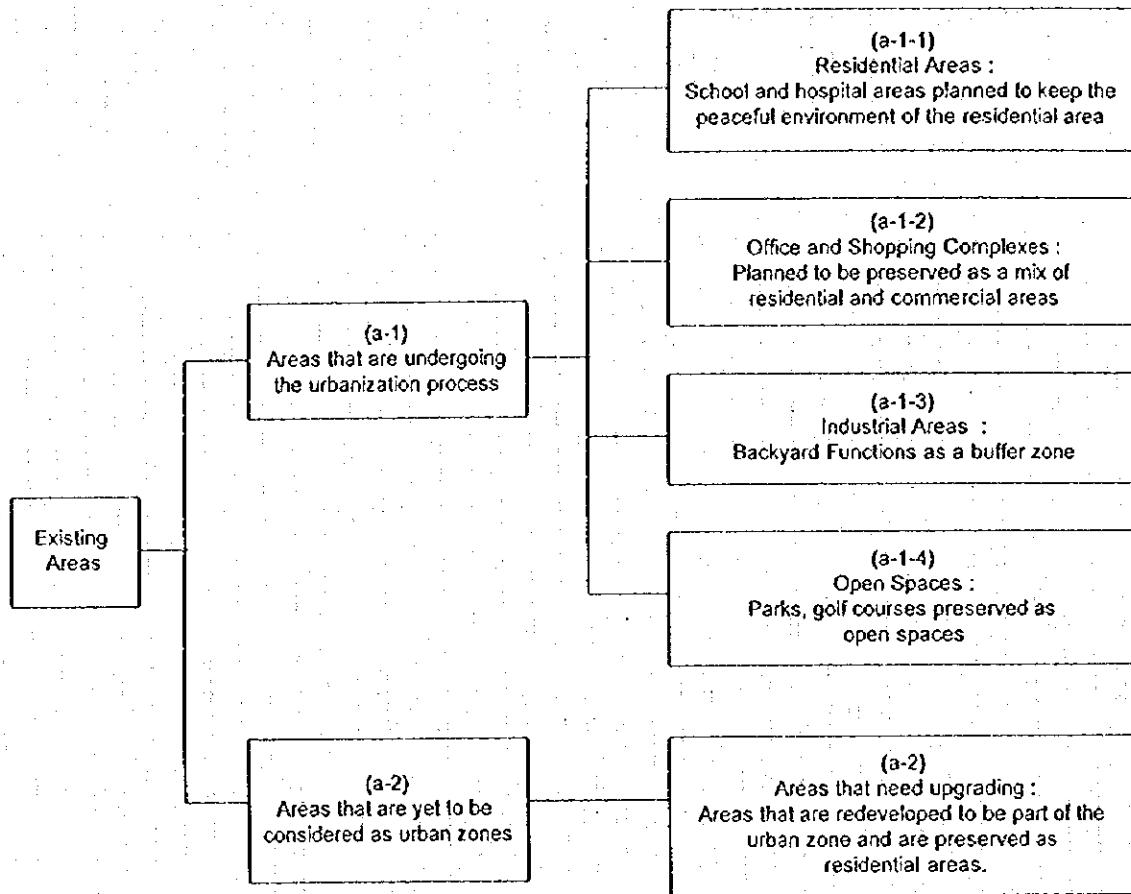


Figure 7-1 : Classification of Existing Area

2) Classification of Planning Area (type b)

This type of area should comprise land that is not gazetted for urbanization and is not part of the existing area. However, it has been gazetted as an area to be developed as according to the following :

- Local Plans
- Approved for building or in the process of applying for private sector development.
- Planned by particular authorities to be a location for public facilities.

With regard to this type of planning area, the planning context is fixed and the land use planning is classified as shown in Figure 7-2.

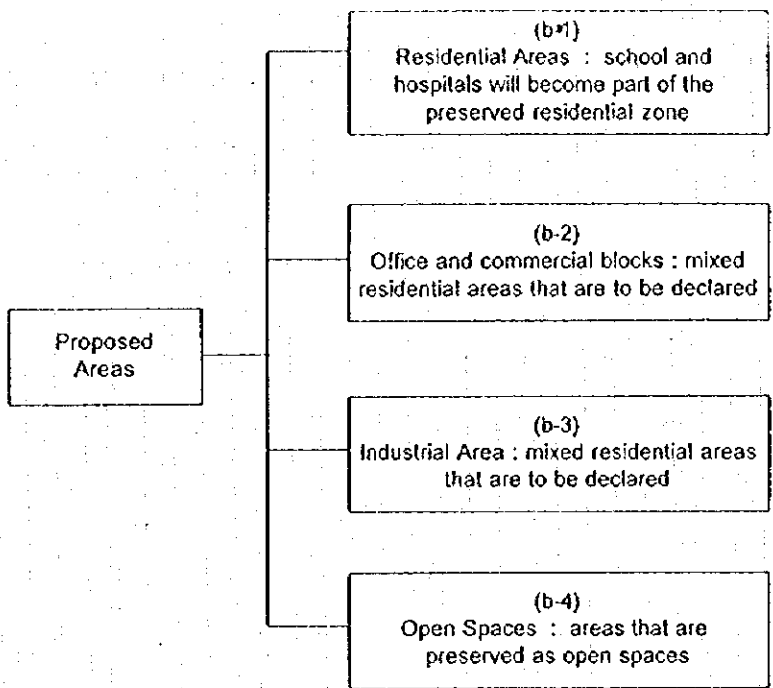


Figure 7-2 : Classification of Planning Area

3) Classification of Undeveloped Areas (type c)

These types of areas are comprised of those that are not included in the land use plan for urban development. They are also not classified as part of the existing area and are not part of the area to be developed. Moreover, they should be not gazetted as green areas or forest reserves. These types of areas will be included in the structure plan for expansion of urban areas according to the following:

- Categorized as additional area for urbanization in the structure plan
- Not categorized as forest reserve or naturel preservation area.

For an area that is selected to be used for infrastructure purposes, such as a highway interchange, the requirement is specified as follows :

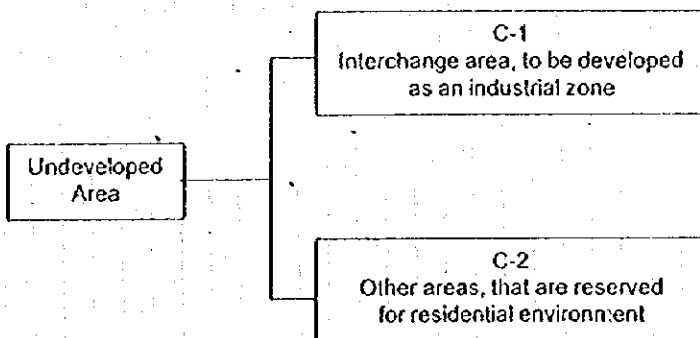


Figure 7-3 : Classification of Undeveloped Area

7.3 AREA CLASSIFICATION AND ENVIRONMENTAL COUNTERMEASURES

The schedule below explains the implementation of environmental countermeasures for the classified area of highway. This cutline schedule is a plan for overcoming noise pollution from road traffic.

Table 7-1 : Area Classification and Environmental Countermeasure

Area Classification		Road Surface Countermeasure				Road Side Countermeasure		
		Counter Measure on Source of outbreak	Traffic Management	Counter Measure on Road Surface Structure	Improvement of Road Structure	Buffer Zone	Restricted Land Use of Road Side Area	Road Side Development
a: Existing Area	a-1-1 Residential Area	●	●	●	★	●		
	a-1-2 Commercial Area	●	●	★		★	●	
	a-1-3 Industrial Area	●	●	★		★	●	
	a-1-4 Open Space	●	●				●	
	a-2 Reserve Area	●	●	★			●	
b: Planning Area	b-1 Residential Area	●	●	●	★	●	●	●
	b-2 Commercial Area	●	●			●	●	
	b-3 Industrial Area	●	●			★	●	
	b-4 Open Space	●	●			★	●	
c: Undeveloped Area	c-1 Interchange Area	●	●				●	●
	c-2 Others	●	●			●	●	

- Countermeasure is applicable
- ★ Countermeasure may be applicable

7.4 PRESENT CONDITION OF THE STUDY AREA

To provide suitable environmental countermeasures, the present condition of the study area should be examined, since the implementation method is selected for each town area.

(1) Evaluation items for present condition analysis

The following method is presented to show how to evaluate the peculiar characteristics of the present condition in order to implement the selected environmental countermeasures for the study area.

■ Collation of the Present Condition Data

Some 200 meters of the road side area, measured from the edge of the expressway, is considered to be environmentally effected. So, both sides of the road are reserved for the collation of the present condition data.

Areas where the expressway interfaces with many natural and man made features, such as rivers, roads, railways and interchanges have to be reserved accordingly. The reserve should indicate a clear division of these features.

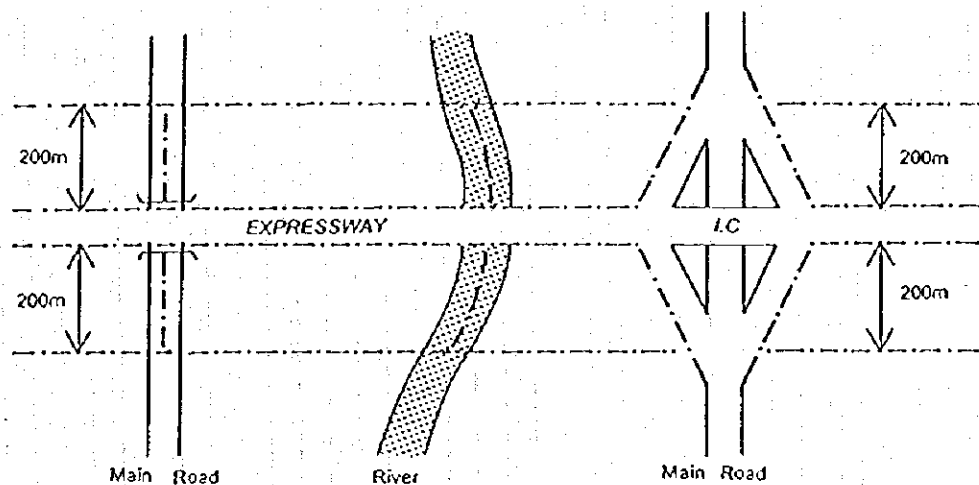


Figure 7-4 : Areas for Collecting Existing Data

■ List of Items for the Present Condition Data

For the implementation of the town area classification, the following data should be collected :

- Density of buildings
- Land use patterns
- Condition of the infrastructure of the town
- Availability of the area development plan and its content
- Distance from the interchange

■ Pattern of the Present Plans of the Area




The pattern of the present plans of the area are stated below :

Table 7-2 : Pattern of the Present Plans of the Area

Item	Content	
Density of Houses or Buildings	<ul style="list-style-type: none"> • To measure the density of houses or building that have been built in the target zones • unit : house/ha 	
Land Use Planning	<ul style="list-style-type: none"> • With regard to the land use in the target zone, the schedule below indicates the division of land use that had been planned and the total land area available 	
	Division of Land Use	Land Use Breakdown
	Residence Area	Sites for houses, schools, hospitals, libraries, religious use facilities and other facilities that need a quiet environment and facilities that require ample space (example : parking lots)
	Commercial Area	Sites for stores or shops, offices, hotels and other commercial and business facilities and facilities that require ample space.
	Industrial Area	Sites for factories, distribution facilities and facilities that require ample space.
Roads, parks and others	Road reserves, park reserves, golf parks, grave yards, unused lots and other lots.	
Condition of Land Preservation	<ul style="list-style-type: none"> • Form the land use pattern, the area for urban facilities, such as roads and park have separated from the total available land • Determine the way to preserve the environment for residential areas in target zones. Other items that are relevant to the residential environment need special attention and are open for discussion • On the next page, the research on Land Readjustment in relation to the environmental residence standard will be discussed 	
Development Planning	<ul style="list-style-type: none"> • "Town Planning Development" for the "Inside Target Zone" , (in the Local Plan or other development planning) has to be checked for its existence and context. • This item is easily determined for zones with development planning in which the land use plan at the target zone can be calculated in terms of residential, commercial and industrial uses. 	
Distance from Interchange	<ul style="list-style-type: none"> • The distance from the target zone to the closest interchange is estimated for all interchanges and toll plaza areas. 	

Table 7-3 : Example of Evaluation of Living Environment

CATEGORY	ITEM	Zone 1			Zone 2			Zone 3			Total		
		GOOD	FAIR	BAD	GOOD	FAIR	BAD	GOOD	FAIR	BAD	GOOD	FAIR	BAD
INFRASTRUCTURE AND PUBLIC SERVICE	Road and Bridge												
	Parks and Playgrounds												
	Water Supply												
	Sewerage												
	Drainage												
	Public Transport												
	Health Care												
	Nursery and Kindergarten												
	Primary Education												
	Higher Education												
	Postal Services												
	Electricity												
	Garbage Collection												
	ENVIRONMENT CONDITION	Natural Environment											
Noise Pollution													
Air Pollution													
Water Pollution													
Sanitary Problems													
Security													
OTHER SERVICES	Daily Shopping												
	Banking Service												
	Entertainment / Amusement												
	Sports / Recreation												
	Religious Facilities												
HOUSING LOT	Cultural Facilities												
	Lot Space												
	House Space												
	No. of Rooms												
	Structure / Building Materials												
ECONOMY	Lot Shape / Direction and Location												
	Price of Daily Goods												
NEIGHBOURHOOD	Job Opportunity												
	For Children												
	For Housewives												
ACCESSIBILITY TO AND FROM	For Aged												
	Workplace												
	School												
	Shopping												
OVERALL LIVING ENVIRONMENT	Sports / Culture and Recreation												

-  GOOD : Good or Sufficient or No Problem at All
-  FAIR : Fair or Tolerable
-  BAD : Bad or Insufficient or Problematic

(The Feasibility Study on The Introduction of Land Readjustment)

(2) Guideline For Urban Area Classification

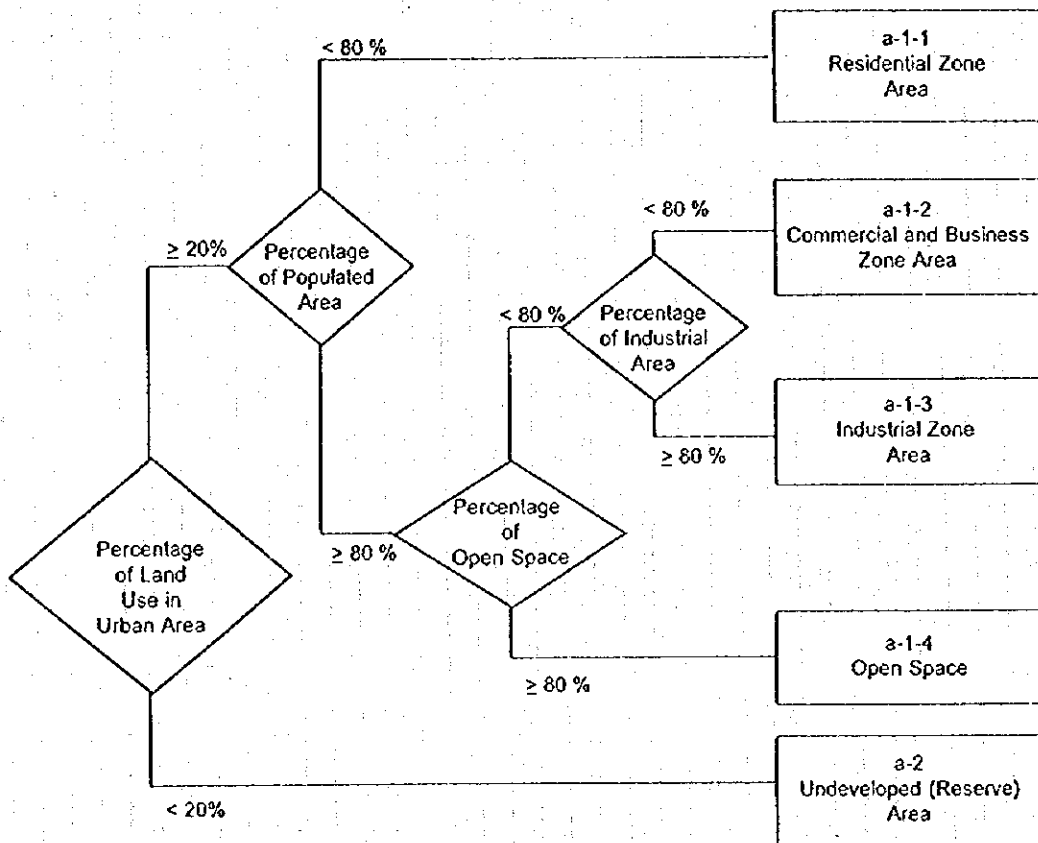
The guideline for determining the urban area classification by specific present condition data is outlined below.

Classification of the Road Side Area According to the Degree of Urban Area.

The road sides of urban areas will be classified to be either established or built up areas, design or planned areas and potential or proposed areas. However, the classification should be treated as only a standard reference due to lack of detailed information on the density of houses or buildings, and the numerous assumptions that need to be made in spite the actual land-use condition.

■ Classification of the Built-up Area

The method to classify the built-up area of an urban area is shown below. However, it should be noted that the specified standards serve only as a reference.

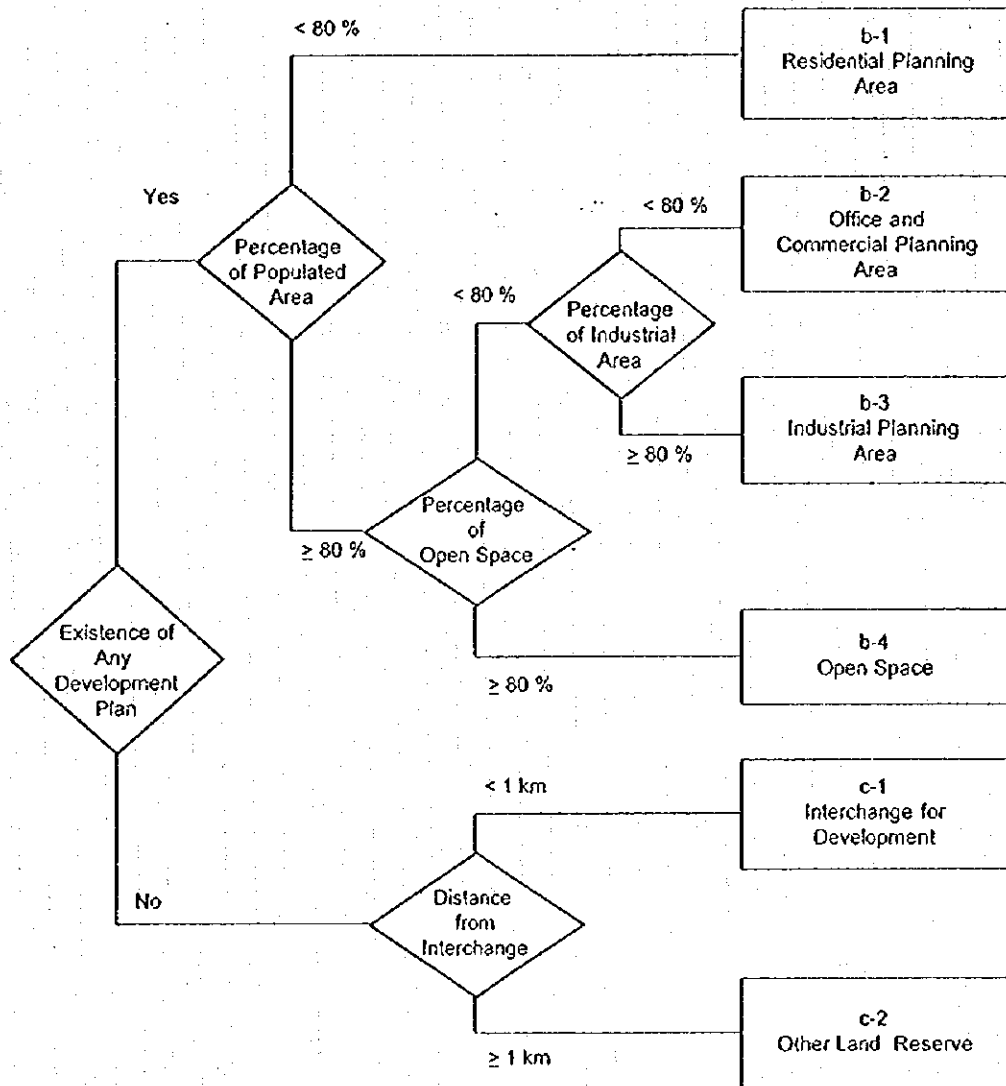


• Percentage of Open Space = (Percentage of Areas Provided for Parks) + (Percentage of Other Land Area)

Figure 7-5 : Classification of the Built-Up Area

■ Classification of the Planned or Designated Area

Classification of planned or designated area outside an urban areas is shown below. However, it should be noted that the specified standards serve only as a reference.



* Percentage of Open Space = (Percentage of Areas Provided for Parks) + (Percentage of Other Land Area)

Figure 7-6 : Classification of the Planned Designated Area