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

VOLUME II

SEWERAGE MASTER PLAN

MARCH 1981

JAPAN INTERNATIONAL COOPERATION AGENCY

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

Guide to the Reports

The Reports consist of the following,

VOLUME I	:	SUMMARY
VOLUME II	:	SEWERAGE MASTER PLAN REPORT
VOLUME III	:	DRAINAGE MASTER PLAN REPORT
VOLUME IV	:	SEWERAGE FEASIBILITY STUDY REPORT
VOLUME V	:	DRAINAGE FEASIBILITY STUDY REPORT
VOLUME VI	:	INSTITUTIONAL STUDY REPORT
VOLUME VII	:	APPENDICES (FOR VOLUME II)
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VOLUME II - SEWERAGE MASTER PLAN REPORT

ORDER OF PRESENTATION

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LIST OF ABBREVIATIONS

ACP	- Asbestos cement pipe
ASTM	- American Society for Testing Materials
BOD	- Biochemical oxygen demand (3-day, 30 degrees C)
CRCP	- Centrifugally cast reinforced concrete pipe
DE	- Department of Environment, Ministry of Science, Technology and Environment
DID	- Drainage and Irrigation Department, Ministry of Agriculture and Fisheries
DO	- Dissolved oxygen
DWF	- Dry weather flow
EHEU	- Environmental Health and Engineering Unit, Ministry of Health
EPU	- Economic Planning Unit, Prime Minister's Office
ft	- feet
FTCP	- Federal Town and Country Planning
g/cap	- grammes per capita
g/day	- grammes per day
gal	- Imperial gallons
gal/cap	- gallons per capita
gal/day	- gallons per day
GDP	- Gross Domestic Product
GSD	- Federal Geological Survey Department
ha	- hectares
hr	- hours
IBRD	- International Bank for Reconstruction and Development
IMF	- International Monetary Fund
kg	- kilogrammes
km	- kilometres
l/day	- litres per day
l/day/cap	- litres per day per capita
l/sec	- litres per second
m	- metres
m^2	- square metres
m^3	- cubic metres

LIST OF ABBREVIATIONS (Continued)

MADA	- Muda Agricultural Development Authority
mg/l	- milligrames per litre
mil	- miles
MLG	- Ministry of Local Government
mm	- millimetres
MPKS	- Majlis Perbandaran Kota Setar (Municipal Council Kota Setar)
MPN	- Most probable number
MS	- Meterological Station
MSWL	- Mean Sea Water Level
NEB (LLN)	- National Electricity Board (Lembaga Letrik Negara)
p/ha	- persons per hectare
pH	- Hydrogen iron potential
ppm	- parts per million
PVCP	- poly Vinyl chloride pipe
PWD (JKR)	- Public Works Department, Ministry of Works and Utilities (Jabatan Kerja Raya)
RCP	- Reinforced concrete pipe
SDID	- State Drainage and Irrigation Department
SEDC	- State Economic Development Corporation
SEPU	- State Economic Planning Unit
SLO	- State Land Office
SMHD	- State Medical and Health Services Department
SS	- Suspended solids
STCP	- State Town and Country Planning
VCP	- Vitrified clay pipe
WHO	- World Health Organization
yr	- years

CONVERSION FACTORS

Multiply imperial unit by figures in multiplier column to obtain metric (Sl) equivalent; multiply metric (Sl) unit by reciprocal to obtain imperial equivalent.

Imperial Unit	Multiplier	Metric unit	Reciprocal
acre	0.4047	hectare (ha)	2.471
ft	0.3048	m	3.281
ft/s	0.3048	m/s	3.281
ft^2	0.0929	m^2	10.76
ft^3	0.02832	m^3	35.31
ft^3/s (cusec)	0.02832	m^3/s (cumec)	35.31
gal	4.546	litre	0.220
gal	0.004546	m^3	220
hp	0.7457	kW	1.341
in	25.40	mm	0.03937
lb	0.4536	kg	2.205
lb/ft^2	4.881	kg/m^2	0.2049
lb/ft^3	16.03	kg/m^3	0.06243
mile	1.609	km	0.6214
$mile^2$	2.589	km^2	0.3862
ton	1.016	tonne	0.9842
yd	0.9144	m	1.094
yd^2	0.8361	m^2	1.196
yd^3	0.7646	m^3	1.308

CHAPTER 1
SUMMARY

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

(a) Develop a comprehensive master plan in which the major elements are properly forecast and generally defined in successive phases to meet the present and future needs in the Study Area up to the 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 sanitary and environmental conditions 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 and 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 in Figure 4.1 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 covering most of the sewerage zone in various sizes and scales except Kuala Kedah areas.

- Except for 21 units served by communal septic tank system, more than 23,600 households are disposing of their excreta either through bucket collection system, individual septic tank, or pit privy/borehole latrine.

- The major 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 existing drains and roadside ditches, mostly acting as a combined sewer at present, are receiving 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 the eastern part of Jl. Sungai Korok; extended area along the Sg. Raja and surrounded area by the Sg. Raja and Sg. Derga, especially Jl. Telok Wan Jah area; and extended area along the 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 an increasing trend in the number of these incidences.

- The current population is assumed to be 139,600 with an average density of 42 persons per ha, which is projected to be 318,300 with an average population density of 96 persons per ha in the target year an 2000 for the Study Area, ranging from 53 to 103 persons per ha, excluding roads, rivers, railway, public spaces, etc..

4. Outline of Proposed Sewerage System is as follows:

- Construction of the system is separated into four phases 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, in which the existing open drainage channels

can be used for collecting 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 5.2 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) 47 km (29.5 miles) of trunk sewers with sizes of 375 to 1050 mm and 380 km (237.3 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 5-2.

- 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 within the whole Study Area according to the actual need and urgency in the Area. Six assessment elements are considered for the evaluation of the urgency, namely, (1) population density, (2) development condition, (3) waste load generation, (4) existing disposal system, (5) flood condition, and (6) incidence of water-borne diseases. A rating procedure has been developed to all the sub-zones of the five

sewerage zones by assigning reasonable relative weights to these six elements. The evaluation result over the entire sewerage sub-zones is in the implementation priority order of B-1, D-1, E, C-1, A-1, D-2, B-3, B-2, A-2 and C-2 as shown in Table 5.13.

- 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 worthy to undertake sewerage construction, M$ 17million is considered appropriate to be contributed by the Government in the five(5) year First Phase (1981-1985) at 1979 price level.

  Assuming annual construction cost escalation for the successive phases from 1979 price level on the basis of the past economic growth rate of the nation, construction costs for Second, Third and Fourth Phases for public sewerage facilities are augmented to be M$ 18.53, 21.76, and 26.71 millions respectively.

- In the same phased areas, the private portions raised from private sector are estimated to be M$3.84, 6.02, 10.34, and 10.38 million for First, Second, Third and Fourth Phases respectively (Refer to Table 5.15). Those phased construction costs can provide sewerage facilities

for an area of 187 ha in the First Phase (1981-1985), similarly 340 ha, 438 ha, and 572 ha in Second (1986-1990), Third (1991-1995), and Fourth (1996-2000) Phases respectively.

- The remainder of sewerage sub-zones (i.e A-2, B-2, B-3, C-2, and D-2) not considered in the phased construction schedule needs M$111.0 million, 49.1 million as Government contribution, and 61.9 million as private contribution at 1979 price 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 phased area to be M$1.84 million, 3.33 million, 5.03 million, and 7.08 million respectively (refer to Table 5.22).

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

5. The following interim measures are considered practicable with minimum financial burden to the MPKS and beneficiaries concerned:

- Improve the existing unsanitary excreta disposal system.

- Provide a sanitary sewerage system for housing development areas with sewers collecting both foul and sullage water together with temporary stabilization ponds. These sewer systems should be converted as a part of overall sewerage system when connected to converted as a part of overall sewerage system when connected to the municipal sewerage system by discharging the temporary stabilization ponds.

- Existing individual and communal septic tanks should be desludged more frequently as suggested in section 2.1 Chapter 6 to maintain normal function of the tanks, improving effluent quality to the waterways.

- Major pollutant sources of the city, which are heavily loading down-streams pollution and/or deteriorating living environment of the residents, should be eliminated by proper interim measures at the sources as recommended in section 2.2 Chapter 6.

- The existing gotongroyong practice should be continued to encouraged for the beautification of the living environment, together with further surveillance on the Kota Setar Municipal Council Anti-Litter By-law enacted recently.

CHPATER 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 activities expands, so will the waste loads be generated, thus affecting living environment in the area. Present wastewater generated in the area is expected to increase up to 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 the new housing area. Most of sullage water and trade wastewater are undiscriminately discharged directly into near by drains and other available watercourses, and human excreta from houses are disposed of either through septic tank or conservancy system (bucket system). As of 1979, there are approximately 25,400 households in the Study Area (as shown in Table 3.8), of which 1,770 households are served by communal septic tank for excreta disposal and the remainder by less satisfactory excreta disposal systems such as private septic tank, conservancy 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 overload beyond self-purification capacity.

The rivers become increasingly polluted while flowing through the build-up areas in the city. The Sg. Anak Bukit, for example, is significantly polluted by the waste loads from the houses, shops and industries, reducing 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 adequate social activities as the provincial government seat of Kedah State and regional centre of Kedah-Perlis area.

It should be mandatory, therefore, to develop a comprehensive sewerage master plan with phased investment programme up to the year 2000 to maintain a reasonable 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 the Government of Japan for technical co-operation in conducting the study to develop a master plan for sanitary sewerage system (The drainage study for Kuala Kedah is included in the scope of work and its report is presented in Volume III for Alor Setar and its urban environs.)

CHPATER 3

BACKGROUND DATA AND INFORMATION FOR THE STUDY

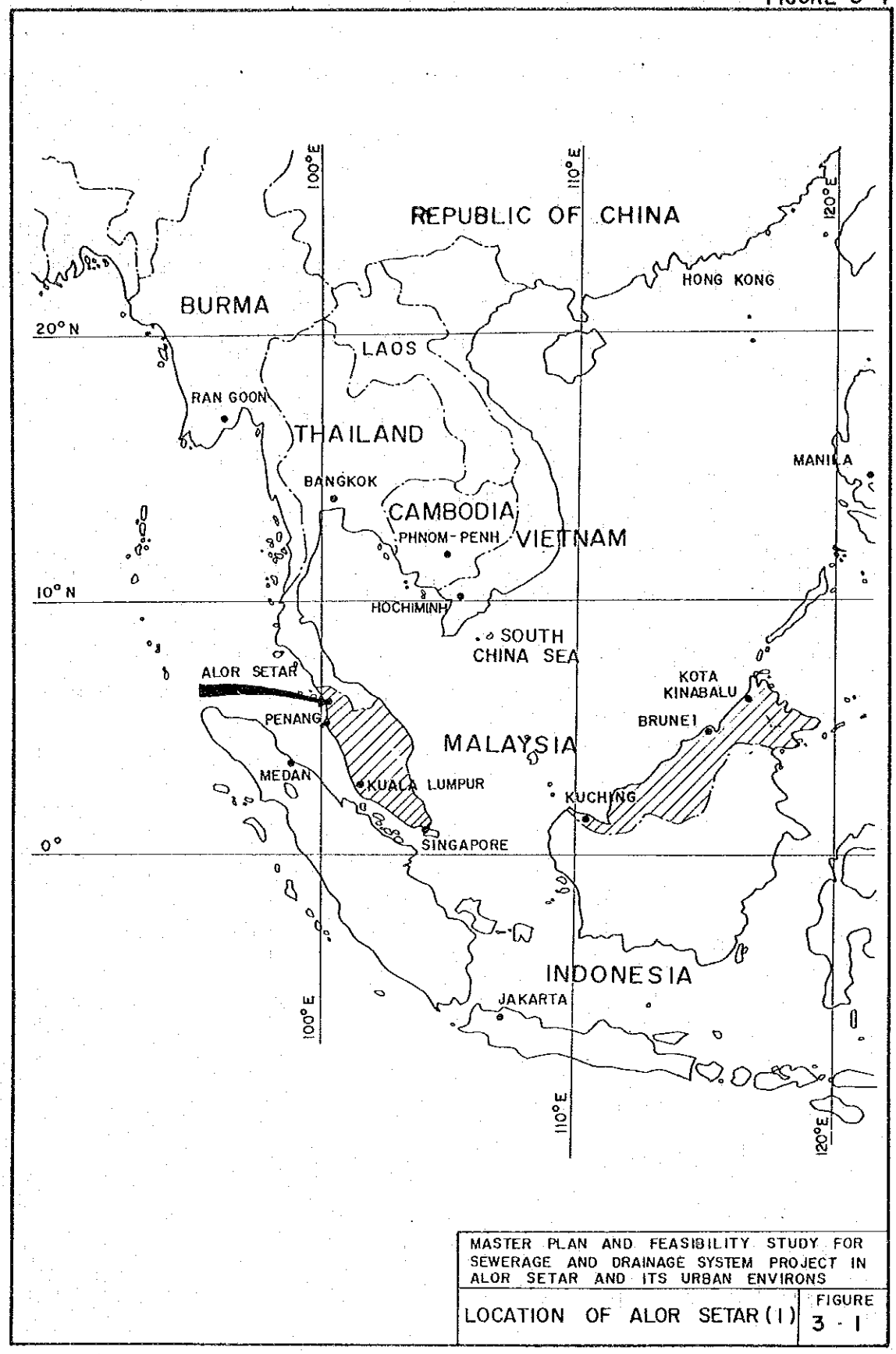
1. LOCATION OF ALOR SETAR

The State of Kedah is situated within the latitudes N 5°05' - N 6°32' and longitudes 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, Langkawi, Kubang Pasu, Padang Terap, Kota Setar, Sik, Yan, Kuala Muda, Baling, Kulim, Bandar Bahru and Pendang (See Figure 3.2).

Alor Setar, the State capital, 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.

FIGURE 3 · 1



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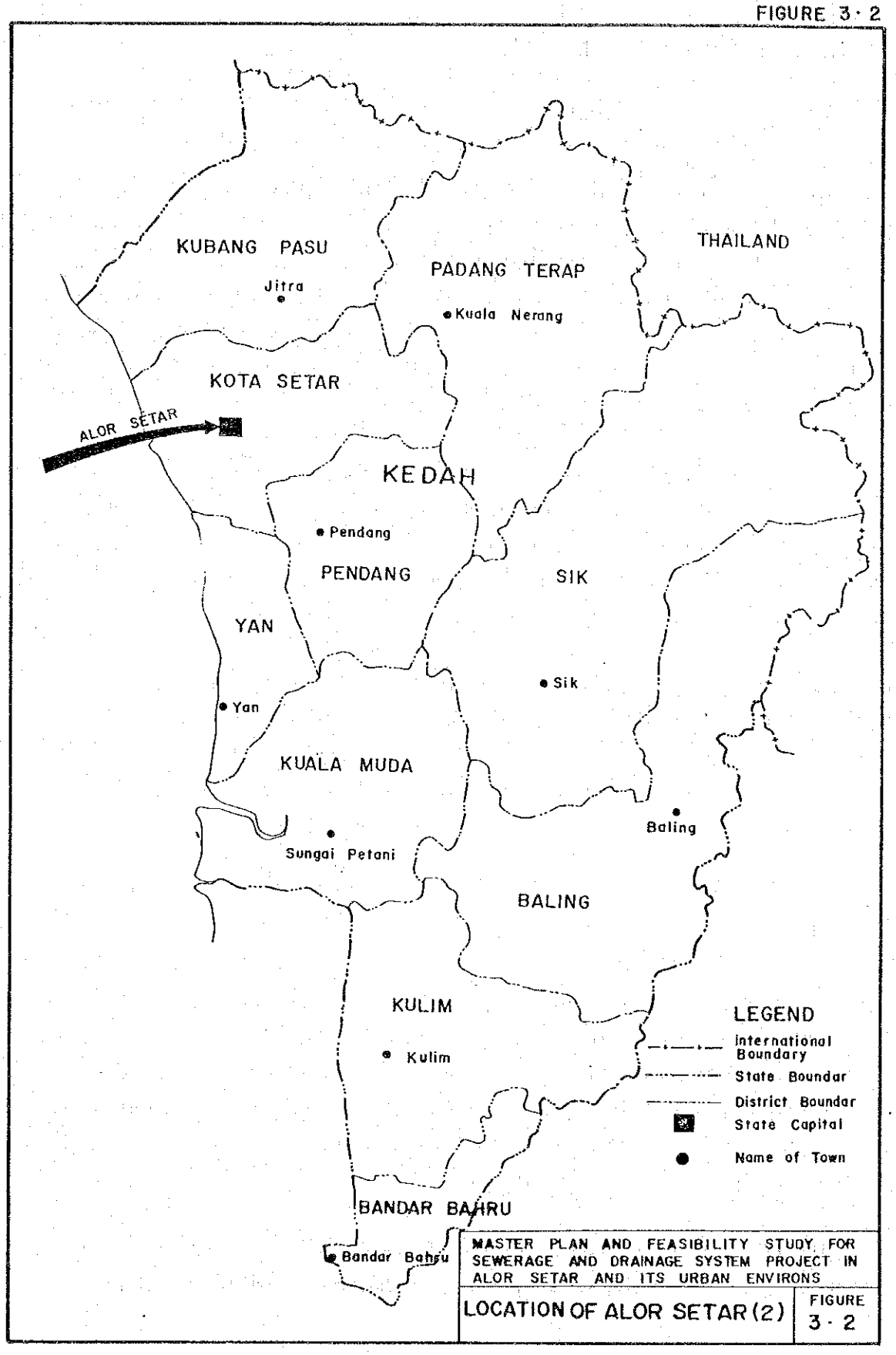
LOCATION OF ALOR SETAR (1) — FIGURE 3 - 1

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 Area 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 fine sand. The water table in the area is generally high with an average elevation of about 1.0 m (3 ft) below the ground surface.

The Sungai Kedah and Sungai Anak Bukit with many small branch streams within the tributaries run through the Study Area. The topography of the area is characterised essentially by a very flat low-lying plain ranging from 1.2 m (4 ft.) to 2.4 m (8 ft.) above mean sea water level (See Figure 3.3).

Most of the rivers are tidal in flow characteristics 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 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 generally bearable but 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

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 during these seasons, 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 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 gusty 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 and minimum monthly 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 Meteorological Station in Alor Setar are shown in Table 3.1-1. Also, rainfall records from 1946 to 1977 are shown in Table 3.1-2.

Table 3.1 - 1 Temperatures, 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

Table 3.1-2 Rainfall Records (1946 to 1977)

(unit: mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	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	2330.6
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	11.9	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°12', Longitude 100°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 major exporter of rubber, palm oil, tropical hardwood timber and pepper. However, it is now diversifying into industry to include 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 of the low external demand for the manufactured goods.

The Government gives high priority to labour intensive, agro-based 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 qualified 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 VII - Appendices.

3.2 Regional Economy

The State of Kedah has a population of approximately 993,000 as of 1970. A major portion of the population is relatively young with 43 per cent in the 0 - 14 years age group, indicating a high dependency ratio. According to the 1970 Census data, the working population is estimated as 366,000. 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 as 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. Kedah State supplies about half of Peninsular Malaysia's demand for rice.

The Federal and State Governments have given high priority and attention to promote the development of various activities, including industries, commercial and infrastructural system in the undeveloped areas in the State. Development projects for agricultural and industrial sectors have been proposed, adopted and implemented. Details are described in Appendix A of Volume VII - 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 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, and 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 focussed upon. The transportation facilities between Alor Setar and Butterworth/George Town where shopping facilities are available has further enhanced the position of Alor Setar as a trading centre. As a service centre, the city also plays a dominant role for Perlis as the State of Perlis is too 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 also high compared to the other towns in the State of Kedah. The Government has planned to undertake further development in the 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 53 ha (130 acres) has been completed while the Phase II which has an area of 41 ha (100 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, 2) Jl. Sungai Korok, and 3) Barrage Site, Mergong, convering a total area cf 107 ha (263 acres).

4. LAND USE AND POPULATION

4.1 Present Land Use

The present land uses in Alor Setar and its urban environs have been prepared by STCP covering the whole of the Study Area. The entire area is divided into the following nine categories with relative percentage of shares as shown in table 3.2 and Figure 3.4.

Table 3.2 Present Land Uses in the Study Area

Land Use	Area (ha)	Percentage
Residential Area	1,218.0	36.9
Commercial Area	80.0	2.4
Industrial Area	46.5	1.4
Agricultural Area	1,290.0	39.1
Open Space, Vacant Land, Public Land (*)	340.0	10.3
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 Sultant's Palace, LLN, MADA Office, General Hospital, Institutional Area, Prison, etc.

As has been the provincial seat of Kedah State, many government offices exist in the central 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 future housing development schemes will be mainly undertaken in this Area.

4.2 Present Population and Its Distribution

4.2.1 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 ever since.

The increase in population from 1971 to 1979 is estimated to be 27,216 persons taking 2.7 percent annual increase rate, applying the same percentage rate for Kota Setar in the Kedah-Perlis Development Study Report, 1978 (Ref. Appendix A of Volume VII).

In addition the increase in population due to the social growth between 1971 and 1975 is estimated to be 11,860 persons taking 0.8 percent, and 1.3 percent between 1976 and 1979, based on a survey carried out by the JICA study team.

Overall annual growth rate is, therefore, taken to be 3.5 percent from 1971 to 1975, and 4.0 percent thereafter, reaching a total estimated population of 139,600 in 1979 as shown in Appendix C of Volume VII.

4.2.2 Population Distribution

Present (1979) population densities are estimated as shown in Table 3.3 by using the existing land uses in Table 3.2 and Figure 3.4 and the estimated population distributions shown in Table C-2 and Figure C-2 in Appendix C.

Table 3.3 indicates that commercial area has the highest average population density (152.5 persons per ha), followed by residential area (95.3), industrial area (64.5), and agricultural area (5.8), and finally by others (1.2), thus being 42.3 persons per ha of gross area in average.

Table 3.3 Present Population Density by Existing Land Use

Land Use	Population	Area (ha)	Population Density (persons/ha)
Residential Area	116,100	1,218.0	95.3
Commercial Area	12,200	80.0	152.5
Industrial Area	3,000	46.5	64.5
Agricultural Area	7,500	1,290.0	5.8
Sub-Total	138,800	2,634.5	52.7
Others (Open Space, Vacant Land, Public Land, Railway, River Trunk Road, etc.)	800	665.5	1.2
Total	139,600	3,300.0	42.3

Note: Refer to Table C-2 in Appendix C in detail.

5. PUBLIC HEALTH CONDITIONS

5.1 Hospital and Health Services

There are five government hospitals in Kedah State with a total of 1,395 beds, which results in a provision of 1.40 beds per thousand population. Beside inpatient services these hospitals provide outpatient services and a 24 hour emergency service. The general hospital in Alor Setar is further supplemented by a polyclinic.

There is also a network of district health offices, health centres and midwife clinics in the State carrying out the following activities:

(1) medical and health services
(2) curative medical care/outpatient service
(3) communicable disease control
(4) malaria eradication
(5) environmental sanitation
(6) health administration

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 a significant 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. Furtheremore, nine cases and 21 carriers have been reported to the State Medical and Health Services 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 Cases of Contagious Diseases Treated in General Hospital in Alor Setar

Disease	Number of Patients Treated		
	1974	1975	1976
1. Inpatient			
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. Outpatient			
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 from Hospital and Clinics Operated by the Government

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 State Government of Kedah. 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 a 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 issued 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 quoted below:

- Code A (for domestic use, and for government quarters, departments, institutions, schools, clubs, bath houses, charitable and religious institutions and local authorities)
  Initial 13.64 m^3 (3,000 gal) at M$1.0 per 4.55 m^3 (1,000 gal), and each additional 4.55 m^3 (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 of trade)
  M$1.5 for each 4.55 m^3 (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 4.55 m^3 (1,000 gal)
- Code D (for ice factory, aerated water factories and swimming pools)
  M$2.5 for each 4.55 m^3 (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 improved 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 Lengkuas, 2) Bukit Wang, 3) Yan, 4) Perigi, and 5) Teloi; however, no water is taken during the dry season when the river water levels is low except in case of Lengkuas.

(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 20,457 m^3/d (4.5 mgd) and minimum 18,184 m^3/d (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 22,730 m^3/d (5.0 mgd).
- Phase III: constructed in 1978/1979 with rapid sand filters at the average production rate of 22,730 m^3/d (5.0 mgd).

The total production capacity of the treatment plant is thus 65,917 m^3/d (14.5 mgd). However, due to the insufficient provision of the distrubution pipes, the plant is presently producing an average of 54,552 m^3/d (12 mgd). Phase IV extension programme is now underway and expected to be completed in the next 3 or 5 years.

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.

Table 3.6 Monthly/Daily Water Consumption Rates Recorded at Bukit 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)	(Average)	
	17,794,425	48,752	

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

(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 Semut, Yan, etc. At some places, small capacity water reservoirs are provided to give higher water pressure to distrubute the water to the houses far away from the water plants. The network is interconnected and from time to time water is supplied from small water headworks located at Yan and Bukit Wang.

The clear 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) in 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 industrial 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 each 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 capita 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 and Jalan Bakar Bata confluenting into the Sungai Kedah slightly down stream of Badlisha 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 3.5. The Sungai Kedah runs about 10 miles westwards flowing through 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 a half 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 or to maintain water surface elevation above zero MSWL.

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 (SDID), while the secondary and other smaller drains are generally under the responsibility of MPKS. The drainage facility in the housing and industrial development schemes are to be provided by developers but after the facility 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 into 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 when coincided with spring tides, severe damages to government and private properties are caused, disrupting the activities of a large number of population.

An arrangement was made among the MADA, DID and MPKS to define the responsibility of each agency, especially in areas where urban development programme is planned. Under the arrangement, the irrigation facilities located within the designated urban development programme area are to be transfered to DID or MPKS 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 forces 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 the combined source of funds, of which 40 percent was furnished by IBRD loan and 60 percent 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

The Networks of irrigation channels for the paddy field within and around the Study Area of the Alor Setar town council are shown in Figure 3.5. Although the most of these channels exist in paddy field and are utilized only for irrigation purpose, some are used for both irrigation and urban drainage, since these channels run from paddy field to town and are connected to the urban drainage.

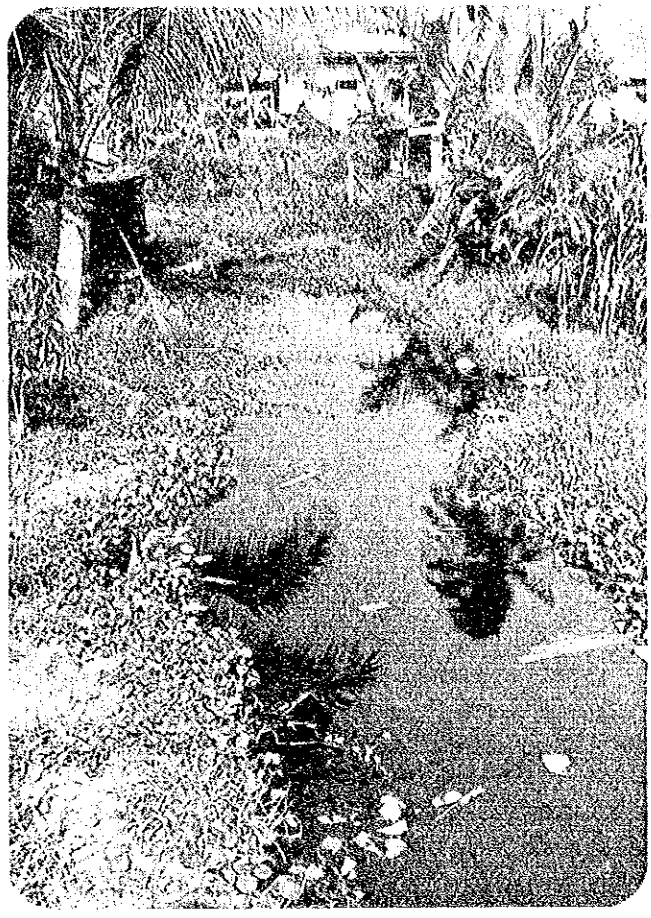


Photo 1 Natural drain at Jl. Titi Siam

Photo 2 Trunk drain at Jl. Sungai Korok

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

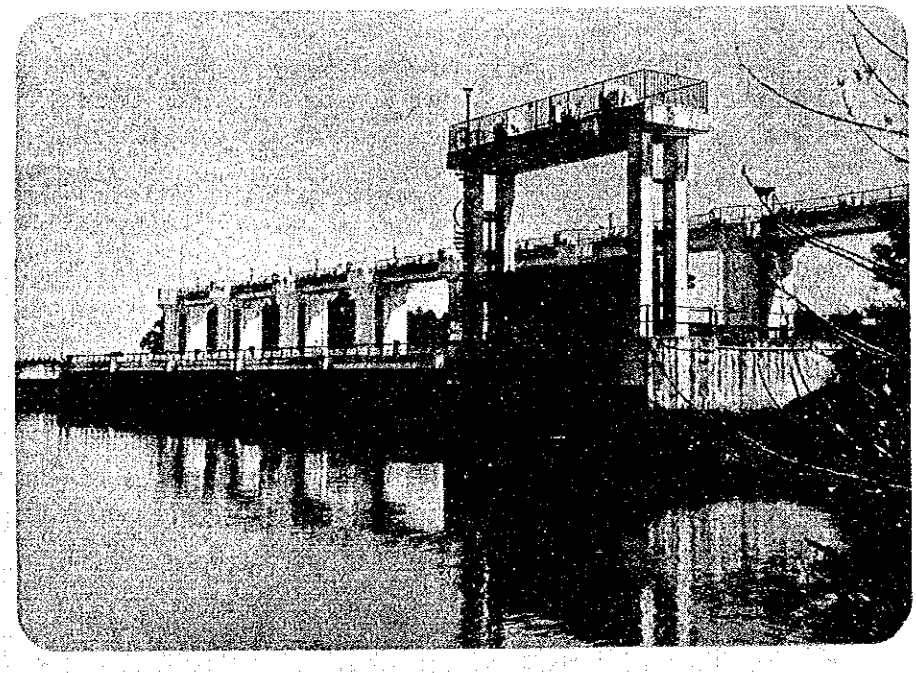


Photo 4 Tidal barrage near South Mergong Industrial Area

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 and numbers of households ulilizing the facilities are shown in Table 3.8.

Table 3.8 Excreta Disposal Facilities in the Study Area

Type of Facility	No. of Facility Exist	No. of Households
1. Flush toilet connected to individual septic tank	12,000	18,000
2. Flush toilet connected to communal septic tank (*)	21	1,770
3. Conservancy (bucket) system (**)	2,533	4,840
4. Others including latrine over water-ways, Pit privy/ borehole latrine	405	770
Total		25,380

Note: (1) (*), (**) Refer to Appendix A in detail
(2) Source: MPKS

There are two types of excreta 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 existing services is the conservancy system, of which 301 are double system and the remaining 2,232 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. The house owner request MPKS for desludging, when sludge accumulates in the tanks.

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 1,000 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 1.2 m (4 ft) by 1.2 m (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$5,783 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 properly selected septic tanks. The contents and effluents were sampled for analysis of BOD, SS and other items as shown in Table B-9 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.

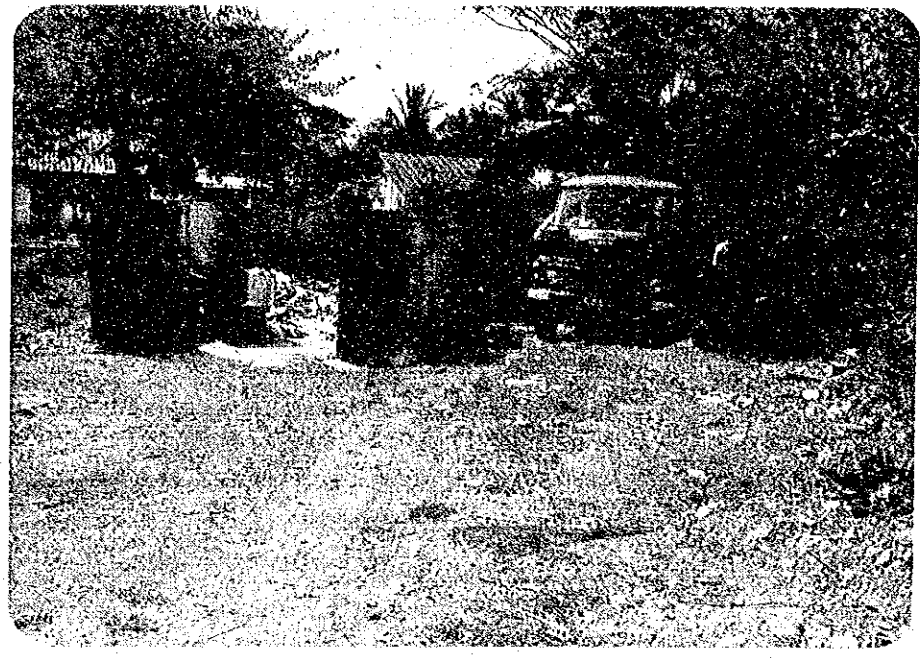


Photo 5 MPKS tank lorry in operation to withdraw septic tank sludge at Lorong Shariff

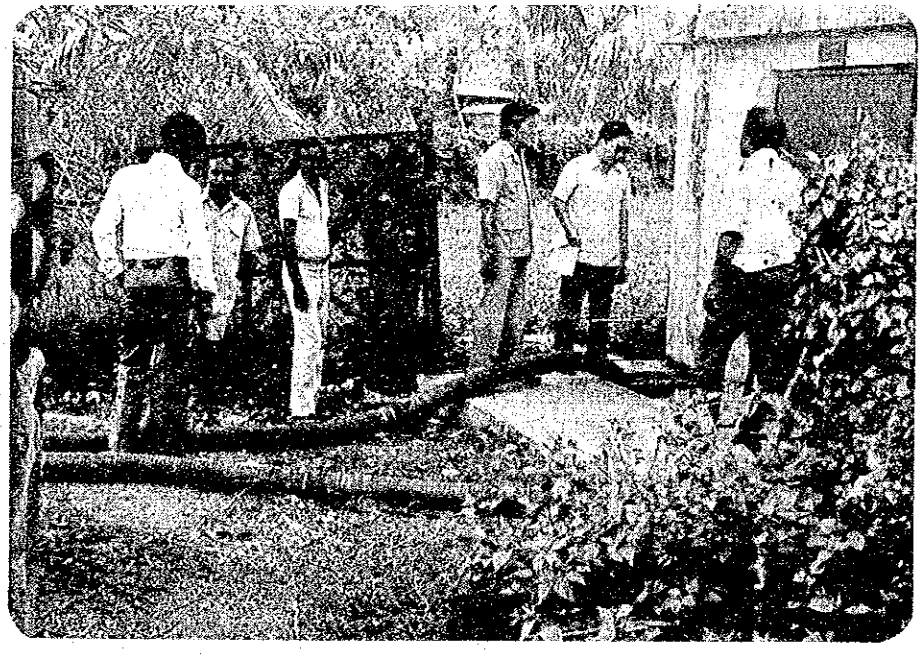


Photo 6 Suction hose of tank lorry

Photo 7 Excreta and sludge disposal site at Jabi

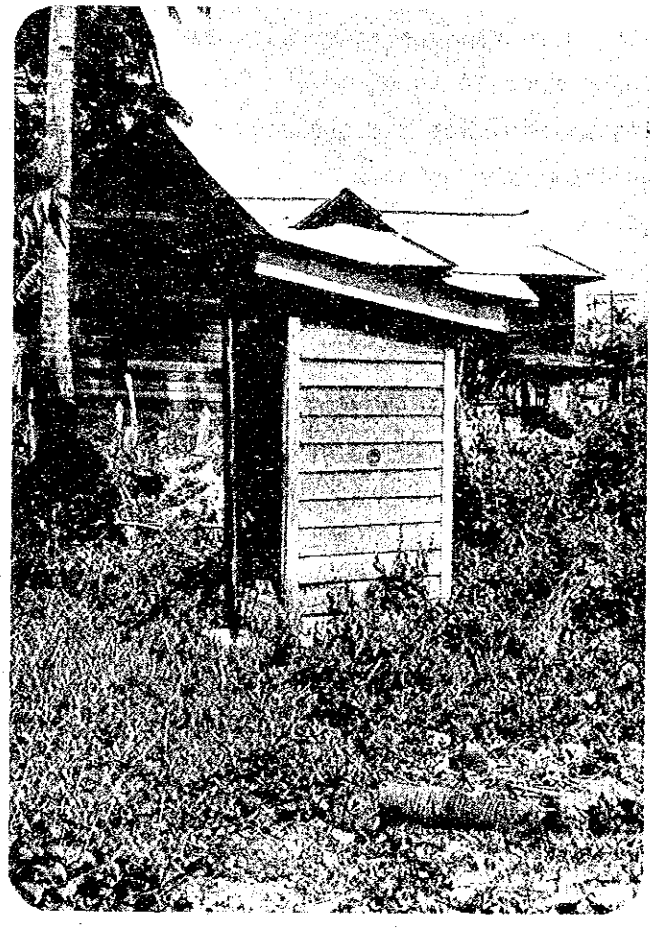


Photo 8 Conservancy toilet system

9. POLLUTION OF WATER COURSES

In addition to major two water courses - the Sg. Kedah and 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 beyond the Study Area, are affected by the volume, velocity organic deposits and inflow of wastewaters, and also 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, ranged from 14 to 66 mg/l in terms of BOD according to the various sampling points, but the qualities 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 trend according to seasons is expected to be observed for DO as well; reference Appendix B.

The results of wastewater quality analysis for 61 places of watercourses, including natural rivers and drains, carried out in June 1979 (wet season) are summarized in Figure 3.6. The results reveal that water qualities in small waterways are more heavily polluted than large waterways, due to the smaller dilution and self-purification capacities. The similar trend has also been observed for dry season according to waterways by site reconnaissance (Refer to Tables B-1, B-2 and B-5 in Appendix B in detail).

10. PREVIOUS STUDIES AND REPORTS REVIEWED

Outlines of the major relevant reports reviewed for this study 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, which is 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 includes identification 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 comply with the criteria in accordance with Street, Drainage and Building Act 1976.

(d) the land required for the sewerage treatment plant sites should be earmarked 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 major points;

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

(b) enhancing the status of Alor Setar to be the regional center by promoting industrial and service activities, transforming the structure of the economy by reducing 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 around the town, (2) the provision of a new industrial estate as it has the infrastructural and the labour pool to support a major industrial development.

(c) relocation of all principal State and Federal government office to Alor Setar should be considered. This will enhance the role of Alor Setar, strengthen its role as a regional center, and facilities interdepartmental contacts.

(d) haphazard development of housing schemes should be prevented.

(e) low cost housing projects should be initiated.

(f) urban drainage and sanitation should be 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 it. 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 be provided with adequate sewage disposal with septic tank as the minimum provision.

SCALE
1 : 60,000

0 1.0 2.0 KILOMETER

0 1.0 2.0 MILE

LEGEND

Boundary of Study Area

Contour line in feet

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

TOPOGRAPHICAL MAP

FIGURE 3 · 3

SCALE
1 : 30,000

0 0.5 1.0 KILOMETER

0 0.5 1.0 MILE

LEGEND

- Boundary of Study Area
- Commercial Area
- Residential Area
- Industrial Area
- Schools
- Open Space, Vacant Land and Public Land
- Mosques, Temples, etc
- Agricultural Area

Sungai Kedah

Alor Setar Station

Sungai Anak Bukit

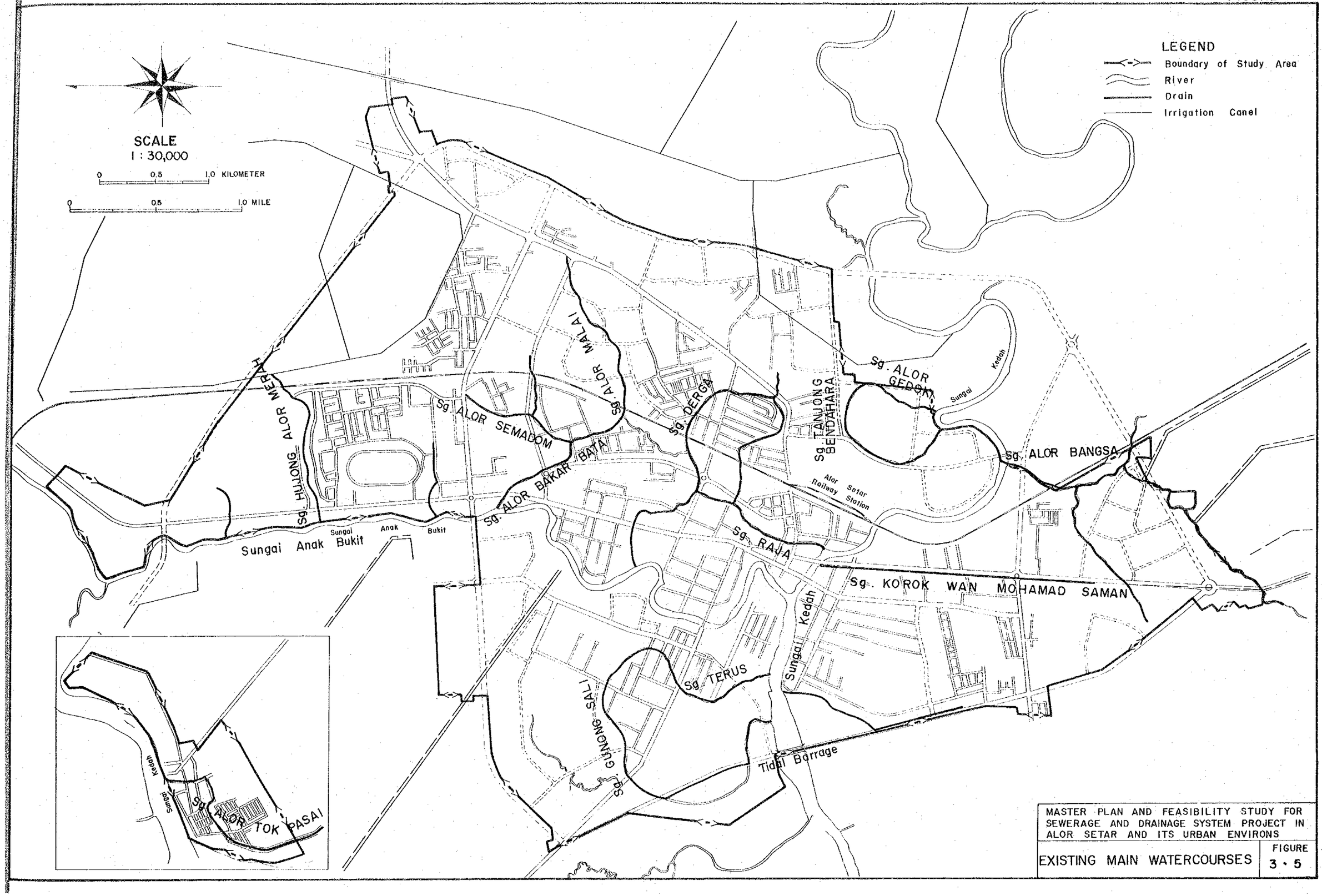
Sungai Kedah

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

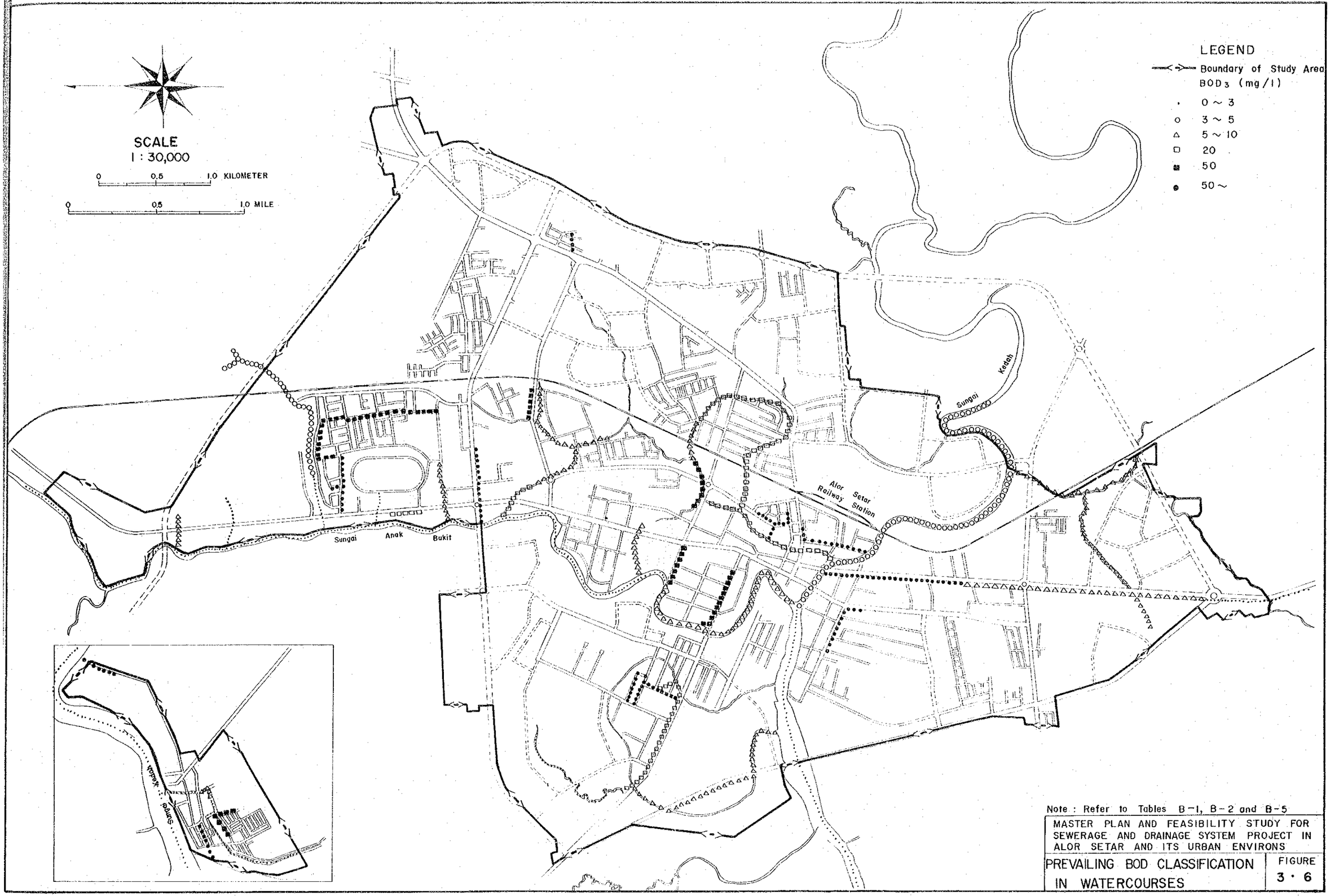
FIGURE 3 · 4



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

EXISTING MAIN WATERCOURSES

FIGURE 3 · 5



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 · 6

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 Mergong Industrial Area (46 ha). The Study Area also includes 125 ha (309 acres) of Kuala Kedah area.

2. DESIGN PERIOD AND PHASED CONSTRUCTION PROGRAMME

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

A phased construction programme is made up to the year 2000 with four phases. Each phase consists of five years considering time needed for detailed design, preparation and evaluation of tender documents and construction work. Therefore, the construction phasing in this report is set out as follows:

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

3. FUTURE LAND USE PLAN

On the basis of the existing land uses of the Study Area as shown in Table 3.2 and Figure 3.4 in Section 4.1, Chapter 3, a 2000-year land use plan is made in consultation with STCP as shown in Table 4.1 and Figure 4.2.

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

Table 4.1 Land Use Plan in the Year 2000

Land Use	Residential Area	Commercial Area	Institutional Area	Industrial Area	Open Space, Vacant Land, Public Land	School	Mosque, Temple	River, Railway	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 89 percent of land in the Study Area will be occupied by three land uses, namely residential, commercial and industrial areas.

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, and
(4) establishing new institutional areas

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", "Preliminary Study for Sewerage Project in Alor Setar and its Urban Environs" and "Urban Sewerage Survey" as incorporated in Appendix C.

Table 4.2 Population Projection in the Study Area up to the 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% increase to the population of 139,600 in 1979, which is arrived at by using assumed rate of 3.5% between 1970 - 1975 and 4% between 1976 - 1979 (Ref. Appendix C).

4.2 Future Population Distribution

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

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, where housing development schemes are assumed to be implemented by developers in the future.

The 120 persons per ha in Residential Area A is considered reasonable as the existing 117 persons per ha over several typical areas is in fact almost under saturated condition, and the 70 persons per ha is supported by the finding that the population density in the existing housing development areas is almost on that level in case of typical housing development scheme of 10 to 15 ha. Similarly, the 2000-year population densities in Commercial and Industrial Area A (the North Mergong Industrial Area) are assumed to be 200 and 100 persons per ha (or 80 and 40 persons per acre) respectively on the basis of the present population densities of 163 and 21 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.

Table 4.3 Population Distribution by Land Use in the Year 1979 and 2000

Land Use	Area (ha)	Population Density(**) (Persons/ha)	Population
Residential Area		(53.5)	(99,700)
A	1,863.6	120	223,632
		(7.3)	(4,150)
B	566.0	70	39,620
			(3,650)
C(*)	91.4		5,648
Sub-total	2,521.0	-	(107,500) 268,900
Commercial Area	174.0	(162.6) 200	(28,300) 34,800
Institutional Area	32.0	(0) 0	(0) 0
Industrial Area		(20.5)	(3,000)
A (North Mergong)	146.0	100	14,600
B (South Mergong, Kuala Kedah)	61.0	0	(***800) 0
Sub-total	207.0	-	(3,800) 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	(42.3) 96.5	(139,600) 318,300

Note (1): (*) Includes such places as Sultan's Palace, Kedah Club, low cost houses, housing area in North Mergong Estate, apartment houses near Chinese Temple at Tongkang Yard, and Police Quarters.

(**) Population density is calculated based on gross area.

(***) The present 800 population is supposed to migrate in the Study Area.

Note (2): Figures shown in the parentheses of both Population Density and Population colums indicate for the 1979 condition.

5. SEWERAGE SYSTEM

5.1 Collection System

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

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

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

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

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

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

(2) Adoption of Alternative (III) 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 preserved and fully used for collecting rainfall runoff exclusively and diverting sanitary wastewater into the newly built sanitary sewerage system. In addition, 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 been polluted by domestic and industrial wastes which requires immediate proper treatment in order to alleviate the existing and further deterioration.

As estimated in Tables D-17 and D-18 in Appendix D, the present (1979) water qualities generated in the Study Area would range from 34 to 163 mg/l of BOD if all wastewater were discharged without any treatment. They would be further deteriorated by the passage of year, reaching to a municipal sewage ranging from 106 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, effluent criteria are provisionally 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 according 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 Treatment Facilities

Parameter	Unit	Value	Remarks
BOD	mg/l	50	3 days at 30°C
Coliforms	N/ml	1,000	-

Based on the tentatively recommended treated effluent quality of 50 mg/l in terms of BOD in Table 4.4 and estimated 2000-year BOD values of 106 to 175 mg/l (excluding Sewerage Zone E, where pre-treatment will be necessary) for sewerage sub-zones as estimated in Table 5.9, degrees of BOD to be removed by treatment facilities are estimated to vary from 53% (106-50/106) to 71% (175-50/175) for which either stabilization pond, aerated lagoon or oxidation ditch system can be sufficient as the most economical system on the basis of comparative study as discussed in the following section.

The water qualities of the major watercourses of the Sg. 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 2000, further degrading from the present BOD values of 14 - 17 mg/l in dry season (Refer to Appendix L for detail).