VOLUME 2

TECHNICAL ASPECTS OF THE PROJECT

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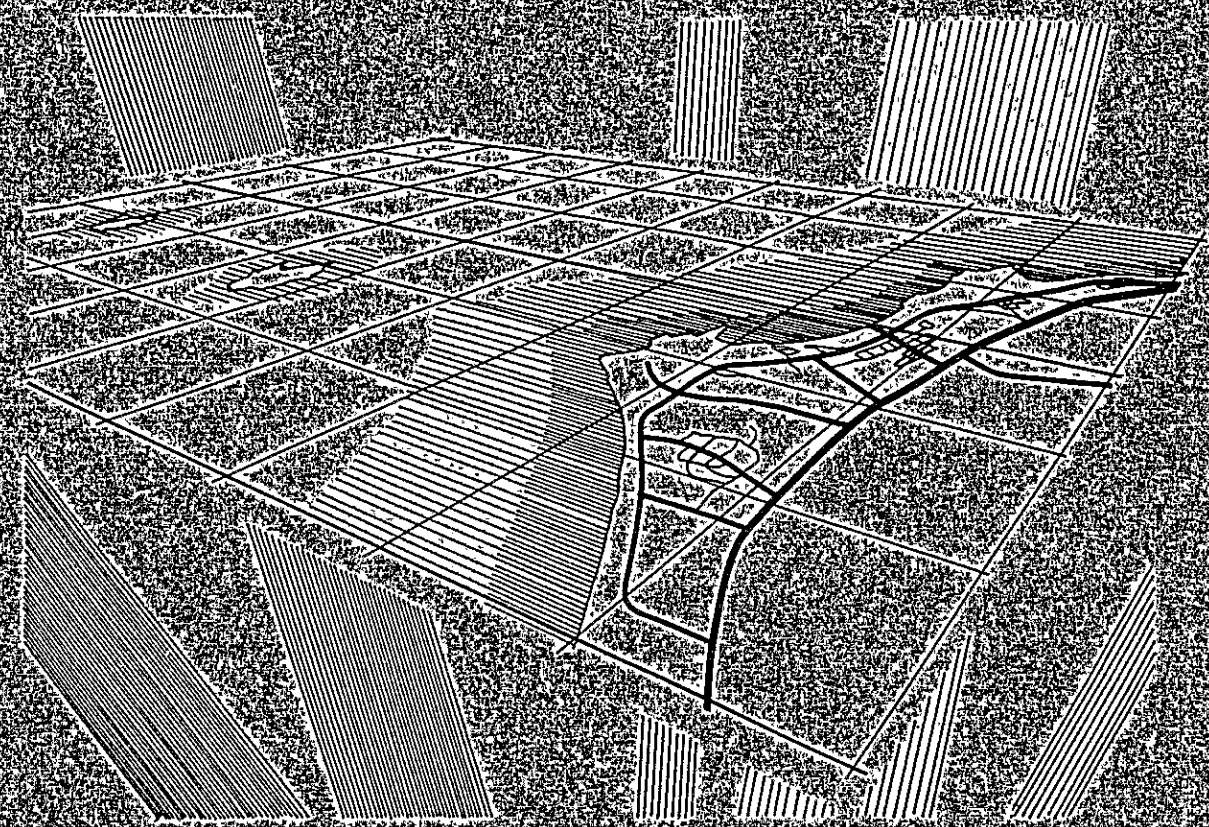
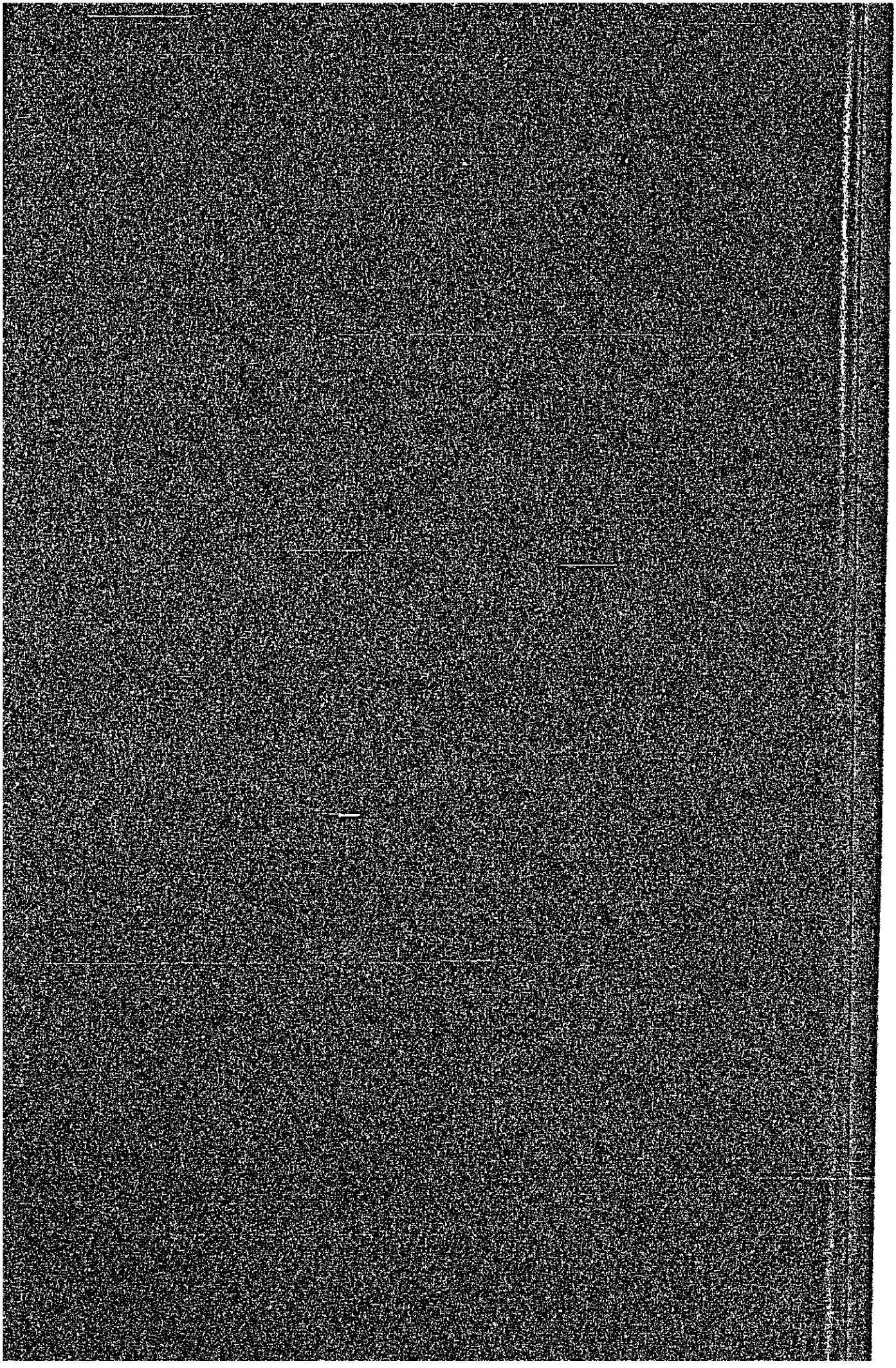




CHAPTER 1 PROJECT DESCRIPTION

1.1 General

(a) Main Elements of the Project

The project will consist of the following main elements:

(1) Infrastructure to be newly developed

- Sewerage System
- Storm Water Drainage System
- Port Facilities

(2) Infrastructure to be improved from existing levels

- Solid Waste Collection and Disposal System
- Road and Street System

These five categories have been studied in the feasibility analysis. The analysis also covers the organization of the implementation of the project.

(b) Supplementary Elements of the Project

In the analysis of the effects of the entire project on the study area, the following necessary auxiliary items have been considered within the scope of the study:

For the tourism area:

(1) By public investment

- Amenity cores
- Inland activities and parks

(2) By private investment

- Hotels
- Restaurants and other recreational facilities

(3) By public investment

- Facilities for the local community

(c) Water Supply System to the Study Area

The Thai Government has announced that a feasibility study for this system has been made and funds have been allocated for detailed design and construction. It is expected that this system will be put into effect as soon as possible in coordination with other parts of the infrastructure. Therefore, this study is not included in a feasibility study for the water supply system, but rough construction and operation costs have been estimated for reference purposes.

1.2 Area to the Covered by the Project

(a) The Project Area

The project site is located about 150 km south of Bangkok and is facing the Upper Gulf. In topography, the area can be divided into three parts.

(1) Pattaya Area

This area faces the Gulf with a 9 km shoreline of sandy and rocky beaches. At the southern end of the 4 km sand beach, there is an existing downtown area which is not harmoniously operating as a tourist center. About two thirds of the existing hotel rooms are located continuously along this beach.

(2) Na Klua Area

Na Klua is the center of the Na Klua sanitary district. Most of the residents are living along the Na Klua river and its neighborhood. To the east of Na Klua, there are tapioca factories, one of the major industries in the area following the tourism industry. The river is located about 3 km north of Pattaya beach. These two areas are connected by local streets and the Sukhumvit Highway.

(3) Ko Lan Island

This beautiful island is about 10 km west from the mainland. It has five sandy beaches at each corner, and is becoming a popular tourist spot. Ko Pai island, which is located about 10 km west from Ko Lan island, is not included in the study area.

1.3 Total Project Cost

Table 1.1 Total Project Cost by Major Public Infrastructure

Unit: million Baht

Major Project Components	Land Acquisition	Civil Works and Equipment	Prof. Services	Total Physical Facilities	Project Administration	Total Project Cost	US$ million
Road and Street System	182.5	129.1	11.5	323.1	26.0	349.1	17.5
Sewerage System	18.1	159.3	14.7	192.1	19.9	212.0	10.6
Storm Water Drainage System	18.4	22.9	2.4	43.7	5.6	49.3	2.5
Solid Waste Disposal System	0.6	19.7	1.8	22.1	13.1	35.2	1.8
Port Facilities	-	53.6	5.4	59.0	6.2	65.2	3.3
Water Supply System	2.2	322.3	29.5	354.0	27.4	381.4	19.1
Base Line Cost	221.8	706.9	65.3	994.0	98.2	1,092.2	54.8
Physical Increase	-	49.5	4.6	54.1	-	54.1	2.7
Price Increase	-	56.6	5.2	61.8	-	61.8	3.1
Contingencies Sub-Total	-	106.1	9.8	115.9	-	115.9	5.8
Total Project Cost	221.8 (20%)	813.0 (73%)	75.1 (7%)	1,109.9 (100%)	98.2	1,208.1	60.6

CHAPTER 2. ROAD AND STREET SYSTEM

2.1 Introduction

A master plan for the road and street system has already been established and a feasibility study has been conducted to obtain greater accuracy following the concepts of the master plan. On the basis of the fundamental concepts established in the master plan, and after feeding newly available information in the course of feasibility study, the final road network system has been established as shown in Fig. 2.2.

For the planning of the road and street system of the study area, consideration should be given to the landscape, the landuse plan, proposed zoning, etc., as a tourist resort. Needless to say, the proposed widths of the roads must have sufficient capacity to meet the future traffic volume; however, the environmental effect of the roads on the surroundings should be substantially taken into consideration. Proper planning should be conducted so that, as it is an international tourist resort, the study area should be affected as little as possible by the noise, vibration, exhaust gas and other pollution coming from vehicles running on the roads and streets in the area.

As most of the roads in Thailand are planned according to the standards of the AASHO, these were adopted for planning road and street network in Pattaya. If necessary, however, the standards for highway structures of the Japan Highway Association should be adopted as well.
Total Project Cost for the system is shown on page 20 table-1.1.

2.2 Existing Road Network

The road and street network of the study area is shown in Fig. 2.1 and the general features are as follows:

- Almost all the roads and streets are paved with asphalt, but there are many damaged portions requiring repair.
- Sukhumvit Highway is used for an access road from Bangkok to Pattaya, and the work to widen it to a four-lane divided highway will soon be completed.
- Three access roads from Sukhumvit Highway lead to Pattaya beach.
- The road network is controlled by the Highway Dept. and the provincial government, as shown in Fig. 2.1.
- Most of the existing hotels, restaurants, stores, etc., are developed in the district lying between the two-lane beach road and the two-lane back road. These two parallel roads are connected by many connection roads (4m to 6m in width).
- At intersections on corners, the radius of the curves or the alignments are not satisfactory.
- Generally, side walks have not been constructed except on a part of the beach road.
- Most roads are not equipped with effective drainage ditches.
- Most of the existing roads are constructed on flat lands without large excavations and have low embankments, being paved with asphalt on sandy ground.

Fig. 2.1 EXISTING ROAD NETWORK

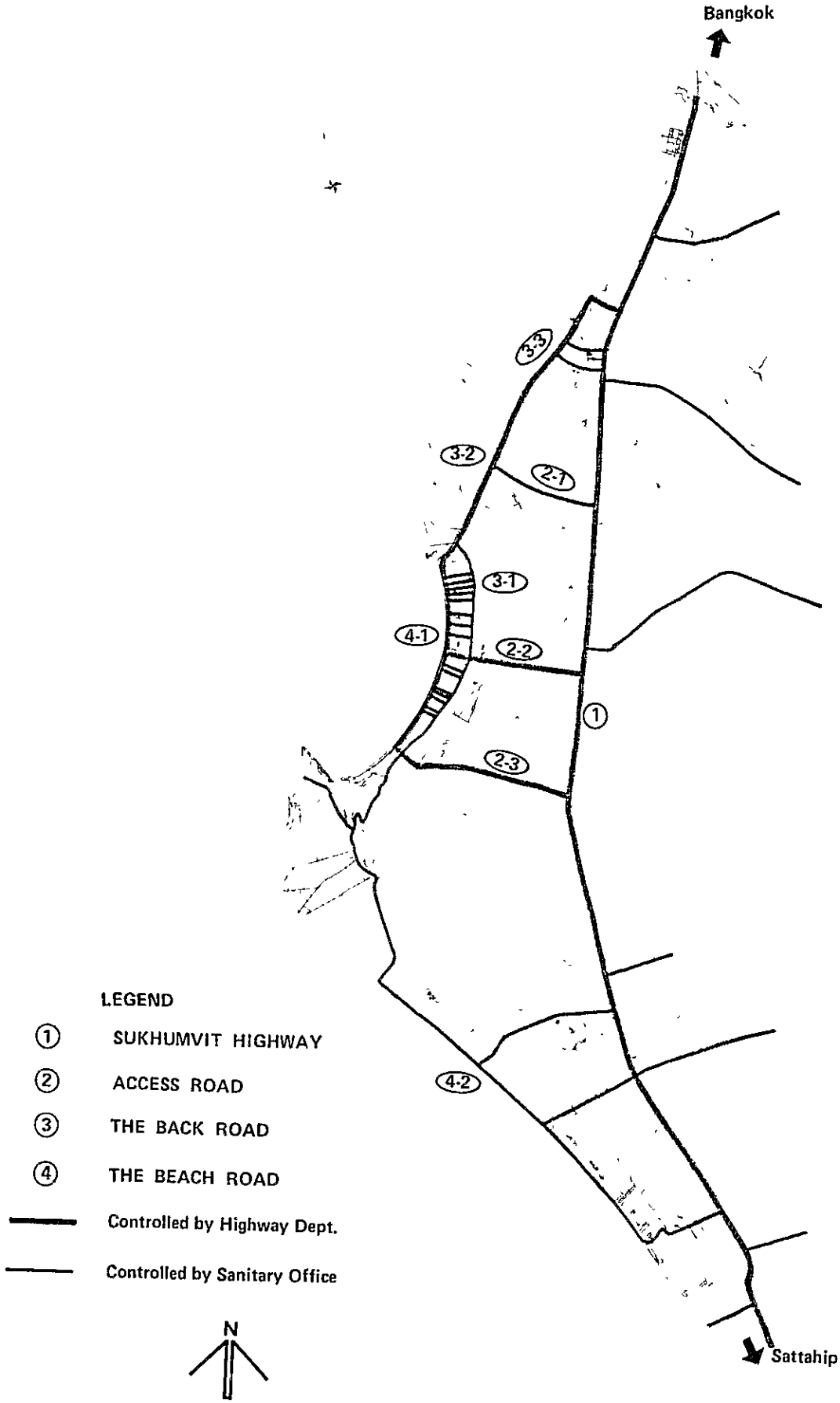


FIG 2.2 ROAD NETWORK

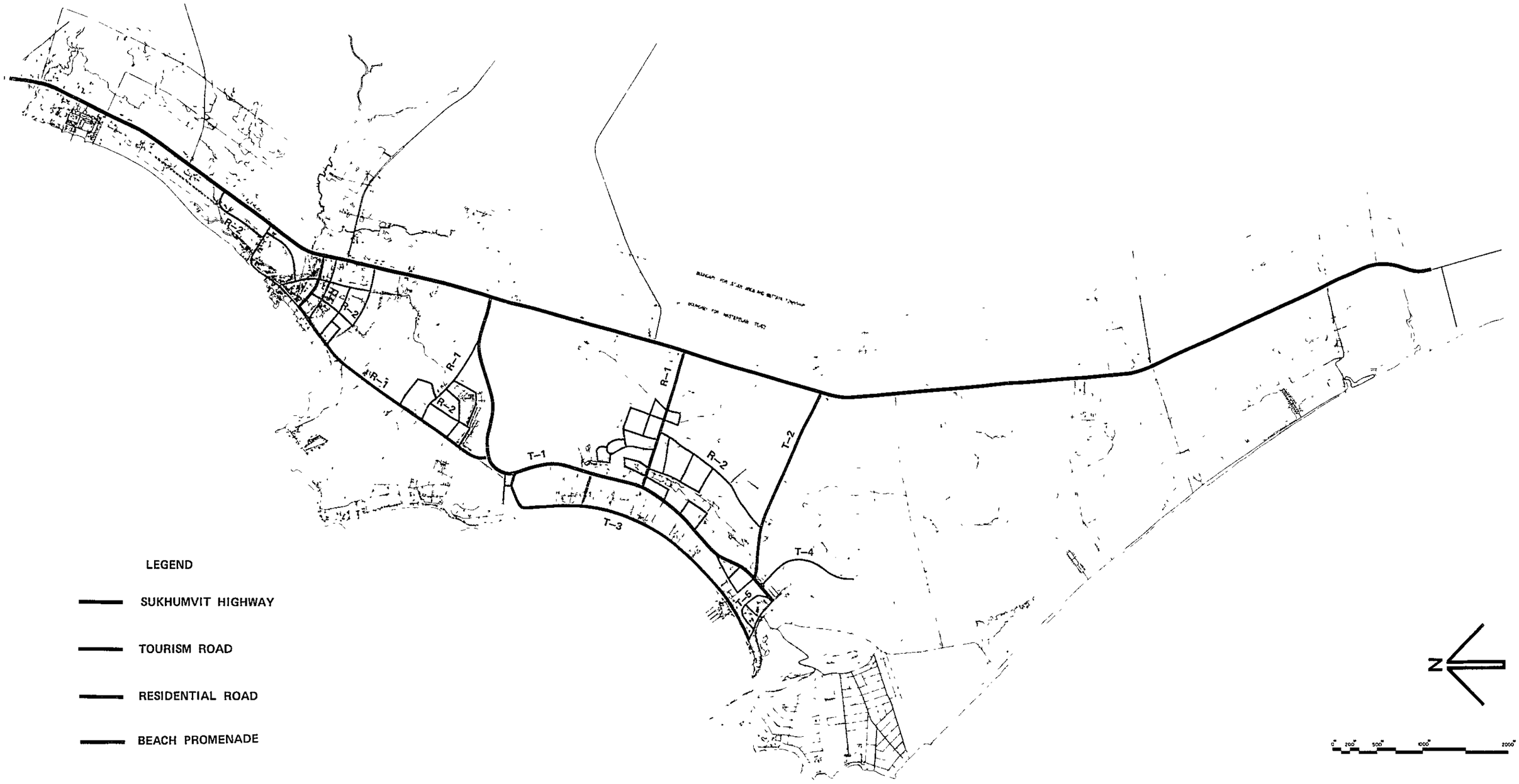


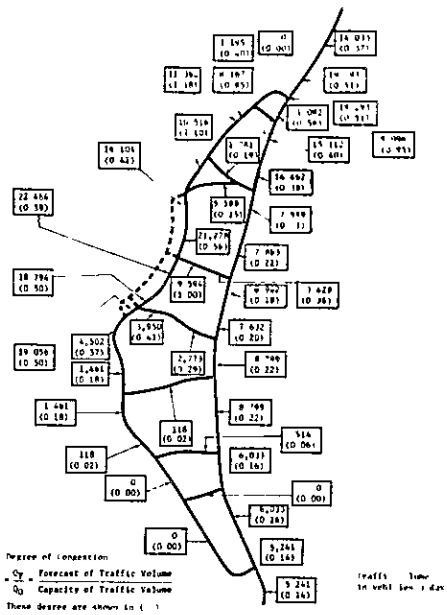
FIG 2.2 ROAD NETWORK

2.3 Traffic Analysis

The general characteristics of traffic in Pattaya are summarized as follows:

- The peak volume was recorded on Saturday and Sunday probably due to the tourism traffic pattern of Pattaya.
- Baht buses (local buses remolded out of small trucks) are generating an overwhelming proportion of the traffic volume compared with other types of vehicles.
- The ratio of daytime to nighttime traffic volume is as high as 1.62 on average.

Future forecasting of traffic volume has been estimated taking into account such factors, existing traffic as original traffic volume, present and future population, tourism activities by zone according to the development plan and other relevant factors. The results of computer analysis are shown in Fig. 2.3.



2.4 Road Design

Taking the estimated assigned traffic volume and the standard criteria for road alignment listed in the following table, typical road section and pavement structure have been determined as illustrated in the following figures and Table 2.1. Detailed design solution is described in the main report.

Table 2.1 Main Design Criteria for Guidance

Item	Unit	Main Design Criteria			
		T-1, T-2	R-1	T-5,R-2,R-2'	Remarks
Design Speed	km/h	80	60	40	
Maximum superelevation	%	6.0	6.0	6.0	
Minimum radius	m	260	140	60	
Maximum gradient	%	4.0	5.0	7.0	
Stopping sight distance	m	110	90	70	
Transition curve	m	$\frac{R}{3} \leq A \leq R$			Clothoid curve

Note

(T-1)	ARTERIAL TOURISM ROAD	(T-5)	TOURISM ACCESS STREET
(T-2)	TOURISM ROAD	(T-6)	TOURISM ACCESS STREET
(T-3)	BEACH PROMENADE	(R-1)	MAIN RESIDENTIAL ROAD
(T-4)	PARK STREET	(R-2)	COLLECTOR STREET

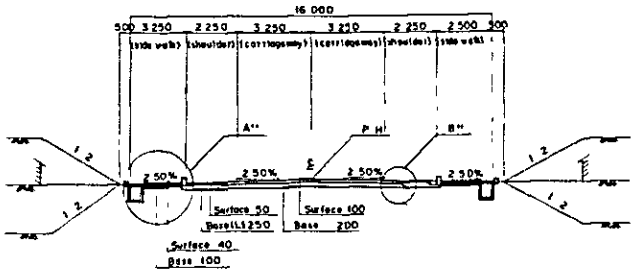


Fig. 2.4 Typical Cross Section of T-5, R-1 & R-2

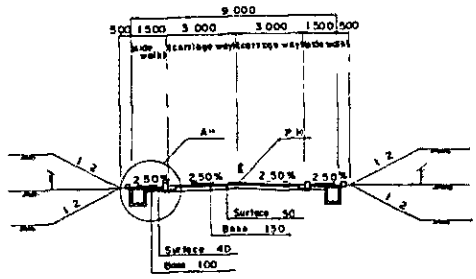


Fig. 2.5 Typical Cross Section of T-6 & R-2

TYPICAL CROSS SECTION

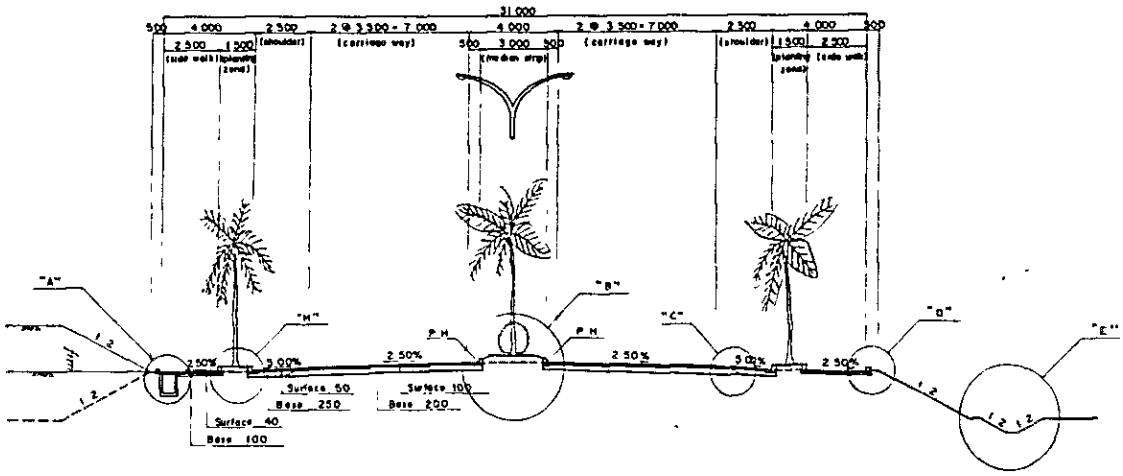


Fig. 2.6 Typical Cross Section of T-1 Arterial Tourism Road

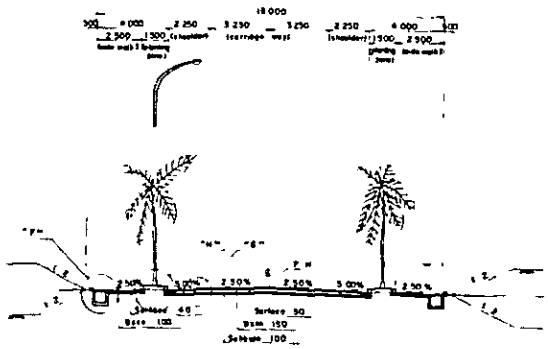


Fig. 2.7 Typical Cross Section of T-2 Tourism Road

Table 2.2 Typical Pavement Section

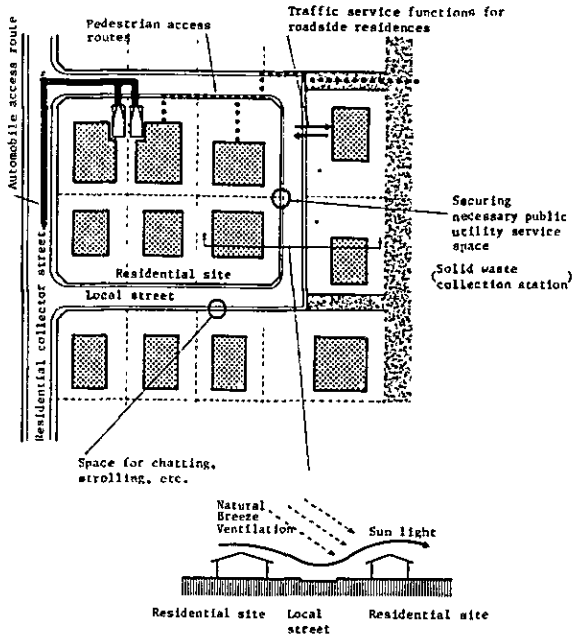
Road Division	Typical Pavement Section	Check of TA
T-1	CBR10 or more	TA = 20 ≤ $10 + \frac{20}{2.0} = 20$ cm
T-2	CBR15 or more	TA = 16 ≤ $5 + \frac{15}{2.0} + \frac{10}{2.7} = 16.2$ cm
R-1	CBR10 or more	TA = 20 ≤ $10 + \frac{20}{2.0} = 20$ cm

Surface
Base Course (High Quality)
Subbase Course (Low Quality)

2.5 Local Streets

In the Master Plan, the basic concepts for the housing area development were established as follows:

- Separation of tourism areas from residential areas
- Improvement of the living environment
- Preservation of natural scenery
- Consideration of existing property divisions
- Control of urban sprawl
- A variety of housing types and low density appearance of the housing area desirable



To formulate the local streets system shown in Fig. 2.2, the general concepts mentioned above and the functional structure of local streets and town units as illustrated in Fig. 2.8 were taken into consideration to cater for the housing demand resulting from the population increase as forecasted in Table 2.3. Since the landuse plan is closely related to local street network planning, a detailed study of the new town development was conducted, including investigation of the social infrastructure (hospitals, schools, town halls, parks, etc.), greenery, pedestrian network, related matters and other factors of residential types, as fully explained in the main report.

Table 2.3 Population Forecast

Persons

Area	1976	'77	'78	'79	'80	'81	'82	'83	'84	'85	1986	1996
Na Klua 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 Klua 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 population 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 proportionally.

2.6 Improvement Plan for the Beach Road

To solve the urgent problems of beach usage and to create an attractive beach area in terms of aesthetics as well as functional usage, the characterization of the beach area, as illustrated in Fig. 2.9, together with the supporting facilities and reorganization of the circulation system in the beach activity area and amenity core areas are the key items. Therefore, the overall development approach has been based on the implementation of the beach service parks and pedestrian promenade along the beach front, as illustrated in figures, instead of the present disorderly beach usage and automobile parking along the beach.

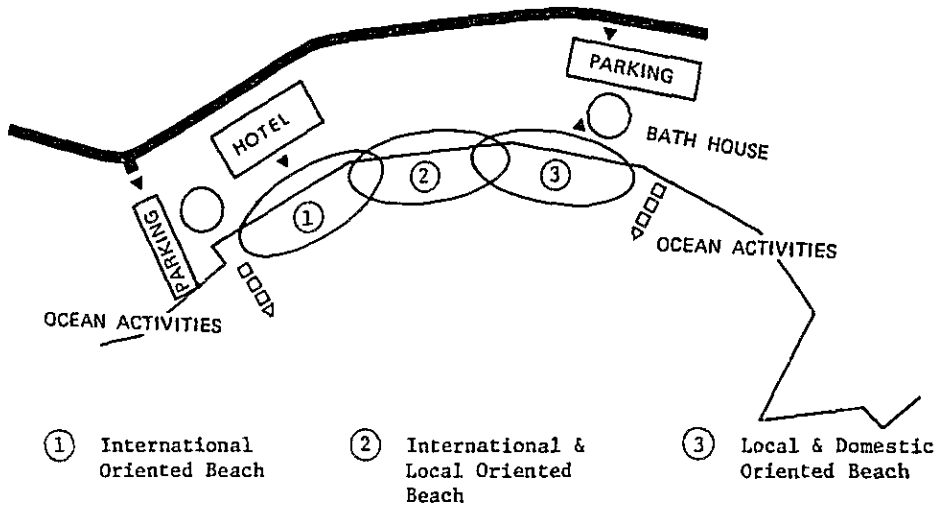


Fig. 2.9a Directing of Visitors

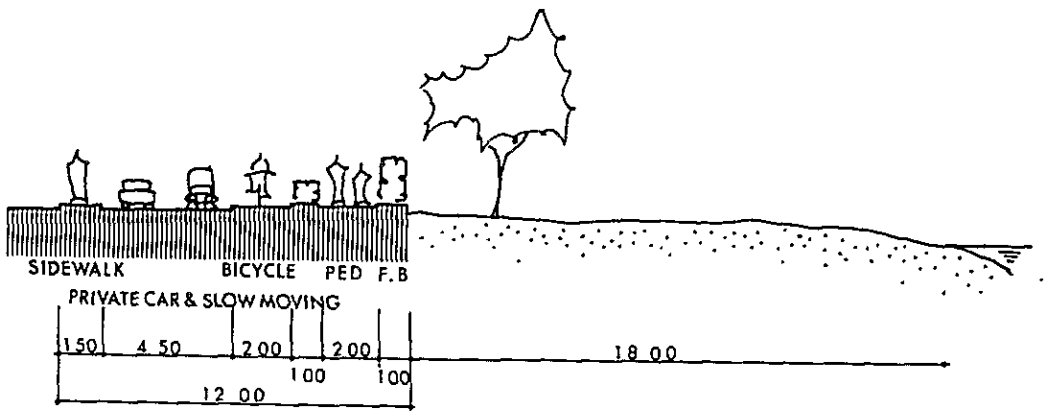
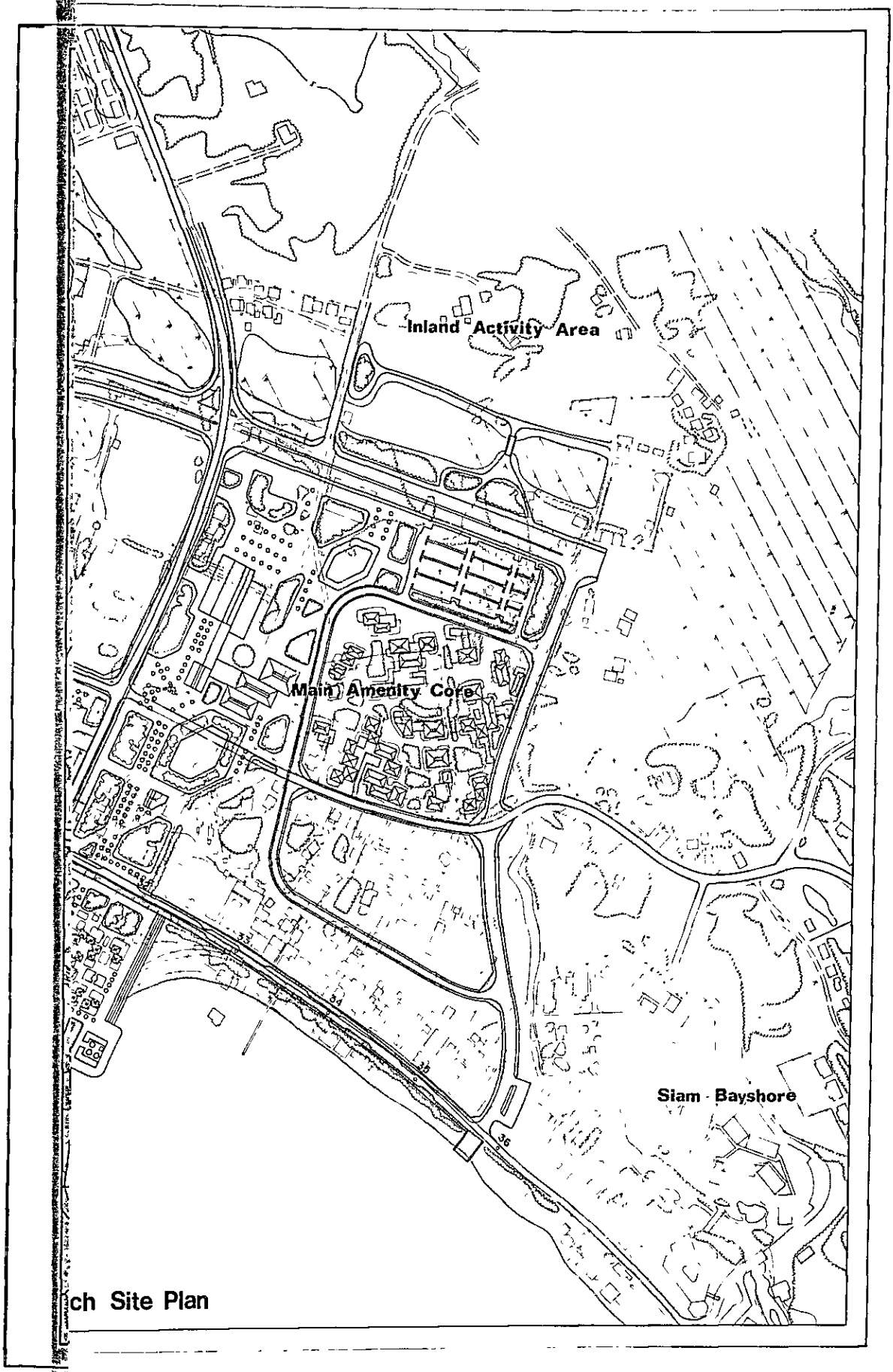


Fig. 2.9b Road Cross Section Proposed - Step 3)



ch Site Plan

Regent Pattaya

Holiday Inn

Nipa Lodge

Hyatt Pattaya

Tropicana

Service Park

Service Park

Orchid Lodge

Northern Core

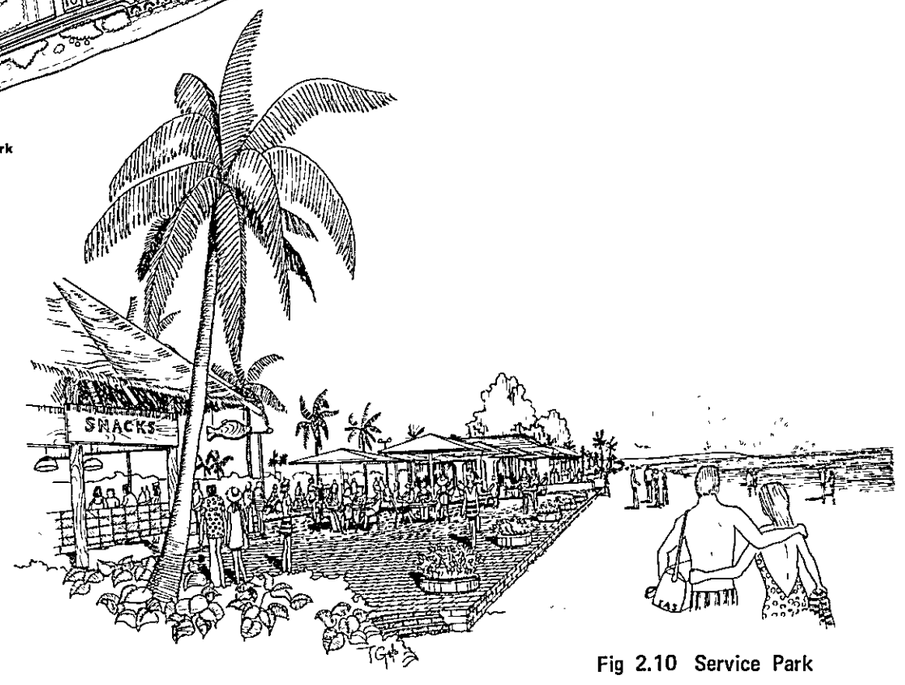


Fig 2.10 Service Park

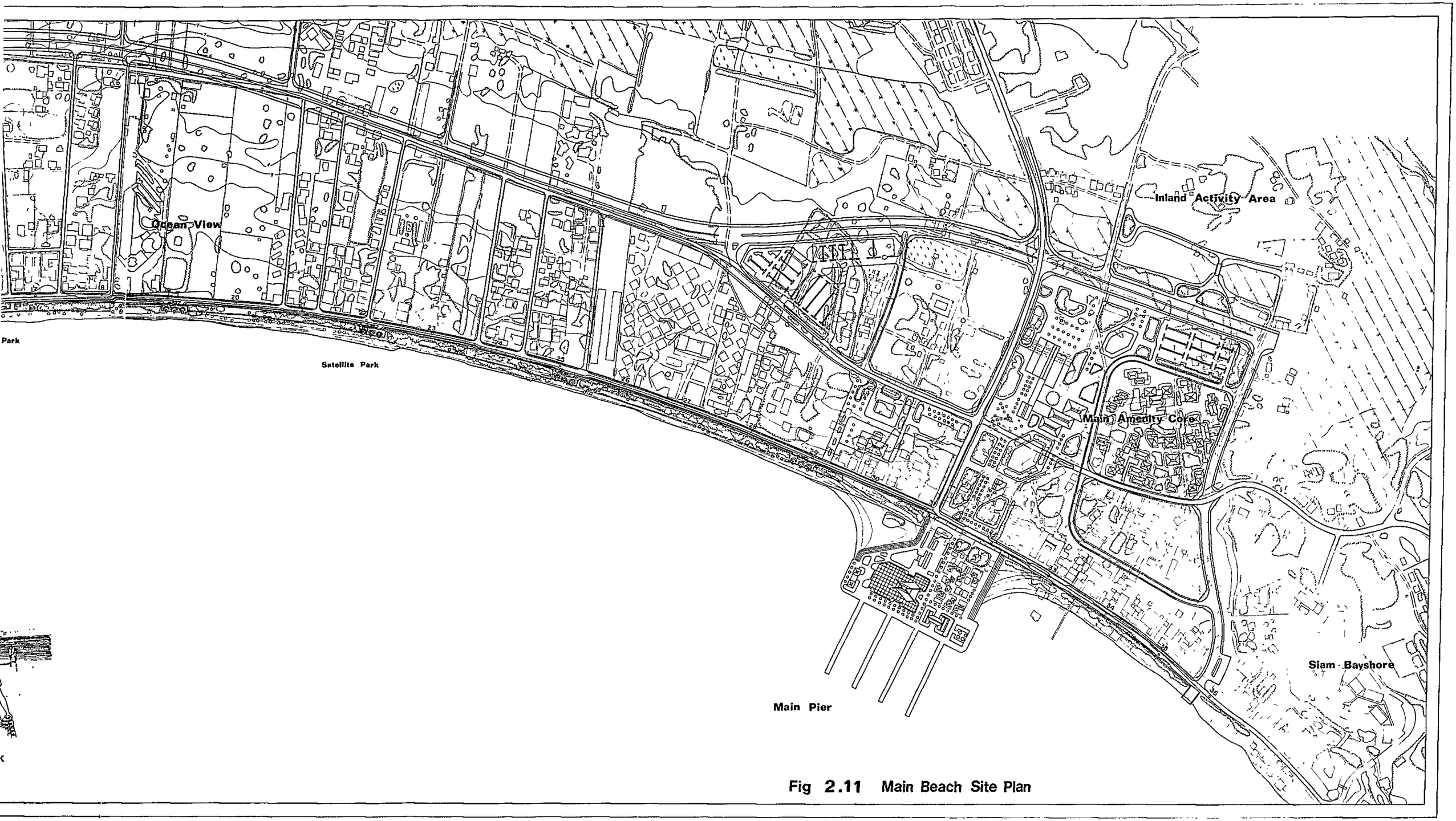
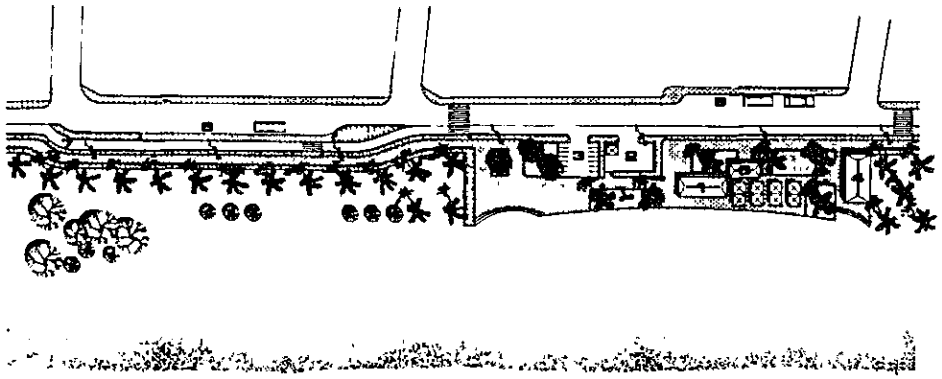
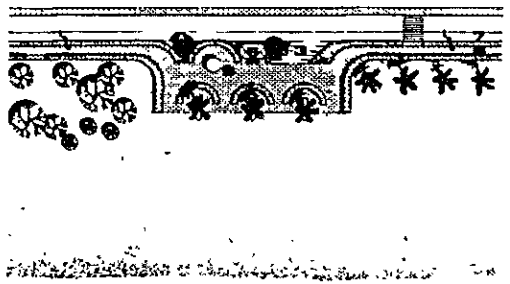


Fig 2.11 Main Beach Site Plan

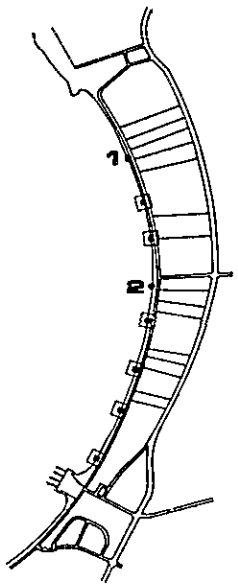
Fig. 2.12 Service Park and Satellite Park Plan



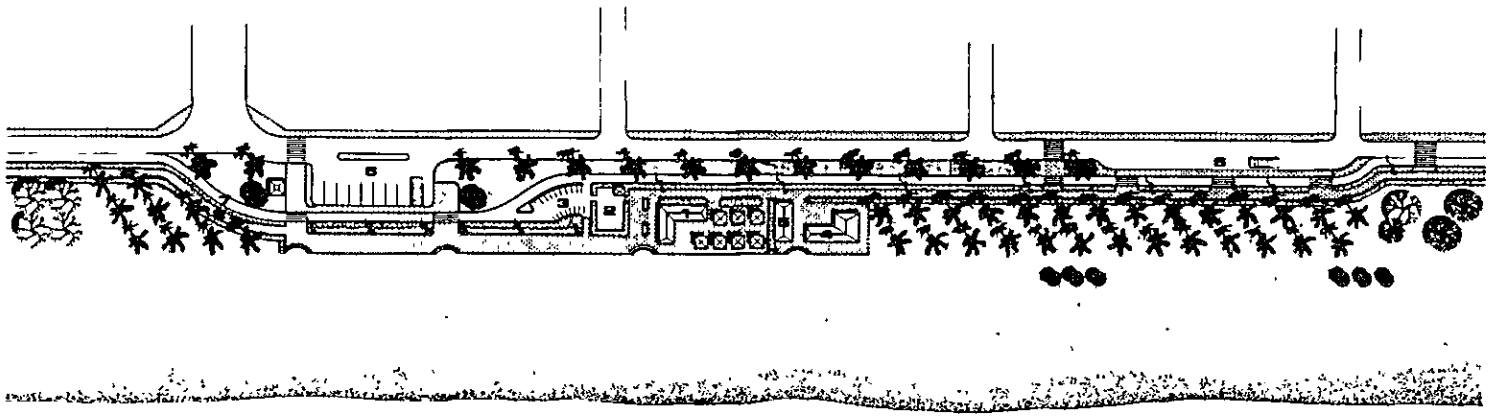
1. SERVICE PARK



SATELLITE PARK



LEGEND
1 SNACK BAR
2 BICYCLE RENTING
3 BICYCLE PARKING
4 SERVICE FACILITIES
5 PUBLIC TOILET
6 TAXI PICK UP STATION
7 BICYCLE WAY
8 PEDESTRIAN WAY
9 VENDING STAND



2. SERVICE PARK

2.7 Road Planning of Ko Lan Island

Following the development policy established in the master plan, the detail planning of the beach activity area, such as the allocation and lay-out of service facilities at the three beach areas, was carried out as described in the main report.

Three types of roads are proposed in this beautiful island, as illustrated in Fig. 2.13, so as to serve the tourists as well as the local people. Careful planning to conserve natural beauty was always the key criterion in the planning of these roads.

The study organization of the beach activity area has basically been conducted with a similar approach as to the main beach in Pattaya. The atmosphere of the beach service park in Ko Lan Island is illustrated in Fig. 2.14.

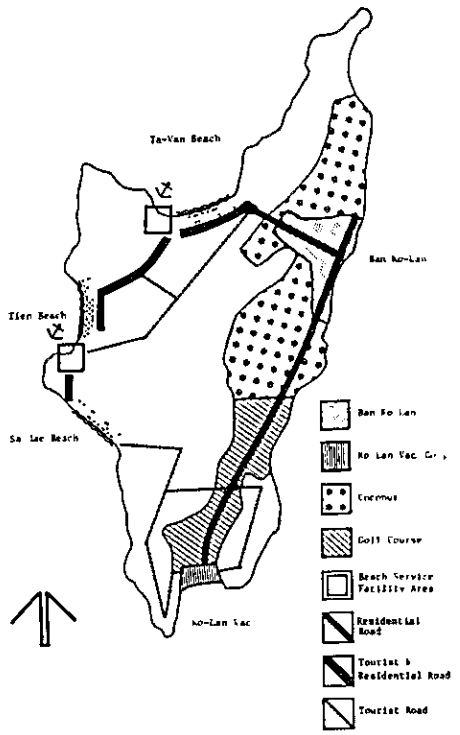


Fig. 2.13 Road Network in Ko Lan Island

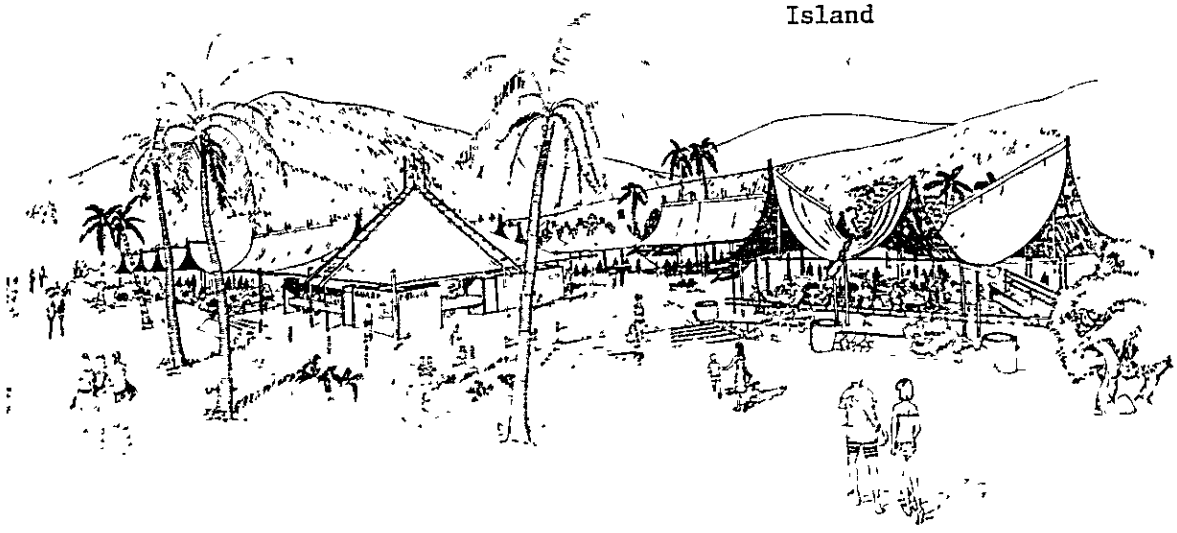


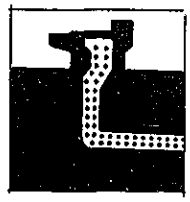
Fig. 2.14 Beach Service Park in Ko Lan Island

2.8 The Implementation Plan

The implementation plan for the proposed roads and streets should be closely coordinated with the number of tourists, traffic volume and new town development plans based on the forecasted population growth. The following Fig. 2.15 shows the steps for implementation each year according to the development plan established in this study.

FIG 2.15 IMPLEMENTATION PLAN

FIG 2.15 IMPLEMENTATION PLAN



CHAPTER 3. SEWERAGE SYSTEM

3.1 Introduction

Sewage generating sources in this planning area can be roughly classified into 3 groups; namely, the tourism industry, such as hotels and restaurants, etc., residential, and Tapioca factories. Some of the hotels and other facilities which have been completed have absolutely no public facilities for water supply and sewage treatment, and some parts of the seashore are contaminated by non-treated sewage.

Pollution is especially bad in the downtown area located at the southern end of Pattaya Beach and the estuary of the Na Klua River. The former seems to be due to the discharged sewage from restaurants and shops, and the latter seems to be due to, sewage from inhabitants and wastewater of Tapioca factories. It is thus very necessary to construct sewage facilities in order to maintain and develop the said area as a "beach resort".

Total Project Cost is shown on Page 20 Table 1.1.

3.2 Present State of Sewage Facilities

(a) Hotels

Existing sewage treatment facilities in the hotels surveyed were mostly designed to use the activated sludge method. A few hotels are treating their sewage very well with new equipment, and some using the activated sludge method are carrying out fairly good maintenance and management.

However, many hotels are, for all practical purposes, not treating their sewage at all. A few hotels utilized oxidation ponds and/or septic tanks but in most cases it was found that they did not seem to be managing or maintaining these facilities properly. Most of the hotels were utilizing after-treatment sewage to spread on their lawns. Some hotels were spreading untreated sewage on their lawns.

(b) Restaurants

Restaurants along the Pattaya seashore are discharging their sewage into the sea directly.

Night soil is temporarily stored in septic tanks without bottom-plates, discharging into the soil and seawater by natural seepage. Most such tanks are washed over by the tides. Those restaurants using septic tanks with concrete bottoms use vacuum-cars to clean residual sludge.

(c) Residences

There are 2 types of residences: Those built next to the beach or along the side of streams and those built inland.

Septic tanks are used for treating the night soil from the houses built inland. These septic tanks have no bottom plates, and as residents reported in direct interviews, the tanks are cleaned once in 1-3 years.

Almost all the domestic after-treatment sewage is sprayed on the ground. Septic tanks are also used for the treatment of sewage from houses existing along the beach or on riversides. However, residents in these areas said that no periodic cleaning is done.

At the estuary of the Na Klua River where water level is sensitive to the tide, which tends to push out the sludge from the septic tanks, domestic sewage is discharged directly into the public water bodies.

The soil conditions in the planning area are, generally speaking, sandy with light permeability. Both these factors make it especially easy for sewage to seep from septic tanks into the ground.

(d) Tapioca Factory

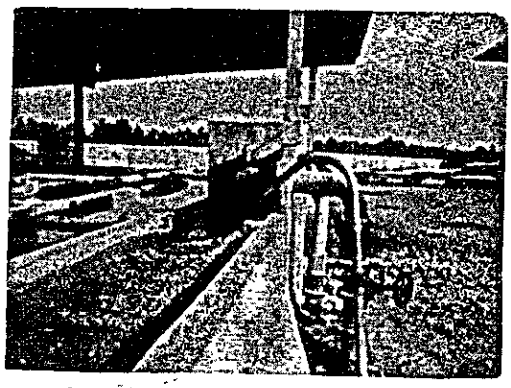
In 1976, 176 Tapioca factories were in operation in Chomburi Province. Among them, 22 factories were in the project area, of which 9 factories have since suspended operation.

For the treatment of wastewater from tapioca factories, the stabilization pond system is used at present.

According to the reference data*, there are 5 Second Grade Factories and one First Grade Factory which are equipped with treatment facilities, while the remaining 16 Second Grade Factories have no treatment facilities. The First Grade Factory has a rather high capacity for the treatment of sewage.

(e) Others

There are rain-drainage facilities along the streets in a part of the Na Klua area and in downtown Pattaya, and culverts have been constructed at several other places for drainage. Various effluents are discharged from houses to the side ditches for rain-drainage in the Na Klua area and downtown Pattaya, and the residents have been complaining about the objectionable odor caused thereby. The side ditches are from time to time cleaned by a pump-car which can remove sediment by pressured-water.



Sewege Treatment Plant at Tapioca Factory

Current Sewege Discharging Pattern

3.3 Environmental Effects of Sewerage System

A sewerage system plays not only a role in enhancing the living enrivonment in an urban area but also a role in solving the problems of water pollution in watersheds for public uses.

In general it is becoming more difficult to develop water as a basic natural resource in the future, and the relation between demand and supply can also be expected to become more strained. This statement is also applicable to the present planning area.

Thus, in order to make effective uses of limited water resources, it may be necessary to try to effect a higher utilization of these resources through a higher degree of sewage treatment, re-use and circulatory uses, as well as through the maintenance of water-quality in public watersheds.

The following diagram shows a water-cycle which demonstrates the close relationship between sewage and water resources.

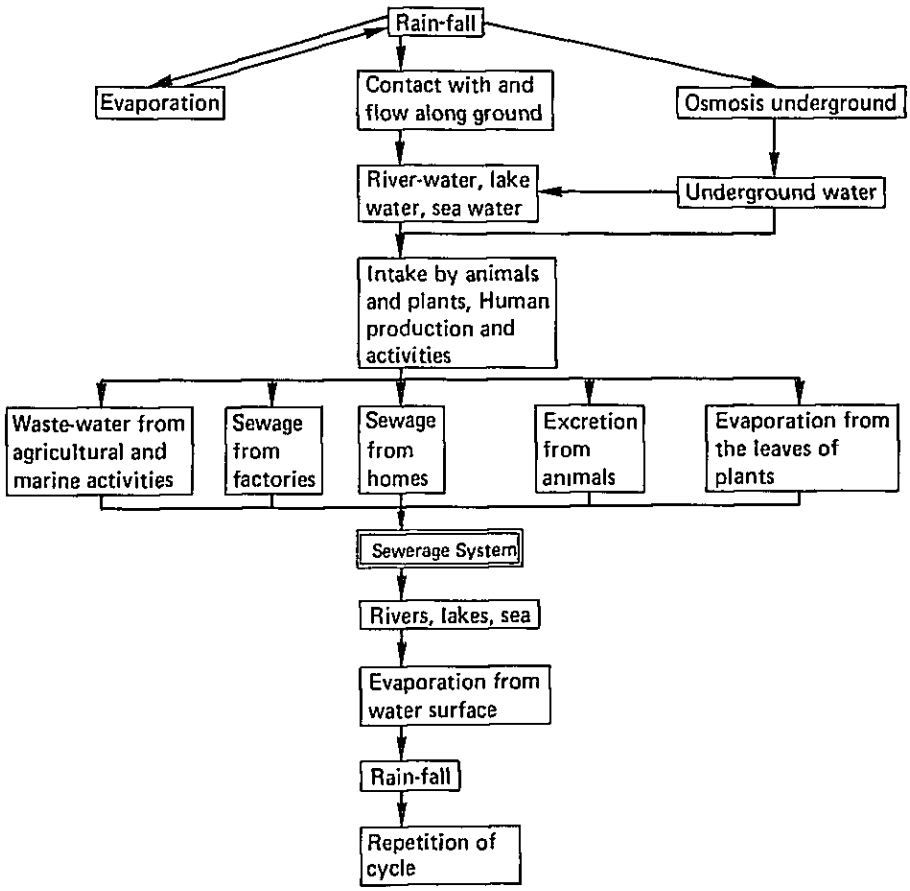


Fig. 3.1 Water Circulation Cycle

A sewerage system in the planning area can play the following roles:

(a) Improvement and Protection of the Living Environment of the Region

1) Improvement of the Regional Environment

The sewage from residences and factories is discharged into the covered culverts and removed promptly, thus eliminating open accumulations of sewage where mosquitoes or flies can breed. This is an important way in which the regional environment can be improved.

The pollution at the estuaries of the Pattaya River and the Na Klua River will be eliminated, and residents in those areas can become free from environmental pollution caused by filthy odors.

2) Improvement of Living Conditions

The conventional toilet can be replaced by the more pleasant and hygienic flush toilet. As for the current system of septic tanks, its sewage treating function is low and it is not adequately maintained. This problem will be solved by the construction of a sewerage system.

3) Prevention of Contagious Diseases

Contagious diseases can be prevented by improving the living environment.

4) Prevention of Floods

By improvement of drainage in low-lying marshlands, it will be possible to prevent flooding of the rivers in the area.

(b) Maintenance of Water Quality in Public Water Areas

A sewerage system, by playing an important role in the cleaning of the public watershed, is an essential condition for human health and pleasant living, which cannot always be measured directly.

For example:

1) Animals and plants in water channels and by the seaside can be protected.

2) Water resources can be protected.

3) The seaside environment can be maintained for recreational activities.

3.4 Basic Policy for the Project

(a) Stepwise Transfer from Present Hotel Sewage Treatment to Public Facilities

It is recommended that sewage from hotels be treated through a public sewerage system. Transition from private to public sewage treatment will be implemented gradually, starting with those hotels whose current operations are unfavorable.

However, the choice of whether sewage from hotels is to be treated by public sewage facilities or by the hotels own facilities is left to the hotels themselves. In the case of those hotels which treat their sewage by themselves, water quality standards for treated water must be clearly explained to the hotel managements and these standards must be maintained.

(b) Service Ratio for Residents

In this feasibility study, a 100% service ratio has been planned for a sewerage system extending to all inhabitants.

However, no planning was made in this feasibility study for the service-piping to inhabitants in remote areas from the existing main roads.

In order that residents will be able to make use of public sewage facilities, it must be expected that residents will have to bear considerable expense for the installation of plumbing and for the improvement of toilets. There is thus, some reason to fear that in some cases the diffusion rate of the new sewerage system might fail to reach the levels specified in the plan. A system of monetary loans is suggested as a possible means of overcoming the problems involved.

(c) Policy with Respect to Tapioca Factories

The Government of Thailand issues strict regulations on wastewater from tapioca factories in keeping with its intention of maintaining a clean environment. Thus in the present project, treatment facilities should meet the requirements of the Government's standards, and the sewage from First Grade Factories need not be received by the public sewerage system. It is planned that sewage from the Second Grade Factories be treated by the public sewerage system. Provision should be made, however, for the possibility that sewage from First Grade Factories in which facilities might fail to meet the Government's criteria could be treated by the public system. Thus, the plan should take into account the possibility of securing the needed land and extending the necessary pipes to cope with such situations.

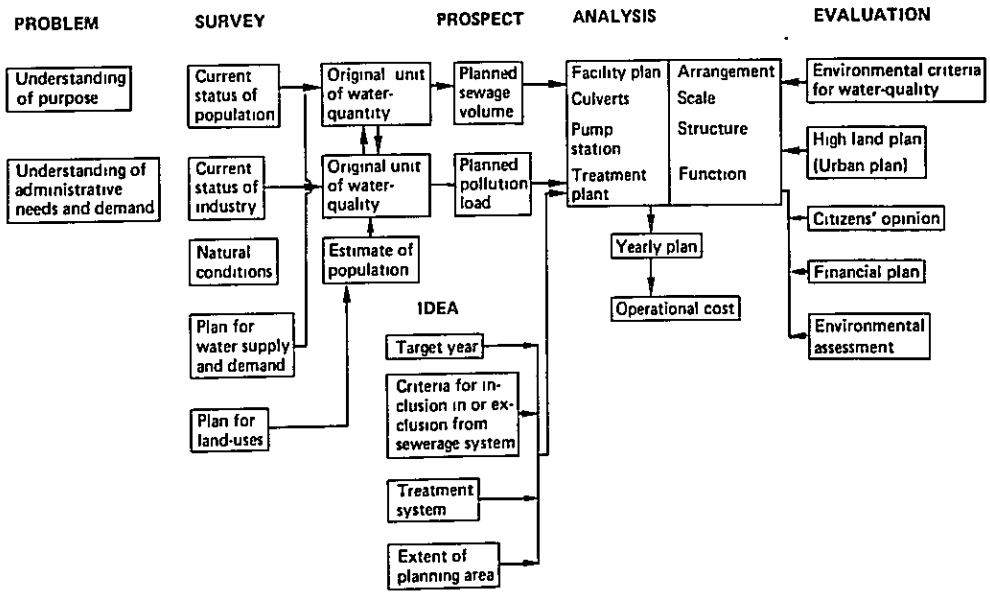


Fig. 3.2 Flow Chart of the Basic Plan of Sewerage System

3.5 Summary of Expected Volume of Wastewater

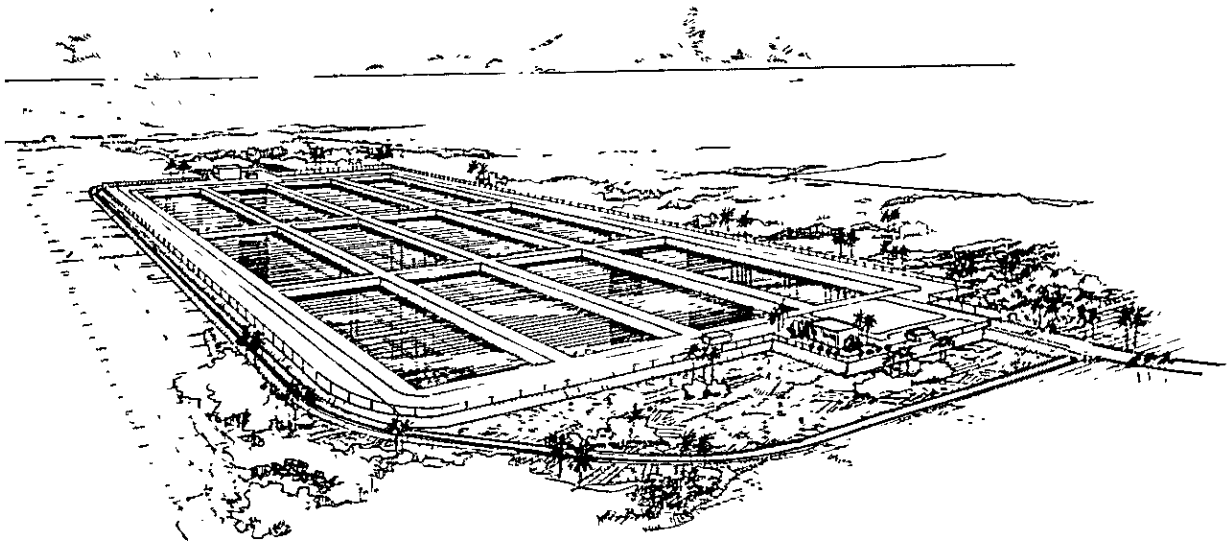
Na Klua Area

Year	Resident			Industry m^3/d	Sewage Quantity		
	Population head	Unit (l/h.d) Discharge	Sewage Quantity m^3/d		Sub Total m^3/d	Ground Water 20% m^3/d	Total m^3/d
1981	21,200	210	4,460	2,600	7,060	1,420	8,480
1986	26,700	220	5,880	2,600	8,480	1,700	10,180

Pattaya Area

Year	Resident			One Day Tripper			Hotel & Bungalow			Restaurant			Sewage Quantity		
	Population head	Unit (l/h.d) Discharge	Sewage Quantity (m^3/d)	Population head	Unit (l/h.d) Discharge	Sewage Quantity (m^3/d)	Noof Room	Unit Discharge $m^3/r\,d$	Sewage Quantity m^3/d	Population head	Unit Discharge (l/h d)	Sewage Quantity m^3/d	Sub Total m^3/d	Ground Water 20% m^3/d	Total
1981	21,700	210	4,570	5,500	45	250	2,050	1.59	3,260	6,980	30	210	8,290	1,660	9,95(
1986	25,500	220	5,620	7,500	45	340	2,050	1.59	3,950	8,760	30	270	10,180	2,040	12,22(

Table 3.1 Expected Volume of Wastewater (Daily Maximum)



Perspective of Proposed Sewage Treatment Plant at Pattaya

FIG 3.3 SEWERAGE SYSTEM

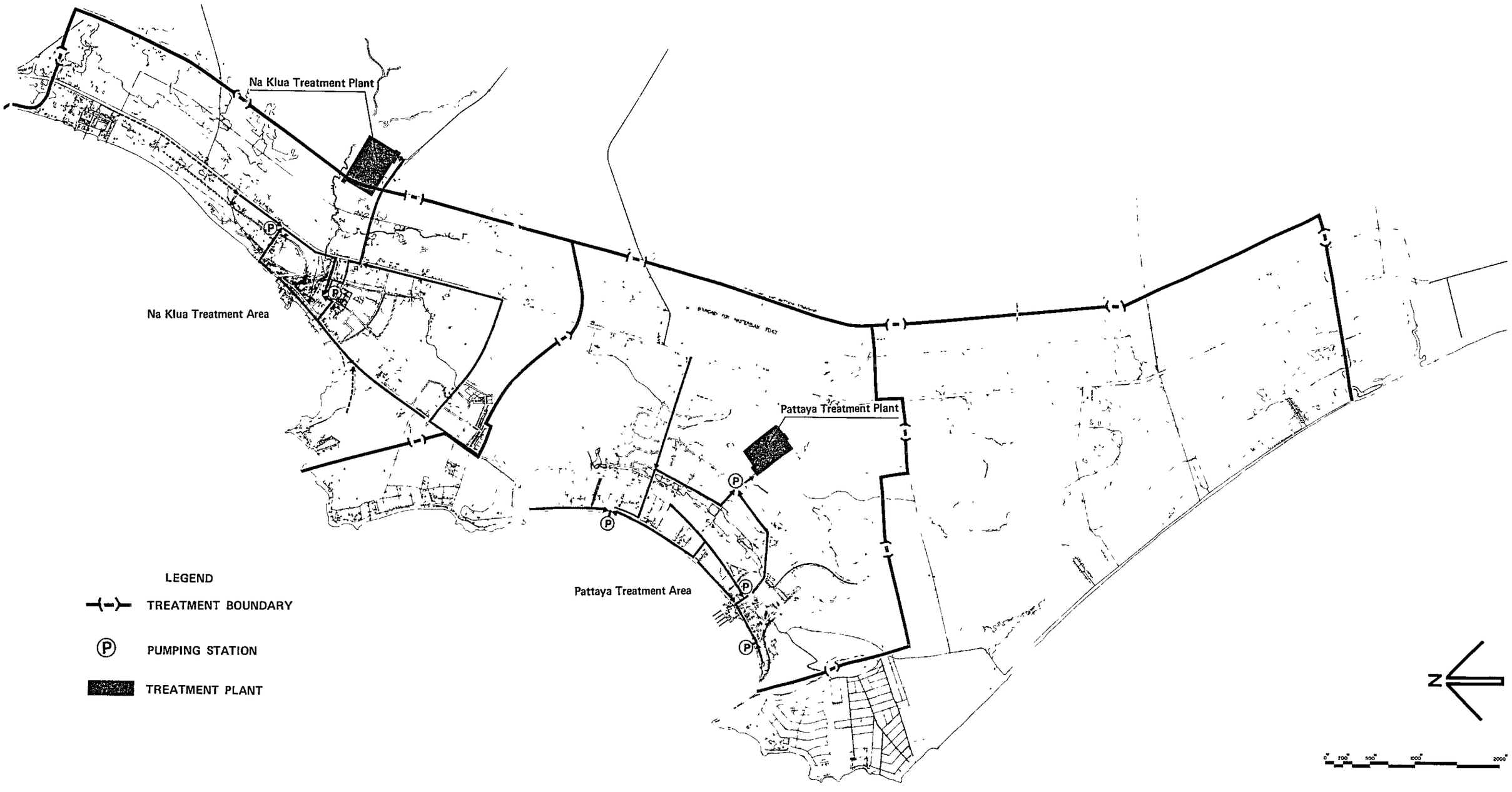


FIG 3.3 SEWERAGE SYSTEM

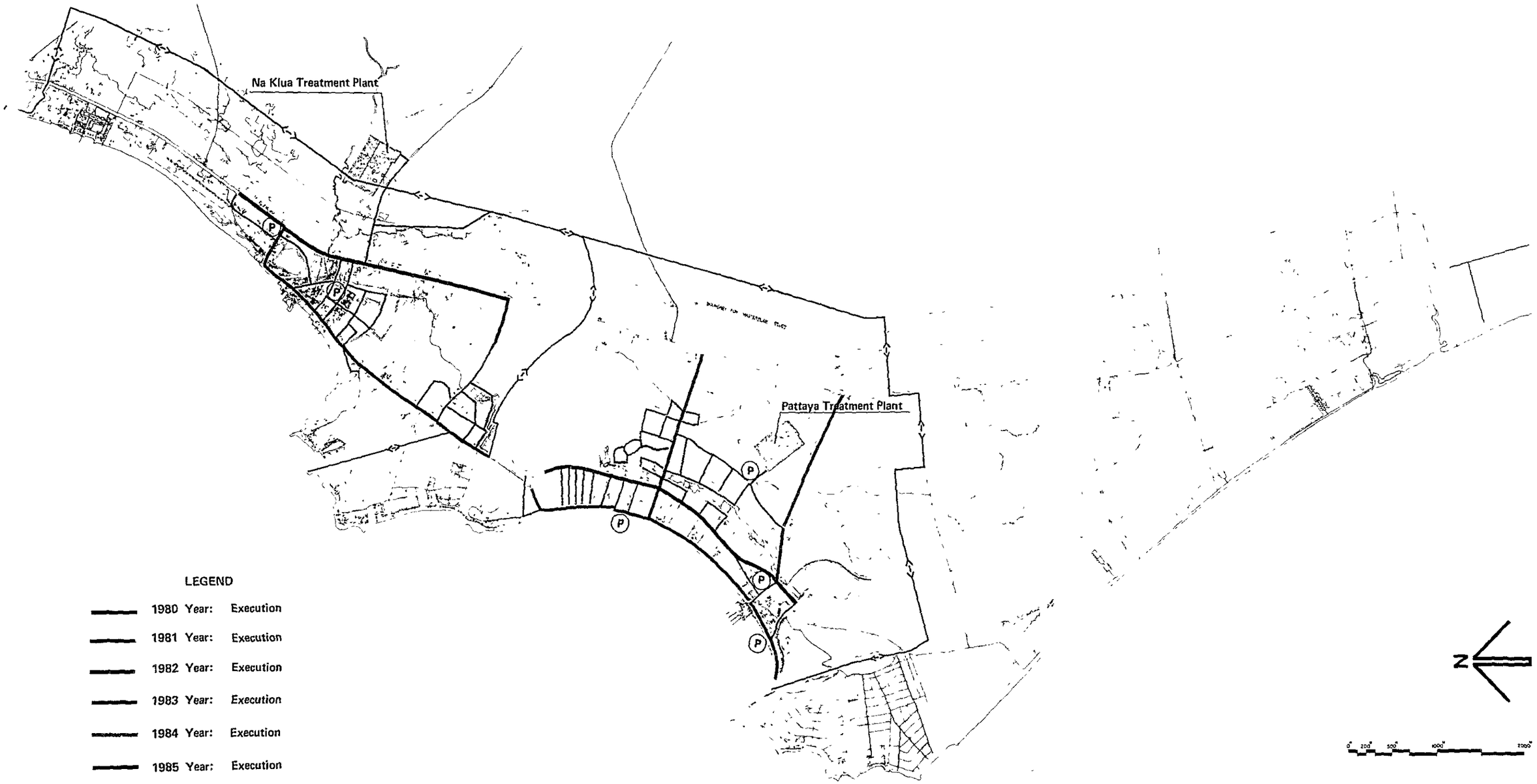


FIG 3.4 SEWAGE COLLECTION SYSTEM

3.6 Recommendation on Technical Aspects

After careful study of the existing conditions in the project area and comparing all the alternative methods for improving these conditions, it was decided to recommend the following:

1) Flush toilets should be connected directly to the public sewerage system providing concentrated treatment, rather than purifying tanks for individual treatment, the latter being relatively ineffective.

2) A separation system for drainage in which rainfall and sewage use different pipes is preferred, rather than a combination system, which is more difficult to control, more costly and more likely to create pollution.

3) Of four possible concentrated methods of treatment, the provision of secondary treatment by the pond method was preferred, using dividing wells, facultative ponds, maturation ponds, mixing ponds and chlorine injection.

4) Disposal of the resulting effluent would be into the Na Klua and Pattaya rivers, for reasons of cost and effectiveness.

5) There would be two centers for treatment, one for Na Klua and one for Pattaya.

6) Pipes should use the natural gravity flow system as far as possible, with a minimum of pumping stations where necessary.

7) Six pumping stations will be needed, two in the Na Klua treatment area and four in the Pattaya treatment area should be installed.

8) Ko Lan island should be provided with a less sophisticated disposal system, namely, septic tanks.

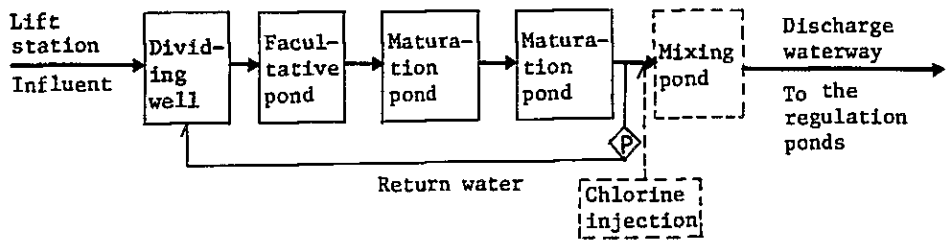


Fig. 3.5 Flow Chart of the Sewage Treatment Plant

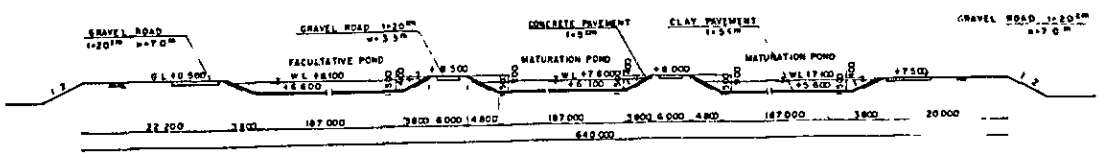
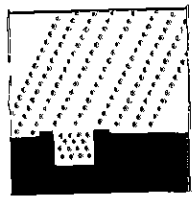


Fig. 3.6 Section through the Sewage Treatment Plant

CHAPTER 4 STORM WATER DRAINAGE SYSTEM

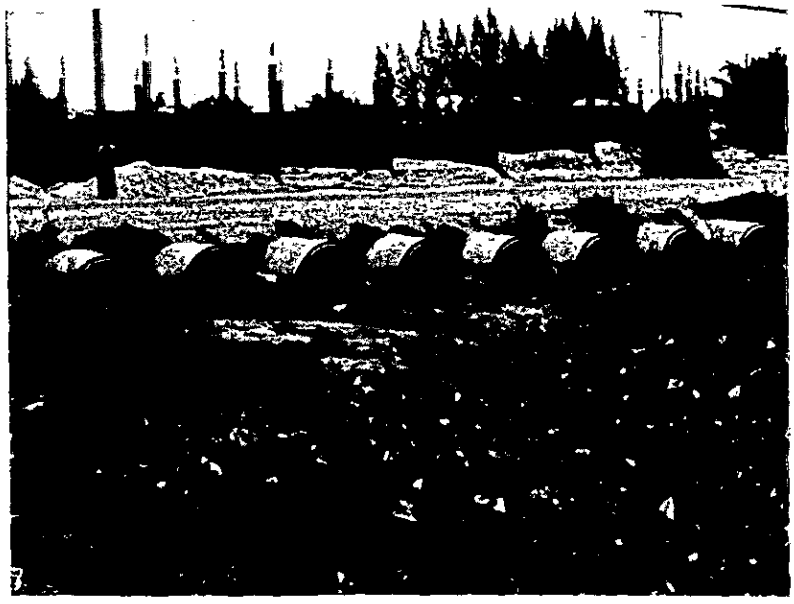


4.1 Introduction

Proper storm water drainage is indispensable for the prevention of damage to private and public property by floods and for the promotion of effective land use. The rice field and swamp areas in the central part of Pattaya area act as a natural storm water regulating pond, preventing a large amount of runoff water for a short duration toward the downstream area. (Refer to Fig. 4.1) This ponding effect has been taken into account for reduction of the peak discharge into the development area, making possible an economical and efficient drainage system. The proposed drainage area is limited to central Pattaya and southern Na Klua areas. (Refer to Fig. 4.1)

In central Pattaya, uncontrolled reclamation for the housing sites is being carried out in the swamp area behind the back road, greatly reducing the flow capacity of the natural water ways. If such reclamation continues, alot of damage by flooding may be caused around the swamp areas at times of heavy rainfall. Downstream Pattaya River meanders radically, box culverts are too small and the channel is narrow in places. Improvement of the existing channel is needed to cope with the peak runoff.

In the southern Na Klua area, the housing sites have been prepared in the swamp area to the north without consideration of functional drainage system. Flooding will occur during heavy rainfall.
Total Project Cost is shown on page 20, Table 1.1.



Existing Pipe Culverts (Central Pattaya Area)

FIG 4.1 PRESENT HYDROGRAPHIC MAP

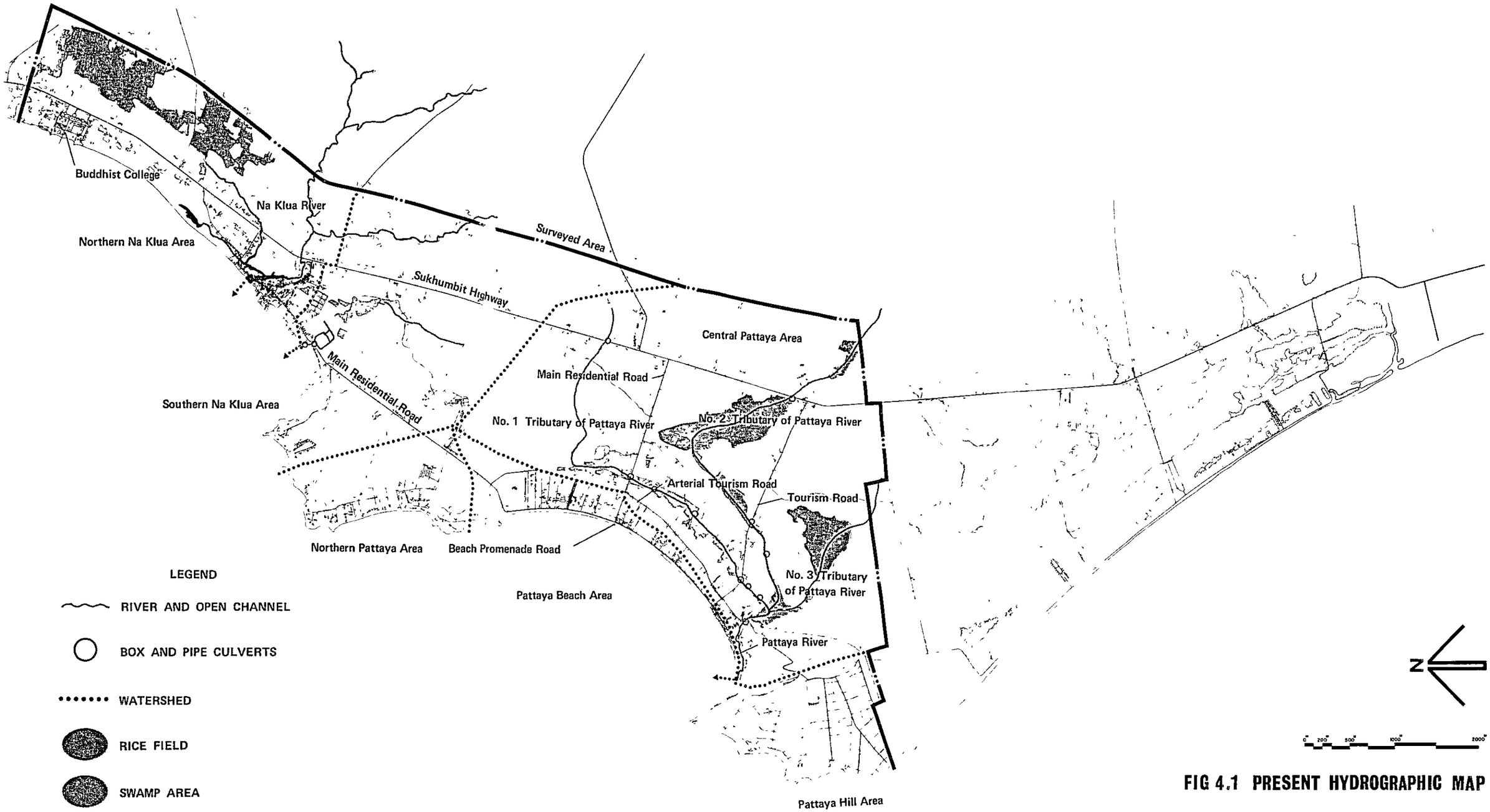


FIG 4.1 PRESENT HYDROGRAPHIC MAP

4.2 Proposed Drainage System

Two alternatives were considered for the drainage system in Pattaya. One was an integrated plan where the storm water is led into regulating ponds before it is discharged into the sea, while the other was a short-cut plan where the storm water is directly discharged into the sea.

Alternative Plan 1 for central Pattaya area: Integrated Drainage Plan

In this plan the storm water in central Pattaya area is lead collectively into the Pattaya River. The storm water in A_1 and B_1 blocks is led to the rice field area, and the storm water in C_1, C_2 and C_3 blocks to the regulating pond in C_3 block for reserving. The water passes through the spillways, box culverts and open channels, to join with the storm water in A_2, B_2 and D blocks and is then discharged into the sea. The regulating pond in C_3 area is utilized for the purpose of regulating the storm water, as well as a buffer for tourism and residential areas, and for aesthetic appreciation. The existing river from the junction to the coast is to be improved for the following reasons:

* The existing river meanders radically.
* The box culverts cannot sufficiently cope with the peak discharge.
* The channel is narrow in places.

Alternative Plan 2 for central Pattaya area: Short-Cut Plan

In this plan, the storm water in central Pattaya area will be diverted along the main residential road. Storm water on the south side of the road is discharged into the sea as in Alternative Plan 1, while the storm water on the north side of the road in C_1 and C_2 blocks is collected by the open channels and discharged into the sea through a short-cut box culvert from the back road to the beach road. This box culvert, approximately 500 meters long, will be buried under the existing road because it is expected to be difficult to secure the right of way for an open channel.

Alternative Plan 2 is not favored for the following reasons:

* In the Alternative Plan 2, the storm water gathered from the north side of the main residential road is directly discharged into the sea without ponding,and considerably influencing the sea with turbid water. The discharge point is located in the sea-bathing area and it may affect the beach activities.
* Constructing such a box culvert will require considerable manpower and time.

Conclusion: As described in the above paragraph, alternative 2 is not recommended. On the contrary, alternative 1 is considered to be much superior from environmental and economic points of view to form the proper tourism communities for both locals and tourist.

Central Pattaya Area

Block		Catchment Area					Mean Runoff Coefficient
		Hotel Area	Residential Area	Rice Field	Other Area	Total	
A	A1	– ha	– ha	30 ha	198 ha	228 ha	0.27
	A2	–	–	–	67	67	0.20
	Sub Total	–	–	30	265	295	0.25
B	B1	–	42	53	475	570	0.27
	B2	–	–	–	41	41	0.20
	Sub Total	–	42	53	516	611	0.26
C	C1	–	6	–	326	332	0.21
	C2	–	37	–	7	44	0.45
	C3	28	48	–	67	143	0.36
	Sub Total	28	91	–	400	519	0.27
D		35	–	–	50	85	0.32
Total		63	133	83	1 231	1 510	0.27

Southern Na Klua Area

Block		Catchment Area					Mean Runoff Coefficient
		Hotel Area	Residential Area	Rice Field	Other Area	Total	
E	E1	– ha	27 ha	– ha	113 ha	140 ha	0.26
	E2	–	61	–	61	122	0.35
	Total	–	88	–	174	262	0.30

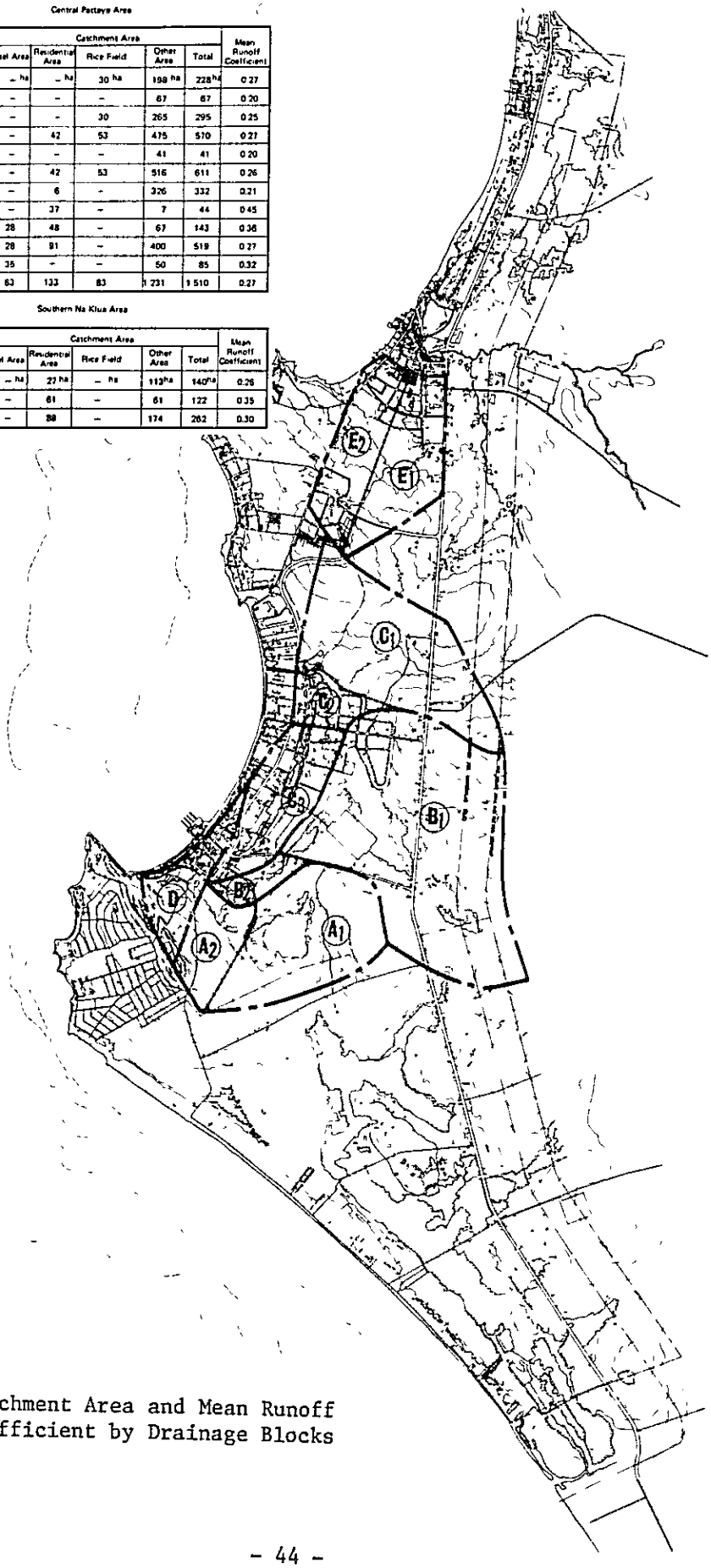


Fig. 4.2 Catchment Area and Mean Runoff Coefficient by Drainage Blocks

FIG 4.3 PROPOSED DRAINAGE NETWORK

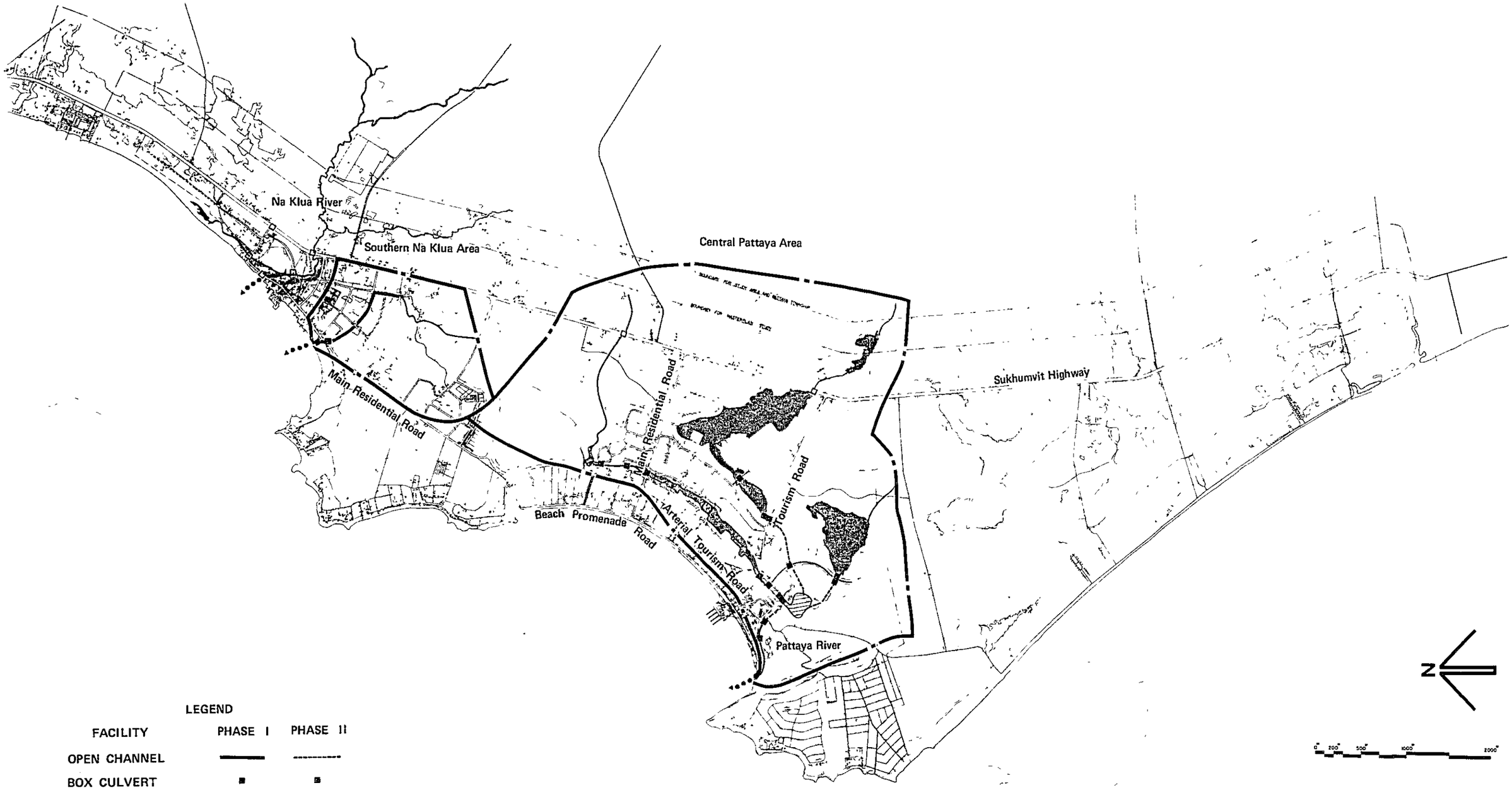


FIG 4.3 PROPOSED DRAINAGE NETWORK

CHAPTER 5 SOLID WASTE DISPOSAL SYSTEM

5.1 Introduction

In planning the solid waste disposal system in the project area for the period from 1980 to 1986, the total volume and weight of waste has been estimated for the four sources of solid waste: namely, 1) residents 2) hotels, 3) restaurants, and 4) beach and parks. The annual quantity of them will be about 16,000 tons and 31,000 tons in 1980 and 1986 respectively.

Total Project Cost is shown on page 20, Table 1.1.

5.2 Disposal System

Five waste disposal methods for the project area were studied, and the costs of construciton and operation were compared. The standard sanitary landfill method was found to be the most suitable method for Pattaya.

Five sites in Fig. 5.1 were evaluated for landfill site alternatives, and preliminary examination was made of the geological and hydrological conditions of the respective sites.

The examination showed that one of the sites A, B or C should be preferred. Site C was considered to be the most preferable, because the influence on the wells in the neighbourhood would be delayed and would appear only after a very long time, and the number of dwelling houses located downstream of the ground water flow is smaller than in the other cases.

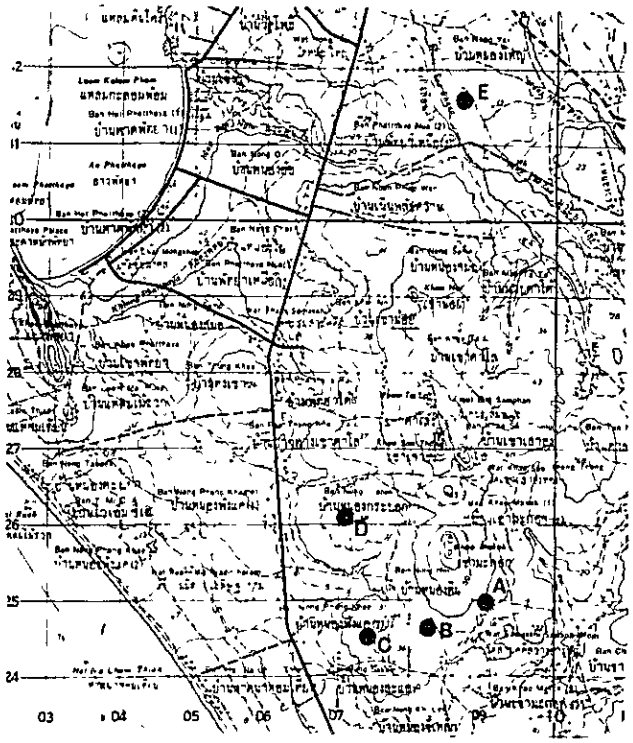


Fig. 5.1 Landfill Site Alternatives

It is recommended that the system shown in Fig. 5.2 be adopted wherein the lower waste material layer is formed by means of the Trench system, whereas the upper waste material layer is formed by means of the Area system.

Three machines will be needed in the proposed landfill site: a landfill compactor, a crawlerdozer with ripper, and a wheel loader.

It has been extimated that upto 1986 the total required capacity of landfill, including waste material and top soil, will be approximately 460,000m^3. To reduce the landfill area and the amount of leachate, the landfill site is planned to be as deep as possible; namely, 4.5 meters in consideration of the boring test results at the location. Consequently, the landfill area is designed to be 300 meters x 285 meters (=85,500m^2) in area.

It is estimated that during the period 1980-86, 330,000m^3 of soil will have to be excavated (410,000m^3 after loosening), 200,000m^3 of which can be used as covering soil while 211,000m^3 will have to be hauled away.

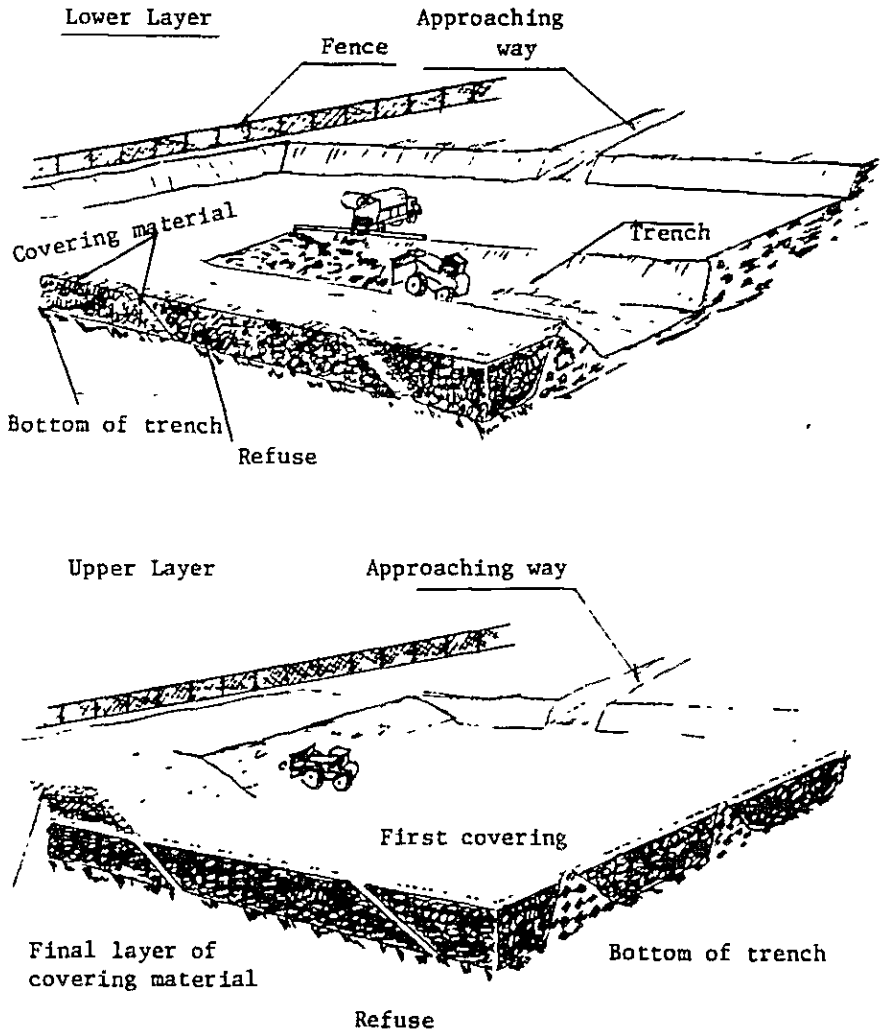


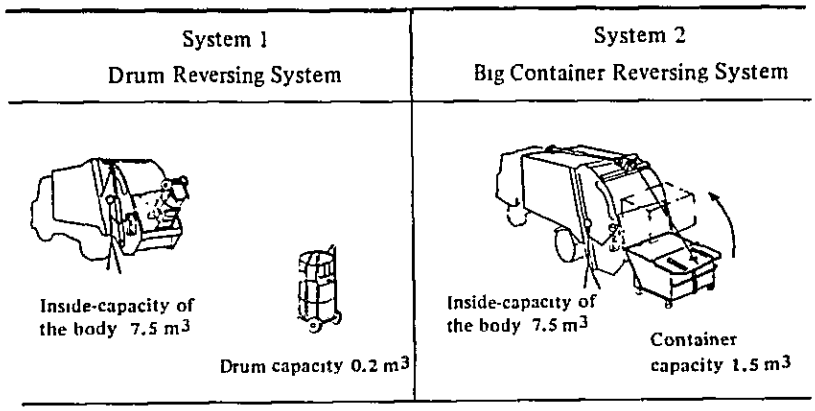
Fig. 5.2 Imaginary Figure for Landfill

5.3 Collection and Transportation

The current system of distributing drums to appropriate places in the town should be continued. However, bigger containers should be employed at places where a great deal of solid waste is discharged at one site, such as, hotels. Medium-sized 4-ton dump trucks are recommended for carrying waste to the landfill site. For collection vehicles, mechanically equipped cars are recommended for collecting solid waste, due to less hard labor for loading and safer operations.

System 1, being similar to the current system, will be mainly adopted for residential areas, restaurants, beach and parks, and System 2 should be adopted using containers with capacities of 1.5m^3 for hotels.

The purchasing schedule for each vehicle was estimated as shown in Table 5.1, taking its life time as 6 years for mechanical collecting cars and 7 years for dump trucks. Number of collection trucks will be 9 and 14 in 1980 and 1986 respectively. Number of containers required will be about 950 and 1,550 in 1980 and 1986 respectively.



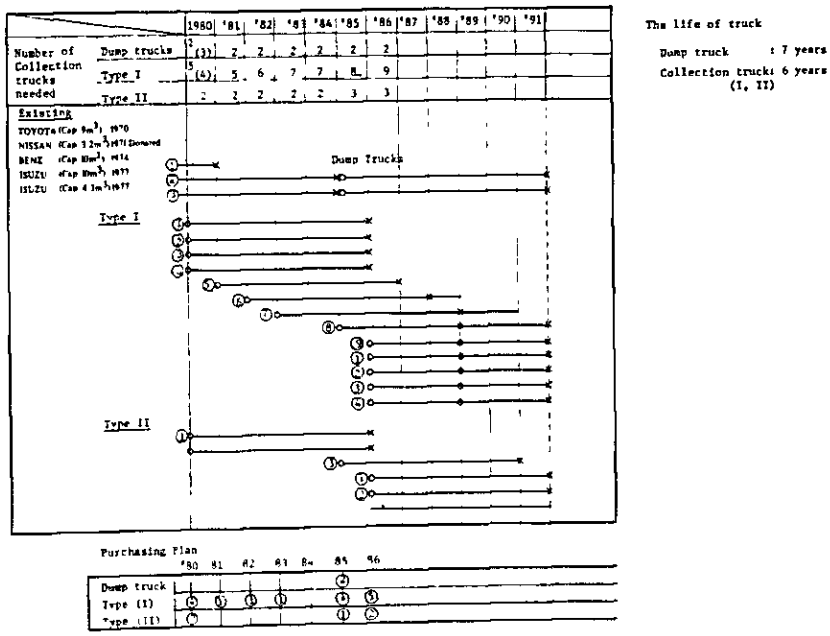


Table 5.1 Purchasing Plan for Collection Trucks

5.4 Planning and Design for Ko Lan Island

Waste disposal systems are needed in Ko Lan Village, Ta-Van Beach, Tien Beach and Sa-Mae Beach. The south beach will be handled by a private developer. These areas are situated away from each other, thus it may not be efficient to set up a centralized plan in view of the topography of the island. Separate plans should be made by dividing the area into three blocks: namely, Ko Lan Village, Ta-Van Beach and Tien Beach & Sa-Mae Beach. The total quantity of waste generated will be about 500 tons and 800 tons in 1981 and 1986 respectively, at Ko Lan Village, 140 tons and 170 tons in 1981 and 1986 respectively, at the other three beaches.

In view of the geological conditions on the island, and the fact that the amount of solid waste discharged from any of the said three regions is small, the most appropriate method in this island would be to use compact and simplified incinerators to stabilize the waste in the early stages and to reduce its bulk, followed by burying the residual ashes in the ground.

Desirable disposal sites for incinerators should be in the centers of the collection zones. Fig. 5.3 shows the proposed sites for each project area.

The following incinerators should be installed at each site.

Ko Lan Village	:	Two units of 1.5 tons/5 hours
Ta-Van Beach	:	One unit of 0.5 tons/5 hours
Sa-Mae Beach	:	One unit of 0.7 tons/5 hours

For Ko Lan Village, one small dump truck with a loading capacity of $0.91m^3$ and a lower loading point should be provided. Operation could be conducted by one operator with one assistant. For the other three beaches, the most suitable means for collecting solid waste in these areas is a push cart with collection done by one worker.

It is estimated that 55 of 100 lit. drums will be needed in 1981, increasing them to 85 in 1986, using the station system with a station Ko Lan Village.

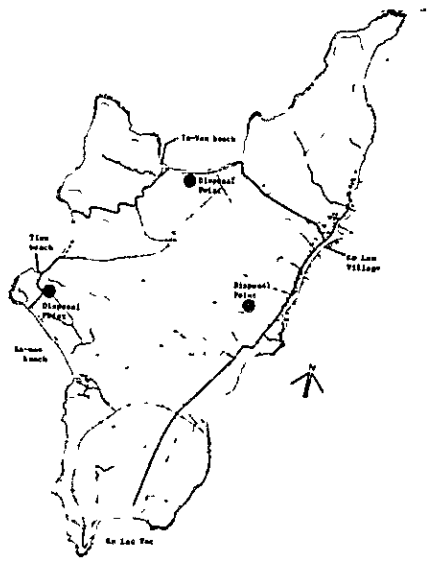


Fig. 5.3 Proposed Disposal Sites in Ko Lan Island

FIG 5.4 SOLID WASTE COLLECTION ARERS

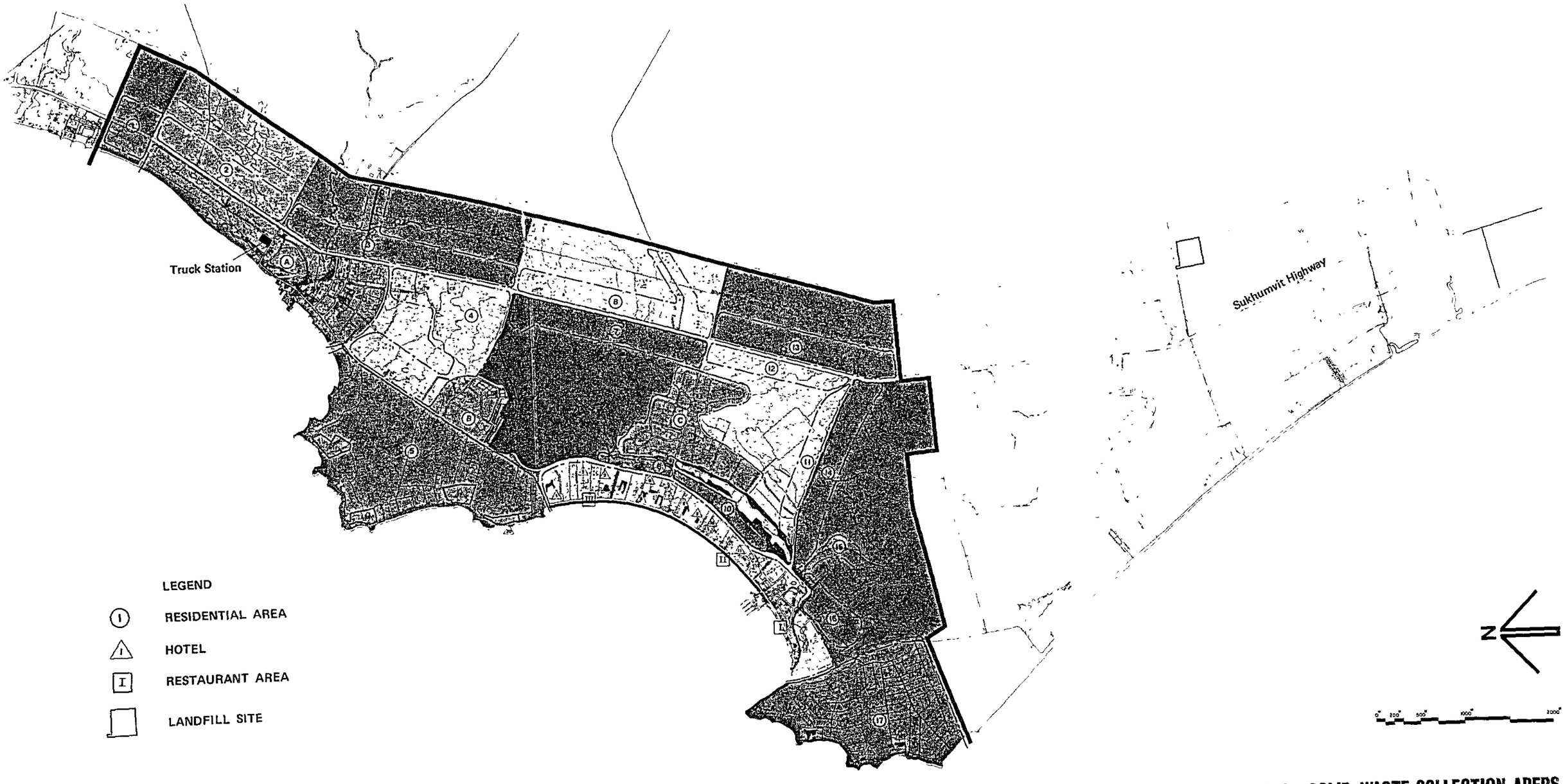


FIG 5.4 SOLID WASTE COLLECTION ARERS