No.

SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS MALAYSIA

VOLUME I
INTERIM REPORT
ON
SEWERAGE MASTER PLAN

OCTOBER 1979

JAPAN INTERNATIONAL COOPERATION AGENCY

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IN
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Engineering

ACP	-	Asbestos cement pipe
BOD	-	Biochemical oxygen demand (3-day, 30 degrees C)
DO	-	Dissolved oxygen
DWF	-	Dry weather flow
ft	-	feet
g/cap	-	Grammes per capita
g/day	-	Grammes per day
gal	-	Imperial Gallons
gal/cap	-	Gallons per capita
gal/day	-	Gallons per day
ha	-	Hectares
hr	-	Hours
kg	-	Kilogrammes
km	-	Kilometres
l/day	-	Litres per day
l/day/cap	-	Litres per day per capita
l/sec	-	Litres per second
m	-	Metres
mil	-	Miles
mg/l	-	Milligrammes per litre
mm	-	Millimetres
MPN	-	Most probable number
m^2	-	Square metres
m^3	-	Cubic metres
p/ha	-	Persons per hectare
pH	-	Hydrogen iron potential
ppm	-	Parts per million
PVCP	-	Poly vinyl chloride pipe
RCP	-	Reinforced concrete pipe
SS	-	Suspended solids
VCP	-	Vitrified clay pipe
yr	-	Years

List of Abbreviations (continued)

Organizations

DE	- Department of Environment, Ministry of Science, Technology and Environment
DID	- The Drainage and Irrigation Department, under the Ministry of Agriculture and Fisheries
EHEU	- The Environmental Health and Engineering Unit, the Ministry of Health
EPU	- The Economic Planning Unit, Prime Minister's Office
FTCP	- Federal Town and Country Planning
GSD	- The Federal Geological Survey Department
MADA	- The Muda Agriculture Development Authority
MLGFT	- The Ministry of Local Government and Federal Territory
MPKS	- Majlis Perbandaran Kota Setar (Municipal Council Kota Setar)
MS	- Meteorological Station
SDID	- State Drainage and Irrigation Department
SEDC	- State Economic Development Corporation
SEPU	- The State Economic Planning Unit
SLO	- The State Land Office
SHD	- The State Health Department
STCP	- State Town and Country Planning
PWD (JKR)	- The Public Works Department, under the Ministry of Works and Utilities

Conversion

Length (1)

m	cm	yd	ft	in.
1	100	1.0936	3.2808	39.370
0.01	1	0.0109	0.0328	0.3937
0.9144	91.440	1	3	36
0.3048	30.480	0.3333	1	12
0.0254	2.540	0.0278	0.0833	1

Length (2)

km	yd	mi
1	1,093.61	0.62137
0.00091	1	-
1.60934	1,760	1

Area

ha	km^2	acre	sq mi	m^2	sq ft
1	0.0100	2.471	0.00386	10,000	107,640
100	1	247.10	0.3861	-	-
0.4047	0.004047	1	0.00156	-	-
259	2.590	640	1	-	-
-	-	-	-	1	10.764
-	-	-	-	0.09290	1

1 sq ft = 144 sq in.   1 sq in. = 0.006946 sq ft

CONVERSION TABLES (Continued)

Volume

l	m^3	cu ft	Imp.gal
1	0.001	0.03531	0.220
1,000	1	35.31	220
28.317	0.02832	1	6.231
4.546	0.004546	0.1605	1

Weight

Kg	t	ounce	lb
1	0.001	35.27	2.2046
1,000	1	3.527×10^4	2,204.6
0.02835	2.835×10^{-5}	1	0.06250
0.4536	$4,536 \times 10^{-3}$	16	1

Velocity

m/sec	km/hr	ft/sec	mile/hr
1	3.600	3.2808	2.237
0.2778	1	0.9113	0.6214
0.3048	1.0973	1	0.6818
0.4470	1.6093	1.4667	1

Conversion (contiunued)

Rate of Flow (1)

1/sec	m^3/hr	m^3/sec	imp.gal/min
1	3.6	0.001	13.198
0.2778	1	2.778×10^{-4}	3.666
1,000	3,600	1	1.3198×10^{4}
0.07578	0.2728	7.577×10^{-5}	1
7.866×10^{-3}	0.02832	7.866×10^{-6}	0.10381
28.32	101.94	0.02832	373.7
52.61	189.41	0.05261	694.4
0.01157	$4,167 \times 10^{-2}$	0.1157×10^{-4}	0.1528

Rate of Flow (2)

cu ft/hr	cu ft/sec	Imp. MGD	m^3/day
127.13	0.03531	0.01901	86.4
35.31	9.810×10^{-3}	5.279×10^{-3}	24
1.2713×10^{5}	35.31	19.01	86,400
9.632	0.002676	1.440×10^{-3}	6.547
1	2.778×10^{-4}	1.495×10^{-4}	0.6796
3,600	1	0.5383	2,447
6,688.2	1.858	1	4,546
1.471	4.087×10^{-4}	2.200×10^{-4}	1

Note: In general the metric system of units is used for all work on the project. However, when reporting on existing installations such as pipes and structures where imperial sizes were used, the appropriate metric sizes rounded off are quoted first and the imperial sizes are appended in brackets, e.g. 250 mm (10 inc.).

CHAPTER 1 - SUMMARY

1. The purpose of the study is, for Alor Setar and its urban environs, to:

(a) Develop a comprehensive master plan in which the major elements are properly forecast and generally defined in successive stages to meet the present and future needs in the Study Area up to year 2000, compatible with sound projections of population increase, housing development, water consumption and water system expansion, income growth, and other national and local socio-economic factors affecting the study.

(b) Suggest interim measures to improve the existing environmental pollutions by identifying sources of pollution and establishing control programme economical but best suited for each case, until the sewerage system is completed and sources of pollution become well under control.

(c) Undertake studies and formulate recommendations regarding the proper organization to effectively carry out the planning & designing, construction, operation, management and administration of the sewerage system together with consideration on proper legislative provision, which may be required for activities of the proposed organization.

2. The Study Area is shown is Figure 2.1 with a total area of 3,300 ha (8,154 acres) as agreed upon by the Governments of Malaysia and Japan.

3. The existing conditions of the Study Area are evaluated for the sewerage study as follows:

- A large number of housing development schemes are on-going coverings most of the sewerage zone in various sizes and scales except Kuala Kedah areas.

- Except for 2,130 households served by communal septic tank system, more than 23,000 households are disposing of their excreta either through buket collection system, individual septic tank, or pit privy/boreble latrine.

- The mojor watercourses, namely Sg. Kedah and Sg. Anak Bukit, is assumed to be further degraded to a range of 19.7 to 39.1 mg/l of BOD by the year 2000 from the present level of 14 to 17 mg/l, if a comprehensive sewerage system is not provided. Further, the exising drains and roadside ditches, mostly acting as a combined sewer at present, are recieving wastewater directly from pollution sources and are already grossly polluted, thus impairing aethetic view as well as human living environment significantly.

- Flood prone areas are confined to the low lying area along and eastern part of Jl. Sungai Korak; extended area along the Sg. Raja and surrounded area by the Sg. Raja and Sg. Derga, especially Jl. Telok Won Jah area; and extended area along and upper reaches of the Sg. Alor Malai.

- The incidences of major water-borne diseases including cholera typhoid and gastro-enteritis in the past three years indicate on increasing trend in the number of these incidences.

- The current population is assumed to be 139,600 with density of 75, which is projected to be 318,300 with average population density of 102 persons per ha in the target year 2000 for the Study Area, ranging from 49 to 125 persons per ha, excluding roads, rivers, railway, public spaces, etc.

4. Outline of Proposed Sewerage System is as follows:

- Construction of the system to be staged into four stages up to the year 2000.

- Adoptation of a separate sewerage system, that is, to collect sanitary wastewater by closed conduit and rainfall runoff by open channels, is recommended in that the existing open drainage channels can be used for collecting only rainfall runoff by diverting sanitary wastewater into the newly proposed sanitary sewerage system. In addition, this system is much easier than the combined system for sewerage and drainage for construction, operation and maintenance.

- Five sewerage zones are proposed for the planning purpose with sewerage treatment facility in each zone.

- Proposed sewerage system layout plan in Figure 2-2 shows routes of trunk sewers with diameter, slope and flow direction, locations of pumping stations, and treatment facilities in the five sewerage zones.

- Major sewerage facilities proposed in the Study Area consist of (1) 57 km (35.4 miles) of trunk sewers with sizes of 375 to 900 mm and 379 km (235.5 miles) of branch and lateral sewers sized with 225 to 300 mm, (2) 18 pumping stations, five in sewerage zone A, similarly, five, four, three, and one in zones B, C, D, and E respectively, (3) five treatment facilities (each in every zone) as shown in Figure 2-2.

- Taking into account of overall economy and easiness of operation and maintenance, stabilization pond process is adopted for all sewerage zones in the beginning. However, due to limited land available, except zone E, the process may require to be converted into aerated lagoon process with minimum additional cost in the future.

- In order to establish implementation schedule, each sewerage zone is divided into sub-zones to identify the priority in each zone according to the actual need and urgency wich exists. Six assessment elements are consdered for the evaluation of the urgency, namely, (1) population density, (2) development condition, (3) waste load generated, (4) existing excreta disposal system, (5) flooding condition, and (6) incidence of water-borne diseases. A rating procedure has been developed to all the sub-zones of the

5 sewerage zones by assigning resonable relative weights to these six elements. The evaluation result over the entire sewerage sub-zones is in the implementation priority by the order of B-1, D-1, E, C-1, A-1, D-2, B-3, B-2, and A-2 as shown in Figure 2-3.

- The Study Area is composed of both "urbanized and/or urbanizing area" (such as sewerage sub-zone A-1, B-1, C-1, D-1, and zone E) and "future development area" (such as sewerage sub-zones A-2, B-2, B-3, C-2, and D-2). The former area includes already developed area by developers as well as being developed. Under such condition, construction for the urbanized and/or urbanizing area excluding areas undertaken by developers will be needed for sewerage system by the Government contribution, except for house connection. In addition, for the future development area mostly developed by developers, trunk sewers and the branch sewers connecting to the terminal sewers provided by developers in the development area are also provided by the Government contribution. The remainder of the sewers (branch and lateral sewers and house connections in the future development area) provided by developers should be provided by private contribution.

- Taking into account of financial viability of the Government, and user's ability and willingness to pay, together with minimum level of work scale worthly to undertake sewerage construction, M$15 million is considered appropriate to be contributed by the Government in the 5 year First Stage (1981-1985) at 1979 price level.

  Assuming five to seven percent actual annual construction cost increment for the successive stages at 1979 price level on the basis of the past economic growth rate of the nation, construction costs for Second, Third and Fourth Stages for public sewerage facilities are estimated to be M$18.21, 21.47, and 27.67 millions respectively.

- In the same staged areas, the private portions raised from private sector are estimated to be M$3.67, 5.76, 9.89, and 9.23 million for **for First,** Second, Third and Fourth Stage respectively (Refer to Figure 2-3). Those staged construction costs can provide sewerage facilities for an area of 187 ha in the First Stage (1981-1985), similar 340 ha, 438 ha, and 572 ha in Second (1986-1990), Third (1991-1995), and Fourth (1996-2000) Stage respectively.

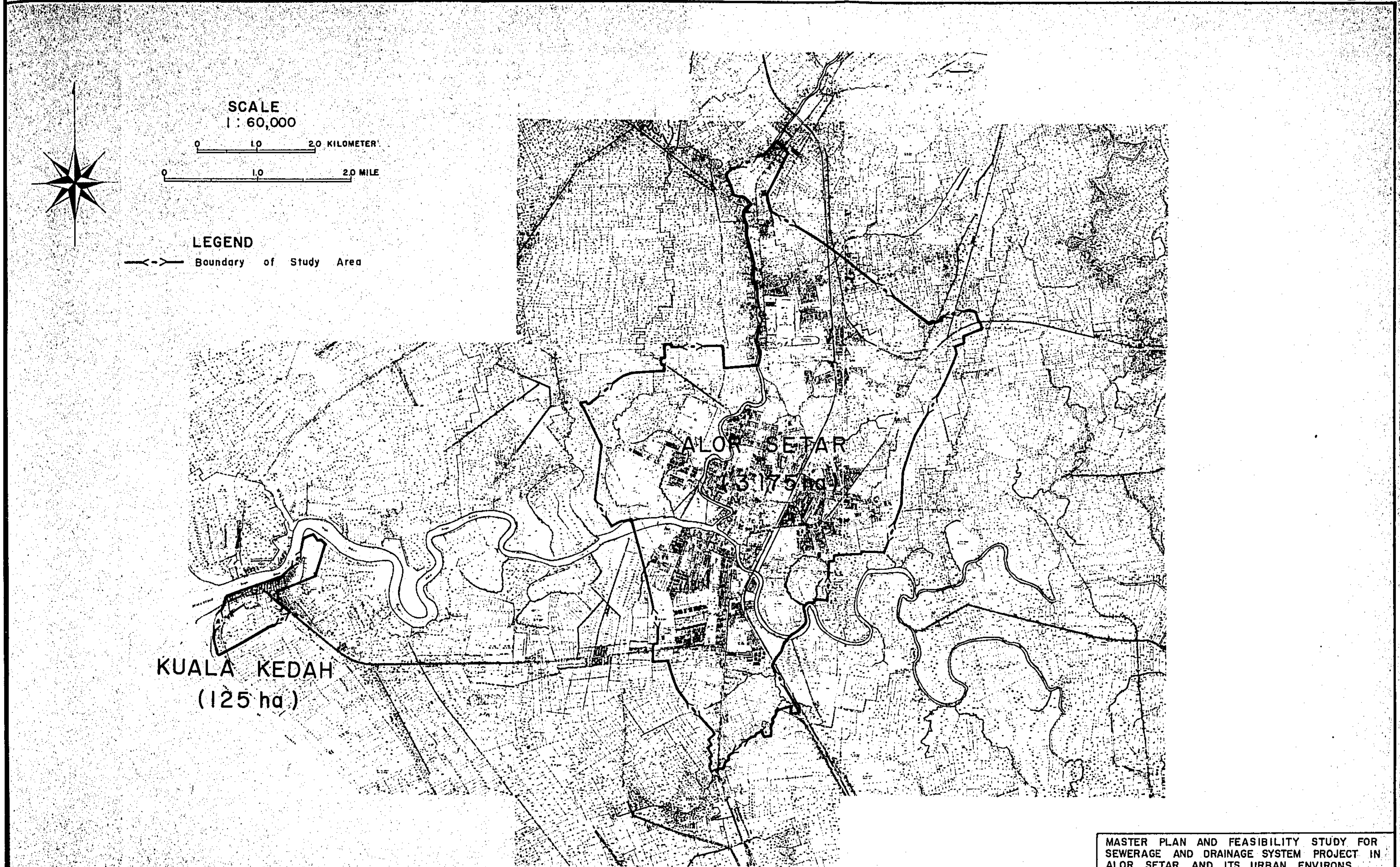
- The remainder of sewerage sub-zones (i.e A-2, B-2, B-3, C-2, and D-2) not considered in the Staged construction schedule needs M$105.7 million, 59.1 million as Government contribution, and 46.6 million as private contribution at 1979 cost level for information only.

- Recurrent costs for operation and maintenance, and administration for public and private sewerage facilities are estimated for the proposed sewerage facilities in the all staged area to be M$1.84 million, 3.33 million, 5.03 million, and 7.08 million respectively.

- Significant various benefits can be derived by prevision of the sewerage system including (1) health and sanitation benefits, (2) water pollution control benefits, (3) values added to land and facilities, and (4) benefits by reduced expenditure for sanitary facilities.

- The interim measure proposes to improve existing environmental condition heavily affected by the efficients from the Public Market, the General Hospital, car repair workshops in Mergon, and sea food factories in Kuala Kedah.

  In addition, there are useful programes already on-going such as (1) Kata Setar Municipal Concil Anti-Litter By-Laws. 1979, (2) Gotong-Rayong, which are contributing to the general sanitation of the area. It would be useful to continue these programes with vigor. Further, new development schemes should install communal waste treatment plants to treat both sullage water and excreta, as planned by the Ministry of Health.

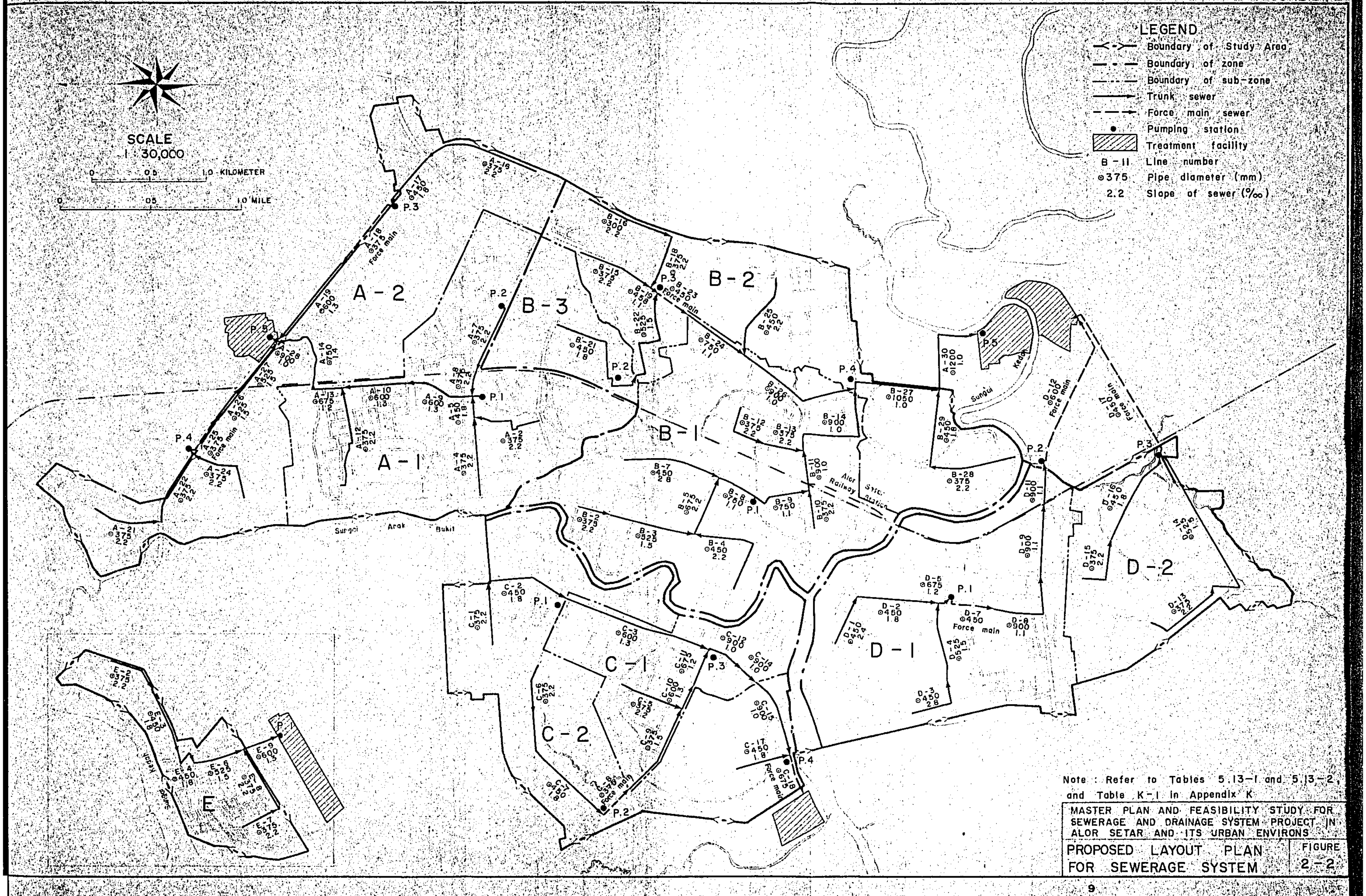


MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS

STUDY AREA

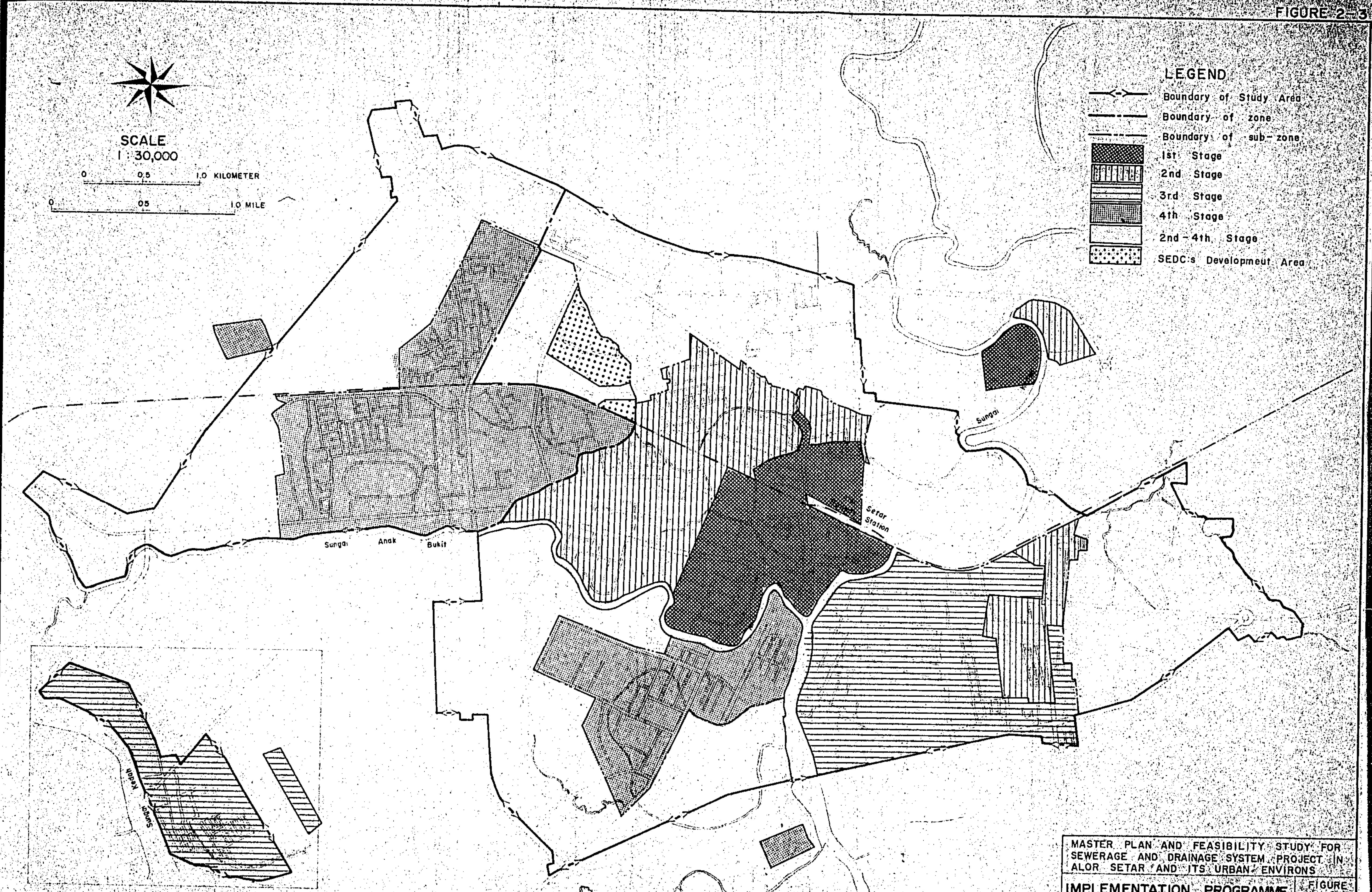
FIGURE 2-1

FIGURE 8-2



PROPOSED LAYOUT PLAN FOR SEWERAGE SYSTEM

FIGURE 2-2



MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS

IMPLEMENTATION PROGRAMME | FIGURE 2-3

CHAPTER 2 - INTRODUCTION

As of 1979, some 139,600 people resides within the Study Area comprizing approximately 3,300 ha (8,154.3 acres). During the last decade, the area has experienced a rapid growth of population together with expanded commercial and industrial activities, and is expected to further continue its growth reaching to 318,300 by the year 2000. As the population increases and social functions expands, so too will the waste loads be generated, thus affecting living environment in the area. Present wastewater generated in the area is expected to be 2.1 times by the year 2000, and similarly 3.1 times for waste load (BOD) generation.

There is at present no comprehensive sanitary sewerage system in the area, except for small scale communal sewage disposal systems in some of new housing area. Most of sullage water and trade wastewater are undiscriminately discharged directly into near by drains and other available watercourses, and of human body wastes from houses are disposed of either through septic tank or bucket system (conservancy system). As of 1979, there are approximately 25,400 houses in the Study Area (as shown in Figure 2-1), of which 2,130 houses are served by communal septic tank for excreta disposal and the remainder by inferior excreta disposal systems such as private septic tank, coservancy system, over-waterway latrine, pit privy and borehole latrine. Most of the effluent from the septic tanks generally find their way into the watercourses, thus resulting in gross pollution and septicity of receiving drains, especially during dry season. In rainy season, on the other hand, the bulk of stagnated waste loads in the watercourses are flushed out into the main watercourses with resulting overloading beyond self-purification capacity of them.

The rivers become increasingly polluted while flowing through the build-up areas in the city. The Anak Bukit, for example, is significantly polluted by the waste loads from the houses, shops and industries, depleting DO level less than 3mg/l in some portions. Also in many portions of drains, especially within the built-up areas where flow is low during dry season, water is grossly polluted. These rivers and drains are expected to become heavily polluted by the rapid growth of the area, if no proper pollution control measure is taken to alleviate the wastewater burden to the waterways.

Public interest has been increasingly and sharply focused on the need for improvement of their living environment and for pollution control measures to conserve the natural quality of environment.

As pointed out in the "Kedah-Perlis Development Study" reports, the Study Area is necessary to be provided by a comprehensive sewerage system(together with drainage system), which is a basic infrustructural facility, to expect normalized social function as the provincial government seat of Kedah State and regional centre of Kedah-Perlis area.

It should be, therefore, mandatory to develop a comprehensive sewerage master plan with phased investment programme up tp year 2000 to maintain a tolerable minimum level of living environment in the area with the most effective investment programme.

The Government of Malaysia has long been cognizant of the situation mentioned above, and requested to the Government of Japan for technical co-operation in conducting the study to develop a master plan for sanitary sewerage system (this report describes only for sewerage side hereafter, since drainage side is discussed in a different report, Volume II) for Alor Setar and its urban environs.

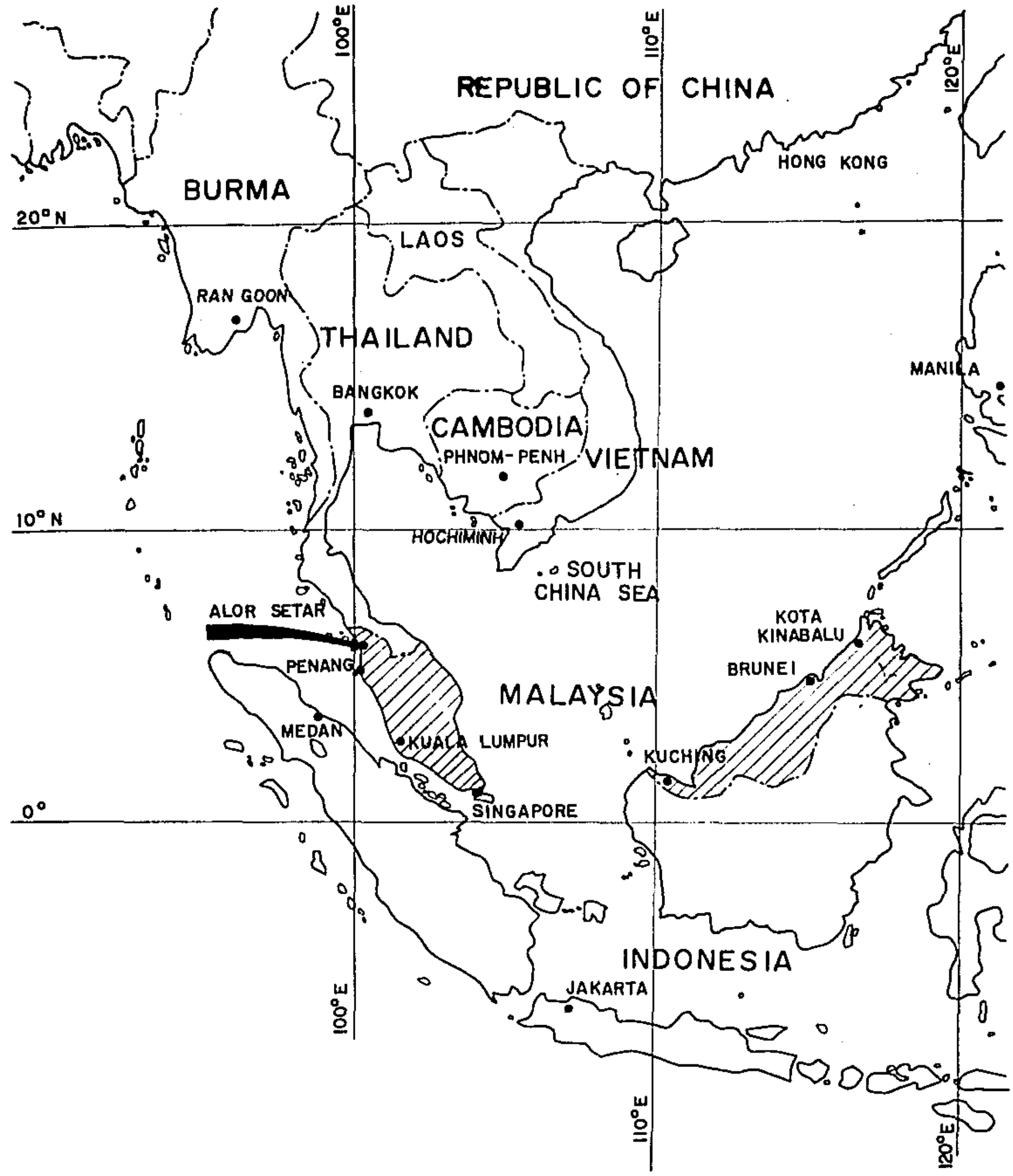
CHAPTER 3 - BACKGROUND DATA AND INFORMATION FOR THE STUDY

1. LOCATION OF ALOR SETAR

The State of Kedah is situated within the latitudes N 5°05' - N 6°32' and lengitudes E 99°39' - E 101°08' as shown in Figure 3-1. It is bounded to the southeast by Perak, the southeast by Penang, and the north by Perlis and bordered by Thailand to the north. Its length from north to south is about 163 km (101 miles) and its width is about 103 km (64 miles) at its widest point with a total area of approximately 9,480 km^2 (3,660 sq. miles). The group of Pulau Langkawi in the northwest is a part of Kedah.

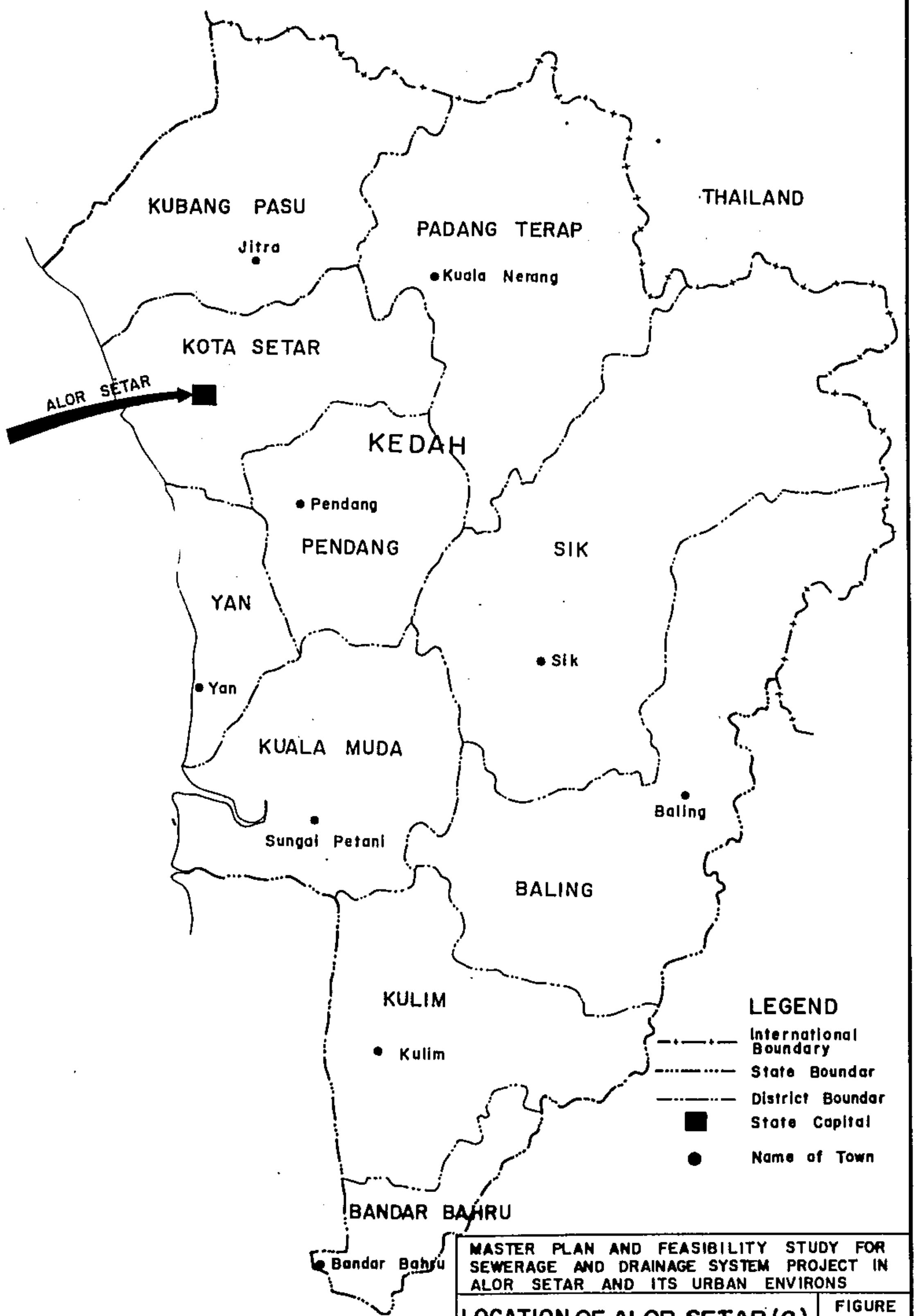
The whole state is divided into 11 districts namely, Pulau Langkawi, Kubang Pasu, Kuala Nerang, Kota Setar including Alor Setar, Sik, Yen, Kuala Muda, Baling, Kulim, Bandar Baru and Pendang (See Figure 3.2).

Alor Setar is located in Northwestern part of Kedah at the latitude of N 6°12' and longitude of E 100°25' as shown in Figures 3.1 and 3.2.



MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS	
LOCATION OF ALOR SETAR (1)	FIGURE 3 - 1

FIGURE 3-2



MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS

LOCATION OF ALOR SETAR (2)

FIGURE 3-2

2. PHYSICAL CHARACTERISTICS

2.1 Geology and Topography

The Study A rea consists of alluvial flood plain, formed over the years by the deposition of silt carried down by the rivers. Although sufficient data are not available to indicate the soil conditions over the entire Study Area, it is considered that the soil conditions in the area are mainly alluvial clay with find sand. The water table in the area is generally high with an average elevation of about 1.0 m (3 ft) from the ground surface.

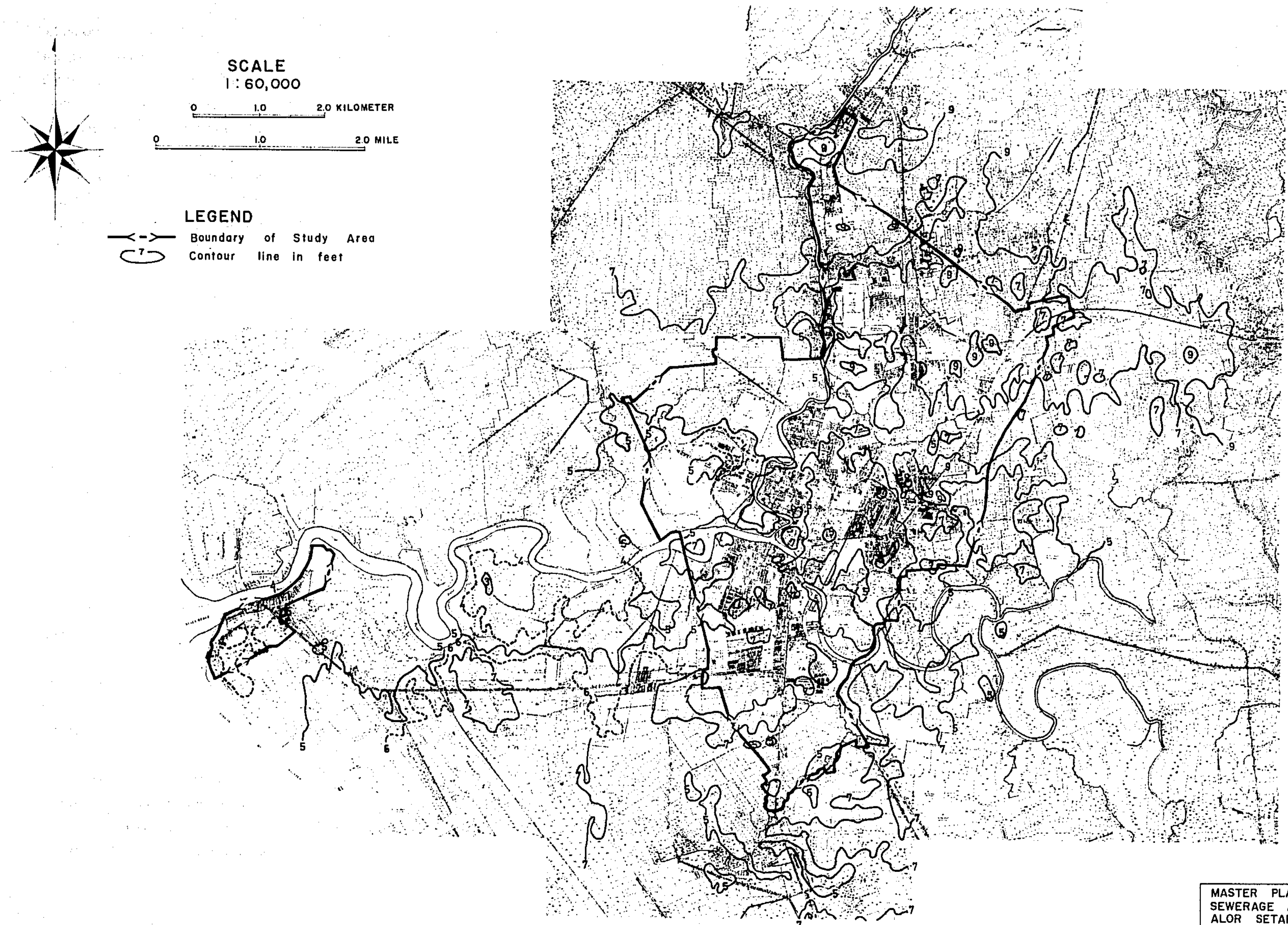
The Sungai Kedah and Sungai Anak Bukit with many small branch streams within the tributaries run through the Study Aera. The topography of the area is characterised essentially by a very flat low-lying plain ranging from 1.2 m to 2.4 m above mean sea water level.

Most of the rivers which are tidal in flow characteristic and the velocity of rivers is extremely slow due mainly to the flat plain. The flow is further affected by the heavy silt deposit carried down by the rivers. The soil type in the tributaries of the rivers is mostly soft yellowish brown silty or sandy clay with some gravel. At deeper strata, a variety of marine clay may be expected.

2.2 Climate

Proximity to the equator has given Peninsular Malaysia a climate of high humidity with uniformly high temperatures and rainfall. The equatorial climate is modified by the region's insularity and exposure to monsoonal wind systems that originate in the Indian Ocean and the South China Sea. On the whole the climate is pleasant and equable and humidity is bearable through sometimes unpleasant.

The north-east and south-west monsoons divide the year into two periods, the former begins in October or November and lasts until



MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS

TOPOGRAPHICAL MAP

FIGURE 3 - 3

February or March while the south-west monsoon blows from mid-April or May to September or mid-October. There are two inter-monsoon seasons of about eight weeks duration. No prevailing winds blow at these times, but there is abundant daily convectional rain. The period of heaviest rainfall in Peninsular Malaysia is during the inter-monsoon seasons, although the west coast has its wettest period during the south-west monsoon, and the north-east monsoon brings the greatest amount of rain to the east coast. The rainfall in Peninsular Malaysia varies from 1,650 mm/yr (65 in/yr) to over 5,000 mm/yr (200 in/yr), the average being about 2,500 2,500 mm/yr (100 in/yr).

Thunderstorms are frequent and, although Malaysia is outside the typhoon belt and cyclones are almost unknown, the south-west monsoon is frequently accompanied by sudden squalls and violent questy winds, especially along the Straits of Malacca where they are known as "Sumatras".

The climate in Kedah is typical of the west coast of Peninsular Malaysia: rainfall varies between 1,637.5 mm (1977) and 2,686.0 mm (1949) with average of 2,176 mm, and the maximum monthly and minimum temperatures are 36°C (96.8°F) and 22°C (71.6°F) respectively. Mean daily temperatures vary about 2°C (4°F) throughout the year but temperatures vary from a day time mean maximum of 36°C (97°F) to the night time mean maximum of 27°C (73°F).

Winds are generally gentle and relative humidity varies between 70 and 90 percent. Maximum humidity is recorded in the morning time with the average of 95 percent throughout the year, while minimum recorded in the afternoon vary from 60 percent in February to about 70 percent in October, influenced by rain. Evaporation is generally high especially during the dry season, but is less significant during the rainy season.

Average monthly temperatures, precipitations, wind velocities, relative humidities and evaporations in 1978 observed at the Metorological Station in Alor Setar are shown in Table 3.1-1. Also, rainfall records from 1946 to 1977 is shown in Table 3.1-2.

Table 3.1 - 1 Temperaturs, Wind Velocities, Relative Humidities and Evaporations (1978)

Month	Temperature (°C)			Relative Humidity (%)	Average Wind Velocity (m/sec)	Total Evaporation (mm/month)
	Maximum	Minimum	Average Temperature			
January	33.3	22.2	26.8	77.3	1.1	151.3
February	35.6	22.6	28.1	69.4	1.3	166.3
March	35.1	23.3	27.9	78.4	0.8	157.4
April	33.8	23.7	27.7	81.3	0.8	132.4
May	33.1	24.7	27.9	85.1	0.7	115.9
June	31.5	23.8	26.9	85.4	0.7	99.2
July	30.8	23.5	26.5	86.5	0.7	99.2
August	31.4	24.1	27.0	85.2	0.8	93.5
September	30.6	23.2	26.0	87.5	0.7	89.8
October	31.2	23.4	26.1	87.5	0.7	90.0
November	31.9	22.5	25.8	86.0	0.6	93.8
December	32.0	22.3	26.3	77.1	1.2	134.1

Source: Meteorological Station, Alor Setar

Table3.1-2 Rainfall Records (1946 to 1977)

(unit: mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
1946	N.A.	N.A.	N.A.	246.9	216.4	191.0	58.7	130.8	371.8	367.0	164.3	135.4	N.A.
1947	87.4	97.3	137.9	181.9	420.8	101.1	225.8	136.9	166.6	301.7	114.0	178.0	2149.4
1948	59.4	78.2	134.4	194.0	56.1	83.3	220.2	331.2	221.2	374.3	131.6	18.5	1902.4
1949	1.3	71.9	142.2	382.5	314.7	175.3	290.3	145.8	307.6	466.8	298.2	89.4	2686.0
1950	35.3	112.8	97.3	266.7	343.4	80.5	376.6	241.5	325.3	336.5	250.7	43.7	2510.3
1951	38.3	158.7	79.0	169.9	163.8	92.5	243.8	246.1	346.2	199.4	456.9	122.7	2317.3
1952	40.1	95.7	250.4	293.9	326.4	150.9	116.8	103.6	178.8	317.7	296.9	114.8	2286.0
1953	91.7	50.8	104.6	374.9	140.2	209.3	245.6	172.5	339.8	273.8	234.2	93.2	2133.5
1954	171.4	32.8	151.1	260.3	117.9	144.5	297.1	225.8	315.2	294.9	106.2	16.3	2133.5
1955	27.2	94.5	41.4	202.2	186.9	306.0	69.3	316.2	103.9	429.2	284.5	21.3	2082.6
1956	48.3	70.3	146.8	169.1	324.3	204.2	146.0	298.9	330.2	325.6	160.0	89.9	2313.6
1957	35.3	58.4	60.7	229.3	161.3	183.6	511.5	88.6	331.9	291.1	144.0	72.4	2168.1
1958	21.6	104.4	81.8	82.5	250.7	186.9	72.9	192.3	235.2	273.0	230.6	Trace	1731.9
1959	2.0	50.0	261.9	95.5	406.1	173.5	233.9	245.9	221.7	306.8	312.6	86.9	2396.8
1960	32.0	17.9	201.4	164.8	262.9	242.0	298.2	238.5	431.5	134.9	200.4	32.3	2250.8
1961	66.5	75.2	110.0	183.1	186.9	222.7	114.0	114.5	351.2	331.2	121.9	215.9	2093.1
1962	10.2	1.3	131.3	182.6	212.8	128.0	258.8	301.2	145.5	433.5	152.4	37.1	1994.7
1963	27.9	7.9	49.0	66.5	155.9	109.0	117.1	151.9	431.2	329.7	305.8	62.7	1814.6
1964	3.5	2.8	0.8	208.3	214.4	65.0	314.9	113.8	298.4	154.9	352.0	72.9	1801.7
1965	0.0	41.4	182.6	335.5	157.5	106.2	211.3	244.8	288.3	385.5	199.9	251.4	2404.4
1966	58.9	141.5	193.5	128.5	312.6	247.9	186.7	246.4	212.6	254.2	141.0	193.5	2317.3
1967	124.7	4.8	60.5	239.8	337.8	388.1	128.5	220.7	220.5	393.4	141.7	4.3	2264.8
1968	0.0	33.8	96.0	116.8	217.7	200.7	250.4	128.3	301.0	227.8	43.9	89.7	1706.1
1969	258.3	37.1	109.5	143.5	164.1	303.0	66.5	352.3	153.1	401.0	328.6	13.7	2330.7
1970	38.9	0.0	121.1	169.7	296.4	156.7	315.7	282.9	291.3	425.7	189.5	97.0	2384.9
1971	3.5	322.3	108.7	41.4	315.7	284.5	75.9	158.7	342.9	296.6	304.8	225.3	2480.3
1972	0.0	83.3	26.4	221.0	126.5	103.4	119.1	228.6	634.1	317.0	359.6	99.1	2298.1
1973	43.7	8.4	85.1	483.3	226.8	134.1	153.1	229.1	175.8	379.9	159.3	174.2	2252.8
1974	51.8	10.2	97.0	269.2	439.4	153.1	142.5	344.6	593.0	175.0	244.6	9.9	2530.3
1975	97.3	144.6	127.4	134.5	250.9	87.8	238.8	132.3	241.6	277.2	266.4	184.2	2183.0
1976	0.0	35.3	134.1	212.3	315.3	172.5	258.7	130.0	337.5	403.2	188.5	61.4	2248.8
1977	10.6	24.7	3.0	78.6	216.8	170.3	90.8	339.9	311.2	326.4	46.9	18.3	1637.5
Average	48.3	63.4	111.7	194.7	240.3	182.5	195.5	216.6	302.3	309.6	220.5	91.1	2176.1

Note: Station, Alor Setar Aerodrome (Kepala Batas)
Latitude $6^{\circ}12'$, Longitude $100^{\circ}25'$ E, Hight above M.S.W.L. 5m.
Source: Meteorological Station, Alor Setar

3. SOCIOECONOMICS

3.1 National Economy

Malaysia has an agriculturally-oriented economy which makes it the largest exporter of rubber, palm oil, tropical hardwood timber and pepper. However, it is now diversifying into industry to concentrate on the manufacturing of finished products from its own natural resources. This is reflected by the increase in contribution to the GNP by the manufacturing sector from 9 per cent of previous year to 12 per cent in 1977. The manufacturing sector accounts for more than one-fifth of Malaysia's total export. Export of machinery, transport equipment and petroleum products have been experiencing strong growth despite the low external demand for the manufactured goods.

The Government gives high priority to labour intensive, agrobased and export oriented industrial projects which use a high percentage of local raw materials. Steps have been taken to distribute industries to the less developed areas so that there will be a balanced geological distribution of industries. Investers whose plans conform to the Government's policy are given attractive incentives.

In promoting the industrialization, the Government has followed a programme of developing industrial estates. To date there are 64 industrial estates and free trade zones and 32 planned industrial estates.

Malaysia has favourable balance of payments since 1969. The surplus for 1977 was US$386 million. The inflow of private long-term capital comprising new foreign direct investment and retained earnings, has been relatively high and stable ever since the country's independence. This signifies the confidence of the foreign investors in the growth potential and economic stability of the country.

Malaysia's satisfactory balance of payments, together with its high foreign exchange reserves has enabled to comply with Article VIII of the agreement of the International Monetary Fund. This means that Malaysia may not, without prior approval of the IMF , impose restrictions on payments for current international transaction, or engage in discriminatary currency arrangements or multiple currency practices. It must provide for free convertibility of Malaysian currency held by foreigners.

Details are discussed in Appendix A of Volume IV Appendices.

3.2 Regional Economy

The State of Kedah has a population of approximately 955,000 as of 1979. A major portion of the population is relatively young with 43 per cent in the 1 - 14 years age group, indicating a high dependency ratio. According to the 1970 Census data, the working population is estimated at 660,000 with an annual growth rate of 2.4 per cent. The unemployment rate is estimated to be 4.3 per cent.
The field of agriculture and forestry is limited to absorve the unemployment but there will be increasing demand by way of industrial growth in the future. The Government is therefore encouraging the establishment of labour intensive projects.

Kedah State has been one of the less developed States in the Peninsular Malaysia, with a per capita income of about M$800 which is only 66 per cent of the National average per capita income of about M$1,512. The total GDP of the State in 1970 is estimated at M$1.0 billion with the State's expenditure being M$63.4 million. The economy of the State is predominantly agricultural, with fishery, forestry and more recently, industrialization being the main economic forms of activities.

The Federal and State Governments have given high priority and attention to promote the development of an efficient network of services, including industries, commercial and infrastructural system in the undeveloped areas in the State. Various strategies for agricultural and industrial sectors have been proposed, adopted and implemented. Details are described in Appendix A of Volume IV - Appendices.

3.3 Economy of Alor Setar

Alor Setar is the capital city of the State of Kedah, serving as the institutional, commercial and transport center in the State.

Commercial activities have been grown rapidly due to the adequate facilities provided by both the Government and private agencies in servicing economic activities. Numerous banks have been opened which offer the normal banking services making loans and advances, discounting trade bills and provision of business investment advisory services.

In addition to the various services available, there is a network of road, rail and a domestic airport that links Alor Setar with the surrounding areas which are predominantry agricultural. This has made Alor Setar a busy centre of the region where all the business and trading activities have forcussed upon. The good communication between Alor Setar and Butterworth where shopping facilities are available has further enhanced the position of Alor Setar as a trading centre. As a service centre, the city plays a dominant role for Perlis too, because the State of Perlis is small to support the same order of activities.

The employment in Alor Setar is largely absorbed by the governmental, agricultural and the commercial sectors, mainly retailing. Industrial employment is high too compared to the other towns in the State of Kedah. The Government has planned to undertake further development on an industrial sector thus diversifying the city's economy.

At present, an industrial estate has been established at Mergong which is located about one and half miles away from the central part of Alor Setar. The Phase I of the industrial estate which occupies an area of 35 ha (86 acres) has been completed while the Phase II which has an area of 33 ha(82 acres) is still underway. Almost all of the land has been taken up for light and service industries. This site has been gazetted as a locational incentive area under which a maximum tax relief period of 10 years can be granted. There are tentative plans to establish another three industrial estates in Alor Setar under the fourth Malaysia Plan which will commence in 1981. The areas where the industrial estates are to be located are, 1) Tandop, Sungai Korok, 2) Jalan Langgar/Hutan Kampung, and 3) Barrage Site, Mergong, covering a total area of 127 ha (313 acres).

4. LAND USE AND POPULATION

4.1 Present Land Use

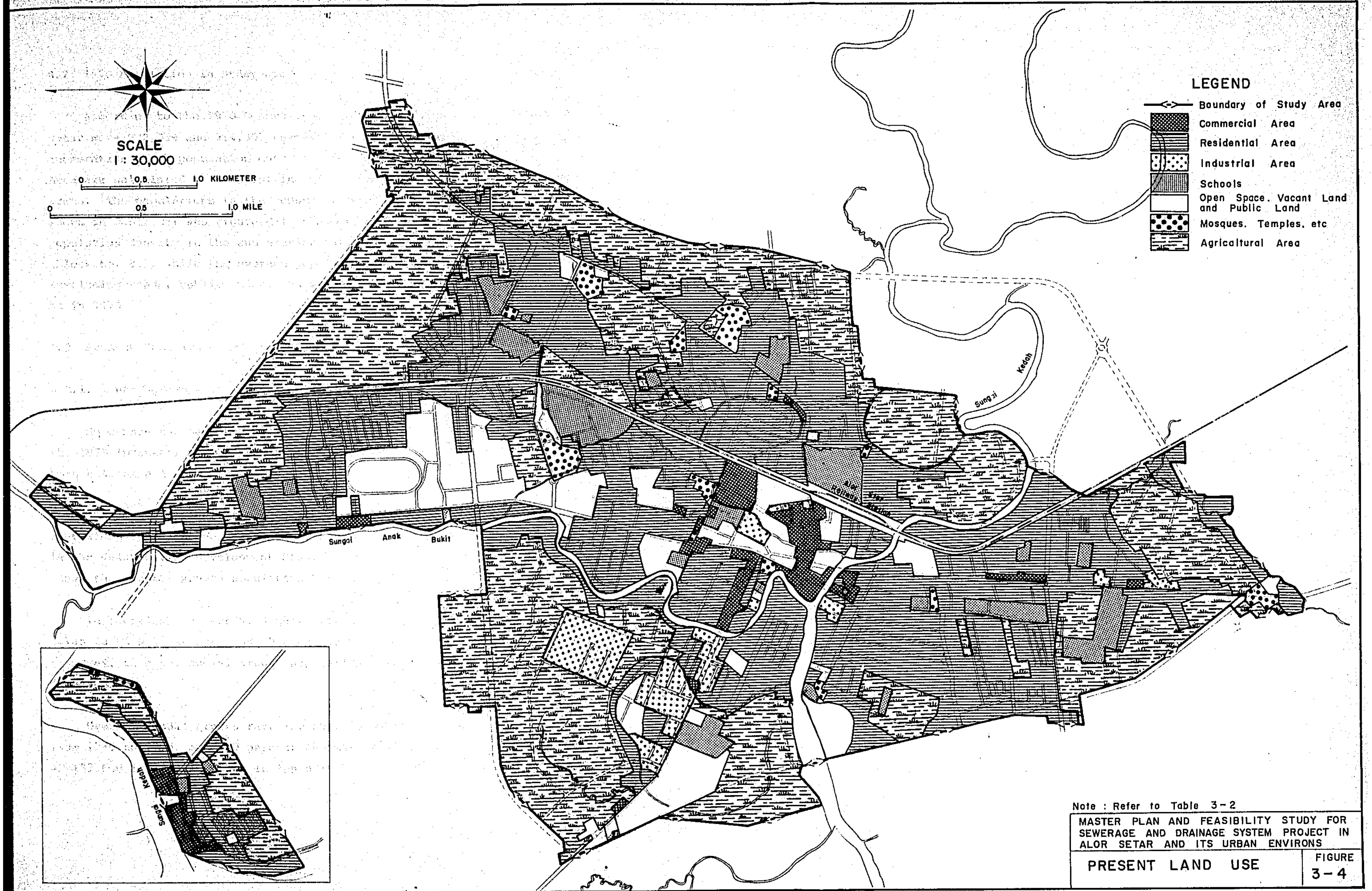
The existing land uses in Alor Setar and its urban environs have been prepared by TCP covering the whole Study Area. The entire area is divided into the following nine categories with relative percentage of shares as shown in table 3.2.

Table 3.2 Present Land Uses in Study Area

Land Use	Area (ha)	Prorat ratio (%)
Residential Area	1,218.0	36.9
Commercial Area	70.0	2.1
Industrial Area	46.5	1.4
Agricultural Area	1,290.0	39.1
Open Space, Vacant Land, Public Land(*)	350.0	10.6
Schools	140.5	4.3
Mosques, Temples, etc.	33.0	1.0
Trunk Roads	42.0	1.3
Rivers & Railways	110.0	3.3
	3,300.0	100.0

Note: (*) Included Institutional Area, General Hospital, Prison, Sultant's Palace, LLN, MADA Office, etc.

As has been the provincial seat of Kedah State, many government offices exist in the downtown area of Alor Setar together with shops and eating places. Recently, SEDC's industrial development schemes have been underway and the small scale industrial firms scattered in the Study Area tend to be relocated to the Mergong Industrial Area. Approximately 39 per cent of the Study Area is still occupied by agricultural land (paddy field) mostly locating at the peripheral portion of the Area. It is expected that housing development schemes will be undertaken in this Area.



Note : Refer to Table 3-2

MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS

PRESENT LAND USE — FIGURE 3-4

4.2 1970 Population in Study Area

According to the 1970 Census, populations in Kedah State and Kota Setar were 992,939 and 314,397 respectively. On the basis of the census enumeration block population data, the 1970 populations in the Study Area are calculated as 100,439, including both Alor Setar and Kuala Kedah areas. The populations in the census enumeration blocks in the Study Area shown in Table C-1 and Figure C-1 in Appendix C indicate that the highest population density in the enumeration blocks is 332.4 persons per ha (block No. 84), while the average population density in the net Study Area (excluding roads, public space, railway, rivers, etc.) is 75 persons per ha in 1970.

4.3 Present Population and Its Distribution

4.3.1. Present Population

No census has been carried out in Malaysia since 1970. Therefore, the 1979 (present) population in the Study Area is estimated considering both natural and social factors.

The natural annual growth rate between 1970 and 1979 is taken to be approximately 2.7 percent applying the same percentage rate for Kota Setar in the Kedah-Perlis Development Study Report, 1978 (Ref. Appendix A), thus, the natural growth population between 1970 and 1979 beging 27.215.

In addition, the social annual growth rate between 1970 and 1975 is taken to be 0.8 percent, and 1976 and 1979 to be 1.3 percent, based on a survey, thus the social growth population between 1970 and 1979 being 11,946.

Overall annual growth rate is, therefore, taken to be 3.5 percent from 1970 to 1975, and 4.0 percent thereafter, reaching a total population of 139,600 in 1979 as shown in Appendix C.

4.3.2 Population Distribution

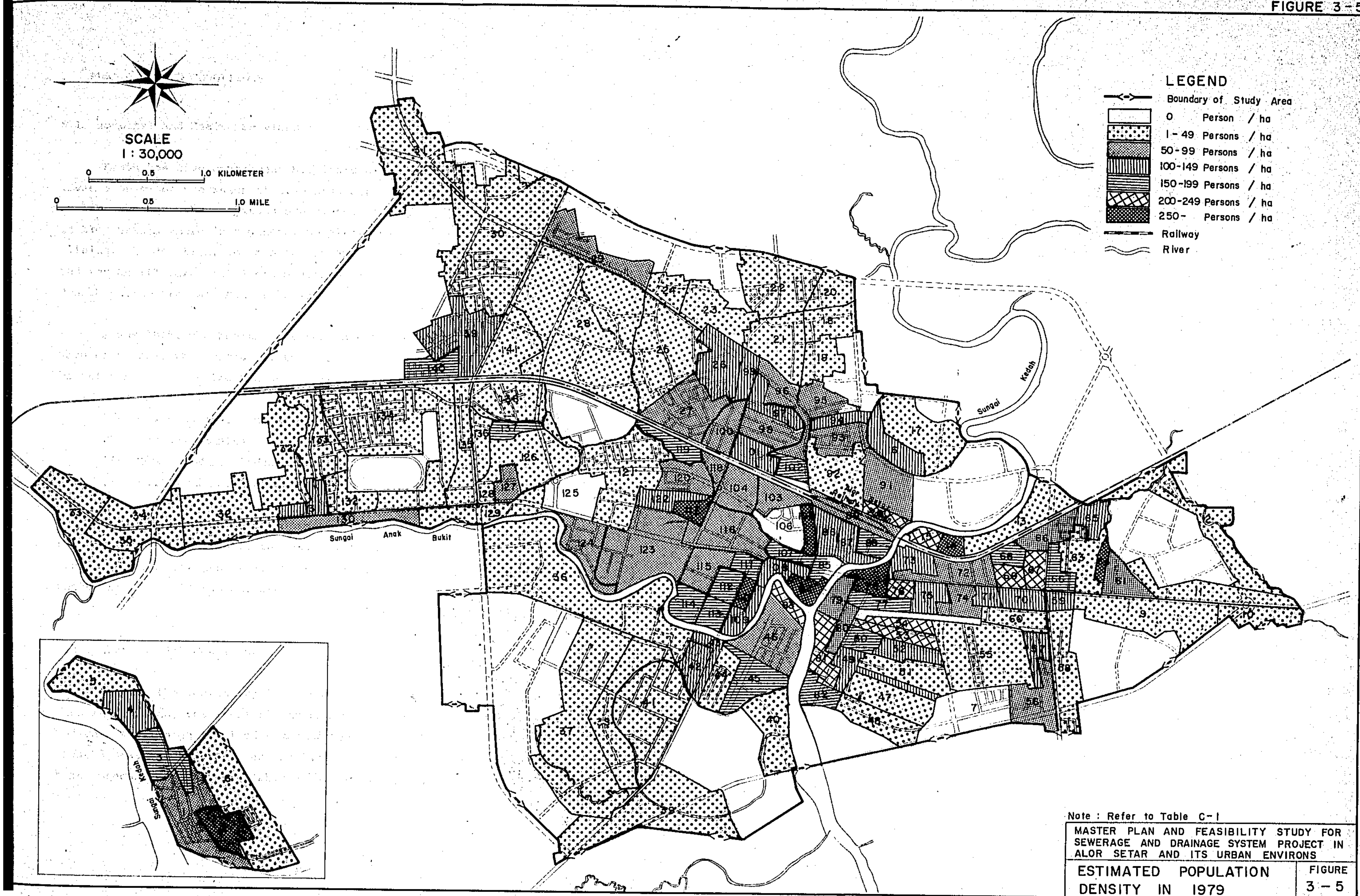
1979 population densities are estimated by land use as shown in Table 3.3, based on the 1979 population densities in the 141 enumeration blocks in Figure 3-5. Population densities in these enumeration blocks indicate that commercial area has the highest range of population density (73-408 persons per ha), followed by residential area (31-335) and industrial area (1-115), and finally by paddy field (4-46), thus being 105 persons per ha of net area in average.

Table 3.3 1979 Population Densities by Land Use

Land Use	Population Density (persons/ha)
Residential	31 - 335
Commercial	73 - 408
Industrial	1 - 115
Agricultural	4 - 46
Others (Open Space, Vacant Land, Public Land, Railway, etc.	0
Average	* 41.7

Note (1) Refer to Table C-1 in Appendix C for detail.

(2) * 105 persons per ha of net area in average.



MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS

ESTIMATED POPULATION DENSITY IN 1979

FIGURE 3-5

5. PUBLIC HEALTH CONDITIONS

5.1 Hospital and Health Services

Kedah has five government hospitals with a total of 1,395 beds, which gives a level of provision of 1.40 beds per thousand population. For urban health services, the hospitals are opened 24 hours a day for out-patients. In Alor Setar, there is a general hospital which is supplemented by poly-clinics. In addition, for monitoring and controlling the various diseases and for health care, the State Health Department has Main Health Centre, Health Sub-centres and Midwife Clinics in the area.

Since 1975, the health services in Kota Setar and Pendang districts have been under the control of the State Health Department's Health District No. 4, covering the activities regarding:

(1) Environmental sanitation
(2) Personal health
(3) Communicable diseases control
(4) Health administration

When diseases are reported to the Department through local offices, the Department investigates the cases and takes necessary steps for treatment. Patients are generally treated in the General Hospital, with most cases free from all expenditures.

5.2 Public Health Conditions

Despite the continuing improvement of the health and medical facilities in the area, the available information on the health conditions indicate still high level of communicable diseases in the area. Among these diseases, cholera is an excellent indicator of water-borne contamination hazards. As shown in Table 3.5, the cases of cholera in Kota

Setar and Pendang districts, from 1977 to 1978, were 4 and 94. Furthermore, nine cases and 21 carriers have been reported to the State Health department from January to March 1979, which are mostly concentrated in Alor Setar and Kuala Kedah areas where the population density is high and sanitation conditions are worse than other areas.

The incidences of other contagious diseases in Alor Setar and its urban environs are also high as shown in Tables 3.4 and 3.5.

Table 3.4 Incidences of Contagious Diseases Treated in General Hospitals in Alor Setar

Disease	Number of Patients Treated		
	1974	1975	1976
1. In-partients			
Dysentry	2	4	-
Amoebic dysentry	2	-	-
Typhoid	8	2	-
Gastro-enterities			
4 weeks to 2 yr age	373	330	266
2 yr or more	195	313	219
2. Out-patients			
Gastro-enterities			
4 weeks to 2 yr age	644	416	83
2 yr or more	927	582	160

Source: Alor Setar General Hospital.

Table 3.5 Incidences of Major Water-borne Diseases

Disease	1976		1977		1978	
	No. Case	Incidence rate per 100,000	No. Case	Incidence rate per 100,000	No. Case	Incidence rate per 100,000
Cholera	N.A.*	N.A.	4	1.10	94	25.30
Typhoid	37	10.48	40	11.04	47	12.66
Gastro-entritics	2,480	703.0	4,675	1,291	4,974	1,338

Source: Kedah State Health Department, Health District No. 4
Note: * N.A. refers to not available

The figures in the above tables indicate the increasing trend in the numbers of the incidences, however, it is suggested by the agencies that the figures do not necessarily mean the incidences are increasing, because the monitoring system has been improved in the last two years.

6. WATER SUPPLY SYSTEM

6.1 Water Supply Agency

The water supply system for Alor Setar area is managed by the State Public Works Department (JKR) under the Ministry of Works and Utilities. The water supply system covers the entire Kedah State, managed by three local district offices namely, 1) North Kedah, 2) Central Kedah, and 3) South Kedah. The water supply system for Alor Setar is under the responsibility of the North Kedah district office.

The present water supply system is based on the plan that was developed in 1962. Currently, the State JKR is in the process of developing comprehensive water supply study, which will include projection of future water demands, agricultural requirements and requirements for other uses such as fisheries, recreation etc., as well as management of water pollution control in the water resources. The study is scheduled to be completed by the end of 1979.

Water supply facilities are constructed, operated and managed under the local offices. All the houses and buildings are checked by reading meters at alternate month basis. The water bill are issured by the Central Counting Office, while the actual collection of the water charges is the local office's responsibility. It is said that a computerization of the billing system is now being studied by the agency and is expected to become available by 1981.

The rates of the water charge were revised in 1976 and the current rates, according to the classification and definition of the Government, are as follows:

- Code A (for domestic use, and for government quarters, departments, institutions, schools, clubs, bath houses, charitable and religious institutions and local authorities)

  Initial 3,000 gal at M$1.0 per 1,000 gal, and each additional 1,000 gal at M$1.2.

- Code B (for business premises where the water is used for purposes of sanitation and hygiene and for the purposes of business or trade)
  M$1.5 for each 1,000 gal.
- Code C (for trade purposes including restaurants, coffee shops, ice-shops, markets, building operations, service stations, etc.)
  M$2.0 for each 1,000 gal.
- Code D (for ice factory, aerated water factories and swimming pools)
  M$2.5 for each 1,000 gal.

6.2 Area and Population Served

The total population served by the system in Kedah is approximately 500,000 or about 50 per cent of the total population. An extension programme of the system is now underway and it is planned that about 75 per cent of the Kedah population will be served by the system by the year 1980.

Sufficient data were not obtainable to indicate the exact number of the houses receiving the water supply services in Alor Setar area, however, the agency estimates that about 80 per cent of the population in the city is currently served by the piped water system. The rest of the people obtain their water either from wells or rivers.

6.3 Water Supply Conditions

Water supply conditions in Alor Setar have been imporved to a great extent since the capacity of the treatment plant was increased and distribution pipes extended, but problems still exist. Many areas in Alor Setar and its urban environs suffer from chronic low water pressure in service pipes especially during the peak hours. Poorly supplied area are concentrated in the southern sectors or peripheral zones of the city, where conditions are worse than other areas due mainly to insufficient pipe capacity and the long distance from the water treatment facilities. In Kuala Kedah area, for example, residents in some kampung, where water pressure is far low to reach the houses, dug holes beside the public road and take the water directly from the water distribution main. Another problem persisting throughout the city is the turbid distributed water probably causing, as explained by the agency, when water velocity in pipes change with impact and rubs off the accumurated interior pipe scale.

For some areas where no piped water is available and also when the water supply is suspended by low water pressure, JKR delivers the water to each house by means of water tank mounted lorries. The water is taken from the water supply system.

6.4 Water Supply Facilities

The raw water for the water supply system for Alor Setar is taken from the intakes located at five places, namely 1) DID irrigation channel at Langkuas, 2) Bukit Wang, 3) Yan, 4) Perigi, and 5) Teroi; however, no water is taken during the dry season when the river water levels is low except in case of Langkuas.

(a) Water Treatment Facilities

Currently raw water for the system is treated in the Bukit Pinang Water Treatment Plant. The plant has been constructed and extended in three phases as follows:

- Phase I: completed in 1935 with only chlorination, at the production rates of between maximum 4.5 mgd and minimum 4.0 mgd since the year 1955.
- Phase II: completed the construction and started its operation in 1967 with rapid sand filters, producing the treated water at the average rate of 5.0 mgd.
- Phase III: constructed in 1978/1979 with rapid sand filters at the average production rate of 5.0 mgd.

The total production capacity of the treatment plant is thus 14.5 mgd .owever, due to the insufficient provision of the distribution pipes, the plant is presently producing an average of 12 mgd. Phase IV extension programme is now underway and expected to be completed in the next 3 or 5 years.

The facilities constructed in the Phase I have pressure rapid sand filters while the other batteries constructed in Phase II and III are provided with gravity rapid sand filters. In the process, chemicals such as copper sulphate, chlorine, sodium alminate and alum are added prior to the sedimentation basins for conditioning, and again before being pumped up to the reservoirs additional chemicals such as chlorine, lime, and sodium silico fluride are dosed. Residual chlorine level is controlled to have 0.4 mg/l at the plant outlet.

Treated water is finally pumped up to three water reservoirs, two of which are provided at the height of 85.3 m (279.83 ft) and the other at 88.7 m (291.13 ft) above mean sea water level, with a total capacity of 26,370 m^3 (5.8 mg). Water consumption rates recorded at the Bukit Pinang Treatment Plant in the past one year (1978) are shown in Table 3.6. It shows that monthly/daily fluctuation of water consumed is not significant according to months.

(b) Water Distribution System

The distribution pipe network covers the entire Alor Setar area, and surrounding towns and villages, i.e., Sanglang, Alor Janggus, Changloon, Tunjang, Kota Sarang Senut, Yan, etc. At some of places, small capacity water reservoirs are provided to give higher water pressure to distribute the water to the houses far awayfrom the water plants. The network is interconnected and from time to time water is supplied from small water headworks located at Yen and Wang.

Table 3.6 Monthly Water Consumption Rates Recorded at Bukit Daily Pinang Water Treatment Plant

Month	Monthly Water Consumption (m^3/month) (1)	Daily Water Consumption (m^3/day) (2)	Ratio to Daily Average Consumption Rate (*) (3)
1	1,464,453	47,240	0.97
2	1,322,259	47,224	0.97
3	1,404,950	45,321	0.93
4	1,354,431	45,148	0.93
5	1,382,761	44,605	0.91
6	1,412,001	47,067	0.97
7	1,625,731	52,443	1.08
8	1,610,511	51,952	1.07
9	1,537,989	51,266	1.05
10	1,601,197	51,652	1.06
11	1,434,195	47,807	0.98
12	1,643,947	53,031	1.09
Total or Average	(Total) 17,794,425	(Average) 48,752	-

Note: (*) figures in this column (3) are calculated by dividing the figures in column (2) by daily average consumption rate (17,794,425 ÷ 365)

Theclear water from Bukit Pinang Treatment Plant is delivered through three water mains, each having 381 mm (15 inches), 457 mm (18 inches) and 610 mm (24 inches) diameter. The water delivered through these main pipes is recorded at the plant, between 6:00 a.m. to 6:00 a.m. next day.

Provision of the water connection pipes within the private housing and industrial development areas in the development areas is the developers' responsibility. In addition, the necessary distribution pipes in the area to be developed by the private developers for water supply are also to be provided by the developers but will be transferred to JKR for operation and maintenance.

6.5 Per Capita Consumptions

Total amount of water supplied and consumed for the year 1975, 1976, and 1977 is available for both entire Kedah State and North Kedah district as shown in Table 3.7, revealing that per capita water consumption rates of the North Kedah district are larger than those of entire Kedah State for every year probably because the former comprises the state capital, Alor Setar. Further, per capita water consumption rates are considered almost constant during the past three years.

Table 3.7 Per Capita Consumption in Kedah and North Kedah in the Past Three Years

	1975		1976		1977	
	Kedah	North Kedah	Kedah	North Kedah	Kedah	North Kedah
Population served (persons)	410,991	234,590	439,849	247,960	455,991	253,900
Water supplied (1,000 m^3)	27,319	19,712	31,251	21,411	31,987	20,956
Water metered (1,000 m^3)	16,434	10,270	17,516	10,321	21,703	13,787
% metered to total water supply	60	52.1	56	48.2	68	65.8
Average daily supply (m^3)	74,827	57,598	87,874	43,960	87,556	63,098
Per capital per day (l)	182	230	200	235	191	226

7. RIVER, DRAINAGE AND IRRIGATION SYSTEMS

7.1 River System

The Sungai Anak Bukit runs southerly in pararel with Jalan Anak Bukit, Jalan Alor Merah, Jalan Lebuh Raya Darulaman and Jalan Bakar Bata confluenting into the Sungai Kedah slightly down stream of Badushah Bridge, whereas various small rivers converge into the Sungai Kedah between four miles Southern part from the confluent point with the Sungai Anak Bukit as shown in Figure 3-6. The Sungai Kedah runs about 10 miles westwards sawing the Muda paddy field from the confluent point, finally flowing into the Ocean (the straits of Malacca) at Kuala Kedah.

A tidal barrage is located at one mile downstream of the confluent point. The tidal barrage has been constructed by the Drainage and Irrigation Department under the Muda Irrigation Project and this structure serves to prevent the ingress of saline water during high tides and releases runoff from upper reaches of the Sungai Kedah during low tides.

7.2 Drainage System

The existing urban drainage system of the city consists of trunk drains, secondary drains and roadside drains. Rehabilitation and construction, as well as maintenance of the trunk drains have been undertaken by the State Drainage and Irrigation Department (DID), while the secondary and other smaller drains are generally under the responsibility of MPKS. The drainage facility in the housing and industrial development schmes are to be provided by developers but after the facility is completed it is transferred to MPKS.

The drainage system is generally provided throughout the urbanized areas in the city. However, some of them are natural earth drains without lining and also in many portion their capacity is reduced by the deposits either carried down from upstream or uncontrolled dumping of solid wastes the drains. In addition, because of the low ground surface elevation varying from +1.2m (+4.0 ft) to +2.3 m (+7.5 ft) above the mean sea water level, and also its very slow surface slope, wide areas of the city are liable to occasional flooding or inundation. During the rainy seasons especially these coincide with spring tides, severe damages to government and private property are caused disrupting the activities of a large number of population.

An agreement was made between the MADA and DID to define the responsibility of each agency, especially in areas where urban development programme is planned. Under the agreement, the irrigation facilities located within the designated urban development programme area are to be transfered to DID and converted into urban drainage system.

7.3 Irrigation System

7.3.1. Muda Agricultural Development Authority

In Kedah State, the Muda Agricultural Development Authority (MADA) is responsible for the development of irrigation schemes, including construction of facilities and management of the irrigation system. The quasi-government agency was established in July 1970 to manage the scheme autonomously and provide the multi-disciplinary force needed to achieve its objectives. MADA has been implementing the country's largest irrigation project providing irrigation facilities for a net area of 960 km^2 (237,000 acres), and by double cropping it supplies about half of Peninsular Malaysia's demand for rice. The scheme occupies the interstate coastal alluvial plain of Kedah and Perlis and dominates irrigated agricultural development in these two states.

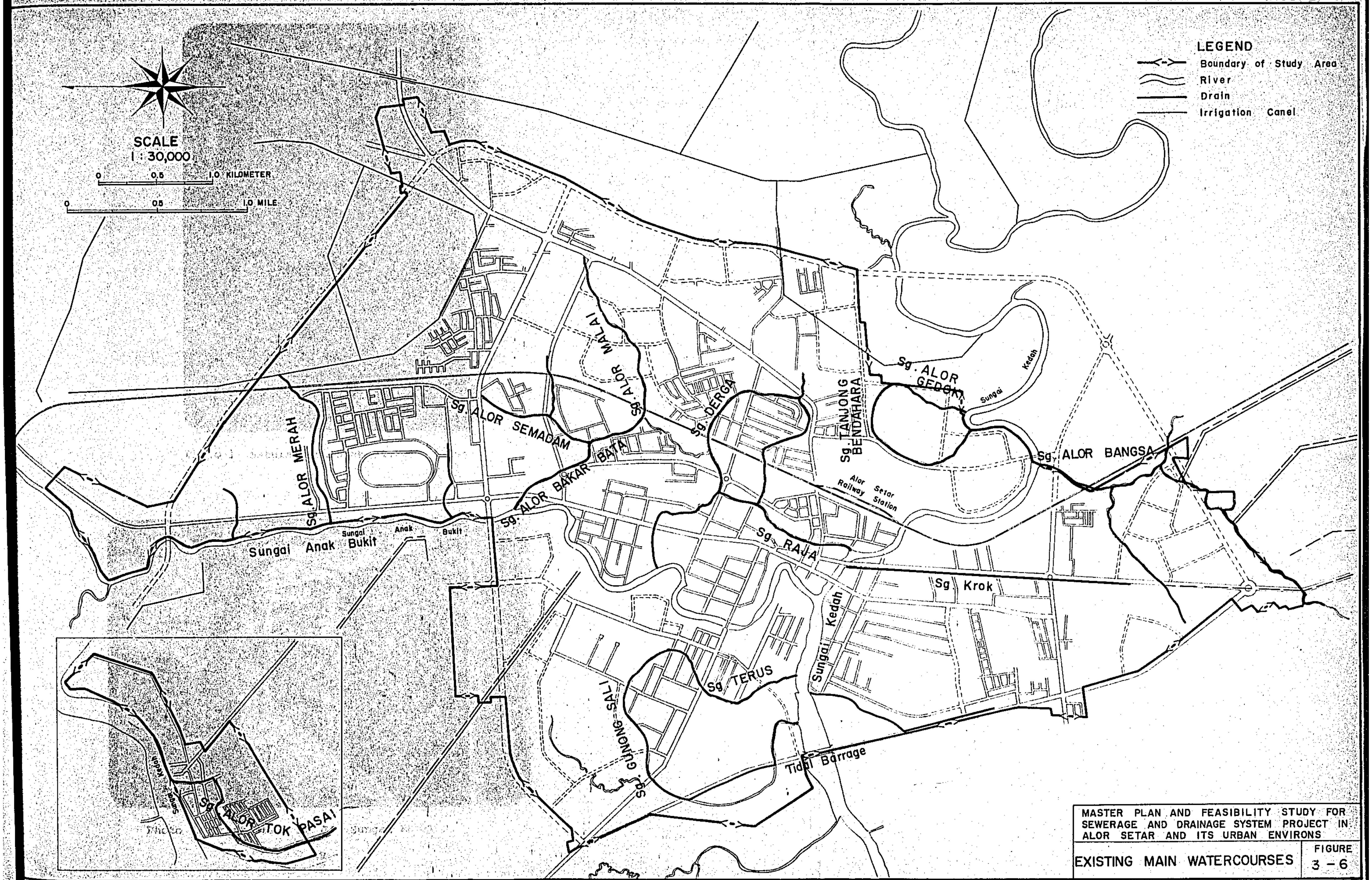
MADA's first agricultural project started in 1966 with source of fund, of which 40 per cent was furnished by IBRD loan and 60 per cent from the Federal Government, and completed in 1970.

Outside MADA scheme areas, the DID in Kedah has irrigation development scheme. DID irrigation water is drawn from rivers. The schemes are generally served by headworks and by gravity feed pipes.

7.3.2 Existing Irrigation Facilities

A network of the irrigation channels in the State is provided for the paddy field as shown in Figure 3.5. The distributed irrigation water after used for raising rice is discharged to either rivers or drains that are under the responsibility of DID.

Within the Study Area, most of the irrigation channels and auxiliary facilities are already transfered to DID to be used for urban drainage system except for some areas where paddy field is still in use. At many locations in the Study area, irrigation channels cross urban drains but generally do not affect significantly to the drainage functions.



MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS

EXISTING MAIN WATERCOURSES

FIGURE 3 – 6

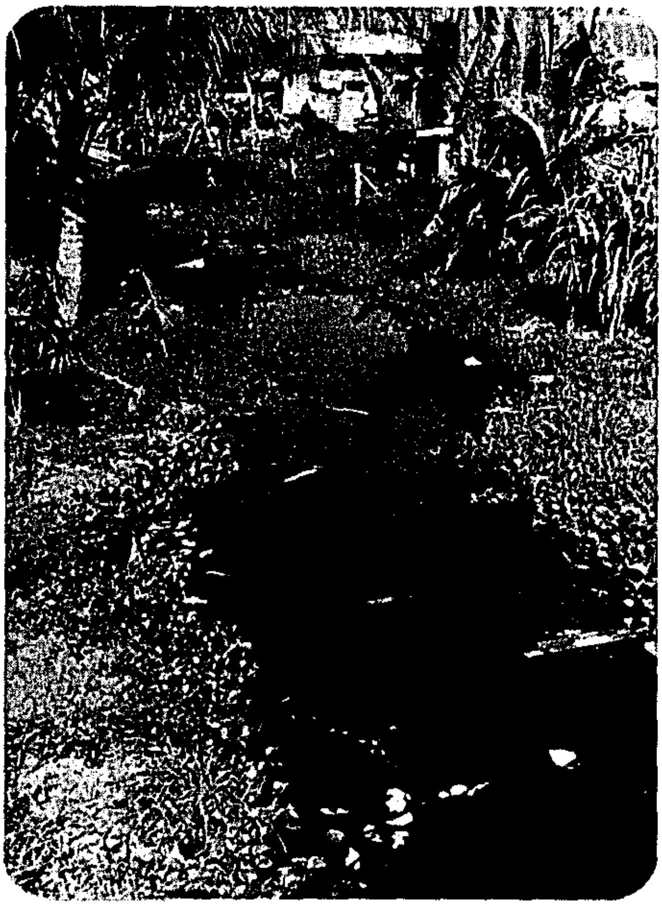


Photo 1 Natural drain at Jl. Titi Siam

Photo 2 Trunk drain at Jl. Sungai Korok

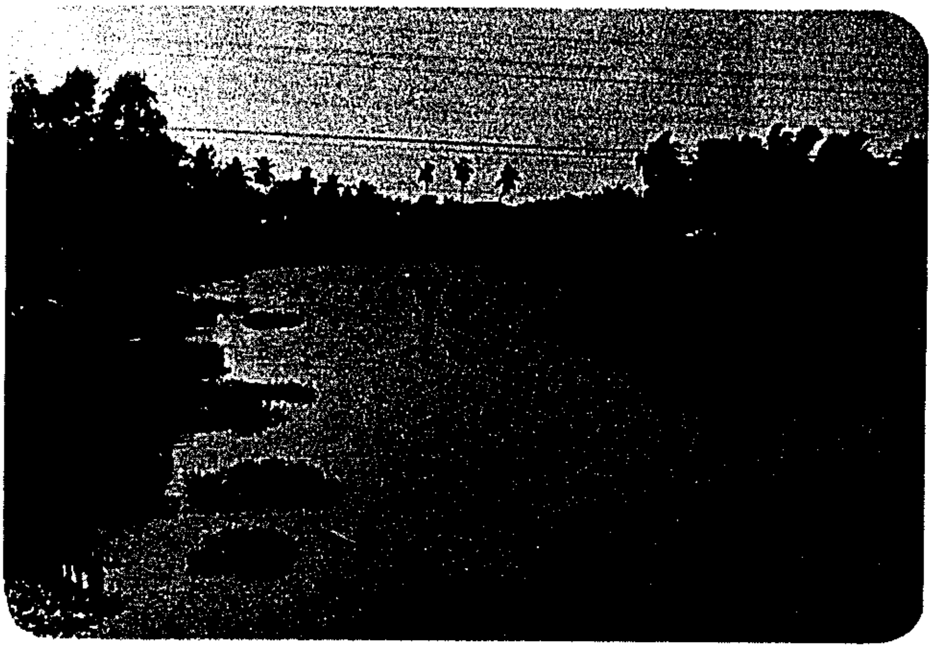


Photo 3 Sungai Kedah at Jl. Sungai Korok near the railway bridge

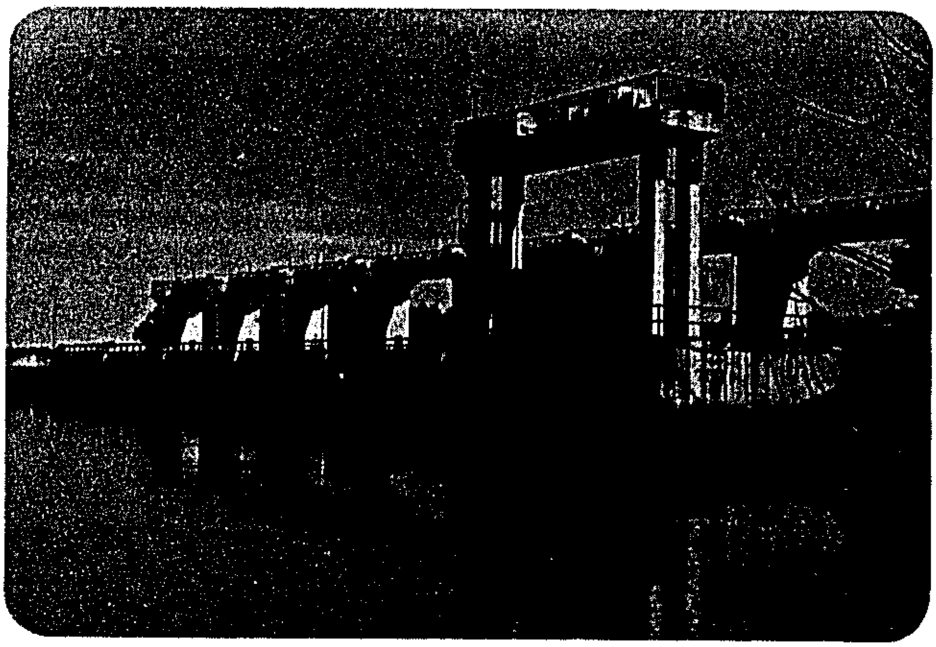


Photo 4 Tidal barrage near South Mergong Industrial Area

8. EXISTING WASTEWATER DISPOSAL SYSTEM

8.1 Existing Excreta Disposal Systems

In the Study area, there are four different types of excreta disposal system currently in use. These are:

(1) Flush toilet with septic tank;

(2) Flush toilet connected to sewerage system with communal septic tank or Imhoff tank;

(3) Conservancy (bucket) system;

(4) Others including latrine over waterway, pit privy/borehole latrine.

Cleaning services for both conservancy and septic tank systems are MPKS's responsibility. The excreta collection and disposal are undertaken by contractors franchised by MPKS. The excreta disposal facilities by type are shown in Table 3.8.

Table 3.8 Excreta Disposal Facilities in Study Area

(in 1979)

Type of Facility	No. of Facility Exist
1. Flush toilet connected to private septic tank	20,310
2. Flush toilet connected to communal septic/ tank (*)	2,130
3. Conservancy (bucket) system (**)	2,533
4. Others including latrine over water-ways, Pit privy/ borehole latrine	405
Total number of houses	25,378

Note: (1) (*), (**) refer to Appendix A for detail
(2) Source: MPKS

There are two types of collection services in the conservancy system depending upon the services provided, one being single system and the other double system. The former system offers the collection service at alternate day at the monthly service charge of M$2.5 per house, while the latter system is operated on the daily basis at the charge of M$5 per house. In the double system, the bucket is cleaned by the contractor's crew after it is emptied, but not for the single system. As of 1979, a total of 2,533 houses has the conservancy system, of which 301 houses use double system and the remaining 2,232 houses apply the single system.

Presently, there are 21 communal septic tank systems in the area. Most communal systems are not functioning well and the effluent contains high BOD and SS, and tend to causing water contamination of receiving waterways. Most of these systems have been operated and maintained by MPKS. However, individual septic tanks are maintained by house owners. When sludge accumurates in the tanks the house owner request MPKS for desludging.

Pit privy/borehole latrine are still in use, especially in suburban area. Most of the excreta in these latrines is designed to penetrate into the ground, but due to the flat ground surface slope and high groundwater table of the area, the excreta in the system does not necessarily infiltrate, and in some low-lying area the contents of latrines overflow during the rainy season and contaminate the waterways.

8.2 Excreta and Sludge Collection and Final Disposal

The services for the conservancy system has been undertaken by contractors. They generally start their collection service at around 3:00 a.m. and finish it before 7:00 a.m. Bucket is first carried to large pail and then is emptied to tank lorry and finally transported to the disposal site. There used to be several transfer stations for storing the collected excreta but these were abandoned because of sanitary reasons.

Currently, MPKS has two tank lorries of 600 gal capacity. However, only one lorry has been in use for collection and disposal of the septic tank sludge. Another lorry is used for street water spray service. The lorry in use is shown in Photos 5 and 6.

Both excreta and sludge collected are carried to the designated final disposal site at Jabi, located about 19 km (12 miles) northeast of the city. At the disposal site, the ditch of 4 ft by 4 ft is dug and the collected excreta or sludge is poured into the ditch. After the excreta or sludge is dumped, lime is sprayed on the surface and then covered by tree branches to prevent fly breeding. When the ditch is filled, it is covered by earth. The area of the disposal site is about 16 ha (40 acres) which has enough space to bury the collected excreta and sludge. From 5 to 10 years after the ditch is dug and filled all over the area, then return to the beginning place where left undugged between the previous ditches. The ditches at the disposal site are shown in Photo 7.

The bucket service charge is collected by MPKS and the contractors receive the collection service fee from MPKS, M$2.2/house for the double system and M$2.1/house for the single system per month. MPKS paid the contractors an average monthly service fee of M$5,372 in 1979.

The frequency of cleaning of septic tanks in the area average about once every 7 to 8 years, which seems to be too long to function septic tanks properly to produce the acceptable effluent quality. In order to obtain more detailed information as to the performance of the existing septic tanks in the area, a survey was conducted for representative septic tanks. The contents and effluents were sampled for analysis of BOD, SS and other items as shown in Table B-18 of Appendix B. The effluent BOD and SS values were resulted in a range of 9.6 to 70.6 mg/l for BOD and 10 to 117 mg/l for SS respectively.

Photo 5 MPKS tank lorry in operation to withdraw septic tank sludge at Lorong Shariff

Photo 6 Suction hose of tank lorry

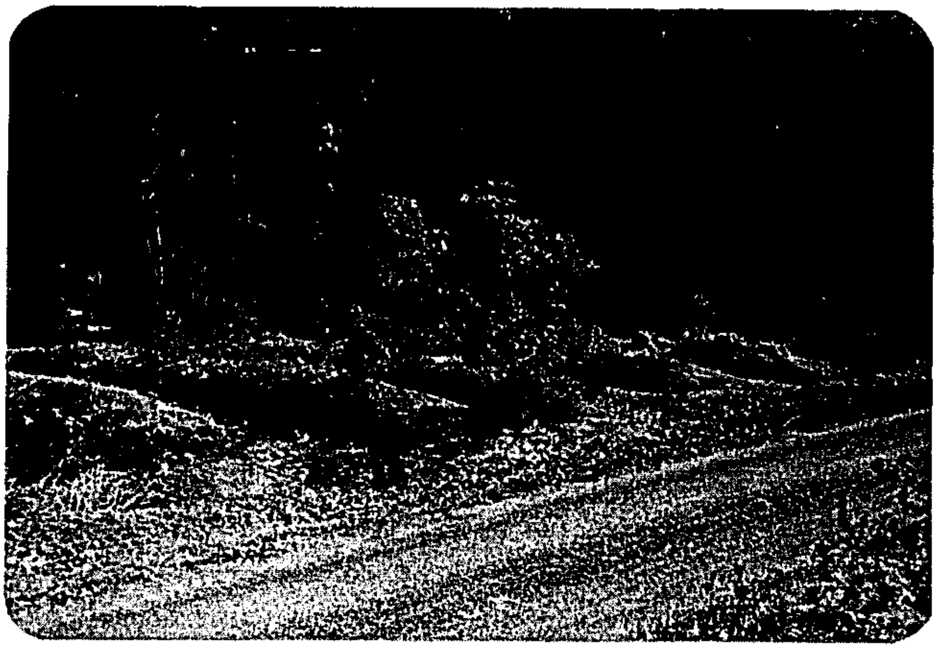


Photo 7 Excreta and sludge disposal site at Jabi

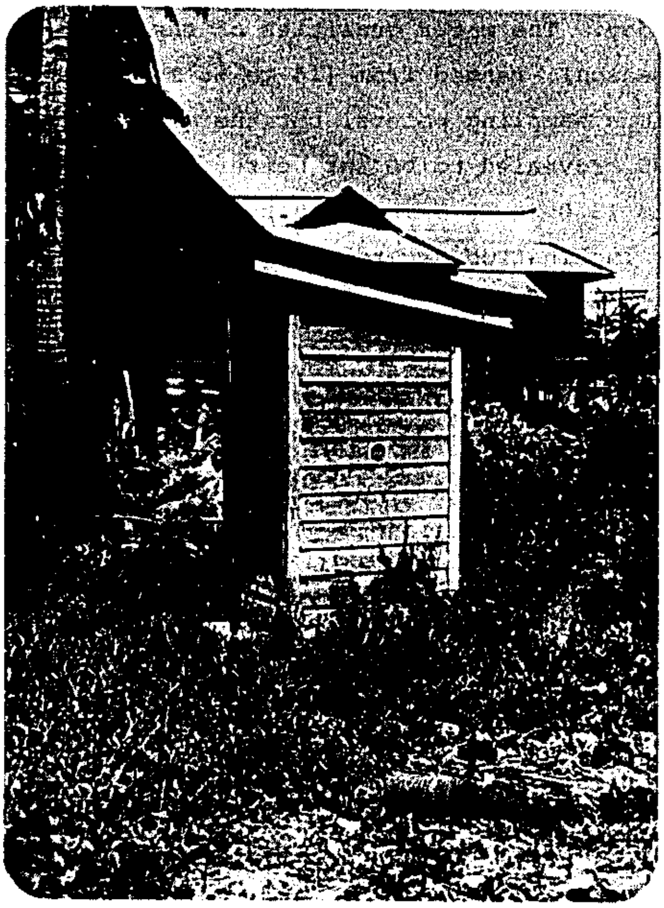


Photo 8 Conservancy toilet system

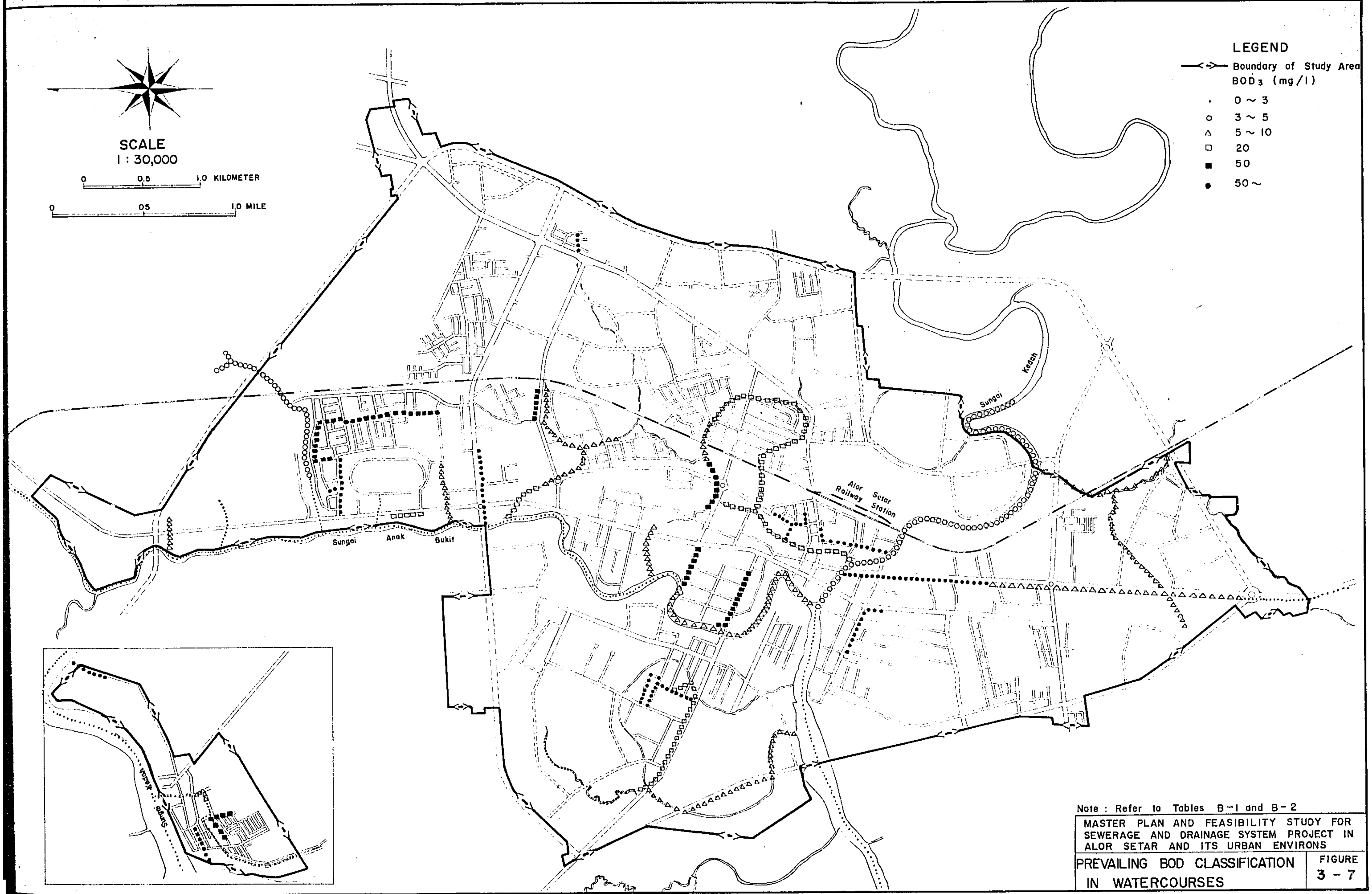
9. POLLUTION OF WATER COURSES

In addition to major two water courses - the Sg. Kedah and the Sg. Anak Bukit, a number of drains and road side ditches exist in the Study Area.

Wastewaters generated in the area flow into the two water courses through these drains and ditches. Water qualities of the two major water courses, which are influenced by tides to upstreams beyond the Study Area, are affected by the volume and velocity of the water courses, organic deposits, inflow of wastewaters, especially by the changes of the quantity and velocity of the water courses.

In dry season (from October to February), the tidal barrage located at 1.4 km downstream from the confluent point of the two major rivers, is mostly closed, while in wet season, the gates are opened more than once every day. The water qualities of the major rivers sampled in March 1979 (dry season), ranged from (14 to 66 mg/l) in terms of BOD according to the various sampling points, but the qualities in wet season, sampled in June 1979, revealed to be far better than the qualities in dry season ranging from (3.8 to 19.9 mg/l) at the same sampling points in March. The similar inclination according to seasons can be said for DO as well (refer to Appendix B).

The results of wastewater quality analysis for 61 places of water-courses, including natural rivers and drains, carried out in June 1979 (wet season) are summalized in Figure 3.7. The results reveal that water qualities in small waterways are heavily polluted than large waterways, due to the difference of dilution and self-purification capacities. The similar inclination has also been observed for dry season according to waterways by site reconnaissance (Refer to Tables B-1 and B-2 in Appendix B for detail).



MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS

PREVAILING BOD CLASSIFICATION IN WATERCOURSES

FIGURE 3 - 7

10. PREVIOUS STUDIES AND REPORTS REVIEWED

Outlines of the major relevant reports reviewed are described below;

1. Preliminary Study for the Sewerage Project in Alor Setar and Its Urban Environs (prepared by the Environmental Health and Engineering Unit, Ministry of Health, December, 1978)

This report, being the basis of the terms of Reference for the present studies, recommends that;

(a) a detailed Master Plan and Feasibility Study be carried out as soon as possible. This study include the evaluation of the extent of the Study Area, the evaluation of the existing conditions and the existing sanitary facilities in the Area, the type of system to be adopted, and the organizational set-up and the financial aspects that are necessary for the implementation of the project.

(b) a comprehensive urban development plan, showing all the existing roads, the proposed roads and layout plan for proposed residential, commercial developments in the Study Area, be prepared as soon as possible as the basis for the Master Plan and Feasibility Studies.

(c) for immediate action, all new housing projects should include a sanitary waterborne sewerage system, for domestic wastewater used with some form of temporary treatment facilities. In areas where septic tanks are used, the septic tank facilities should be provided in accordance to Street, Drainage and Building Act 1976.

(d) the land required for the sewerage treatment plant sites should be reserved as soon as possible. Acquisition of these land can be done on completion of the Master Plan and Feasibility Studies.

2. Kedah-Perlis Development Study

The report recommends the following hierarchy;

(a) Alor Setar should remain and be further developed as the regional center for the two states

(b) enhancing the status of Alor Setar to enable it effectively to fulfil its role as the regional center by promoting industrial and service activities to transform the structure of the economy and reduce its present overwhelming dependence upon agriculture, the report proposes for a comprehensive planning study for the district of Kota Setar including (1) a western bypass round the town, (2) the provision of a new industrial estate because Alor Setar has the infrastructure and the labour pool to support a major industrial development.

(c) relocation of all principal State and Federal government offices is recommended to Alor Setar. This will enchance the role of Alor Setar, strengthen its role as a regional center, and facilitate interdepartmental contacts.

(d) haphazard spread of housing should be prevented.

(c) low cost housing projects are initialed.

(f) urban drainage and sanitation are improved.

The study supports the recommendation of the WHO/IBRD "Urban Sewerage Study" in which the long term "Water Supply and Sewerage authorities" should be set up, with local authorities playing a major role in them. In the short term, the report proposes that Sewerage Joint Committees should be formed for the largest urban areas consisting of officials of the local authority and relevant government department (JKR, DID, TCP, etc.). These committees should have responsibility for sewerage, sewage disposal, pollution control, urban drainage and flood prevention and should supervise technical work carried out by, or on behalf of local authorities.

As for sanitation measures, the report recommends that all houses constructed in urban areas should incorporate adequate sewage disposal with septic tank as the minimum provision.

CHAPTER 4. FUNDAMENTAL PLANNING CONSIDERATIONS

1. DEFINITION OF THE STUDY AREA

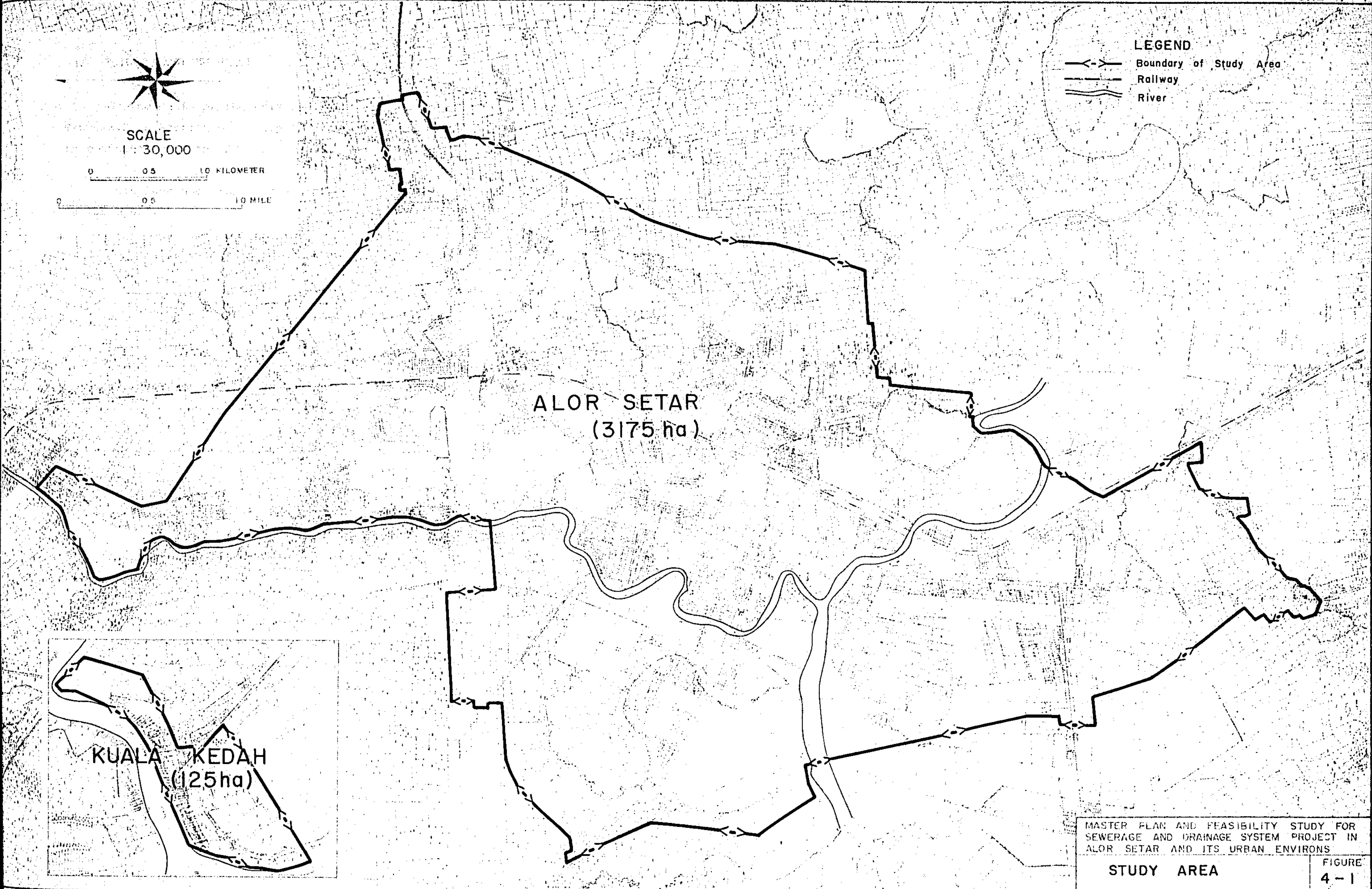
The Study Area is shown in Figure 4.1 with a total area of 3,300 ha (8,154 acres), modifying the original Study Area in the Terms of Reference as agreed upon by the Government of Japan, by adding the Southern Mergong Industrial Area (near the tidal barrage, 43 ha)which has been under preparation for construction, and the low cost housing area located at northern portion of the Northern Mergon Industrial Estate (46 ha). The Study Area also includes 125 ha (309 acres) of Kuala Kedah area.

2. DESIGN PERIOD AND STAGED CONSTRUCTION PROGRAMME

The Master Plan is a long-term programme with a project period of 20 years from 1981 to 2000.

A staged construction programme is made up to the year 2000 with four stages. Each stage consists of five years considering time needed for detailed design, preparation and evaluation of tender documents and construction supervision. Therefore, the construction staging in that report is set out as follows:

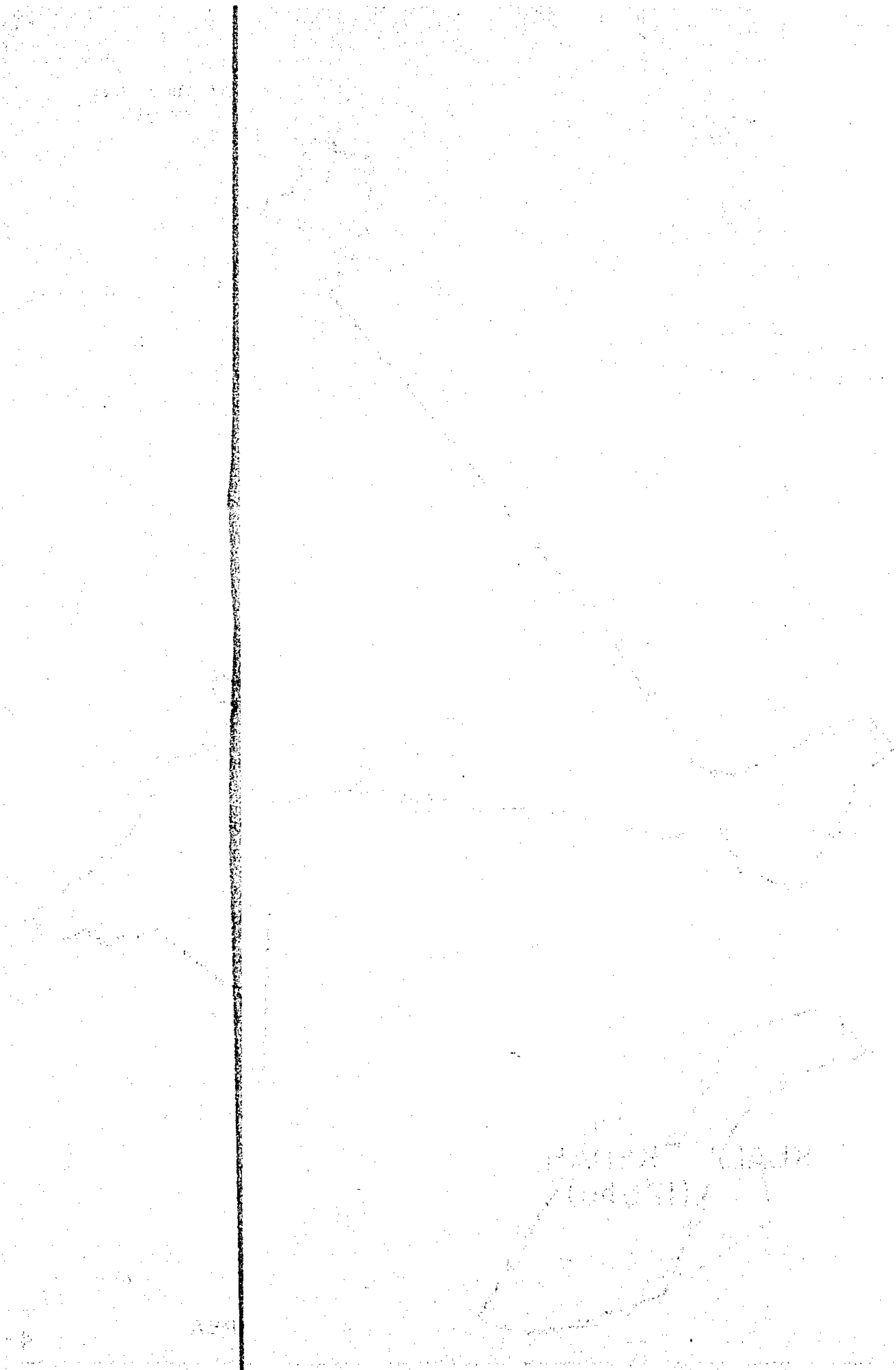
First Stage	:	1981 - 1985
Second Stage	:	1986 - 1990
Third Stage	:	1991 - 1995
Fourth Stage	:	1996 - 2000



MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS

STUDY AREA

FIGURE 4-1



3. FUTURE LAND USE PLAN

On the basis of the existing land uses of the Study Area as shown in Table 3.2 in Section 4.1, Chapter 3, a 2000-year land use plan is made in consultation with STCP as shown in Figure 4.2.

This land use plan consists of several land uses as breaked down in Table 4.1.

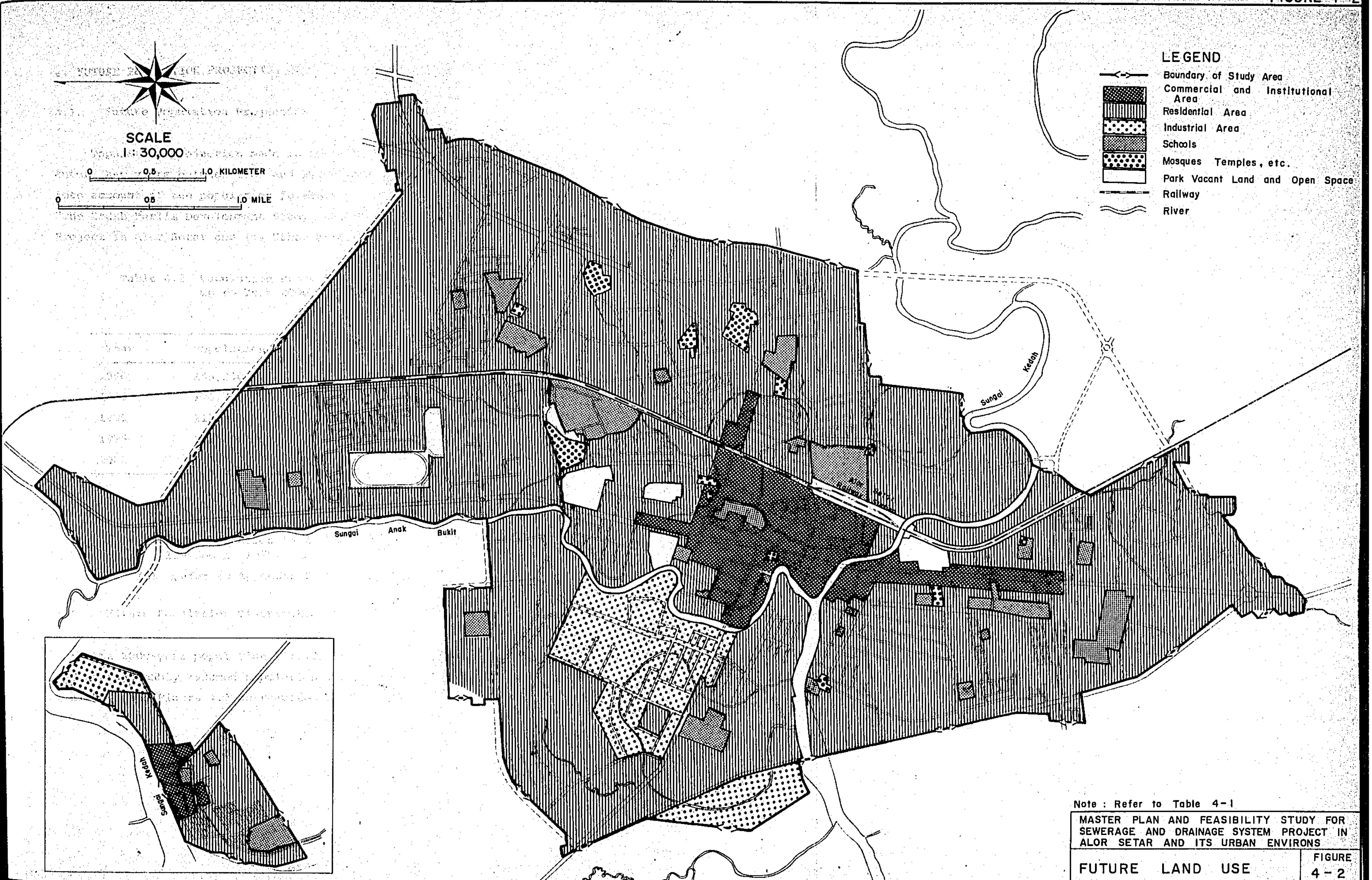
Table 4.1 Land Use Plan in the Year 2000

Land Use	Resi-dential Area	Comm-ercial Area	Institu-tional Area	Indu-strial Area	Open Space Vacant Land, Public Land	School	Mosque, Temple	River, Rail-way	Total
Area (ha)	2,521.0	174.0	32.0	207.0	64.0	159.0	33.0	110.0	3,300
Prorata Ratio(%)	76.4	5.3	1.0	6.3	1.9	4.8	1.0	3.3	100

It is assumed that 88 percent of land in the Study Area will be occupied by three land uses, namely residential, commercial and industrial area.

Main features of the future land use plan in connection with the present land uses in Section 4.1, Chapter 3 include;

(1) converting the agricultural area into residential area
(2) expanding industrial area both at the Mergong and Kuala Kedah
(3) expanding commercial area
(4) establishing institutional area

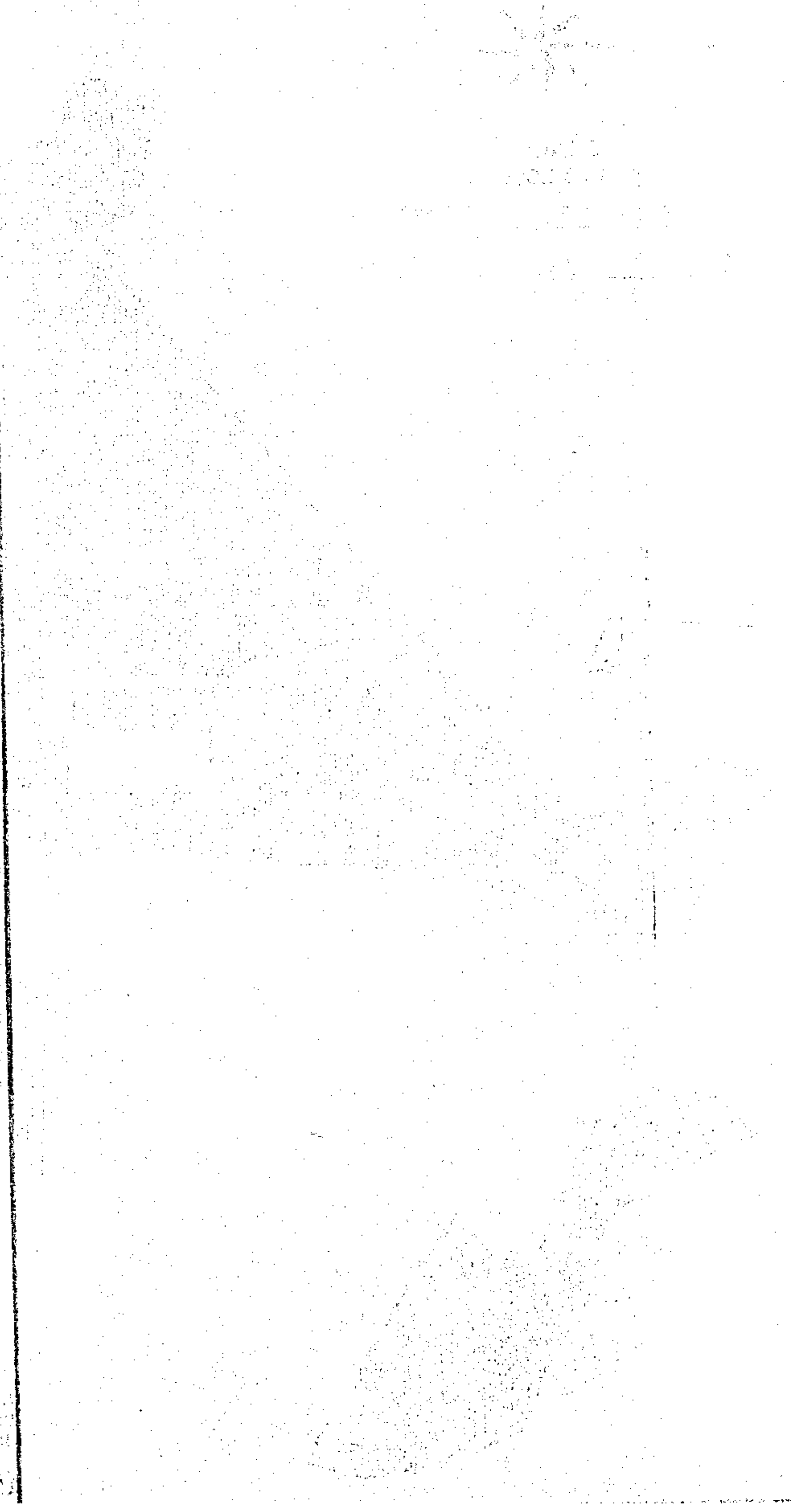


Note : Refer to Table 4-1

MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS

FUTURE LAND USE

FIGURE 4-2



4. FUTURE POPULATION PROJECTION AND ITS DISTRIBUTION IN THE STUDY AREA

4.1. Future Population Projection

Population projection made in this study is shown in Table 4.2 for future key years between 1980 and 2000 based on the 1970 census taking into account of the population forecast in the previous studies such as "The Kedah-Perlis Development Study" and "Preliminary Study for Sewerage Project in Alor Setar and its Urban Environs" as discussed in Appendix C.

Table 4.2 Population Projection in the Study Area up to Year 2000

Year	Population	Annual Growth Rate (%)
1980	145,200	
1985	176,700	
1990	215,000	4.0
1995	261,600	
2000	318,300	

Note: (1) 1970-population in the Study Area is estimated to be 100,439 based on the 1970 census.

(2) 1980 population is 4% larger than the population of 139,600 in 1979.

(3) Refer to Appendix C for detail.

4.2. Future Population Distribution

The 2000-year population (318,300 persons in Table 4.2) is distributed by reasonably assumed population densities for the future land uses in Table 4.1 and Figure 4.2 as resulted in Table 4.3.

Table 4.3 Population Distribution According to Land Uses in the Year 2000

Land Use	Area (ha)	Population Density (**) (persons/ha)	Total Population
Residential Area			
A	1,863.6	120	223,632
B	566.0	70	39,620
C (*)	91.4	5 - 800	5,648
Sub-total	2,521.0	-	268,900
Commercial Area	174.0	200	34,800
Institutional Area	32.0	0	0
Industrial Area			
A (North Mergong)	146.0	100	14,600
B (South Mergong, Kuala Kedah)	61.0	0	0
Sub-total	207.0	-	14,600
School	159.0	0	0
Park	64.0	0	0
Mosque, Temple	33.0	0	0
River, Railway	110.0	0	0
Total	3,300	-	318,300

Note (1): (*) includes such places as Sultan's Palace, Kedah Club, low cost houses, housing area in North Mergon Estate, apartment houses near Chinese Temple at Tong Kang Yard, and Police Quarters.
(**) population density is calculated based on gross area.

The projected 2000-year population density in Residential Area A, which is defined as "urbanized and/or urbanizing area" consisting of the City Council Area promulgated in 1974, is assumed to be 120 persons per ha (or 48 persons per acre), while 70 persons per ha (or 28.3 persons per acre) in the extended area from the 1974 City Council Area to the Study Area limit wherein housing development schemes are assumed to be implemented by developers.

The 120 persons per ha in Residential Area A is justified because existing 117 persons per ha over several typical areas seems to be almost under saturated condition, and the 70 persons per ha is supported by the finding that the population density in the typical existing housing development areas is reaching to that level in case of reasonable housing development scales from 10 to 15 ha. Similarly, the 2000-year population densities in Commercial and Industrial Area A (the Northern Mergong Industrial Area) are assumed to be 200 and 100 persons per ha (or 80 and 40 persons per acre) repectively on the basis of the present population densities of 154 and 83 persons per ha in the same areas.

It should be noted that the resident population is considered nil in Institutional Area, Industrial Area B, (South Mergong and Kuala Kedah) School, Park, and Mosque and Temple of the land use categories in Table 4.3 , although actual sewerage system design is considered for day time population in these areas.

5. SEWERAGE SYSTEM

5.1 Collection System

Three alternative sewage collection systems are considered in the Study Area as follows;

(a) Alternative 1: Combined system collecting sanitary wastewater and rainfall runoff in a closed conduit

(b) Alternative 2: Separate system collecting sanitary wastewater and rainfall runoff by separate closed conduit

(c) Alternative 3: Separate system collecting sanitary wastewater by closed conduit and collecting rainfall runoff by open channel

Considering the following various reasons, (c) is recommended in the Study Area.

(1) DID has a plan to improve the existing drainage system by both remolding the existing main open drainage channels and installing pumping stations with reservoirs.

(2) Separate system can contribute greatly for water pollution control than otherwise.

(3) Adoption of Alternative (3) above is the most economical one among the three alternatives because the existing open drainage channels which are recieving both rainfall runoff and sanitary waste at present can be used for collecting exclusively rainfall runoff by diverting sanitary, wastewater into the newly built sanitary sewerage system. Similarly, this system is much easier than any other alternatives for construction and maintenance, considering the existing traffic congestion of the main roads and a number of underground structures in the area.

5.2 Treatment and Sludge Disposal System

5.2.1 Need and Degree of Treatment

As discussed in Appendix D, "Water Qualities and Quantities", water in the drains and rivers in the urbanized areas have already polluted by domestic and industrial wastes which requires immediate need for proper treatment in order to alleviate the existing and further deterioration.

As estimated in Tables D-16 and D-17 in Appendix D, the present (1979) water qualities generated in the Study Area would range from 34 to 170 mg/l of BOD if all wastewater were discharged without any treatment. They would be further deteriorated by the passeage of year, reaching to a neighbourhood from 105 to 175 mg/l, in the year 2000.

Taking into consideration of the environmental quality regulations for sewerage and industrial effluent currently being drafted in Malaysia, tentative effluent criteria are proposed here as shown in Table 4.4, which are used in studying and proposing sewage treatment facilities. It is noted, however, that the proposed effluent quality criteria should be modified matching to the actual need of the water qualities of the receiving watercourses in the future.

Table 4.4 Tentatively Recommended Effluent Quality Criteria for Sewage, Facilities

Parameter	Unit	Value	Remarks
BOD	mg/l	50	5 days at 20°C
Coliforms	N/ml	1,000	-

Based on the tentatively recommended effluent quality of 50 mg/l in terms of BOD in Table 4.4 and estimated 2000-year BOD values of 147 to 253 mg/l for sewerage sub-zones as estimated Table 5.5-10, degrees of BOD to be removed by treatment facilities are estimated to vary from 65.3 to 70.2 %, for which either stabilization pond, aerated lagoon or oxidation ditch system can be sufficient as the most economical system according to the comparative study as discussed in the following section.

The water qualities of the major watercourses of Anak Bukit and Sg. Kedah at the upstream of the tidal barrage is estimated to be less than 7.2 mg/l of BOD in the dry season by the year 2,000 by providing the treatment facilities with effluent quality of 50 mg/l of BOD. However, if the treatment facilities are not provided, the water qualities of the same watercourses will be in a range of 20 to 35 mg/l of BOD in the year 2,000, further degrading from the present BOD values of 14 - 17 mg/l in dry season(Refer to Appendix L for detail).

5.2.2 Comparison of Alternative Treatment Methods

Three possible alternative treatment methods are studied in detail (Ref. Appendix E,"Alternative Sewarage System Considered"namely (1) stabilization pond process (2) aerated lagoon process, and (3) oxidation ditch process) to select the most appropriate treatment method in Study Area. The study includes the local conditions such as possibility of land acquisition, availability of skilled labours, and recurrent costs of the facilities. These alternative methods are described below.

(1) Stabilization Pond System

Treatment by stabilization pond by natural conditions involves the action of algae and bacteria under the influence of sunlight (photo-syntheses) and temperature. In order to facilitate easy repairs, maintenance and flexibility in operation, stabilization pond is provided with at least more than two ponds in parallel, depending upon the magnitude of the flow and the topography of the site, with considered facultative and maturation ponds arranged in series.

(2) Aerated Lagoon System.

Aerated Lagoon process consists of aerated lagoon and maturation pond. This is the activated sludge units operated without sludge returns. Aerators are used to supply the necessary oxygen and mixing power.

The effluent from aerated lagoon is to be treated further in a maturation pond which will achieve a high degree of bacteriological purification and suspended solid removal. Both the aerated lagoon and maturation pond are provided with at least two or more pond in parallel for easy repairs and maintenance and also flexibility in operation.

(3) Oxidation Ditch Process

Oxidation ditch is essentially a modification of the activated sludge process. This method of aerobic stabilization circulates wastewater in a closed circuit ditch aerated by mechanical aerators. After circulation in the ditch, the mixed liquor is led to the final sedimentation basin and solids are removed, then supernatant water is discharged to receiving water bodies after disinfection.

The excess sludge produced in final sedimentation basin should be withdrawn into drying beds. Oxidation ditch process consists of oxidation ditch, sedimentation basin, and drying beds.

In these three treatment systems mentioned above, the treated water is designed to flow by gravity into the receiving water body with the expected BOD removal of more than 75 percent if the systems are properly designed and efficiently operated.

To compare the alternatives, each type of treatment is designed for the flow rate of 5,000 ,10,000 , 30,000 and 50,000 cu m daily, then the cost accruing to alternatives, are estimated using cost functions developed. (Ref. Appendix G, "Method for Construction and Recurrent Cost Estimates")

Table 4.5 shows the results of comparison of cost.

The cost of each selected alternative is estimated in terms of total annual cost with respect to construction, land acquisition, operation and maintenance at 1979 price . taking into account of the life of the facilities provided.

The result of cost analysis indicates that the stabilization pond process will be the most suitable treatment and disposal system for the Study Area regardless to the scale of treatment facilities.

Table 4.5 Cost Comparison of Alternative Treatment/Disposal System by Annual Cost Basis

(M$1,000)

Alternative	Flow Rate (cu m/day)			
	5,000	10,000	30,000	50,000
Alt.I Stabilization Pond Process	454.34	668.19	2,336.94	3,613.08
Alt. II Aerated Lagoon Process	575.47	1,059.50	2,463.29	3,793.86
Alt. III Oxidation Ditch Process	862.61	1,639.69	4,456.12	7,485.44

Note: Refer to Appendix G for detail

CHAPTER 5. MASTER PLANNING

1. STUDIES CARRIED OUT IN THE MASTER PLAN

A sewerage master plan is developed in the Study Area of 3,300 ha for the target year 2000, on the basis of fundamental planning and design elements set out in the preceding chapters as for future land use, population forecast and its distribution, collection system and treatment and disposal system.

The sewerage master plan recommends for (1) sewerage zones and sub-zones (refer to Section 2), (2) population distributed into sewerage zones and sub-zones (refer to Section 3), (3) estimation of wastewater quantities and qualities with respect to proposed land uses (refer to Section 4), (4) establishment of design criteria (refer to Section 5), (5) materials and methods of construction (refer to Section 6), (6) proposed sewerage system and facilities (refer to Section 7), (7) basic for construction and recurrent cost estimates (refer to Section 8), (8) financial considerations including priority of sewerage zone areas, viable magnitude of capital invested for each stage and users' ability and willingness to pay (refer to Section 9), (9) project cost (refer to Section 10), (10) interim measures (refer to Section 11) and (11) benefits anticipated by implementation of the sewerage master plan (refer to Section 12).

The recommendations for some of the foregoing planning and design elements are supported by detailed studies for key items as shown in Appendices.

2. PROPOSED SEWERAGE ZONES AND SUB-ZONES

2.1 Proposed Sewerage Zones and Sub-zones

The physical characteristics of the Study Area are (1) populated urban areas are limited, (2) huge rural area still remain to be paddy field at present will be developed in the future, and (3) mostly the Area has flat ground surface.

If a comprehensive sewerage system is planned in a large flat ground surface as described above, large-sized deep trunk sewers are required to convey sewage from individual houses all the way to the treatment plant, causing high initial investment in addition to the difficulties in implementing construction programme particularly in the built-up areas.

Under the circumstances, it is considered practical, that the Study Area be properly divided into sewerage zones and sub-zones to be dealt with separately, rather than planning a area-wide system to cover the whole Study Area. The advantages of this independent system by sewerage zone basis would be:

(a) Design of sewer facilities can be possible according to the characteristics of each area.

(b) Implementation of construction plan will be flexible to adjust according to the degree of requirement and availability of financial resources in the future.

(c) Long distant conveyance of sewage can be averted to avoid inconvenience in construction and to enable better control of sulfide build-up later.

(d) The future development area will remain flexible for future modification.

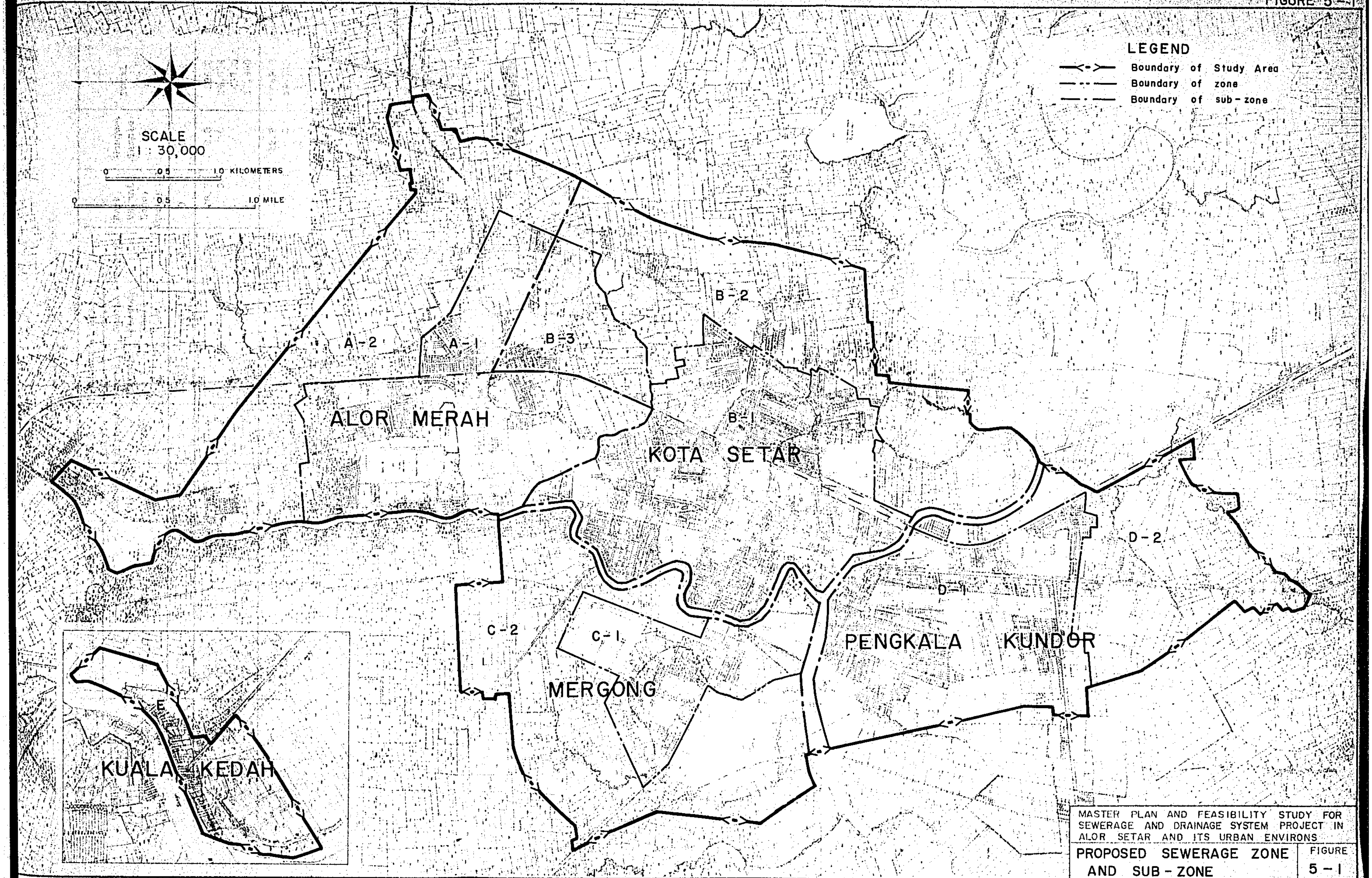
Table 5.1 Existing Population and Population Density by Sewerage Sub-Zone

Name of Sewerage Zone	Name of Sewerage Sub-Zone	Area (ha) *	Population (person)	Population Density (persons/ha)
A (Alor Melah)	A - 1	385	15,112	39.3
	A - 2	437	3,666	8.4
	Sub-Total	822	18,778	
B (Kota Setar)	B - 1	459	45,629	99.4
	B - 2	410	11,407	27.8
	B - 3	102	1,243	12.2
	Sub-Total	971	58,279	
C (Mergoug)	C - 1	187	7,827	41.9
	C - 2	427	2,897	6.8
	Sub-Total	614	10,724	
D (Peukala Kundor)	D - 1	388	35,025	90.3
	D - 2	270	7,689	28.5
	Sub-Total	658	42,714	
E (Kuala Kedah)	E	125	9,105	72.8
Total		3,190	139,600	43.8

Note: (1) * These areas do not include rivers and railway.

(2) Sub-zones 1 (such as A-1, B-1, C-1, D-1 and E) comprize urbanized/urbanizing areas, where sub-zones 2 future development areas. B-3 includes SEDC's housing development scheme area.

FIGURE 5-1



MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS

PROPOSED SEWERAGE ZONE AND SUB-ZONE

FIGURE 5-1

Table5.2 2000-year Population in Sewerage Zones and Sub-zones

Zones and Sub-zone / Land Use / Population Density (Persons/ha)(*)		Residential Area			Commer-cial Area	Insti-tutional Area	Industrial Area		School	Park, Vacant Land, OpenSpace	Mosque, Temple	Total
		A	B	C			North Mergong	South Mergong Kuala Kedah				
		120	70		200	0	100	0	0	0	0	
A (Alor Melah)	A-1	238.1		55.1		17.4			36.9	28.7	8.8	385.0
		28,572		1,102		0			0	0	0	29,674
	A-2	190.0	214.8	25.2					7.0			437.0
		22,800	15,036	144					0			37,980
B (Kota Setar)	B-1	251.9		3.4	116.0	14.6			34.5	25.7	12.9	459.0
		30,228		782	23,200	0			0	0	0	54,210
	B-2	92.9							8.1		1.0	102.0
		11,148							0		0	11,148
	B-3	242.7	152.2	1.2					5.7		8.2	410.0
		29,124	10,654	960					0		0	40,738
C (Mergon)	C-1	62.9		5.0			119.1					187.0
		7,548		2,000			11,910					21,458
	C-2	142.2	199.0				26.9	43.0	15.9			427.0
		17,064	13,930				2,690	0	0			33,684
D (Pengkala Kundor)	D-1	315.5		1.5	40.0				19.3	9.6	2.1	388.0
		37,860		660	8,000				0	0	0	46,520
	D-2	249.6							20.4			270.0
		29,952							0			29,952
E (Kuala Kedah)	E	77.8			18.0			18.0	11.2			125.0
		9,336			3,600			0	0			12,936
Total		1,836.6	566.0	91.4	174.0	32.0	146.0	61.0	159.0	64.0	33.0	3,190.0
		223,632	39,620	5,648	34,800	0	14,600	0	0	0	0	318,300

Note: (1) 2000-year population for Sewerage Sub-zone A-1 in Residential Area A is calculated as 28,572 by multiplying 120 and 238.1.

(2) Figures of upper row in each sewerage sub-zone are component areas of land use.

(3)* Refer to Section 1.4.2 and Table 4.3 in Chapter 4.

Table 5.3 Population in Sewerage Zones and Sub-zones for Future Key Years

(Persons)

Sewerage Zone	Sewerage Sub-Zone	1979 (base year)	1980	1985	1900	1995	2000 (target year)
A (Alor Melah)	A-1	15,112	15,805	19,272	22,739	26,206	29,674
	A-2	3,666	4,142	5,520	8,072	11,926	37,980
	Sub-total	18,778	19,947	24,792	30,811	38,132	67,654
B (Kota Setar)	B-1	45,629	46,038	48,081	50,124	52,167	54,210
	B-2	11,407	12,899	17,193	25,140	37,146	40,738
	B-3	1,243	1,277	6,500	8,049	9,599	11,148
	Sub-total	58,279	70,214	71,774	83,313	98,912	106,096
C (Mergon)	C-1	7,827	8,476	11,721	14,967	18,212	21,458
	C-2	2,897	2,975	8,400	16,828	25,256	33,684
	Sub-total	10,724	11,451	20,121	31,795	43,468	55,142
D (Pengkala Kundor)	D-1	35,025	35,572	38,309	41,046	43,783	46,520
	D-2	7,689	8,705	11,603	16,966	25,068	29,952
	Sub-total	42,714	44,277	49,912	58,012	68,851	76,472
E (Kuala Kedah)	E	9,105	9,311	10,101	11,069	12,237	12,936
	Sub-total	9,105	9,311	10,101	11,069	12,237	12,936
Total		139,600	145,200	176,700	215,000	261,600	318,300

Note: (1) Population in sub-zones A-1, B-1, C-1 and D-1 between 1979 and 2000 are calculated in proportion to years increased.

(2) The 1979 population for future key years is considered to increase at an annual rate of 2.7% till 1985 with additional 5,000 population for both B-3 and C-2 sub-zones in 1985, reflecting development schemes for these area. Then population between 1985 and 2000 in the same sub-zones are calculated in proportion to years increased between the two.

(3) The remaining population (subtracting the population in (1) and (2) from the total populations) for future key years are distributed in sub-zones A-2, B-2, D-2 and E by reflecting the present population rates of these areas.

2.2 Present Situation of Sewerage Zones and Sub-zones

(1) Alor Melah Sewerage Zone (Zone A)

This sewerage zone lies extreme north of the Study Area with a total area of 822 ha exclusive of rivers and railway, surrounded by the Sg. Anak Bukit in the west, by Sg. Bakar Bata and Jl. Sultanah the south, and by the bypass roads in the east and north.

Topography of this zone is almost flat with a very gentle declivity from south to north and from east to west with ground elevations ranging from 2.7 m (9 ft.) to 1.8 m(6 ft.) above MSWL.

Further, Jl. Bakar Bata, which is a national road, runs west part of this zone from north to south, similary the railway runs central part from north to south.

Sullage water generated in this zone pours into either Sg. Alor Melah or Sg. Bakar Bata, and then finally into Sg. Anak Bukit.

This sewerage zone is divided into two sub-zones, namely A-1 and A-2. The former comprizes mainly urbanized and/or urbanizing area and the latter mainly future development area.

(a) Sub-zone A-1

This sub-zone consists of 385 ha with a resident population of over 15,000 at the time.

The newly built housing areas, such as Taman Golf and Taman Uda, together with kampung area along the Sg. Alor Melah exist in this sub-zone in addition to public utilities such as Kedah Club, Horse Race Course, Park, General Hospital, Prison and Schools.

(b) Sub-zone A-2

This sub-zone covers 437 ha with a resident population of approximately 3,700 at present. Most of the population concentrates along the Jl. Baker Bata and the remaining scatters to the area still remains to be paddy field. The Sultan's place is also situated on the Jl. Baker Bata of this sub-zone.

(2) Kota Setar Sewerage Zone (or Zone B)

This sewerage zone lies in the central part of Alor Setar area with a total area of 971 ha exclusive of rivers and railway, surrounded by the Sg. Anak Bukit in the west, and by Sg. Kedah in the South, also by future bypass road (or Jl. Lenchong Timor) in the east and finally by both Sg. Bakar Bata and Jl. Sultan in the north.

The sewerage zone is extremely flat ranging from 4 feet (1.2 m) to 6 feet (1.8 m) above MSWL, with a few fragmentary areas along Jls. Sultanah and Langer and along Sg. Anak Bukit, which lie approximately from one to two feet higher than the rest of the area.

Several waterways run through either from east to west, or from south to north. The Sg. Derga is the former case and Sgs. Raja, Tanjong Bendahara and Alor Gedok the latter case. Some low laying areas are subject to frequent flooding caused by unimproved main watercourses receiving the flows charged from the upstream watercourses.

As in the case of the Alor Melah Sewerage Zone, the Kota Seta Sewerage Zone is divided into sub-zones B-1 and B-2, the former comprising mainly urbanized and/or urbanizing area, the latter future development area. In addition, the triangular northeastern part of this sewerage zone surrounded by railway, Sq.Alor Malai and Jl. Jirat China, is identified as B-3, wherein a large scale housing development.

scheme by SEDC has been undertaken and is separated from other sub-zones, since a comprehensive sewerage plan in the area is being developed by the agency.

(a) Sub-zone B-1

This sewerage sub-zone consists of 459 ha with a resident population of over 46,000 at present. This sub-zone has been almost urbanized compared to any other areas in AlorSetar area with the highest population density of approximately 100 persons per ha.

Most of the government offices for the State government together with the Municipal Council of Kota Setar are located in this sub-zone along with a largest portion of commercial area in Alor Setar.

The low lying region along the Sg. Raja, especially the upstream area which is one of the highest density areas, is subject to frequent flooding.

(b) Sub-zone B-2

This sub-zone covers 410 ha with a current population of 11,000. This sub-zone lies in broad terms, in the east from Jl. Langger extending to the northeastwards from the Sg. Kedah.

Urbanization in the ribbon has been in progress along Jls. Langger, Derga and Bendahara, while a kampung zone has been formed along the Sg. Tanjong Bendahars. The remaining area, except for several localized newly developed areas, is still paddy field.

It is considered that urbanization can be accelerated implementing bypass road plan running through a part of the paddy field area which is conveniently situated adjacent to central portion of Alor Setar.

(c) Sub-zone B-3

This sub-zone is encircled by railway, Jl. Sultan, Jl. Langgar and Sg. Alor Malai with a total area of 102 ha, 34 ha of which has been reserved for a large scale housing area by SEDC.

In the north western portion of this sub-zone with a present resident population of 1,243, both Taman Syed Mohamad and Sultanah Bahiyah Schools exist. The remaining area, except the occupancy by several buildings such as MADA is either paddy field or untilled land.

The SEDC's sewerage plan covering the 34 ha has provided 5.2 acres (or 2.1 ha) for the sewage treatment facility at the southwestern corner of this sub-zone.

(3) Mergong Sewerage Zone (or Zone C)

This sewerage zone lies in the north of the Sg. Kedah and west of the Sg. Anak Bukit, comprizing 615 ha demarcated by the Sg. Kedah in the south, similarly by the Sg. Anak Bukit, Western Bypass (or Jl. Lencong Barat) and proposed road (to be connected to Jl. Sultanah) in the east, west and north respectively. This sewerage zone is also flat ranging from 1.5 metres (5 ft.) to 1.8 metres (6 ft.)

The Sg. Gunong Sali runs the western part of this zone towards south, and similarly Sg. Terus runs the central part of this zone towards south, both of which finally pour into the Sg. Kedah.

The northern part of Jl. Seberang Putera, which runs eastwestwards at one-third portion of the zone from the Sg. Kedah, is the North Mergong Industrial Area.

The South Mergong Industrial Area with a total area of 43 ha bounded by the Sg. Kedah (in the south), Jl. Lencong Barat (in the east) and the high tension line (in the west and north) has been developed by SEDC as a large scale industrial estate.

Low cost houses are scheduled to be built by the Federal Government in the extreme northan portion of this zone from the MADA irrigation canal running from northwest to southeast, but their construction schedule is not available yet.

Considering the above urbanizing situation of this zone, this sewerage zone is divided into two sub-zones, C-1 and C-2, the former covering mainly of urbanized and/or urbanizing area and the latter mainly future development area inclusive the South Mergong Industrial Area.

(a) Sub-zone C-1

This sub-zone covers the North Mergon Industrial Area, and urbanized area lying in the east of the Sg. Terus and south of Jl. Seberang Putera. The total area of this sub-zone is 187 ha with a present resident total population of 7,800.

Most of the factories in the North Mergon Industrial Area are either cottage industry (or home industry) or car dealer's shop,and therefore the industrial wastewater discharged is not significant. However, the grease and oil wastes generated from car repairing shops are causing pollution by the indiscriminate discharge into nearly road side ditches.

The southern side of Jl. Seberang Putera, except for the ribbon area along the road, is residential area.

In the central portion of the North Mergon Industrial Area, a block of flats for employees in the industrial area has already been existance with complete sewerage system including a stabilization ponds.

(b) Sub-zone C-2

This sub-zone lies in the peripheral area of Sub-zone C-1 comprising 427 ha with a total population of 2,900.

Most of the area is still paddy field except for the South Mergon Industrial Area and the low cost housing area as described previously.

(4) Pengkala Kundor Sewerage Zone (or Zone D)

This sewerage zone is located in the northern part of Alor Setar, demarcated by the Sg. Kedah (in the north), the Western bypass (in the west) and the Sg. Alor Bangsa (in the south and east), comprizing 660 ha with a total present population of a little less than 43,000.

Same as in the case of other sewerage zones, this sewerage zone is almost flat with ground elevations ranging from 5 feet (1.5 m) to 7 feet (2.1 m) above MSWL. However, the area inclines very gently from south to north.

Jl. Sungai Korok (a federal road) runs through the middle of the zone from south to north.

The urbanized and/or urbanizing area along Jl. Sungai Korok and the Sg.Kedah are one of the oldest blocks in Alor Setar. The remaining area is also urbanizing in a very fast tempo.

The sullage water generated in this sewerage zone finally flows into the Sg. Kedah either through the Sg. Korok, Sg. Alor Bangsa or roadside ditches.

This sewerage zone is divided into two sub-zones, D-1 and D-2, the former comprizing mainly of urbanized and/or urbanizing area and the latter future development area.

(a) Sub-zone D-1

The sub-zone consists of urbanized and/or urbanizing area mixed with old and new housing blocks comprizing 388 ha with a population of 35,000. Some housing development schemes have been undertaken in this sub-zone.

Although population was concentrated along Jls. Seberan Perak and Sungei Korok in the past, it is foreseen that population distribution would be levelled out like sub-zone B-1 in the very near future.

(b) Sub-zone D-2

This sub-zone covers 270 ha with a current population of 7,700.

Most of this sub-zone area remains to be paddy field yet except an eastern part of the railway and a part of the area along Jl. Sungai Korok.

(5) Kuala Kedah Sewerage Zone (or Zone E)

This sewerage zone is located at about 8 km (or 5 miles) west of Alor Setar town centre lying at the mouth of the Sg.Kedah. The zone extends approximately 2 km along the Sg.Kedah with average width of 0.7 km; covering 125 ha with a population of 9,000.

This area has been developed as a town of fishing port.

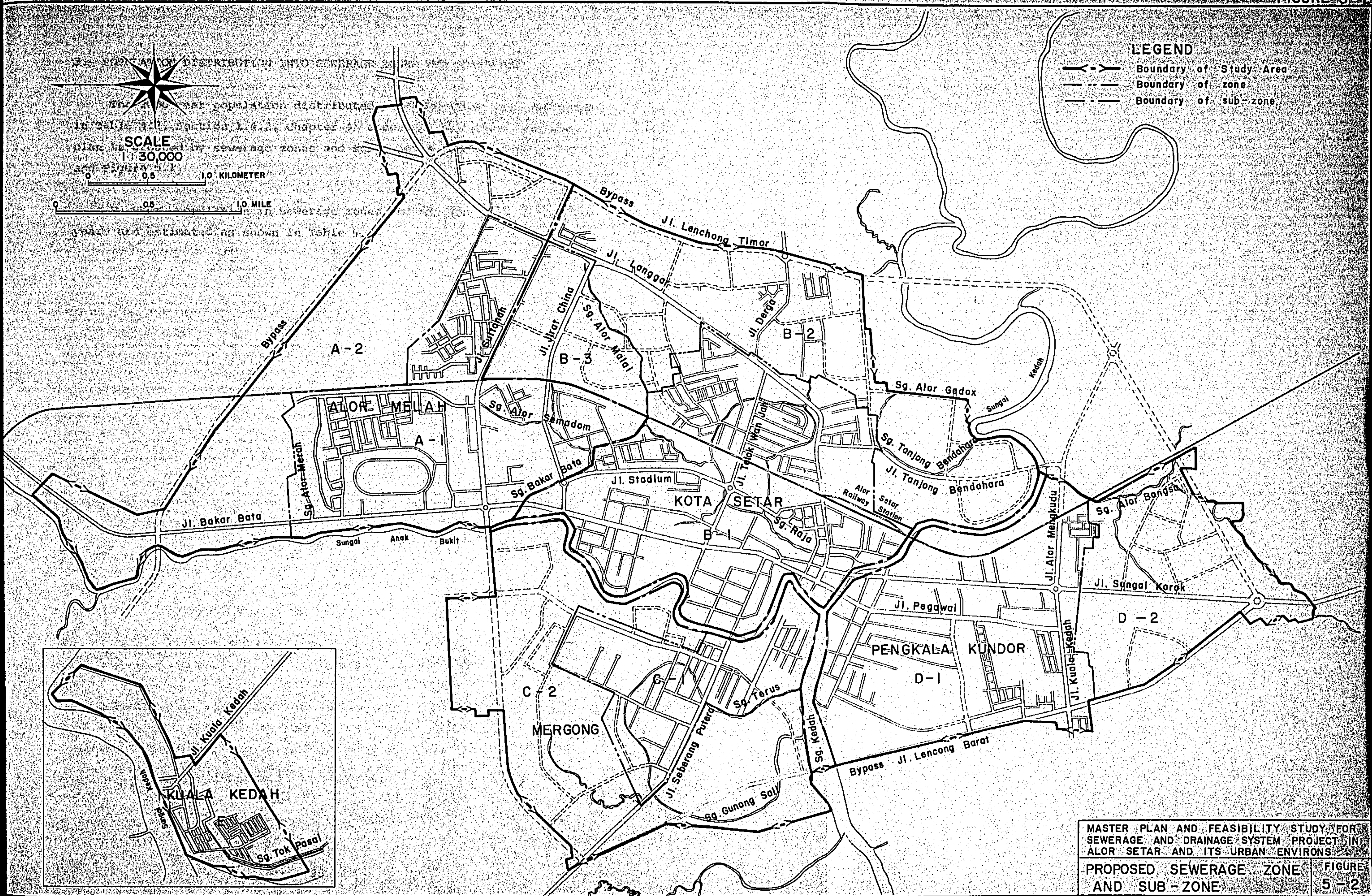
Most recently, town remodelling programme has been in progress in this area according to TCP's proposed plan and also an regional development has been undertaken as a large scale marine product industry complex outlined by SEDC.

The sewerage zone is almost flat ranging from 6 feet (1.8 m) to 7 feet (2.1 m) with several spotted depressions. The MADA paddy field in the background lies from 3 to 4 feet level.

The remodelled town area as well as new housing development areas is provided with either communal septic tank or individual septic tank, whereas the old kampung area is provided with either pit privy or river latrine.

The sullage water generated in this zone pours into Sg. Kedah directly or through Sg. Alor Tok Pasai.

Sub-zone is not established in this zone because this zone covers very small area (125 ha) and most of the area is considered to be urbanized in the immediate future.



MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS

PROPOSED SEWERAGE ZONE AND SUB-ZONE

FIGURE 5-2

3. POPULATION DISTRIBUTION INTO SEWERAGE ZONES AND SUB-ZONES

The 2000-year population distributed into the Study Area (as shown in Table 4.3, Section 1.4.2, Chapter 4) according to future land use plan is grouped by sewerage zones and sub-zones as shown in Table 5.2 and Figure 5.1.

Further, population in sewerage zones and sub-zones for future key years are estimated as shown in Table 5.3.

4. WASTEWATER QUANTITIES AND QUALITIES

Wastewater quantity for the future years up to 2000 differs according to the water usage and categories of land use.

Data of water consumption, which will be used as a basis of estimates for wastewater quantity, are collected from the JKR's meter reading records for the past one year for typical residential, commercial, institutional and industrial areas inclusive of schools, general hospital and prison.

Future wastewater quantity for each of the areas categorized in future land use is estimated taking into account of various available studies in sewerage plans undertaken in Malaysia and other Asian countries, as resulted in Table D-3 in Appendix D.

Wastewater qualities for the future years up to 2000 are also forecasted according to categories of land use on the basis of the outcome of water quality analysis carried outat selected typical areas including residential, commercial, institutional and industrial. Reference is also made for the estimated future wastewater qualities in various previous sewerage studies in Malaysia and other Asian countries as resulted in Table D-3 in Appendix D.

4.1 Domestic Wastewater

Three typical residential areas are selected as shown in Table D-1, Figure D-1 in Appendix D and per capita water consumption rates are calculated for the past one year.
Average per capital water consumption rate for 1979 is estimated to be 170 litres per day. No significant difference in water consumption rate is acknowledged according to types of house.

Taking into account of increasing trend of water consumption everywhere in urban area, the 2000-year flow rate is reasonably estimated at 230 l/cap/day (refer to Appendix D, Wastewater Quantities and Qualities).

According to the wastewater quality analysis sampled from several typical blocks in residential area, wastewater concentration in terms of BOD as well as SS is resulted in 202 mg/l, which is equivalent to 34.4 g/cap/day of BOD (and SS) generation with per capita water consumption rate of 170 litres per day. It is reasonable to assume that the 2000-year wastewater concentration will be 200 mg/l because per capita water consumption rate as well as per capita BOD (and SS) generation could increase in the almost same ratio as estimated in Table 5.4-1.

Table 5.4-1 Domestic Wastewater Quantity and Quality Estimated for the Years 1979 and 2000

Wastewater Quantity		Wastewater Quality (both for BOD/SS)
1979 (l/cap/day)	2000 (l/cap/day)	1979 - 2000 (mg/l)
170	230	200

Note: Refer to Appendix B for detail

4.2 Commercial Wastewater

Water consumption data are collected for 59 units of various kinds of business as shown in Table D-4 and Figure D-1 in Appendix D in two typical blocks in the commercial area
for the past one year, including eating shops, restaurants, electrical appliance shops, cloth shops, book stores, etc. The buildings are ranging from two to four stories and some of them are used jointly for business and dwelling.

Present average per capita wastewater generation rate in commercial area is thus estimated at 340 litre per day. The 2000-year per capita wastewater generation rate is assumed to be 460 litre per day in the same manner done in residential wastewater in Section 4.1 above.

Wastewater concentration in commercial area is assumed to be 200 mg/l from 1979 to 2000.

Table 5.4-2 Commercial Wastewater Quantity and Quality
Estimated for the Year 1979 and 2000

Wastewater Quantity		Wastewater Quality (both for BOD/SS)
1979 (l/cap/day)	2000 (l/cap/day)	1979 - 2000 (mg/l)
340	460	200

Note: (1) Refer to Appendix F for detail.

(2) Both BOD and SS generations for 1979 and 2000 are assumed to be 72 and 92 (g/cap/day) respectively.

4.3 Institutional Wastewater

There are various government buildings near MPKS office because Alor Setar is the seat of State government in Kedah. In the government buildings, no resident is assumed as shown in Table 4.3 (Section 1.4.2, Chapter 4). However, daytime population is considered in the plan with an average of 23 litres of water consumed per head per day based on the past one year metre reading record for several selected government buildings (refer to Table D-5, and Figure D-1 in Appendix D). The water consumption rate in institutional buildings is considered invariable up to year 2000. The wastewater concentration in institutional area is reasonably assumed to be 200 mg/l from 1979 to 2000.

Table 5.4-3 Institutional Wastewater Quantity and Quality
Estimated up to Year 2000

Wastewater Quantity	Wastewater Quality (both for BOD/SS)
1979 - 2000 (l/cap/day)	1979 - 2000 (mg/l)
23	200

Note: Both BOD and SS generations from 1979 and 2000 are estimated to be 4.6 g/cap/day.

4.4 Industrial Wastewater

Amount of industrial waste generated in the three industrial areas, namely North Mergong, South Mergong and Kuala Kedah, is estimated independently due to different characteristics of wastewater. However, wastes generated from small scale (home-scale) factories scattered in the residential and commercial areas are not considered conspicuous, and could be averaged out with the residential and commercial wastewater in these areas.

4.4.1 North Mergong Industrial Area

Sixteen typical factories as shown in Table D-1 and Figure D-1, Appendix D, are selected for on-the-spot survey to gauge effluent amount and to analyze wastewater sampled. The factories are adequately selected representing categories in industrial classification including such industries as foodstuffs, rubber and plastic, metal, electrical, automobile repair and overhauling and the others.

Average wastewater generation from unit of gross area (ha) is estimated at 19.2 m^3 per day, assuming to be invariable during the study period up to 2000.

Wastewater strength originated here is assumed to be 58 mg/l for BOD, and 94 mg/l for SS till 2000, based on the various available data obtained in Malaysia and Japan.

Table 5.4-4 North Mergong Industrial Wastewater Quantity and Quality Estimated up to Year 2000

Wastewater Quantity	Wastewater Quantity	
	BOD	SS
1979 - 2000 (m^3/ha/day)	1979 - 2000 (mg/l)	1979 - 2000 (mg/l)
19.2	60	100

4.4.2 South Mergong Industrial Area

Out of gross South Mergong Industrial Area of 43 ha, net 36.24 ha is planned to be occupied by industries, of which 21.24 ha has already been allocated for four big scale industries manufacturing automobile tires, toilet papers and shielding materials, and processing animals as shown in Table D-9 in Appendix D. The remaining 15 ha is assumed to be occupied by the same kinds of industries categorized in the North Mergong Industrial Area. Therefore, wastewater generation from gross unit of area (ha) is estimated at 33.9 m^3 per day up to the year 2000.

Average wastewater concentration generated in the South Mergong Industrial Area is estimated at 279 mg/l for BOD and 266 mg/l for SS, up to the year 2000, taking weighted average considering wastewater amount and waste loads from the industries concerned. The waste load or wastewater concentration generated from unit of area for each relevant industry is assumed adequately adjusting the data obtained in Japan and western countries.

Table 5.4-5 South Mergong Industrial Wastewater Quality and Quantity Estimated up to Year 2000

Wastewater Quantity	Wastewater Quality	
	BOD	SS
1979 - 2000 (m^3/ha*/day)	1979 - 2000 (mg/l)	1979 - 2000 (mg/l)
33.9	280	270

Note: Refer to Table D-11 in Appendix for detail

4.4.3 Kuala Kedah Industrial Area

Data are collected as to the amount of wastewater generated by three fish processing and freezing industries in operation, which is 111.4 m^3 per ha per day as detailed in Table D-12 in Appendix D. This figure is applied over gross Kuala Kedah Industrial Area of 18 ha with 24 factories specialized in either fish processing or freezing industry in the future.

Wastewater strength of the raw wastewaters discharged from the three existing factories are separately measured as to BOD and SS, resulting in 2,000 mg/l and 500 mg/l respectively.

Table 5.4-6 Kuala Kedah Industrial Wastewater Quantity and Quality Estimated up to Year 2000

Wastewater Quantity	Wastewater Quality	
	BOD	SS
1979 - 2000 (m^3/ha*/day)	1979 - 2000 (mg/l)	1979 - 2000 (mg/l)
111.4	2,000	500

4.5 Wastewater from Schools

Same as in the case of institutional area, resident population in schools is considered negligible from planning purpose as shown in Table 4.3 (Section 1.4.2, Chapter 4). However, daytime population (inclusive students, teachers, etc) is estimated to contribute five percent of sewage amount generated per person in residential area, based on the JKR's recent one year water meter reading record for the selected four schools of various sizes as discussed in Appendix D in detail. Total population according to schools for both 1979 and 2000 conditions are estimated in Table D-15 in Appendix D.

Wastewater concentration generated in schools is reasonably assumed to be 200 mg/l for BOD and SS, equal to that of residential area up to year 2000.

Table 5.4-7 Estimated Wastewater Quantities and Qualities from Schools for the Year 1979 and 2000

Wastewater Quantity		Wastewater Quality (both for BOD/SS)
1979 (l/cap/day)	2000 (l/cap/day)	1979 - 2000 (mg/l)
8.5	11.5	200

Note: Both BOD and SS generations for 1979 and 2000 are estimated to be 1.7 and 2.3 g/cap/day respectively.

4.6 Wastewater from General Hospital and Prison

Although the general hospital and the prison lie in residential area, these two places are treated independently because of their large areas.

People in the general hospital and the prison is not treated as resident population in Table 4.3 (Section 1.4.2, Chapter 4), but people in these places are counted for sewerage system planning purpose.

Average water consumption rates in these two places are 316 and 110 m^3/day respectively based on the past one year record. The sewage amount from the general hospital will be increased by 1.5 times by the year 2000 assuming the population in the influential area of the general hospital is expected to increase in the same rate, while the sewage amount from the present prison will not be increased up to year 2000 because the accommodation for criminals is fully occupied and no expansion of facility is expected in the future.

Wastewater concentrations from the two places are assumed to be 200 mg/l, invariable up to year 2000.

Table 5.4-8 Estimated Wastewater Qualities and Quantities from General Hospital and Prison up to Year 2000

Wastewater Quantity		Wastewater Quality (both for BOD/SS)	
General Hospital	Prison	General Hospital	Prison
1979 - 2000 (m^3/day)	1979 - 2000 (m^3/day)	1979 - 2000 (mg/l)	1979 - 2000 (mg/l)
316	110	200	200

4.7 Extraneous Water

Since no sewerage system is available within or near the Study Area for reasonable estimation of the extraneous water allowance into sewers, the values set out in the Butterworth/Bukit Mertajam Metropolitan sewerage study by an extensive field survey in a selected existing sewerage system in the Metropolitan area is applied in this Study considering the similarity of physical characteristics of the two. The extraneous water allowances applied in this study are shown in Table 5.4-9.

Table 5.4-9 Design Extraneous Water Allowances

Type of Area	Allowance	
	(m^3/ha/day)	(m^3/m of pipe length/day)
Residential	6.3	0.045
Commercial	4.5	0.045
Industrial	4.5	0.045

Note: Referred to extroneour water allowance values applied in the Butterworth/Bukit Mertajam Metropolitan sewerage study as discussed in Section 6, Appendix D.

4.8 Estimated Wastewater Quantities and Qualities by Zones for 2000

Table 5.4.10 provides estimated wastewater quantities (volume) generated from sewerage zones and sub-zones in terms of daily average flow basis for the year 2000. Further the same table indicates estimated wastewater qualities (strength) as to both BOD and SS for the year 2000. These quantities and qualities are utilized for preliminary designing of treatment facilities.

Table 5.4-10 Estimated Wastewater Quantities and Qualities Generated for Sewerage Sub-zones in the Year 2000

Sewerage Zone	Sewerage Sub-zone	Area (ha)	Population (Person)	Daily Average Flow* (m^3/day)	BOD Concentration *(mg/l)	SS Concentration *(mg/l)
A (Alor Melah)	A - 1	385	29,674	10,018	152	152
	A - 2	437	37,980	11,549	152	152
	Sub-total	822	67,654	21,567	152	152
B (Kota Setar)	B - 1	459	54,210	21,094	175	175
	B - 2	410	40,738	12,065	157	157
	B - 3	102	11,148	3,234	160	160
	Sub-total	971	106.096	36,393	168	168
C (Mergoug)	C - 1	187	21,458	5,447	105	120
	C - 2	427	33,684	11,738	160	160
	Sub-total	615	55,142	17,185	144	147
D (Penkala Kundor)	D - 1	388	46,520	15,026	168	168
	D - 2	270	29,952	8,699	161	161
	Su-total	658	76,472	23,725	166	166
E (Kuala Kedah)	E	125	12,936	6,144	633	253
Total		3,190	318,300	105,014	-	-

Note: * Refer to Tables D-16 and D-17 in Appendix D for detail.

5. DESIGN CRITERIA

This section summalizes the design criteria necessary both for master planning and preliminary design stages for sanitary sewers, manholes, pumping stations and treatment and disposal system.

5.1 Sewers

5.1.1 Flow Friction Formula

The Manning's equation shall be adopted for sewers and conduits in the form:

$$V = \frac{1}{n} R^{2/3} S^{1/2}$$

where

V = velocity of flow, in m/sec.

n = coefficient of roughness, 0.013 for new sewers and 0.015 for existing sewers

R = hydraulic radius, in m

S = slope

5.1.2 Sewer Materials

Among the pipe materials available on the local market, the following pipes have been selected for the sewerage system:

- VCP for sizes up to 300 mm in dia.
- RCP for sizes 375 mm in dia. and more.
- ACP for pressure pipes up to 600 mm in dia.
- Steel pipe for pressure pipe of 700 mm and more.

5.1.3 Peak Flow Rate

The ratio of the peak flow rate to the average for the day is given in the following formula:

$$M = \frac{5}{P^{1/7}}$$

where

M = ratio of peak flow to average flow

P = design population, in thousand

Then the design sewage flow rate for sewer design is expressed in the form:

$$Q = P' \times q \times M$$

where

Q = design flow rate, m^3/day

P = population served, persons

q = daily average flow rate, m^3/day, cap

5.1.4 Velocity of Flow

All sewers shall be designed to maintain a mean flow velocity, when flowing full or half full, of not less than 0.6 m/sec (2 ft/sec) for VCP, based on the Manning's equation using an 'n' value of 0.013. However, for centrifugally cast reinforced concrete pipe or any other cement-bonded pipe materials, a minimum design flow velocity of 0.75 m/sec (2.5 ft/sec) shall be applied using the 'n' value of 0.013.

Velocity shall not exceed 3.0 m/sec (10 ft/sec) in any type of sewer, to protect sewer erosion. Where the ground surface slope is steep and velocity of more than 3.0 m/sec will result, special consideration shall be given on the protection of pipes against erosion and shock.

5.1.5 Sulfide Corrosion

All sewers shall be so designed and constructed that mean velocities of flow will not be less than 0.6 m/sec for VCP and 0.75 m/sec for RCP and cement-bonded pipes to protect from sulfide corrosion.

5.1.6 Design Depth of Flow

All circular pipes shall be designed on the basis of 100 per cent full capacity for the peak flow rate.

5.1.7 Minimum Size of Sewer

No sewer shall be less than 150 mm (6 in.) in dia. For public sanitary sewers, a minimum size of 225 mm (9 in.) in dia. is recommended to facilitate good maintenance.

5.1.8 Manhole

For the preliminary engineering design (feasibility study) purpose, the following maximum manhole spacings are proposed:

Pipe diameter	Maximum spacing
600 mm (24 in.) or less	100 m (328 ft)
675 mm (27 in.) or more	150 m (492 ft)

The spacings mentioned above are recommended on the basis of the field investigations and evaluation of the types of sewer cleaning equipment such as rod type widely in use in the sewerage system in Georgetown of Penang. The rod type cleaning equipment, which normally has a cleaning performance up to 150 m of pipe leangth per day, will be used as a major cleaning device for the new sewerage system, instead of highly mechanized equipment such as hydraulic sand ejectors. This is because the rods are generally far lower in cost and easy to handle as compared with the mechanized equipment.

Except for very shallow depth of sewers, all manholes are planned to have adequate dimensions for entry and for operation of the cleaning rods. The minimum diameters of manholes shall be as follows:

Pipe diameter	Minimum manhole diameter
Less than 900 mm	1,200 mm (47 in.)
900 - 1,200 mm	1,500 mm (59 in.)
More than 1,200 mm	1,800 mm (71 in.)

Watertight manhole covers of either cast iron or concrete shall be used wherever the manhole tops is subject to flooding by street runoff or high water. Manholes of brick or segmented block shall be waterproofed on the exterior wall with plaster coatings where necessary. Manhole steps shall be a sulfide corrosion resistant material such as cast iron or equivalent provided at 30 cm intervals and embedded to reach the dome wall.

5.1.9 Depth

The external crown of public sewers shall be at least one metre (3.3 ft) below the ground surface, with an exception for specific situations that prove shallower depths are preferable. Main and submain sewers shall be sufficiently deep so as to receive sewage from branch and lateral sewers.

5.2 Pumping Station

For the provision of pumping stations, basic considerations on location, layout, type of equipment and structure are given. Following are the major elements to be considered for the proper design of pumping station.

5.2.1 Design Flow

The design of pumping station shall be based on the peak flow of the sewage, unless lower rate of flow for design is justified. All pipes and conduits shall also be designed to carry the expected peak flow plus some allowance for abnormal flow increase.

Appropriate storage capacity shall be provided in wells, where automatic controls and variable speed drives are not furnished to match pumping rates exactly with inflow rates.

5.2.2 Type and Structure

In view of the local availability of circular caisson for small structures, it is recommended that the circular type be used for small capacity stations and rectangular type for large capacity stations.

5.2.3 Grit Removal Units and Screening Devices

For sanitary sewage pumping stations, no grit removal units are recommended. Coarse bar screens (100 mm clearance between the screen bars) manually cleaned shall be provided prior to the pump well, to prevent large objects from entering into the wet well.

5.2.4 Ventilation and Prevention of Odour and Noise

Pumping stations shall be enclosed in a concrete structure to prevent the diffusion of odour and noise to the nearby residences. However, a suitable ventilation shall be provided for all stations to ventilate the screening room or any other portion requiring maintenance or inspection.

5.2.5 Pumps

Pump capacity shall be increased according to the stages of implementation of the system, although the structure shall be designed for the year 2000.

In the preliminary engineering design, initial capacity of pumps shall be adequate to meet the condition of the year 1990 so that excessive pre-investment can be avoided. At least two pumps shall be provided initially, then additional pumps shall be installed at latter stages according to the increase of flow.

For the selection of type of pumps, care is given on alternative types including screw, centrifugal and submersible pumps. In view of the present conditions of the area and also easiness in installation and operation and maintenance, submersible non-clogging pumps are recommended.

5.2.6 Pump Drives

In selecting a type of pump drives, careful considerations are given on the frequency of electrical power suspension and its duration as well as on cost comparison between electric motor and engine. The experience indicates that generally the use of electricity is more economical and dependable than engine or other source of power. Further, electricity has been used for years in Malaysia without much trouble, therefore, it is recommended that pump drives in all pumping stations be of electric motor.

5.3 Treatment and Sludge Disposal System

Recommended Design criteria for the three treatment process, namely for stabilization pond, aerated lagoon and oxidation ditch, are shown in Tables 5.5 5.6 and 5.7 respectively, based on the various data obtained in Malaysia and other countries.

Table 5.5 Design Basis for Stabilization Pond

Item	Design Loading
1. Sedimentation Cell	
Detention Time	3 hr (max.)
Depth	3 m (max.)
2. Facultative Pond	
Surface BOD Loading	300 kg/day.ha (268 lb/day acre)
Depth	1.5 m (5 ft)
3. Maturation Pond	
Detention Time	3 days
Depth	1.5 m
4. Expected Effluent Quality	
BOD	50 mg/l (max.)
Coliforms	1,000 N/ml

Table 5.6 Design Basis for Aerated Lagoon

Item	Design Loading
1. Sedimentation Cell	
Detention Time	3 hr (max.)
Depth	3 m (max.)
2. Aerated Lagoon	
Surface BOD loading	1,500kg/day.ha (1,326 lb/day.acre)
Depth	3 m (10 ft)
3. Maturation Pond	
Detention Time	5 days
Depth	1.5 m (5 ft)
4. Expected Effluent Quality	
BOD_5	50 mg/l (max.)
Coliforms	1,000 N/ml

Table 5.7 Design Basis for Oxidation Ditch

Item	Design Loading
1. Oxidation Ditch	
Volumetric BOD loading	0.4 kg/m^2
Depth	1.5 m (5 ft)
2. Sedimentation Basin	
Detention Time	2 hr.
3. Area of Drying Beds	0.10 $m^2/m^3/day$
4. Expected Effluent Quality	
BOD_5	50 mg/l (max.)
Coliforms	1,000 N/ml

6. MATERIALS AND METHODS OF CONSTRUCTION

6.1 Construction Materials

6.1.1 Structural Materials

Presently most construction materials for the sewerage programme are available at Malaysia except equipment required for pumping stations and treatment facilities such as pumps, piping, electric and control facilities, gates, aerators, flow metres, etc.

Sand and gravel suitable for concrete aggregate are available in adequate quantities in Kedah State. Portland cement is also manufactured in Kedah State, conforming with internationally acceptable standards, suitable for sewerage construction, such as pressure and non-pressure concrete pipes, and civil and building works for pumping stations and treatment facilities.

Since most of the sewerage structures are subject to sulfide attack, high-quality sulphate-resisting Portland cement specified as Type II, by ASTM, is recommended for below-ground structural work. The actual specification of concrete mixes and strengths is a matter to be decided during final design; however, in view of the importance of preventing not only structural failure but ground-water infiltration, all concrete for sewerage should be dense and properly cured to obtain the full advantage of quality control.

6.1.2 Pipe Materials

Pipes currently available in Malaysia are limited both in sizes and materials. Vitrified clay pipe is available with limited pipe sizes and the quality is totally suitable for sewerage use. Asbestos-cement pipe and PVC pipe conforming to internationally accepted standards are manufactured in Malaysia, but sizes are limited.

For the selection of sewer materials, careful consideration is given to the problems of corrosion by sulfide buildup in sewers. Because of the high temperatures and expected relatively high BOD of the wastes, the sulfide problem can be expected to be serious. Preference was therefore given to use of corrosion resistant materials, such as vitrified clay pipe, in order that the sewers to be installed will indeed have a useful life for many decades, as desired. Therefore, a study was made selecting the most economical kind of pipe for different materials and pipe sizes considering sulfide attach to sewer as discussed in Appendix I.

In view of the above study results and on the assumption that these pipe materials will become available during the period of the project implementation, the use of the following pipe materials for sewerage construction is proposed:

(a) Sanitary sewers of 300 mm in diametre or less should generally be of vitrified clay pipes or PVC pipes.

(b) Sanitary sewers from 375 mm and more in diametre should generally be of centrifugally-cast reinforced concrete pipes with 12 mm thick high alumina cement mortar lining.

(c) ACP for pressure pipes up to 600 mm in diametre.

(d) Steel pipe for pressure pipes of 700 mm and more.

6.1.3 Sewer Bedding Materials

All sewer pipes are bedded either in a monolithic cradle of plain concrete or crushed stone and/or gravel, having a minimum thickness of 60 mm for a 150 mm diameter service connexion pipe under the pipe barrel. The concrete cradle should extend up to the sides for a height equal to about 30 percent the outside diameter, having a width at least equal to or more than the outside diameter of the pipe barrel.

Granular materials are recommended for the bedding of vitrified clay pipe, and RCP pipes up to 500 mm, in lieu of shaping the trench bottom The granular bedding material, in addition to providing firm uniform support for the pipe, frequently also must stabilize the trench bottom. The pipe bedding material must remain firm and not permit displacement of the pipe, either during pipe laying and backfilling or following completion of construction.

For larger sewer pipes of 600 mm or more, the use of well graded crushed stone is recommended. Well graded crushed stone generally will provide the most satisfactory pipe bedding when compacted thoroughly and properly placed, to provide uniform support for the pipe barrel and to completely fill all voids under and around the pipe.

In many cases sewer bedding materials and design may depend on the various conditions e.g., soil condition and the calculated loads. Care should therefore be taken in designing sewer bedding to sustain the expected loads. There will be cases which require pipe casing to protect the body of pies.

6.1.4 Manhole Materials

The manhole frame and cover should normally be made of cast iron, having adequate strength to support superimposed loads, with a minimum diameter of 600 mm. Ventilation vents may be provided on the cover to prevent oxygen depletion in the sewers. However, for manholes at depressed areas subject to flooding, such vents should not be provided, thus maintaining tightness so that undesirable entry of stormwater and grit can be avoided.

Manhole materials include brick, precast concrete section, and cast-in-place concrete. A taper section may be furnished to reduce the diameter of manhole at the top to accommodate the frame and cover. For the vertical portion of wall, cast-in-place concrete, or brick may be used, depending upon the depth of manholes or soil conditions.

6.2 Sewer Construction Methods

The critical factors to construct sewers which will not fail under imposed loads and which permits the minimum amount of infiltration into the sewer are (a) trench bedding, (b) backfill, and (c) proper jointing of pipes. It is also necessary to proceed with minimum interference to the normal activities of the people and traffic in the vicinity of the construction area and to maintain minimum risk to the workmen. In those areas where open cut excavation is to be used, the following factors should be considered:

6.2.1 Trench Dimensions

The width of the excavated trench should be kept to a minimum considering the pipe diameter, trench bracing, and working room required for placing, jointing, and backfilling of the pipe.

6.2.2 Excavation

To minimize the quantity of surface restoration required, as narrow a trench as possible should be used. To limit interference with traffic in narrow roadways or highly congested down town areas, the excavated material should be removed to a storage area, and returned later to be used as backfill. Excavation should proceed only slightly in advance of the installation of the pipe and backfilling. It is advisable to limit the amount of open trench to 100 m in open areas and 30 to 40 m in developed areas.

6.2.3 Sheeting and Bracing

In the majority of the locations in the Study Area, the soil will be primarily sandy silt and/or clay and high water table will be encountered.

In sand and clay soils no lateral bracing will be required for depth up to 2 to 3 m with vertical walls and 3 to 4 m with slopping walls. In those areas of primarily silty soil, extra tight bracing will be required at most depths of excavation. For deep excavation in soft clay soil, special precaution is required against heaving caused by the low shear strength in wet condition. This problem may be overcome by driving the sheeting below the final excavation depth.

6.2.4 Dewatering

For most of the areas in the Study Area, removal of ground water from the excavated trench will be required. The low permeability of the clay soil will keep the quantity of infiltrated water to a manageable level in the areas where the ground water table is relatively low, and dewatering can be handled by sump pumps at the end of the trench. Where the soil is sandy with high ground water table, and excessive water is encountered, a well-point system may be necessary.

6.2.5 Pipe Bedding

For sewer beds, Two different types of materials are proposed for sewer beds. Where a granular bed is used, the bedding should be placed initially to an approximate level and gradient and socket holes are then to be scooped out and each pipe be bedded into the granular material. Where concrete protection is to be used, a thin concrete mat may be put down setting to approximate level and gradient, or pipes may be placed on precast blocks set on the trench bottom or the mat concrete, and after laying and testing the pipes the required concrete is then placed in one operation.

Pipe laying should normally start at the lower and of a line, working with sockets pointing uphill. Small size pipes may be trued to line and grade after jointing, but larger pipes are to be laid in their final positions as they are joined.

6.2.6 Backfilling

For normal conditions, the initial lightly-tamped layer should extend to 300 mm above the crown of the pipes. This layer must not contain large stones, roots, or lumps of clay. Subsequent filling of trenches and around manholes should be built up on layers not exceeding 150 to 250 mm (uncompacted thickness), and each layer should be thoroughly compacted before any further material is added.

6.3 Construction of Deep Foundation Structures

Pumping stations will require a foundation extending approximately 7 m below the existing ground surface. This construction may pose for particular problems because of high water table and the type of soil at the sites. The normal method of excavation, using sheet pilling, will be practicable for application at sites with deep foundations applying a series of well-points or sumps for drainage.

7. PROPOSED SEWERAGE FACILITIES

7.1 Location of Major Facilities

Sewerage facilities should be properly located for the best use of each facility such as sewers, pumping stations and treatment Facilities considering economy, possibility for construction, and availability of lands for the facilities.

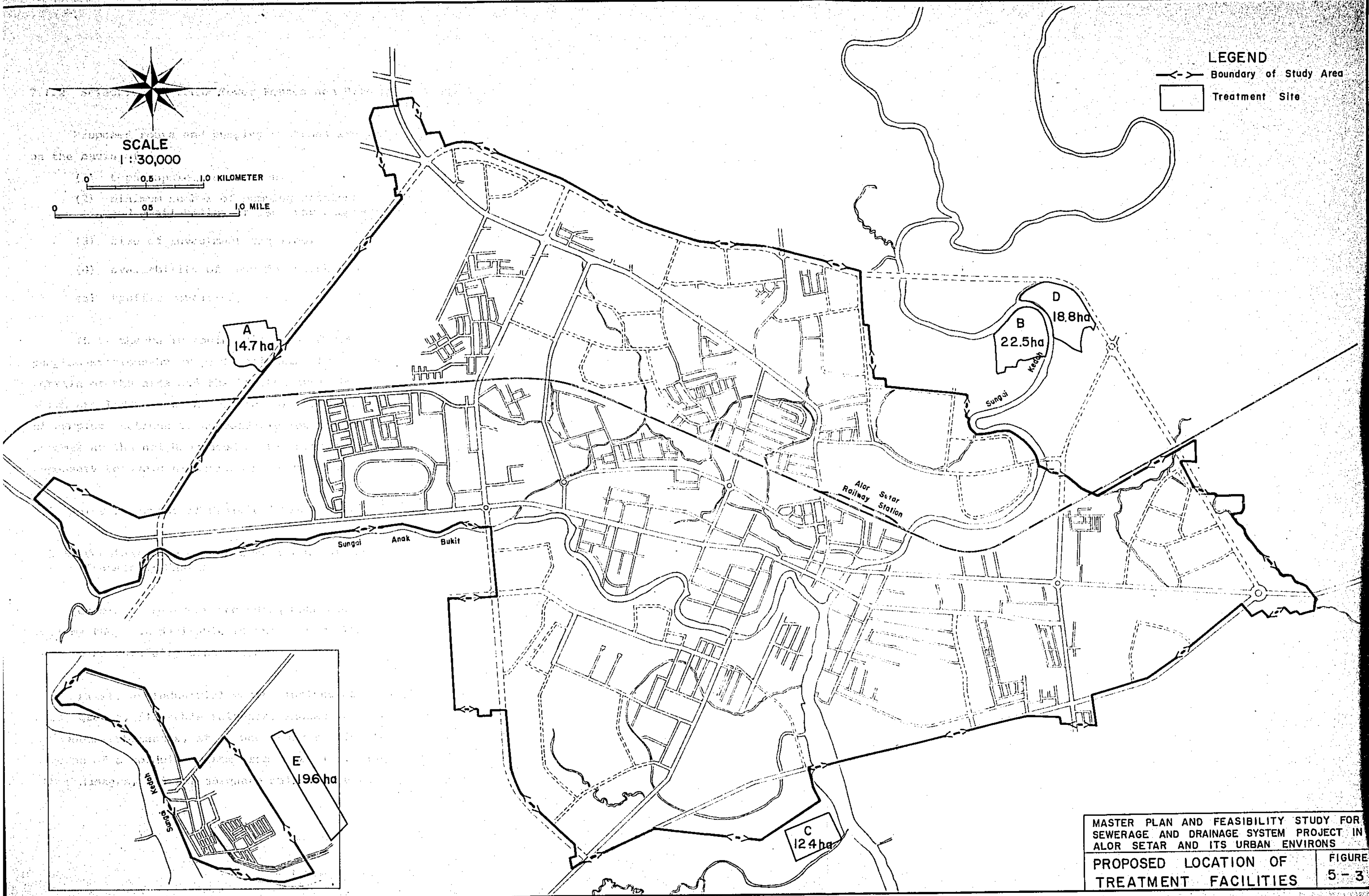
7.1.1 Selection of Treatment Facility Site

Sewerage layout plan is made considering to minimize the overall cost, inclusive both for construction and operation/maintenance. Since the Study Area is almost flat, it is most economical to locate the treatment facilities near the central portion of each sewerage zone. However, the layout plan is decided, heavily influenced by the availability of the land for such facilities.

Several alternative treatment sites are brought into discussion with the agencies concerned as indicated in Section 3 of Appendix E and as a consequence the proposed plan is attached in Figure 5.3 with land available for treatment facility in each sewerage zone as shown in Table 5.8.

Table 5.8 Land Available for Treatment Facility in Each Sewerage Zone

Sewerage Zone	ha (acres)
A	14.7 (36)
B	22.5 (56)
C	12.4 (31)
D	18.8 (46)
E	19.6 (48)



MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS

PROPOSED LOCATION OF TREATMENT FACILITIES

FIGURE 5-3

7.1.2 Selection of Trunk Sewer Routes and Pumping Station Sites

Proposed route and pumping stations are indicated in Figure 5-4 on the basis of;

(1) topographical condition,

(2) minimum number of pumping stations involved and availability of land for pumping stations,

(3) size of investment required,

(4) availability of land for trunk sewers,

(5) traffic condition,

It is the basic engineering consideration to minimize the number of pumping stations by properly selecting trunk sewer routes. Due to flat terrain of the area and the limited availability of treatment facility sites, which are located at the outside of the Study Area, installation of minimum number of pumping stations is unavoidable for the Project. When sewer invert depth becomes at the neighbourhood of 6-7 meters, a pumping station should be necessary to avoid excessive extra cost for lying deep sewers.

7.2 Joint Treatment of Municipal Wastewater and Industrial Wastes

7.2.1 Consideration on Joint Treatment of Domestic and Industrial Wastes

Combined treatment including both domestic and industrial wastes will be the most desirable in this study although certain problems have to be carefully considered.

First, as industrial wastes include objectionable matters, such as oils, grease, flammable solvents, excessive acidity or alkalinity and poisonous substances, it is necessary to give due consideration for protection of a conduit system from corrosion, clogging, explosion, and other damages, and for adequate maintenance of treatment facility.

Since the treatment facilities for joint treatment use some form of biological treatment, it is essential for satisfactory operation that extremes in industrial waste characteristics be avoided and the waste mixture be (1) as homogeneous in composition and uniform in flow rate as possible and free from shock loads, (2) not highly loaded with floatable and suspended matters, (3) free from excessive acidity or alkalinity, (4) free from undecomposable materials and toxic metals, (5) not too high BOD materials, such as carbohydrates, sugar, starch and cellulose and (6) low in oil and grease content.

In most of sewerage zones, industrial wastes are comparatively little compared to domestic wastewater, process of pretreatment will not necessarily be required because the minor objection of industrial wastes could be eliminated by overwhelming domestic wastewater in treatment plant.

For Kuala Kedah sewerage zone, where a large scale of fishery industries are under consideration, however, care should be taken on the characteristics of the wastes, and adequate measures of the following will be required to meet the actual needs.

(a) To lengthen the detention time of the wastes on treatment process.

(b) To modify or supplement treatment facilities by provision of oil skimming tank and pretreatment facility, sludge return system, etc.

7.2.2 Treatment for Wastewaters from Industrial Areas

(1) North and South Mergong Industrial Areas

Since light industries are considered dominant in both the North and South Mergong Industrial Area, it is estimated not to affect a joint treatment of the wastewater with domestic wastewater, if grease and oil is removed before discharging into the public sewers by installing oil trap as suggested in Appendix B.

(2) Kuala Kedah Industrial Area

24 large fish processing industries are planned to be established in this industrial area in the future including the three factories in operation at present.

Based on the water quality analysis of the three existing factories, BOD and SS values at present and in the future are assumed to be 2,000 mg/l and 500 mg/l respectively as discussed in Section 4.4.3 of Chapter 5.

Taking into consideration of the social contribution of the particular enterprises producing a high priority commodities for the society and the degree of contribution for the local economy, and realistic ability of individual factories for pre-treatment and appropriate operation and maintenance, it is proposed to regulate each factory to pre-treat by requesting to install preliminary treatment facilities (or plain sedimentation tank) with a removal rate of 20% for BOD and 60% for SS. Thus estimated wastewater effluent qualities from the Kuala Kedah factories are calculated in Table 5.10. It should be noted that low materials recovered by the pretreatment will be returned to the production process of the factories for economy.

Table 5.9 Proposed Effluent Quantities from Kuala Kedah Fish Processing Industries

	Quality of Raw Wastewater (mg/l)	Proposed Removal Rate (%)	Proposed Effluent Quality from Industry (mg/l)
BOD	2,000	20	1,600
SS	500	60	200

7.3 Proposed Treatment Method

7.3.1 Wastewater Quantity and Quality

On the basis of discussions in the previous sections, quantities and qualities which are discharging into treatment facility in each sewerage zone, are estimated as shown in Table 5.10.

It should be noted that wastewater qualities (BOD and SS) from the Kuala Kedah Industrial Area is the reduced estimate by pre-treatment by the individual industries.

Table 5.10 Estimated Wastewater Qualities and Quantities Generated from Sewerage Sub-zones in the Year 1979 and 2000

Sewerage Zone	Sewerage Sub-zone	1979 Condition			2000 Condition		
		Daily Average Flow (m^3/day)	BOD Concentration (mg/l)	SS Concentration (mg/l)	Daily Average Flow (m^3/day)	BOD Concentration (mg/l)	SS Concentration (mg/l)
A (Alor Melah)	A - 1	5,484	113	113	10,018	152	152
	A - 2	3,400	38	38	11,549	152	152
	Sub-total	8,884	84	84	21,567	152	152
B (Kota Setar)	B - 1	14,863	170	170	21,094	175	175
	B - 2	4,571	88	88	12,065	157	157
	B - 3	867	52	52	3,234	160	160
	Sub-total	20,301	147	147	36,393	168	168
C (Mergoug)	C - 1	3,009	82	96	5,447	105	120
	C - 2	3,085	58	34	11,738	160	160
	Sub-total	6,094	59	65	17,185	144	147
D (Penkala Kundor)	D - 1	9,420	153	153	15,026	168	168
	D - 2	3,050	89	89	8,699	161	161
	Sub-total	12,470	138	138	23,725	166	166
E (Kuala Kedah)	E	2,869	203	154	6,144	532	176
Total		50,618			105,014		

Note: refer to Appendix D in detail.

7.3.2 Proposed Treatment Method

As discussed in Appendix E, stabilization pond process is considered most economical treatment method for this Project taking into account of construction, operation and maintenance and land cost. The land required by the stabilization pond process for each sewerage zone is shown in Table 5.12, on the basis of 2000-year wastewater quantities and qualities in Table 5.10.

It is evident, however, that, except for zone E, the available land for each sewerage zone on the stabilization pond process, according to proposal in the Master Plan, is almost half of the 2000-year wastewater generated, which necessitates the second economical treatment method - aerated lagoon process. This process requires approximately 60 percent of the land required by stabilization pond process.

By comparing the 2000-year daily average flow in each sewerage zone and sub-zone in Tables 5.10 and 5.11 and total treatment capacity by stabilization pond process in full land use available, it is clear that the 2000-year wasteaster from only urbanized and/or urbanizing area (A-1, B-1, C-1, D-1 and E) can be safely treated by stabilization pond process except for Sewerage Zone B.

Therefore, stabilization pond process should be converted to aerated lagoon process before the stabilization ponds are overloaded by the additional wastewater from the future development area (such as A-2, B-2, C-2 and D-2) as indicated in Table 5.13.

Table 5.11 Treatment Capacity by Stabilization Pond Process in Full Land Use Available

Name of Sewarage Zone	Daily Average Flow (refer to Table 5.10) (m^3/day)	Required Land Space by Stabilization Pond Process (ha)	Available Land Space for Treatment Facility (ha)
A	21,567	25.4	14.7
B	36,393	41.6	22.5
C	17,185	20.5	12.4
D	23,725	27.8	18.8
E	6,144	19.6	19.6
Total	105,014	134.9	88.0

7.4 Design of Sewers and Pumping Stations

7.4.1 Sewers

The separate system, proposed in Section 2.1 of Chapter 4, collects and conveys all wastewaters from residential, commercial,institutional and industrial areas to treatment facility provided at the terminal of the system.

The design sewage flows are calculated for the conditions in the year 2000, including extraneous flows such as groundwater infiltration. For industrial areas, wastewater flows are estimated using the unit flow rate per hectare plus some extraneous inflow.

Sewer capacity has been determined using the design criteria as discussed in Section 5, Chapter 4. The proposed routes of trunk sewers and flow direction with diameters and slopes are shown in Figure 5.4. Hydraulic computations and profiles for trunk sewers are shown in Appendix K.

As the above design includes the sewerage system in the future development areas, when new development plans are submitted with sewerage systems for approval, MPKS should review the developers' plan as to sewer size, branch and lateral sewers' route, flow direction, slope and invert elevation, and location of temporary treatment facilities, in accordance with the design criteria developed under the present study.

7.4.2 Pumping Stations

A total of 18 pumping stations are required for the sewerage system covering the entire Study Area, five stati-ns in Zone A, and five, four, three, and one stations in Zones B, C, D and E respectively as shown in Figure 5.4. Each of these pumping stations is designed on the basis of the design criteria discussed in Section 5, Chapter 4. All pumping stations are designed to meet the conditions in the year 2000.

7.5 Proposed Sewerage Facilities

On the basis of various discussions in previous sections in this Chapter and other Chapters concerned, proposed layout plan for sewerage facilities including trunk sewers, pumping stations and treatment plant are shown in Figure 5.4, and in Table 5.12.

Table 5.12 Proposed Sewerage Facilities

Name of Sub-zone	(*) Government Contribution				(**) Private Contribution			
	Trunk Sewer		Branch and Lateral Sewer		Branch and Lateral Sewer		House Connection	
	Dia. (mm)	Length (m)	Dia. (mm)	Length (m)	Dia. (mm)	Length (m)	Dia. (mm)	Length (m)
A - 1	375 - 900	5,660	225 - 300	29,140	225	6,480	150	80,930
A - 2	375 - 600	6,570	225 - 300	20,820	225	42,040	150	103,580
Sub-Total		12,230		49,960		48,520		184,510
B - 1	375 - 1,200	10,720	225 - 300	39,690	225	1,270	150	147,850
B - 2	375 - 450	5,210	225 - 300	20,900	225	35,790	150	111,100
B - 3	375 - 525	2,530	225 - 300	6,780	225	5,460	150	30,400
Sub-Total		18,460		67,370		42,520		289,350
C - 1	375 - 900	4,870	225 - 300	18,460	225	3,300	150	58,520
C - 2	375 - 450	3,840	225 - 300	19,540	225	40,770	150	91,870
Sub-Total		8,710		38,000		44,070		150,390
D - 1	375 - 900	8,200	225 - 300	36,450	225	3,300	150	126,870
D - 2	375 - 525	5,720	225 - 300	15,140	225	19,560	150	81,090
Sub-Total		13,920		51,590	450	22,860		208,560
E	375 - 600	3,340	225 - 300	8,180	225	6,650	150	35,280
Total	-	56,660	-	215,100	-	164,620	-	868,090

Note: (*), (**) refer to Section 10.3 in Chapter 5.

Table 5.13 Proposed Pumping Stations and Treatment Facility

Name of Zone	Refer No. (refer to Fig. 5.4)	Pumping Station		Treatment Facility		
		Peak Flow *1) (m^3/s)	Required Land Area (m^2)	Treatment Method	Design Flow *2) (m^3/day)	Available Land Area (ha)
A	P1 P2 P3 P4 P5	0.20 0.02 0.15 0.12 0.58	240 50 50 210 *3)	*5) SP → AL	21,567	14.7
B	P1 P2 P3 P4 P5	0.38 0.11 0.25 0.89 0.95	330 *4) 270 540 *3)	SP → AL	36,393	22.5
C	P1 P2 P3 P4	0.40 0.51 0.12 0.13	330 380 200 210	SP → AL	17,185	12.4
D	P1 P2 P3	0.29 0.46 0.25	280 360 270	SP → AL	23,725	18.8
E	P1	0.21	*3)	SP	6,144	19.6

Note: *1) Peak Flow in the Year 2000

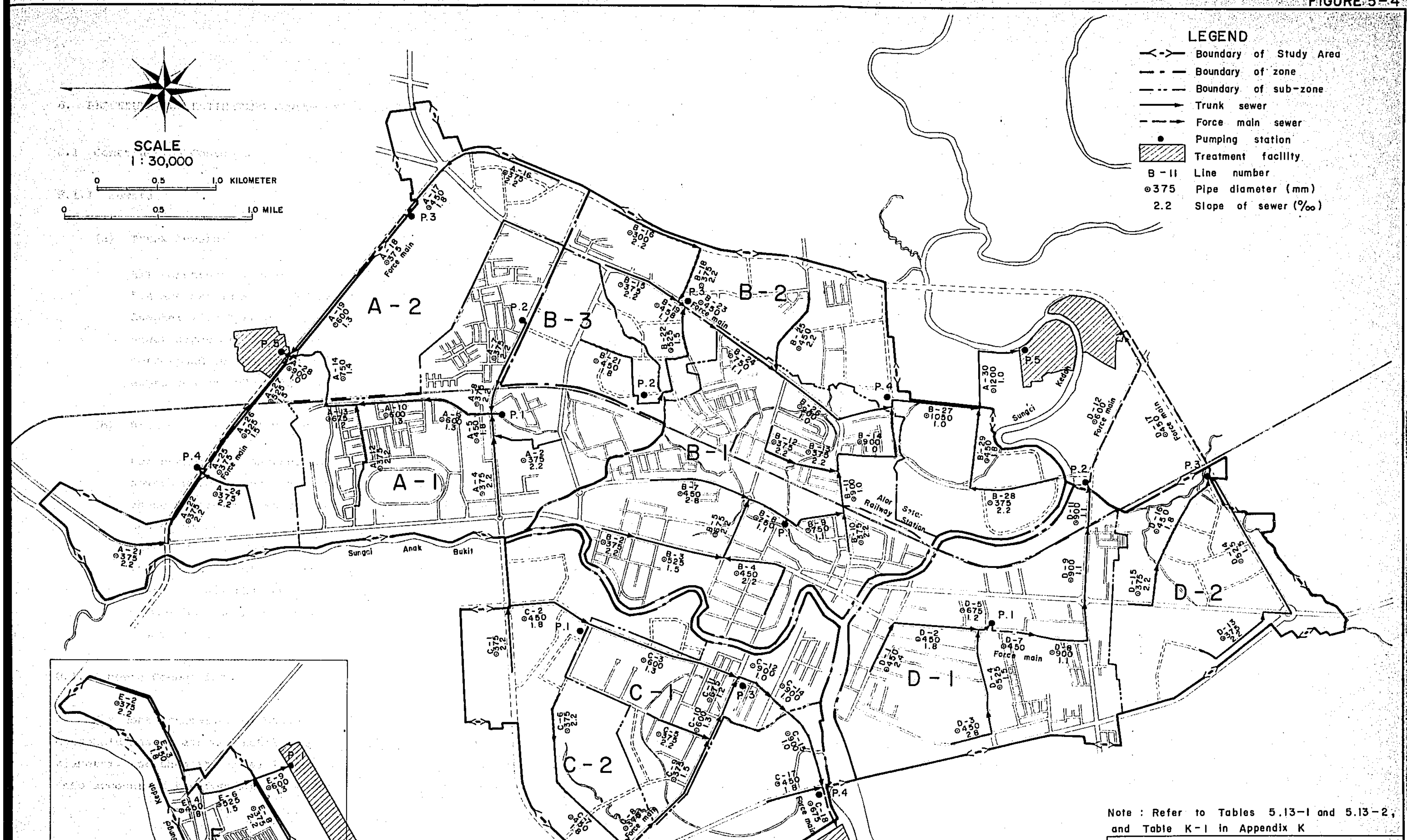
*2) Daily Average Flow in the Year 2000

*3) Within the Treatment Site

*4) Within the proposed SECD's treatment site

*5) SP → AL indicates that stabilization pond in the early stage will be converted to aerated lagoon in the future.

FIGURE 5-4



MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS

PROPOSED LAYOUT PLAN FOR SEWERAGE SYSTEM — FIGURE 5-4

8. PROCEDURE FOR ESTIMATING CONSTRUCTION COSTS

8.1 Construction Costs

8.1.1 Sewers

(a) Trunk Sewers

All construction costs for the proposed trunk sewers in Figure 5.4 are estimated on the basis of the procedures described in Chapter 1 in Appendix G. Construction costs for each size of sewer pipes are derived from unit construction costs which correspond to the designated sewer depth. All costs are expressed at 1979 price level.

(b) Branch and Lateral Sewers

For estimating construction costs of branch and lateral sewers which is not shown in Figure 5.4, the total lengths of these sewers by size are obtained by preliminary engineering design of sewers from the selected blocks of residential areas which are considered to be representing an average future condition in these areas as studied in Appendix H. Then, the construction costs for all the sewer sizes are estimated, multiplying the unit costs to the lengthes, thus finally estimated sewer construction cost for a unit of area.

8.1.2 House Connections

For cost estimation of house connections, it is assumed that each household has an average total length of 15 meter pipe with a 150 mm diameter, and then the total length of these pipes are calculated taking into account of the population served and the average size of a family.

The average construction cost for house connection is estimated to be M$40 per metre.

8.1.3 Pumping Stations

Pumping stations will be provided in all stages, four stations (inclusive one station in the SEDC housing development area in sewerage Sub-zone B-3) in the First Stage, similary one, two, five stations in Second, Third, and Fourth Stage respectively, on the basis of the staged implementation schedule as shown in Table 5.17 in Section 10.

All construction costs for these stations are estimated by applying the cost function developed in Chapter 2 in Appendix G derived on the basis of the unit costs for building, civil works and equipment, assuming that most of equipment including pumps, controlling devices, electric facilities, screening, gates and piping materials will be imported, but materials for building and civil works will be available in Malaysia.

8.1.4 Treatment Facilities

All construction costs for treatment facilities are estimated by using the cost function developed in Chapter 3 in Appendix G derived on the basis of the unit costs developed for ciivil works and equipment assuming that most of equipment, including pumps, flow measuring devices, electric facilities, and others will be imported, but materials for civil works will be available in Malaysia.

8.2 Operation and Maintenance Costs

8.2.1 Sewers

Operation and maintenance costs for sewer pipes are estimated based on reasonable assumptions as discussed in Chapter 4 in Appendix G derived from data obtained in Malaysia and Japan, assuming that all sewers will be cleaned at least every four years by use of thrusting rods and/or bucket machines.

8.2.2 Pumping Stations

Operation and maintenance costs for pumping stations are estimated by using the cost function developed in Chapter 4 in Appendix G derived from the current costs for labour and materials, power, fuel, water in Kedah State for cooling and sealing, lubrication, grit and screening removal, overhauling and repairing of mechanical equipment and repairing of the structure by estimating on the basis of peak flow rates.

8.2.3 Treatment Facilities

Operation and maintenance costs for treatment facilities are estimated by using the cost function developed in Chapter 4 in Appendix G derived from the current costs for labour and materials, power, fuel, water in Kedah State for cooling, sealing lubrication, overhauling and repairing of mechanical equipment, and repairing of the civil works and structures.

9. FINANCIAL CONSIDERATIONS

9.1 Implementation Priority by Sewerage Sub-Zone

The Study Area is firstly divided into two areas, "urbanized and/or urbanizing area" and "future development area (or rural area)", in broad terms.

The former area, composed of sub-zones 1 in every sewerage zone such as A-1, B-1, C-1, and D-1 and Zone E is proposed to be provided with public sewerage system, while the latter area, composed of sub-zones 2 in every sewerage zone such as A-2, B-2, C-2 and D-2, is considered to be principally proveded with sewerage facilities by developers.

For overall evaluation of the urgency of sub-zones in order to determine priority for implementation, six assessment elements are considered, namely, (1) population density, (2) development condition, (3) waste load generation aspect, (4) excreta disposal system, (5) flooding condition, and (6) incidence of waterborne diseases, and a rating procedure is developed by assigning reasonable relative weights to these major controlling parametres as follows:

		Point assigned
(1)	Population density	300
(2)	Development condition	200
(3)	Waste load generated	300
(4)	Excreta disposal system	100
(5)	Flooding condition	50
(6)	Incidence of water-borne diseases	50
	Total	1,000

Note: An evaluation item "availability of water supply" is not considered for this particular situation because the Study Area is almost uniformly served by the water supply system.

Detailed explanation for each of the elements is described in the following:

(1) Population Density

Most important element of sewerage system is the improvement of environment level for the welfare of the maximum population which will be benefited by the system. It is, therefore, particularly important to provide sewerage facilities in high population density area, in order to gain the maximum benefit with the minimum expenditure thus making the benefit cost ratio higher. Hence, the highest point is assigned for the population density.

(2) Development Condition

Development condition of the Study Area differs largely according to areas and land uses. The greater portion of the future development area lying periphery of the Study Area remains to be paddy field yet, thus unabling to provide sewerage system for the time being.

(3) Waste Load Generated

300 points is assigned to this element.
The waste load generated from the housing, commercial and industrial areas are generally discharged into drains and rivers without any treatment except septic tanks. It is, therefore, necessary to consider the quality (or the waste load) generated in each of the sewerage zones to determine the urgency of the need of sewerage facilities.

(4) Excreta Disposal System

Since there is no sanitary sewerage system in the Study Area, except a few local systems, practically all of the excreta produced in the area is disposed of either by septic tank, bucket, pit privy or directly to waterways, causing water pollution at many places in the Study Area. The existing excreta disposal system is, therefore, analyzed, and 100 points is given for the rating.

(5) Flooding Condition

Due to the incomplete condition of the existing rivers and drains, flooding has occurred frequently and caused substantial damage in the built-up areas. Sanitary conditions in these areas have been significantly deteriorated by the flood, and improvement by the provision of the sewerage system. would be significant.

(6) Incidence of Water-borne Diseases

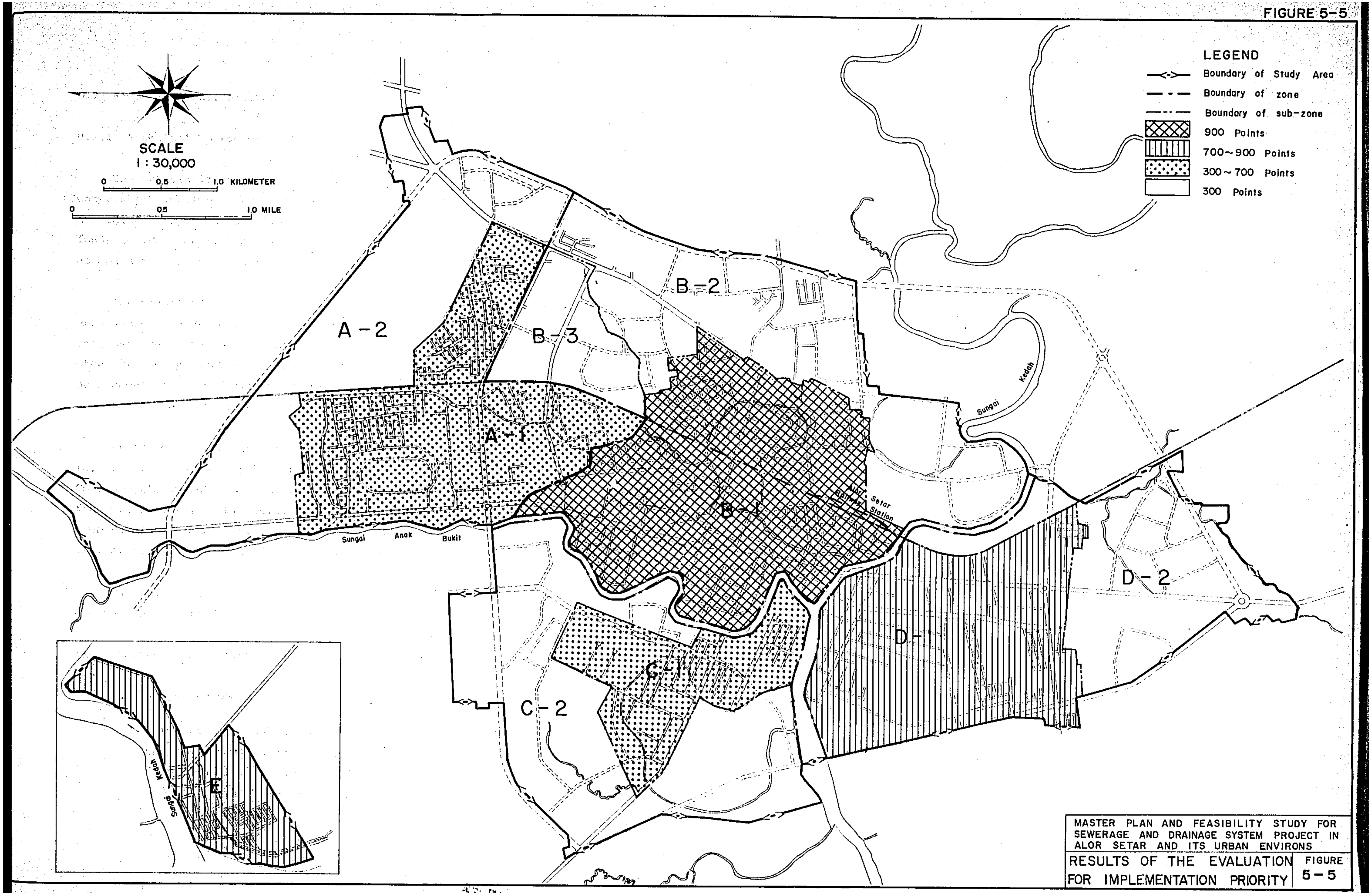
Incidence of water-borne diseases is also effected by sanitation conditions, but this is less critical than the above five elements, as incidence of Cholera is not significant in the Study Area.

The evaluation result over the entire sewerage sub-zones is given in Table 5.14, with each assessment points of six items. As indicated "Implementation Priority" column in the same table, it deserves to note that the urbanized and/or urbanizing areas, namely sewerage sub-zones B-1, D-1, E, C-1 and A-1and zone E are ranked in higher priority than the future developing area such as D-2, B-3, B-2, A-2 and C-2 as shown in Figure 5-5.

Table 5.14 Overall Evaluated Points by Sub-Zone

Sub-zone	Population Density	Urbaniza-tion	Waste Loading	Existing Excreta Disposal System	Flooded Area	Distribution of Water Borne Disease	Total	Implementation Priority
A - 1	90	150	100	0	0	0	340	5
A - 2	30	50	50	0	0	25	155	9
B - 1	300	200	300	100	50	0	950	1
B - 2	90	50	50	50	0	0	240	8
B - 3	90	100	50	0	0	25	265	7
C - 1	180	200	0	0	0	0	380	4
C - 2	0	50	50	0	0	50	150	10
D - 1	270	200	200	100	25	0	795	2
D - 2	150	100	50	0	0	0	300	6
E	180	100	300	100	50	0	730	3

Note: Refer to Appendix J for detail.


LEGEND
Boundary of Study Area
Boundary of zone
Boundary of sub-zone
900 Points
700~900 Points
300~700 Points
300 Points
SCALE
1 : 30,000
0 0.5 1.0 KILOMETER
0 0.5 1.0 MILE
A-2
A-1
B-2
B-3
B-1
C-1
C-2
D-1
D-2
E
Sungai Anak Bukit
Sungai Kedah
Alor Setar Railway Station
MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS
RESULTS OF THE EVALUATION FOR IMPLEMENTATION PRIORITY
FIGURE 5-5

9.2 Financial Consideration

9.2.1 Potential Source of Funds

The substantial amount of capital is normally required for sewerage works which involves the extensive construction. It is therefore necessary for the Government to consider the specific arrangement to generate the funds to meet the capital requirements for the construction, and as well as operation of the systems after completion.

The viability of the project is largely dependent on adequately arranged source of funds including less burdensome long terms and low interest loans, the Government's grant, equitable sewer use charge and other revenue projections. The specific arrangement for finding would be needed during the early years of the programme when there is virtually no means to generate revenue through services.

It is to be noted that there are two different kind of costs, that is, (1) to be borne by public sector which should be financed by the Government's own capital source or arrangement of external loan either from multilateral or bilateral lending agency, and (2) to be recovered from developers and those individuals who will receive the direct benefits from systems construction including household and property owners.

The followings are potential sources of capital for construction and revenue required for operation of the systems.

(1) Capital Sources from Public Sector

(a) Long-term Loans

Prior to the construction, the funding arrangement will be necessary through one of several alternative sources, loans from Federal Government or State Government, multi-lateral and bi-lateral lending agencies.

It is desirable to arrange the loans of long term and low interest to support the viability of the Project with deferred repayment of principal to mitigate the cash flow problem in early years of construction while there are no means to raise the funds through connections to the sewerage systems. The World Bank and Asian Development Bank are examples of multi-lateral sources of loans. The recent loans provided by both World Bank and Asian Development in Malaysia indicates interest rate 7-9%, and repayment terms of 20 years with grace period of 5 years. The World Bank has recently been providing loans to Malaysia with favourable terms. Bi lateral loan agreements are also considered to be made with U.S.A., Japan, Germany, Canada and others that have aid programmes for developing nations, sometimes with more favourable conditions than those from the multi-lateral sources.

(b) Government Grant

Since the sewerage works contribute to the improvement of sanitary as well as environmental condition of the society which provide with community benefits accruing to the population at large, some form of support from Government is relevant at least structural works such as trunk sewers and treatment facilities and pumping stations similar to other public works for infrastructure development such as road construction.
The direct grant from the Government will enable the construction of downstream disposal and other major facilities earlier than would be effectuated through the funds raised by other means.

In addition to direct grant, there are indirect grants in various forms such as interest-free advances, advance payment of direct benefit charges against Government properties or the establishment of special favourable loan terms from Government sources, and setting up a revolving fund to assist houseowners who may have difficulty in paying the required cash for the connection and relevant plumbing costs.

(2) Capital Sources from Private Sector

The capital to be obtained from the individuals who will receive the direct benefits from the systems usage will significantly contributes to reduce the amount of loan required for development project and decrease the financial burden on the Government. There are several alternative methods to raise such capital.

(a) Benefit Assessments

Benefit assessments are basically applied to cover the costs for branch and lateral sewers which provide benefits to the property served by improving the marketability and value of the properties. The assessments can be levied against all property owners based on front footage, or the area of property or assessed value, or annual equivalent rental value of the properties.

(b) House Connection

The full costs of connecting a property to a branch or lateral sewer including relevant replumbing costs are recovered by individual houseowners since the benefits derived from such connection accrue to the properties connected only. The specific arrangement will be necessary, however, for the collection method of charge as well as legal provision to prevent a delay of connection resulting from houseowners' reluctancy to the connection.

(c) Developers Contribution

The infrastructure systems including sewerage system should preferably be developed prior to the other construction on the new housing and industrial development areas, otherwise, it will cause inconvenience and extra costs such as rebuilding and remodelling of existing systems. In order to avoid such inconvenience, the developers are commonly required to construct such infrastructure systems when they develop the areas. The costs incurred from such constructions can be compensated by including such costs in their sale prices of lands. Therefore, incumbent developers in this proposed Project will be fully responsible for the construction of branch and lateral sewers and drains as well as house connections. The installment of the systems can be made either by developers themselves or by the Govern who may recover the costs from the developers.

(3) Potential Sources of Operation Revenue

The well planned revenue sufficient to sustain the Project on a financially viable base will be necessary during the whole life of the Project. The revenues are basically required to meet the costs for operation and maintenance of the system including administration expenses plus long term debt service payment. Among the several methods commonly applied to raise the revenue, the well suited to the proposed Project with simple, logical practicable, enforceable and equitable nature should be selected.

(a) Service Charge

The service charges are applied to individual users of the systems on proportion to the use they make. In calculating the charge there are following methods available in some cities in the world.

i) Pedestal Charge

The flat rate is multiplied by the numbers of water closet (WC) pedestal in the households to calculate the charge on the theory that the waste volume is linked with pedestal. The collection of the charge is administratively easy, but it does not appear that the waste discharge is closely related to the pedestal, and more adequate method should be considered.

ii) Fixture-unit Charge

The numbers of water fixtures, such as faucets, water heaters, air coolers, and flush toilets, are multiplied by flat rate so as to provide the revenue required based on the theory that volume of waste discharge is related to the volume of water consumption, hence to the numbers of fixtures. The households which have many fixtures do not necessarily consume much water and more rational method should be considered.

iii) Per Capita Charge

The charge is calculated multiplying the numbers of residents or employees in the households or commercial property by a flat rate fee based on the theory that volume of waste discharge proportionate to the numbers of residents. This method has also a disadvantage in obtaining the accurate waste discharge as same as above method.

iv) Water Rate Surcharge

The water rate surcharge is service charge related to water use which is calculated by adding a fixed rate to metred water consumption. This method would appear to be the best alternative satisfying the required nature for recommendable method as mentioned above. The volume of waste discharge is closely related to water consumption which is accurately metred. The collection of the charge is enforceable by cutting-off the water supply in the event of non-payment. The collection of charge can be made without difficulty in combination of billing procedure for water supply already in existence. There will be certain cases where water consumption is difficult to measure as consumers draw water from private sources (wells). However, the most water in the Project area is supplied by pipe, and there will be no setback in adopting this method.

(b) Annual Subsidies from Government

The self-supporting system without any Government subsidies is most desirable in operation of public utility systems, including sewerage system, but it depends ultimately on the ability of the users to pay the required charge of the systems who may be liable to substantial burden. In as much as the amount of revenue collectable from the users is limited to defray not necessarily to cover all the expenses for operation and maintenance expenses, and debt service payment, certain amount of Government subsidies will be justified as a social costs for improvement of public health and sanitation as well as protection of water pollution of the area at large.

9.2.2 Preliminary Financing Plan

The component of the recommended financing plan for sewerage programme up to the year 2000 are presented in Table 5.15.

Table 5.15 Preliminary Financing Plan for Sewerage Programme up to the Year 2000

	Description of Work	Required Funds by Stage (M$1,000)					Suggested Sources of Funds
		1st stage	2nd stage	3rd stage	4th stage	Total	
1.	Government contribution Construction of (i) Trunk Sewer, (ii) (iii) Pumping Station, (iv) Treatment Facilities, (v) Land Acquisition	14,945	18,211	21,422	27,665	82,243	Long term loan and Government grant (to be repaid benefit assessments and water surcharge)
2.	Private Contribution Construction of (i) Branch and Lateral Sewer, (ii) House Connections	3,668	5,758	9,889	9,929	29,244	Developers' contribution for branch and lateral sewers. Direct payments by household owners of house connection.
3.	Annual System Operation and Maintenance Costs excluding debt service payments	367	665	1,008	1,414	3,455	Water rate surcharge based on water consumption

Note: The figures are on 1979 price level.

9.2.3 Users' Ability and Willingness to Pay

(a) Users' Ability to Pay

A survey was conducted in June 1979 of households income in selected area in Project Area based on the sampling approach. A summary of the survey, showing a profile of household income levels as well as the average household income, is presented in Table 5.16. Among the total households of 73,13 households, which represent large in number, fell within the income range of $201 - 300/month. It should be also noted that 22 households, about 30 per cent of total households, fell within the salary scale of between $301 and 500/month, and these 35 households will be considered predominant and representing major salary group in all household in the Project Area. From this fact, it may be concluded that the majority of family income can be of $350/month. According to an analysis, sewerage charge on domestic household will be $6.80 per month. This means that average household will be paying about 1.9 per cent of its income for sewerage services. It can be said that the income Survey revealed that the average households income less living expenses could afford to pay the required service charge in the Study Area.

(b) Users' Willingness to Pay

From the survey shown in Table 5.16, people living in commercial and one story attached terrace house show rather high degree of willingness to pay of about $10/month. This was ascertaind during house visiting. In fact, some people, who know the sewerage system that contributes to the improvement of sanitary condition of the society, expressed their possitive cooperation for provision of sewerage system and show willingness to pay for sewerage service.

It may be expected that households with existing septic tanks of their own may be initially reluctant to avail of government sewerage services. However, once the sewerage system is operational, tangible improvements in the sanitation of the area will be demonstrated and this should entice more users, including those with septic tanks.

It may be generally stated that at the outset the willingness of people to pay for sewerage service may not be as explicit as their willingness to pay for water supply services. The community traditionally looks at sanitation and sewerage activities as government responsibilities similar to the provision of roads and infrastructures. There is,therefore, an inherant need of the government to educate the people in their role of supporting the financial operations of the sewerage utility. One solution can be public legislation on payment for sewerage services.

Table 5.16 Household Economic Survey (June, 1979)

Salary Scale M$/Month	Numbers of Selected Households by House Type						
	Total	I	II	III	IV	V	VI
101 - 200	9	2	1	1	3	2	
201 - 300	13	1	2	3	3	2	2
301 - 400	11	2	1	3	2	2	1
401 - 500	11	2	1	2	3	2	1
501 - 600	7			1	2	3	1
601 - 700	4	1	1		2		
701 - 800	1			1			
801 - 900	6	1	1	1		3	
901 - 1,000	4				1	2	1
1,001 - 2,000	7	1				2	4
More than 2,000							
Total	73	10	7	12	16	18	10
Average Income (M$)	580	532	460	432	445	685	916
Average Nos. of Residents	5.5	6	6	6	6	5	4
Average water Bill (M$)	11.2	9	9	8	20	9	8
Max Service Charge within Willingness to Pay (M$)	3.7	3.60	4.30	3.00	5.00	3.40	3.00
Existing Waste Disposal System		PL, PST	PL, PST	BS, PST	OP, BS	BS, PST	PST

Note: House Type

I: Wooden house in kampung Area

II: One story attached terrace house

III: Two story attached terrace house

IV: Commercial house

V: Semi-detached house

VI: Terrace house located in newly developed residential area

BS: Bucket System

PL: Pit Latrine

CST: Communal Septic Tank

PST: Private Septic Tank

RL: River Latrine

OP: Oxidation Pond

9.2.4 Proposed Magnitude of Capital Inevestment

A reasonable magnitude of capital investment for each stage of 5 years was studied on the basis of engineering approaches supported by the financial consideration. The magnitude of investment for one stage was determined to be M$ 15 million, considering minimum effective scale of sewerage facility and at the same time financial capability of local authority.

The financial viability of each stage project was checked from the revenue sources that the local authority can expect and pay for recurrent cost of the sewerage programme. It is assumed that at present there are two sources of revenues of sewerage system: (i) the allocation to local authority by the State Government of a portion of the area tax in a form of benefit assessment in accordance with the increase of annual value due to the provision of sewerage system, which can cover debt servie of capital investment, and (ii) a sewerage fee to be charged on metered water consumtion on sewerage areas, which can be met for operation and maintenance cost and administration.

The sewage fee, together with the area tax assessment, may produce revenue at least to cover operating expenses and debt services of the local authority. As it is assumed that net cash generation may cover debt service, annual capital investment of M$ 3 million may be feasible, and therefore an optimal magnitude of capital investment in construction would be M$ 15 million for the first stage of 5 years, to be followed by the successive stages based on annual economic growth as M$ 18.2 million, M$ 21.4 million M$ 27.8 million for the second , third and forth stages respectively.

As can be seen in the above paragraph, long-term loan from the Federal Government or multi-lateral and bi-lateral lending agencies was considered to meet the capital cost of sewerage works'construction in accordance with principal intention of the Federal Government. However, it is recommended that the Federal Government subsidize the debt service requirement in case local authority's own revenue could not cover the debt service, and if possible, provide funds for future system replacements. This Government subsidy should be considered as social cost for health and environmental protection.

10. ESTIMATED CONSTRUCTION AND RECURRENT COSTS BY STAGE UP TO YEAR 2000

10.1 Government and Private Contribution

As discussed in Section 2, Chapter 5, the Study Area is composed of both "urbanized and/or urbanizing area" (such as sewerage sub-zone A-1, B-1, C-1, D-1, and zone E) and "future development area" (such as sewerage sub-zones A-2, B-2, B-3, C-2, and D-2). The former area includes already developed area by developers as well as being developed.

Under such condition, construction for the urbanized and/or urbanizing area excluding areas undertaken by developers will be needed for sewerage system by the Government contribution, except for house connection. In addition, for the future development area mostly developed by developers, trunk sewers and the branch sewers connecting to the terminal sewers provided by developers in the development area are also provided by the Government contribution.

The remainder of the sewers (branch and lateral sewers and house connection in the future development area) provided by developers should be provided by private contribution.

10.2 Proposed Implementation Schedule and Construction Costs by Stage

On the basis of "Construction Priority for Sewerage Sub-zones" (Section 9 , Chapter 5) and "Proposed Magnitude of Capital Invested" (Section 9, Chapter 5), an implementation schedule is proposed up to year 2000 with four stages as set out in Section 2, Chapter 4.

The priority areas to be implemented in the four stages are tentatively indicated in Table 5.17 and Figure 5.5 with identification of Government and private developers contribution. The table further shows the areas and populations served in the four stages.

The total construction cost (inclusive of contingency, engineering fee and land cost) providing sewerage facilities in the sewerage sub-zones to be implemented in the four stages is proposed to be 111.5 million; 82.24 million to be raised from the Government and 29.24 million from private sources as shown in Table 5.17 and Tables 5.19 through 5.22. It is noted that construction cost for the sewerage facilities by SEDC's housing development scheme now underway are not included.

Table 5.17 Priority Areas to be Implemented and Estimated Construction Costs in Four Stages

Stage	Construction Cost(M$1,000 at 1979 Prive Level)		Sewerage Sub-Zone to be Implemented	Area Served (ha)	Population (Person in 2000)
	Government Contribution	Private Contribution			
First Stage (1981-1985)	14,945	3,668	A part of B-1	187	25,470
Second Stage (1986-1990)	18,211	5,758	The remaining B-1,	272	29,520
			A part of D-1	68	8,940
Third Stage (1991-1995)	21,422	9,889	The remaining D-1, and	313	37,580
			E	125	12,940
Fourth Stage (1996-2000)	27,665	9,929	C-1	187	21,460
			A-1	385	29,670
Total	82,243 111,487	29,244		1,537	165,580

Note: Average branch and lateral sewer length in urbanized and/or urbanizing area is estimated at 110 m/ha, while in future development area is 127 m/ha (refer to Appendix H)

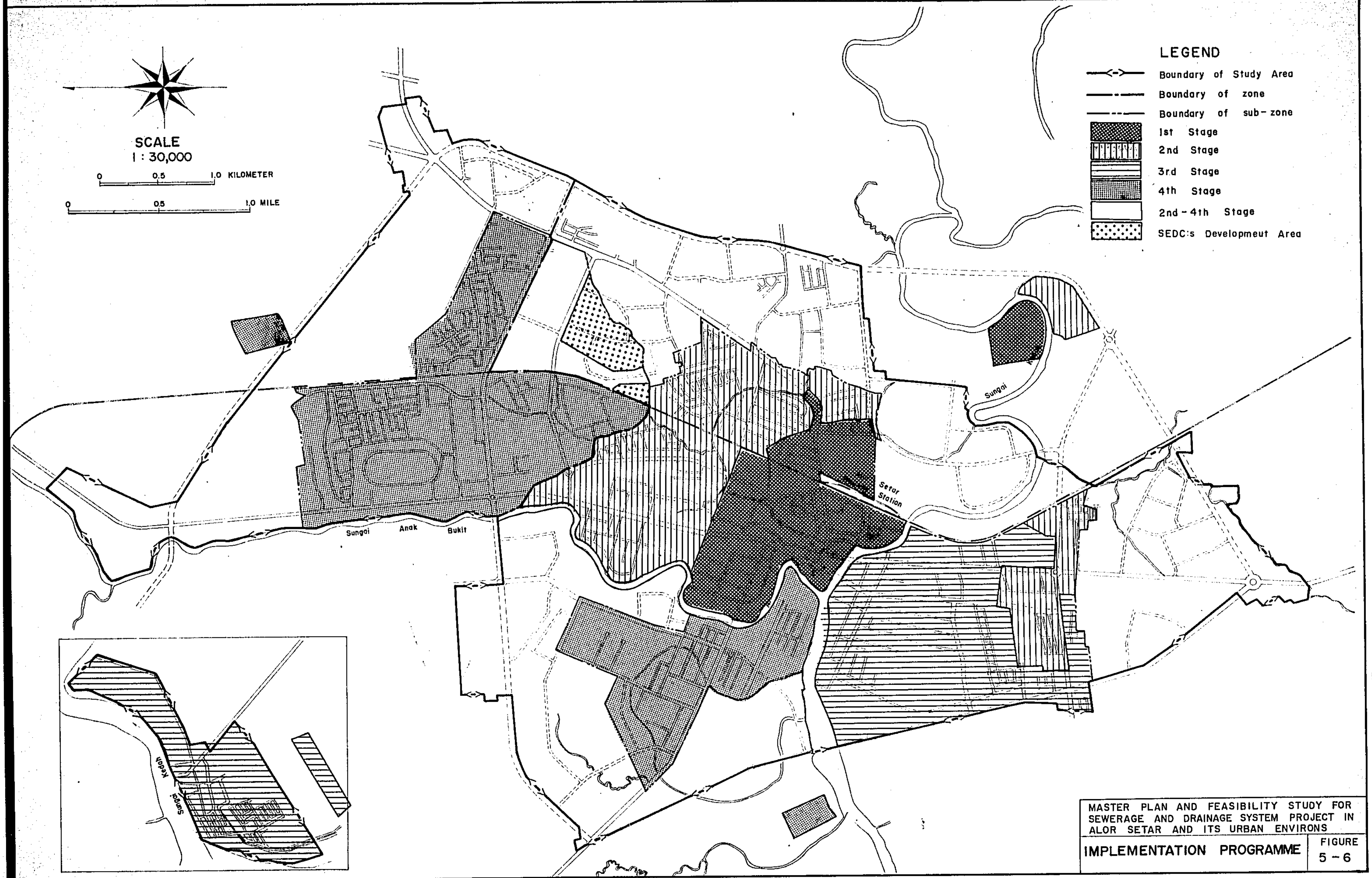
The remainder of sewerage sub-zones not considered in the Staged Implementation Schedule up to year 2000 are shown in Tables 5.18 and 5-23 and Figure 5-6 with estimated construction cost at 1979 cost level for information only.

Table 5.18 Non-Staged Sewerage Sub-zones with Estimated Construction Cost

(M$1,000 at 1979 Price Level)

Name of Sub-zone	Construction Cost		Area Served (ha)	Population (Person in 2000)
	Government Contribution	Private Contribution		
A - 2			437	37,980
B-- 2			410	40,740
B - 3*	46,639	59,088	68	6,940
C - 2			427	33,680
D - 2			270	29,950
Total	46,639	59,088	1,612	149,290
	105,727			

Note: * Excluded the SEDC developed area in Sewerage Sub-zone B-3.



MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS

IMPLEMENTATION PROGRAMME

FIGURE 5-6

10.3 Government and Private Contribution

As discussed in Section 2, Chapter 5, the Study Area is composed of both "urbanized and/or urbanizing area" and "future development area". The former area includes already developed area by developers as well as areas gradually developed. Although urbanization in same of the areas are considered to be an advanced stage, night soil disposal is dominantly dealt with either by individual septic tank or communal septic tank. Sullage water in these area is discharged directly into near by road side ditches or water courses. The urbanized and/or urbanizing area will be served by sewerage system constructed by the Government's contribution. It is found that average sewer length in the urbanized and/or urbanizing area, excluding trunk sewers, is estimated at 110 metres per ha (refer to Appendix H in detail).

Sewerage system mainly provided by developers in future development area should be planned compatible with the wewerage master plan in flow direction, design criteria, etc., so that to be able to merge in the comprehensive sewerage system in the future with minimum additional cost. Therefore, proposed sewerage plan submitted by developers for permission should be carefully reviewed by MPKS. The sewer length of branches and laterals in the future development area is estimated at 30 metres per ha based on the typical model area as discussed in Appendix H. Also, the sewer length of branches and laterals to be contributed by private developers is estimated at 127 metres per ha (refer to Appendix H).

All sewerage facilities except for house connections in urbanized and/or urbanizing area will be contributed by the Government, while in future development area be contributed by both the Government and Private sector as proposed in Appendix H.

Table 5.19-1 Summary of Sewerage Construction Costs for First Stage Programme (1981 - 1985) (Government Contribution)

(M$1,000 at 1979 Price Level)

Description	Local Currency	Foreign Currency	Total	Remarks
a. Tunk Sewer	3,201	565	3,766	
b. Branch & Lateral Sewer	3,136	554	3,690	
c. Pumping Station	1,767	514	2,281	
d. Treatment Facilities	1,075	269	1,344	
e. Cleaning Machine	-	112	112	
f. Sub-Total	9,179	2,014	11,193	
g. Engineering Fee				
Design	280	280	560	(f) x0.05
Supervision	280	280	560	(f) x0.05
h. Contingency	1,948	515	2,463	(f + g) x0.20
i. Land Acquisition	169	-	169	
Total	11,856	3,089	14,945	

Note: 15 percent of sewer construction cost., 20 percent of construction cost for treatment facilities, and 50 percent of engineering fee are estimated as foreign currency. In case of pumping station, construction cost of mechanical and electrical works is estimated as foreign currency.

Table 5.19.2 Summary of Sewerage Construction Costs for First Stage Programme (1981 - 1985) (Private Contribution)

(M$1,000 at 1979 Price Level)

	Description	Local Currency	Foreign Currency	Total	Remarks
a.	Branch & Lateral Sewer	-	-	-	
b.	House Connection	2,362	417	2,779	
c.	Sub-Total	2,362	417	2,779	
d.	Engineering Fee				
	Design	139	-	139	(c)x0.05
	Supervision	139	-	139	(c)x0.05
e.	Contingency	528	83	611	(c+d)x0.20
	Total	3,168	500	3,668	

Note: 15 percent of construction cost is estimated as foreign currency, and no foreign currency is estimated for engineering fee.

Table 5.20-1 Summary of Sewerage Construction Costs for Second Stage Programme (1986 - 1990) (Government Contribution)

(M$1,000 at 1979 Price Level)

Description	Local Currency	Foreign Currency	Total	Remarks
a. Tunk Sewer	3,142	554	3,696	
b. Branch & Lateral Sewer	6,158	1,087	7,245	
c. Pumping Station	390	1,041	1,431	
d. Treatment Facilities	1,084	271	1,355	
e. Sub-Total	10,774	2,953	13,727	
f. Engineering Fee Design	343	343	686	(e)x0.05
Supervision	343	343	686	(e)x0.05
g. Contingency	2,292	728	3,020	(e+f)x0.20
h. Land Acquisition	92	-	92	
Total	13,844	4,367	18,211	

Note: 15 percent of sewer construction cost, 20 percent of construction cost for treatment facilities, and 50 percent of engineering fee are estimated as foreign currency.
In case of pumping station, construction cost of mechanical and electrical works is estimated as foreign currency.

Table 5.20.2 Summary of Sewerage Construction Costs for Second Stage Programme (1986 - 1990) (Private Contribution)

(M$1,000 at 1979 Price Level)

Description	Local Currency	Foreign Currency	Total	Remarks
a. Branch & Lateral Sewer	214	38	252	
b. House Connection	3,493	617	4,110	
c. Sub-Total	3,707	655	4,362	
d. Engineering Fee				
Design	218	-	218	(c)x0.05
Supervision	218	-	218	(c)x0.05
e. Contingency	829	131	960	(c+d)x0.20
Total	4,972	786	5,758	

Note: 15 percent of construction cost is estimated as foreign currency, and no foreign currency is estimated for engineering fee.

Table 5.21-1 Summary of Sewerage Construction Costs for Third Stage Programme (1991 - 1995) (Government Contribution)

(M$1,000 at 1979 Price Level)

	Description	Local Currency	Foreign Currency	Total	Remarks
a.	Tunk Sewer	3,028	534	3,562	
b.	Branch & Lateral Sewer	7,620	1,345	8,965	
c.	Pumping Station	537	341	878	
d.	Treatment Facilities	2,218	555	2,773	
e.	Sub-Total	13,403	2,775	16,178	
f.	Engineering Fee				
	Design	404	404	808	(e)x0.05
	Supervision	404	404	808	(e)x0.05
g.	Contingency	2,842	717	3,559	(e+f)x0.20
h.	Land Acquisition	69	-	69	
	Total	17,122	4,300	21,422	

Note: 15 percent of sewer construction cost, 20 percent of construction cost for treatment facilities, and 50 percent of engineering fee are estimated as foreign currency.
In case of pumping station, construction cost of mechanical and electrical works is estimated as foreign currency.

Table 5.21.2 Summary of Sewerage Construction Costs for Third Stage Programme (1991 - 1995) (Private Contribution)

(M$ 1,000 at 1979 Price Level)

Description	Local Currency	Foreign Currency	Total	Remarks
a. Branches Lateral Sever	1,684	297	1,981	
b. House Connection	4,683	827	5,510	
c. Sub-total	6,367	1,124	7,491	
d. Engineering Fee				
Design	375	-	375	(C)x0.05
Supervision	375	-	375	(C)x0.05
e. Contingency	1,423	225	1,648	(C+d)x0.50
Total	8,540	1,349	9,889	

Note: 15 percent of construction cost is estimated as foreign currency, and no foreign currency is estimated for engineering fee.

Table 5.22.1 Summary of Sewerage Construction Costs for Fourth Stage Programme (1996 - 2000) (Government Contribution)

(M$ 1,000 at 1979 Price Level)

Description	Local Currency	Foreign Currency	Total	Remarks
a. Tunk Sewer	4,389	775	5,164	
b. Branch & Lateral Sewer	9,611	1,696	11,307	
c. Pumping Station	1,589	864	2,453	
d. Treatment Facilities	1,389	347	1,736	
e. Cleaning Machine	-	112	112	
f. Sub-total	16,978	3,794	20,772	
g. Engineering Fee				
Design	519	519	1,038	(f) x 0.05
Supervision	519	519	1,038	(f) x 0.05
h. Contingency	3,603	966	4,569	(f+g) x 0.20
i. Land Acquisition	248	-	248	
Total:	21,867	5,798	27,665	

Note: 15 percent of sewer construction cost, 20 percent of construction cost for treatment facilities, and 50 percent of engineering fee are estimated as foreign currency. In case of pumping station, construction cost of mechanical and electrical works is estimated as foreign currency.

Table 5.22-2 Summary of Sewerage Construction Costs for Fourth Stage Programme (1996 - 2000) (Private Contribution)

(M$1,000 at 1979 Price Level)

Description		Local Currency	Foreign Currency	Total	Remarks
a.	Branch & Lateral Sewer	1,556	389	1,945	
b.	House Connection	4,740	837	5,577	
c.	Sub-Total	6,296	1,226	7,522	
d.	Engineering Fee				
	Design	376	-	376	(c)x0.05
	Supervision	376	-	376	(c)x0.05
e.	Contingency	1,410	245	1,655	(c+d)x0.20
	Total	8,458	1,471	9,929	

Note: 15 percent of construction cost is estimated as foreign currency, and no foreign currency is estimated for engineering fee.

Table 5.23-1 Summary of Sewerage Construction Costs for Non-Staged Sub-Zones (A-2, B-2, B-3(1), C-2, and D-2)

(Government Contribution)

(M$1,000 at 1979 Price Level)

Item	Trunk Sewer		Branch & Lateral Sewer		Pumping Station		Treatment Facilities		(A) Sub-Total		(B) Engineering Fee Design		(B) Engineering Fee Supervision		(C) Contingency		Land Acquisition		Total	
Name of sub-zone	Local Currency	Foreign Currency	Local Currency	Foreign Currency	Local Currency	Foreign Currency	Local Currency	For'n Currency	Local Currency	For'n Currency	Local Currency	For'n Currency	Local Currency	For'n Currency	Local Currency	For'n Currency	Local Currency	For'n Currency	Local Currency	For'n Currency
A - 2	1,869	330	4,903	865	236	320	364	729	7,372	2,244	481	-	481	-	1,667	449	0.09	-	10,001.09	2,693
B - 2	1,300	229	2,434	429	279	231	518	1,007	4,531	1,896	321	-	321	-	1,035	379	9	-	6,217	2,275
B - 3	296	52	1,162	205	-	40	122	289	1,580	586	108	-	108	-	359	117	-	-	2,155	703
C - 2	1,537	271	4,626	816	355	671	306	624	6,824	2,382	460	-	460	-	1,549	476	18	-	9,311	2,858
D - 2	1,929	341	3,361	593	269	231	393	781	5,952	1,946	395	-	395	-	1,348	389	1	-	8,091	2,335
Total	6,931	1,223	16,486	2,908	1,139	1,493	1,703	3,430	26,259	9,054	1,765	-	1,765	-	5,958	1,810	28.09	-	35,775.09	10,864

46,639

Note: (1): excluding SEDC developed area

(B): design fee and supervision are estimated as (A+B) x 0.05 respectively

(C): (A + B) x 0.20

Construction costs of pumping station is based on peak flow in the each sub-zones in the year 2000.

Construction costs of treatment facilities is estimated for improvement cost of ponds and installation cost of acrators.

Table 5.23-2 Summary of Sewerage Construction Costs for Non-Staged Sewerage Sub-Zones (A-2, B-2, B-3[1], C-2 and D-2)

(Private Contribution)

(M$1,000 at 1979 Price Level)

Item / Name of Sub-Zone	Branch & Lateral Sewer		House Connection		(A) Sub-Total		(B) Engineering Fee Design		(B) Engineering Fee Supervision		(C) Contingency		Total	
	Local Currency	Foreign Currency	Local Currency	Foreign Currency	Local Currency	Foreign Currency	Local Currency	For'n Currency	Local Currency	Foreign Currency	Local Currency	Foreign Currency	Local Currency	For'n Currency
A - 2	7,110	1,255	3,522	621	10,632	1,876	625	-	625	-	2,251	375	14,133	2,251
B - 2	6,053	1,068	3,777	667	9,830	1,735	578	-	578	-	2,197	347	13,183	2,082
B - 3	923	163	643	114	1,566	277	92	-	92	-	350	55	2,100	332
C - 2	6,895	1,217	3,123	551	10,018	1,768	589	-	589	-	2,239	354	13,435	2,122
D - 2	3,308	584	2,777	490	6,085	1,074	358	-	358	-	1,360	215	8,161	1,289
Total	24,289	4,287	13,842	2,443	38,131	6,730	2,242	-	2,242	-	8,397	1,346	51,012	8,076

59,088

Note: (1): excluding EDC development area

(B): (A) x 0.05

(C): (A+B) x 0.20

15 percent of sewer construction cost is estimated as foreign currency, and no foreign currency is estimated for engineering fee.

10.4 Recurrent Costs by Stage

Recurrent cost including operation, maintenance payroll and administration costs by Construction Stage is shown in Table 5-24 at 1979 price level, based on Tables 5.19, 5.20, 5.21, 5.22, 5.25 and operational maintenance cost estimate procedure explained in Section 8.2, Chapter 5, and schedule of estimated staff requirement in Section 2.5, of Volume III.

Table 5.24 indicates the recurrent costs by Stage incurred by the contributions both by the Government and Private sectors separately.

It is recommended that all sewerage facilities as indicated "Public Portion" in Table 5.24 except for house connection (private sewer) be operated and maintained by the MPKS.

Recurrent costs for the sewerage facilities which are not included in the staged construction programme (non-staged sewerage facility) in Table 5-18 are not estimated in this report because of uncertainty for future development of those areas.

Table 5-24 Recurrent Costs for Sewerage System by Stage

(Cumulative)

(M$1,000 at 1979 Price Level)

Description	First Stage (1981-1985)	Second Stage (1986-1990)	Third Stage (1991-1995)	Fourth Stage (1996-2000)
(1) Public Portion (Operated by MPKS)				
(a): Operation and Maintenance Cost				
(1) Trunk Sewers	110	315	495	710
(2) Branch & Lateral Sewer	90	370	835	1,440
(3) Pumping Station	510	1,165	1,690	2,740
(4) Treatment Facilities	115	300	470	650
(b): Administration and Payrool	920	1,070	1,395	1,395
(c): Contingency	92	107	140	140
Total	1,837	3,327	5,025	7,075
(2) Private Portion: House Connection (Operated by Individual)	65	145	255	365

Table 5.25 Average Annual Recurrent Costs for Sewerage System by Stage

(Cumulative)

(M$1,000 at 1979 Price Level)

Description	First Stage (1981-1985)	Second Stage (1986-1990)	Third Stage (1991-1995)	Fourth Stage (1996-2000)
(1) Public Portion(Operated by MPKS):				
(a) Operation and Maintenance Cost				
(i) Trunk Sewers	22	63	99	142
(ii) Branch & Lateral Sewer	18	74	167	288
(iii) Pumping Station	102	233	338	548
(iv) Treatment Facilities	23	60	94	130
(b) Administration and Payroll(*)	184	214	279	279
(c) Contingency(**)	18	21	28	28
Total	367	665	1,008	1,415
(2) Private Portion: House Connection	13	29	51	73

Note: (1)(*) Payroll is estimated from "Schedule of Estimated Staff Requirement" in Section 2.5 "Staff Requirement" of Volume III (Institutional Study).

(2)(**) Contingency is estimated to be 10% of payroll.

11. INTERIM MEASURE

11.1 General

In view of the fact that implementation programme for the sewerage system of the City as discussed in previous Chapters imposes long period of time and considerable amount of capital funds for construction, and it is ,therefore, considered necessary to establish an Interim Measure for immediate implementation to improve existing environmental condition until sewerage facilities are completed.

Basically, the purpose of this programme as an Interim Measure is to develop the general approach to be performed for immediate improvement of the sanitary conditions with limited resources to be incorporated with the overall sewerage system programme in the future.

To develop the most effective means of an Interim Measure,comprehensive survey and investigation on the existing sanitary condition in the Study Area have been carried out through the actual field works during the course of the Project. The requirements for improvement of the sanitary conditions are then identified on the basis of the findings of field survey. Following paragraphs deal with the results of analysis on the existing sanitary conditions which deserve immediate attention and recommendation for the interim measure.

11.2 Water Pollution and Its Cause

From the results of the survey on existing water pollution as discussed in details in "Water Quality Study" Appendix B, it is summarized as shown in Table 5-26.

As presented above table, the main sources of the present water pollution are the wastewater discharge from the Public Market, the General Hospital, car repair workshops in Mergong, and sea food factories in Kuala Kedah. The wastewaters originated from these sources discharge into many of water courses namely Sungai Raja, Sungai Derga, Drain 6 referred in Appendix B, and road side drains. These rivers and drains are heavily polluted by discharge from above sources together with domestic, commercial and institutional wastes, and illegal dumping of garbage thus resulting in blockage many places. Generally, since these water ways are flat invert slopes owing mainly to the topographic condition of the area, with gentle ground surface gradient and low ground elevation, these are liable to become the stagnated conditon, anaerobic and odorous.

11.3 Implementation of Existing Programme.

In addition to the recommendation itemized in Table 29, there are useful programmes already on-going, which are contributing to the general sanitation of the area. It would be useful to continue these programmes with vigor, and they are referred briefly in the followings:

(1) Kota Setar Municipal Council Anti-Litter By-laws, 1979

The Anti-Litter By-laws 1979 enforced in February 1979 by the Municipal Council, is intended to keep the cleanliness and beauty in the locality of Kota Setar Municipal Council and for the harmony of all the residents.

Any person found guilty shall be liable to a fine not exceeding M$2,000 or inprisonment not exceeding one year. Amount of a find collected from March to July 1979 is more than M$5,000.

In spite the organization of inspection is not currently sufficient in MPKS, the implementation has proven to be useful and will increase its effectiveness against illegal dumping of garbage and others.

(2) Gotong-Royong

Gotong-Royong which means work together, involves cooperative and voluntary movement of cleaning environs by residents under leadership of MPKS, namely sending officers of MPKS and arranging cleaning equipments including lorries.

Although this movement could not be carried out frequently due to arranging schedule through out Kota Setar, it is expected to interest residents in keeping their environs clean as effective media for public education.

(3) Communal Waste Treatment Facilities

In addition to the above, to contribute to water pollution control, the Ministry of Health has planned to install communal wastes treatment plant which treat both sullage and excreta for new developing of housing area, since existing housing areas, more than forty in number by private developers, include communal or individual septic tanks for the treatment of excreta, while sullage is discharged without any treatment.

This plan should also be regarded as interim programme to be implemented immediately together with other measures already referred.

11.4 Recommended Interim Measure

The Interim Measure is mainly dealt with economically and technically feasible countermeasure against water pollution.

The recommendation is carefully considered and is discussed in Table 5-27, which should be followed by frequent cleaning operation of the water ways.

Table 5-26 Water Pollution and Its Cause

Area	Water Way	Origin of Water Pollution
Alor Setar	Sg. Raja Sg. Derga Drain 6	Polluted by domestic, commercial and institutional wastes, due to flowing highly populated area. Stagnation occurred by illegal dumping of garbage.
	Wan Mohamad Saman	From middle reach to downstream, polluted by domestic wastes and wastes from the Public Market.
	Roadside Drain Jl. Sultanah	Polluted by wastes from the General Hospital
	Roadside Drain Mergong	Polluted by waste oil from care repair workshop. Waste oil are originated from car washing process and illegal dumping.
Kuala Kedah	Roadside Drain town center	Polluted by domestic wastes
	Roadside Drain Industial Estate	Polluted by trade wastes from sea fish processings Factories.

Table 5.-27 Point Sources of Water Pollution and their Interim Measure.

Point Source	Causes of waste	Countermeasure	Interim Measure
Public Market	. Bleeding of poulty processing . Tables of fish and meat selling. . Cook stalls	Although wastes treatment facility should fundamentaly be necessary, astes load will be decreased by recovering blood from poulty processing.	Recovering blood from Poulty processing
General Hospital	. Cooking wastes . Laundry wastes . Malfanctioning of septic tanks	Already planned to install new septintanks which are capable to treat bota sullage and excreta.	Installation of septin tanks which treat both sullage and excreta.
Car Repair Workshops in Mergong	. Waste oil from car waking process and illegal dumping	. Installation and operation of oil traps for washing process. . Prevention of illegal dumping of waste oil.	Same as left
Sea fish processing factories in Kuala Kedah	. processing	. Although fundamentaly waste treatment facility should be necessary. A certain amount of waste load will be decreased by plain sedimentation.	Installation of plain sedimentation tank for every factory. Bottom sediments are re-used to be fish meal or powder.

12. BENEFITS

12.1 Anticipated Benefits

Significant benefits to public health of the community can be derived from installation of an adequate sewerage system in the sewerage implementation area. The benefits to be derived from the construction and operation of the recommended sewerage system can be grouped into several categories, namely (1) health benefits, (2) environmental benefits, (3) economic benefits, and (4) general benefits.

All anticipated benefits have been evaluated for the sewerage project on the basis of either quantifiable or nonquantifiable benefits.

12.2 Recognition and Measurement of Benefits

Associated benefits through a more pleasant community environment, greater potential for tourism, opportunity for more intensive land use, and opportunities to facilitate housing and industrial construction, together with a cause of other less tangible benefits have been identified.

Major benefits resulting from the improvement of health conditions, environmental aspect, increases in land values, and from reduced expenditure for sanitary facilities are quantified as follows.

12.2.1 Health and Sanitation Benefits

The one of the major benefits from the proposed sewerage system will be the sanitation improvement resulting from removal of human excreta and other wastes from the community.

Anticipated benefit resulting from the sewerage system can be measured if the cause and effect relationship of the sewerage system to incidence of the water-borne diseases and to the levels of mortality and morbidity of the populations served by the system, are determined, and if reduction of pertinent diseases are estimated on the basis of reasonable assumptions.

A statistical data obtained from State Health Department indicates that the number of water-borne diseases including cholera, typhoid and gastro-entritics diseases in the Study Area is 4,917 per year by an average occurred in the past two years (1977 and 1978) as presented in previous Chapter (Section 5, Chapter 3). Also, a survey on the cost for treatment of the diseases at 1979 price level indicates that expenses for treating water-borne diseases, including amounts spent for medical care, cost about M$31 per person per day for an average of two weeks hospitalization. To estimate the benefit to be derived from the sewerage system, it is assumed that approximately 50 percent of these is attributable to unsatisfactory excreta disposal, and if this can be eliminated by the sewerage system, then this represents a quantifiable cost of about M$1,067,000 per year (4917/2 x 31M$ x 14 days).

The main elements of indirect cost can also be calculated assuming the average wage lost and the number of man-days lost due to disability. The wage loss is estimated to be about M$174,000 per year on an average at 1979 price level; assuming from the data collected that the average income of labour participation group is M$275 per person per month. This is on the basis of assumption that the incidence and age distribution of diseases to be affected for assumption of wage loss will be limited to the labour force, which is approximately 55 percent of the total population, excluding unemployment factor.

In addition, other benefits, although mostly unquantifiable, are expected, including (1) reduction of discomfort and distress, (2) improvements in environmental aesthetics from elimination of the present sewage odours emanating from drains and sludge accumulation, (3) reduction of groundwater contamination resulting from improved measures for handling sanitary wastes.

12.2.2 Water Pollution Control Benefits

From the extensive investigation to the drains and rivers under the present project (Ref. Appendix B), most of drains in urbanized area of the Study Area have been polluted and are expected to become much polluted in the future. Also rivers will be polluted from the drain flows. Currently, these drain and river waters are used for the purpose of fishing, etc.

The reduction of waste loads or improvement of water quality in the drains and rivers is,therefore,the major benefit to be derived from the sewerage system. Waste loads in sewered areas will be reduced considerably through the treatment plant and will improve the river water qualities.

12.2.3 Values Added to Land

Investment in sewerage facilities will have the effect of raising the intrinsic values of the parcels of land served by the system. These additional land values constitute a major economic benefit of the project in that, by improving the sanitary and aesthetic quality of the community, they not only contribute to the quality of life of the residents, but also to contribute as additional source of taxation for the revenue in favour of government authorities. The value of such benefit is measured by the additional price observed in the areas where similar projects have been carried out, that buyers are willing to pay for properties on which such physical improvements have been made.

On the basis of the data obtained at project site during 1979, the present land value in the study area is rated to an average of M$30/$m^2$ by the categories of land use employed (i.e. institutional and commercial area of 70 ha, residential area of 1,218ha, industrial area of 46.5 ha, and agricultural area of

1,290 ha). It was also obtained that the existing value for the study area is on the basis of calculation and development were M$0.5/m^2 for built-up urban area and developed industrial area respectively. Hence, total land value of the whole area excluding areas for park, public land, schools, mosques, temples, roads, river and railways is estimated to be about M$770 million at 1979 price level.

After the Study Area is improved by development programme based on the land use envisaged by the year 2000, the land value would be increased to an average of M$60/m^2 by an assued 3.5% of annual increase of land, taking into account of recent trend of land value increase plus value derived by installation of sewerage facility in the land. Then, land value for the whole area is estimated to increase to M$1,760 million approximately.

For evaluation of the benefit derived from the increase in land values, it is assumed that 20 percent of land value increased is attributed by the construction of sewerage system, then quantifiable cost is estimated to be approximately M$198 million at 1979 price level [(1,760 - 770) x 0.2] million.

12.2.4 Benefits by Reduced Expenditure for Sanitary Facilities

As discussed in Section 8, Chapter 3, the existing excreta disposal systems in the Study Area are mainly represented by two systems namely, septic tank and bucket. For operation and maintenance of these facilities, MPKS has to expend approximately M$64,464 in the year 1979, estimated based on the actual expenditures in which MPKS paid to the contractors so far, at an average monthly service fee of M$5,372, covering 2,533 bucket system. For septic tank, no available data has been obtained in the Study Area. Therefore, an assumption is made based on the data on past experience in Malaysia. The available data in Malaysia indicate that an annual expenditure for operation and maintenance for septic tank is of M$12.2 per capita at 1976 price level.

Note: (1) Population served by either septic tank and bucket system is estimated by assuming of 5.5 persons/household.

(2) Estimated annual maintenance cost for proposed sewerage system includes all cost for trunk, branch and lateral, house connection, pumping station and treatment facilities.

12.3 Benefit Justification

On the basis of the results of evaluations of benefits by the proposed sewerage system for the Study Area, both tangible and intangible, it is concluded that the Project is definitely justifiable. If no sewerage system were provided in the areas, sanitary conditions, which are already deplorable in many areas of the city, will become progressively worse. Moreover, if this Project is not undertaken at this time, the cost for implementation at later times will become increasingly higher. Thus the accumulated total cost could become so high that Project could become almost unmanageable. The Project, therefore, is indeed timely now.

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