2.4.4 Planning of Intersection

Intersection planning is proposed on basis of the traffic analyses presented in Section 2.3; however, the traffic capacity at the intersections should be in conformity with the Standards of Highway Structure of the Japan Highway Association.

(a) Methods of Traffic Control

Intersections are classified according to the method of traffic control, as follows.

- Intersections not subjected to traffic control.
- Intersections subjected to traffic control. --- signal controlled intersections, low priority roads.

If the intersection has a traffic volume demand which can be possibly handled by signs, it can be designed under a warning stop control by properly positioning traffic safety signs such as traffic signs, road marking, etc.

On the basis of AASHO's requirements, Table 2.4.11 shows the standards for the traffic volume required for passing at the intersections without obstructing the main lane traffic without signals.

Table 2.4.11 Maximum allowable Traffic Volume at Crossing Without Obstructing the Main Lane Traffic (max. allowable vehicles by two ways per hour)

vehicles

Two-lane main highway	Main highway traffic volume	400	500	650
	Intersecting traffic volume	250	200	100
Four-lane main highway	Main highway traffic volume	1,000	1,500	2,000
	Intersecting traffic volume	100	50	25

From the result of the traffic analysis, there are places where traffic demand originates which can not be handled under a warning stop control at the intersections of arterial roads (Sukhumvit, T-1, T-2, R-1). Therefore, the study should be based on the following design considerations.
On the intersection of both arterial roads, the signal control will be implemented according to the traffic volume.
At the other intersections warning stop controls will be provided so that the priority of through and non-through highway is made clear.

Table 2.4.12 Principles of Traffic Control Method

Main highway \ Intersecting road	R-2 or Existing road	R-1	T-1, T-2	Sukhumvit H.W.Y
Sukhumvit H.W.Y	B	B	A, B	
T-1, T-2	B	A, B		
R-1	B			
R-2 or Existing road	B			

A; Intersections with signals
B; Temporary stop intersections

(b) Study of Intersections with Signals

Investigations of intersections with signals shall be performed at the 10 places shown in Fig. 2.4.12.

(1) Incoming and outgoing traffic volumes in 1986 and 1996 are shown in Fig. 2.4.13.

(2) When the traffic flow is deemed as a complete "Poisson arrival", the crossable maximum traffic volume under non-signal conditions can be obtained from the following formula.

$$\lambda = \frac{\mu e^{-\mu t}}{1 - e^{-\mu To}}$$

whereas,
- λ: Crossable maximum traffic volume (vehicles/hr)
- μ: Traffic volume through highway per unit time (vehicles/hr)
- To : Interval of consecutively crossing (seconds)
- t : Time required for crossing the through highway (seconds)
- e : Base of the natural logarithum

Supporting that it is 7.5 seconds on a four-lane highway and 6 seconds on a two-lane highway, the traffic volume passable without disturbing the main highway traffic flow is within the range of (B) shown in Fig. 2.4.14.

(3) When all exclusive right turn lanes are to be added with a sufficient length, the range of traffic volume passing by signals will become as follows.
When the main highway is of four-lanes:

$P_1 = 1800^{*1} \times 2 \times 0.960^{*3} \times 0.950^{*4} \times 0.90^{*5}$ = 2,955 vehicles/green light hour

When the main highway is of two-lanes:

$P_1 = 1800^{*1} \times 1 \times 0.960^{*3} \times 0.90^{*5}$ = 1,555 vehicles/green light hour

In the case of intersecting roads:

$P_2 = 1200^{*2} \times 2 \times 0.960^{*3} \times 0.90^{*5}$ = 2,305 vehicles/green light hour

Whereas,

*1 Basic traffic capacity of non-intersections	: 1,800 vehicles/green light hour
*2 Basic traffic capacity of turning lanes	: 1,200 vehicles/green light hour
*3 Correction due to mixing of large-sized vehicles	: 0.960 (assumed as 5%)
*4 Correction due to mixing of left-turning vehicles	: 0.950 (assumed as 10%)
*5 Safety factor due to intersection delay, etc.	: 0.90

From the above calculation, the traffic volume passig by the signal is within the range of (A) shown in Fig. 2.4.14.

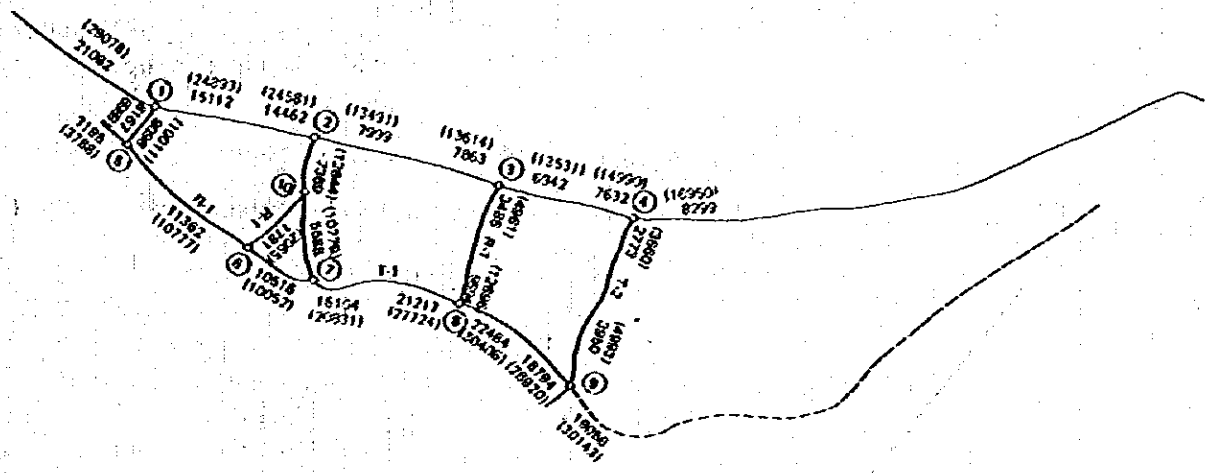


Fig. 2.4.12 Traffic Assignment 1986 (1996)

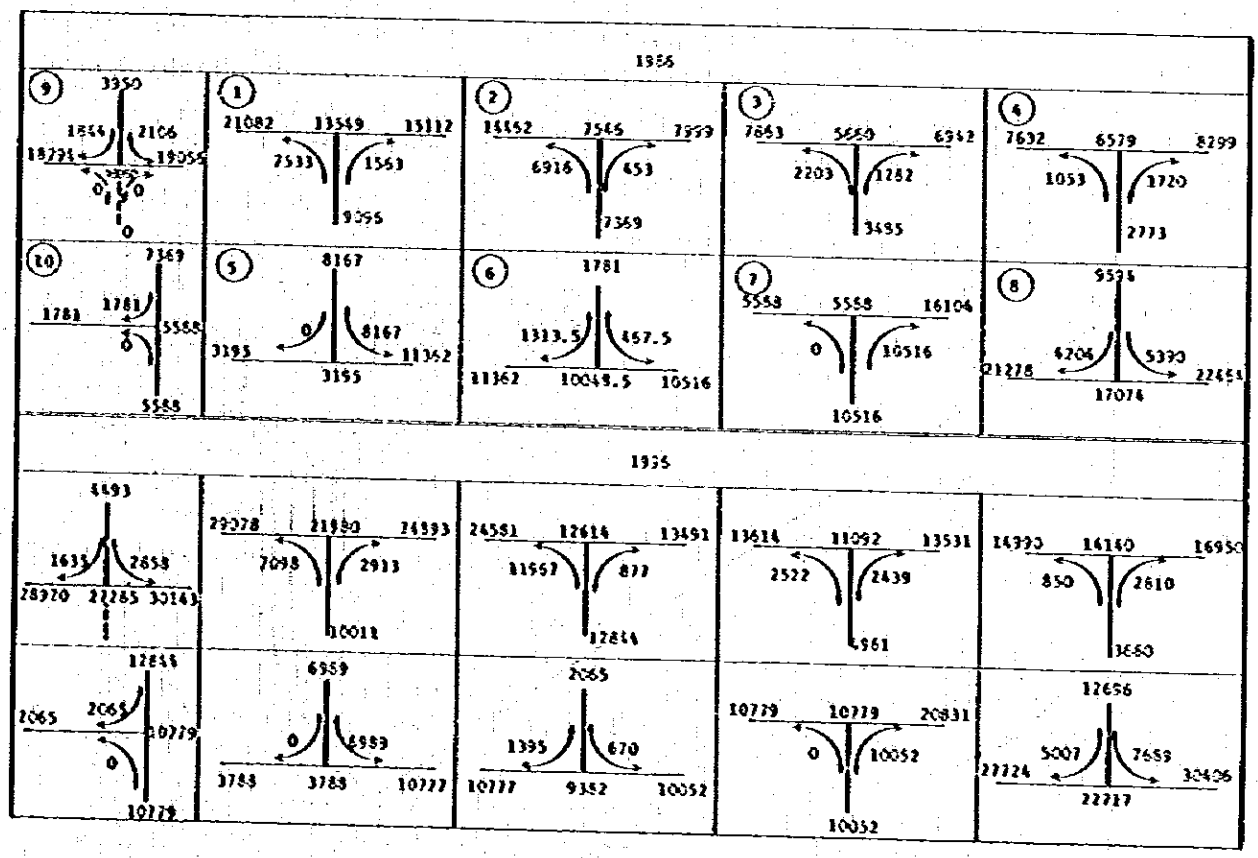


Fig. 2.4.13 Traffic Assignment in Each Direction (1986 and 1996)

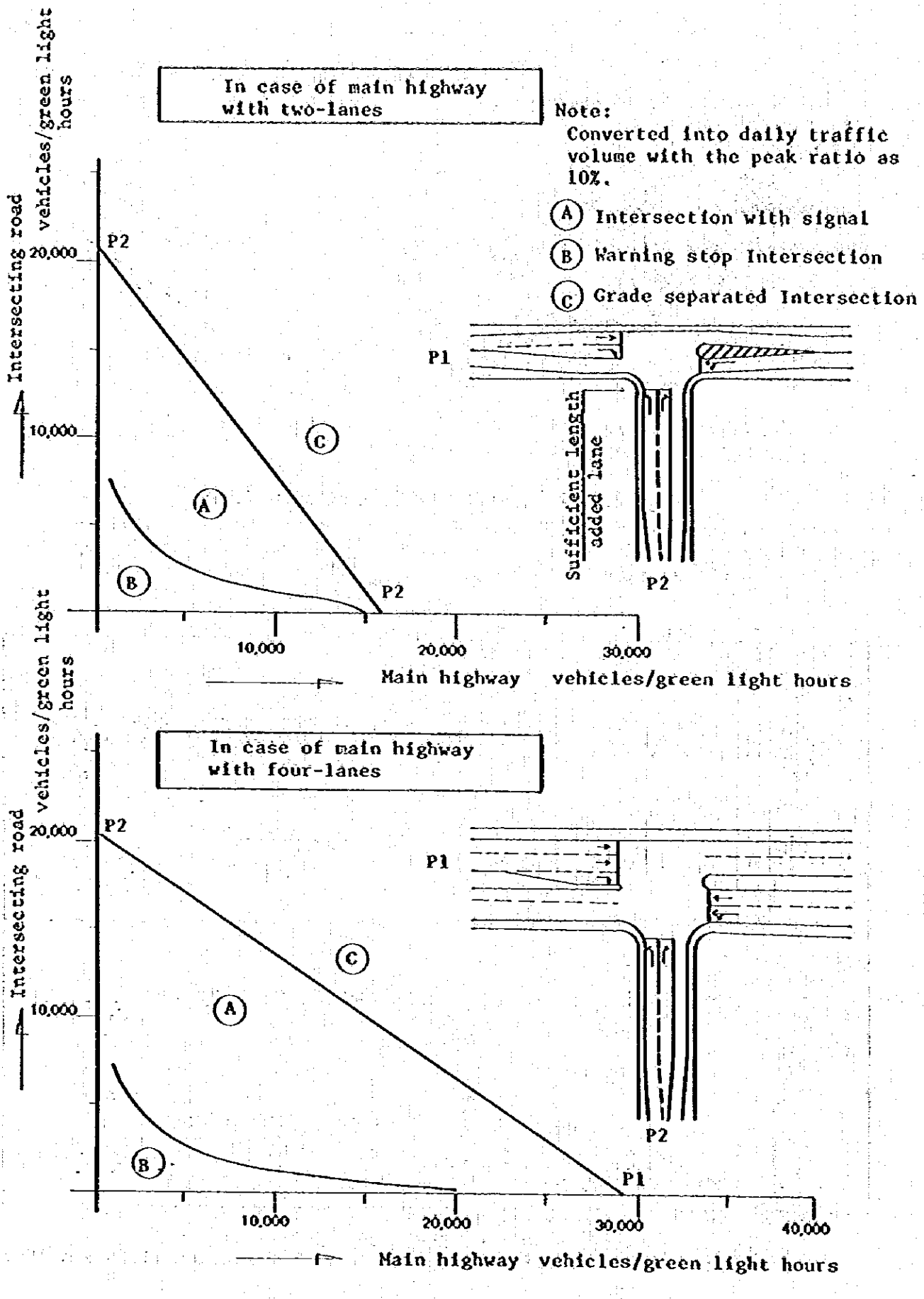


Fig. 2.4.14 Range of Traffic Control Method

(4) Intersections provided with signals

Table 2.4.13 shows the classified traffic control methods obtained from Fig. 2.4.14. Intersections and places where the establishment of signals are preferable are also shown at the same time in Table 2.4.13.

Table 2.4.13 Classification of Traffic Control Methods

No.	1986	1996	Decided control method	Remarks
1	A	C	A	
2	A	A	A	
3	A	A	B	
4	A	A	B	
5	A	A	A	
6	A	A	B	
7	A	A	A	
8	A	C	A	
9	A	C	A	
10	B	A	B	

It would be premature to determine that the traffic volume exceeding the sphere (B) shown in Fig. 2.4.14 is the standard for establishing signals and the following problem aspects are found when the traffic volume is relatively small.

- Leads to a traffic volume capacity reduction when futile stops are implemented.
- When the establishment of control by signals is not suitable, ill effects such as increases in rearend collisions, traffic capacity reductions, etc., are accompanied.
- Since Pattaya is a tourist resort, the time fluctuation is great and a uniform provision of signals leads to a decline in the service.

Therefore, a comprehensive technical evaluation is necessary for determining the employment of signal controls.
In accordance with the "Signal Establishment Standards" which is introduced in the standards of highway structure, signal establishment places in Pattaya shall be the 6 places shown in Table 2.4.15. In these cases, establishing signals at intersections for mainly performing traffic regulation of vehicles:

In the year 1996, a slight shortage of capacity will occur at these intersections (8) and (9); however, since these intersections are on T-1, it has been planned to increase capacity by conversion into a coordinated signal control to be mentioned later and by establishment of left-turn exclusive lanes.

Table 2.4.14 Standard for Warning Stopping Intersection

Main roads	Carriageway width		Both ways traffic volume of automobiles, etc., on main roads	Inflow traffic volume of automobiles, etc., on a road which possesses the maximum inflow volume among minor roads
	Main roads	Minor roads	More than the following vehicles for 12 hours (or for 1 peak hour)	More than the following vehicles for 12 hours (or for 1 peak hour)
Main arterial roads	Less than 10 m	Less than 10 m	6,000 (650) 7,000 (750) 9,000 (1,000)	2,700 (300) 2,100 (230) 1,500 (160)
	Less than 10 m	More than 10 m	6,000 (650) 7,000 (750) 9,000 (1,000)	3,300 (360) 2,500 (280) 1,800 (190)
	More than 10 m	Less than 10 m	7,000 (800) 8,000 (900) 11,000 (1,200) 14,000 (1,500)	2,700 (300) 2,100 (230) 1,500 (160) 1,050 (120)
	More than 10 m	More than 10 m	7,000 (800) 8,000 (900) 11,000 (1,200) 14,000 (1,500)	3,300 (360) 2,500 (280) 1,800 (190) 1,300 (140)
Urban area street	Less than 10 m	Less than 10 m	8,000 (750) 9,000 (800) 13,000 (1,200)	3,800 (350) 3,100 (270) 2,000 (190)
	Less than 10 m	More than 10 m	8,000 (750) 9,000 (800) 13,000 (1,200)	4,500 (420) 3,500 (320) 2,500 (220)
	More than 10 m	Less than 10 m	10,000 (900) 12,000 (1,000) 15,000 (1,400) 20,000 (1,800)	3,800 (350) 3,100 (270) 2,000 (190) 1,450 (140)
Urban area street	More than 10 m	More than 10 m	10,000 (900) 12,000 (1,000) 15,000 (1,400) 20,000 (1,800)	4,500 (420) 3,500 (320) 2,500 (220) 1,700 (160)

(5) Types of signals

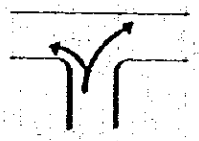
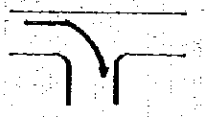
Types of signals can be roughly classified into the fixed-time control and the traffic actuated control. The types of signals in Pattaya shall be of the fixed-time control type for the following reasons.

Maintenance and operation are easy and economical in comparison with the traffic actuated control type.

The fixed-time control is easily adapted to coordinate applications and accommodations to traffic volume increase is facilitated. With the application of multiple fixed-time controls, the setting of phased matching time zones such as peak hours, normal hours, night hours, etc., can be done and this proves to be effective.

Moreover, computing the approximate phased time in the peak time zone of 6 intersections where signals are to be established, they will become as shown in Table 2.4.15 (Provided however, it is the traffic volume of 1986 and has been computed with a ratio of direction with as high a percentage of traffic as 60% and a peak ratio at 10%.)

Table 2.4.15 Appropriate Phased Time of Peak Hours (Second)

		1	2	5	7	8	9
First phase		22 + 4	14 + 4	10 + 4	29 + 4	35 + 4	54 + 4
Second phase		31 + 4	35 + 4	37 + 4	53 + 4	25 + 4	17 + 4
Third phase		25 + 4	29 + 4	31 + 4		18 + 4	7 + 4
Total		90	90	90	90	90	90

Note: 4 seconds is the time of (Yellow + Red).

(c) Design of Intersections

On the basis of the previously mentioned principles, the designed at-grade intersections are shown in Fig. 2.4.16.

Exclusive right-turn lanes have been designed for all arterial roads for the following reasons.

Straight traffic is the main traffic road at intersections and this main traffic will not be obstructed by mixing with right-turn vehicles. Therefore, design of exclusive right-turn lanes prevents reduction of traffic capacity.

At intersections, not only traffic capacity reduction is encountered, but they become bottlenecks also from the aspect of traffic accidents. Therefore, together with the geometric design aspects, the design should be made upon correlating it with the traffic safety facility plan mentioned in Item 2.4.5.

Now, in the analysis of these intersections, it is mentioned that we will use the traffic volume of 1986 for the design of intersections. Therefore, the timing of signal establishment at the above mentioned 6 signal intersections will become a problem. At present, however, it would be difficult from the point of view of accuracy to mention its time of establishment and it should be established in the year when such a necessity arises according to the degree of congestion.

1) Geometric design standards

(1) Design vehicles

Fig. 2.4.15 Design Vehicles

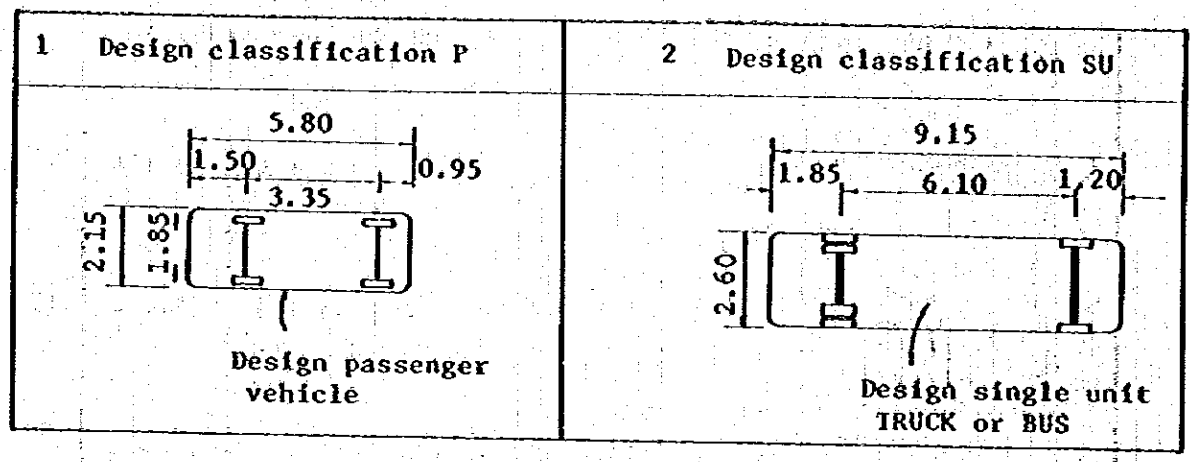


Table 2.4.16 Minimum Turning Radius of Design Vehicles

Design vehicle type	Passenger car	Single Unit truck	Single Unit bus
Symbol	P	SU	BUS
Figure	C-1	C-2	C-3
Min. turning radius, feet	24	42	42
Min. inside radius, feet	15.3	28.4	20.3

There shall be no incoming and outgoing of semi-trailers on roads and highways in the Pattaya area. Moreover, there shall also be no incoming and outgoing of large-sized vehicles such as buses, etc., on the roads.

Based on the above conditions, at-grade intersections can be largely classified into two types; those including R-2 and those not including R-2. (At intersections of R-2 roads, trucks can somehow make position shifts.)

- Design with design classification P: R-2, R-2' (Streets)
- Design with design classification SU: Other roads

(2) Minimum design value of turning carriageway

The design values of P vehicles (Passenger vehicles) and SU vehicles (single unit trucks or buses) are based on AASHO standards.

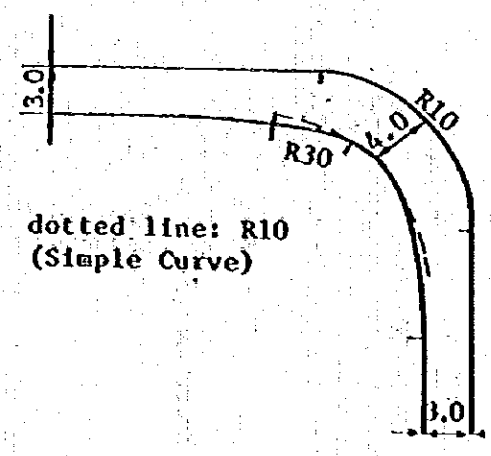
Table 2.4.17 Minimum Design Value of Turning Carriage Way

		3-Centered Compound Curve	Simple Curve	Remarks
Passenger Vehicles (P)	Inside	100-20-100 30-6-30	30 10*	*Use the large radius in case of less than the standard width (12 ft) of AASHO.
	Width	2+8.7+2=12.7 4.0	-	
	Outside	20+12.7=32.7 6.0+4.0=10.0	-	
Single Unit Trucks or Buses (SU)	Inside	120-40'-120 36-12-36	50 22*	*Use the large radius in case of less than the standard width (12 ft) of AASHO.
	Width	2+13.6+2=17.6 5.5	-	
	Outside	40+17.6=57.6 12.0+5.5=17.5	-	

Upper dimensions in Table: AASHO minimum standard value (ft)
Lower dimensions in Table: Values used in this design (m)

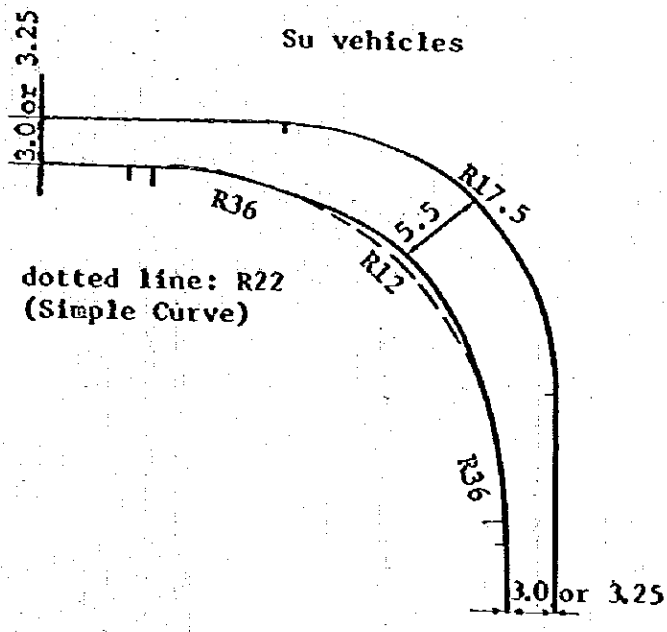
The Standard Type of 3-Centered Compound Curve

P vehicles



dotted line: R10
(Simple Curve)

Su vehicles



dotted line: R22
(Simple Curve)

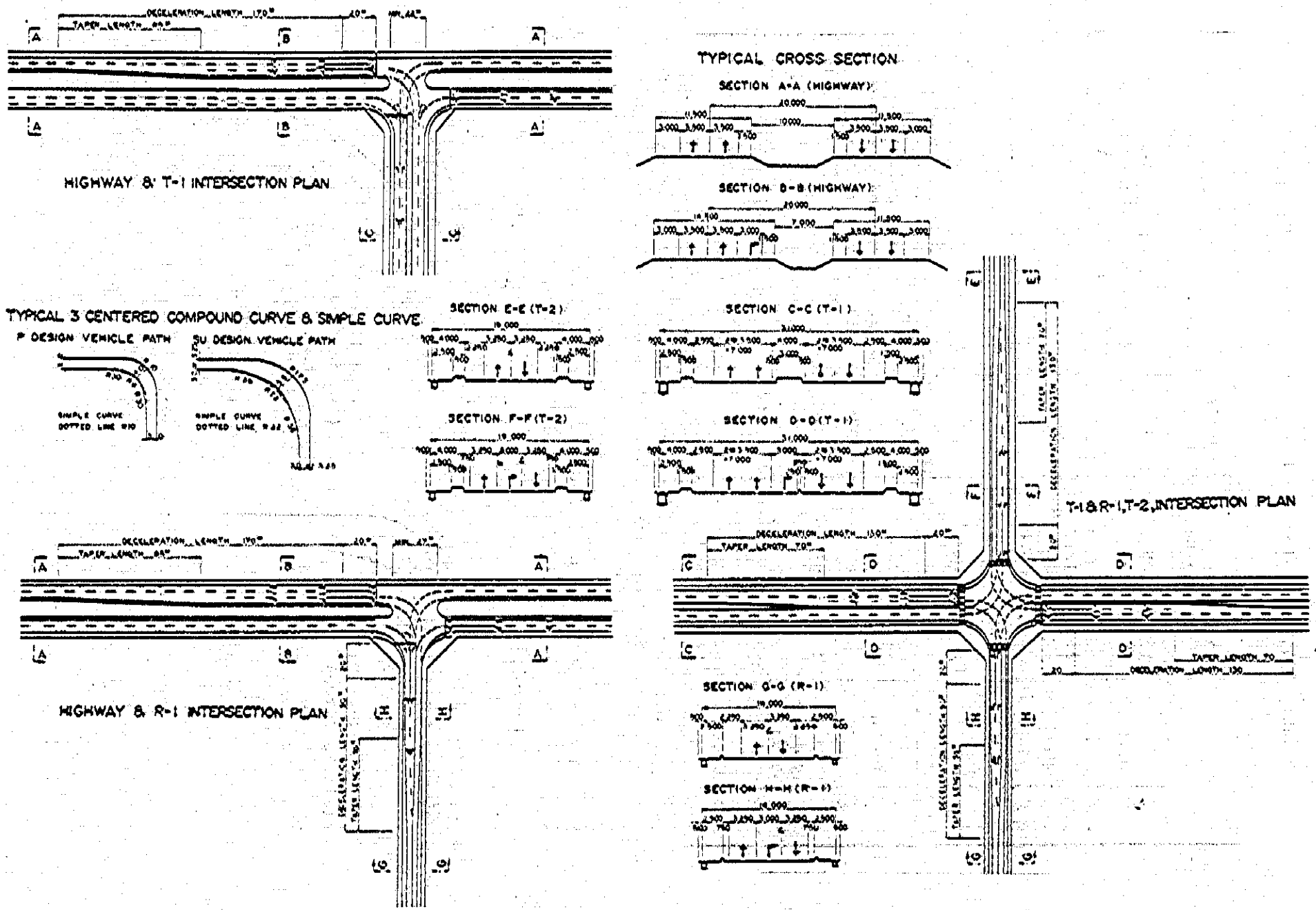


Fig. 2.4.16 (1) Standard Design of At-Grade Intersection

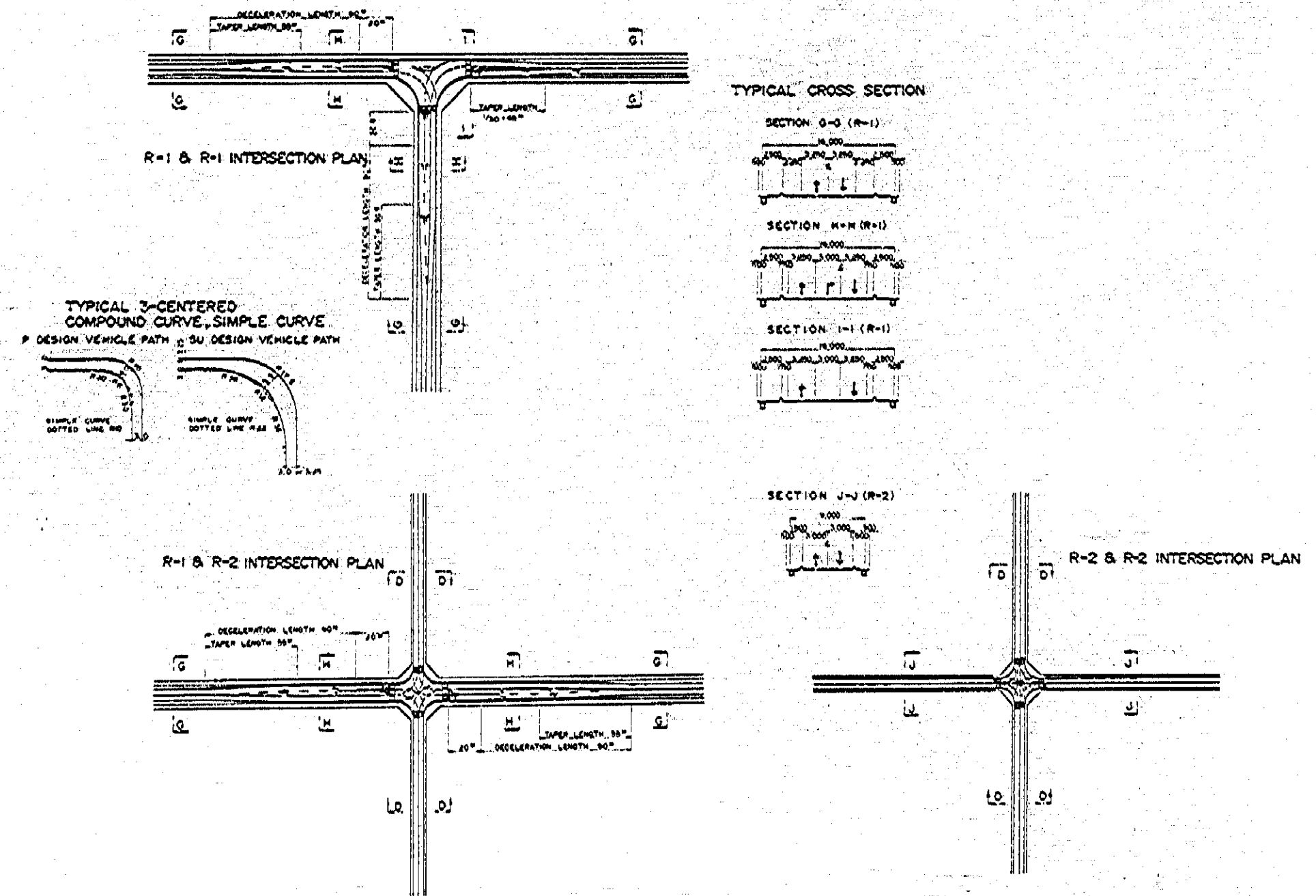


Fig. 2.4.16 (2) Standard Design of At-Grade Intersection

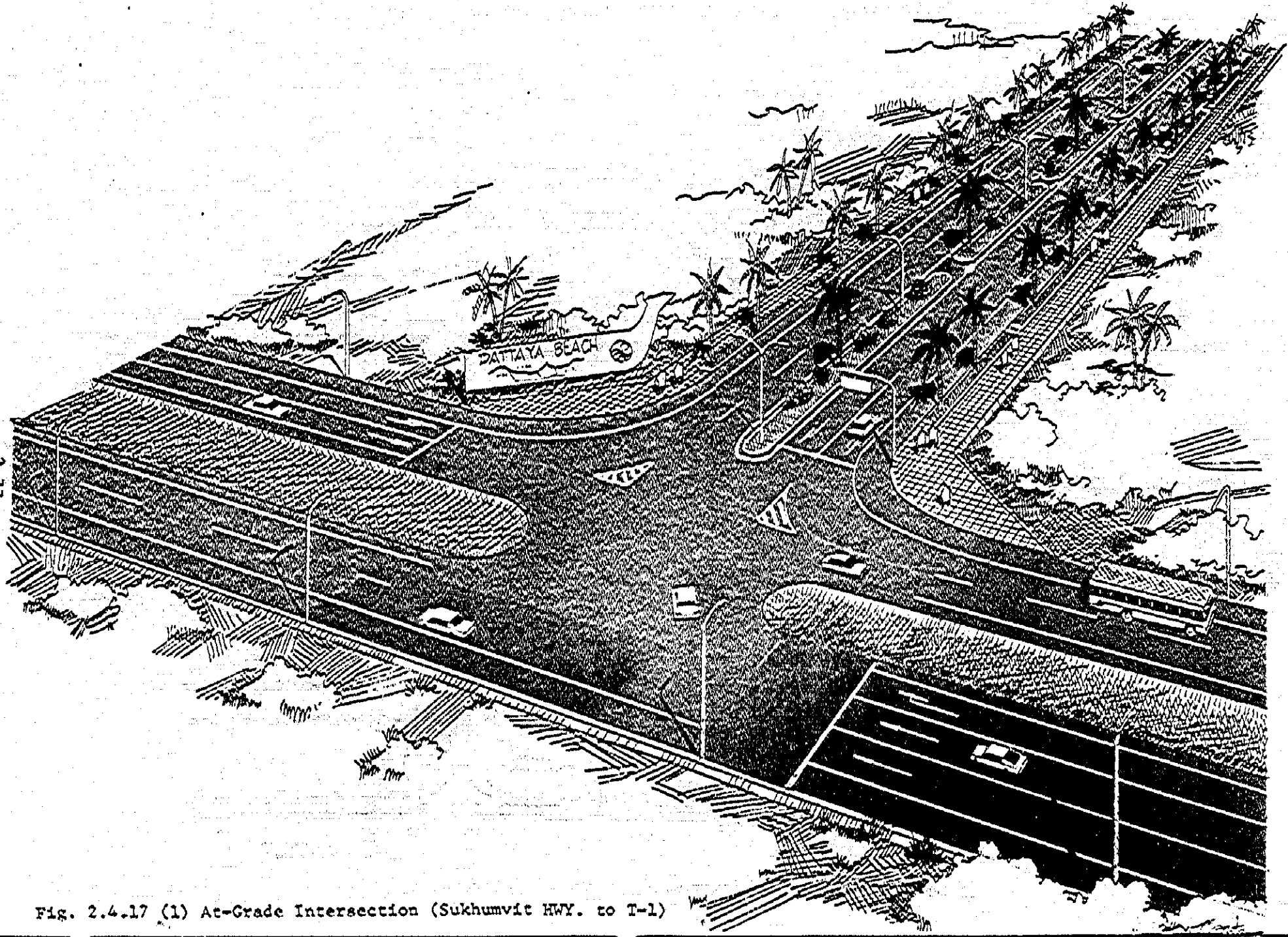


Fig. 2.4.17 (1) At-Grade Intersection (Sukhumvit HWY. to T-1)

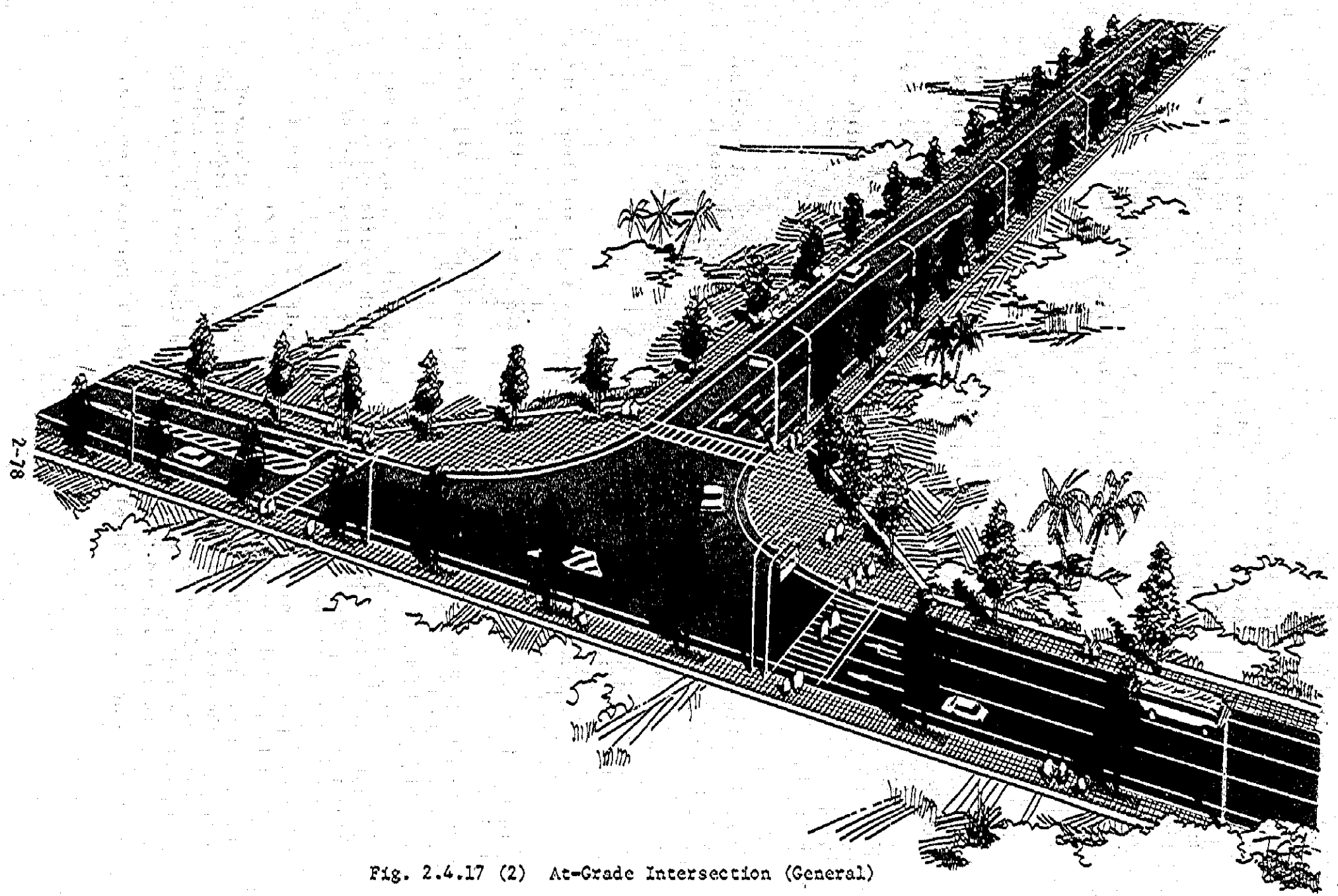


Fig. 2.4.17 (2) At-Grade Intersection (General)

2.4.5 Traffic Safety Facility Plan

Traffic safety facilities will be provided for the purpose of sufficiently achieving the functions which ensure safety and the smooth running of road traffic. These main facilities are traffic signs, traffic marking, traffic signals, highway lighting, etc.

(a) Traffic Signs

From their functions, traffic signs can be classified into

- Danger or warning signs
- Regulatory signs
- Informatory signs, etc.

Since the signal places provided are mainly located at intersections, there are many danger or warning signs and regulatory signs needed in this study area. Due to this characteristic, it has been designed as a block with road markings, etc.

The example of traffic signs at intersections and traffic signs along the road side of this study area are shown in Fig. 2.4.18.

These signs are based on the United Nations Conference on Road Traffic - Vienna, October 7 to November 8, 1968, which conform to those of the existing standards utilized in Thailand.

(b) Traffic Markings

Traffic markings can be classified into, pavement markings, curb markings, vertical paint markings, markers like chatter bars. In this design, the main traffic marking is for pavement markings.

Pavement markings in this plan consist of the following.

- Center line marking (T-2, R-1, R-2)
- Boundary line marking (T-1)
- Border line marking (T-1, T-2, R-1, R-2)
- Other markings (arrow marks, pedestrian crossings, stop-lines, etc., at intersections)

These markings must be harmonious with the existing standards utilized in Thailand.

The examples of pavement markings at intersections are shown in Fig. 2.4.19.

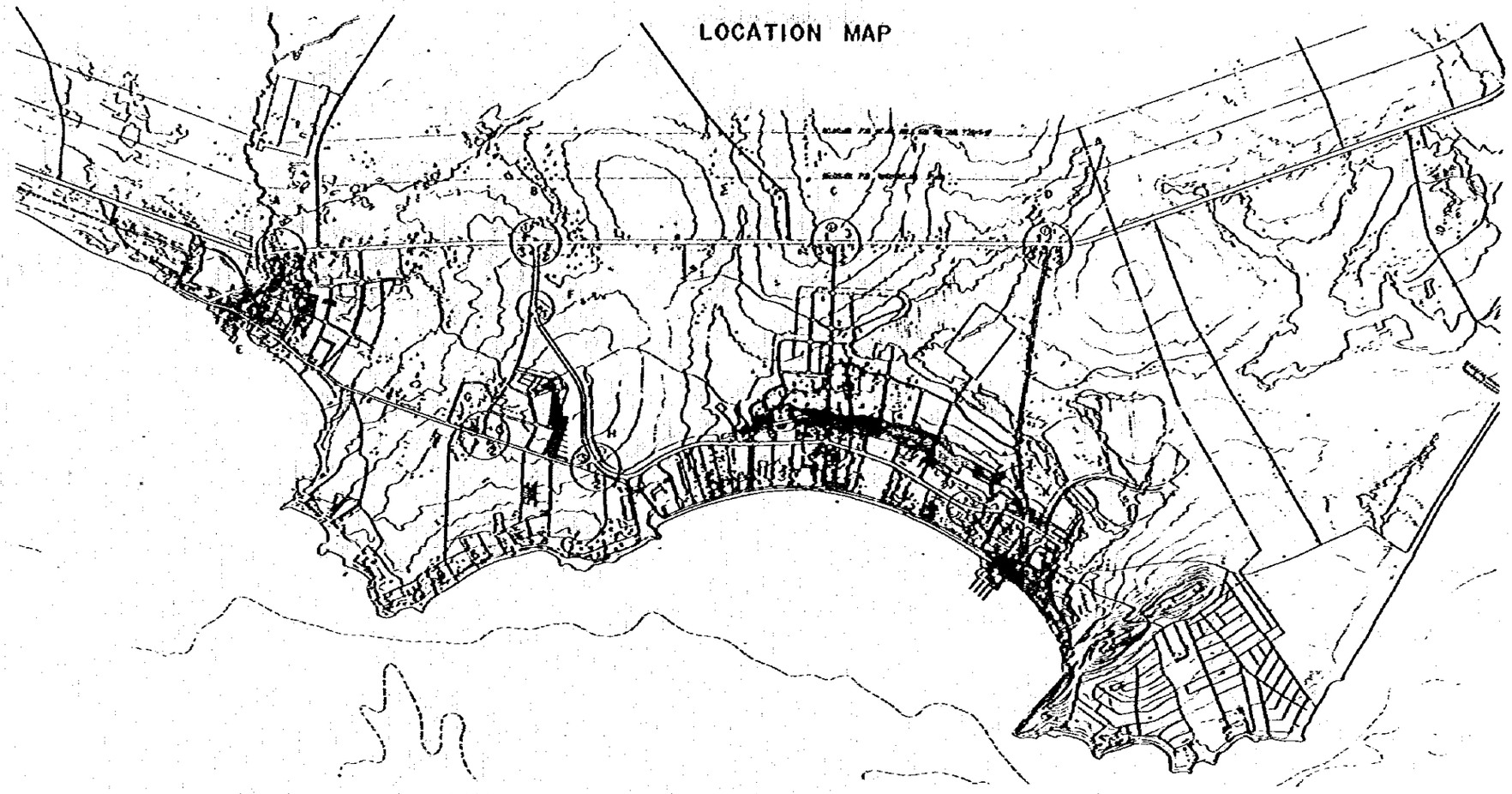
(c) Highway Lighting

Highway lighting is established because of the following needs. One is from the driver's side for providing safe and smooth traffic and the other is from the pedestrians and residencial sides for prevention of crime and improvement of the living environment.

Under this plan, continuous lighting has been designed for the tourism roads (T-1, T-2 and T-3) and residential roads (R-1 and R-2).

Moreover, this should be have a high priority from the point of view of attracting the attention of drivers by changing the color of lighting for road sections of uninterrupted flow and for intersections. Thus, sodium lamps could be used at such corresponding places where the Sukhumvit Highway intersects with T-1 and T-2.

The lighting of R-1 and R-2 is planned to be used in Pattaya at present.



LIST OF INFORMATORY ROAD SIGN

POSITION		ROAD SIGN	POSITION		ROAD SIGN	POSITION		ROAD SIGN	POSITION		ROAD SIGN	POSITION		ROAD SIGN	POSITION		ROAD SIGN
A	①	Sattahip Na Klua →	C	①	Sattahip Pattaya Northern New Town →	E	①	Pattaya Beach ← Sukhumvit HWY	G	③	← Pattaya Beach Na Klua →	I	③	Sukhumvit HWY Na Klua Sukhumvit HWY → ← Pattaya Beach	K	④	Sukhumvit HWY Parking Commercial Area and Hotel Area Na Klua Hotel Area
	②	Bangkok ← Na Klua		②	Bangkok ← Pattaya Northern New Town		②	Na Klua Sukhumvit HWY →		④	Main Amenity Area Parking Na Klua →		④	Sukhumvit HWY Main Amenity Area → ← Sukhumvit HWY Na Klua			
	③	← Bangkok Sattahip →		③	Bangkok Sattahip →		③	← Pattaya Beach Na Klua →		②	Sukhumvit HWY ← Na Klua	J	②	Pattaya Beach Amenity Area Parking Commercial Area and Hotel Area			
B	①	Sattahip Pattaya Beach Northern Amenity Area →	D	①	Sattahip Pattaya Beach Main Amenity Area →	F	①	South Na Klua Pattaya Beach Northern Amenity Area		③	← Sukhumvit HWY Main Amenity Area Parking →		①	Parking Commercial Area and Hotel Area Pattaya Beach Amenity Area → ← Sukhumvit HWY			
	②	Bangkok ← Pattaya Beach Northern Amenity Area		②	Bangkok Pattaya Beach Main Amenity Area →		②	Pattaya Beach ← Sukhumvit HWY		①	Main Amenity Area Pattaya Beach → ← Sukhumvit HWY		②	Pattaya Beach Amenity Area Na Klua Na Klua Parking Commercial Area and Hotel Area			
	③	← Bangkok Sattahip →		③	← Bangkok Sattahip →		③	Na Klua Sukhumvit HWY →		②	Pattaya Beach Sukhumvit HWY → ← Main Amenity Area		③	Na Klua Na Klua Sukhumvit HWY → ← Pattaya Beach Amenity Area			

Fig. 2.4.18 (1) Informatory Road Signs

Fig. 2.4.18 (2) Road Sign

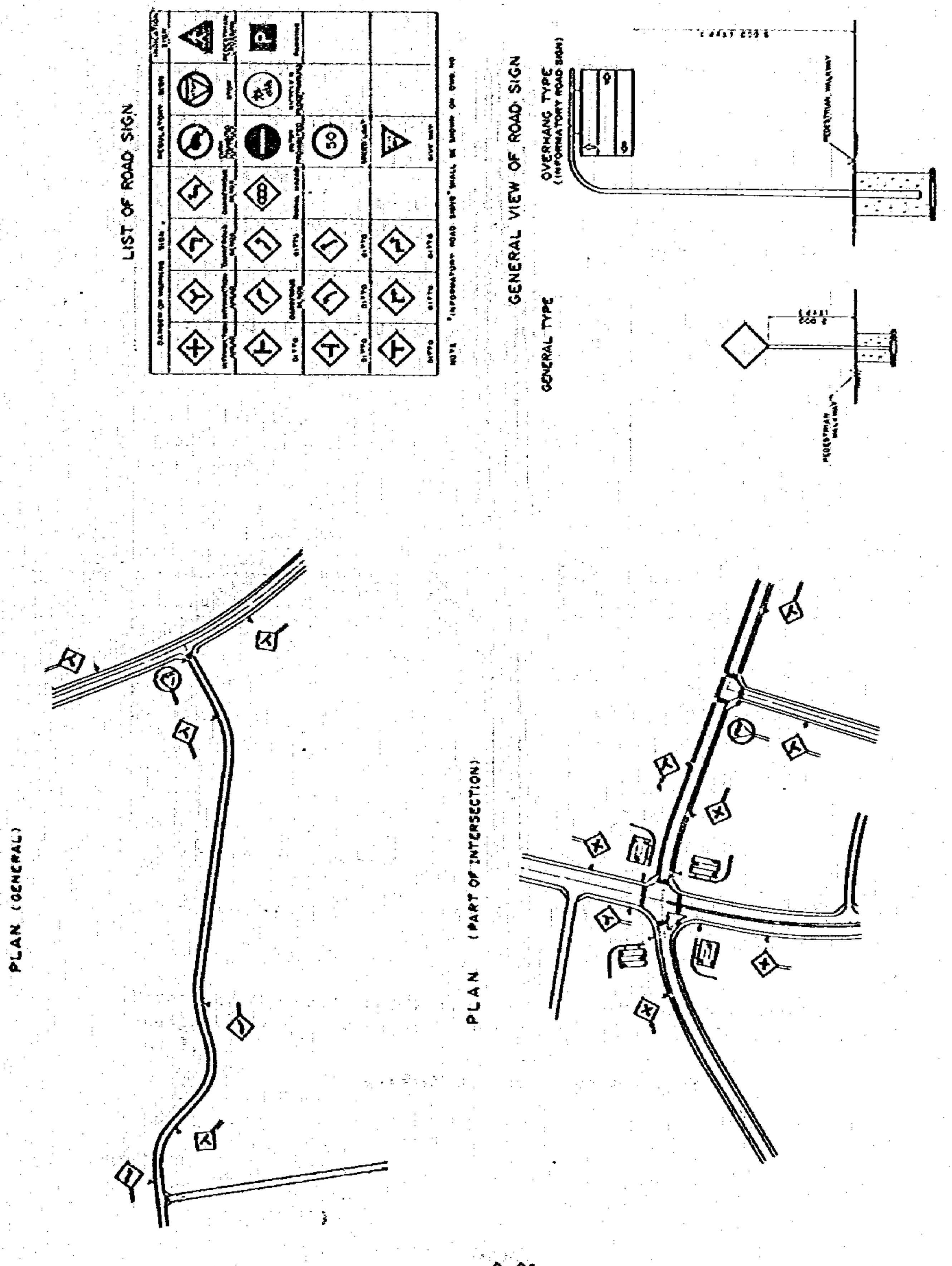
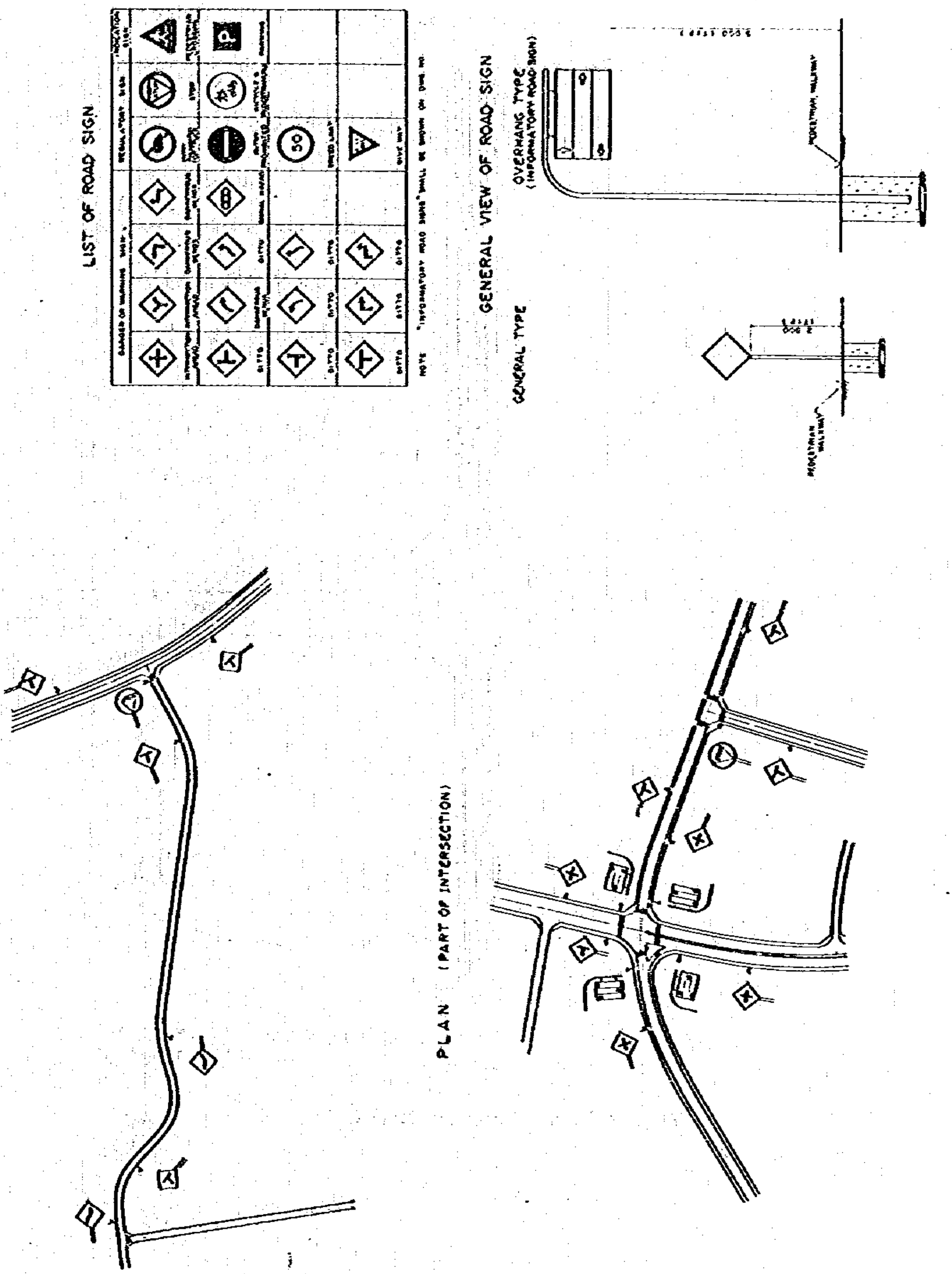


Fig. 2.4.18 (2) Road Sign



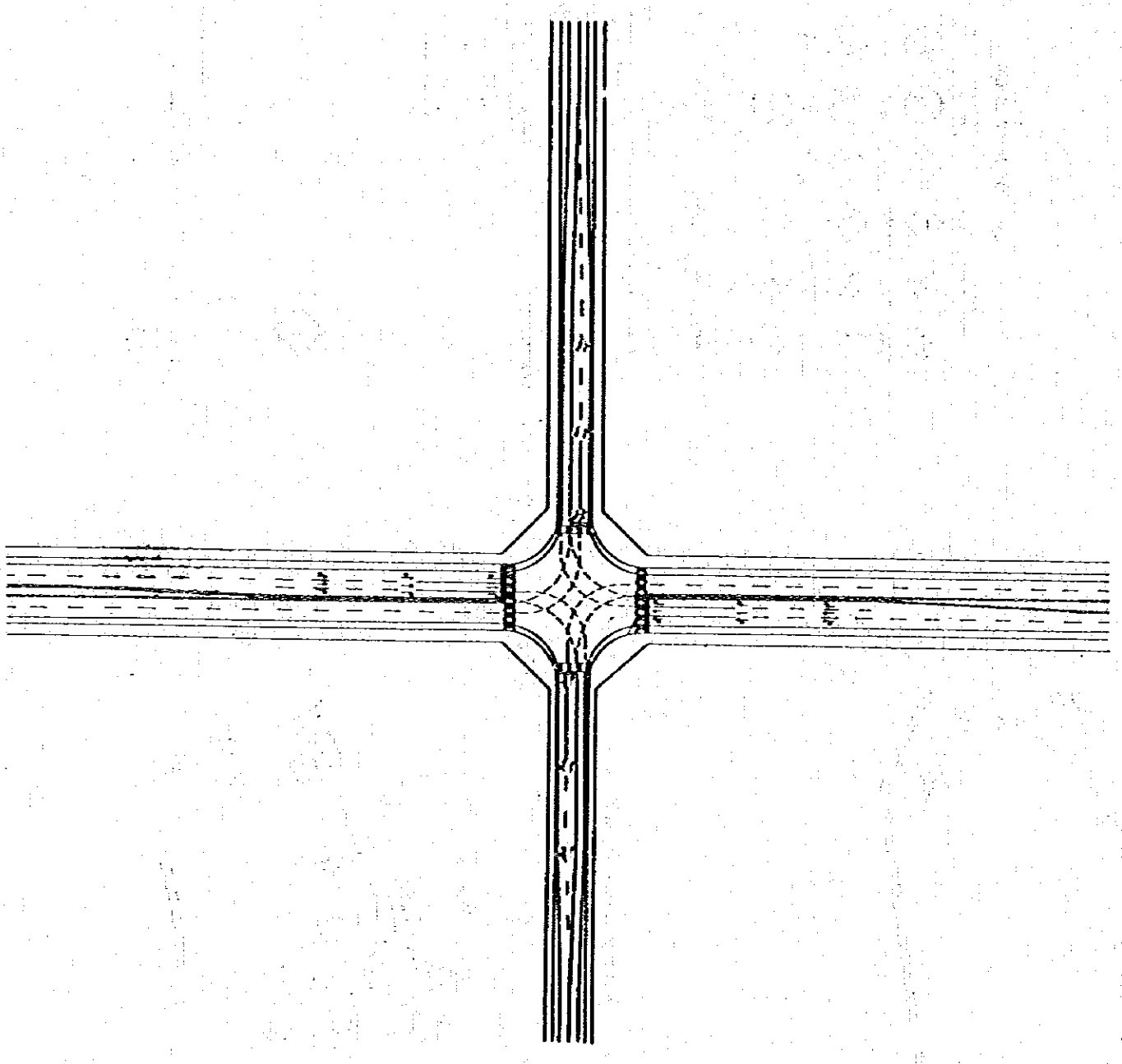


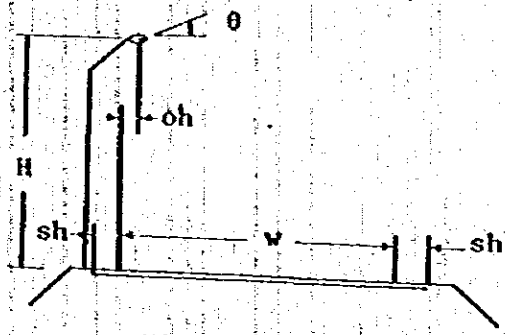
Fig. 2.4.19 Pavement Marking

(1) Design Conditions

Design conditions are shown in Table 2.4.18.

Table 2.4.18 Design Conditions of Lighting Plan

Legend	Conditions	Remarks
Light source	High pressure mercury lamp	
Tools	Semi-cut-off	
Road mean luminosity intensity T-1 T-2 T-3	 1.0 nt (15 lux) 0.5 nt (7 lux) 1.0 nt (15 lux)	Road condition: Asphalt
Mean illumination transformation coefficient	15 lux/nt	
Legends of illumination pole H oh θ	 12 m 0 m 5°	See Fig. 2.4.20.



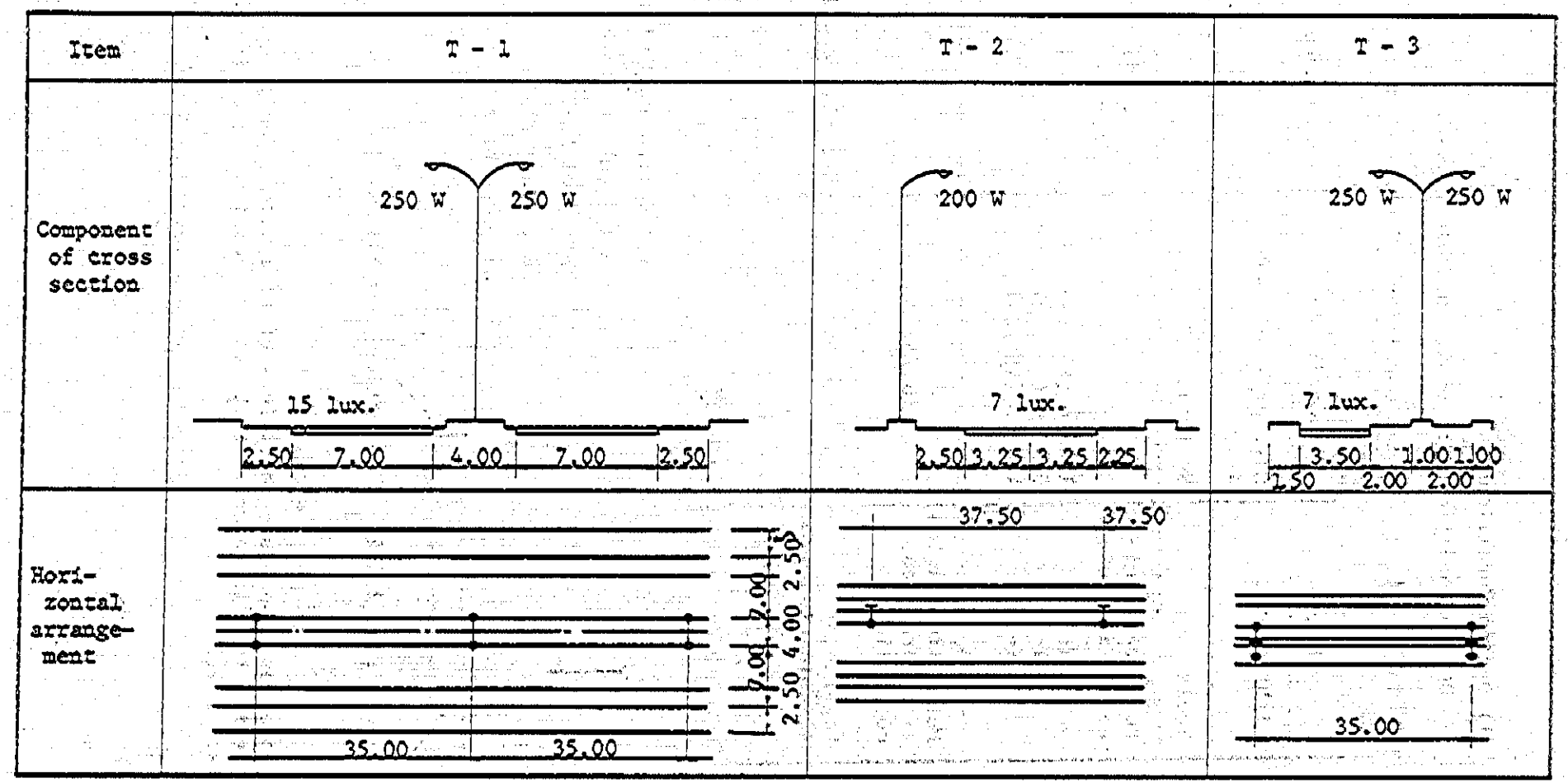
w : Carriageway width
sh : Shoulder width
H : Tool height
θ : Slant angle
oh : Overhang

Fig. 2.4.20 Explanation on table 2.4.18

Moreover, the basic conditions of road width, design speed, design traffic volume, etc., are in accordance with Iteas 2.3.2 and 2.4.2.

(2) Pole arrangement

Fig. 2.4.21 Lighting Arrangement Plan



2.4.6 Planting Plan

The roadside planting of trees is aimed at beautification of the town scenery, providing shade to make pedestrians comfortable, dust prevention, windbreak, smoke prevention, fire prevention, and other purposes. These purposes are derived from the various functions of roads.

Table 2.4.19 Various Functions of Road Space

	Function	Content
Psycho-logical function	Function of recog-nition	Media for symbolism and formation of intention.
Physical functions	Role as traffic system (travelling means)	Role as space for travelling, driving safety, utility space for communication, electricity, water-supply and sewage lines
	Role as external space	Role as open space, or green space
	Role as space for daily life	Role as commercial (shopping) space, and recreation space

The following table gives the classification of the planting of roadside by function corresponding to its purposes. (See Table 2.4.20)

(a) Planting Belt on Sidewalk

The planting belt on the sidewalk varies with the width of the road, functions required for the planting belt, road traffic conditions, etc.; it can be classified as given in Table 2.4.21.

The items to which attention should be paid when the sidewalk planting belt is designed are as follows:

(1) As a rule, the sidewalk planting belt should be constructed between the sidewalk and the lane. Where there are pedestrian roads (promenades) and bicycle roads on the sidewalk, a planting belt may be constructed between the pedestrian roads and the bicycle roads, too.

(2) The planting area of the sidewalk belt should be at least 0.6m in width. Where medium high trees and high trees are planted, the interior width of the planting belt should be more than 1.5m.

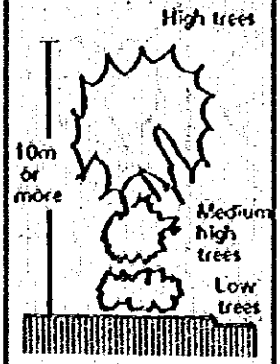
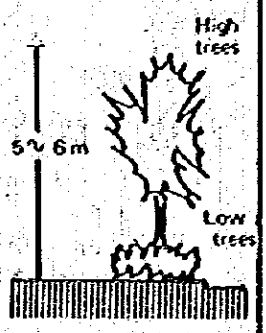
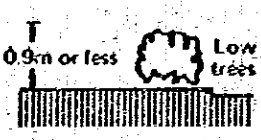
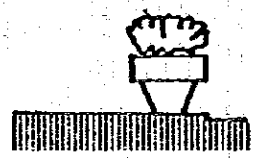
(3) The extension of the sidewalk planting belt should be 2.5m (minimum) or longer.

(4) The planting system of the belt should be successive planting (continuous, or repetitive, or unbroken, in the same planting pattern), or overall planting throughout the sidewalk planting belt.

Table 2.4.20 Classification of Roadside Planting

Green Area	Type	Functions
(1) Sidewalk planting belt (sidewalk green belt)	Planting belt constructed between the road and the sidewalk; this type corresponds to the width of the planting belt and the arrangement of the plants (planting method) depending on the required functions.	(1) Comfort for walking: the road is clearly separated from the sidewalk so that the foot path is independent from the road and the feeling of safety is increased, also the pedestrian space is surrounded with greenery providing increased comfort. (2) Restoration of nature: function as measure for afforestation of the town, and introduction of the natural environment on the scale of the town. (3) Function of preventing environmental pollution: since the planting belt is constructed between the road and the sidewalk, it often includes a function as a psychological screen reducing adverse effects on pedestrians.
(2) Median and central median	This is provided to separate traffic, lanes, etc., and has the shape of a band. The width of bare earth for greenery should be at least about 1m.	(1) Function of road traffic: in the case of the lanes divided by a central median the green space causes the separating function of lanes to further increase and display a good lane directional effect. Moreover, this function has a good light-interception effect on cars travelling in opposing directions (2) Crossing control function: crossing control of pedestrians in the no crossing area;
(3) Traffic island, rotary and interchange	The type is determined by taking into account the traffic flow and traffic engineering. Most of these types form a triangular shape.	(1) Function of landscape: in most of these types of green spaces, they are located in the intersection or in the center of the intersection, and serve as a landmark for road traffic. Also, they make it possible to bring about a beautiful landscape for the road.
(4) Remaining road land and abutment site	Both are unnecessary directly for road traffic; they are remaining land and reserved land and their types are not fixed. In many cases, an open ground, playing space or the like may be included.	(1) Function of recreation; in view of their locations and types, they are often used for other things than roads; for instance, for an open space, children's playground, linear park, rest corner and place for recreation.

Table 2.4.21 Form of Planting

	Width of sidewalk 4m or more	Width of sidewalk 2.5m ∿ 4m	Width of sidewalk 2.0m	Sidewalk without planting belt
Effect	Securing of screen effect, uniform landscape, and green area	Securing of comfort of walking space, and landscape effect.	Clear division between sidewalk and lane.	Clear division between sidewalk and lane.
Type	High trees, medium high trees and low trees are arranged. 	High trees are planted among the low trees planted in a row. 	Only low trees are densely planted in the form of a hedge. 	Flower pots are used. 
Roads	Arterial roads (for tourism)	Main roads (for tourism)	Main residential roads	Local streets in residential areas

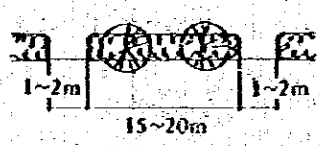
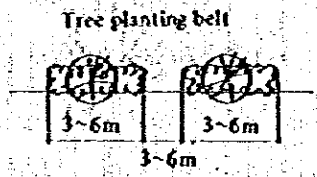
(5) No planting belt should be constructed in the space needed for a pedestrian crossing, grade separation facilities (pedestrian crossing bridge), entrance, sloping-down at the end of a sidewalk, public mailboxes, bus stops, public telephone boxes, household waste and garbage collecting areas, taxi stands, and the like facilities.

(6) The road lighting, traffic signs, utility poles, other similar road attachments and miscellaneous things may be constructed in the planting belt.

(7) No protective fence on the sidewalk should, in principle, be constructed in the sections which have greenery. If one must be constructed for traffic safety, it should be so constructed that the plants in the green belt will not be damaged: for instance, in a manner that guardrails, guard fences, guard ropes, etc., will not interrupt sunshine; thus, a protective fence which may eliminate the good effect of tree planting should not be used.

On the basis of the above, the sidewalk planting belts in the streets of the study area are proposed as tabled below.

Table 2.4.22 The Type of Planting on Sidewalk

Road name	T-1, T-2	R-1, T-5	R-2
Basic policy	As the width of the road is 4m, it is possible to make a long sidewalk planting in the shape of a belt.	The width of the sidewalk is 2.5m. In order to make the traffic of pedestrians smooth, no long planting belt is constructed, but a tree planting belt is to be intermittently provided so that spaces where pedestrians can pass each other are secured.	The width of the sidewalk is 1.5m. Since it is difficult to plant a tree belt, it is planned to provide a green space by using flower pots.
Type	A combination of high, medium high and low trees.	High trees are intermittently arranged among low trees planted in a row.	Flower pots are to be used.
		 A space where pedestrians can pass each other; in this case, the road site frontage is used.	
Type of tree	High trees: Coconut Medium high trees: Acacia, Bougainvillea, others Low trees: Hibiscus, others	High trees: Tamarind, Acacia, others Low trees: Hibiscus, others	

(b) Central Median

The planting of a central median should be determined from the viewpoint of problems concerning maintenance and control, the area of the planting space, and traffic safety, taking into account the sight distance. The relation between the width of the central median and the type of tree planted is explained in the following table.

Table 2.4.23 Width of Central Median and Type of Tree Planted

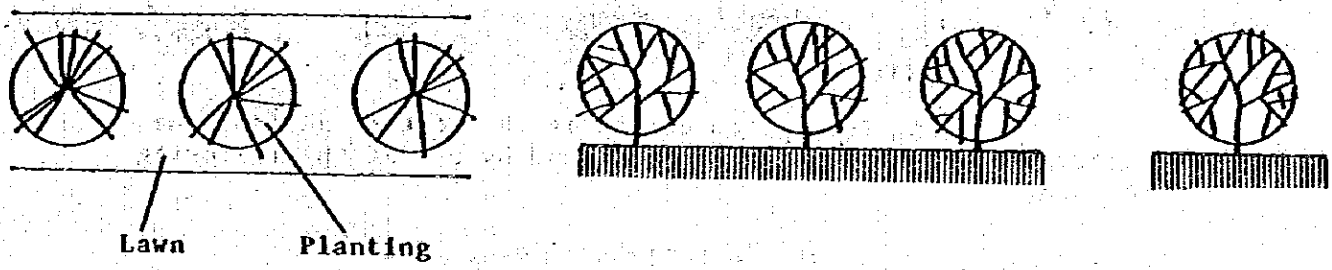
Width	1.0m or less	1.0 ~ 3.0m	3.0m or more
Type of tree planted	In the ordinary case, it is impossible to construct a tree planting belt. The surface is to be paved with concrete, asphalt concrete, etc.	The planting can be made with low trees, lawns (0.9m or less in height). This type can provide a headlight interception effect, control of pedestrians crossing, a directional effect, etc.	It is possible to plant high trees. This type can expect the same effects of left as well as a landscape effect.

Judging from the planting pattern of the central median, three types such as a trimming type, a row type and an arrangement type can be planned. They have the following merits and demerits, respectively.

Trimming type: This is the generally used planting pattern; spherically trimmed low trees are planted at fixed intervals.

Merits : The head-light interception effect is high. An aesthetic effect can be provided.

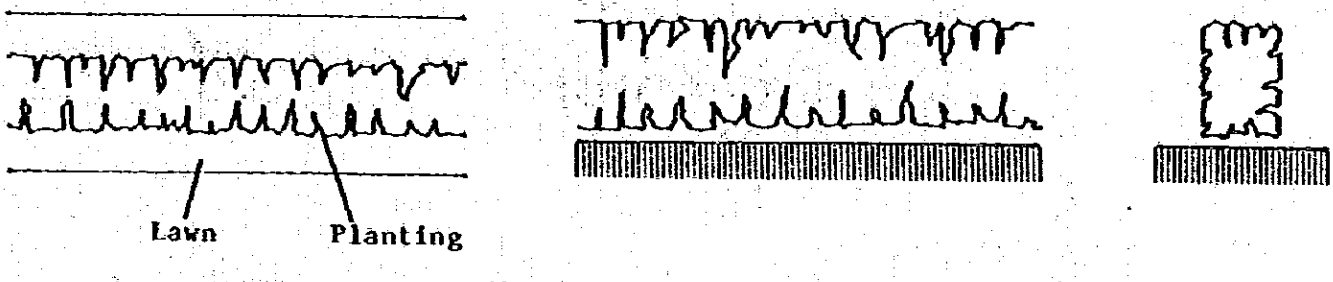
Demerits: Maintenance and control are difficult. Where the width of the median is large, it is unsuitable.



Row type : Young trees are planted in a row in the shape of a fence.

Merits : Effective for controlling pedestrians crossing. Labor-saving and mechanization of the maintenance and control are done with comparative ease.

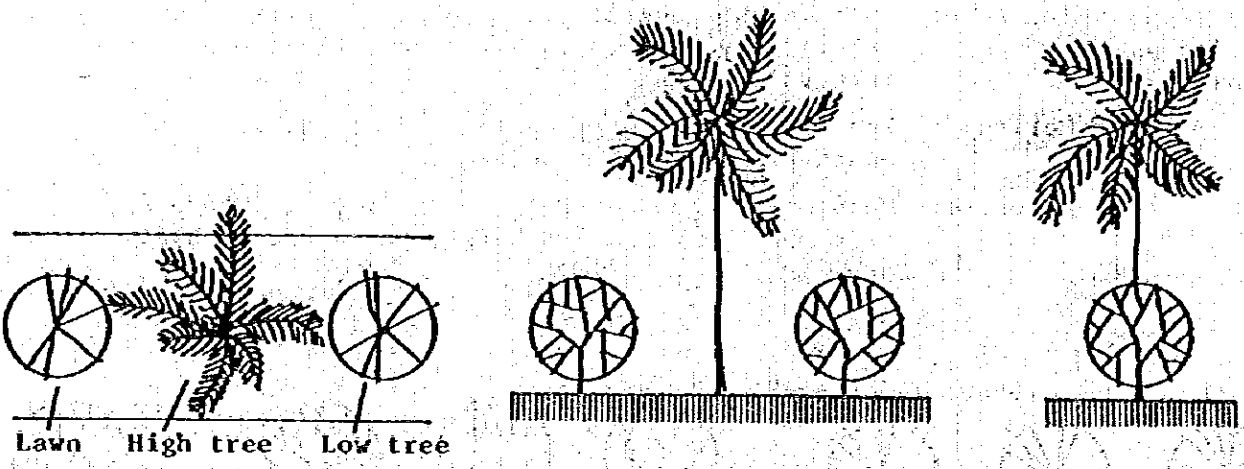
Demerits: When the planting can not be maintained at the proper height, the head-light interception becomes ineffective.



Arrangement type: On the main roads, a combination of high trees and low trees is planned in a place where decoration is necessary.

Merits : Aesthetic effect is high.

Demerits: The maintenance and control are complicated and troublesome.

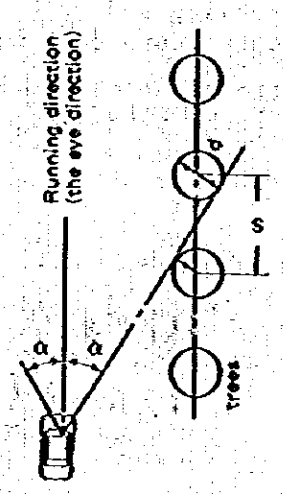


When determining the screen effect in the central median, the interval of tree planting can be found by use of the following formula.

$$S = \frac{d}{\sin \alpha}$$

Where S = Interval of roadside trees
d = Branch spread of roadside trees
α = Visual angle for the running direction

Running direction (the eye direction)



(c) Tree Planting Plan

On the basis of the above considerations, the planting on the streets in the study area, and that at the major intersections are planned as follows:

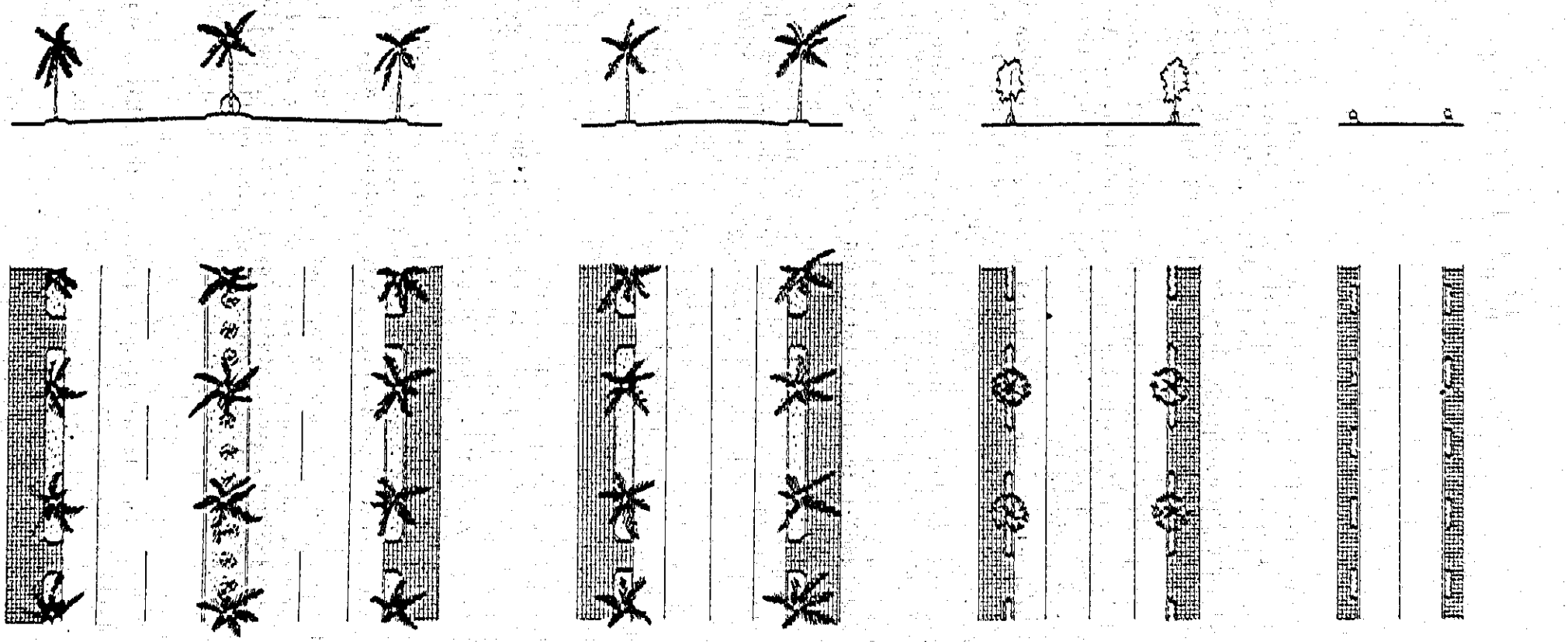


Fig. 2.4.22 Planting Plan

2.5 Local Streets

2.5.1 Outline

In this section we will describe the feeder network planning in the residential area. In item 2.5.2, we will study the basic policy of local street planning. Since it is necessary to establish a local street network system in close relationship with land use, we will make further detailed studies of residential area land-use planning in the master plan in Item 2.5.3

In Item 2.5.4, we will do comparative studies in feeder road arrangement plan, and in Item 2.5.5, we will indicate the land-use plan. In Item 2.5.6, we will deal with the problems and remedies of the implementation stage in these drafted projects.

According to the master plan, four residential areas (Na Klua Town A, Na Klua Town B, Northern New Town and South New Town) are planned in Pattaya as shown in Fig. 2.5.1.

Among these, the planned residential areas in the first stage are portions of Na Klua Town A, Northern New Town and the entire area of Na Klua Town B.

The residential areas in Pattaya have been planned to accommodate the expected population increase in tourism-related and regional service-related employees and their families.

The future population of Pattaya is estimated to be 58,100 for 1986 and 80,200 for 1996. The percentages of the population to be accommodated in the aforementioned four residential areas are about 45% for 1986 and about 60% for 1996.

2.5.2 Basic Policy

(a) Functions of Local Streets

1) Traffic service for roadside residences:
Since local streets are provided adjacent to each residential site, they serve as originating and or ending points of automobile and pedestrian journeys, and also as an interval access for pedestrians.

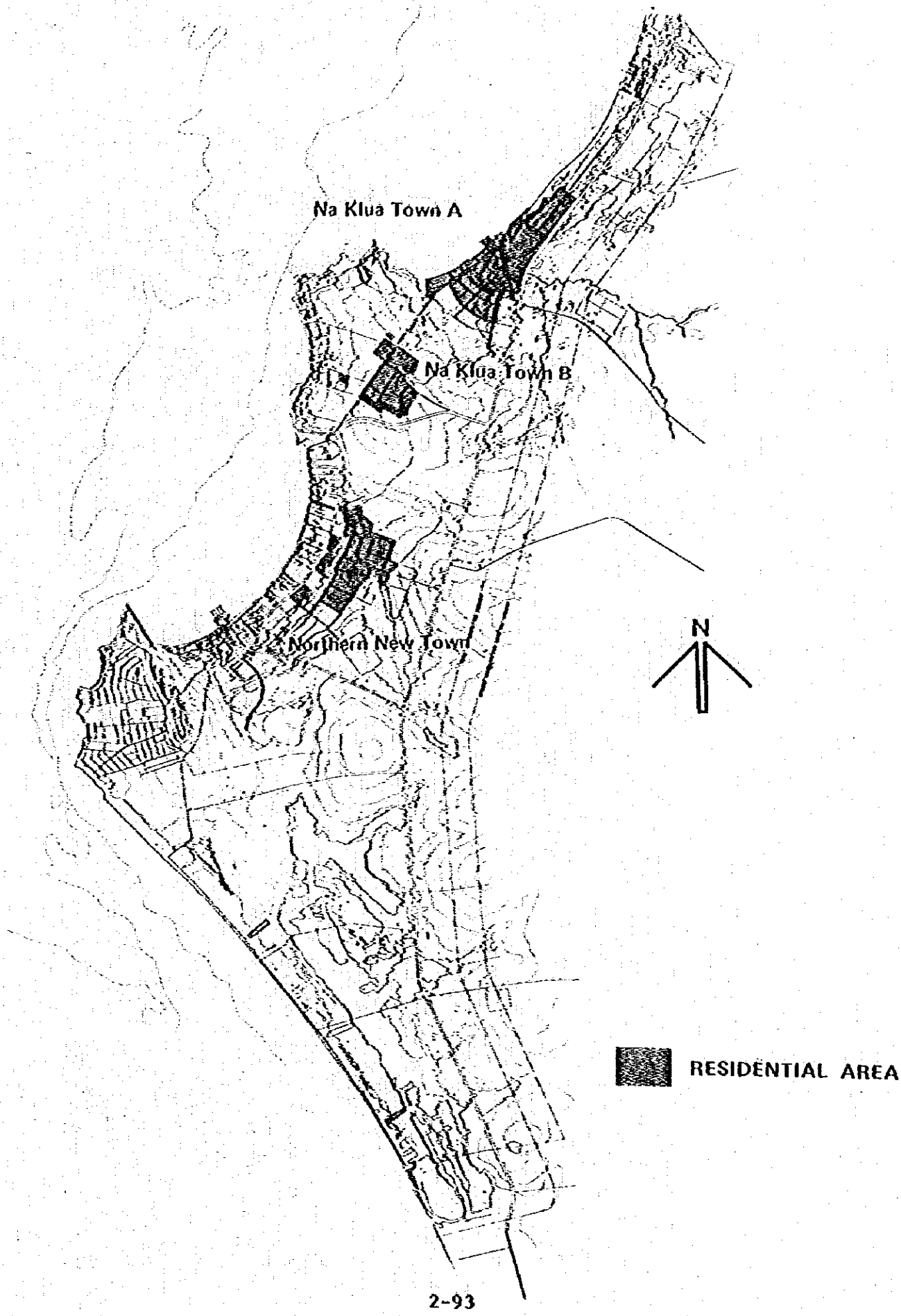
2) Providing necessary spaces for public utility services, such as water supplies, sewerage pipes, solid waste disposal and collection, gas and electric power supplies, telephone services, fire hydrants, etc.

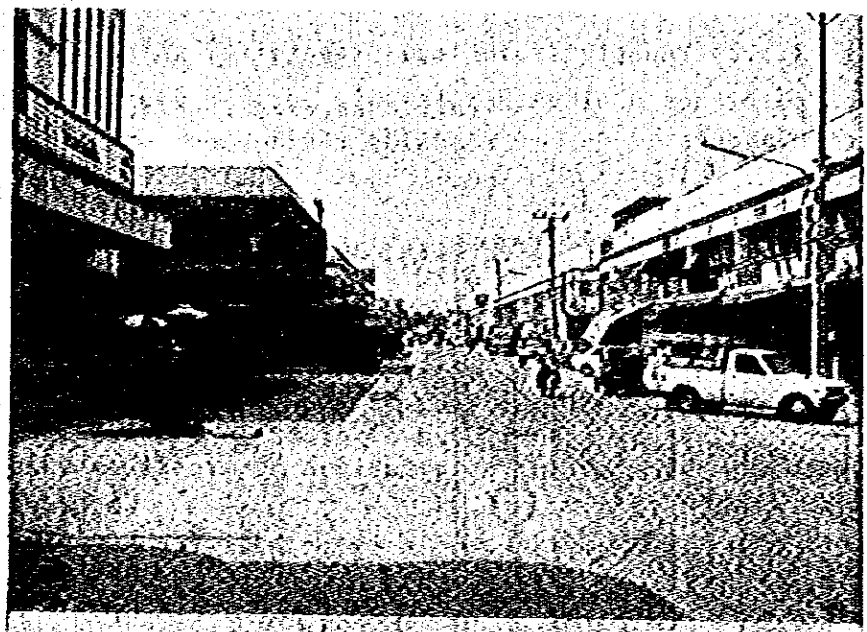
3) Improving and conserving the living environment of the community.
Local streets will provide valuable open space for community ventilation and establishing a favorable physical living for environment, in addition to providing vital access for fire prevention, and preservation of the general living environment.

4) Other functions

Besides those mentioned above, local streets are used for chats, stroll, etc., in ordinary daily life.

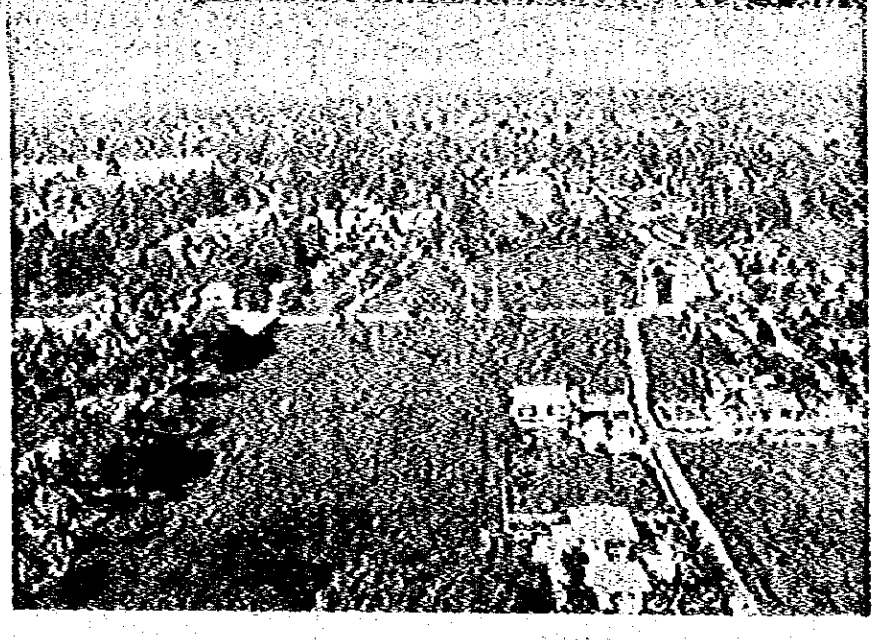
FIG 2.5.1 RESIDENTIAL AREA PLAN





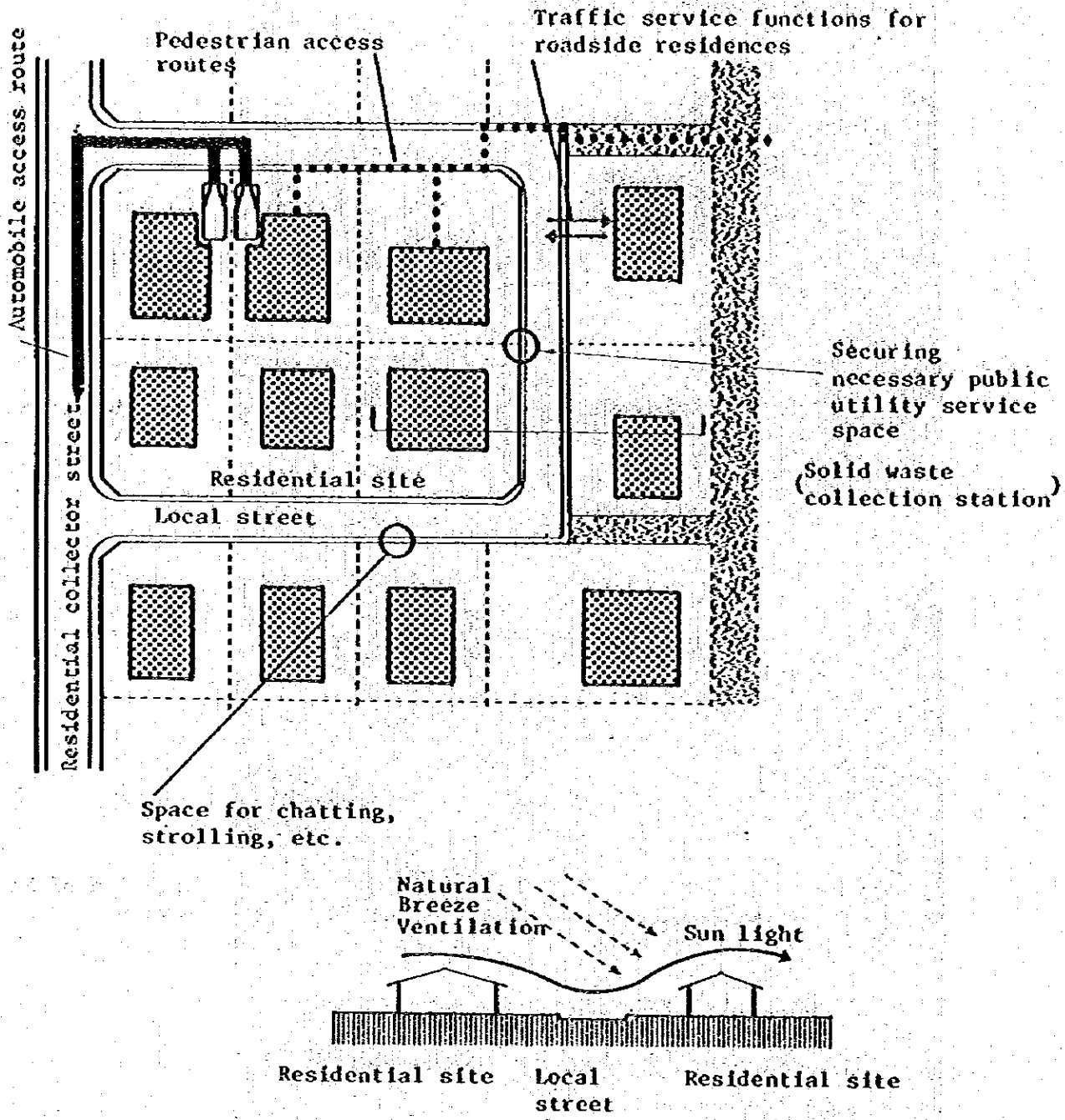
Location of Na Klua Town A

Location of Na Klua Town B



Location of Northern New Town

Fig. 2.5.2 Functions of Local Streets



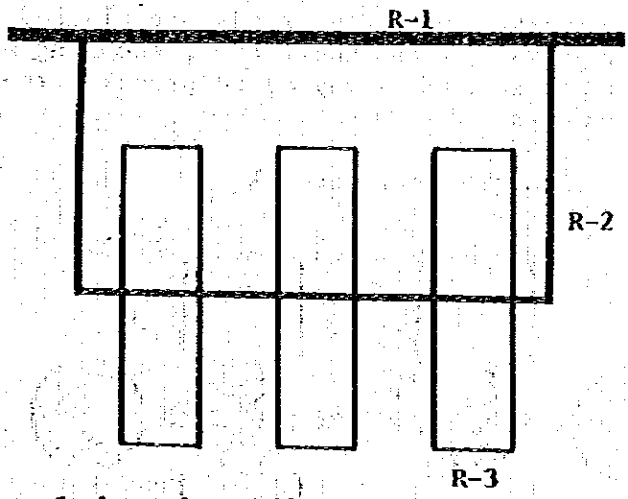
(b) Planning Policy for Local Streets

Local streets must be planned taking into consideration the following factors.

1) Connection

Local streets are connected mutually to one another or to the residential collector street (R-2), and direct connection to the main residential roads will be avoided. The connection of local streets directly to the main residential roads may interrupt the smooth flow of through-traffic and lead to accidents due to sudden changes in driving speed caused by frequent entrance and exit from the local streets onto the main residential roads. That is to say, such a connection would reduce road capacity and increase accidents on the main residential roads.

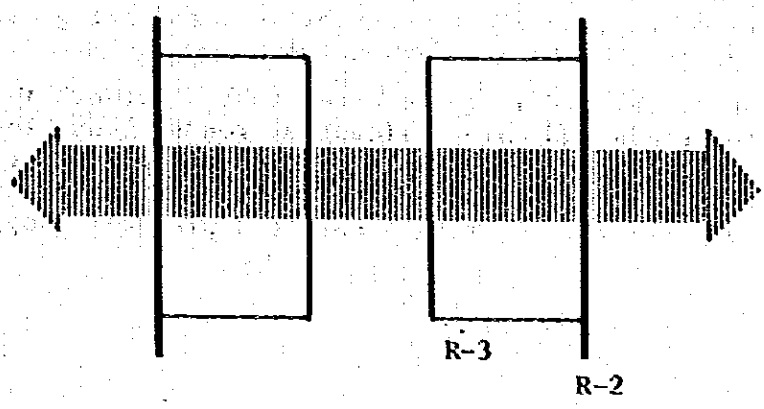
1. Connection



2) Elimination of through traffic

Local streets should be mainly planned within the residential area where introduction of a large volume of traffic and high speed driving is not desirable for the maintenance of a better living environment. Therefore, through traffic which has no relation with the residential area should be planned to be as little as possible and arrangements which reduce traffic volume and driving speed should be studied.

2. Elimination of through traffic



3) Accessibility

Since local streets are subjected to traffic volume reduction, unnecessary detours should be avoided. Therefore, they should be arranged so as to enable the access service to be as smooth as possible between the following destinations.

Residential site ←→ Residential collector road ←→ Main residential road

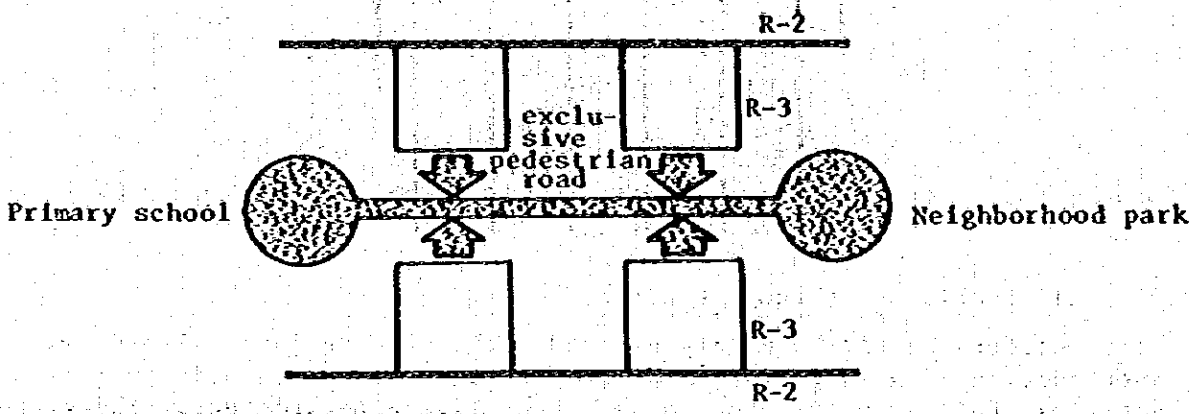
4) Separation of pedestrians and automobiles

A road network and a road design which will enable the separation of pedestrians and automobiles should be evaluated so as to reduce the danger of traffic accidents.

5) Combination with the greenery network

Safe and pleasant exclusive pedestrian roads are planned in the residential area to connect with parks, public facilities, shopping areas, etc. Local streets must be arranged in such a way as to preserve the overall integrity of these greenery networks.

3. Combination with greenery network



6) Relationship with landuse

Since the functions which local streets should perform differ according to land-use, they should be suitable so as to correspond with land-use.

- Residential areas: The streets should be mainly arranged so as to take into consideration the elimination of through traffic, the separation of pedestrians and vehicles, and integration of the street plan with the greenery network.
- Shopping areas: It is quite often that a network is formed by collector roads and main residential roads. When locating the routes of local streets, ample consideration must be given in the separation of pedestrians and automobiles (the formation of a shopping mall) for securing a safe and pleasant shopping area.

(c) Configuration of local Street Networks

There are 3 basic patterns for local street networks, namely grid, cul-de-sac and loop. In addition, the application of these patterns and several revised patterns should be considered.

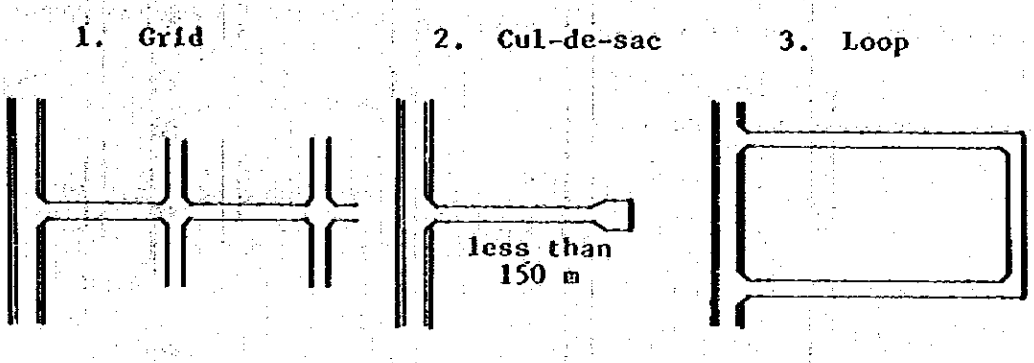


Fig. 2.5.3 Basic Patterns of Local Streets

Merits and demerits of the basic patterns are as follows.

1) Grid

Merits : An extremely simple street pattern is formed.

Demerits : Through traffic is frequently interrupted. Streets are apt to become monotonous. The percentage of the area occupied by roads is high. Pedestrian and automobile separation is difficult.

2) Cul-de-sac

Merits : Through traffic can be avoided. Complete separation of pedestrians and automobiles becomes possible.

Demerits : It does not function when a portion becomes closed.

3) Loop

Merits : Through traffic can be avoided. Demerits of a cul-de-sac are avoided.

Demerits : Although separation of pedestrians and automobiles is possible, it may not be ideal.

The separation of pedestrians and automobiles can be planned using the cul-de-sac and loop patterns by combining them with exclusive pedestrian roads. An integreated system of cul-de-sac and loop patterns with exclusive pedestrian roads would be as shown below.

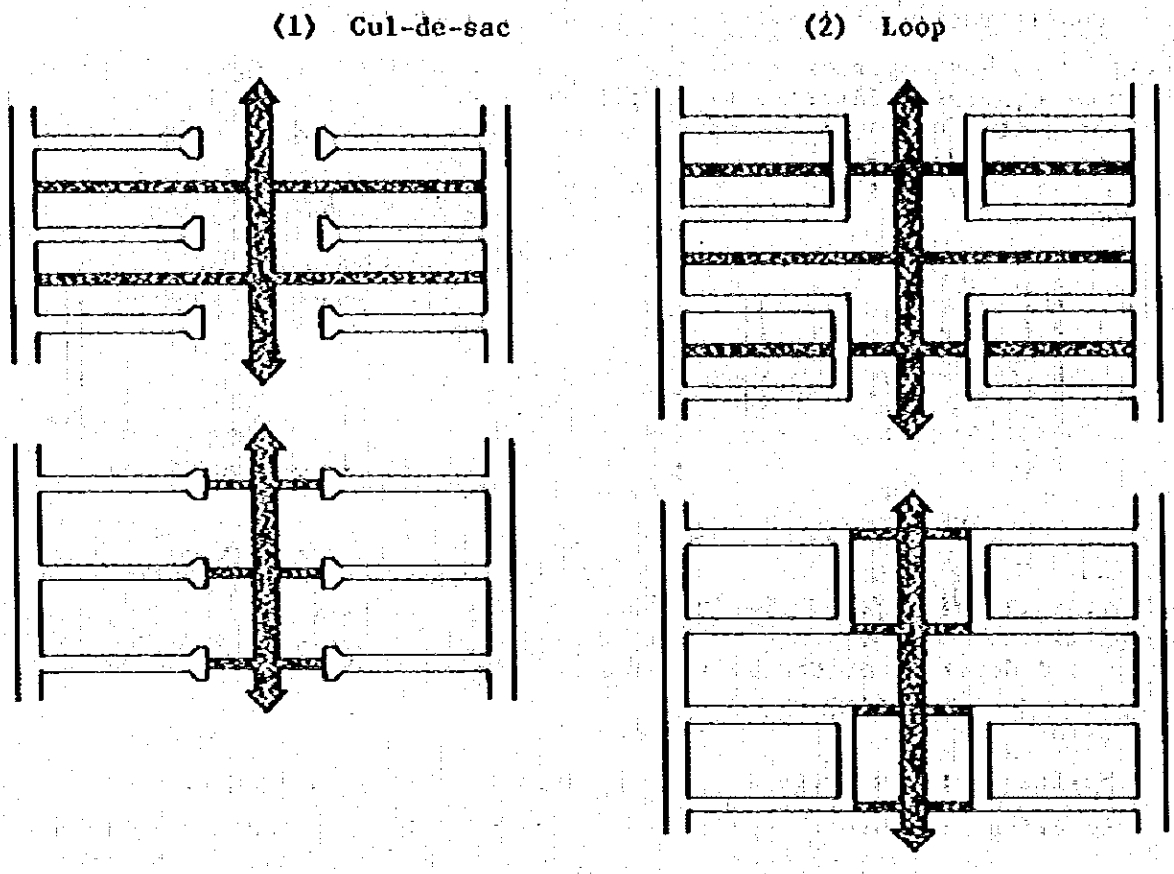


Fig. 2.5.4 Combination of Cul-de-sacs and Loops with Exclusive Pedestrian Roads

(d) Road Section

The width of a local street is planned to be 7 m and a standard section would be as shown in Fig. 2.5.5.

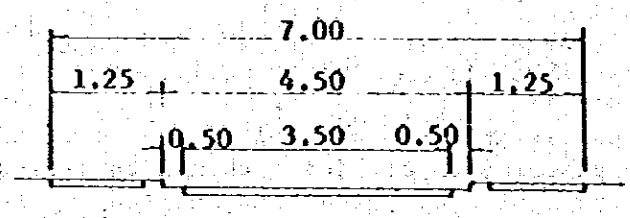


Fig. 2.5.5 Typical Section of a Local Street : R-3

2.5.3 Fundamental Policy of Land-Use Planning in Residential Areas

(a) Policy of the Master Plan

In the master plan, in order to accommodate the expected population increase as a result of tourism development, it is planned to construct 3 residential areas in Na Klua Town A, B and Northern New Town in the first phase. The policy of land-use planning for residential areas in the master plan is summarized as follows.

1) Separation of tourism areas from residential areas

It is desirable to separate tourism areas from residential areas by parks, green belts or buffer zones for the purpose of enhancing the respective qualities of both areas. This buffer zone will provide a meeting place between tourists and local people as well as to ensure physical separation.

2) Improvement of the living environment

To avoid disproportionate differences in the quality of the living environments in the tourism and residential areas, it is essential to provide a basic infrastructure for the residential areas as well including service facilities such as community centers, schools, parks, etc.

3) Preservation of natural scenery

In planning road and street network and the land-use plan, care should be taken not only to preserve natural resources, such as existing vegetation, swamps, ponds, paddy fields and other tourist resources for the sake of tourism promotion, but also to minimize the destruction of such natural resources.

4) Consideration of existing property divisions

Existing property divisions should be carefully treated to ensure that development will be smoothly implemented without obstacles. Particularly in the implementation of the road plan, the existing roads should be fully taken into consideration in order to minimize the relocation of existing buildings.

5) Control of urban sprawl

In Pattaya, the construction of buildings in a disorderly manner along the roads is considered a great impediment to the implementation of rational land-use and improvement of the living environment. As a consequence, such sprawl should be controlled by proper land-use implementation in advance.

6) The variety of housing types and the low density appearance of the housing area

As a part of the tourism complex, the appearance of the residential area is a matter of concern. The harmonious mixture of various housing types to meet future demands will be a great asset. The low density traditional Thai appearance of the housing area will strengthen the rural image of the Pattaya beach resort.

(b) Population Forecast

The year by year population forecast for the Na Klua Towns and the Northern New Town will be as follows:

Table 2.5.1 Population Forecast

Persons

	1976	'77	'78	'79	'80	'81	'82	'83	'84	'85	1986	1996
Na Kulua Town A	7,700	8,200	8,700	9,200	9,700	10,300	10,900	11,500	12,100	12,700	13,300	20,600
Na Kulua Town B	0	500	1,000	1,500	2,000	2,500	3,000	3,500	4,000	4,500	5,000	5,000
Northern New Town	2,400	2,600	2,800	3,000	3,300	3,600	4,300	5,000	5,800	6,600	7,400	12,000

Note: The estimated populations shown for the years, 1976, 1981, 1986 and 1996 are based on the figures in the master plan and the estimations for intermediate years were derived proprotionately.

(c) Standards for Residential Plan

In response to the demand for a variety of dwellings, three types of residential area are proposed in the master plan as follows:

1) Higher density residential areas

Population density	150 persons/ha (Gross) 222 persons/ha (Net)
Number of residential units	40 houses/ha (Net)
Lot size	240∿300 m^2/house
Building size	100∿140 m^2/house
Floor area ratio	70%
Height limitation	15 m
Building coverage ratio	40%
Housing type	Terraced house or walked-up apartments (2∿3 stories)

2) Medium density residential areas

Population density	100 persons/ha. (Gross) 148 persons/ha. (Net)
Number of residential units	26 houses/ha. (Net)
Lot size	300∿460 m^2/house
Building size	100∿140 m^2/house
Floor area ratio	50%
Height limitation	8 m

Building coverage ratio	40%
Housing type	Detached, semidetached

3) Low density residential areas

Population density	80 persons/ha. (Gross) 118 persons/ha. (Net)
Number of residential units	21 houses/ha. (Net)
Lot size	380∿580 m^2/house
Building size	100∿140 m^2/house
Floor area ratio	40%
Height limitation	8 m
Building coverage	30%
Housing type	Detached

(d) Standards for the Commercial Area Plan

The standards for the commercial area plan in the master plan are as follows.

Population density	150 persons/ha. (Gross)
Floor area ratio	100%
Height limitation	15 m
Building coverage ratio	50%

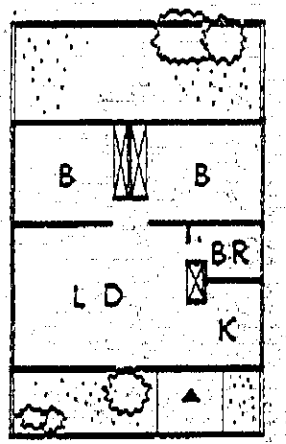
(e) Residential area plan and population distribution plan

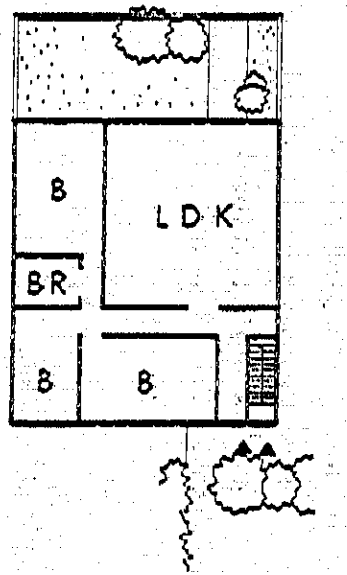
The residential area plan and the population distribution plan are evaluated based on the standards described in the previous paragraphs and summarized in the following figures. The allocation of residential areas different from the master plan is planned in Na Klua Town B. Although the southern section of Na Klua Town B is designated as a low density residential area in the master plan, a change in the high density residential area was made because of current environmental conditions.

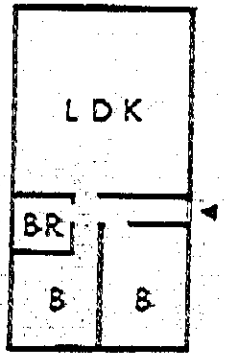
(f) Public facility plan

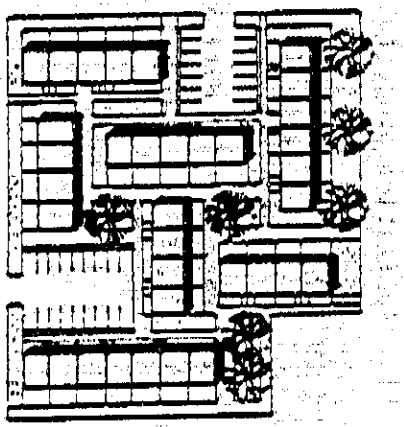
The main public facilities proposed in the master plan are as follows:

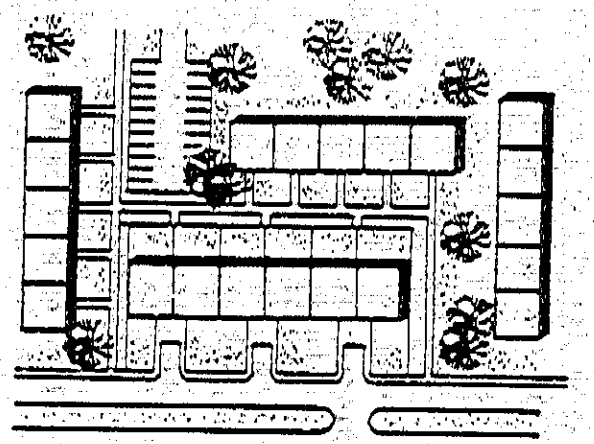
Na Klua Town A	:	town hall, post office, police station, administration facilities, fire station, hospital, primary school, secondary school
Na Klua Town B	:	Primary school
Northern New Town	:	town hall, post office, police box, hospital (clinics), primary school, secondary school











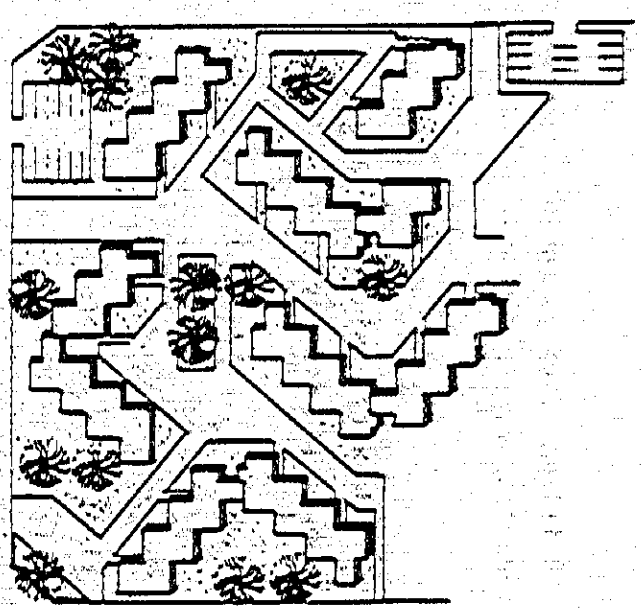


Fig. 2.5.6 Model Plans of Terraced Houses

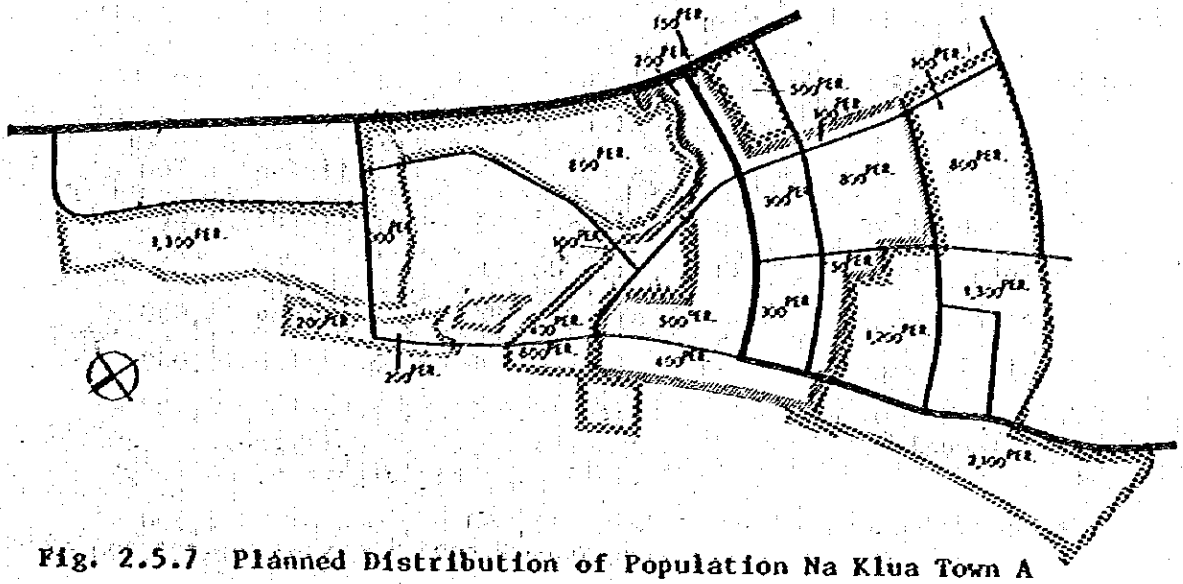


Fig. 2.5.7 Planned Distribution of Population Na Klua Town A

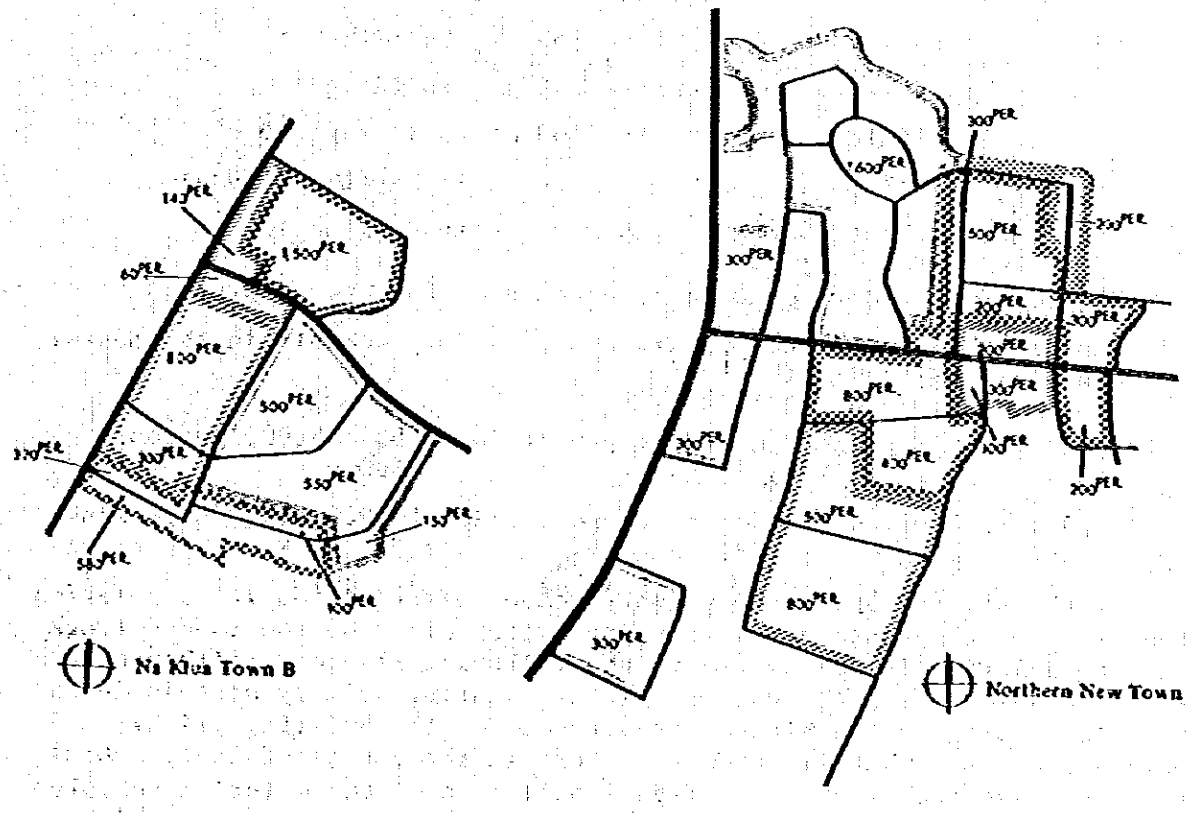


Fig. 2.5.8 Planned Distribution of Population
Na Klua Town B and Northern New Town

Regarding administration facilities, and primary and secondary schools, these facilities will be used as much as possible. The scale of each facility in 1986 is estimated as follows:

Na Klua Town A:	
Town hall	site 1,200 m^2, building 500 m^2
Post office	site 300 m^2, building 200 m^2
Police station	site 1,000 m^2, building 2,000 m^2
Administration facilities	site 28,000 m^2
Fire station	site 1,000 m^2, building 4,000 m^2
Hospital	site 6,500 m2, building 20,000 m^2
Primary school (per school)	site 16,000 m^2, school 2,700 m^2, gymnasium 700 m^2, playground 7,200 m^2 (including kindergarten, nursery)
Secondary school	site 16,000 m^2, school 2,500 m^2, gymnasium 700 m^2, playground 8,400 m^2
Na Klua Town B:	
Primary school	the same as in Na Klua Town
Northern New Town:	
Town hall	site 600 m^2, building 300 m^2
Post office	site 50 m^2, building 50 m^2
Police box	site 40 m^2, building 30 m^2
Hospital (clinics)	site 500 m^2, building 750 m^2
Primary school	the same as in Na Klua Town A
Secondary school	the same as in Na Klua Town A

(g) Primary and secondary schools arrangement plan

Arrangement standards for the primary and secondary schools in the master plan are as follows:

Primary school: school district population 2,500∿5,000 persons
walking distance 500 m

Secondary school: school district population 10,000∿12,000 persons
walking distance 1,000 m

Presuming the situations of the primary school district and its population on the basis of these standards, the population plan and the road network plans, the solution is summarized in the following figures. Although we took into consideration the use of all the existing primary schools in the master plan, owing to the biased arrangements of the existing primary schools and the somewhat irrational factors in the ratios of their school district populations as shown in fig. 2.5.11, one of the existing schools is recommended to be integrated with a neighboring school, as shown in fig. 2.5.9. As for the secondary school, the existing ones are going to be used. Therefore, in Na Klua Town A, five primary schools and one secondary school are recommended.

As regards Na Klua Town B, the use of the two existing two primary schools makes the school district population unusual as shown in fig. 2.5.10.

In the Northern New Town, as shown in fig. 2.5.10, there are three primary schools and one secondary school and in 1986, the scale of the secondary school will be adequate at half of the standard school scale.

(h) Greenery networks

In the master plan, subjects related to public open spaces and pedestrian passage systems were studied to some extent. In the feasibility study, it is necessary to study them in more detail, in respect of local streets which separate pedestrians from vehicles.

Greenery networks are planned to provide exclusive pedestrian connections from each housing lot to the main destinations, such as commercial facilities, public facilities, bus stops and other areas so as to avoid direct crossing of the automobile traffic as much as possible. At the same time, the greenery networks should be incorporated with public or semipublic open spaces.

1) Pedestrian passage networks

The combination of cul-de-sacs and loops with pedestrian passages in green open spaces is shown in fig. 2.5.4, though, in the case of a grid pattern, the main circulation of pedestrians occurs on the pedestrian paths.

2) Public open spaces

Neighborhood parks, children's playgrounds and play lots in proportion to the scale, and needs of the residential areas, are planned in public open spaces. The standard required areas and arrangement standards of each park are as follows:

Neighborhood parks ----------	Standard area 1.0∿2.0 ha. Arrangement standard one place per ten thousand persons
Children's playgrounds --------	Standard area 1,000∿2,500 m^2. Arrangement standard one place per primary school district, walking distance 250 m
Play lot ----------	Standard area 100∿300 m^2. Arrangement standard according to circumstances

Arrangements for neighborhood parks and children's playgrounds on the basis of these standards are shown in Table 2.5.2 and figures 2.5.12 ∿ 2.5.14.

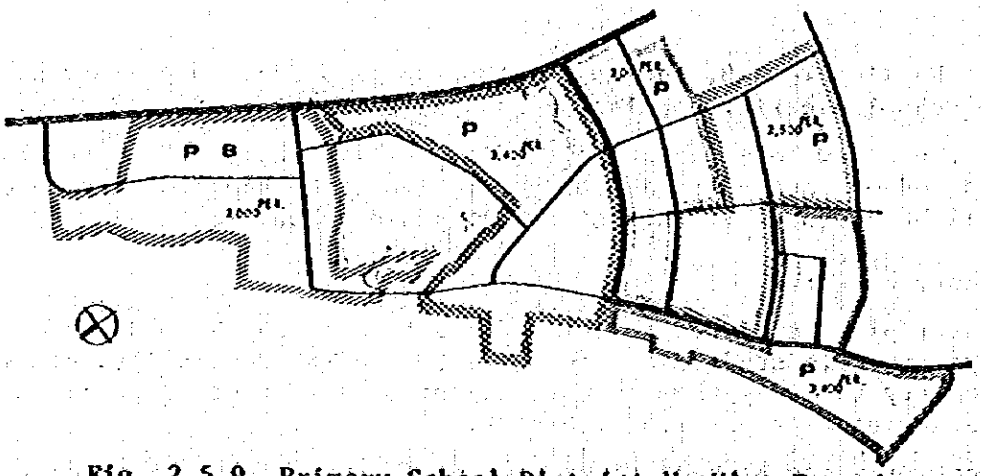


Fig. 2.5.9 Primary School District Na Klua Town A

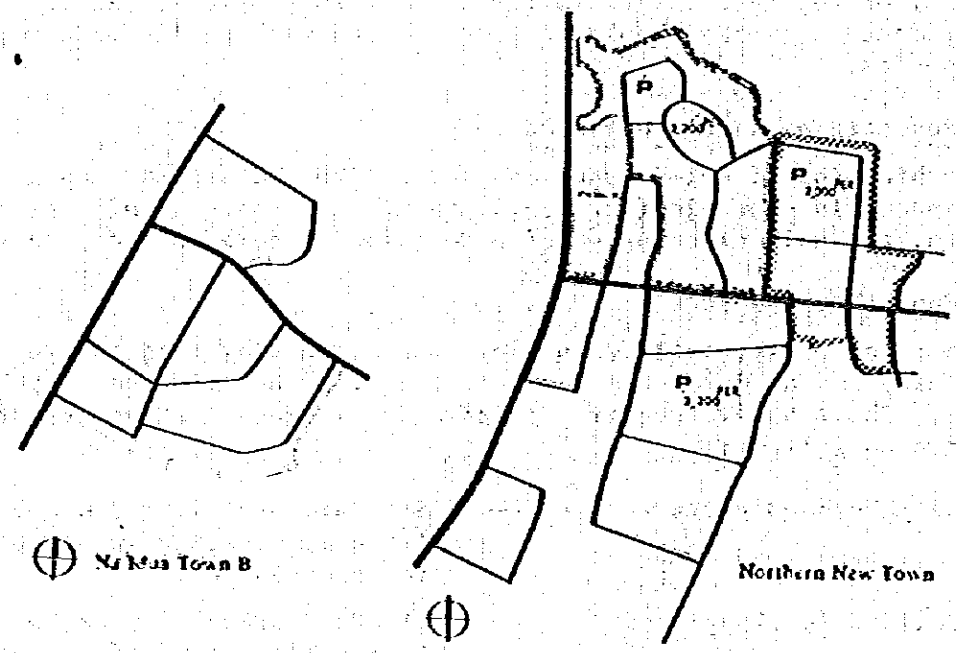


Fig. 2.5.10 Primary School District

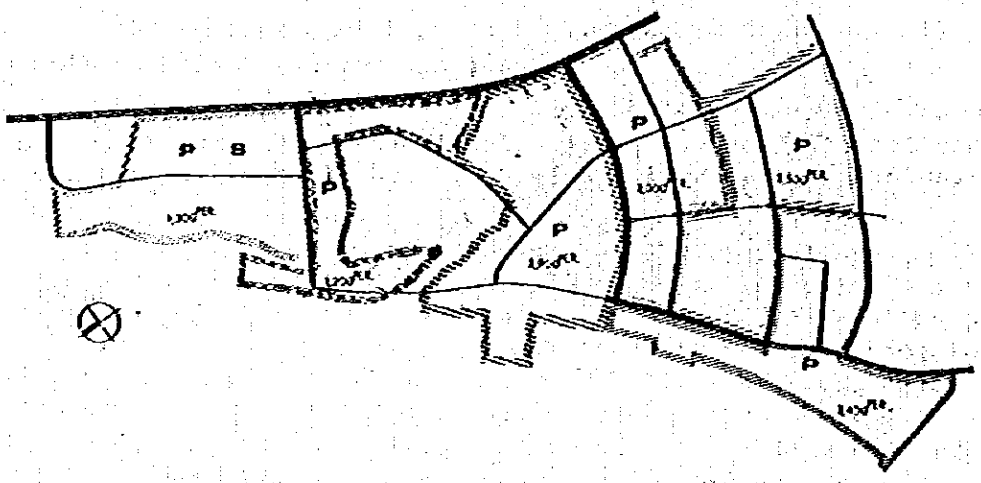


Fig. 2.5.11 Primary School District (if all existing schools are utilized) Na Klua A

Table 2.5.2 Arrangement Plans for Parks

	Neighborhood Park	Children's Playground
NA KLUA TOWN A	1.8 ha. 1.9 ha.	2,500 m^2 5 places 1,600 m^2
NA KLUA TOWN B	---	2,500 m^2 2 places
NORTHERN NEW TOWN	1.2 ha.	1,500 m^2 1,200 m^2 2,500 m^2 3,000 m^2
TOTAL	4.9 ha.	22,700 m^2

3) Semipublic open spaces

If cul-de-sac and loop systems are adopted, belt-shaped open spaces will be created at the back of the dwelling sites.

These spaces are considered mainly as recreational areas available privately for people living there and we called semipublic open spaces which function as pedestrian passages as well.

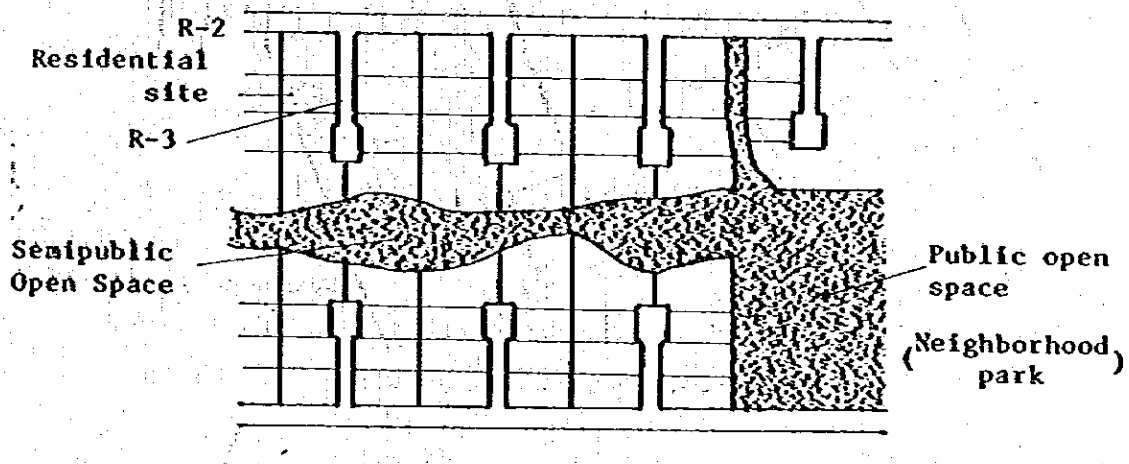


Fig. 2.5.12 Public and Semipublic Open Spaces

4) Shopping malls

In the commercial areas, it is required to create safe and pleasant commercial spaces by means of separating pedestrians from vehicle circulation. As a basic rule, the entry of vehicles into these malls should be prohibited. Therefore, shopping malls will only be open for pedestrians. In addition to the above planning consideration, an other effective method for implementing the pedestrian shopping malls, is to combine the separation of pedestrians from vehicles depending on the proper time for services with design considerations, such as raising the pedestrian paths.

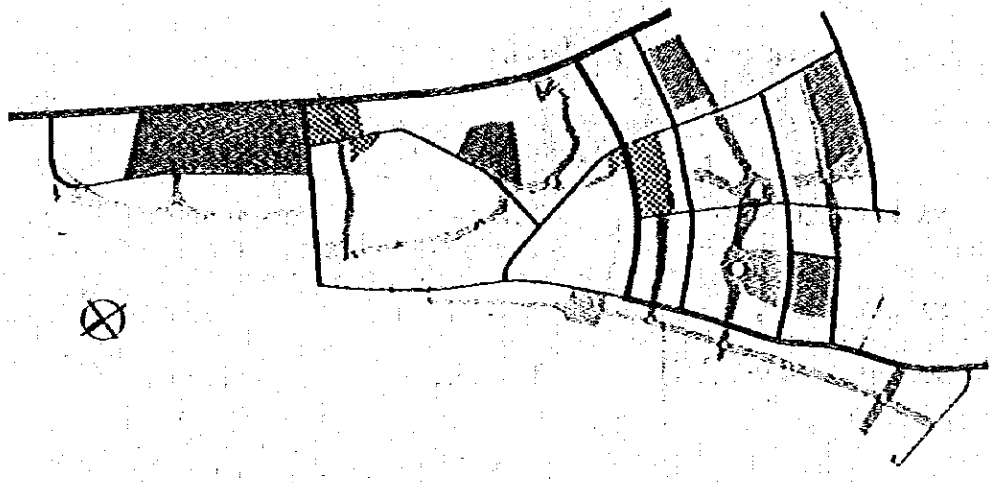


Fig. 2.5.13 Greenery Network Na Klua Town A

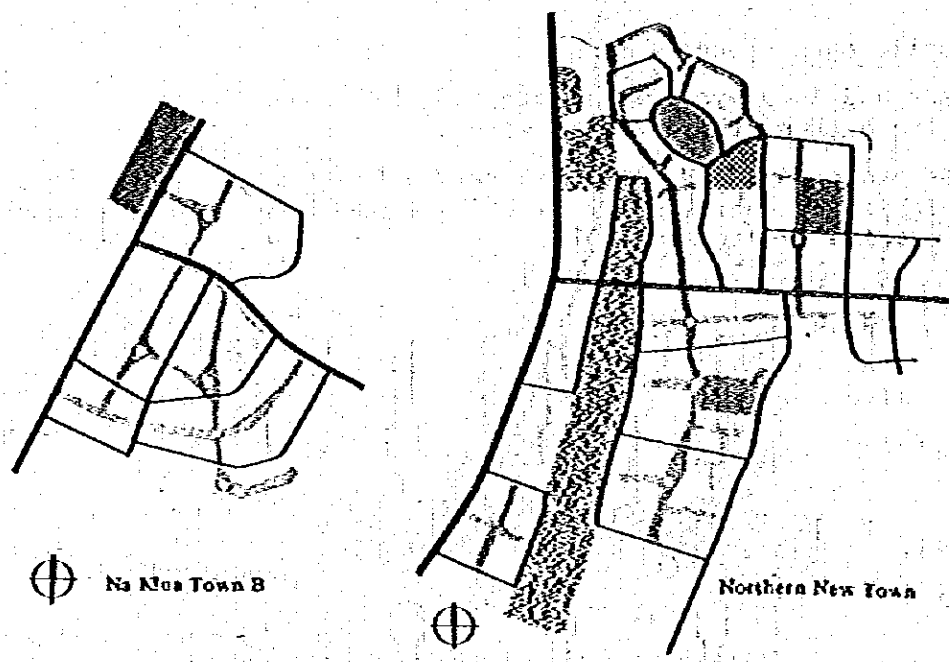


Fig. 2.5.14 Greenery Network

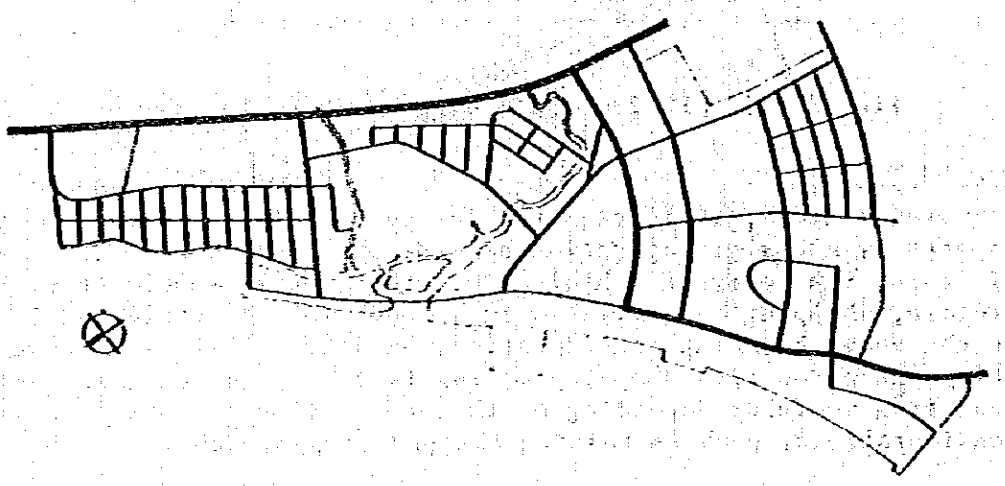


Fig. 2.5.15 Road Pattern Alternative 1 Na Klua Town A

2.5.4 Network for Local Streets

A comparative study was made of the following two alternatives as shown in Fig. 2.5.15 to Fig. 2.5.19. The basic policies of both plans are summarized in Table 2.5.3.

Table 2.5.3 Basic Policies for Demarcated Roads

Land Use \ Alternatives	Alternative 1	Alternative 2
High Density Residential Areas	Superblock approach Semipublic open space Concentrated parking	Superblock approach Semipublic open space Concentrated parking
Medium Density Residential Areas	Grid approach	Loop approach Pedestrian passages
Low Density Residential Areas	Grid approach	Cul-de-sac approach Pedestrian passages
Commercial Areas	Superblock approach Shopping malls Concentrated parking	Superblock approach Shopping malls Concentrated parking

In comparing both alternatives, the respective merits and demerits are discussed as follows:

First alternative:

Merits
1. The outline of the residential area is orderly.

Demerits
1. The image of the residential area tends to be monotonous.
2. Separation of pedestrians from vehicles is difficult.
3. Road occupancy rate becomes high.

Second alternative:

Merits
1. Separation of pedestrians from vehicles is facilitated.
2. Quiet and private living environments are maintained without transit traffic.
3. Road occupancy rate is less.

Demerits
1. The orderliness of the local streets tends to be lost.

In comparing both alternatives, the approaches of loops and cul-de-sacs in the second alternative give a more favorable environment for living and for maintaining safe conditions against traffic accidents, although the general appearance of the residential area tends to be less orderly.

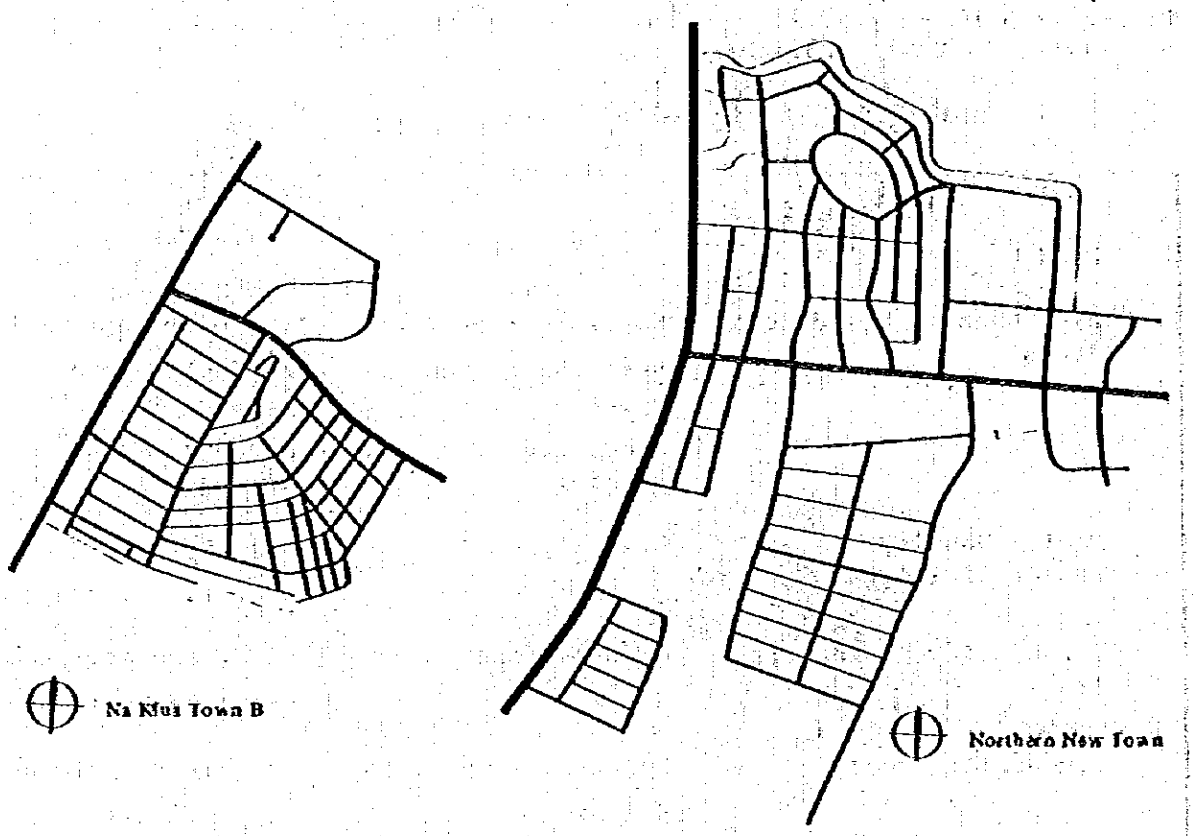


Fig. 2.5.16 Road Pattern Alternative 1

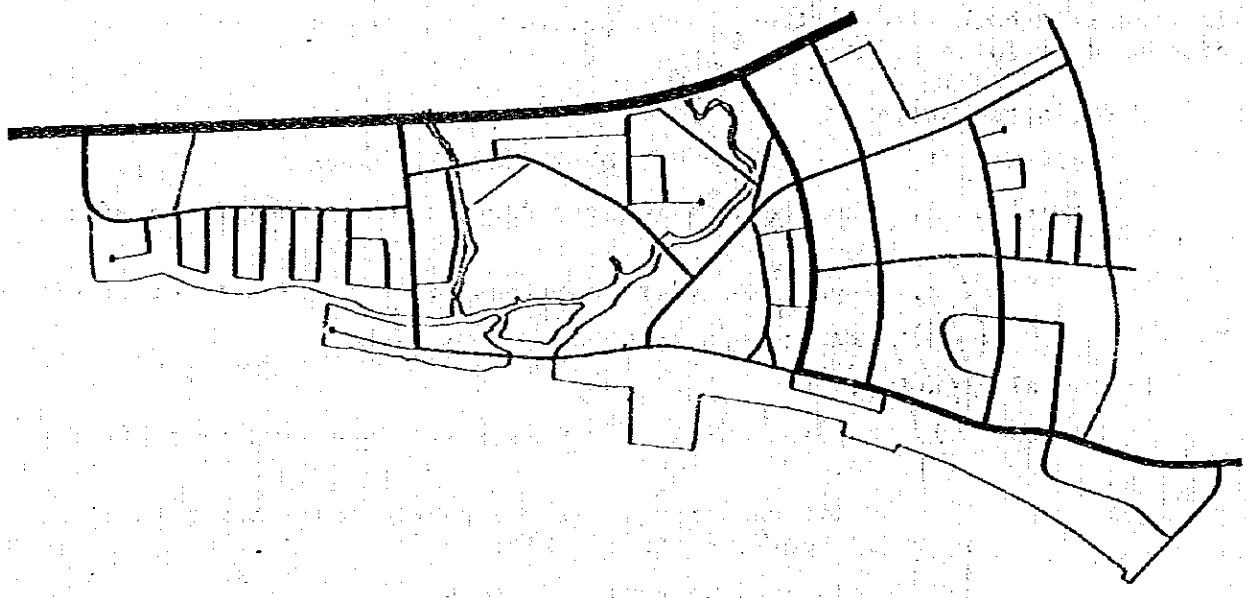


Fig. 2.5.17 Road Pattern Alternative 2 Na Klua Town A

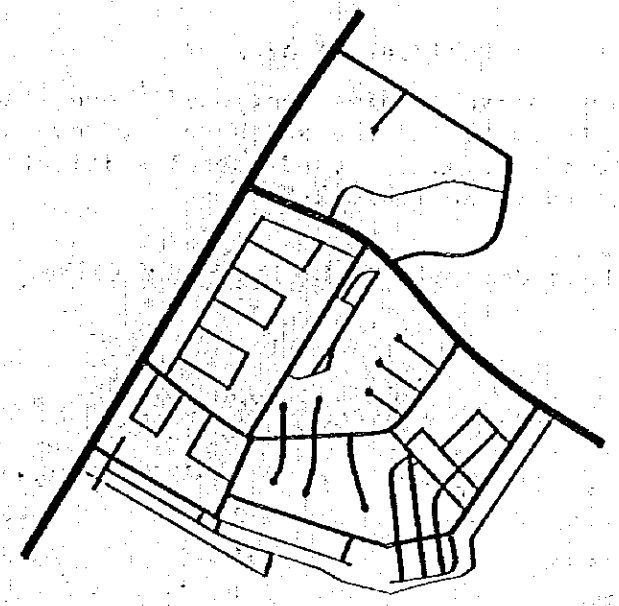


Fig. 2.5.18 Road Pattern Alternative 2 Na Klua Town B

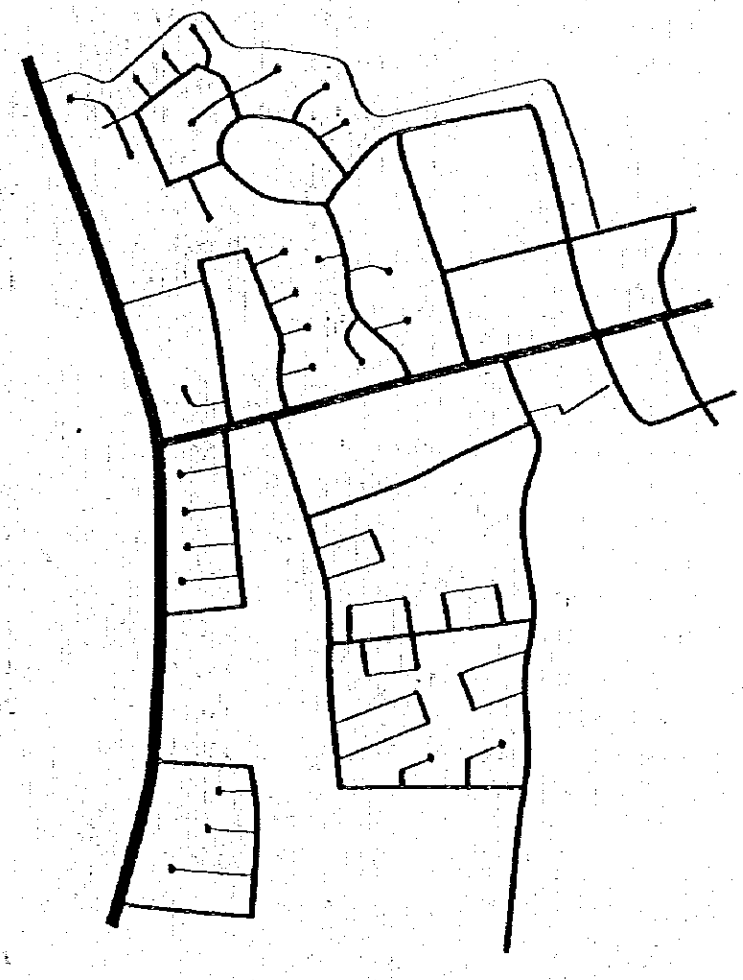


Fig. 2.5.19 Road Pattern Alternative 2 Northern New Town